Additional Opportunities for Energy Efficiency in New Hampshire

Final Report – January 2009

Prepared for the

New Hampshire Public Utilities Commission

Prepared and Submitted by:

GDS Associates, Inc.
Engineers and Consultants

In partnership with

RLW Analytics and Research Into Action

With Telephone Survey Support Provided by

RKM Research and Communication

GDS Associates, Inc. • 1181 Elm Street • Suite 205 • Manchester, NH 03101 • www.gdsassociates.com
Marietta, GA • Austin, TX • Auburn, AL • Manchester, NH • Madison, WI • Indianapolis, IN • Augusta, ME

ACKNOWLEDGEMENTS

This report was prepared for the New Hampshire Public Utilities Commission (NHPUC) by GDS Associates, Inc. with substantial data collection and analysis assistance provided by RLW Analytics, Research Into Action, and RKM Research and Communications (collectively, the GDS Team). The GDS Team would like to acknowledge the many helpful data sources and the technical input provided by the NHPUC, the New Hampshire electric and gas utility sponsors and the Office of the Consumer Advocate. GDS would like to give special recognition to Tom Frantz, Anne Ross and Commissioner Clifton Below all of the NHPUC, and Gil Gelineau and Tom Belair (PSNH), Derek Buchler (Northern Utilities), Lisa Glover (Unitil), David Jacobson (National Grid), Carol Woods (NHEC), Stephen Eckberg (NH OCA), and Tom Rooney and Eric Readdy of TRC Companies, Inc., all of whom were instrumental in providing insights and information and reviewing detailed plans, data collection instruments and inputs and results from analyses developed by the GDS Team including electric and gas load forecasts, energy efficiency measures, costs, energy savings, useful lives, saturation levels and remaining potential estimates.

This report provides valuable and up-to-date electric and natural gas (and associated propane and oil) energy efficiency potential savings information for New Hampshire's regulators and utility decision-makers. It will also be useful to electric and gas energy efficiency program designers and implementers and for others who may need a template for their own energy efficiency potential studies. This report includes a thorough and up-to-date assessment of the impacts that energy efficiency measures and programs can have on electricity and gas, propane and oil use in New Hampshire. Clearly there remains a significant amount of cost effective energy savings potential to be tapped within the state.

NOTICE

Scott M. Albert, Principal & Northeast Region Manager
GDS Associates, Inc., January 2009

Table of Contents

Page Number

List of Appendices

List of Tables

Page Number

List of Figures

Section 1: Executive Summary

This study presents results from an evaluation of additional opportunities for energy efficiency in New Hampshire. Estimates of technical potential, maximum achievable potential, and maximum achievable cost effective potential by the year 2018 (a 10-year period) are provided for electricity, natural gas and related propane and fuel oil savings at the state level and for each of the four New Hampshire retail electricity providers and two natural gas distribution companies. Results from a potentially obtainable savings scenario are also presented to estimate that portion of the cost effective potential that might be achievable after consideration of customer behavior. Finally, estimates are presented of the installed costs required to achieve resulting savings for each scenario (excluding costs for marketing, program design and administration)

All results were developed using customized residential, commercial and industrial sector-level energy efficiency potential assessment models and New Hampshire Public Utilities Commission (NHPUC)-specified cost-effectiveness criteria[1] including the region's most recent avoided energy cost projections.[2] To help inform these models, actual electric and gas utility customer information was collected through a combination of telephone surveys with residential and small commercial/industrial customers and site visits at larger commercial and industrial facilities. Work was conducted by GDS Associates, Inc. with important input and assistance provided by RLW Analytics, Research Into Action and RKM Research and Communications (the GDS Team).

Technical potential studies need to be understood and viewed as a highly theoretical construct/tool – therefore, the data used for this report was based on the best data available at the time the models were run – when better data was identified, it was used where possible, but given the demands and limits of time for this project, it is possible that some sources were overlooked.

1.1 Study Scope

The objective of this study was to evaluate additional opportunities for energy efficiency in New Hampshire to provide insights for continued electric and gas utility program filings and implementation plans and to inform expanded planning for energy efficiency programs that may rise from New Hampshire's participation in the Regional Greenhouse Gas Initiative and the recommendations of the NH Climate Change Policy Task Force. Following is a listing and a brief overview of the approach undertaken to complete each of the major tasks required for this study effort:

[1] The NHPUC's total resource cost effectiveness test (TRC) derives from the 7/6/99 report from the NH Energy Efficiency Working Group (pp. 14-18) in DR 96-150, available at: www.puc.nh.gov/Electric/96-150%20%20NH%20Energy%20Efficiency%20Working%20Group%20Final%20Report%20(1999).pdf, and was modified by Attachment C of the 2008 Core Energy Efficiency filing approved by Order No. 24,815 in DE 07-106 that provided that "[t]he use of the 15% adder to represent environmental and other benefits as recommended by the [NHEEWG] ...was discontinued because the 2007 AESC avoided costs include market-based price proxies for power plant emission of NOx, SO2, Mercury and CO2."

[2] *Avoided Energy Supply Costs in New England: 2007 Final Report*, August 10, 2007, prepared by Synapse Energy Economics, Inc., available at: www.synapse-energy.com/Downloads/SynapseReport.2007-08.AESC.Avoided-Energy-Supply-Costs-2007.07-019.pdf.

Analyze current saturations of energy using equipment and penetrations of energy efficiency equipment and practices in each end-use category. This task was completed through analysis of a combination of primary and secondary data sources including carefully designed questions and a statistically valid sample of telephone surveys and site visits.

Produce an up-to-date list of currently available and soon to be commercially available technologies which may play a part in future efficiency programs – This task was based initially on existing GDS databases of sector-specific electricity and natural gas end-use technologies and efficiency measures. It was extensively supplemented to include other technology areas of interest to the New Hampshire Public Utilities Commission, the New Hampshire Office of the Consumer Advocate, and the four electric and two natural gas utilities supporting this project.

Estimate customer participation rates/levels by program, based on different payback/incentive levels and define/analyze significant barriers that customers face when investing in additional energy efficiency – This task was based on results from the GDS Team's phone surveys and site visits. Where insufficient customer-specific data was available, these estimates were informed through the project sponsors' and Team's combined existing and extensive knowledge of not only NH's current electric/gas utility programs, but also best practices and barriers associated with programs being implemented elsewhere in the region and throughout the country.

Develop, by sector, a simplified end-use model of state electricity and natural gas consumption and peak demand – This task was completed using data provided directly by each participating New Hampshire electric and gas utility. Results were assessed against forecasts published through the New England Power Pool (NEPOOL) and ISO-New England, Inc. to ensure reasonableness.

Estimate, state-wide and for each of the four New Hampshire retail electricity providers and two natural gas distribution companies, the technical, maximum achievable, maximum achievable cost effective potential, and a potentially obtainable scenario, for electricity, natural gas and related propane and fuel oil savings over the next 10-year period, and the budgets (where appropriate) required to achieve that potential – These activities were based on the GDS Team's existing sector-level supply curve and potential analysis models, NHPUC cost-effectiveness criteria/methodologies and associated up-to-date assumptions[3] including the region's current avoided energy cost projections, elements of which were already in hand. Wherever possible, these models were customized based on state utility-specific data and the saturation and penetration survey results obtained through this project's primary data collection (telephone survey and site visit) activities. All results were analyzed and compared for reasonableness against overall state consumption and consideration of past New Hampshire utility energy efficiency program participation.

[3] The measure specific savings values used to develop the following estimates of technical potential vary considerably in the level of certainty. Some measures. such as commercial lighting. have a long history of implementation and have fairly well documented costs and savings while some measures which also show large potential, such as retro-commissioning, have had little large scale implementation to date and estimates of their savings and cost effectiveness are based on a limited number of real world installations. Other high potential measures, such as floating head pressure controls have tended to work well in the short term but are often overridden by on-site maintenance personnel who are not comfortable with running their systems at lower pressures. It is important for anyone using this study to set actual program budget and savings targets to further refine the less certain estimates before starting large scale implementation of such measures.

Evaluate extent to which past and current energy efficiency programs have achieved energy savings to date, provide sensitivity analysis of realized energy savings based on different resource levels (including absence of current SBC-funded model), and recommend modifications to program and measure offerings that would increase the likelihood of achieving identified potential – These activities were based on a combination of factual data comparisons, analysis of survey results associated with end-use customer sector barriers identification, the collective GDS Team's experience with looking at programs from a logic-modeling perspective, and the GDS Team's extensive knowledge of other local, regional and national programs and best practices.[4] Focus of these evaluations and sensitivities were at the statewide level (vs. utility-specific).

More information on each of these items is presented in the methodologies and subsequent sections of this report.

The definitions used in this study for energy efficiency potential estimates are as follows:

- **Technical potential** is defined in this study as the complete and immediate penetration of all measures analyzed in applications where they were deemed technically feasible from an engineering perspective. For the residential sector, two technical potential scenarios were developed: a technical potential (best) scenario, where "best" options are assumed to be installed in situations where "good/better/best" options exist; and a technical potential (traditional) scenario, where "good/better/best" options are allocated for model installation across applicable populations.

- **Maximum Achievable potential** is defined as the maximum penetration of an efficient measure that would be adopted absent consideration of cost or customer behavior. The term "achievable" refers to efficiency measure penetration, based on estimates of New Hampshire-specific building stock, energy using equipment saturations and realistic efficiency penetration levels that can be achieved by 2018 if all remaining standard efficiency equipment were to be replaced on burnout (at the end of its useful measure life) and where all new construction and major renovation activities in the state were done using energy efficient equipment and construction/installation practices. In certain circumstances, where early replacement of specific measures is becoming standard practice, maximum achievable potential includes the retrofit of measures before the end of their useful measure life (i.e., T8 lighting, thermostats, insulation and weatherization of existing homes).

- **Maximum Achievable Cost Effective (M.A.C.E.) potential** is defined as the portion of the maximum achievable potential that is cost effective according to the economic criteria currently used to determine energy efficiency program cost-effectiveness (New Hampshire Public Utility Commission's approved Total Resource Cost Test – NH TRC), before consideration of customer behavior. Application of the TRC test is based on the

[4] Assessments based on a logic-modeling perspective recognize current program resources (dollars, staffing, etc.) and activities (measure installations, promotional rebates/incentives, marketing/outreach, education/training, etc.) and seek to identify their causal links to anticipated outputs (measures installed, in-program energy and capacity savings, # of customers served, market actors trained, etc.), short-, intermediate- and long-term outcomes (changes in awareness and behavior, market-wide/sustainable energy, economic and environmental benefits, etc.). In addition, logic models recognize the existence and potential impacts of external influences (price of energy, state of the local and regional economy, federal tax incentives, other non-program sponsored activities, etc.).

latest values for avoided cost (electric, natural gas and other fuels) and excludes environmental externalities not already captured with avoided cost values, consistent with current utility and PUC procedures.

- **Potentially Obtainable scenario** is a new output developed for this study[5] and can be defined as an estimate of the potential for the realistic penetration over time of energy efficient measures that are cost effective according to the NH TRC, taking customer behavior into consideration (including consideration of priorities and price). To achieve this potential, a concerted, sustained campaign involving aggressive programs and market interventions would be required. As demonstrated later in this report, the State of New Hampshire and its electric and gas utilities would need to continue to undertake, and perhaps aggressively expand its efforts to achieve these levels of savings.

LIMITATIONS TO THE SCOPE OF STUDY As with any assessment of energy efficiency potential, this study necessarily builds on a large number of assumptions, from average measure lives, savings and costs, to the discount rate for determining the net present value of future savings. The RFP for this study also called for a simplifying assumption that new buildings are constructed to meet minimum energy codes, even though that may not actually be the case. While, as noted above, the authors have sought to use the best available data, there are many assumptions where there may be reasonable alternative assumptions that would yield somewhat different results. For example, the "good, better and best" scenarios for housing weatherization and retrofit, while constructed to be reasonable illustrations, are not necessarily typical of many homes because of the wide diversity in size, age, type, and quality of construction, renovation and maintenance of existing homes. Furthermore, while the measures lists are extensive and represent most, if not all, commercially available, and some emerging, energy efficient measures, they are not exhaustive, particularly for peak electric demand reduction measures and potential fuel oil and propane savings, as further noted in footnote 30 of this report. Also, there was no attempt to place a dollar value on some difficult to quantify benefits that may result from some measures, such as increased comfort or reduced maintenance, which may in turn support some personal choices to implement particular measures that may otherwise not be cost-effective or only marginally so.

Thus, the various potential estimates are specific to and limited by the detailed measures lists and assumptions described in this study. As new and improved energy efficiency products and strategies emerge and as regulatory, market, and behavioral barriers are reduced, the potentially obtainable estimate of energy efficiency might reasonably be expected to increase. In any case, we have provided here one well informed reasonable scenario of potentially obtainable increases in cost-effective energy efficiency for New Hampshire. Others are plausible. With this report we are providing the PUC with a complete copy of the spreadsheet model with all the measures and assumptions to facilitate further analysis by them, including revisions and updates to the assumptions and measures list.
The main outputs of this study are summary data tables and figures identifying the potential for additional energy efficiency opportunities in New Hampshire over the ten-year period, 2009 through 2018. Wherever possible, this study makes use of actual New Hampshire residential,

[5] There has been a recent trend to temper estimates of cost-effective potential by taking into consideration behavioral, market, regulatory, financing and/or political barriers. A just released study by the Electric Power Research Institute used a similar concept that they called the "Realistically Achievable Potential (RAP)." See: *Assessment of Achievable Potential from Energy Efficiency and Demand Response Programs in the U.S.: (2010–2030)*, EPRI, Palo Alto, CA: 2009. 1016987, p. xiv. See also National Action Plan for Energy Efficiency (2007), *Guide for Conducting Energy Efficiency Potential Studies*, prepared by Philip Mosenthal and Jeffrey Loiter, Optimal Energy, Inc., www.epa.gov/eeactionplan, p. 2-4.

commercial and industrial customer data collected through phone surveys and site visits. Given the magnitude of efficiency measures included for consideration in this study, in cases where New Hampshire customer-specific information was not available, data on measure savings, costs and penetration rates were compiled through a combination of secondary research (including reviews of other previous relevant studies), utility-provided data, manufacturer specifications, and direct calculation through energy calculators and building simulation modeling. Collectively, these data sources provided an important and extensive foundation for estimates of electric energy, natural gas and related oil and propane savings potential by measure type, end-use and customer sector.

1.2 Results Overview

Energy-efficiency opportunities typically are physical, long-lasting changes to buildings and equipment that result in decreased energy use while maintaining the same or improved levels of energy service. This study shows that there is still significant savings potential in New Hampshire for cost effective electric and natural gas energy-efficiency measures and practices (and associated oil and propane savings).

As shown in Table 1, the Technical potential savings (all sectors combined) for electric energy efficiency measures in New Hampshire is over 27 percent of projected 2018 kWh sales in the State, and similarly over 27 percent for non-electric (natural gas, oil and propane) efficiency measures. The Maximum Achievable Cost Effective potential (before consideration of customer behavior) is over 20 percent (nearly 2,700 gWh annually) of projected 2018 kWh sales (over 15 percent summer peak demand reduction), and over 16 percent of projected 2018 non-electric sales (more than 15,440,000 MMBTu).[6] It is important to note, in the industrial sector, that the Maximum Achievable and Maximum Achievable Cost Effective potentials are the same. As explained in more detail in Section 6 of this report, this is because all end uses assessed in the industrial sector were screened as cost effective during the modeling process. The Potentially Obtainable scenario (including consideration of customer behavior) shows savings from electric and non-electric efficiency measures of approximately nearly 11 percent of 2018 kWh sales and approximately eight percent of projected 2018 non-electric (natural gas, oil and propane) sales. The Potentially Obtainable electric savings is equal to approximately 78 percent of the projected growth in electricity consumption over the next decade.

Estimates of the associated potential reductions in CO_2 emissions are also shown in Table 1, along with estimated costs that would be required to achieve these potentials. Depending on the scenario considered, these emission reductions and costs to achieve can be quite substantial (i.e., over three million tons at nearly seven billion dollars, based on the combined electric and non-electric Technical potential scenarios; or more than one million tons and nearly nine hundred million dollars based on the Potentially Obtainable scenarios).[7] In developing these estimates, savings opportunities from market driven (replace on burnout and new construction) and retrofit (early retirement) energy efficiency program strategies were considered, where applicable.

The potential savings estimates, and costs to achieve those savings, are shown separately for electric, non-electric, and natural gas (a subset of non-electric) efficiency measures in Table 2,

[6] Based on cost-effectiveness screening using the NH PUC- approved Total Resource Cost Test methodology as specified and described in Footnote 1, excluding environmental externalities not already captured within avoided cost values, consistent with current utility and NHPUC procedures.

[7] This is equivalent to removing over 509,000 cars from New Hampshire's highways under the Technical Potential scenarios, or 178,000 cars under the Potentially Obtainable scenario.

Table 3, and Table 4 respectively. As shown in these tables, more electric savings can be obtained within the residential sector than in the commercial or industrial sectors. However, the cost to achieve that savings is substantially lower in the commercial and industrial sectors and highest in the residential sector. This implies that programs targeting the commercial and industrial sectors will yield the greatest electric energy savings per dollar spent, while substantial savings can also be obtained within the residential sector, but at nearly twice the cost per kWh saved. For instance, as shown in Table 2 under the commercial sector potentially obtainable scenario, 492 million kWh of annual savings is estimated by the year 2018 at an installed cost of just under $125 million (approximately 26 cents per kWh saved). In comparison, the residential sector yields approximately 698 million kWh of annual savings of estimated potential by the year 2018 at an installed cost of $383 million (55 cents/kWh saved). Similarly in the non-electric sectors, although there is more savings potential within the residential sector, the cost to achieve that savings is substantially greater than that required to save energy in the non-electric commercial and industrial sectors. For instance, per Table 3 under the commercial sector potentially obtainable scenario, nearly 3.3 million MMBTu of annual non-electric energy savings is estimated by the year 2018 at an installed cost of just over $102 million ($31/MMBTu). In comparison, approximately 3.6 million MMBTu of annual savings potential is estimated in the residential sector by the year 2018 at an installed cost of over $200 million. ($56/MMBTu).

Table 1. Summary of Energy Savings Potentials by 2018 – Combined Electric and Non-Electric Measures

	Estimated Annual Electric Savings by 2018 (MWh)	Savings in 2018 as % of Sector 2018 Electric Consumption	Estimated Annual Demand Savings by 2018 By Sector (MW)	Estimated Savings as % of Peak Sector Demand by 2018	Estimated Annual Non-Electric Savings by 2018 (MMBtu)	Savings in 2018 as % of Sector 2018 Non-Electric Fuel Consumption	Total Estimated Costs to Achieve 2018 Annual Savings ($2008 NPV)	Total Estimated CO2 Reductions (tons)*	Total Estimated Annual Benefits Associated W/Combined Savings in 2018 ($2008 NPV)	Simple Payback (NPV Total Costs / NPV Annual Savings)
RESIDENTIAL SECTOR										
Technical Potential (Best Only)	1,770,861	31.7%	66.7	5.5%	16,918,392	50.0%	$ 5,774,815,282	1,868,111	$ 537,038,623	10.8
Technical Potential (Traditional)	1,489,861	26.7%	56.1	4.7%	12,099,639	35.8%	$ 4,426,572,142	1,422,161	$ 431,607,466	10.3
Max. Achievable Potential	1,217,145	21.8%	45.9	3.8%	7,463,743	22.1%	$ 2,421,842,542	992,217	$ 329,670,655	7.3
Max. Achievable Cost Effective	1,170,398	20.9%	44.1	3.7%	6,313,954	18.7%	$ 1,088,457,430	893,638	$ 308,833,633	3.5
Potentially Obtainable	698,069	12.5%	26.3	2.2%	3,633,554	10.7%	$ 583,533,793	523,728	$ 182,946,598	3.2
COMMERCIAL SECTOR										
Technical Potential (Traditional)	1,598,032	29.8%	476.9	37.3%	11,981,017	26.4%	$ 2,193,294,132	1,455,559	$ 256,276,208	8.6
Max. Achievable Potential	1,298,063	24.2%	385.9	30.2%	10,075,678	22.2%	$ 1,887,366,888	1,206,409	$ 211,424,997	8.9
Max. Achievable Cost Effective	1,066,772	19.9%	317.1	24.8%	7,710,337	17.0%	$ 636,534,346	951,512	$ 168,353,689	3.8
Potentially Obtainable	492,023	9.2%	146.3	11.4%	3,252,204	7.2%	$ 227,057,997	417,563	$ 74,769,619	3.0
INDUSTRIAL SECTOR										
Technical Potential (Traditional)	515,486	24.5%	109.7	22.0%	1,755,089	11.2%	$ 153,382,708	321,722	$ 60,659,145	2.5
Max. Achievable Potential	442,671	21.1%	94.2	18.9%	1,415,809	9.0%	$ 130,703,312	269,877	$ 51,327,675	2.5
Max. Achievable Cost Effective	442,671	21.1%	94.2	18.9%	1,415,809	9.0%	$ 130,703,312	269,877	$ 51,327,675	2.5
Potentially Obtainable	213,810	10.2%	81.9	16.5%	683,836	4.4%	$ 63,129,699	130,350	$ 24,791,267	2.5
ALL SECTORS COMBINED										
Technical Potential (Traditional)	**3,603,379**	**27.6%**	**642.7**	**21.6%**	**25,835,745**	**27.2%**	**$ 6,773,248,982**	**3,199,443**	**$ 748,542,819**	**9.0**
Max. Achievable Potential	**2,957,879**	**22.7%**	**525.9**	**17.6%**	**18,955,230**	**20.0%**	**$ 4,439,912,741**	**2,468,502**	**$ 592,423,327**	**7.5**
Max. Achievable Cost Effective	**2,679,841**	**20.5%**	**455.3**	**15.3%**	**15,440,100**	**16.3%**	**$ 1,855,695,087**	**2,115,027**	**$ 528,514,996**	**3.5**
Potentially Obtainable	**1,403,902**	**10.8%**	**254.5**	**8.5%**	**7,569,594**	**8.0%**	**$ 873,721,489**	**1,071,642**	**$ 282,507,484**	**3.1**

*The average vehicle in the United States produces around 12,100 lbs of carbon dioxide per year. This means that realizing the full Technical Potential calculated here would be the carbon equivalent of taking over 509,000 cars off the road. Realizing the Potentially Obtainable figure would be the equivalent of removing 178,000 cars.

Table 2. Summary of Energy Savings Potentials by 2018 – Electric[8]

	Estimated Annual Sales by 2018 (kWh)	Estimated Annual Savings by 2018 (kWh)	Savings in 2018 as % of Sector 2018 Electric Consumption	Savings in 2018 as % of Total 2018 Electric Consumption	Estimated Annual Sales by 2018 (MW)	Estimated Annual Demand Savings by 2018 By Sector (MW)	Estimated Savings as % of Peak Sector Demand by 2018	Estimated Savings as % of Total Peak Demand by 2018	Estimated Costs to Achieve 2018 Annual Savings (10 Year Cumulative) ($2008 NPV)	Total Estimated Annual Benefits Associated W/Combined Savings in 2018 ($2008 NPV)	Simple Payback (NPV Total Costs / NPV Annual Savings)
RESIDENTIAL SECTOR											
Technical Potential (Best Only)	5,589,807,380	1,770,860,535	31.7%	13.6%	1206	66.7	5.5%	2.2%	$2,554,517,348	$ 376,791,837	6.8
Technical Potential (Traditional)		1,489,861,317	26.7%	11.4%		56.1	4.7%	1.9%	$2,149,167,880	$ 317,002,707	6.8
Max. Achievable Potential		1,217,144,947	21.8%	9.3%		45.9	3.8%	1.5%	$1,214,926,125	$ 258,975,945	4.7
Max. Achievable Cost Effective		1,170,397,964	20.9%	9.0%		44.1	3.7%	1.5%	$632,287,942	$ 249,029,435	2.5
Potentially Obtainable		698,069,156	12.5%	5.4%		26.3	2.2%	0.9%	$383,050,068	$ 148,530,477	2.6
COMMERCIAL SECTOR											
Technical Potential (Traditional)	5,353,798,946	1,598,032,244	29.8%	12.2%	1279	476.9	37.3%	16.0%	$971,216,931	$ 142,795,006	6.8
Max. Achievable Potential		1,298,062,604	24.2%	9.9%		385.9	30.2%	12.9%	$850,883,854	$ 115,990,687	7.3
Max. Achievable Cost Effective		1,066,771,952	19.9%	8.2%		317.1	24.8%	10.6%	$311,837,064	$ 95,323,300	3.3
Potentially Obtainable		492,022,609	9.2%	3.8%		146.3	11.4%	4.9%	$124,823,769	$ 43,965,553	2.8
INDUSTRIAL SECTOR											
Technical Potential (Traditional)	2,102,729,959	515,485,621	24.5%	4.0%	498	109.7	22.0%	3.7%	$133,914,929	$ 46,000,232	2.9
Max. Achievable Potential		442,671,155	21.1%	3.4%		94.2	18.9%	3.2%	$114,998,894	$ 39,502,510	2.9
Max. Achievable Cost Effective		442,671,155	21.1%	3.4%		94.2	18.9%	3.2%	$114,998,894	$ 39,502,510	2.9
Potentially Obtainable		213,810,168	10.2%	1.6%		81.9	16.5%	2.7%	$55,544,466	$ 19,079,712	2.9
ALL SECTORS COMBINED											
Technical Potential (Traditional)	**13,046,336,285**	**3,603,379,183**	**27.6%**	**27.6%**	**2982**	**642.7**	**21.6%**	**21.6%**	**$3,254,299,740**	**$505,797,945**	**6.4**
Max. Achievable Potential		**2,957,878,706**	**22.7%**	**22.7%**		**525.9**	**17.6%**	**17.6%**	**$2,180,808,873**	**$414,469,142**	**5.3**
Max. Achievable Cost Effective		**2,679,841,071**	**20.5%**	**20.5%**		**455.3**	**15.3%**	**15.3%**	**$1,059,123,900**	**$383,855,246**	**2.8**
Potentially Obtainable		**1,403,901,933**	**10.8%**	**10.8%**		**254.5**	**8.5%**	**8.5%**	**$563,418,303**	**$211,575,742**	**2.7**

Total Estimated CO2 Reductions (tons)	
Technical Potential (Traditional)	**1,389,391**
Max. Achievable Potential	**1,140,499**
Max. Achievable Cost Effective	**1,033,293**
Potentially Obtainable	**541,317**

0.322575231

Total NH 2018 Peak Demand	2982 MW

[8] For purposes of this study, a simplifying assumption was used to estimate peak demand savings. Percentage sector peak demand savings are calculated to show savings over the summer coincident peak demand period only and are not broken out separately for summer and winder peak periods.

Table 3. Summary of Energy Savings Potentials by 2018 – Non-Electric

	Estimated Annual Sales by 2018 (MMBtu)	Estimated Annual Savings by 2018 (MMBtu)	Savings in 2018 as % of Sector 2018 Non-Electric Fuel Consumption	Savings in 2018 as % of Total 2018 Non-Electric Fuel Consumption	Estimated Costs to Achieve 2018 Annual Savings (10 Year Cumulative) ($2008 NPV)	Total Estimated Annual Benefits Associated W/Combined Savings in 2018 ($2008 NPV)	Simple Payback (NPV Total Costs / NPV Annual Savings)
RESIDENTIAL SECTOR							
Technical Potential (Best Only)	33,838,195	16,918,392	50.0%	17.8%	$ 3,220,297,934	$ 160,246,785	20.1
Technical Potential (Traditional)		12,099,639	35.8%	12.8%	$ 2,277,404,262	$ 114,604,759	19.9
Max. Achievable Potential		7,463,743	22.1%	7.9%	$ 1,206,916,417	$ 70,694,710	17.1
Max. Achievable Cost Effective		6,313,954	18.7%	6.7%	$ 456,169,489	$ 59,804,197	7.6
Potentially Obtainable		3,633,554	10.7%	3.8%	$ 200,483,725	$ 34,416,121	5.8
COMMERCIAL SECTOR							
Technical Potential (Traditional)	45,329,915	11,981,017	26.4%	12.6%	$ 1,222,077,201	$ 113,481,202	10.8
Max. Achievable Potential		10,075,678	22.2%	10.6%	$ 1,036,483,035	$ 95,434,310	10.9
Max. Achievable Cost Effective		7,710,337	17.0%	8.1%	$ 324,697,281	$ 73,030,388	4.4
Potentially Obtainable		3,252,204	7.2%	3.4%	$ 102,234,228	$ 30,804,066	3.3
INDUSTRIAL SECTOR							
Technical Potential (Traditional)	15,673,818	1,755,089	11.2%	1.9%	$ 19,467,779	$ 16,623,765	1.2
Max. Achievable Potential		1,415,809	9.0%	1.5%	$ 15,704,417	$ 13,410,187	1.2
Max. Achievable Cost Effective		1,415,809	9.0%	1.5%	$ 15,704,417	$ 13,410,187	1.2
Potentially Obtainable		683,836	4.4%	0.7%	$ 7,585,234	$ 6,477,120	1.2
ALL SECTORS COMBINED							
Technical Potential (Traditional)	**94,841,928**	**25,835,745**	**27.2%**	**27.2%**	**$ 3,518,949,242**	**$ 244,709,726**	**14.4**
Max. Achievable Potential		**18,955,230**	**20.0%**	**20.0%**	**$ 2,259,103,869**	**$ 179,539,207**	**12.6**
Max. Achievable Cost Effective		**15,440,100**	**16.3%**	**16.3%**	**$ 796,571,187**	**$ 146,244,773**	**5.4**
Potentially Obtainable		**7,569,594**	**8.0%**	**8.0%**	**$ 310,303,186**	**$ 71,697,307**	**4.3**

Total Estimated CO2 Reductions (tons)	
Technical Potential (Traditional)	**1,679,847**
Max. Achievable Potential	**1,239,514**
Max. Achievable Cost Effective	**1,005,418**
Potentially Obtainable	**536,933**

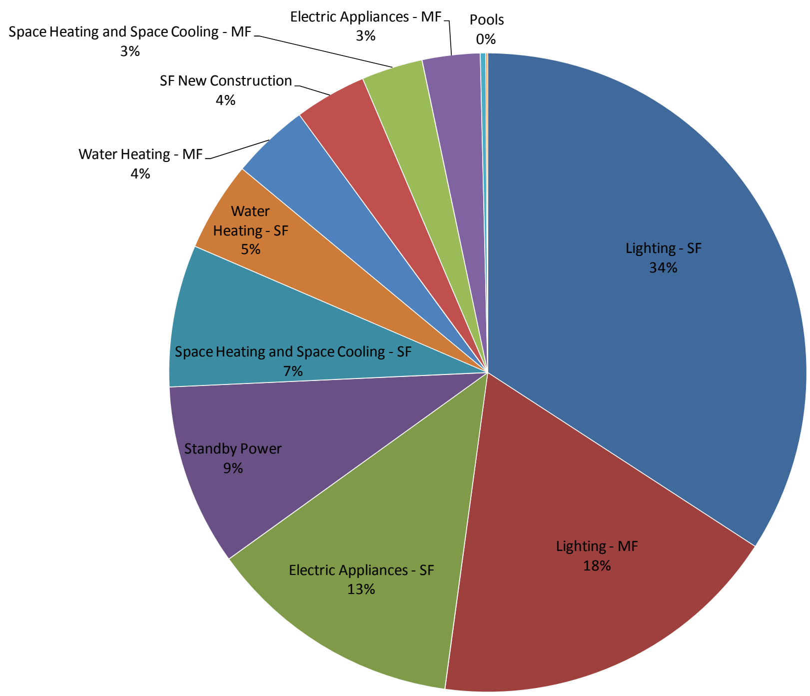
Table 4. Summary of Energy Savings Potentials by 2018 – Natural Gas

	Estimated Annual Sales by 2018 (MMBtu)	Estimated Annual Savings by 2018 (MMBtu)	Savings in 2018 as % of Sector 2018 Non-Electric Fuel Consumption	Savings in 2018 as % of Total 2018 Non-Electric Fuel Consumption	Estimated Cumulative Costs to Achieve 2018 Annual Savings (10 Year Cumulative) ($2008 NPV)	Total Estimated Annual Benefits Associated W/Combined Savings in 2018 ($2008 NPV)	Simple Payback (NPV Total Costs / NPV Annual Savings)
RESIDENTIAL SECTOR							
Technical Potential (Best Only)	8,189,374	5,250,770	64.1%	19.8%	$1,122,335,585	$ 55,849,078	20.1
Technical Potential (Traditional)		3,776,852	46.1%	14.2%	$807,290,166	$ 40,624,889	19.9
Max. Achievable Potential		2,262,674	27.6%	8.5%	$426,300,163	$ 24,970,384	17.1
Max. Achievable Cost Effective		1,807,030	22.1%	6.8%	$117,928,736	$ 15,460,555	7.6
Potentially Obtainable		1,057,239	12.9%	4.0%	$54,192,333	$ 9,302,949	5.8
COMMERCIAL SECTOR							
Technical Potential (Traditional)	12,665,712	3,347,637	26.4%	12.6%	$304,022,371	$ 28,231,297	10.8
Max. Achievable Potential		2,815,263	22.2%	10.6%	$261,039,375	$ 24,035,234	10.9
Max. Achievable Cost Effective		2,154,359	17.0%	8.1%	$88,161,415	$ 19,829,123	4.4
Potentially Obtainable		908,704	7.2%	3.4%	$27,607,959	$ 8,318,519	3.3
INDUSTRIAL SECTOR							
Technical Potential (Traditional)	5,699,570	638,214	11.2%	2.4%	$7,079,192	$ 6,045,006	1.2
Max. Achievable Potential		514,840	9.0%	1.9%	$5,710,697	$ 4,876,432	1.2
Max. Achievable Cost Effective		514,840	9.0%	1.9%	$5,710,697	$ 4,876,432	1.2
Potentially Obtainable		248,667	4.4%	0.9%	$2,758,267	$ 2,355,316	1.2
ALL SECTORS COMBINED							
Technical Potential (Traditional)	**26,554,656**	**7,762,703**	**29.2%**	**29.2%**	**$1,118,391,730**	**$ 77,773,595**	**14.4**
Max. Achievable Potential		**5,592,777**	**21.1%**	**21.1%**	**$693,050,235**	**$ 55,079,225**	**12.6**
Max. Achievable Cost Effective		**4,476,228**	**16.9%**	**16.9%**	**$211,800,848**	**$ 38,885,121**	**5.4**
Potentially Obtainable		**2,214,611**	**8.3%**	**8.3%**	**$84,558,558**	**$ 19,537,733**	**4.3**

Total Estimated CO2 Reductions (tons)	
Technical Potential (Traditional)	**427,919**
Max. Achievable Potential	**308,302**
Max. Achievable Cost Effective	**246,752**
Potentially Obtainable	**133,064**

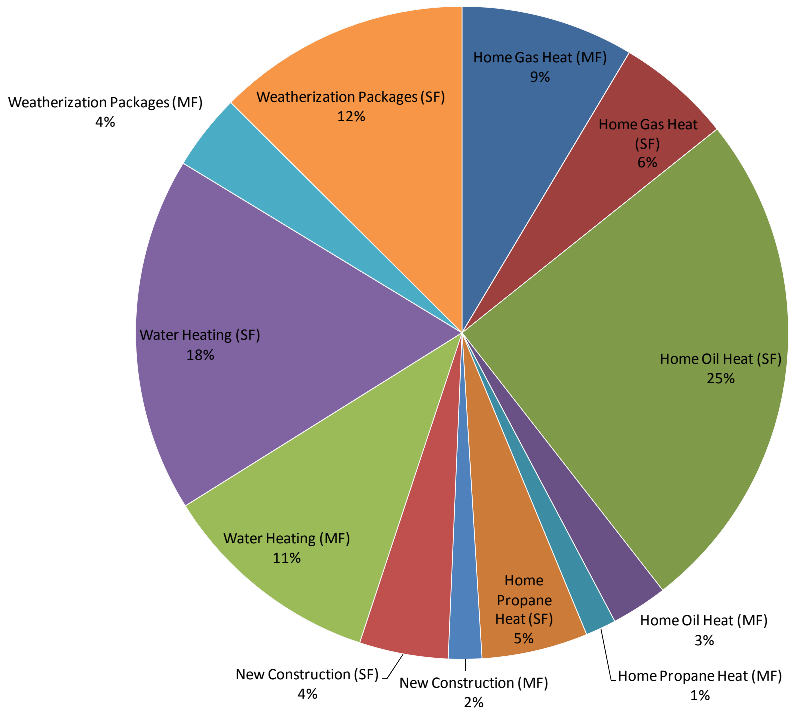
As shown in Figure 1, in the residential sector, New Hampshire's greatest areas for electric energy savings from the installation of cost-effective energy efficiency measures come from combined single family (SF) and multifamily lighting[9] (MF) (52% of the annual savings by the year 2018), electric appliances (16% by 2018, combined SF and MF), and space heating and cooling combined SF and MF (10% by 2018) followed by standby (phantom) power (9%) and water heating (9% – 5% SF and 4% MF) and new construction activities (4%). Figure 2 shows the greatest areas for non-electric savings come from space heating (oil-fueled) and water heating (all fuels), nearly 30% each when SF and MF potentials are combined, and weatherization packages (all fuels) in single family homes (16% SF and MF combined). The large potential for savings from oil-fueled space heating measures is not surprising since nearly 60 percent of all homes in New Hampshire heat with oil. The greatest potential for natural gas savings in the residential sector comes from replacement of inefficient gas furnaces and boilers in multifamily and single family homes (nearly 9% and 6% respectively).

Figure 1. Residential Electric Energy Efficiency Maximum Achievable Cost Effective – by End Use



[9] Lighting savings in the residential sector are largely being driven by savings from CFL bulbs and or CFL fixtures in single family and multi-family homes. It is very important to note, that these savings might be overstated for the post-2012 period for two main reasons. First, this study does not take into direct consideration future changes to energy codes as they relate to residential lighting applications, including improved federal efficiency standards for incandescent bulbs (the base technology from which current lighting savings are calculated) that are designated to become effective in 2012. This study was conducted based on the standards and energy savings differentials (e.g., between CFLs and incandescent bulbs) in existence as of 2009. Secondly, although this study includes emerging lighting technologies (i.e., LEDs), there is a high likelihood that as these new and emerging lighting technologies enter the market, the penetration of CFLs will be significant and new improved efficiency incandescent light bulbs will also be entering the market. Thus, the incremental savings going from a CFL to a new technology (such as LED or super high efficiency incandescent) will be dramatically lower than the current incremental savings going from standard incandescent to compact florescent (CFL). This consideration was addressed partially by the assumption that new technologies will always emerge, and savings will always be present as a result – however, it is true, that those savings, as stated previously, will be lower, and as a result, may be somewhat overstated during the second half of the study's 2009 through 2012 forecast horizon.

Figure 2. Residential Non-Electric Efficiency Maximum Achievable Cost Effective – by End Use



Savings within the commercial sector were assessed separately for existing buildings and for potential new construction. As shown in Figure 3 (existing buildings) and Figure 4 (new construction), New Hampshire's greatest areas for electric savings from the installation of cost-effective energy efficiency measures come from lighting and/or lighting controls – i.e., 39% by 2018 from existing buildings, including retrofit of existing lighting systems; and 42% from new construction activities, mainly from lighting design. The next significant area for electric savings is from refrigeration – i.e., 19% by 2018 from existing buildings and 18% from new construction activities. HVAC systems and controls (in existing buildings) and building envelope improvement packages (in new construction) also provide substantial savings.

Figure 3. Max Achievable Cost Effective Electric Savings by End Use for Commercial Existing Buildings

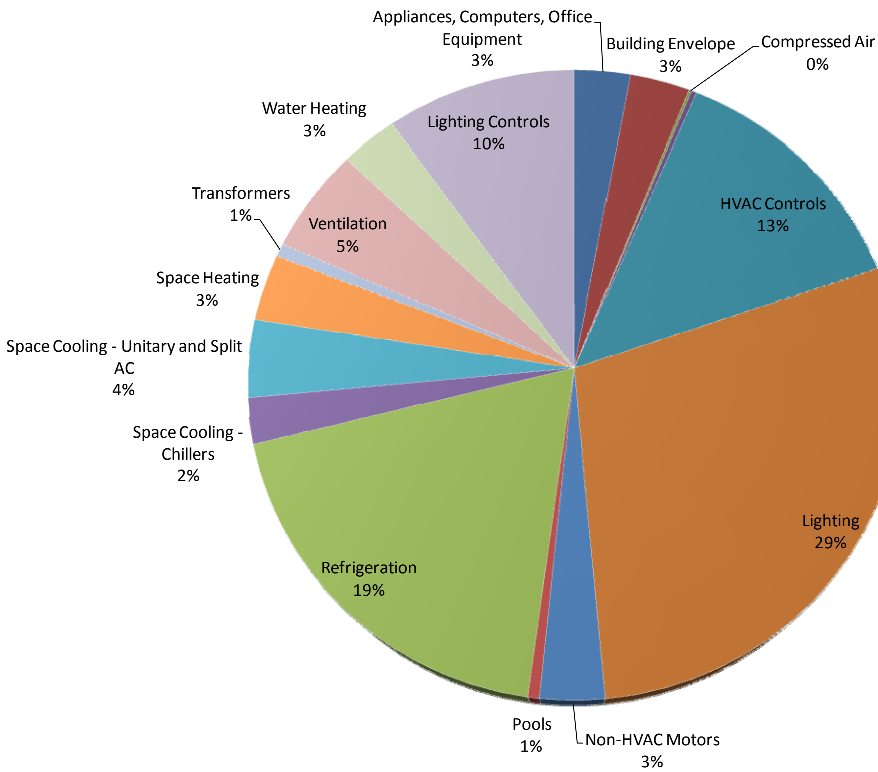
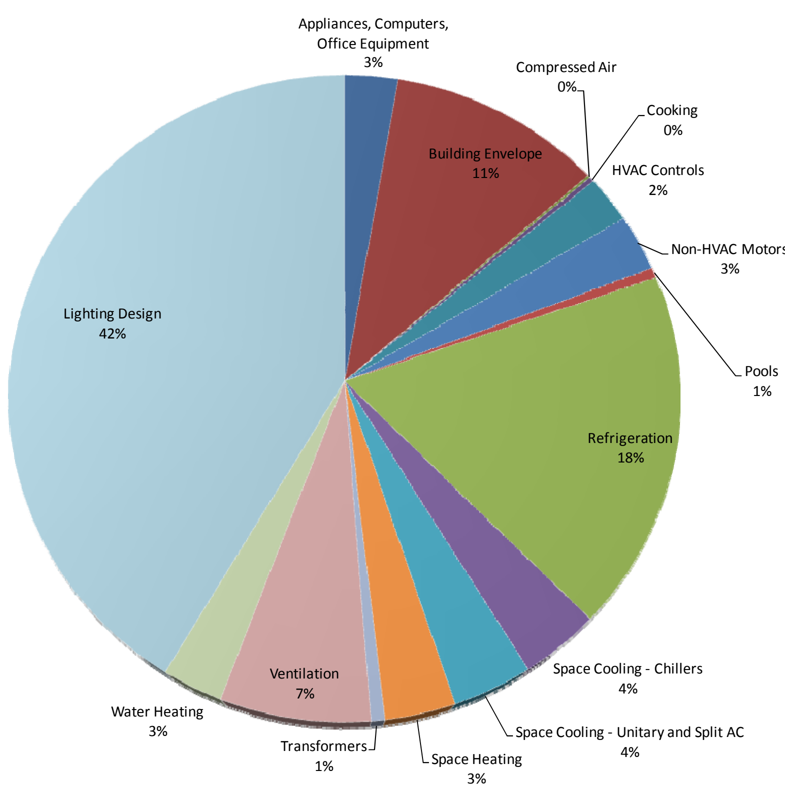


Figure 4. Max Achievable Cost Effective Electric Savings by End Use for Commercial New Construction



New Hampshire's greatest areas for non-electric energy savings in the commercial sector come from the installation of cost-effective space heating (44%), water heating and HVAC controls (17% each) and building envelope (13%) in existing buildings, as shown in Figure 5. Space heating measures also provide the greatest potential for non-electric savings in the commercial new construction area (44%) as shown in Figure 6, followed by building envelope and water heating (16%), and HVAC controls (15%).

Figure 5. Max Achievable Cost Effective Non-Electric Savings by End Use - Commercial Existing Buildings

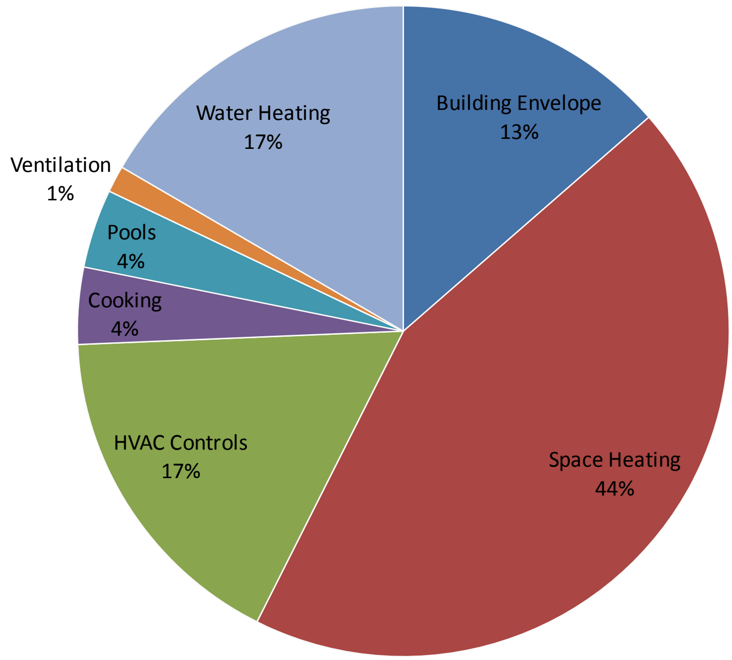
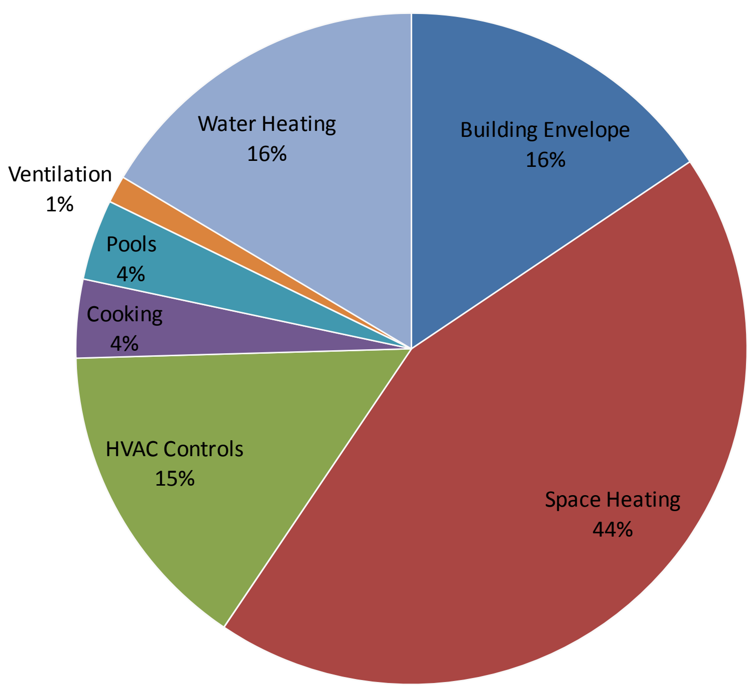


Figure 6. Max Achievable Cost Effective Non-Electric Savings by End Use - Commercial New Construction



Within the Industrial sector, Figure 7 shows that the greatest areas for electric energy savings come from machine drives (40%), sensors and controls (16%), lighting (15%), process heating measures (13%), and facility HVAC (11%). As shown in Figure 8, the greatest areas for non-electric savings in the industrial sector come from process heating, conventional boiler use and facility HVAC measures (52%, 33% and 13% respectively).

Figure 7. Max Achievable Cost Effective Electric Savings by End Use for NH Industrial Sector

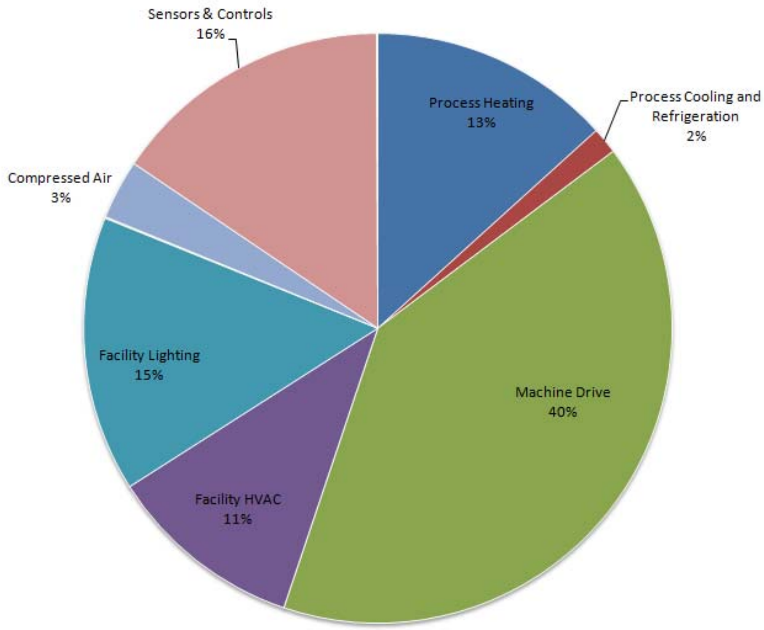


Figure 8. Max Achievable Cost Effective Non-Electric Savings by End Use for NH Industrial Sector

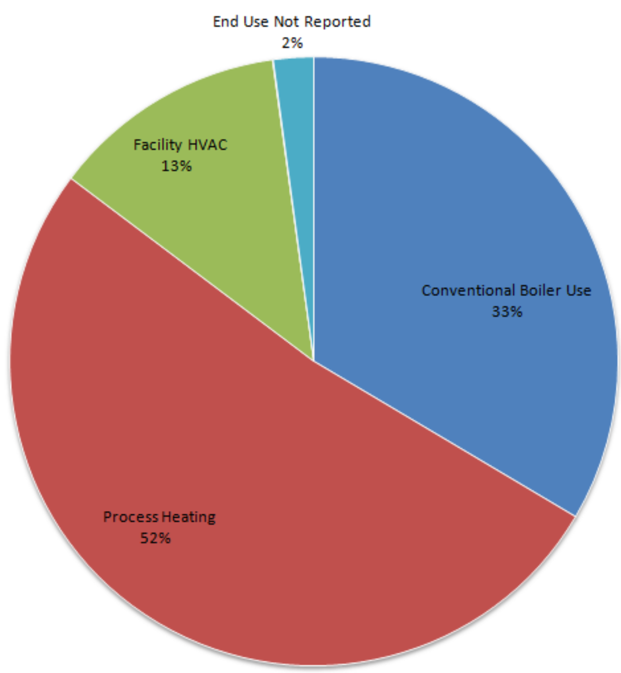


Table 5 and Table 6 present the estimated 2018 Technical, Maximum Achievable, Maximum Achievable Cost Effective potentials and results from the Potentially Obtainable scenario for each of the four New Hampshire retail electricity providers and two natural gas distribution companies. As can be seen from these tables, the greatest potential for electric savings exists within PSNH's service territory (approximately 73% of the state's projected kWh and MW savings), followed by Unitil (nearly 12%), National Grid (over 8%) and the NH Electric Cooperative (just under 7%). Seventy-seven percent of the natural gas savings potential exists within National Grid's service territory, with the remaining 23% coming from Northern Utilities territory. It is important to note that a majority of the non-electric savings potential comes from measures installed in oil and propane-fueled homes and businesses.

Table 5. Additional Energy Efficiency Opportunities Potential by 2018 - Breakdown by Utility – Electric

All Sectors	Estimated Annual Savings by 2018 (kWh)	Estimated Utility Max. Achievable Cost Effective Savings in 2018 as a Percent of Total Estimated Savings	Estimated Annual Sales by 2018 (kWh)	Estimated Annual Demand Savings by 2018 (MW)	Estimated Utility Max. Achievable Cost Effective Demand Savings in 2018 as a Percent of Total Estimated Savings	Estimated Annual Sales by 2018 (MW)
PSNH						
Technical Potential (Traditional)	2,641,281,301	73.0%	9,535,258,276	466.2	72.5%	2,139
Max. Achievable Potential	2,166,873,873			381.4		
Max. Achievable Cost Effective	1,956,745,201			329.9		
Potentially Obtainable	1,022,507,558			183.9		
NH Electric Co-op						
Technical Potential (Traditional)	240,590,220	6.8%	880,356,308	43.3	6.6%	206
Max. Achievable Potential	197,148,030			35.2		
Max. Achievable Cost Effective	181,927,003			29.9		
Potentially Obtainable	99,640,017			15.3		
Unitil						
Technical Potential (Traditional)	410,156,541	11.8%	1,524,047,235	75.7	12.2%	406
Max. Achievable Potential	339,044,561			62.4		
Max. Achievable Cost Effective	315,351,394			55.5		
Potentially Obtainable	166,137,024			33.9		
National Grid-Electric						
Technical Potential (Traditional)	311,351,120	8.4%	1,106,674,467	57.6	8.8%	231
Max. Achievable Potential	254,812,243			47.0		
Max. Achievable Cost Effective	225,817,473			40.1		
Potentially Obtainable	115,617,334			21.4		
All Electric Utilities - Totals						
Technical Potential (Traditional)	3,603,379,183	100.0%	13,046,336,285	642.7	100.0%	2,982
Max. Achievable Potential	2,957,878,706			525.9		
Max. Achievable Cost Effective	2,679,841,071			455.3		
Potentially Obtainable	1,403,901,933			254.5		

Table 6. Additional Energy Efficiency Opportunities Potential by 2018 - Breakdown by Utility – Natural Gas

All Sectors	Estimated Annual Savings by 2018 (MMBtu)	Estimated Utility Max. Achievable Cost Effective Savings in 2018 as a Percent of Total Estimated Savings	Estimated Annual Sales by 2018 (MMBtu)
National Grid - Natural Gas Savings Only			
Technical Potential (Traditional)	5,294,129	76.7%	20,089,887
Max. Achievable Potential	3,916,204		
Max. Achievable Cost Effective	3,198,934		
Potentially Obtainable	1,558,051		
Northern Utilities - Natural Gas Savings Only			
Technical Potential (Traditional)	1,589,633	23.3%	6,193,361
Max. Achievable Potential	1,195,725		
Max. Achievable Cost Effective	973,825		
Potentially Obtainable	466,856		
All Natural Gas Utilities Combined - Totals			
Technical Potential (Traditional)	6,883,763	100.0%	26,283,248
Max. Achievable Potential	5,111,929		
Max. Achievable Cost Effective	4,172,758		
Potentially Obtainable	2,024,907		

1.3 Potentially Obtainable Scenario

In the Potentially Obtainable scenario developed for this report, all cost-effective energy efficiency measures were assessed in light of customer priorities and estimated pricing behaviors (i.e. sensitivity to payback). Concerning priorities, customers' responses to questions included in this projects' sector-specific telephone surveys and site visits were used to determine the percentage of customers that stated they were "extremely likely" to purchase energy efficient equipment (73% of residential customers, and 48% of commercial and industrial customers). Customer behaviors regarding pricing were estimated based on some simplifying assumptions that all "extremely likely to purchase" customers would potentially install energy efficient measures if the price were below a certain level (i.e., 7 cents levelized cost per /kWh saved) and half of those same customers would likely install cost-effective measures in cases where the costs were more than 7 cents/kWh saved (the model also built in functionality to eliminate those measures with extremely high levelized costs in order to avoid outliers from being considered in the Potentially Obtainable scenario). Embedded within this approach was the assumption that fifty percent of the associated energy efficiency measure cost would be provided to these customers through a measure rebate to achieve the desired customer purchase action (essentially reducing the customer's out-of-pocket cost to 3.5 c/kWh in this example, or equivalent to approximately a 1 to 2 year payback on the customers' portion of the energy efficiency measure investment). This rebate level assumption is based upon a previous review conducted by GDS of numerous energy efficiency studies, including a National Energy

Efficiency Best Practices Study and was supplemented with data collected through the phone surveys and site visits conducted as part of this current project.[10,11]

1.4 Implementation Costs

To achieve the Potentially Obtainable amount of energy efficiency savings by 2018, substantial efforts, including continued and expanded utility programmatic support will be required. Such programmatic support would include rebates to customers (including potential targeted mid-stream and upstream market actors), program marketing and outreach, administration, planning, and program evaluation activities. Although not included in this report's "cost to achieve estimates," all such costs would be required to ensure the delivery of quality and reliable energy efficiency products and services to New Hampshire's consumers. As noted above, the projection for Potentially Obtainable electricity and non-electric energy savings assumes that customers receive rebates equivalent to fifty percent of measure incremental (or full) costs. This incentive level assumption will help to reduce customer out-of-pocket costs and will quicken the paybacks on measures installed to more actionable levels. The fifty percent incentive is based both upon customer provided input (via this project's phone surveys and site visits data collection efforts), and from review of numerous energy efficiency studies including the National Energy Efficiency Best Practices Study. If customers had to receive 100% of measure incremental or full costs to achieve the Potentially Obtainable scenario's savings levels, then program budgets would double.

1.5 Market-Driven vs. Retrofit

Energy efficiency potential in the existing stock of buildings can be captured over time through two principal processes:

1. as equipment replacements are made normally in the market when a piece of equipment is at the end of its useful life (often referred to as "market-driven" or "replace-on-burnout"); and,

2. at any time in the life of the equipment or building (referred to as "retrofit").

Market-driven measures are generally characterized by incremental measure costs and savings (e.g., the incremental costs and savings of a high-efficiency versus a standard efficiency air conditioner); whereas retrofit measures are generally characterized by full costs and savings (e.g., the full costs and savings associated with retrofitting ceiling insulation into an existing attic). A specialized retrofit case is often referred to as "early replacement" or "early retirement". This refers to a piece of equipment whose replacement is accelerated by several years, as compared to the market-driven assumption, for the purpose of capturing energy savings earlier than they would otherwise occur.

---

[10] See "National Energy Efficiency Best Practices Study, Volume NR5, Non-Residential Large Comprehensive Incentive Programs Best Practices Report", prepared by Quantum Consulting for Pacific Gas and Electric Company, December 2004, page NR5-51.

[11] As part of this project, telephone surveys were conducted with 400 residential customers and 200 small commercial customers, and site visits were conducted with 100 larger commercial customers and 100 industrial customers. Questions were included in these surveys and site visits to assess customer interest in energy efficiency and the value of incentives to the customer decision-making process.

For this study, the GDS Team has examined the impacts of "early replacement" for a select group of measures (i.e., T-8 lighting, insulation and weatherization measures in existing buildings). For these measures, GDS assumed that customers would receive an incentive equivalent to 50% of the full cost of the energy efficiency measures at the time of retrofit.[12]

1.6 Customer Participation and Barriers

Based on results from the customer telephone surveys and on-site interviews, a number of insights regarding customer participation, preferences and barriers have been identified. Highlights are presented below. Please refer to Section 7 of this report for more detailed information.

1.6.1 Residential Customer Program Participation and Barriers Summary

- Over 90% of the residential customers surveyed said they pay "some" or "substantial" attention to controlling energy costs
- After being read a definition of energy efficiency and the fact that such measures typically cost more than less efficient models (often 20 to 30% more), 73% stated that they were "extremely likely" to purchase energy efficient equipment if it lowered their energy bill, increased comfort, or helped the environment.
- Installation of energy efficiency features are commonly considered as part of remodeling projects (64% among recently remodeled homes, and 90% among homes with a future remodeling plan).
- About half of the households surveyed are aware of their utility offering energy efficiency programs, and 30% have participated in them in some way.
- Low income households were found to have a significantly higher participation rate (they are twice as likely to report participating in such programs).
- Among participants, satisfaction with their utilities' programs seems extremely high.
- The two most frequently cited reasons for nonparticipation were: (1) there was no recent purchase of energy-using household items, and (2) unawareness of program resources.

1.6.2 Commercial and Industrial Customer Program Participation and Barriers Summary

- Of the small and large commercial and industrial customers surveyed, 86% of respondents reported some or high level of attention to controlling energy costs.
- 48% stated that they were "extremely likely" to purchase energy efficient equipment if it lowered their energy bill, increased comfort, or helped the environment.
- Overall awareness of energy efficiency programs and incentives offered by utility providers was significantly higher in the large commercial/industrial respondents (86%) compared to the small commercial/industrial respondents (60%).
- Past participation in utility provider offered programs was similarly higher in the large customer group who was aware of the programs offered (86%) compared to the small customer group aware of the programs offered (30%).
- Of respondents who have participated in their utility's energy efficiency programs, a significant majority of both small customers (94%) and large customers (98%) reported that they would participate in the programs again if given the opportunity.

[12] Tying incentives to the full installed cost of targeted measures in the case of early replacement (retrofits) is typical of the way that retrofit programs are currently being implemented here in New Hampshire and throughout the country.

- The single largest barrier to respondents investing in energy efficiency measures was concern about initial premium costs of equipment and insufficient payback (69%).
- Respondents indicated that the two most important factors influencing decisions to invest in energy efficient equipment are: (1) expectations of lower monthly energy bills and (2) rebates or incentives for purchasing energy efficient equipment that would help offset some of the initial costs.
- Other factors such as business image, environmental impact, occupant comfort, and sales person recommendation were less likely to influence decisions to invest in energy efficient equipment.

1.7. Past/Current Program Capture and Recommendations

To date, New Hampshire's electric and gas utilities have been quite effective in achieving energy and capacity savings and energy efficiency measure penetration across the state. But, as shown in Table 7 and Table 8 below, there is much room for additional penetration. In total, from 2002 through 2008, the electric energy efficiency programs are saving an estimated cumulative total of nearly 560 million kWh per year of energy[13]. This represents a savings of five percent of the total forecast energy usage for New Hampshire in 2008. Similarly from 2003 through 2008, the natural gas efficiency programs saved an estimated total of over 2.4 million therms per year[14]. This represents a savings of 1.1 percent of the total forecasted natural gas usage for New Hampshire in 2008.

Table 7. Cumulative Annual Program Savings as Percent of 2008 Sales: 2002-2008 – Electric

Sector	Total Annual Savings Since 2002 (MWh)	Forecasted Sales 2008 (MWh)	Cummulative Annual Savings as a Percent of 2008 Sector Sales	Cummulative Annual Savings as a Percent of 2008 Total Sales
Residential	120,064	4,537,480	2.6%	1.1%
Commercial/Industrial	437,210	6,650,732	6.6%	3.9%
Total	**557,274**	**11,188,212**		**5.0%**

Table 8. Cumulative Annual Program Savings as Percent of 2008 Sales: 2003-2008 – Natural Gas

Sector	Total Annual Savings Since 2003 (decatherms)	Forecasted Sales 2008 (decatherms)	Cummulative Annual Savings as a Percent of 2008 Sector Sales	Cummulative Annual Savings as a Percent of 2008 Total Sales
Residential	95,387	8,435,900	1.1%	0.4%
Commercial/Industrial	150,248	14,267,000	1.1%	0.7%
Total	**245,635**	**22,702,900**		**1.1%**

It is important to note that the figures in the above two tables are conservative in several ways. First, the utility providers have been actively offering efficiency programs since well before 2002 so the total amount of energy saved since the inception of efficiency programs is much higher.

[13] Estimate is based on reported lifetime savings from 2005-2008 available on NHPUC website, GDS estimates for program measure lives used to calculate annual savings, and extrapolated kWh savings estimates for 2002-2004.

[14] Estimate based on reported savings from 2003-2007 and GDS estimates for program measure lives

Second, these figures consider only cumulative annual savings, not lifetime savings[15]. In reality, annual savings are realized every year over the assumed measure life of the programs. The data was reported in the above manner to provide an appropriate comparison to the forecast 2008 usage. More details regarding this analysis are presented in Section 8 of this report.

To increase the likelihood of achieving the additional energy efficiency savings potential highlighted in this study, the following findings/recommendations are suggested (see Section 8 for more details):

To date, the efficiency programs offered in New Hampshire by the state's four largest electric utilities and two natural gas distribution companies have been successful and have saved a substantial amount of energy. Many of the programs have and are continuing to perform quite well in terms of cost per unit of energy saved and customer participation. Several other programs have shown positive trends becoming more cost effective on a yearly basis.

For all programs, but most notably in the electric market, the cost per kWh saved in the commercial and industrial sectors has been better than in the residential market. This might explain why in general, commercial and industrial customers have indicated a higher awareness of the utilities' efficiency programs available to them as well as an increased likelihood of program participation compared to residential customers. Given the scale of energy consumption in the commercial and industrial sectors, these customers continue to represent a substantial area for potential energy savings in the upcoming years.

- Recommendation: Additional penetration can be achieved through increased outreach to small commercial/industrial customers and by expanding current program offerings to include other cost effective measures not currently included in the companies' CORE and utility-specific programs.

Residential customer participation in the state's electric and natural gas energy efficiency programs has met or exceeded program expectations on a yearly basis. However, in the phone surveys more than half of respondents indicated that they were not aware of the programs offered by their utilities, or that they were even eligible. Of the customers who were aware of the programs, a high percentage participated and indicated they would participate in the future.

- Recommendation: This data underscores the importance of increasing consumer education on the programs available to residential customers and of the associated benefits.

One final finding from the study is that nearly all of the most cost effective energy efficiency measures are included in current programs in some manner. In several programs, however, the cost effective measures are targeted to a small percentage of consumers. The best example of this is the *Home Energy Solutions* program which targets consumers with 65% or greater electric heating. Customers with electric heat as their primary heating source represent approximately 4% of the total population based on the phone surveys.[16]

[15] Cumulative annual savings were calculated by determining the annualized savings in a given year and summing those annual savings for each of the program years reviewed.
[16] The 4% represents total number of customers with electric heat as their primary source for heating. A smaller percentage than 4% would qualify for participation in the Home Energy Solutions program, since 65% or more of their space heating needs to be met with electric heat.

- Recommendation: Expanding the number and types of products and services available through the existing residential energy efficiency programs, and promotion of those programs to include a larger number of potential participants may lead to increased overall energy savings. It is important to recognize that such expansion would require providing services to customers that heat with fuels other than electric or natural gas. Issues regarding who would pay for the provision of services to such customers would need to be addressed.

1.8 Structure of this Report

Section 2 of this report provides an overview of current and forecasted electric and natural gas energy usage in New Hampshire. Information on geographic, economic, demographic and energy usage characteristics of the State is also presented in Section 2. Section 3 of this report provides a detailed discussion of the research plan and methodologies used for the collection and analysis of all data in this report. Results from the participation, preferences and barriers questions asked as part of this project's phone surveys and site visit interviews are also presented in Section 3. Sections 4, 5 and 6 provide detailed results from the electric and non-electric energy efficiency potential analysis conducted for the residential, commercial and industrial sectors, respectively. Detailed results are presented in these sections regarding technical potential, maximum achievable potential, maximum achievable cost effective potential and the potentially obtainable scenario. Energy (kWh), capacity (kW), and associated therm (MMBTu) and environmental (tons of CO_2) savings are presented along with additional description of the methodologies used, where applicable.

This project included a major enhancement to a majority of the technical potential studies that have been conducted across the country in the past. Rather than relying on best available information from existing secondary sources to estimate current levels of energy using equipment saturations and penetration of energy efficiency measures, significant primary data collection efforts were undertaken to help inform and derive New Hampshire-specific values where possible within the time requirements and work scope specified for this project. As such, this effort was completed through a combination of primary and secondary data collection and analysis activities. Detailed findings and an assessment of the value resulting from this enhanced, New Hampshire-specific data collection effort is presented in Section 7 of this report.

Section 8 assesses the amount of energy savings that past and current energy efficiency programs in the state have already captured. Recommendations for potential program modifications and measure offerings are also included in this section.

Section 2: Characterization of Customer Base, Electric and Natural Gas Usage, and Load Forecasts for the State of New Hampshire

This section of the report provides electric and natural gas utility forecasts for energy usage in the State of New Hampshire based on data provided by the four electric and two natural gas utilities supporting this project. The utility-provided forecast information has been compared against the latest available ISO-NE forecasted data, where appropriate, to ensure reasonableness. In order to develop estimates of energy savings potential, it is important to understand how energy is used by households and businesses in New Hampshire. Therefore, this section also provides information on geographic, economic, demographic and energy usage characteristics of the State.

2.1 New Hampshire Geographic and Demographic Characteristics

New Hampshire is the third largest state in New England after Maine and Vermont by total land area (fourth largest by population after Massachusetts, Connecticut and Maine).[17] The State is bordered by Canada, Vermont, Massachusetts, and Maine. The Connecticut River forms the western boundary with Vermont, while Maine forms a boundary for nearly its entire eastern border, until meeting the Atlantic Ocean near its southeastern border with Massachusetts. Manchester is the largest of New Hampshire's 221 towns with an estimated population of 109,497 in 2006 according the US Census data. [18]

New Hampshire ranks 41st in the country (by population), and at approximately 9,000 square miles, is the fourth smallest state by total area (68 miles at its widest point, and 190 miles long). New Hampshire is the second most forested state in the country, after Maine, in percentage of land covered by woods. Major regions of the state include the Great North Woods, the White Mountains, the Lakes Region, the Merrimack Valley, the Monadnock Region, the Dartmouth-Lake Sunapee Region, and the Seacoast.

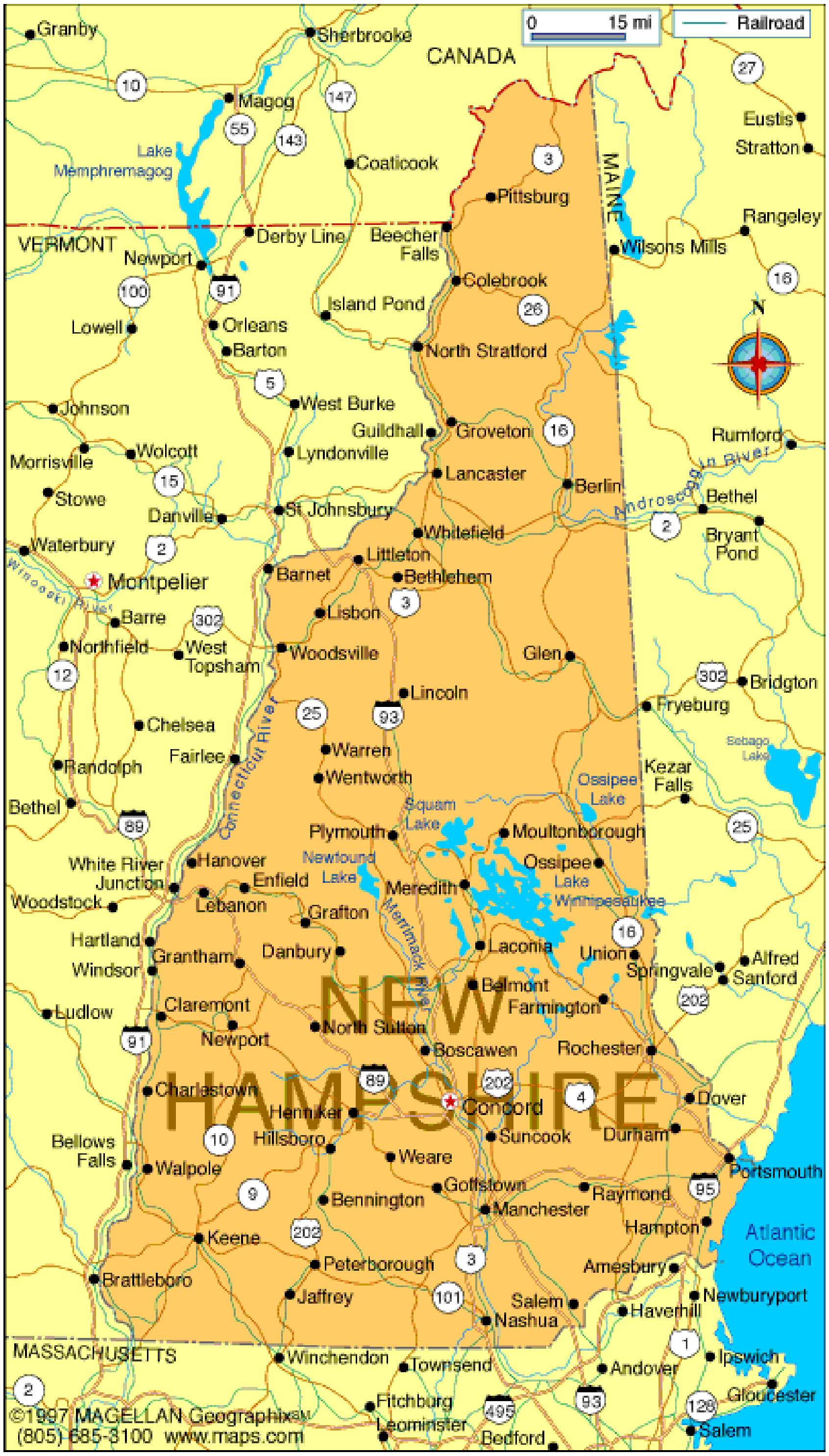
The White Mountain National Forest covers approximately 1,171 square miles in the north-central portion of the state (including 5.6% of which is in the neighboring state of Maine). Lake Winnipesaukee is the largest lake in New Hampshire, covering approximately 72 square miles in the east-central part of the state.[19] The Seacoast area of New Hampshire has the smallest shoreline of any coastal state (just 18 miles long). Figure 9 provides a map of the state.

[17] http://quickfacts.census.gov/qfd/states/44000.html. New Hampshire's population density of 137.8 persons per square mile is higher than the population density in Vermont (65.8) and Maine (41.3), but it is much lower than the other three New England states. For more detailed information, see http://www.answers.com/topic/list-of-u-s-states-by-population-density.

[18] 2006 population estimate for Manchester, NH. http://www.nh.gov/nhes/elmi/htmlprofiles/manchester.html

[19] http://en.wikipedia.org/wiki/New_Hampshire.

Figure 9. New Hampshire Map[20]



20 http://www.infoplease.com/atlas/state/newhampshire.html

2.2 New Hampshire Economic and Demographic Characteristics

New Hampshire is a rural state with a population of approximately 1,350,000 persons in 2008 and 604,000 housing units.[21] According to the Energy Information Administration, the state's energy consumption per capita is among the lowest in the country. This is due, in part to the low demand for air conditioning and the fact that relatively few households use electricity as their primary energy source for home heating. Over half of the households in New Hampshire heat their homes with fuel oil in the winter.[22]

The New Hampshire Employment Security Economic and Labor Market Information Bureau prepares an annual Economic Analysis Report for the state.[23] The Bureau's 2008 Report noted that New Hampshire has been growing faster than any of the other New England states, although this growth is occurring as a decreasing rate. Gross Domestic Product was $57.3 billion at the end of 2007, a 2.3% increase from 2006, but well below the 4.9% and 4.0% growth in 2005 and 2004 respectively. The seasonally adjusted unemployment rate for New Hampshire was 3.8% at the end of the first quarter 2008, and has been consistently below the country's average rate over the past fifteen years. Total employment is projected to grow in the state by 13.9% from 2006 to 2016. Although real estate activity has declined 5.6% from April 2007 to April 2008, this decline has been one of the smallest compared to the other New England states. Major areas for job growth are expected to include: healthcare, social services, computers and mathematics, and personal services.

To get a sense of the population mix in the state, electric and natural gas utility customer information was provided and is summarized below. This information was used in sample plan development for telephone surveys and site visits that were conducted as part of this project. As shown in Table 9, the four investor-owned electric utilities analyzed for this report have a collective total of 612,636 residential and low income customers, with PSNH serving a majority of these customers (67% and 83% respectively). A majority of natural gas customers are served by National Grid (61%).

Table 9. Total Customer Counts – Residential, Low Income NH Electric and Natural Gas Utilities[24]

Utility	Residential		Low Income		Total	
PSNH	392,202	67%	22,118	83%	414,320	68%
NH Electric Coop	64,164	11%	2,423	9%	66,587	11%
Unitil	58,550	10%	2,083	8%	60,633	10%
National Grid-Electric	70,986	12%	110	<0.5%	71,096	11%
Subtotal Electric*	585,902	100%	26,624	100%	612,636	100%
National Grid-Gas	33,882	61%	1,117	100%	34,999	61%
Northern Utilities	21,988	39%	0	0%	21,988	39%
Subtotal Natural Gas+	58,870	100.0%	1,117	100.0%	56,987	100.0%

[21] Data obtained by GDS from "On-demand reports and maps from Business Analyst Online", based on U.S Bureau of the Census, 2000 Census of Population and Housing, ESRI forecasts for 2008 and 2013.
[22] Primary data collection – results from this project's residential telephone surveys
[23] *New Hampshire Economic Analysis Report 2008*, New Hampshire Employment Security Economic and Labor Market Information Bureau
[24] Likely underestimates the number of low-income customers for each utility. As shown in this table, the estimated percentage of New Hampshire's population within these combined utility service territories is 4.3% (26,624/612,636), excluding double counting from natural gas utility customers that are also electric utility customers. In comparison, according to the 2007 American Community Survey of the U.S. Census Bureau, the percentage of the state's population at or below the poverty level is 7.1%.

* Excludes municipal electric utility customers
+ Represents subset of electric customers

The State's commercial and industrial customer base, to accommodate data collection efforts required for this report, were separated into small (<100 kW peak demand or 300,000 kWh/year) and larger customer groupings. As shown in Table 10, the majority of small non-residential electric customers are located in PSNH's service territory (74%). The number of small commercial/industrial natural gas customers are split fairly evenly at 53% Northern Utilities and 47% National Grid. Based on review of Standard Industrial Classification (SIC) Code data included in some of the utility-provided customer data files, it appears that approximately 40% of New Hampshire's small non-residential electric and natural gas customers are in the Services sector (SIC codes 70-89). Between 11% and 12% of the state's small commercial/industrial customers appear to be in the Retail Trades sector (SIC Codes 52-59). The Finance, Insurance and Real Estate sector (SIC Codes 60-67) make up the next largest small C/I customer focus at approximately 4%. Followed by Manufacturing and Transportation/Public Utilities (SIC Codes 20-39 and 40-49 respectively).

Table 10. Total Customer Counts – Small Non-Residential NH Electric and Gas Utilities

Utility	Count	% Total
PSNH	72,031	74%
NH Electric Coop	9,845	10%
Unitil	9,092	9%
National Grid-Electric	6,627	7%
Subtotal Electric*	97.595	100%
National Grid-Gas	5,708	47%
Northern Utilities	6,470	53%
Subtotal Natural Gas+	12,178	100.0%

* Excludes municipal electric utility customers
+ Represents subset of electric customers

The overall number of estimated large commercial and industrial accounts, as shown in Table 11 is 2,369. In summarizing data by SIC code in the top portion of the table, information provided by the utilities during the data acquisition/submission process was used. Not all utilities had complete customer SIC code information available for use, but based upon the SIC information received, manufacturing, services and retail trade were the three largest sectors observed. The bottom portion of the table allocates those SIC codes associated with Manufacturing as Industrial and the remainder as Commercial. As can be seen, just over 31% of those accounts classified in the data are industrial accounts.

The information presented in Table 11, shows an estimate of New Hampshire's large commercial and industrial (C&I) customer population based on a count of the number of utility-provided customer accounts. For these larger accounts, it is helpful to view the customers based on their energy usage. As shown below in Table 12, the overall amount of electric consumption among the utilities' larger commercial and industrial customers is estimated to be over 3,700 GWh. Although the industrial sector customers represent less than one third of all accounts classified in the utility data, these industrial sector customers represent nearly 43% of the consumption of all classified accounts.

Table 11. Customer Count of Large C&I Population Summary (Number of Accounts)

SIC Code Grouping	Gas Service	Electric Only	Total
By SIC Code Grouping			
01-09: Agriculture, Forestry and Fishing	0	2	2
10-14: Mining	0	3	3
15-17: Construction	2	1	3
20-39: Manufacturing	192	367	559
40-49: Transportation and Public Utilities	26	93	119
50-51: Wholesale Trade	9	21	30
52-59: Retail Trade	134	240	374
60-67: Finance, Insurance and Real Estate	46	97	143
70-89: Services	137	352	489
91-97: Public Administration	27	36	63
99: Non Classified Establishments	3	6	9
Not Provided	69	506	575
Total	645	1,724	2,369
By Commercial vs. Industrial			
Commercial	384	851	1,235
Industrial	192	367	559
Not Provided	69	506	575
Total	645	1,724	2,369

Table 12. Electric Energy Consumption of Large C&I Population Summary (kWh - 2007)

SIC Code Grouping	Gas Service	Electric Only	Total
By SIC Code Grouping			
01-09: Agriculture, Forestry and Fishing	0	3,457,200	3,457,200
10-14: Mining	0	1,345,640	1,345,640
15-17: Construction	357,542	566,960	924,502
20-39: Manufacturing	522,971,163	942,650,275	1,465,621,438
40-49: Transportation and Public Utilities	50,356,974	184,107,025	234,463,999
50-51: Wholesale Trade	9,624,800	27,927,516	37,552,316
52-59: Retail Trade	184,430,793	395,511,692	579,942,485
60-67: Finance, Insurance and Real Estate	62,338,610	225,973,672	288,312,282
70-89: Services	165,927,326	567,668,427	733,595,753
91-97: Public Administration	34,460,608	51,171,299	85,631,907
99: Non Classified Establishments	2,094,145	3,322,085	5,416,230
Not Provided	48,549,165	240,062,143	288,611,309
Total (kWh)	1,081,111,126	2,643,763,935	3,724,875,061
By Commercial vs. Industrial			
Commercial	509,590,798	1,461,051,516	1,970,642,314
Industrial	522,971,163	942,650,275	1,465,621,438
Not Provided	48,549,165	240,062,143	288,611,309
Total (kWh)	1,081,111,126	2,643,763,935	3,724,875,061

2.2.1 Survey Respondent Characteristics

The primary data collection efforts for this project included a combination of phone and site surveys of residential, commercial and industrial New Hampshire customers. The surveys were used to obtain a great deal of customer demographic information. The most relevant customer demographic information is summarized below; additional information obtained from the surveys is presented in Appendix J to this report.

Of residential survey respondents, 94% were permanent as opposed to seasonal residents, and nearly 80% of respondents owned the property they were living in. Over 53% of homes were more than 28 years old. Over 72% of respondents had completed at least some college and nearly 18% have completed postgraduate studies.

Among the small commercial and industrial respondents, 62% owned the property and 38% leased the space. 98.5% of respondents pay for electricity in the space. The mean square footage of the small commercial and industrial facilities surveyed was 11,747 square feet.

Among the large commercial and industrial respondents, 73% owned the property and 27% leased the space. The mean square footage of the large commercial and industrial facilities surveyed was nearly 90,000 square feet.

2.3 Forecasted Electricity and Natural Gas Sales in New Hampshire

Based on sales information provided directly by this project's four participating electric utilities and two participating natural gas distribution companies, total and customer sector-specific energy (GWH), demand (MW) and fuel (MMBTu) forecasts were compiled. Where applicable, these forecasts were compared against relevant ISO-NE and EIA data to assess reasonableness. As shown in Figure 10, electric energy sales projected by the four participating electric utilities in New Hampshire is projected to grow from approximately 11,200 GWH in 2008 to over 13,000 GWH by the year 2018. This represents an annual rate of 1.3 percent. This represents nearly 93 percent of the total electric energy sales in the state, when compared with ISO-NE's latest forecast and appears reasonable given that the utility forecasts do not include sales from a number of smaller municipal electric utilities that also serve customers in the state. Figure 11 shows how the utilities' electric energy sales projections are broken down between residential, commercial and industrial customer sectors. The residential sector has the greatest sales, approximately 40 percent of total sales (4,537 GWH) in 2008, and is projected to grow slightly to 5,590 GWH by 2018 (representing a 1.7 percent annual growth rate). Commercial sector sales also currently make up approximately 40 percent (4,525 GWH) of the combined utilities' total 2008 electric energy sales, and are projected to grow just slightly to 5,354 GWH by 2018 (a 1.4 percent projected annual growth rate). The industrial sector currently represents 19 percent of total 2008 sales (2,126 GWH) and is expected to stay fairly constant, dropping slightly to 2,103 GWH by the year 2018 (a 0.1 percent annual decline). This figure also shows approximately 42 GWH/year in projected street lighting sales (representing 0.3 percent of total projected sales in 2018).

Figure 10. Forecasted Electric GWH Sales Total (2008 – 2018) - from Utility Data vs. ISO-NE Projections

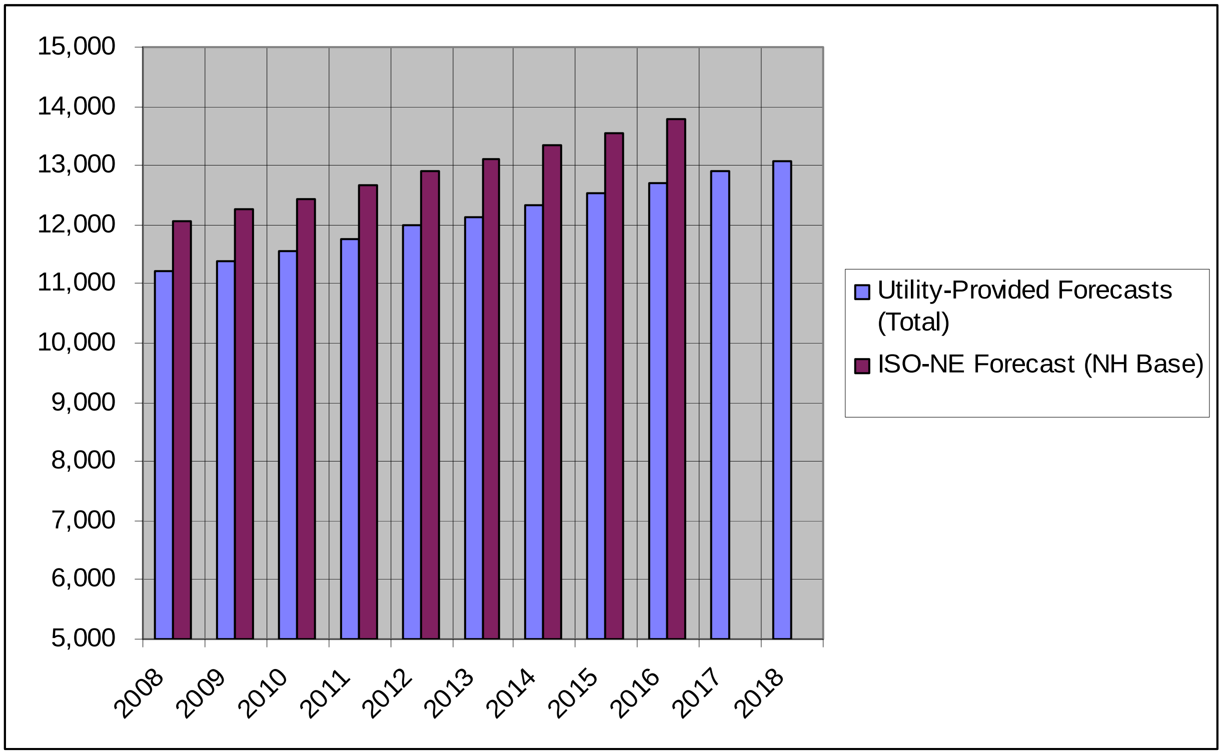
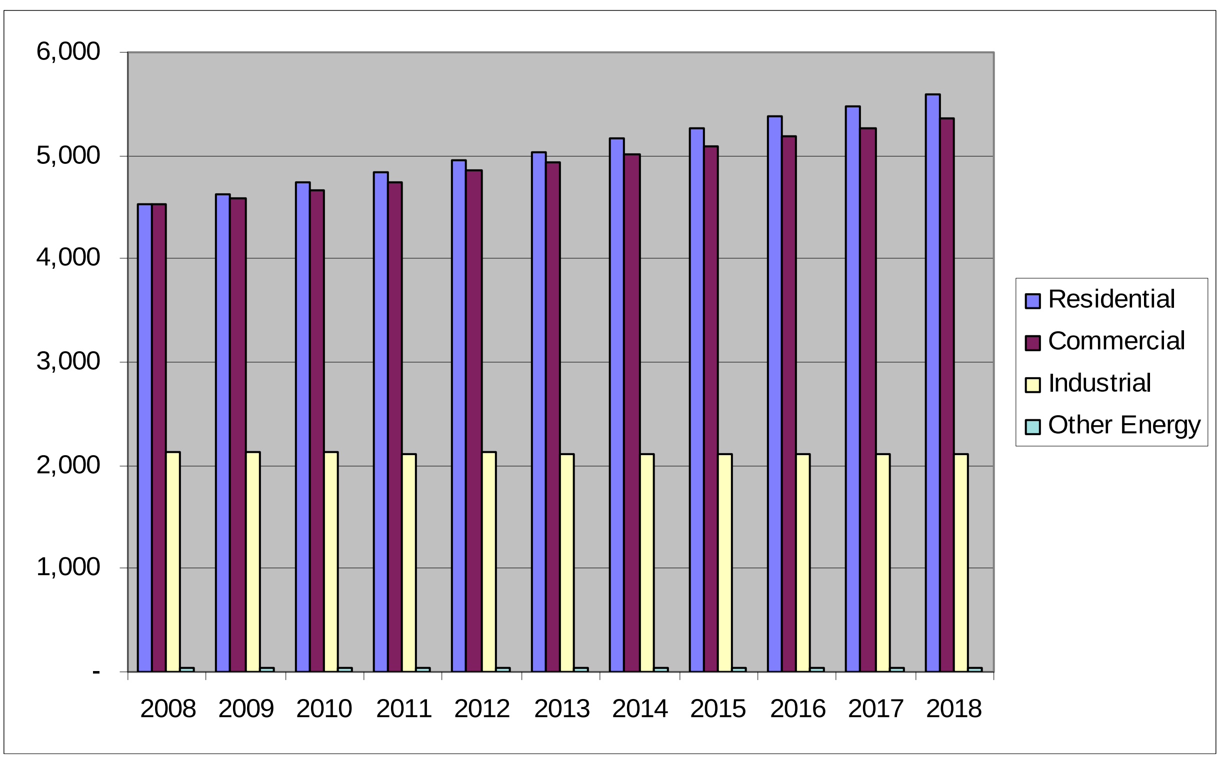


Figure 11. Forecasted Electric GWH Sales By Sector (2008 – 2018)



Electric system peak load for the combined four participating electric utilities in New Hampshire, as shown in Figure 12, is projected to grow from approximately 2,400 MW in 2008 to nearly 3,000 MW by the year 2018 (an annual rate of 1.8 percent). This represents nearly 95% of the state's total forecasted electric demand, when compared with ISO-NE's latest forecast, and appears reasonable given that the utility forecasts do not include peak load projections from a number of smaller municipal electric utilities that also serve customers in the state. Figure 13 shows how the utilities' electric peak load projections are broken down between residential, commercial and industrial customer sectors. The commercial sector has the greatest peak demand, approximately 43 percent (1,023 MW) in 2008, and is projected to grow slightly to 1,279 MW by 2018 (representing a 1.8 percent annual growth rate). Residential sector demand currently makes up approximately 40 percent (962 MW) of the combined utilities' total 2008 peak, and is projected to grow to 1,206 MW by 2018 (also a 1.8 percent projected annual growth rate). The industrial sector currently represents just under 17 percent of total 2008 peak load (962 MW) and is expected to grow to 498 MW by the year 2018 (a 1.9 percent annual increase). This figure also shows approximately 3 MW per year in projected street lighting demand (constant for the period 2008 through 2018).

Figure 12. Forecasted Electric Demand (MW) Total 2008 – 2018 - Utility Data vs. ISO-NE Projections

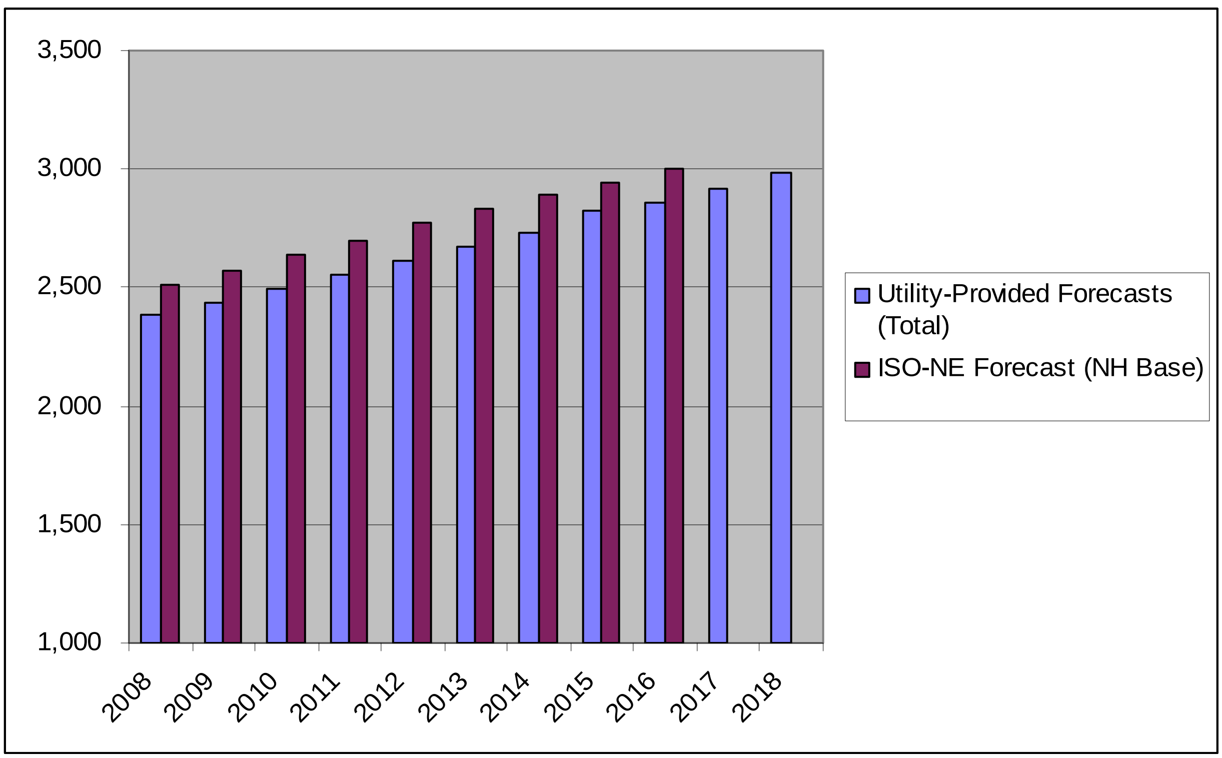
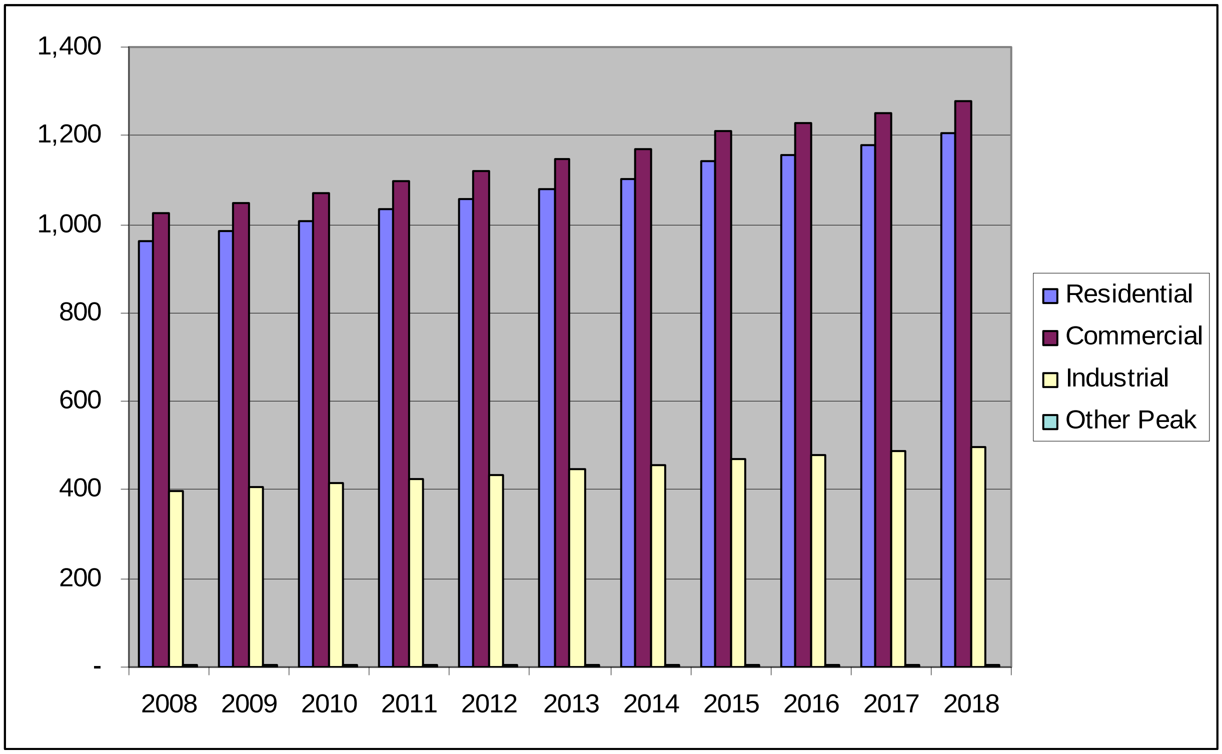


Figure 13. Forecasted Electric Demand (MW) By Sector 2008 – 2018



In addition to electric energy and peak demand, this study estimates the potential for additional natural gas energy efficiency and related propane and fuel oil savings opportunities. As such, Figure 14, shows that natural gas sales is projected to grow from 20,640 MMBTu in period 2008 to 26,283 MMBTus by 2018 (an annual growth rate of 2 percent).[25] This compares reasonably to the most recent data available from the US Department of Energy's Energy Information Administration (EIA), where New Hampshire's natural gas sales for 2007 was estimated to be 21,722 MMBTu. Figure 15 shows how New Hampshire's the natural gas utilities' MMBTu sales projections are broken down between residential, commercial and industrial customer sectors. The commercial sector has the greatest sales approximately 44 percent (9,428 MMBTu) in 2008, and is projected to grow to 12,666 MMBTu by 2018 (representing a 2.6 percent annual growth rate). Residential sector sales currently makes up approximately 36 percent (7,698 MMBTu) of the combined utilities' total 2008 natural gas sales, and is projected to grow to 8,189 MMBTu by 2018 (a 0.6 percent projected annual growth rate). The industrial sector currently represents just over 19 percent of total 2008 sales (4,041 MMBTu) and is expected to grow to 5,428 MMBTu by the year 2018 (a 2.6 percent annual increase).

[25] Based on participating New Hampshire Natural Gas distribution company-provided projections.

Figure 14. Forecasted Natural Gas MMBTu Sales Total (2008 – 2018) - Utility Projections vs. EIA Data

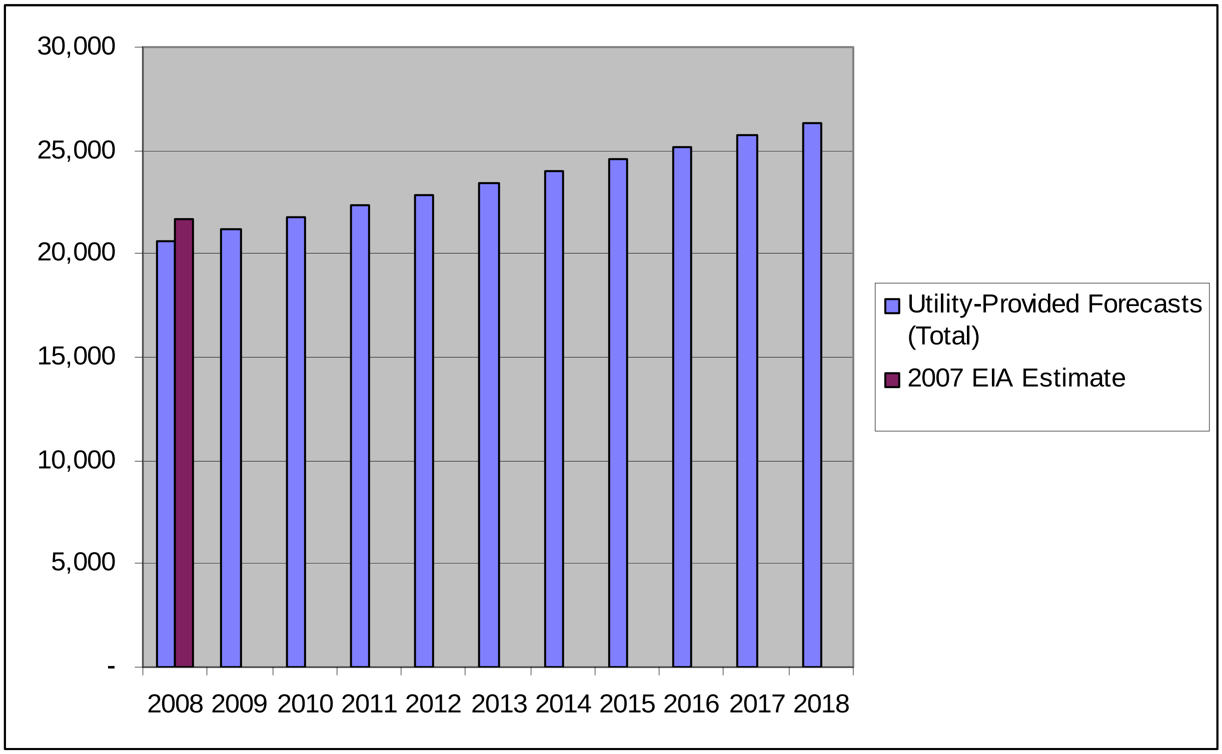
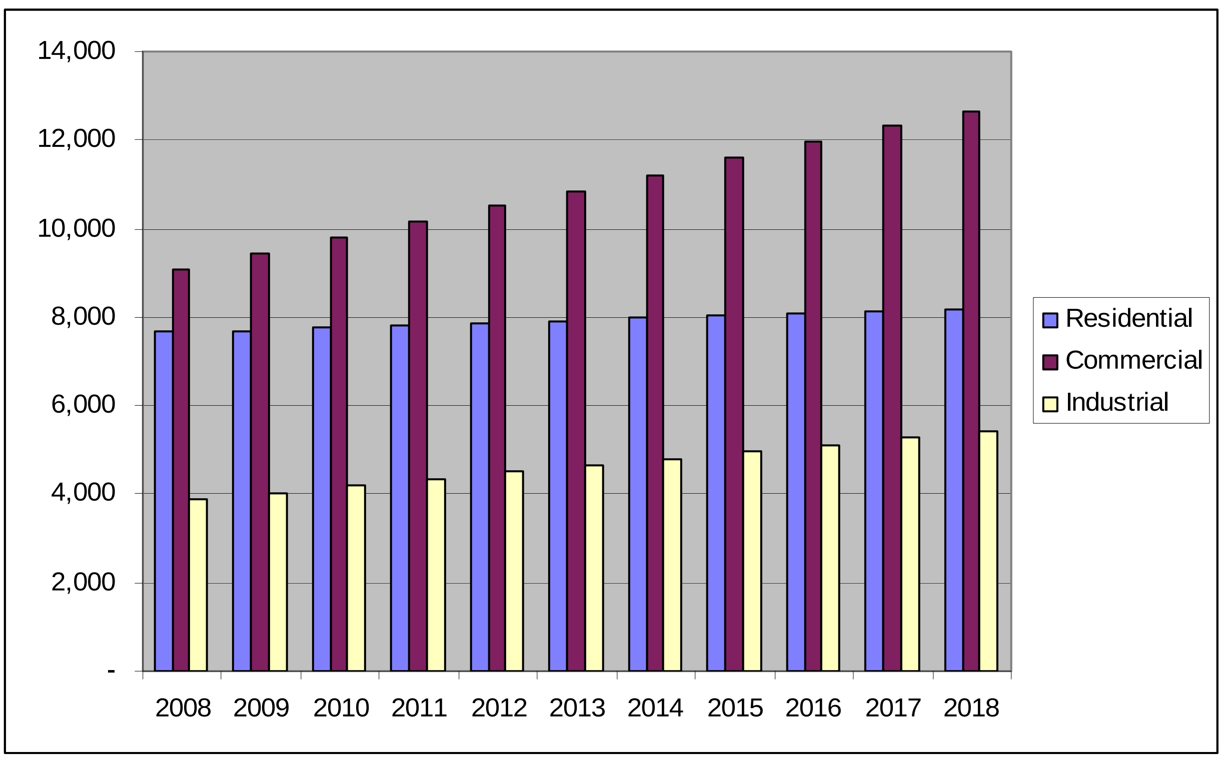


Figure 15. Forecasted Natural Gas MMBTu Sales By Sector (2008 – 2018)



New Hampshire's electric and natural gas utilities have been operating energy efficiency programs for a number of years. The above forecasts reflect the energy savings that have already resulted from these utilities' previous efficiency program efforts.

In New Hampshire, as with all states, the growth in the demand for electricity and natural gas will vary by region where some regions may see much higher growth rates. On a statewide basis, however, areas showing faster growth are offset by slower growth areas of the state to produce an overall projected growth rate of approximately only 1.3, 1.8 and 2.0 percent for electric energy, demand and natural gas sales respectively.

Section 3: Overall Project Implementation Approach

This section of the report presents an overview of the approach and methodologies used by the GDS Team for completion of each of the following tasks:

- Analyzing current saturations of energy using equipment and penetrations of energy efficiency equipment and practices in each end-use sector
- Producing an up-to-date list of currently available and soon to be commercially available technologies which may play a part in future efficiency programs
- Estimating customer participation rates/levels by program, based on different payback/incentive levels and define/analyze significant barriers that customers face when investing in additional energy efficiency
- Developing, by sector, a simplified end-use model of state electricity and natural gas consumption and peak demand
- Estimating, state-wide and for each of the four New Hampshire retail electricity providers and two natural gas distribution companies, the technical, maximum achievable, maximum achievable cost effective, and potentially obtainable scenario for electricity, natural gas, and related propane and fuel oil savings over the next 10 year period, and the budgets (where appropriate) required to achieve that potential
- Evaluating extent to which past and current energy efficiency programs have achieved energy savings to date, provide sensitivity analysis of realized energy savings based on different resource levels (including absence of current SBC-funded model), and recommend modifications to program and measure offerings that would increase the likelihood of achieving identified potential

3.1 Energy Using Equipment Saturations and Efficiency Penetrations Analysis

This task represents a major enhancement to technical potential studies that have been conducted across the country in the past. Rather than relying on best available information from existing secondary sources to estimate current levels of energy using equipment saturations and penetration of energy efficiency measures, significant primary data collection efforts were undertaken to help inform and derive New Hampshire-specific values where possible within the time requirements and work scope specified for this project. As such, this effort was completed through a combination of primary and secondary data collection and analysis activities. Detailed results and an assessment of the value resulting from this enhanced, New Hampshire-specific data collection effort is presented in Section 7 of this report. Following is a discussion of the methodologies utilized to complete this task.

First, a measure list was compiled, the approach for which is described in Section 3.2 below. The current saturation of each relevant type of energy using equipment and the penetration of associated energy efficiency equipment and practices was then determined. In this effort, it was important to recognize and quantify differences in end-use saturations and penetrations between the residential, commercial and industrial sectors, and building types within in each sector (see Table 13, Table 14 and Table 15).

Table 13. Residential Sector Building Types and Energy Using Equipment

Building Types/Considerations
Single Family
Multi Family
Low Income
Existing Homes
New Construction
Energy Using Equipment/End-Use Measures
Appliances
Water Heating
Space Conditioning (heating/cooling)
Lighting
Building Envelope
Other (pools, standby power)

Table 14. Commercial Sector Building Types and Energy Using Equipment

Building Types/Considerations
Warehouse
Retail
Grocery
Office
Lodging
Health
Restaurant
Education
Other (assembly, etc.)
Existing Buildings/New Construction
Energy Using Equipment/End-Use Measures
Appliances, Computers & Office Equipment
Water Heating
Space Heating
Space Cooling – Chillers
Space Cooling – Unitary & Split AC
Ventilation
HVAC Controls
Non-HVAC Motors
Building Envelope
Lighting
Lighting Controls
Refrigeration
Cooking
Compressed Air
Pools
Other (transformers)

Table 15. Industrial Sector Business Types and Energy Using Equipment

Business Types/Considerations
Apparel And Other Finished Products Made From Fabrics And Similar Materials
Chemicals And Allied Products
Electronic And Other Electrical Equipment And Components, Except Computer Equipment
Fabricated Metal Products, Except Machinery And Transportation Equipment
Food And Kindred Products
Furniture And Fixtures
Industrial And Commercial Machinery And Computer Equipment
Leather And Leather Products
Lumber And Wood Products, Except Furniture
Measuring, Analyzing, And Controlling Instruments; Photographic, Medical, And Optical Goods; Watches And Clocks
Miscellaneous Manufacturing Industries
Paper And Allied Products
Petroleum Refining And Related Industries
Primary Metal Industries
Printing, Publishing, And Allied Industries
Rubber And Miscellaneous Plastics Products
Stone, Clay, Glass, And Concrete Products
Textile Mill Products
Tobacco Products
Transportation Equipment
Energy Using Equipment/End-Use Measures
Conventional Boiler Use
CHP and /or Cogeneration Process
Process Heating
Process Cooling and Refrigeration
Machine Drives
Electro-Chemical Processes
Other Process Use
Facility HVAC
Facility Lighting
Other Facility Support
Onsite Transportation
Conventional Electric Generation
Other Non-Process Use

As noted above, a combination of primary and secondary data collection and analysis activities were conducted by the GDS Team to develop the New Hampshire sector and building-specific saturation and penetration rates used for this report. Primary data collection consisted of telephone surveys of a statistically valid sample of residential and small commercial/industrial customers (400 residential customers and 200 small commercial customers) and site visits for a sample of 100 larger commercial and 100 industrial customers.

3.1.1 Survey Instruments and Site Visit Data Collection Forms

The process of developing survey questions and site visit data collection forms was mostly dictated by the types of data required by the computer models being used by the GDS Team to estimate energy saving potential. For the questions that examined current saturations and penetrations of energy efficient equipment and practices, GDS first identified a list of currently and soon-to-be commercially available technologies that may play a part in future efficiency programs; then specific questions that address these technologies were developed.

For the phone surveys, survey instruments from two existing studies served as references: the 2004 California Statewide Residential Appliance Saturation Study (for the residential questionnaire), and the U.S. Department of Energy's 2003 Commercial Buildings Energy Consumption Survey (for the small commercial/industrial questionnaires). For the site visit data collection forms, instruments based on somewhat relevant previous projects were used as a starting point. In addition, the survey instruments included questions to explore customers' attitudes toward and perceptions of energy efficiency. These questions addressed factors that affect the adoption of energy efficiency measures, significant barriers customers may face when investing in energy efficiency measures, awareness of energy efficiency, program participation and satisfaction, and past purchase practices. A major challenge in this effort was to develop instruments that would provide useful information on a number of important energy end-use measures, without requiring respondents to spend too much time on the phone, or on site. Targeted durations of 15 minutes per phone survey and 2.5 hours per site visit were set.

New Hampshire Public Utility Commission reviewed preliminary research instruments, both for the phone surveys and site visits, in several phone conferences, and discussed their priorities with the GDS Team. Based on these discussions, RIA finalized the phone survey instruments for the residential and the small commercial/industrial surveys which primarily asked questions in a closed-ended format, with a few opportunities for verbatim responses. GDS and RLW finalized the site visit data collection forms using identical questions from the phone surveys wherever practical and a tabular format for collection of end-use area and measure specific saturation and penetration data. Appendix A presents the Team's Residential Sector Telephone Survey. Appendix B is the Small Commercial/Industrial Sector Telephone Survey. Appendix C provides a copy of the On-Site Data Collection Instrument for the Larger Commercial and Industrial Sector.

3.1.2 Sampling

The sampling plans for residential and small commercial/industrial telephone surveys were developed based on records received from each of the electric and gas utilities. Records that represented duplicates due to multiple program participation were combined and participation codes were retained for programs. In residential accounts, all low-income customers were identified based on their rate code or income flag. Identified low-income customers represented 5% of the customer accounts received. A similar approach was taken with the small commercial/industrial accounts, which were also screened to ensure that all electric accounts had less than 100kW demand or 300,000 kWh annual consumption.

By definition, all records for gas utility customers are duplicates since all gas customers also are customers of one of the electric utilities and would be included in those records. Therefore, as an initial step, each gas customer record was matched by telephone number to one of the electric utilities. The next step was to remove records with no phone number. Table 16 and Table 17 display the final sample quotas for the residential and small commercial/industrial phone surveys. As shown in Table 16, quotas were included in the residential sample to ensure representation from both the non-low-income and low-income populations, and for electric and gas customers associated with each of the four major electric and two major natural gas utilities in the state. The residential sample is designed to achieve 5 percent precision at a 95 percent confidence level, with 10 percent precision and 90 percent confidence level for each of the utilities.[26]

Table 16. Sample Quotas - Residential NH Electric and Gas Utilities

Utility	Non Low Income				Low Income				Total
	Random Draw	Electric Only	w/Gas Service	N	Random Draw	Electric Only	w/Gas Service	N	
PSNH	3,500	142	33	175	300	12	3	15	190
NH Electric Coop	1,280	52	12	64	120	5	1	6	70
Unitil	1,280	52	12	64	120	5	1	6	70
Granite State Electric	1,280	52	12	64	120	5	1	6	70
Totals	7,340	298	69	367	660	27	6	33	400

As shown in Table 17, specific quotas were also included with the small commercial/industrial sector to ensure representation from both electric and gas customers. This small commercial/industrial sample is designed to achieve 5 percent precision at the 85 percent confidence level, with 12 percent precision at the 85 percent confidence level for each of the utilities.

Table 17. Sample Quotas – Small C/I NH Electric and Gas

Utility	Random Draw	N		Total
		Electric Only	Gas Service	
PSNH	3,325	87	8	95
NH Electric Coop	1,225	32	3	35
Unitil	1,225	32	3	35
Granite State Electric	1,225	32	3	35
Totals	7,000	183	17	200

In the end, 411 interviews with residential customers and 200 interviews with small commercial/industrial customers were completed. As shown in Table 18 and Table 19, over 6,100 and 4,000 calls to residential and small commercial customers respectively had to be made to fill the 400/200 quotas targeted. More information and summary results from the phone survey efforts are presented later in this report.

Table 18. Disposition of Residential Survey

DISPOSITION	TOTAL	% TOTAL
Complete	411	6.7%
No answer	789	12.8%
Answering machine	2,838	46.1%
Busy	167	2.7%
Bad number	476	7.7%
Fax number	29	0.5%
Call intercept	7	0.1%
Appointment	451	7.3%
First refusal	214	3.5%

[26]. Estimates for subgroups within the residential sample, including the low-income estimates, are based on smaller sample sizes. Thus the margin of error for these estimates is higher

DISPOSITION	TOTAL	% TOTAL
Second refusal	549	8.9%
Language barrier	24	0.4%
No eligible respondent	24	0.4%
Business – NPR	95	1.5%
Never call	15	0.2%
Quota full	0	0.0%
Partial – Callback	39	0.6%
Partial – Refusal	31	0.5%
TOTAL DIALINGS	**6,159**	**100%**
INCIDENCE (%)	**95.46**	

Table 19. Disposition of Small Commercial/Industrial Survey

DISPOSITION	TOTAL	% TOTAL
Complete	200	4.9%
No answer	1,750	43.1%
Answering machine	81	2.0%
Busy	151	3.7%
Bad number	135	3.3%
Fax number	25	0.6%
Updated contact	176	4.3%
Appointment	815	20.1%
First refusal	61	1.5%
Second refusal	285	7.0%
Language barrier	3	0.1%
No eligible respondent	12	0.3%
Private residence	194	4.8%
Never call	3	0.1%
Quota full	0	0.0%
Partial – Callback	55	1.4%
Partial – Refusal	25	0.6%
Own but not occupy	10	0.3%
Residential use	6	0.2%
Made at corporate	76	1.9%
TOTAL DIALINGS	**4,063**	**100%**
INCIDENCE (%)	**73.13**	

A key element of the larger commercial and industrial on-site surveys was the systematic selection of sample points to visit. As originally proposed, 200 site visits were targeted for performance overall. A sample size of 68 provides an expected absolute precision of 10% for proportional results. This suggests that a sample size of 200 can be considered adequate for the consideration of targeting sub-groups of the sample such as commercial versus industrial or fuel types (gas).

Table 20 below presents the number of accounts determined to be Large C&I after identifying[27] them from the sponsor provided electric customer data. The overall number of estimated large commercial and industrial accounts is 2,369. In summarizing data by SIC code in the top portion of the table, information provided by the sponsors during the data acquisition/submission process was used. Not all sponsors had SIC code information available for use, but based upon the SIC information received, manufacturing, services and retail trade were the three largest sectors observed. The bottom portion of the table allocates those SIC codes associated with Manufacturing as Industrial and the remainder as Commercial. Just over 31 percent of those accounts classified in the data are industrial accounts.

[27] For PSNH, Large C&I were defined as their rate code GV or LV. For Unitil, they were defined as having a demand greater than 100 kW based upon a provided Total Demand field or as having more than 300,000 kWh of annual consumption if demand was not available. Similarly for National Grid they were defined as customers having a demand greater than 100 kW based upon a provided Average Bill Demand kW field or as having more than 300,000 kWh/year if demand was not available. NHEC provided a list of Small C&I customers as queried to meet the study designated Small C&I definition of accounts with less than 100 kW of demand when available, otherwise less than 300,000 kWh/year.

To identify gas customers, the GDS Team gathered gas customer data from the sponsors. Using the address, company name, and phone numbers within the gas customer data, a total of 645 customers within the large C&I electric customer dataset were identified as having gas service. There are sure to be more gas customers in the sample frame beyond those identified. In fact we received a total of 12,178 total (small and large) gas commercial or industrial customer records from National Grid and Northern Utilities from which the 645 Large Commercial and Industrial accounts were successfully mapped in to the dataset of identified large electric Commercial and Industrial customers. This identified group represents just over 31 percent of the Large C&I population gathered from the electric sponsors.

Table 20. Large C&I Population Summary (Accounts)

SIC Code Grouping	Gas Service	Electric Only	Total
By SIC Code Grouping			
01-09: Agriculture, Forestry and Fishing	0	2	2
10-14: Mining	0	3	3
15-17: Construction	2	1	3
20-39: Manufacturing	192	367	559
40-49: Transportation and Public Utilities	26	93	119
50-51: Wholesale Trade	9	21	30
52-59: Retail Trade	134	240	374
60-67: Finance, Insurance and Real Estate	46	97	143
70-89: Services	137	352	489
91-97: Public Administration	27	36	63
99: Non Classified Establishments	3	6	9
Not Provided	69	506	575
Total	645	1,724	2,369
By Commercial vs. Industrial			
Commercial	384	851	1,235
Industrial	192	367	559
Not Provided	69	506	575
Total	645	1,724	2,369

Table 21 below presents the electrical consumption (kWh) of the Large C&I customers, also by SIC Code and Commercial versus Industrial. The overall amount of electric consumption among the large Commercial and Industrial sample frame is estimated to be 3,725 GWh. Although the industrial accounts represent a third of the accounts classified in the sponsor data, they represent nearly 43 percent of the consumption of all classified accounts.

Table 21. Large C&I Population Summary (kWh)

SIC Code Grouping	Gas Service	Electric Only	Total
By SIC Code Grouping			
01-09: Agriculture, Forestry and Fishing	0	3,457,200	3,457,200
10-14: Mining	0	1,345,640	1,345,640
15-17: Construction	357,542	566,960	924,502
20-39: Manufacturing	522,971,163	942,650,275	1,465,621,438
40-49: Transportation and Public Utilities	50,356,974	184,107,025	234,463,999
50-51: Wholesale Trade	9,624,800	27,927,516	37,552,316
52-59: Retail Trade	184,430,793	395,511,692	579,942,485
60-67: Finance, Insurance and Real Estate	62,338,610	225,973,672	288,312,282
70-89: Services	165,927,326	567,668,427	733,595,753

91-97: Public Administration	34,460,608	51,171,299	85,631,907
99: Non Classified Establishments	2,094,145	3,322,085	5,416,230
Not Provided	48,549,165	240,062,143	288,611,309
Total	1,081,111,126	2,643,763,935	3,724,875,061
By Commercial vs. Industrial			
Commercial	509,590,798	1,461,051,516	1,970,642,314
Industrial	522,971,163	942,650,275	1,465,621,438
Not Provided	48,549,165	240,062,143	288,611,309
Total	1,081,111,126	2,643,763,935	3,724,875,061

Based upon the exploration of the Large C&I data gathered, a sample approach that targeted large industrial and large commercial equally seemed reasonable – particularly given that the modeling and analysis of additional energy efficiency potential will be done discretely for each and that the consumption of industrial versus commercial accounts is moderately close to 50/50.

The sample design requested in the RFP asked for adequate representation of each sponsor (i.e., the four electric utilities and the two natural gas distribution companies) in the final sample. Table 22 presents the number of accounts by utility for electric and gas as determined from aggregating the entire large commercial and industrial electric customer information and an effort to map in information from the gas utilities based upon information in common fields.

Table 22. Large C&I Accounts by Sponsor and by Commercial versus Industrial

Utility	Commercial		Industrial		Unclassified		Total	
	N	%	N	%	N	%	N	%
Electric								
NHEC	15	1%	0	0	316	57%	331	14%
PSNH	1,012	83%	492	88%	8	1%	1,512	65%
Unitil	84	7%	12	2%	158	29%	254	11%
GSE	112	9%	58	10%	71	13%	241	10%
Total	1,223	100%	562	100%	553	100%	2,338	100%
Gas								
National Grid	232	61%	142	74%	30	82%	404	63%
Northern	149	39%	50	26%	42	18%	241	37%
Total	381	100%	192	100%	72	100%	645	100%

Due to an inability to fully categorize all of the sponsor information by the various sectors among electric customers, the GDS Team felt that the best approach to sampling for the large C&I site visits would be to target 100 commercial facilities and 100 industrial facilities with minimum sample quotas for each electric utility with an overall quota for gas customers. Such a sample would further seek to balance the need for targeting the number of large C&I customers from each sponsor to their approximate portion of the total (with a minimum quota size of 7) with the need to visit customers with gas use. This would be done iteratively as the recruitment process proceeds depending upon the actual incidence of gas customers among the recruited Large C&I sample frame (discussed later).

Table 23 below provides the GDS Team's proposed sample design in which we have allocated the targeted visits within the commercial and industrial categories similarly as the proportion of accounts by utility in each category are very similar (Table 22). The predicted gas column in

Table 23 provides an estimate of the number of gas customers that would naturally fall into the sample for each sponsor given the identified gas customers in each sector – along with the gas utility they are likely to represent. An estimated 64 gas customers were anticipated to be recruited naturally in this regard, comprised of 30 in the large commercial sector and 34 in the industrial. Given the interest in gas measures as part of this study, the GDS Team believed that additional targeting of this group of customers was needed. Therefore, visiting 68 gas customers overall was suggested, which targets a 90 percent confidence with +/-10 percent relative precision for proportional results. Therefore, depending on the incidence of gas customers experienced in the recruitment process, an additional 4 gas sites may need to be explicitly targeted to achieve a total of 68.

Table 23. Large C&I Sample Design

Utility	Large Commercial		Large Industrial	
	N	Predicted Gas Subset	N	Predicted Gas Subset
NHEC	7	0	7	0
PSNH	76	16 NGRID and 9 Northern	75	21 NGRID and 7 Northern
Unitil	8	2 NGRID and 1 Northern	7	5 NGRID
GSE	9	2 (Northern)	11	2 (Northern)
Total	100	30	100	34

In the end, all the electric utility-specific quotas were met for both the commercial and industrial sectors. The predicted gas utility subsets were exceeded (23 Northern Utility completes vs. predicted 21, and 59 National Grid completes vs. predicted 44).

Scheduling and fielding began on June 9th and all site visits were completed before August 9th, 2008. Advance letters were sent by the PUC to 500 randomly selected customers within the quota areas targeted and a drawing for a $500 gift card was offered to increase likelihood of participation.[28] Appendix D provides a copy of the PUC advance letter and the GDS Team's recruiting script. Although the GDS Team was able to achieve a 40% response rate (200 completes, out of a 500 customer sample frame), as discussed in more detail in the section below, the time required to recruit, schedule and conduct the site visits, and hard enter and analyze all resulting data greatly exceeded original estimates.

3.1.3 Data Collection and Analysis

The telephone interviews were conducted from RKM Research and Communication's call center using trained, professional survey managers and interviewers who utilized a computer assisted telephone interviewing (CATI) system. All staff were thoroughly trained as to the nature of the study, the importance of the information being collected, and management of the sample. Before the final data collection phase, RKM conducted a pretest with 20 residential and 22 commercial/industrial completes to identify any problems the respondents or interviewers might have understanding questions, or with the survey length. Some modifications were made to questions based on the results of the pretest, but these were insignificant and the total number of pretests was included in the final dataset.

Fielding of the phone surveys was conducted from June 17th through 26th, 2008, during the day, evening, and weekend hours to reach as many targets as possible. The average length of the

[28] NH Industries, Lebanon, NH was the winner of the drawing held on September 5th at the PUC offices. Instead of a $500 gift card, per their request, a charitable donation was made on their behalf to the United Way of the Upper Valley.

survey was 16 minutes for the residential survey and 17 minutes for the small commercial/industrial survey. To counteract non-response bias, up to six attempts per telephone number were made to complete the surveys. All soft refusals were put into a separate sample file and were assigned to different interviewers to call back. All were called back except those refusals received in the very last days of the study, as a result of the waiting period between when the initial refusal was received and when the callback was attempted. Detailed call disposition information was presented earlier in Table 18 and Table 19. The completed survey data was analyzed using SPSS statistical software and appropriate data entry accuracy verification and data cleaning procedures.

The site visits were conducted by experienced RLW and GDS engineers and trained staff. Starting with development of the site visit data collection form, key staff from both RLW and GDS (including a number of those that would be conducting the actual site visits) were actively involved in the development of the form and the planning/scheduling approach for the site visits. All dedicated site visit staff (totaling more than 8 individuals) were thoroughly trained as to the nature of the study, the importance of the information being collected, and management of the sample.

As part of the initial data collection phase, RLW and GDS staff pretested the site visit data collection form by jointly conducting visits during the first two weeks in the field to identify any problems the auditors might have understanding questions or with the visit length, collecting the required measure data, and ensuring consistency of interpretation and treatment of equipment and situations encountered in the field by multiple auditors. Some modifications were made to implementation approaches based on the results of the pretest, but these were insignificant and the total number of pretests was included in the final dataset. Open and regular communication between the multiple auditors was encouraged and conducted throughout the site visit fielding period to maximize consistency.

Fielding of the site visits was conducted from June 9th through August 9th, 2008, during the workday hours to reach as many targets as possible. The average length per site visit was 3.25 hours. Project sponsors were kept aware of weekly schedules and attended as observers on a number of the site visits. To counteract non-response bias, up to six attempts per potential respondent were made to recruit facilities for the site visits. After identifying the correct person or persons to speak with at the targeted facility, all soft refusals or referrals to other personnel within the office or corporate headquarters location, were noted in the sample file and called back. All were called back except those refusals received in the very last days of the study, as a result of the waiting period between when the initial refusal was received and when the callback was attempted. After preparing the random sample required to fill specified quotas, additional facility names were not added until a direct refusal was received or six attempts were made to recruit each facility on the quota list.

The completed survey data for each site was recorded in paper files (22 pages per completed site visit) and was entered manually into an analyzable Excel spreadsheet file. Direct conversations between data entry personnel and field data collection staff were held when necessary to ensure proper interpretation of field notes. Data entry accuracy verification and data cleaning procedures were employed and analyses were conducted using pivot tables and targeted data mining where appropriate.

3.1.4 Derivation of Saturation and Penetration Values and Weighting of Results

Results from the phone surveys and site visits were analyzed to derive values for saturation of energy using equipment and penetration of energy efficiency equipment and practices, where applicable, in each end-use sector. Results from these analyses are discussed in more detail in

Section 7 of this report. For the residential sector and small commercial/industrial sector phone surveys, multiple cross tabulations were run to identify appropriate measure-specific responses based on heating source, single and multifamily housing types, building type and numerous other relevant variables.

For the larger commercial and industrial facility results, values were derived using multiple pivot tables. In all cases where sufficient responses existed (N>30, or lower if deemed to be reasonably representative of the building type of interest), values from the site surveys were reported for the specific building type. Otherwise, values were averaged across and applied to all building types for a specific measure. This was done to ensure that statistical validity was maintained in the model and that results were not skewed by a small number of responses.

Results from the small commercial and industrial phone surveys and large commercial and industrial site visits were combined using a weighted average. The weighting factors were developed using customer-specific energy sales information provided by the electric and gas utilities for their small (less than 100kW demand) and large customers. The weighting factors were based on the ratio of total electrical consumption in the small commercial and industrial sector compared to total electrical consumption in the large commercial and industrial sector. This ratio was applied to the results for the small and large customers to determine a weighted average for both the electric and non-electric models.

Excellent New Hampshire-specific information was collected on saturations and penetrations (referred to in our models as base and remaining factors) for a number of residential, commercial and industrial energy using equipment through the phone surveys and site visits conducted as part of this project. Such real customer-specific values have typically not been collected as part of the numerous technical potential studies that have been completed to-date for others across the country. Given the extensive list of measures identified for assessment in this study (as discussed in more detail in the section below), it was not possible to develop survey and site visit instruments of sufficient depth and breadth to collect information from which to derive values for all measures of interest to the Commission, OCA and the project's participating utilities. As such, in numerous cases, secondary sources for penetration and saturation data were identified, used and documented. Wherever possible, these secondary sources were verified for reasonableness, or modified based on results obtained through this project's primary data collection activities.

3.2 Measures List Development

This task was initially proposed to be based mainly on the GDS Team's existing information and databases of sector-specific electricity, gas and other fossil fuel end-use technologies and efficiency measures, and was to be supplemented as necessary to ensure inclusion of other technology areas of interest to the Commission, the OCA, and the four electric and two gas utilities supporting this project. Initial lists of electric and natural gas measures were compiled by GDS for the state's residential, commercial and industrial customer sectors, and were shared with the project sponsors on April 3rd for review and comment. As shown in Table 24, Table 25, and Table 26, these initial sector-specific lists contained a total of 252 unique measures (79 residential, 130 commercial, and 43 industrial).

Table 24. Measure End Uses and Number of Measures Per End Use – Residential

Residential Sector			
Electric Measures		Non-Electric Measures	
Appliances	9	2	Dryers
Lighting	4	7	Building Envelope
Space Heating, Cooling and Building Envelope	21	8	Space Heating, Cooling and Building Envelope
Water Heating	9	13	Water Heating
Standby Power	1	-	
Pools	1	-	
New Construction	1	-	
Low Income	3	-	
Total Measures in Sector	**49**	**30**	**79 (total)**

Table 25. Measure End Uses and Number of Measures Per End Use - Commercial

Commercial Sector			
Electric Measures		Non-Electric Measures	
Space Heating	3	17	Space Heating
Water Heating	5	12	Water Heating
Building Envelope	2	7	Building Envelope
Space Cooling – Chillers	3	3	Pool heating
Space Cooling – Packaged AC	8	1	Dryers
Space Cooling – Maintenance	3	6	Cooking
HVAC Controls	4	-	
Ventilation	11	-	
Motors	2	-	
Lighting	20	-	
Lighting Controls	7	-	
Refrigeration	12	-	
Compressed Air	2	-	
Monitor Power Management	1	-	
Transformers	1	-	
Total Measures in Sector	**84**	**46**	**130 (total)**

Table 26. Measure End Uses and Number of Measures Per End Use - Industrial

Industrial Sector			
Electric Measures		Non-Electric Measures	
Process Heating	1	2	Process Heating
Process Cooling & Refrigeration	1	20	Space Heating
Machine Drives	1	5	Water Heating
Facility HVAC	1	7	Building Envelope
Facility Lighting	1	-	
Other Facility Support	1	-	
Onsite Transportation	1	-	
Sensors & Controls	1	-	
Other End Uses	1	-	
Total Measures in Sector	**9**	**34**	**43 (total)**

Following multiple meetings and discussions over the subsequent 5 month period, ending September 26th, 2008, these lists grew by nearly a factor of two to 471 individual measures as shown in Table 27, Table 28 and Table 29. A significant amount of time was also expended during this period identifying, reviewing and documenting secondary and other available data sources to develop reasonable assumptions regarding measure lives, installed incremental and full costs (where appropriate), and electric energy, demand, and MMBTu savings associated with each of the measures included on the final lists.[29] Please refer to Appendix E for a comprehensive listing of all residential electric and non-electric measures and associated

[29] The GDS Team's existing sector-specific technical potential calculation models were also modified substantially during this period to accommodate the large increase in the number of measures and expanded measure categories to be assessed.

assumptions and sources assessed in this report. Appendix F and Appendix G provide similar detailed information for the commercial and industrial sectors respectively.[30]

Table 27. Measure End Uses and Number of Measures Per End Use - Residential

Residential Sector	
Combined Electric and Non-Electric Measures	
Appliances	17
Lighting	13
Space Heating and Cooling	59
Building Envelope	75
Water Heating	41
Standby Power	3
Pools	9
New Construction	Addressed in Building Envelope Measures
Low Income	
Total Measures in Sector	**217 total (up from 79)**

Table 28. Measure End Uses and Number of Measures Per End Use - Commercial

Commercial Sector			
Electric Measures		Non-Electric Measures	
Appliances/Office Equipment	7	-	
Space Heating	3	30	Space Heating
Water Heating	12	17	Water Heating
Pools	7	5	Pools
Building Envelope	5	13	Building Envelope
Space Cooling – Chillers	7	2	Space Cooling – Chillers
Space Cooling – Packaged AC	11	5	Process Heat
Cooking	6	10	Cooking
HVAC Controls	8	7	HVAC Controls
Ventilation	17	6	Ventilation
Motors	2	-	
Lighting	28	-	
Lighting Controls	12	-	
Refrigeration	18	-	
Compressed Air	2	-	
Transformers	1	-	
Total Measures in Sector	**146**	**95**	**241 total (up from 130)**

Table 29. Measure End Uses and Number of Measures Per End Use - Industrial

Industrial Sector			
Electric Measures		Non-Electric Measures	
Process Heating	1	1	Process Heating
Process Cooling & Refrigeration	1	1	Conventional Boilers
Machine Drives	1	-	
Facility HVAC	1	1	Facility HVAC
Facility Lighting	1	-	
Other Facility Support	1	1	Other Facility Support
Onsite Transportation	1	-	
Sensors & Controls	1	-	
Other End Uses	1	-	
Total Measures in Sector	**9**	**4**	**13 total (down from 43)**

[30] Although the measures lists are extensive, they are not exhaustive, particularly for potential fuel oil and propane savings. Some potential measures were identified that were not modeled due to data or other limitations. These include, but are not limited to air conditioning peak demand savings from off peak cooling with energy storage, more advanced windows than double pane with low-E, super high efficiency gas condensing hot water heaters used particularly in combo systems that provide both space and hot water heating, data center and certain information technology potential energy saving measures, and some emerging but not yet commercialized technologies.

3.3 Customer Program Participation Rates and Barriers

Estimates of customer participation rates/levels by program and identification of barriers that customers face when investing in additional energy efficiency were developed based mainly on direct results from the GDS Team's phone surveys and site visits. Specifically, for each customer sector, questions were asked to assess customers' attitudes towards energy efficiency, past program participation and satisfaction, and barriers that might be preventing them from making future investments in energy efficiency.

3.3.1 Residential Customer Attitudes

The residential survey included questions about respondents' attitudes toward energy efficiency. More specifically, these questions attempted to explore respondents' level of consideration of energy saving and to assess factors that affect the adoption of energy efficiency measures. First, the respondents were asked to rate the level of attention their household pays to controlling energy costs through general energy efficiency operational practices such as adjusting room temperatures, shutting computers and lights off, etc. Table 30 provides the result. In general, the level of attention paid to controlling energy cost seems high. About two thirds (63 percent) said they pay "substantial attention," and 30 percent said they pay "some attention." Only a small percentage of the respondents said they pay "very little" or "no attention" to these matters (6 percent).

Table 30. Attention Paid to Controlling Household Energy Costs

	Frequency	Valid Percent
Substantial attention to these matters	256	63.4%
Some attention	121	30.0%
Very little attention	20	5.0%
No attention	5	1.2%
Don't know	2	0.5%
Total	404	100%

Respondents rated their likelihood of purchasing energy efficient equipment instead of standard equipment given several conditions generally assumed to increase the attractiveness of adopting energy efficient equipment. Just before introducing this question, the term "energy efficient equipment" was defined by stating "I am referring to new equipment specifically designed to be more energy efficient than other new models. Energy efficient models typically cost more than other models, perhaps 20-30 percent more." The order of these factors was randomized to avoid any response biases. The result is shown in Table 31. Overall, it seems the respondents found these factors appealing. In particular, a high percent of respondents (78 percent) said they would be "extremely likely" to purchase energy efficient equipment if their monthly energy bill would be less. This was rated significantly higher than any other factor ($p<.05$). The next highest rated factors were increased comfort, increased home value, feeling pro-environment, and receiving a rebate (more than 70 percent of the respondents said they are "extremely likely" to choose energy efficiency equipment as a result of these factors).[31] In contrast, "sales persons' recommendation" was rated significantly lower than any other factors ($p<.05$). Twenty-four percent reported they were "not at all likely" and 35 percent said they were "extremely likely" to purchase energy efficient equipment over standard items given this (sales person recommendation) condition.

[31] Respondents with lower educational achievement rated this factor significantly lower ($p<.05$).

Table 31. Likelihood of Purchasing Energy Efficient Equipment

		1=NOT AT ALL LIKELY	2	3	4	5= EXTREMELY LIKELY	TOTAL
a… your monthly energy bill would be less	N	12	1	22	50	306	391
	Row %	3%	0%	6%	13%	78%	100%
b… it increased the level of comfort	N	22	7	31	55	276	391
	Row %	6%	2%	8%	14%	71%	100%
c… you felt you were helping to protect environment	N	29	8	24	55	278	394
	Row %	7%	2%	6%	14%	71%	100%
d… it increased the home value	N	23	7	26	30	224	310
	Row %	7%	2%	8%	10%	72%	100%
e… you received a rebate	N	33	2	29	53	278	395
	Row %	8%	1%	7%	13%	70%	100%
f… your sales person recommended it	N	91	25	74	59	134	383
	Row %	24%	7%	19%	15%	35%	100%

Note: "Don't know" responses were treated as missing data. Frequency of "it increased the home value" (d) is shown only if the respondents were home owners.

Table 32 shows factors respondents identified as barriers to investing in energy efficiency measures. The table provides a coded summary of the open-ended responses. Nearly three quarters of the responses dealt with uncertainty of payback and initial higher upfront costs (71 percent). In a distant second place, 10 percent of respondents said that current equipment is meeting their needs; 5 percent said they are renters and not able to do home improvements. Six percent of the respondents were concerned about various aspects of energy efficient equipments such as quality, design, features, and safety.

Table 32. Primary Reasons for Not Purchasing Efficient Equipment/Making Efficiency Improvements

	Frequency	Valid Percent
Cost / benefit, payback	189	71%
Current equipment is satisfactory	27	10%
Renters, not owners of property	14	5%
Quality concern	10	4%
Concerned about cosmetics, features	3	1%
Concerned about safety	2	1%
Other	20	8%
Total	265	100%

Note: "Don't know," "refusal," and "no reason" responses were treated as missing data.

3.3.2 Residential Customer Program Awareness and Participation

Finally, the surveyed households were asked about their awareness of and participation in their utilities' energy efficiency programs. Table 33 shows the respondents' awareness of their utilities' energy efficiency programs. Overall, approximately 50 percent of the households know their utility offers energy efficiency programs. NH Electric Coop's customers have the highest awareness level (61 percent) and Granite State Electric's customers have the lowest awareness (42 percent) of their utilities' efficiency programs.[32] However, the differences in customers' awareness among the four utilities were not statistically significant.

Table 33. Awareness of Utility's Energy Efficiency Programs

		GRANITE STATE ELECTRIC	NH ELECTRIC COOP	PSNH	UNITIL	TOTAL
Yes	N	28	41	89	35	193
	Column %	41.8%	61.2%	47.1%	51.5%	49.4%
No	N	39	26	100	33	198
	Column %	58.2%	38.8%	52.9%	48.5%	50.6%
Total	N	67	67	189	68	391
	Column %	100%	100%	100%	100%	100%

Note: "Don't know" responses were treated as missing data.

Table 34 shows the respondents' participation in their utilities' energy efficiency programs, including participation by purchasing products promoted through these programs. Of the respondents who are aware of their utilities' program, the overall participation rate was 31 percent (15 percent of the sample population). There was no difference in the participation rates among the four utilities. One interesting finding was that the low income households reported significantly higher participation in efficiency programs.[33] The low income group was about twice as likely to have participated in such programs (58 percent) as the non-low income group (29 percent). Though not shown in the table, the data indicate an extremely high rate of satisfaction among participants. Almost all participating respondents reported they would participate again in their utilities' efficiency program if they have a future opportunity. Satisfaction and interest in repeat participation was equally high among both low and non-low income groups.

Table 34. Participation in Utility's Energy Efficiency Programs

		GRANITE STATE ELECTRIC	NH ELECTRIC COOP	PSNH	UNITIL	TOTAL
Yes	N	9	14	28	8	59
	Column %	33.3%	34.1%	31.8%	23.5%	31.1%
No	N	18	27	60	26	131
	Column %	66.7%	65.9%	68.2%	76.5%	68.9%
Total	N	27	41	88	34	190
	Column %	100%	100%	100%	100%	100%

Note: This question was asked only if the previous question (PS1) is "yes". "Don't know" responses were treated as missing.

[32] It is important to note that Granite State Electric customers differed significantly from those of the other utilities, having a larger proportion of lower income families and the demographic characteristics associated with that.
[33] Low income was defined as 183% of Federal Poverty line (per utility low income program eligibility criteria).

For those who reported not participating in their utilities' energy efficiency program, an additional question was asked about the reasons why they have not participated. Each possible reason was read by interviewers and the respondents were allowed to provide multiple reasons. If a respondent agreed that a certain reason contributed to their non participation, they were considered to have "endorsed" that particular reason.

Table 35 summarizes the responses. The most frequently mentioned reason was they have not recently purchased items that use energy (44 percent). The next most frequent reasons for nonparticipation seem to relate to their lack of awareness of or knowledge about utility efficiency programs. Twenty-eight percent reported they "did not know they are eligible," followed by "did not know how to find out about the program" (18 percent). It is possible that some respondents have not made recent purchases because they are unaware of programs that may alleviate their financial concerns about investing in energy efficient products. Several other reasons were mentioned with notably high frequencies. Those are: the sales person did not mention the program (13 percent), insufficient incentive (12 percent), bought unqualified equipment (11 percent), and "was not worth the hassle" to participate in programs (10 percent).

Table 35. Possible Reasons for Not Participating in an Energy Efficiency Program

		ENDORSED	NOT ENDORSED	TOTAL
Haven't recently purchased items	N	59	75	134
	Row %	44%	56%	100%
Didn't know I was eligible	N	37	97	134
	Row %	28%	72%	100%
Don't know how to find out more about program	N	24	110	134
	Row %	18%	82%	100%
Sales person didn't talk about program	N	18	116	134
	Row %	13%	87%	100%
Incentives were not enough	N	16	118	134
	Row %	12%	88%	100%
Have purchased items but not energy efficient	N	15	119	134
	Row %	11%	89%	100%
Wasn't worth the hassle	N	13	121	134
	Row %	10%	90%	100%
Renter, not owner (from "other: specify")	N	3	131	134
	Row %	2%	98%	100%
No need (from "other: specify")	N	3	131	134
	Row %	2%	98%	100%
Other	N	11	123	134
	Row %	8%	92%	100%

Note: Respondents were allowed to provide multiple answers to this question, and later all responses were coded. Thus, the N=134 represents the total number of valid responses.

3.3.3 Residential Customer Program Participation and Barriers Summary

Installation of energy efficiency features are commonly considered as part of remodeling projects (64 percent among recently remodeled homes, and 90 percent among homes with a future remodeling plan). About half of the households surveyed are aware of their utility offering energy efficiency programs, and 30 percent have participated in them in some way. Low income households were found to have a significantly higher participation rate—they are twice as likely to report participating in such programs (one likely reason for this higher participation could be the fact that these households qualify to receive rebates of 100%). Among participants, satisfaction with their utilities' programs seems extremely high. The most frequently cited reasons for nonparticipation were there were no recent purchase of energy-using household items, and unawareness of program resources. It is possible the former reason may be triggered by the latter reason—that is, they have not made a recent purchase of efficient products because they are not informed of available programs.

Awareness of the ENERGY STAR® logo also seems fairly high (82 percent), especially among non-low income households. Reducing the monthly energy bill, in particular, appears to be an important driving factor when making decisions of energy efficient product purchases. Other factors such as increased comfort, protection of the environment, increased home value, and receiving rebates are also highly appealing in making decisions on such purchases. The single biggest barrier for households in investing in energy efficient measures is their concern and uncertainty of payback and initial higher costs.

3.3.4 Commercial and Industrial Customer Attitudes

This section summarizes commercial and industrial customer attitudes on energy efficiency practices and programs. The results are based upon phone surveys of small commercial and industrial customers in addition to site surveys and discussions with larger commercial and industrial customers. Large customers are defined as properties using over 300,000 kWh's of energy per year. The surveys were utilized to obtain information on past purchases and practices, awareness of efficiency programs and equipment, and overall attitudes toward energy efficiency.

3.3.5 Commercial and Industrial Customer Respondent Characteristics

The analyses began with an examination of characteristics of commercial and industrial respondents, followed by question-by-question analysis. Ownership characteristics of respondents and the primary business activities were recorded to determine the distribution of respondents among the four electric utility providers. A summary for both small commercial and industrial customers and large commercial and industrial customers is provided in Table 36 below.

Table 36. Respondent Characteristics Summary

		Warehouse	Retail	Grocery	Office	Lodging	Health	Education	Industrial	Restaurant	Other	**Total**
Small Commercial and Industrial Respondents												
NATIONAL GRID	N	0	6	3	10	0	5	2	2	2	5	35
	Column %	.0%	26.1%	23.1%	17.9%	.0%	35.7%	40.0%	8.7%	20.0%	10.9%	17.5%
NH ELEC COOP	N	1	2	2	10	5	0	0	3	1	11	35
	Column %	25.0%	8.7%	15.4%	17.9%	83.3%	.0%	.0%	13.0%	10.0%	23.9%	17.5%
PSNH	N	3	8	6	26	1	4	3	12	6	26	95
	Column %	75.0%	34.8%	46.2%	46.4%	16.7%	28.6%	60.0%	52.2%	60.0%	56.5%	47.5%
UNITIL	N	0	7	2	10	0	5	0	6	1	4	35
	Column %	.0%	30.4%	15.4%	17.9%	.0%	35.7%	.0%	26.1%	10.0%	8.7%	17.5%
Total	N	4	23	13	56	6	14	5	23	10	46	200
	Column %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Large Commercial and Industrial Respondents												
NATIONAL GRID	N	0	0	0	3	1	2	0	10	0	2	18
	Column %	.0%	.0%	.0%	14.3%	7.7%	16.7%	.0%	11.1%	.0%	9.1%	9.1%
NH ELEC COOP	N	1	2	0	0	3	0	1	2	2	1	12
	Column %	20.0%	28.6%	.0%	.0%	23.1%	.0%	6.3%	2.2%	50.0%	4.5%	6.1%
PSNH	N	4	5	7	15	8	9	15	73	2	16	154
	Column %	80.0%	71.4%	100.0%	71.4%	61.5%	75.0%	93.8%	81.1%	50.0%	72.7%	78.2%
UNITIL	N	0	0	0	3	1	1	0	5	0	3	13
	Column %	.0%	.0%	.0%	14.3%	7.7%	8.3%	.0%	5.6%	.0%	13.6%	6.6%
Total	N	5	7	7	21	13	12	16	90	4	22	197
	Column %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

3.3.6 Commercial and Industrial Customer Program Awareness and Participation

Respondents were polled to determine customer awareness and participation in the existing energy efficiency and incentive programs offered by the utility providers. Program awareness was significantly higher among the large commercial and industrial customers (86 percent) compared to small commercial and industrial customers (60 percent). Past participation in efficiency and incentive programs was also notably higher among large customers (85 percent) compared to small customers (30 percent). Differences in awareness and participation levels among utility providers were not statistically significant. Results of small and large customer surveys are summarized below in Table 37.

Table 37. Awareness of Existing Energy Efficiency Programs and Incentives

		Warehouse	Retail	Grocery	Office	Lodging	Health	Education	Industrial	Restaurant	Other	**Total**
Small Commercial and Industrial Respondents												
YES, AWARE	N	4	13	7	33	4	7	4	14	2	27	115
	Column %	100.0%	56.5%	53.8%	62.3%	66.7%	53.8%	80.0%	63.6%	20.0%	61.4%	**59.6%**
NO, NOT AWARE	N	0	10	6	20	2	6	1	8	8	17	78
	Column %	.0%	43.5%	46.2%	37.7%	33.3%	46.2%	20.0%	36.4%	80.0%	38.6%	40.4%
TOTAL	N	4	23	13	53	6	13	5	22	10	44	193
	Column %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Large Commercial and Industrial Respondents												
YES, AWARE	N	3	2	6	18	11	10	13	77	1	21	162
	Column %	60.0%	40.0%	85.7%	90.0%	84.6%	90.9%	92.9%	87.5%	25.0%	95.5%	**85.7%**
NO, NOT AWARE	N	2	3	1	2	2	1	1	11	3	1	27
	Column %	40.0%	60.0%	14.3%	10.0%	15.4%	9.1%	7.1%	12.5%	75.0%	4.5%	14.3%
TOTAL	N	5	5	7	20	13	11	14	88	4	22	189
	Column %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Respondents who indicated that they were aware of the existing efficiency and incentive programs offered by their utility providers were then asked whether they had participated in the programs. As summarized in Table 38 below, a substantial difference in participation levels was noted between small (30 percent) and large (86 percent) commercial and industrial respondents.

Table 38. Participation in Utility's Energy Efficiency Programs

		Warehouse	Retail	Grocery	Office	Lodging	Health	Education	Industrial	Restaurant	Other	**Total**
Small Commercial and Industrial Respondents												
YES	N	2	2	2	6	2	2	3	3	2	8	32
	Column %	50.0%	16.7%	28.6%	20.7%	66.7%	33.3%	75.0%	21.4%	100.0%	30.8%	**29.9%**
NO	N	2	10	5	23	1	4	1	11	0	18	75
	Column %	50.0%	83.3%	71.4%	79.3%	33.3%	66.7%	25.0%	78.6%	.0%	69.2%	70.1%
TOTAL	N	4	12	7	29	3	6	4	14	2	26	107
	Column %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Large Commercial and Industrial Respondents												
YES	N	3	1	2	14	8	8	13	66	1	12	128
	Column %	100.0%	100.0%	100.0%	82.4%	80.0%	88.9%	100.0%	88.0%	100.0%	66.7%	**85.9%**
NO	N	0	0	0	3	2	1	0	9	0	6	21
	Column %	.0%	.0%	.0%	17.6%	20.0%	11.1%	.0%	12.0%	.0%	33.3%	14.1%
TOTAL	N	3	1	2	17	10	9	13	75	1	18	149
	Column %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: This question was only asked of respondents who were aware of their utilities' energy efficiency programs

Small commercial and industrial respondents who indicated that they had not participated in the energy efficiency programs were asked additional questions regarding their nonparticipation. The most frequently given response for nonparticipation among small customers was they "have not purchased energy-using equipment" (49 percent). The next three most frequently cited reasons seem to relate to their lack of awareness of the programs. Of respondents who have participated in their utility's energy efficiency programs, a significant majority of both small customers (94 percent) and large customers (98 percent) reported that they would participate in the programs again if given the opportunity.

3.3.7 Commercial and Industrial Customer Motivations and Barriers

To first assess customer attitudes towards energy efficiency, respondents were asked to qualify the amount of attention they spend on controlling energy costs through general efficiency practices such as adjusting room temperatures when not occupied and shutting off computers and lights at night. As shown in Table 39, 86 percent of respondents indicated that they pay at least "some attention" to controlling energy costs. No significant differences were observed among any groups or between small and large customers.

Table 39. Attention Paid to Controlling Company Energy Costs – Small/Large Respondents Combined

	Frequency	Valid Percent
Substantial attention to these matters	165	43%
Some attention	163	43%
Very little attention	37	10%
No attention	13	3%
Don't know	4	1%
Total	382	100%

Respondents were then asked to rate the likelihood of purchasing energy efficient equipment instead of standard equipment given several conditions generally assumed to increase the attractiveness of adopting energy efficient equipment. Respondents were told to assume that the energy efficient cost between 20 and 30 percent more than standard models. Among all respondents, reduction of monthly energy bills and receiving a rebate were the reasons most likely to encourage the purchase of energy efficient equipment. Increasing occupant comfort, environmental protection and improving business image were less likely to motivate respondents to specify energy efficient equipment in both small and large customers. A complete summary of results across all building types is provided in Table 40 below.

Table 40. Likelihood of Purchasing Energy Efficient Equipment

		1=NOT AT ALL LIKELY	2	3	4	5= EXTREMELY LIKELY	TOTAL
Small Commercial and Industrial Respondents							
a… your monthly energy bill would be less	N	12	2	16	39	129	198
	Row %	**6%**	**1%**	**8%**	**20%**	**65%**	100%
b… it increased occupant comfort	N	19	5	38	40	97	199
	Row %	**10%**	**3%**	**19%**	**20%**	**49%**	100%
c… you felt you were helping to protect the environment	N	14	3	35	41	104	197
	Row %	**7%**	**2%**	**18%**	**21%**	**53%**	100%
d… it improved business image or value	N	21	4	29	49	94	197
	Row %	**11%**	**2%**	**15%**	**25%**	**48%**	100%
e… you received a rebate	N	17	2	20	31	128	198
	Row %	**9%**	**1%**	**10%**	**16%**	**65%**	100%
f… your sales person recommended it	N	23	11	44	41	75	194
	Row %	**12%**	**6%**	**23%**	**21%**	**39%**	100%
Large Commercial and Industrial Respondents							
a… your monthly energy bill would be less	N	4	9	25	49	94	181
	Row %	**2.2%**	**5.0%**	**13.8%**	**27.1%**	**51.9%**	100.0%
b… it increased occupant comfort	N	8	30	45	47	50	180
	Row %	**4.4%**	**16.7%**	**25.0%**	**26.1%**	**27.8%**	100.0%
c… you felt you were helping to protect the environment	N	5	21	45	48	63	182
	Row %	**2.7%**	**11.5%**	**24.7%**	**26.4%**	**34.6%**	100.0%
d… it improved business image or value	N	8	24	29	48	69	178
	Row %	**4.5%**	**13.5%**	**16.3%**	**27.0%**	**38.8%**	100.0%
e… you received a rebate	N	2	7	21	49	102	181
	Row %	**1.1%**	**3.9%**	**11.6%**	**27.1%**	**56.4%**	100.0%
f… your sales person recommended it	N	14	19	50	54	42	179
	Row %	**7.8%**	**10.6%**	**27.9%**	**30.2%**	**23.5%**	100.0%

Respondents were asked to identify the primary reasons why they would not purchase energy efficient equipment or make energy efficient improvements to the space. Table 41 provides a coded summary of the open-ended responses. By far the most frequent response was concerns over the cost of the equipment and the payback (69 percent). Other responses included satisfaction with current equipment (6 percent), purchasing decisions made at corporate level (5 percent), tenants unwilling to invest in capital improvements for spaces they do not own (4 percent), and no need to replace equipment that is currently in working order (3 percent). Other reasons cited included the use of specialized equipment and the belief that energy efficient equipment would be not available for the specialized process (3 percent), and the quality and reliability of energy efficient equipment (3 percent).

Table 41. Primary Reasons for Not Purchasing Equipment/Making Improvements – Small/Large

	Frequency	Valid Percent
Cost / benefit, payback	225	69%
Current equipment is satisfactory/no need	20	6%
Corporate decision	16	5%
Renting, not owner of property	13	4%
Replacing as needed	8	3%
Not compatible with business needs	10	3%
Quality	9	3%
Not well informed	4	1%
Other	21	6%
Total	326	100%

3.3.8 Commercial and Industrial Customer Program Participation and Barriers Summary

Of the small and large commercial and industrial customers surveyed, 86 percent of respondents reported some or high level of attention to controlling energy costs. Overall awareness of energy efficiency programs and incentives offered by utility providers was significantly higher in the large commercial/industrial respondents (86 percent) compared to the small commercial/industrial respondents (60 percent). Past participation in utility provider offered programs was similarly higher in the large customer group who was aware of the programs offered (86 percent) compared to the small customer group aware of the programs offered (30 percent). Of respondents who have participated in their utility's energy efficiency programs, a significant majority of both small customers (94 percent) and large customers (98 percent) reported that they would participate in the programs again if given the opportunity.

The single largest barrier to respondents investing in energy efficiency measures was concern about initial premium costs of equipment and insufficient payback (69 percent). Respondents indicated that the two most important factors influencing decisions to invest in energy efficient equipment are expectations of lower monthly energy bills and rebates or incentives for purchasing energy efficient equipment that would help offset some of the initial costs. Other factors such as business image, environmental impact, occupant comfort, and sales person recommendation were less likely to influence decisions to invest in energy efficient equipment.

3.4 Forecast Model of State Electricity and Natural Gas Consumption and Peak Demand

Results from this task were presented in Section 2.3 above. As noted previously these forecast models were compiled by RLW for this project based on sales information provided to the GDS Team directly by the project's four participating electric utilities and two participating natural gas distribution companies. Separate total and customer sector-specific energy (MWH), demand (MW) and fuel (MMBTu) forecasts were developed for the state as a whole and by utility service territory. Where applicable, these forecasts were compared against relevant ISO-NE and EIA data to assess reasonableness. Please refer to Figure 10, Figure 11, Figure 12, Figure 13, Figure 14, and Figure 15, presented in Section 2.3 of this report for a summary of these model forecast results.

As will be discussed in more detail in the additional energy efficiency potential modeling methodology section below, these customer-sector electric and gas forecast models served as critical inputs used to estimate the percent potential values for additional energy efficiency opportunities statewide. They were also used to develop energy efficiency potential percentages at the utility-specific territory level.

3.5 Estimates of 10-Year Technical, Maximum Achievable, Maximum Achievable Cost Effective Potentials and Potentially Obtainable Scenario

A main objective of this study was to estimate, state-wide and for each of the four New Hampshire retail electricity providers and two natural gas distribution companies, the technical, maximum achievable, maximum achievable cost effective potentials, and savings from a potentially obtainable scenario for electricity, natural gas, and related propane and fuel oil savings over the next 10 year period, and the budgets (where appropriate) required to achieve that potential. As described in more detail below, the activities undertaken to develop these estimates were based on the GDS Team's existing sector-level models, DR 96-150 cost-effectiveness criteria, and the region's current avoided energy cost projections, as expanded to reflect the increased list of measures to be assessed and customized based on state utility-specific data and the saturation and penetration survey results obtained through this project's survey and site visit activities. All results have been analyzed and compared for reasonableness against overall state consumption and consideration of past participation.

This section of the report presents an overview of the approach and methodology that was used to ultimately determine the various savings potentials additional energy efficiency opportunities in New Hampshire.

3.5.1 Energy Efficiency Potential – Key Data Sources

Data required for performing the energy efficiency potential analysis elements of this study can be grouped into three major categories:

- Measure-specific data including: energy savings (kWh, kW, MMBTu), measure costs (full/incremental), measure lives (full/effective and persistence), etc.

- New Hampshire customer-specific historical, current and forecasted data including: number and types of customers (residential, low income, single/multi-family, commercial, industrial), customer sales by customer class and end use (space heating, space cooling, water heating, lighting, etc.), customer types (SIC/NAICS), average size (square footage of typical single, multi-family homes and commercial/industrial buildings), typical energy use intensity broken down by end use (lighting, cooling, water heating, process), saturation of electric water heating, central cooling, other energy efficiency measures and appliances (and associated appliance saturation trends), and peak load coincidence factors for major electric end-uses by sector.

- New Hampshire statewide and utility-specific and other system-related data including: forecast of electric and natural gas avoided costs (generation, transmission, distribution), electric line losses, reserve margin planning assumption, general rate of inflation and appropriate discount rate, and information on environmental benefits that may occur per kWh or MMBTu saved from energy efficiency programs. Values and sources for these data are provided in Appendix H.

3.5.2 Energy Efficiency Potential Calculation Stages

Three key calculations that have been undertaken to complete this assessment are described below. Following the descriptions, these three stages of potential energy savings calculation are shown graphically in a Venn diagram in Figure 16.[34] A fourth stage, developed for this project, relates to calculation of the likely obtainable potential (a subset of the maximum achievable cost effective potential), and is described separately at the end of this section. Savings interactions for measures like lighting and lighting controls are taken into account at every potential stage listed below.

The first stage in determining energy efficiency potential requires estimation of the technical potential for energy savings in New Hampshire. **Technical potential** is defined as the complete penetration of all measures analyzed in applications where they are deemed to be technically feasible from an engineering perspective. The technical potential for electric energy efficiency for this study was developed from estimates of the technical potential of individual energy efficiency measures applicable to each sector and for relevant end-uses within each sector (residential, commercial, industrial, energy efficient space heating, energy efficient water heating, etc.). For each energy efficiency measure, GDS calculated the electricity savings that could be captured if 100 percent of inefficient electric appliances and equipment were replaced instantaneously (where they are deemed to be technically feasible). Separate technical potentials were calculated for natural gas and related propane and oil saving measures, also by sector and end-use.

The second stage relates to calculation of the maximum achievable energy efficiency potential. **Maximum Achievable potential** is defined as the maximum penetration of an efficient measure that would be adopted absent consideration of cost or customer behavior. The term "achievable" refers to efficiency measure penetration, based on estimates of New Hampshire-specific building stock, energy efficient equipment saturations and realistic penetration levels that can be achieved by 2018 if all remaining standard efficiency equipment were to be replaced on burnout (at the end of its useful measure life) and where all new construction and major renovation activities in the state were done using energy efficient equipment and construction/installation practices. Under this scenario, energy efficient measures with measure lives over ten (10) years would have their potential savings calculated based on the study life divided by measure life ((Study Life = 10) / Measure Life).

In certain circumstances, where early replacement of specific measures is becoming standard practice, maximum achievable potential includes the retrofit of measures before the end of their useful measure life (i.e., T8 lighting, insulation and weatherization of existing homes). In such cases, the entire stock of measures to be retrofitted were modeled so that all were replaced over the ten year study period.

Calculation of the Maximum Achievable Cost Effective (M.A.C.E) potential is the third stage. **Maximum Achievable Cost Effective potential** is defined as the potential for the realistic penetration of energy efficient measures that are cost effective according to the Total Resource Cost (TRC) Test, and would be adopted given aggressive funding levels, and was determined absent consideration of customer behavior. A concerted, sustained campaign involving highly aggressive programs and market interventions would be required to achieve this level of savings.

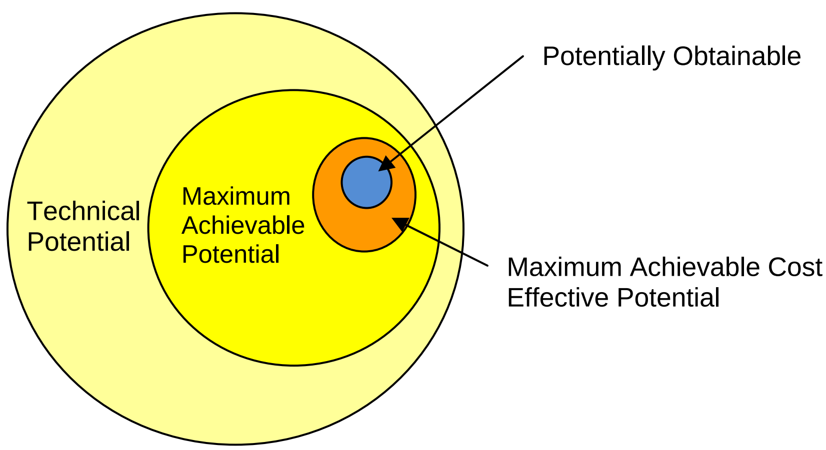
To develop the maximum achievable cost effective potential, GDS retains only those electric and non-electric energy efficiency measures in the analysis that were found to be cost effective (according to the TRC) based on individual measure cost effective analyses conducted in this study. Energy efficiency measures that are not cost effective were excluded from the estimate of maximum achievable cost effective energy efficiency potential.

Potentially Obtainable scenario is a new output developed for this study and can be defined as an estimate of the potential for the *realistic penetration over time* of energy efficient measures that are cost effective according to the NH TRC, and would be adopted after consideration of customer behavior and given aggressive funding levels, and by determining the level of market penetration that can be achieved with a concerted, sustained campaign involving highly aggressive programs and market interventions. As demonstrated later in this report, the State of New Hampshire and its electric and natural gas utilities would need to continue to undertake, and perhaps aggressively expand its efforts to achieve these levels of savings.

Based on information collected through this project's telephone surveys and site visits, a Potentially Obtainable scenario was developed for each customer sector by electric and non-electric fuel types.

Figure 16 below shows the four stages of electric energy savings potential (this Venn diagram figure is for illustrative purposes only and does not reflect actual data for New Hampshire).

Figure 16. Venn Diagram of the Stages of Energy Savings Potential



3.5.3 General Methodological Approach

The GDS Team's analytical approach began with a careful assessment of the existing saturation of energy using equipment and penetration of energy efficiency measures that has already been achieved in New Hampshire. As discussed earlier in this section, this was accomplished through a combination of primary data collection and identification, review and documentation of secondary data sources. For each energy efficiency measure, this analysis assessed how much energy efficiency has already been accomplished as well as the remaining potential for energy efficiency savings. For example, if 100 percent of the homes in New Hampshire had electric lighting, and 30 percent of light sockets were already using high efficiency compact fluorescent bulbs (CFLs), then the remaining potential for energy efficiency savings is the 70 percent of light sockets in the residential sector that are not already using high efficiency fluorescent bulbs.

The general methodology used for estimating the potential for energy efficiency in the residential, commercial and industrial sectors in New Hampshire included the following steps:

1. Identification of energy efficiency measures to be included in the assessment.
2. Identification of data sources for determining costs and savings for all electric and non-electric energy efficiency measures.
3. Determination of the characteristics of each energy efficiency measure including its incremental or total cost, electric energy consumption and savings, demand and MMBTu savings, current saturation, the percent of installations that are already energy efficient, and the useful life of the measure (with care taken to document the sources for each characteristic and to recognize potential difference in values by sector, building type and/or time of installation – i.e., new construction, existing buildings, replace on burnout, retrofit). In addition, the determination of any technical limitations or barriers that may be present when attempting to install an energy efficient measure is also considered.
4. Calculation of cost-effectiveness screening metrics (e.g., the Total Resource Cost Test benefit cost ratio) and sorting of measures from least-cost to highest cost per kWh (or MMBTu) saved. Interactions between measures were not considered for determining measure specific benefit cost ratios.
5. Collection and analysis (where data was available) of the baseline and forecasted characteristics of the electric and non-electric end use markets, including equipment saturation levels and consumption, by market segment and end use over the forecast period.
6. Integration of measure characteristics and baseline data to produce estimates of cumulative costs and savings across all measures.
7. Determination of the cumulative technical and maximum achievable potentials using supply curves, by sector (separately for electric and non-electric measures).
8. Determination of the achievable cost effective potential for electric and non-electric energy savings over the forecast period.
9. Estimation of the likely obtainable potential for electric and non-electric energy savings over the forecast period.

A key element in this approach is the use of energy efficiency supply curves. The advantage of using an energy efficiency supply curve is that it provides a clear, easy-to-understand framework for summarizing a variety of complex information about energy efficiency technologies, their costs, and the potential for energy savings. Properly constructed, an energy-efficiency supply curve avoids the double counting of energy savings across measures by accounting for interactions between measures. The supply curve also provides a simplified framework to compare the costs of energy efficiency measures with the costs of energy supply resources.

The supply curve is typically built up across individual measures that are applied to specific base-case practices or technologies by market segment. Measures are sorted on a least-cost basis and total savings are calculated incrementally with respect to measures that precede them. Supply curves typically, but not always, end up reflecting diminishing returns, i.e., costs increase rapidly and savings decrease significantly at the end of the curve. There are a number of other advantages and limitations of energy-efficiency supply curves (see, for example, Rufo 2003).[35]

[35] Rufo, Michael, 2003. *Attachment V – Developing Greenhouse Mitigation Supply Curves for In-State Sources, Climate Change Research Development and Demonstration Plan,* prepared for the California Energy Commission, Public Interest Energy Research Program, P500-03-025FAV, April. http://www.energy.ca.gov/pier/reports/500-03-025fs.html

3.5.4 Energy Efficiency Potential Calculations - Core Equations

This section describes the calculations used to estimate the energy efficiency potential in the residential, commercial, and industrial sectors. There is a core equation, shown below, used to estimate the technical potential for each individual efficiency measure and it is essentially the same for each sector. However, for the residential sector, the equation is applied using a "bottom-up" approach where the equation inputs are displayed in terms of the number of homes or the number of high efficiency units (e.g., compact fluorescent light bulbs, high efficiency air conditioning systems, programmable thermostats, etc.). For the commercial and industrial (C&I) sectors, a "top-down" approach was used for developing the technical potential estimates. In this case, the data is displayed in terms of energy rather than number of units or square feet of floor area.[36] For the commercial and industrial sectors, GDS used New Hampshire-specific equipment saturation and end use data wherever such data was available. The core equations used by GDS are very similar to the equations used in prior energy efficiency potential studies.

3.5.4.1 Core Equations for Estimating Technical Potential

The core equation used to calculate the energy efficiency technical potential for each individual efficiency measure for the residential sector is shown below. Section 4 provides more details on how this core equation was applied within the residential sector's bottom-up modeling approach.

Technical Potential of Efficient Measure	=	Total Number of Residential Households	X	Base Case Equipment End Use Intensity (annual kWh use per home)	X	Base Case Factor	X	Remaining Factor	X	Convertible Factor	X	Savings Factor

where:

- **Number of Households** is the number of residential customers in the market segment.

- **Base-case equipment end use intensity** is the energy used per customer per year by each base-case technology in each market segment. This is the consumption of the energy using equipment that the efficient technology replaces or affects. For example purposes only, if the efficient measure were a high efficiency light bulb (CFL), the base end use intensity would be the annual kWh use per bulb per socket associated with an incandescent light bulb that provides equivalent lumens to the CFL.

- **Base Case factor** is the fraction of the end use energy that is applicable for the efficient technology in a given market segment. For example, for residential lighting, this would be the fraction of all residential electric customers that have electric lighting in their household.

- **Remaining factor** is the fraction of applicable dwelling units or lighting sockets that have not yet been converted to the energy efficiency measure; that is, one minus the fraction of households that already have the energy-efficiency measure installed.

[36] It is important to note that square-foot based saturation assumptions cannot be applied to energy use values without taking into account differences in energy intensity (e.g., an area covered by a unit heater may represent two percent of floor space but a larger percent of space heating energy in the building because it is likely to be less efficient than the main heating plant).

- **Convertible factor** is the fraction of the applicable dwelling units that is technically feasible for conversion to the efficient technology from an *engineering* perspective (e.g., it may not be possible to install CFLs in all light sockets in a home because the CFLs may not fit in every socket in a home).

- **Savings factor** is the percentage reduction in energy consumption resulting from application of the efficient technology.

The core equation used to calculate the electric energy efficiency technical potential for each individual efficiency measure for the commercial and industrial sectors is shown below. More information is presented in Sections 5 and 6 regarding how this core equation was applied within the commercial and industrial sectors using the top-down modeling approach.

$$\text{Technical Potential of Efficient Measure} = \text{Total End Use kWh Sales by Building or Industry Type} \times \text{Base Case Factor} \times \text{Remaining Factor} \times \text{Convertible Factor} \times \text{Savings Factor}$$

where:

- **Total end use kWh or MMBTu sales (by segment)** is the forecasted level of electric or natural gas sales for a given end-use (e.g., space heating) in a commercial or industrial market segment (e.g., office buildings).

- **Base Case factor** is the fraction of the end use energy that is applicable for the efficient technology in a given market segment. For example, for fluorescent lighting, this would be the fraction of all lighting kWh in a given market segment that is associated with fluorescent fixtures.

- **Remaining factor** is the fraction of applicable kWh sales that are associated with equipment that has not yet been converted to the energy efficiency measure; that is, one minus the fraction of the market segment that already have the energy-efficiency measure installed.
- **Convertible factor** is the fraction of the equipment or practice that is technically feasible for conversion to the efficient technology from an *engineering* perspective (e.g., it may not be possible to install VFDs on all motors in a given market segment).

- **Savings factor** is the percentage reduction in energy consumption resulting from application of the efficient technology over the base technology.

Technical electric and non-electric energy efficiency savings potential was calculated in two steps. In the first step, all measures are treated *independently*; that is, the savings of each measure are not reduced or otherwise adjusted for overlap between competing or synergistic measures. By treating measures independently, their relative economics are analyzed without making assumptions about the order or combinations in which they might be implemented in customer buildings. However, the total technical potential across measures cannot be estimated by summing the individual measure potentials directly because some savings would be double-counted. For example, the savings from a weatherization measure, such as low-e ENERGY STAR® windows, are partially dependent on other measures that affect the efficiency of the system being used to cool or heat the building, such as high-efficiency space heating equipment or high efficiency air conditioning systems; the more efficient the space heating equipment or electric air conditioner, the less energy can be saved from the installation of low-e ENERGY STAR windows.

For the residential and commercial sectors, GDS addressed the new construction market as a separate market segment, with measures targeted specifically at the new construction market. In the residential new construction market segment, for example, detailed energy savings estimates for the ENERGY STAR Homes program were used as a basis for determining energy savings for this market segment in New Hampshire. For the commercial sector, in addition to end-use specific measures applicable to new construction projects, integrated design measures (e.g., for building shell, lighting design, etc.) were assessed. Within the new construction market segment for the commercial sector, an assumption was built into the model that ½ the commercial new construction sales were attributed to new construction projects, while the other half was directly attributable to growth of the existing commercial market segment. In the case of the industrial sector, the model functions very similarly but uses an all-inclusive factor which incorporates the four (4) factors discussed above into one multiplier to achieve the same approximate end result as the individual factor approach.

3.5.5 Rates of Implementation for Energy Efficiency Measures

For new construction, energy efficiency measures can be implemented when each new home or building is constructed, thus the rate of availability is a direct function of the rate of new construction. For existing buildings, determining the annual rate of availability of savings is more complex. Energy efficiency potential in the existing stock of buildings can be captured over time through two principal processes:

1. as equipment replacements are made normally in the market when a piece of equipment is at the end of its useful life (we refer to this as the “market-driven” or “replace-on-burnout” case); and,

2. at any time in the life of the equipment or building (which we refer to as the “retrofit” case).

Market-driven measures are generally characterized by incremental measure costs and savings (e.g., the incremental costs and savings of a high-efficiency versus a standard efficiency air conditioner); whereas retrofit measures are generally characterized by full costs and savings (e.g., the full costs and savings associated with retrofitting ceiling insulation into an existing attic). A specialized retrofit case is often referred to as “early replacement” or “early retirement”. This refers to a piece of equipment whose replacement is accelerated by several years, as compared to the market-driven assumption, for the purpose of capturing energy savings earlier than they would otherwise occur.

For the market driven measures, existing equipment is assumed to be replaced with high efficiency equipment at the time a consumer is shopping for a new appliance or other energy using equipment, or if the consumer is in the process of building or remodeling. Using this assumption, equipment that needs to be replaced (replaced on burnout) in a given year is eligible to be upgraded to high efficiency equipment. For the retrofit measures, savings can theoretically be captured at any time; however, in practice it takes many years to retrofit an entire stock of buildings, even with the most aggressive of efficiency programs.

As noted above, a special retrofit case is “early retirement” of energy equipment that is still functioning well, and replacing such equipment with high efficiency equipment. For this project, early retirements were considered only for a small number of measures (e.g., insulation/weatherization). For these early retirement energy efficiency measures, GDS assumed the same measure life for the measure that was replaced early as a time of replacement measure. In addition, savings were based on the whole measure life for retrofit / early replacement type measures.

3.5.6 Benefit/Cost (Cost-Effectiveness) Modeling

To determine maximum achievable cost effective potential GDS has used its existing energy efficiency measure and program screening tool. The GDS screening tool is user friendly, well documented, and provides the following benefit/cost ratio calculations: Total Resource Cost Test, Utility Cost Test, Participant Test, Rate Impact Measure Test, and Societal Test. For this Report, only the Total Resource Cost Test was used for screening purposes (consistent with New Hampshire utility and Commission procedures). The annual discount rate assumed for this test to determine net present values (NPV) is 5.0%.

The model is comprehensive and uses the following types of data as input: costs, useful lives and energy savings of energy efficiency, load management or demand response measures, load shape impacts of electric or natural gas energy efficiency measures, avoided costs of electricity for generation, transmission and distribution, avoided costs of natural gas and other fuels (propane, fuel oil, etc.), avoided water costs, projected or actual measure or program penetration assuming no program, projected or actual measure or program penetration with a program, participant costs, energy efficiency organization or utility costs (including rebates or financial incentives), non-energy benefits of measures or programs, electric line losses, discount rate, and inflation rate.

As noted above, the model provides calculations of five benefit/cost ratios as well as year-by-year and cumulative energy savings, dollar costs and dollar benefits. The GDS screening tool provides the flexibility to vary assumptions in the analysis to reflect uncertainty, changing market circumstance, statutory change or other factors that influence assessment of reasonably available potential through the efficiency utility. The GDS measure and program screening tool allows for the incorporation of changes to reflect real world circumstances and a dynamic environment. The GDS tool exists in a single Microsoft Excel file, and includes several linked worksheets that present clearly documented inputs and outputs. More information on the model and key input assumptions being used for this report is included in Appendix H.

3.6 Assessment of Past and Current Program Capture and Recommendations

For this task, the GDS Team evaluated the penetration of energy efficiency savings (electric and natural gas) resulting from past and current utility-sponsored program activities. A review of the utilities' annual Core New Hampshire Program Highlights reports formed the basis for this evaluation and results are presented from both a cumulative savings as a percent of sales and number of customers served as a percent of population basis. Recommendations for potential modifications to program and measure offerings that could increase the likelihood of achieving identified potentials are made and have been developed mainly through information on barriers collected directly from New Hampshire utility customers (through this project's telephone surveys and site visits) and supplemented by the GDS Team's experience with looking at programs from a logic-modeling perspective, and extensive knowledge of other local, regional and national programs and best practices.[37] Results from these analysis and assessments are presented in Section 8 of this report.

[37] Assessments based on a logic-modeling perspective recognize current program resources (dollars, staffing, etc.) and activities (measure installations, promotional rebates/incentives, marketing/outreach, education/training, etc.)

Section 4: Residential Sector Energy Efficiency Potential

This section of the report presents the estimates of electric and non-electric technical (best), technical (traditional), maximum achievable, maximum achievable cost effective, and potentially obtainable energy efficiency potential for the existing and new construction market segments of the residential sector in New Hampshire. More information regarding how these potentials were derived is also presented.

According to this analysis, there is still a large remaining potential for electric and non-electric energy efficiency savings in the residential sector. Table 42 and Table 43 below summarize the savings by potential type by the year 2018 for residential electric and non-electric measures respectively. The estimated total costs to achieve each level of savings by 2018 are also presented in these tables. In addition, Table 42 presents peak demand savings for each potential level of savings associated with the electric energy efficiency measures.

Table 42. Summary of Residential Electric Energy Efficiency Savings Potential

	Estimated Cumulative Annual Savings by 2018 (MWh)	Savings in 2018 as a Percent of Total 2018 Residential Sector Electric Energy Consumption	Estimated Summer MW*	Estimated Total Cost to Achieve (Cummulative)	Estimated Total Cost to Achieve (Annual)
Technical Potential (Best Only)	1,770,861	31.7%	66.7	$ 2,554,517,348	$ 255,451,735
Technical Potential (Good, Better, Best)	1,489,861	26.7%	56.1	$ 2,149,167,880	$ 214,916,788
Max Achievable Potential	1,217,145	21.8%	45.9	$ 1,214,926,125	$ 121,492,613
Max Achievable Cost Effective Potential	1,170,398	20.9%	44.1	$ 632,287,942	$ 63,228,794
Potentially Obtainable	698,069	12.5%	26.3	$ 383,050,068	$ 38,305,007

33% * Estimated Summer Load Factor

Table 43. Summary of Residential Non-Electric Energy Efficiency Savings Potential

	Estimated Cumulative Annual Savings by 2018 (MMBTU)	Savings in 2018 as a Percent of Total 2018 Residential Sector Other Fuels Energy Consumption	Estimated Total Cost to Achieve (Cummulative)	Estimated Total Cost to Achieve (Annual)
Technical Potential (Best Only)	16,918,392	50.4%	$ 3,220,297,934	$ 322,029,793
Technical Potential (Good/Better/Best)	12,099,639	35.7%	$ 2,277,404,262	$ 227,740,426
Max Achievable Potential	7,463,743	22.0%	$ 1,206,916,417	$ 120,691,642
Max Achievable Cost Effective Potential	6,313,954	18.6%	$ 456,169,489	$ 45,616,949
Potentially Obtainable	3,633,554	10.7%	$ 200,483,725	$ 20,048,372

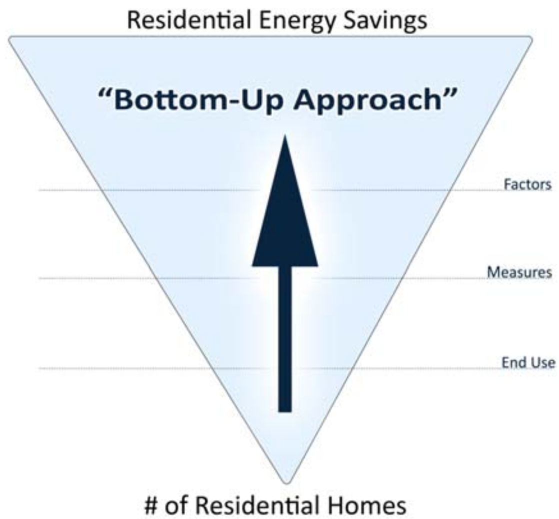
On the electric side, the maximum achievable cost effective potential in the residential sector is over 1.1 million MWh, approximately 21 percent of the New Hampshire residential sector sales forecast in 2018. With regard to non-electric end uses, the maximum achievable cost effective potential in the residential sector is more than 6.3 million MMBTu, just under 19 percent of New Hampshire's residential sector fossil fuel (natural gas, oil and propane) sales forecast in 2018. The lists of measures that make up the savings for each of these levels are shown in Table 44 and Table 45 in Section 4.2.1 below.

and seek to identify their causal links to anticipated outputs (measures installed, in-program energy and capacity savings, # of customers served, market actors trained, etc.), short-, intermediate- and long-term outcomes (changes in awareness and behavior, market-wide/sustainable energy, economic and environmental benefits, etc.). In addition, logic models recognize the existence and potential impacts of external influences (price of energy, state of the local and regional economy, federal tax incentives, other non-program sponsored activities, etc.).

4.1 Residential Sector Savings Methodology Overview

The residential sector analysis was modeled using what is considered a "bottom-up approach". This methodology, shown visually in Figure 17 below:

Figure 17. Residential Sector Savings Methodology – Bottom Up Approach



As shown in this figure, the methodology started at the bottom based on the number of residential customers (splitting them into single-family and multi-family customers as well as existing vs. new construction). From that point, each home was then broken into a series of end-uses depending on whether the home fits the single-family or multi-family profile. An example of an end-use might be "Single-Family Water Heating". From that point, a series of measures are identified that belong to that end-use. To keep with our example, we would then create a series of measures such as "Energy Star Clothes Washer", "Energy Star Dishwasher", "Pipe-Wrap", etc – all these measures fit into that end use category of Single-Family Water Heating.

The next step in our bottom up approach was to determine how many of the homes in the profile we are looking at (single-family or multi-family) have each of those measures within each of those end uses. This is one of the multiple applicability factors that were used to screen each measure to determine savings. The applicability factors include the base case factor, the remaining factor, the convertible factor, and the savings factor. The full formula to determine savings at the measure level is shown below.

$$\text{Technical Potential of Efficient Measure} = \text{Total Number of Residential Households} \times \text{Base Case Equipment End Use Intensity (annual kWh use per home)} \times \text{Base Case Factor} \times \text{Remaining Factor} \times \text{Convertible Factor} \times \text{Savings Factor}$$

The goal of the formula is to determine how many households this measure applies to (base case factor), then of that group, how many already have the efficient version of the measure we are installing (remaining factor). From there, we looked to make sure there were not any technical reasons why the measure cannot be installed, and if so, made a correction (convertible factor) for that reason. The last factor which needed to be applied was the savings factor, which is the percentage savings achieved from installing the efficient measure over a standard measure. In cases where multiple measures could interact within the same end use, a "more than one choice" factor was also included in the model to avoid double counting of potential savings. In addition, the model ranks measures by levelized cost in order to make assumptions about which measures will be installed in what order. This ranking also takes into account measure interactions where applicable so that savings are not over-stated due to double-counting. For example, if you install insulation and air seal, and then install a programmable thermostat, the savings potential for the thermostat is reduced to account for the reality that insulation has already been improved thus reducing the potential for higher levels of savings. This type of scenario is done throughout the residential model among a variety of scenarios within the models.

Another example to help illustrate the functionality of the model is single family homes with gas fired boilers. This measure would have space heating and space cooling measures installed in the following levelized cost order: programmable thermostats, energy efficient windows, and high efficiency boiler. The base use for space heating and space cooling would be adjusted based on savings from each measure. The full base use would have programmable thermostat savings applied. This new adjusted base use would then be used for the energy efficient window savings and finally the further adjusted base use would then be used for the high efficiency boiler savings.

One other example is single family homes with electric water heaters. In this case, the measure includes more than one choice for dishwasher upgrades and efficient electric water heaters upgrades. The electric water heating measures are in the following levelized cost order: low flow shower showerhead/faucets, Energy Star Dishwasher, efficient water heater, beyond Energy Star dishwasher, pipe wrap, high efficiency water heater, water heater blanket, Energy Star clothes washer, heat pump water heater, whole-house tankless water heater, and solar water heating. In this case the adjusted domestic hot water base use for calculated savings is more complicated. Where a second measure for the same use would be installed the base usage would not be reduced by the earlier measure. The most direct path for base usage reduction is the following: initial base usage is used for the low flow showerhead/faucets; then the Energy Star dishwasher reduces the domestic hot water base use by the percentage of this measure's electric savings that is associated with water heating; then the low flow and dishwasher reductions are used for the base usage for efficient water heater savings, then pipe wrap, then water heater blanket, then Energy Star Clothes Washer and finally solar water heating. In the case of high efficiency water heater- the base usage is decreased by low flow showerhead/faucets, Energy Star dishwasher water heating savings and pipe wrap before the high efficiency water heater savings are applied.

This type of process was run on every measure within all measure end-use categories and for all customer groups (single-family, multi-family, new construction, existing-construction – and blends thereof). This process, while described here at a very high level, was run within the confines of a complicated model under various scenarios to determine the varying savings potential levels.

In addition to the modeling technique described above, custom measures were included for the residential sector to achieve "Good, Better, Best" scenarios for weatherization (split further by each fuel type) and integrated building design (for each fuel type as well). All of these scenarios were reality-based through use of building simulation software to achieve targeted savings and cost levels for each distinct scenario level. This process required a mix of measures from lower cost and complexity to higher cost and complexity. The weatherization packages were designed to allow a degree of residential customers to follow a "good, better, or best" approach for insulating their existing home. For each of the weatherization approaches, a set of costs and savings assumptions were developed, as well as assumptions regarding current market penetration.

For the new home stock, a good, better, best approach was also created along with assumptions regarding the percentage of new home customers who would be likely to follow each approach. The assumption made was that 80% of new homes would do one of the three (3) packages, while the remaining 20% would not participate in efficiency programs or install efficiency measures. More information regarding the specific measures and associated costs included within each good, better, best scenario is presented in Appendix I.

The costs to achieve savings potential estimates within the residential sector are calculated on a measure by measure basis using the levelized cost ($/kWh in the electric model and $/MMBTu within the non-electric model) for each measure. These figures (levelized costs) represent the cost to save a unit of energy. These levelized costs are then taken and multiplied (again at the measure level) by the 2018 annual savings associated with the potential level being addressed (technical potential, maximum achievable, etc.). A net present value (NPV) formula is then used in conjunction with each measure's measure life along with an overall discount rate to determine the $ cost per /first year kWh (or MMBTu) saved for each measure. The cost per first year savings figure is then multiplied by the savings potential estimate being evaluated in order to yield the cost to achieve the savings potential in the year 2018 at the measure level. Each measure is then summed up at each potential level to yield the total cost to achieve savings in the residential sector (within the potential level being analyzed) to represent the cost to achieve the potential savings level by the year 2018. This number can then be divided by the study length (10 years) in order to yield an estimate of annual spending needed to reach the potential level target in question.

4.2 Residential Sector – Energy Efficiency Potential Results

Eighty-seven (87) residential electric, and one-hundred-ten (110) residential non-electric energy efficiency measures or programs were included in the analysis for the residential sector. In order to develop the list of energy efficiency measures to be examined, GDS worked closely with project sponsors and reviewed recent measure life, savings and cost assumptions studies including a Measure Life Report prepared by GDS for the New England State Program Working Group in June 2007 and a GasNetworks measures assumptions update project completed by GDS during the summer 2008. In addition, GDS reviewed other related electric and non-electric residential energy efficiency measure-specific data sources and technical potential studies that have been conducted recently in the US. Focus was for comprehensiveness on the electric and natural gas measures, less so for fuel oil and propane. Even within electric and natural gas some measures were not analyzed due to a combination of measure-specific-limitations, and unavailability of reliable data (e.g., A/C peak demand savings from off peak cooling with thermal energy storage, more advanced windows than double pane with low-E, super high efficient gas hot water heaters/boilers and combo systems, air drying of laundry, etc.).

The set of energy efficiency measures considered was pre-screened to include mainly those measures that are currently commercially available and cost effective (i.e., achieving a TRC benefit/cost ratios equal to or greater than 1.0 – although measures with TRC ratios between 0.9 and 1.0 were also included). Thus, emerging technologies not currently in the marketplace that had benefit cost ratios below 0.9 were not included in the analysis. The portfolio of measures includes retrofit and replace on burnout programmatic approaches to achieve energy efficiency savings.

4.2.1 Characteristics of Energy Efficiency Measures

GDS collected data on the energy savings, incremental costs, useful lives and other key "per unit" characteristics of each of the residential electric and non-electric energy efficiency measures. Estimates of the size of the eligible market were also developed for each efficiency measure. For example, electric water heater efficiency measures are only applicable to those homes in New Hampshire that have electric water heaters. More information regarding measure-specific savings, cost and measure life assumptions can be found in Appendix E.

For the residential new construction market segment, GDS calculated a forecast of the number of new homes estimated to be built each year based on NH new housing permits as reported by the US census bureau[38] The sizes of various end-use market segments were informed based on project primary data collection efforts. This analysis is based on the most recent residential electric sales forecast for New Hampshire for the years 2009 to 2018.[39] Energy-efficiency measures were analyzed for the most important electric and non-electric consuming end uses in the residential sector.

Tables[40] 44 and 45 below list the residential sector electric and non-electric energy efficiency measures included in the technical (best), technical (traditional), maximum achievable, maximum achievable cost effective, and potentially obtainable potential analyses.

[38] The source of this economic/demographic forecast for NH is the US Census Bureau's reporting of new building permits. http://www.census.gov/const/www/permitsindex.html

[39] This residential sector load forecast was provided to GDS by project sponsors.

Table 44. Residential Electric Energy Efficiency Savings Potential by Measure

Measure Name	Tech. Potential	Max. Achievable	Max. Achievable C.E.	% of MACE	Pot. Obtainable
CFL Bulbs (Homes w/ partial CFL installation)-High Use	205,995,520	205,995,520	205,995,520	17.6%	150,376,729
Timers/Motion/Photocell controlled outdoor lighting	165,140,752	165,140,752	165,140,752	14.1%	60,276,374
CFL Bulbs (Homes w/ no CFL bulbs installed)-High Use	127,335,921	127,335,921	127,335,921	10.9%	92,955,222
Phantom Power	107,603,656	107,603,656	107,603,656	9.2%	39,275,334
Second Refrigerator Turn In	91,805,345	91,805,345	91,805,345	7.8%	67,017,902
CFL Bulbs (Homes w/ partial CFL installation)-Low Use	74,907,462	62,422,885	62,422,885	5.3%	45,568,706
Energy Star Clothes Washer (w/ Electric DWH)	44,725,994	40,659,995	40,659,995	3.5%	29,681,796
Energy Star office equipment including monitors, copiers, multi-function machines.	39,473,144	39,473,144	39,473,144	3.4%	28,815,395
CFL Bulbs (Homes w/ no CFL bulbs installed)-Low Use	46,303,971	38,586,643	38,586,643	3.3%	28,168,249
Efficient Furnace Fan (Non-Electric Furnace)	58,906,077	32,725,599	32,725,599	2.8%	11,944,843
Integrated Building Design - Good (ENERGY STAR Home ~ 20% Savings) - Oil Heat	48,692,079	19,476,832	19,476,832	1.7%	14,218,087
Energy Star Compliant Top Freezer Refrigerator	21,277,584	16,367,372	16,367,372	1.4%	11,948,182
Integrated Building Design - Better (ENERGY STAR Home ~35% Savings) -Oil Heat	39,392,813	15,757,125	15,757,125	1.3%	6,188,189
Low Flow Showerhead/Faucets	11,734,228	11,734,228	11,734,228	1.0%	8,565,987
Insulation/weatherization package - Good (Improved Base Home) - Oil Heat + Central Air	21,746,630	10,873,315	10,873,315	0.9%	3,960,640
LED options, inc. MR 16, R16, R20, R30, R38 & G25	21,171,891	10,585,946	10,585,946	0.9%	3,863,870
Programmable Thermostats (Electric Heat)	9,418,498	9,418,498	9,418,498	0.8%	6,875,503
Second Freezer Turn In	8,651,053	8,651,053	8,651,053	0.7%	6,315,269
Energy Star Compliant Side by Side Refrigerator	9,482,762	7,294,433	7,294,433	0.6%	5,324,936
TVs - Energy Star over standard	7,026,645	7,026,645	7,026,645	0.6%	5,129,451
Energy Star Dehumidifer	8,424,392	7,020,326	7,020,326	0.6%	5,124,838
Energy Star Room A/C	8,236,565	6,863,804	6,863,804	0.6%	5,010,577
Energy Star Dishwasher (w/ Electric DHW)	7,098,605	6,453,277	6,453,277	0.6%	4,710,892
Insulation/weatherization package - Better (Improved Base Home to Current NH Code) - Oil Heat + Central Air	12,684,414	6,342,207	6,342,207	0.5%	51,140
Energy Efficient Windows (Room AC)	15,369,234	6,147,694	6,147,694	0.5%	2,243,908
Energy Efficient Windows - oil (Heating + Central Air)	15,172,710	6,069,084	6,069,084	0.5%	2,215,216
Integrated Building Design - Best (ENERGY STAR Home ~ 50% Savings) - Oil Heat	13,622,813	5,449,125	5,449,125	0.5%	2,151,414
Beyond Energy Star Dishwasher (w/Electric DHW)	5,237,876	4,761,706	4,761,706	0.4%	3,476,045
Energy Efficient Windows (Electric Heat)	10,532,367	4,212,947	4,212,947	0.4%	3,075,451
Insulation/weatherization package - Best (Major Renovation to ES Home Levels) - LPG Heat + Central Air	8,372,210	4,186,105	4,186,105	0.4%	0
Heat Pump Water Heater	4,181,204	4,181,204	4,181,204	0.4%	1,526,140
Energy Star Dishwasher (w/Oil DHW)	4,572,751	4,157,046	4,157,046	0.4%	3,034,644
Insulation/weatherization package - Good (Improved Base Home) - Gas Heat + Central Air	7,976,442	3,988,221	3,988,221	0.3%	1,455,701
High Efficiency Heat Pump (Tier 2)	6,466,816	3,592,676	3,592,676	0.3%	1,658,075
Energy Star Dishwasher (w/Gas DHW)	3,880,464	3,527,695	3,527,695	0.3%	2,575,217
Insulation & Weatherization Package (Electric Heat) Good	6,507,879	3,253,939	3,253,939	0.3%	1,187,688
Beyond Energy Star Dishwasher (w/Oil DHW)	3,363,504	3,057,731	3,057,731	0.3%	2,232,143
Energy Star Dishwasher (w/Propane DHW)	2,995,915	2,723,559	2,723,559	0.2%	1,604,550
Energy Star Compliant Chest Freezer	3,524,694	2,711,303	2,711,303	0.2%	1,979,251
Duct Sealing (Electric Heat)	5,401,970	2,700,985	2,700,985	0.2%	1,971,719
Beyond Energy Star Dishwasher (w/Gas DHW)	2,854,290	2,594,809	2,594,809	0.2%	1,894,211
Insulation/weatherization package - Good (Improved Base Home) - LPG Heat + Central Air	5,113,583	2,556,791	2,556,791	0.2%	922,897
Energy Star Compliant Upright Freezer	3,290,681	2,531,293	2,531,293	0.2%	1,847,844
High Efficiency Heat Pump (Tier 1)	4,514,842	2,508,246	2,508,246	0.2%	915,510

Table 44. Residential Electric Energy Efficiency Savings Potential by Measure - Continued

Measure Name	Tech. Potential	Max. Achievable	Max. Achievable C.E.	% of MACE	Pot. Obtainable
Insulation & Weatherization Package (Electric Heat) Better	4,898,758	2,449,379	2,449,379	0.2%	894,023
Tree Shading (Room AC)	6,976,963	2,325,654	2,325,654	0.2%	848,864
Duct Sealing - oil (Heating + Central Air)	4,570,466	2,285,233	2,285,233	0.2%	834,110
Energy Star Clothes Washer (w/ Oil DHW)	2,489,692	2,263,357	2,263,357	0.2%	826,125
Pipe Wrap	3,277,927	2,185,285	2,185,285	0.2%	1,595,258
High efficiency water heater (EF=0.95)	2,736,087	2,104,682	2,104,682	0.2%	1,536,418
Water Heater Blanket	2,077,424	2,077,424	2,077,424	0.2%	1,516,520
Efficient Water Heater (EF=0.93)	2,678,040	2,060,031	2,060,031	0.2%	1,503,822
Energy Star Compliant Bottom Freezer Refrigerator	2,661,458	2,047,276	2,047,276	0.2%	1,494,511
Insulation/weatherization package - Better (Improved Base Home to Current NH Code) - Gas Heat + Central Air	4,015,396	2,007,698	2,007,698	0.2%	166,232
Beyond Energy Star Dishwasher (w/Propane DHW)	2,203,656	2,003,324	2,003,324	0.2%	1,462,427
Energy Efficient Windows - gas (Heating + Central Air)	3,538,338	1,415,335	1,415,335	0.1%	516,597
Energy Star Clothes Washer (w/ Propane DHW)	1,519,589	1,381,445	1,381,445	0.1%	504,227
Integrated Building Design - Better (ENERGY STAR Home ~35% Savings) - Gas Heat	3,363,578	1,345,431	1,345,431	0.1%	491,082
Energy Star Clothes Washer (w/ Gas DHW)	2,038,750	1,853,409	1,170,851	0.1%	427,361
High Efficiency Central AC (Tier 1)	2,515,680	1,397,600	1,144,235	0.1%	0
Integrated Building Design - Better (ENERGY STAR Home ~35% Savings) - LPG Heat	2,838,541	1,135,416	1,135,416	0.1%	414,427
Pool Pump and Motor	1,659,631	1,106,421	1,106,421	0.1%	807,687
Programmable Thermostats - oil (Heating + Central Air)	846,592	812,980	812,980	0.1%	296,738
Programmable Thermostats - gas (Heating + Central Air)	751,225	751,225	751,225	0.1%	357,694
Insulation & Weatherization Package (Electric Heat) Best	1,416,236	708,118	708,118	0.1%	212,950
Integrated Building Design - Better (ENERGY STAR Home ~35% Savings) - Electric Heat	1,745,380	698,152	698,152	0.1%	254,825
Duct Sealing - gas (Heating + Central Air)	1,355,776	677,888	677,888	0.1%	247,429
Energy Star Compliant Upright Freezer	874,682	672,832	672,832	0.1%	491,167
Integrated Building Design - Best (ENERGY STAR Home ~ 50% Savings) -Gas Heat	1,346,178	538,471	538,471	0.0%	196,542
Integrated Building Design - Good (ENERGY STAR Home ~ 20% Savings) - Electric Heat	1,149,297	459,719	459,719	0.0%	301,158
Tree Shading - gas (Heating + Central Air)	1,325,456	441,819	441,819	0.0%	161,264
Insulation/weatherization package - Better (Improved Base Home to Current NH Code) - LPG Heat + Central Air	864,447	432,223	432,223	0.0%	38,072
Integrated Building Design - Best (ENERGY STAR Home ~ 50% Savings) - LPG Heat	1,018,369	407,348	407,348	0.0%	148,682
Integrated Building Design - Best (ENERGY STAR Home ~ 50% Savings) - Electric Heat	935,329	374,132	374,132	0.0%	136,558
Integrated Building Design - Good (ENERGY STAR Home ~ 20% Savings) - Gas Heat	520,330	208,132	208,132	0.0%	26,509
Integrated Building Design - Good (ENERGY STAR Home ~ 20% Savings) - LPG Heat	333,721	133,488	133,488	0.0%	7,247
Tree Shading - oil (Heating + Central Air)	138,851	46,284	46,284	0.0%	16,894
Insulation/weatherization package - Best (Major Renovation to ES Home Levels) - Oil Heat + Central Air	7,895,202	3,947,601	0	0.0%	0
Insulation/weatherization package - Best (Major Renovation to ES Home Levels) - Gas Heat + Central Air	2,082,545	1,041,272	0	0.0%	0
Ground Source Heat Pump	6,446,371	3,503,462	0	0.0%	0
Whole-House Tankless Water Heater - Electric <=12 kW	1,638,636	819,318	0	0.0%	0
HVAC Tune-Up	1,722,490	1,722,490	0	0.0%	0
High Efficiency Central AC (Tier 2)	3,130,624	1,739,235	0	0.0%	0
Solar Water Heating	28,785,190	14,392,595	0	0.0%	0
Insulation & Weatherization Package (Room AC)	3,290,327	1,645,164	0	0.0%	0
Induction Cooktop vs Electric Coil Cooktop	33,999,845	16,999,922	0	0.0%	0
Grand Total	**1,489,861,317**	**1,217,144,947**	**1,170,397,964**	**100.0%**	**698,069,156**

Table 45. Residential Non-Electric Energy Efficiency Savings Potential by Measure

Measure Name	Tech. Potential	Max. Achievable	Max. Achievable C.E.	% of MACE	Potentially Obtainable
Programmable Thermostats (SF) - oil boiler (Heating only)	605,009	605,009	605,009	9.6%	441,656
High Efficiency Water Heater - Oil (EF=0.66)	434,489	434,489	434,489	6.9%	158,589
High Efficiency Furnace - Natural Gas	621,946	310,973	310,973	4.9%	227,010
Insulation/weatherization package - single family - Good (Improved Base Home) - Oil Heat + Central Air	571,525	285,763	285,763	4.5%	208,607
Insulation/weatherization package - single family - Better (Improved Base Home to Current NH Code) - Oil Heat + Central Air	539,052	269,526	269,526	4.3%	98,377
Energy Efficient Windows (SF) - oil heat	551,014	220,406	220,406	3.5%	160,896
Programmable Thermostats (SF) - oil furnace (Heating only)	209,283	209,283	209,283	3.3%	152,777
High Efficiency Boiler - Oil	350,960	175,480	169,331	2.7%	61,806
HVAC Tune-Up (Gas Heat)	160,093	160,093	160,093	2.5%	58,434
HVAC Tune-Up (Oil Heat)	153,010	153,010	153,010	2.4%	55,849
High Efficiency Furnace - Propane	279,335	139,667	139,667	2.2%	101,957
Duct Sealing - oil	276,937	138,468	138,468	2.2%	101,082
Energy Star Dishwasher (w/Oil DHW)	143,164	130,149	130,149	2.1%	95,009
High Efficiency Water Heater - Propane (EF=0.67)	126,173	126,173	126,173	2.0%	46,053
Gas-Condensing Water Heater - Propane (EF=0.80)	168,449	112,299	112,299	1.8%	40,989
Energy Star Clothes Washer (w/ Gas DHW)	113,205	102,914	102,914	1.6%	37,564
High Efficiency Water Heater - Natural Gas (EF=0.62)	100,211	100,211	100,211	1.6%	73,154
High Efficiency Boiler - Natural Gas	192,623	96,312	96,312	1.5%	35,154
Energy Star Dishwasher (w/Gas DHW)	103,568	94,153	94,153	1.5%	68,731
Energy Star Clothes Washer (w/ Oil DHW)	101,425	92,205	92,205	1.5%	33,655
Beyond Energy Star Dishwasher (w/Oil DHW)	97,481	88,619	88,619	1.4%	64,692
Insulation/weatherization package - multi family - Good (Improved Base Home) - Gas Heat + Central Air	155,600	77,800	77,800	1.2%	28,397
Integrated Building Design - Good (ENERGY STAR Home ~ 20% Savings) - Oil Heat	189,676	75,870	75,870	1.2%	55,385
Integrated Building Design - Better (ENERGY STAR Home ~35% Savings) -Oil Heat	188,754	75,501	75,501	1.2%	27,558
Insulation/weatherization package - multi family - Better (Improved Base Home to Current NH Code) - Gas Heat + Central Air	146,917	73,459	73,459	1.2%	26,812
High Efficiency Furnace - Oil	145,664	72,832	72,832	1.2%	26,584
Insulation/weatherization package - single family - Good (Improved Base Home) - Gas Heat + Central Air	143,455	71,727	71,727	1.1%	52,361
Insulation/weatherization package - single family - Good (Improved Base Home) - LP Heat + Central Air	139,226	69,613	69,613	1.1%	50,817
Programmable Thermostats (MF) - oil furnace (Heating only)	68,593	68,593	68,593	1.1%	50,073
High Efficiency Boiler - Propane	134,939	67,470	67,470	1.1%	24,626
Insulation/weatherization package - single family - Better (Improved Base Home to Current NH Code) - LP Heat + Central Air	133,258	66,629	66,629	1.1%	24,320
Programmable Thermostats (MF) - gas boiler (Heating only)	66,583	66,583	66,583	1.1%	48,606
Beyond Energy Star Dishwasher (w/Gas DHW)	70,520	64,109	64,109	1.0%	46,800
Insulation/weatherization package - single family - Better (Improved Base Home to Current NH Code) - Gas Heat + Central Air	125,400	62,700	62,700	1.0%	22,885
Programmable Thermostats (SF) - oil furnace (Heating + Central Air)	61,041	61,041	61,041	1.0%	44,560
Integrated Building Design - Better (ENERGY STAR Home ~35% Savings) - Gas Heat	147,142	58,857	58,857	0.9%	32,935
Energy Star Dishwasher (w/Propane DHW)	62,189	56,536	56,536	0.9%	41,271
Low Flow Showerhead/Faucets -Oil	53,708	53,708	53,708	0.9%	39,207
Energy Efficient Windows (SF) - gas heat	133,249	53,300	53,300	0.8%	38,909
Programmable Thermostats (SF) - oil boiler (Heating + Central Air)	52,609	52,609	52,609	0.8%	38,405
Integrated Building Design - Good (ENERGY STAR Home ~ 20% Savings) - Gas Heat	128,988	51,595	51,595	0.8%	37,665
Programmable Thermostats (MF) - gas furnace (Heating only)	50,416	50,416	50,416	0.8%	36,804
Energy Efficient Windows (SF) - propane heat	120,994	48,398	48,398	0.8%	35,330
Duct Sealing - gas	92,746	46,373	46,373	0.7%	33,852
Gas-Condensing Water Heater - Natural Gas (EF=0.80)	68,060	45,374	45,374	0.7%	16,561
Programmable Thermostats (MF) - gas furnace (Heating + Central Air)	40,963	40,963	40,963	0.6%	29,903
Energy Efficient Windows (MF) - gas heat	100,748	40,299	40,299	0.6%	29,418
Integrated Building Design - Best (ENERGY STAR Home ~ 50% Savings) - Oil Heat	99,121	39,649	39,649	0.6%	14,472
Energy Star Clothes Washer (w/ Propane DHW)	42,478	38,617	38,617	0.6%	14,095
Beyond Energy Star Dishwasher (w/Propane DHW)	42,345	38,496	38,496	0.6%	28,102
Integrated Building Design - Better (ENERGY STAR Home ~35% Savings) - LPG Heat	93,662	37,465	37,465	0.6%	16,426
Insulation/weatherization package - multi family - Good (Improved Base Home) - Oil Heat + Central Air	70,647	35,324	35,324	0.6%	12,893
Programmable Thermostats (SF) - propane boiler (Heating only)	32,551	32,551	32,551	0.5%	23,762
Duct Sealing - Propane	64,857	32,429	32,429	0.5%	11,836
Low Flow Showerhead/Faucets - Natural Gas	32,090	32,090	32,090	0.5%	11,713

Table 45. Residential Non-Electric Energy Efficiency Savings Potential by Measure - Continued

Measure Name	Tech. Potential	Max. Achievable	Max. Achievable C.E.	% of MACE	Potentially Obtainable
Integrated Building Design - Good (ENERGY STAR Home ~ 20% Savings) - LPG Heat	79,145	31,658	31,658	0.5%	23,110
Programmable Thermostats (SF) - propane furnace (Heating only)	30,047	30,047	30,047	0.5%	21,934
Insulation/weatherization package - multi family - Better (Improved Base Home to Current NH Code) - Oil Heat + Central Air	54,490	27,245	27,245	0.4%	9,944
Integrated Building Design - Best (ENERGY STAR Home ~ 50% Savings) -Gas Heat	62,247	24,899	24,899	0.4%	13,694
Whole-House Tankless Water Heater - Nat Gas <=200 kBTUH	36,691	24,461	24,461	0.4%	8,928
Programmable Thermostats (MF) - oil boiler (Heating only)	23,928	23,928	23,928	0.4%	17,467
Insulation/weatherization package - single family - Best (Major Renovation to ES Home Levels) - LP Heat + Central Air	45,444	22,722	22,722	0.4%	8,293
Programmable Thermostats (SF) - gas furnace (Heating only)	22,345	22,345	22,345	0.4%	16,312
Energy Efficient Windows (MF) - oil heat	49,510	19,804	19,804	0.3%	14,457
Insulation/weatherization package - multi family - Good (Improved Base Home) - LP Heat + Central Air	38,286	19,143	19,143	0.3%	6,987
Low Flow Showerhead/Faucets - LP Gas	18,185	18,185	18,185	0.3%	6,637
Insulation/weatherization package - multi family - Better (Improved Base Home to Current NH Code) - LP Heat + Central Air	34,424	17,212	17,212	0.3%	6,282
Integrated Building Design - Best (ENERGY STAR Home ~ 50% Savings) - LPG Heat	41,079	16,432	16,432	0.3%	7,112
Programmable Thermostats (SF) - gas boiler (Heating only)	14,897	14,897	14,897	0.2%	10,875
Programmable Thermostats (SF) - gas furnace (Heating + Central Air)	13,035	13,035	13,035	0.2%	9,515
Programmable Thermostats (SF) - propane furnace (Heating + Central Air)	12,520	12,520	12,520	0.2%	9,139
Programmable Thermostats (MF) - oil furnace (Heating + Central Air)	11,432	11,432	11,432	0.2%	8,346
Improved Steam Vents (SF) - oil	22,574	11,287	11,287	0.2%	8,239
Energy Efficient Windows (MF) - Propane heat	25,226	10,090	10,090	0.2%	7,366
Pipe Wrap - oil DHW	12,853	8,569	8,569	0.1%	3,128
Insulation/weatherization package - multi family - Best (Major Renovation to ES Home Levels) - LP Heat + Central Air	12,671	6,336	6,336	0.1%	2,313
Programmable Thermostats (SF) - propane boiler (Heating + Central Air)	5,008	5,008	5,008	0.1%	3,656
Programmable Thermostats (MF) - propane boiler (Heating only)	4,711	4,711	4,711	0.1%	3,439
Efficient Steam Boiler (SF) - oil	8,486	3,394	3,394	0.1%	1,239
Programmable Thermostats (MF) - gas boiler (Heating + Central Air)	3,171	3,171	3,171	0.1%	2,315
Improved Steam Vents (SF) - Propane	5,958	2,979	2,979	0.0%	1,087
Programmable Thermostats (MF) - propane furnace (Heating only)	2,809	2,809	2,809	0.0%	2,051
Programmable Thermostats (MF) - propane furnace (Heating + Central Air)	2,809	2,809	2,809	0.0%	2,051
Improved Steam Vents (SF) - gas	2,980	1,490	1,490	0.0%	544
Mainline Air vent (MF) - gas	4,112	1,371	1,371	0.0%	1,001
Thermostatic vents (MF) - gas	2,122	1,061	1,061	0.0%	387
Efficient Steam Boiler (SF) - Propane	2,197	879	879	0.0%	321
Insulation/weatherization package - single family - Best (Major Renovation to ES Home Levels) - Gas Heat + Central Air	41,827	20,913	0	0.0%	0
Efficient Steam Boiler (MF) - Propane	0	0	0	0.0%	0
Programmable Thermostats (MF) - propane boiler (Heating + Central Air)	0	0	0	0.0%	0
Efficient Steam Boiler (MF) - gas	749	299	0	0.0%	0
Insulation/weatherization package - multi family - Best (Major Renovation to ES Home Levels) - Oil Heat + Central Air	14,063	7,031	0	0.0%	0
Solar Water Heating - Active, w/ Gas Backup	612,919	306,459	0	0.0%	0
Indirect-fired domestic water heater - NG boiler w/ EF = 0.65	27,384	18,256	0	0.0%	0
Efficient Steam Boiler (SF) - gas	1,099	440	0	0.0%	0
Insulation/weatherization package - single family - Best (Major Renovation to ES Home Levels) - Oil Heat + Central Air	152,847	76,424	0	0.0%	0
High Efficiency Water Heater - Natural Gas (EF=0.67)	80,520	80,520	0	0.0%	0
Programmable Thermostats (SF) - gas boiler (Heating + Central Air)	0	0	0	0.0%	0
Insulation/weatherization package - multi family - Best (Major Renovation to ES Home Levels) - Gas Heat + Central Air	52,375	26,187	0	0.0%	0
Mainline Air vent (MF) - Propane	0	0	0	0.0%	0
Programmable Thermostats (MF) - oil boiler (Heating + Central Air)	0	0	0	0.0%	0
Pipe Wrap - gas DHW	3,854	2,570	0	0.0%	0
Solar Water Heating - Active, w/ Oil Backup	897,169	448,584	0	0.0%	0
Solar Water Heating - Active, w/ Propane Backup	309,452	154,726	0	0.0%	0
Thermostatic vents (MF) - oil	0	0	0	0.0%	0
Pipe Wrap - LPG DHW	507	338	0	0.0%	0
Thermostatic vents (MF) - Propane	0	0	0	0.0%	0
Efficient Steam Boiler (MF) - oil	0	0	0	0.0%	0
Pipe Wrap - Propane DHW	1,337	891	0	0.0%	0
Mainline Air vent (MF) - oil	0	0	0	0.0%	0
Grand Total	**12,099,639**	**7,463,743**	**6,313,954**	**100.0%**	**3,633,554**

4.2.2 Residential Energy Efficiency Potential Comparisons and Savings By Measure Type

Figure 18 and Figure 19 display a graphical comparison of the varying degrees of potential results for both the electric and non-electric sector.

Figure 18. Residential Electric Savings Potential Results Comparison

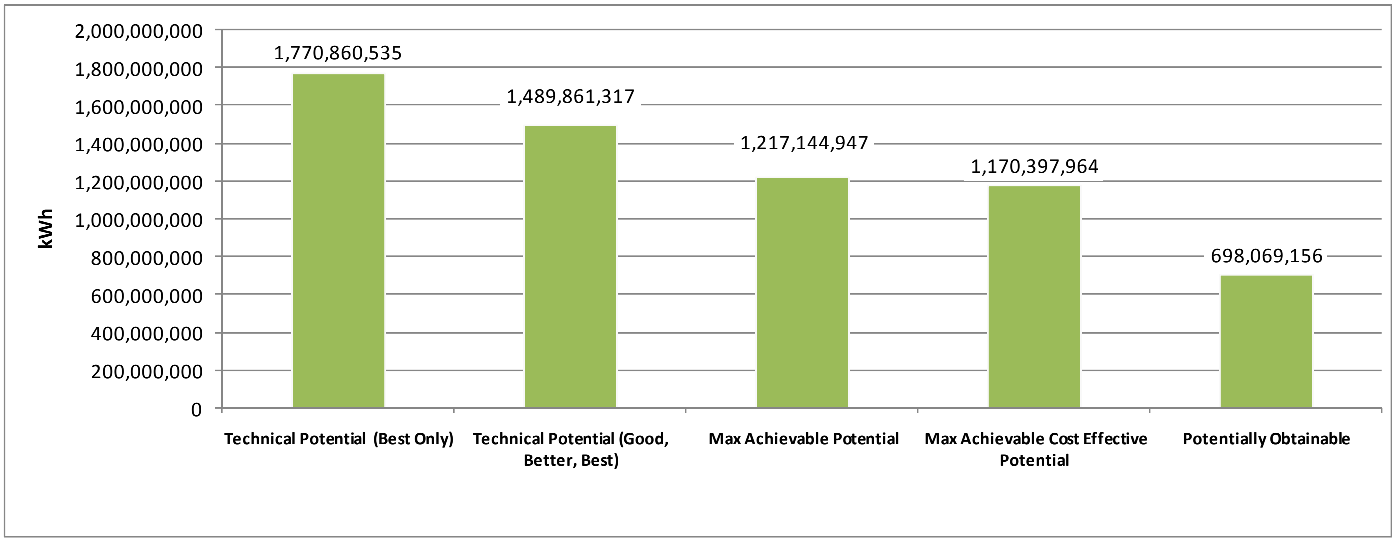


Figure 19. Residential Non-Electric Savings Potential Results Comparison

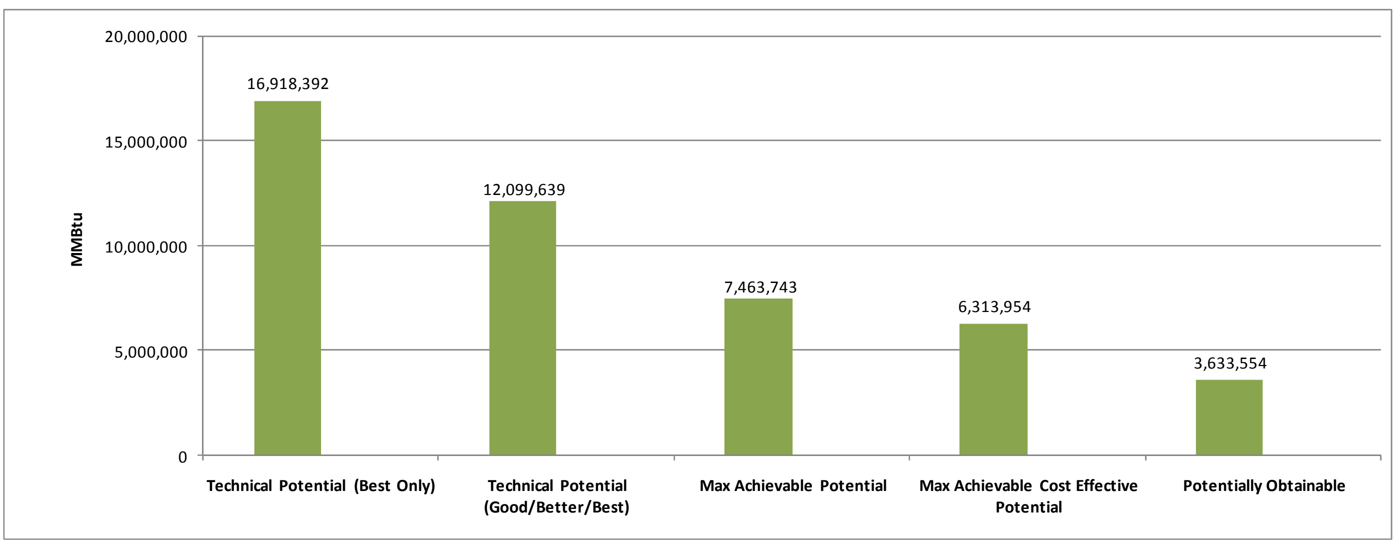


Figure 20 displays a graphical comparison of the varying electrical end-uses within the residential sector. As shown, lighting single-family and lighting multi-family make up the greatest savings potential focus areas (52% combined), followed by electric appliances at 16 percent (SF and MF combined), space heating and cooling (10% combined SF and MF), standby (phantom-load) power and water heating at nine percent each (SM/MF combined).

Figure 20. Residential Max. Achievable Cost Effective <u>Electric</u> Savings Potential by End Use

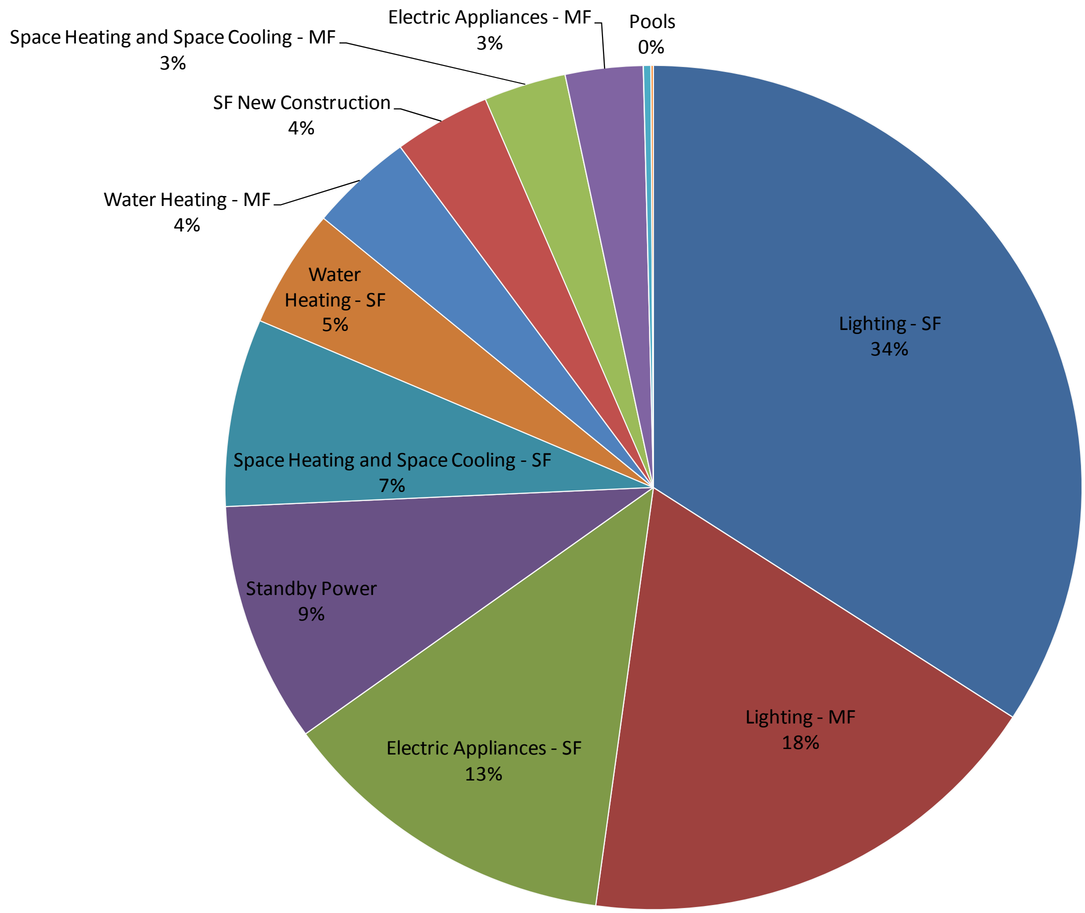


Figure 21 displays a graphical comparison of the varying non-electric end-uses within the residential sector. As shown, single-family home oil heating measures represent the largest area of savings potential at 25%, followed by single-family water heating at 18%, and then single-family weatherization packages at 12%. The remainder is comprised mostly of multi-family water heating, gas-heating measures for single and multi-family, and home propane heating measures.

Figure 21. Residential Max Achievable Cost Effective Non- Electric Savings Potential by End Use

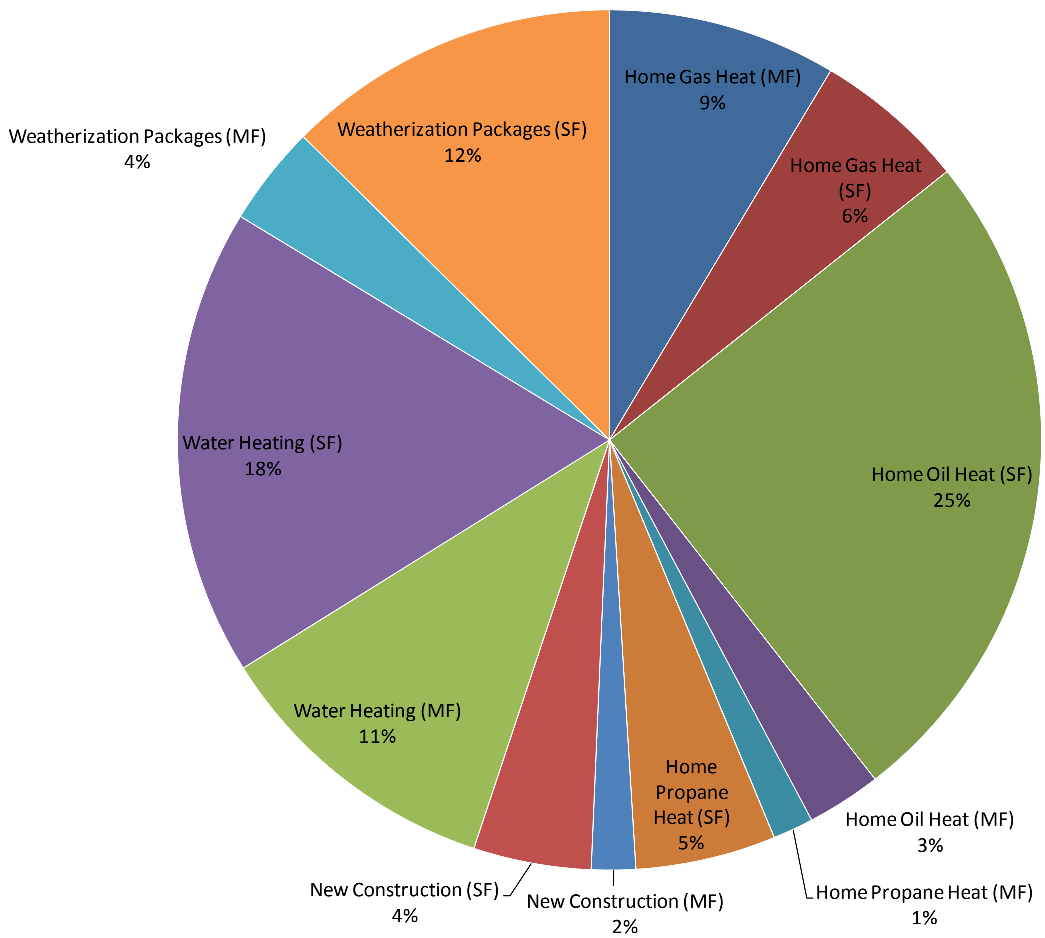
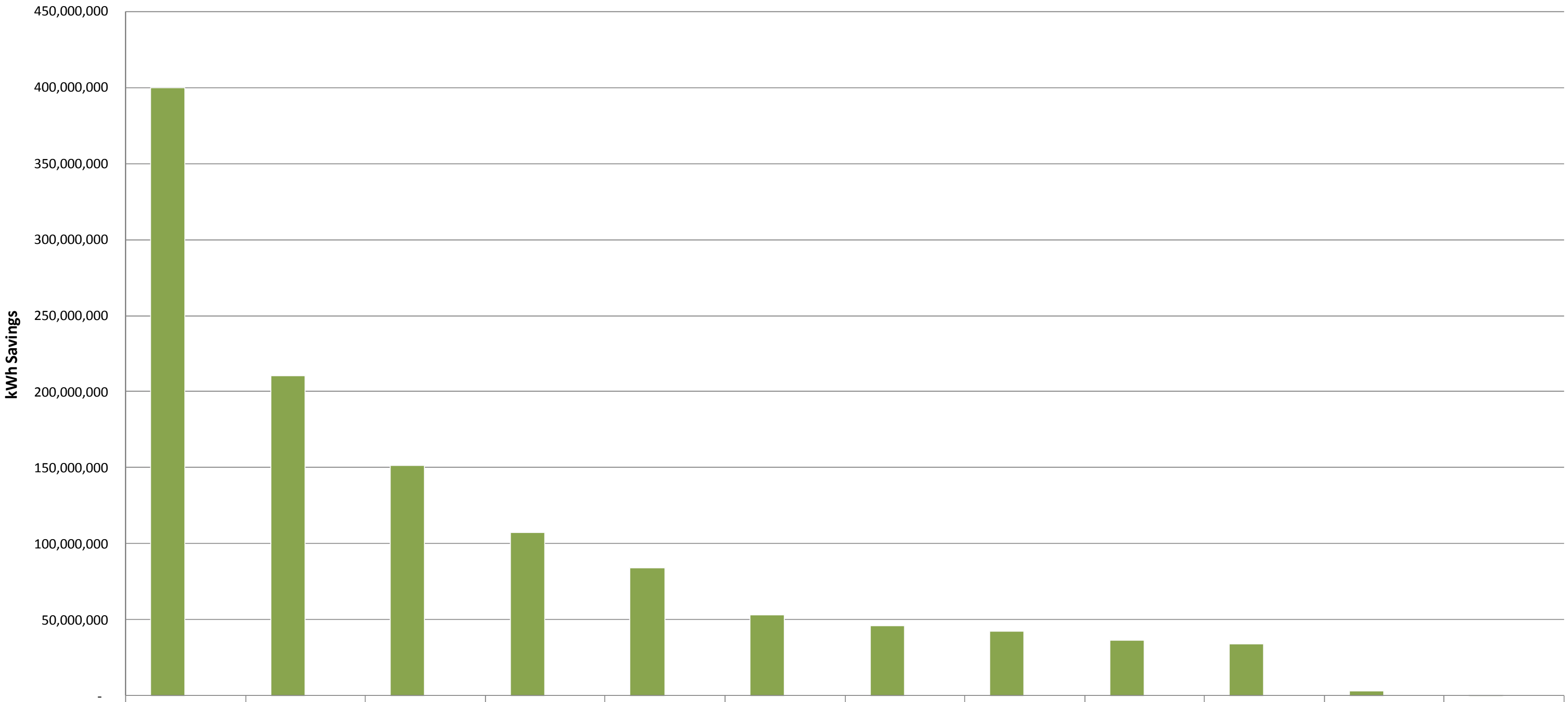


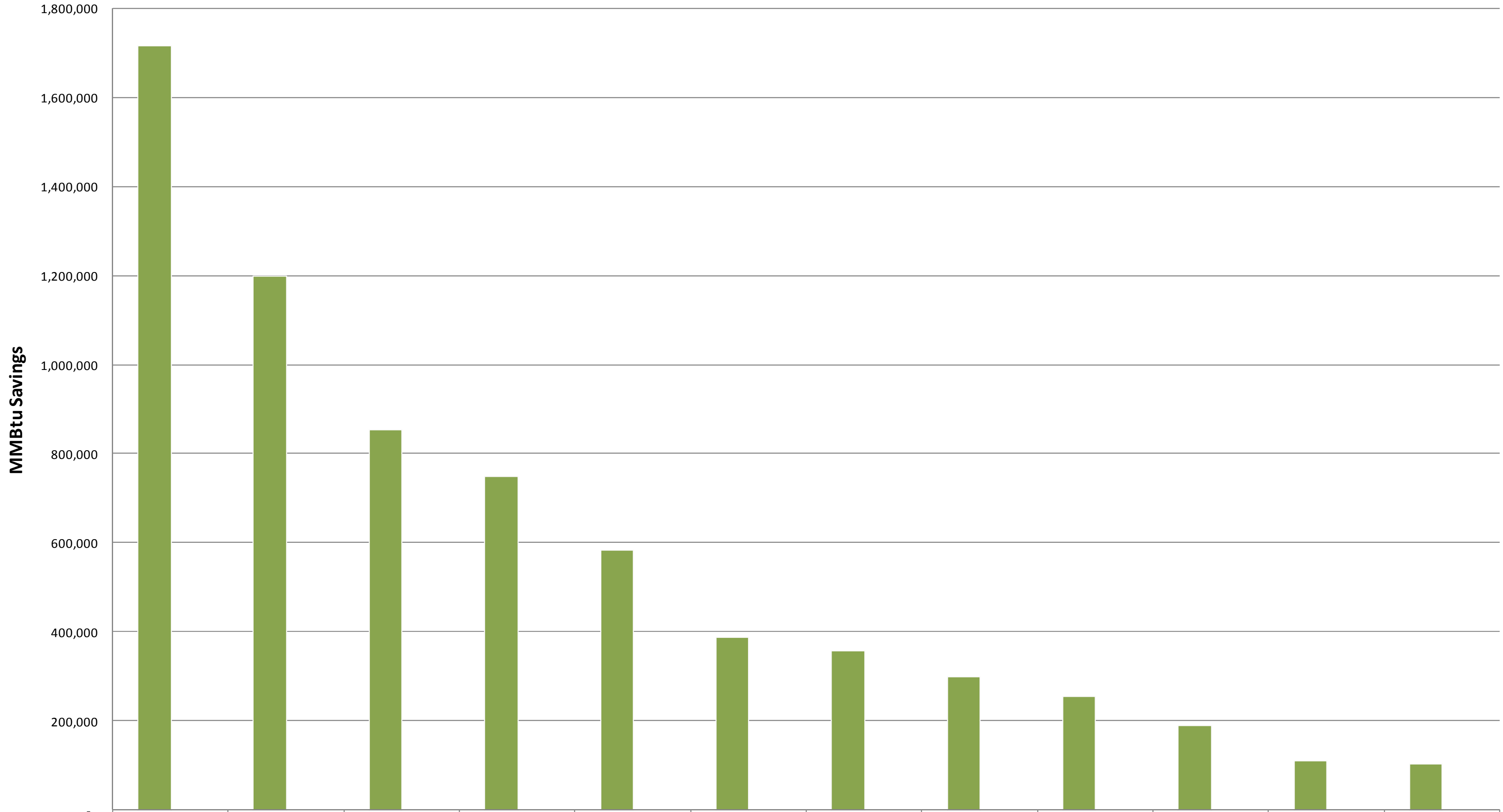
Figure 22 and Figure 23, displayed below, show a graphical comparison of the varying maximum achievable cost effective electric and non-electric savings by end use within the residential sector. While Figure 20 and Figure 21 show relative percent comparisons only, Figure 22 and Figure 23 show both relative and absolute (kWh and MMBTu) comparisons of the savings coming from each end use.

Figure 22. Residential Electric Savings Potential by End Use (with kWh values)



	Lighting - SF	Lighting - MF	Electric Appliances - SF	Standby Power	Space Heating and Space Cooling - SF	Water Heating - SF	Water Heating - MF	SF New Construction	Space Heating and Space Cooling - MF	Electric Appliances - MF	MF New Construction	Pools
Max. Achievable Cost Effective	399,588,082	210,479,584	151,300,008	107,603,656	84,066,189	53,160,336	45,937,312	42,689,666	36,320,508	34,301,015	3,293,705	1,106,421
% of MACE	34.2%	18.0%	12.9%	9.2%	7.2%	4.5%	3.9%	3.6%	3.1%	2.9%	0.3%	0.1%

Figure 23. Residential Non-Electric Savings Potential by End Use (with MMBTu values)



	Home Oil Heat (SF)	Water Heating (SF)	Weatherization Packages (SF)	Water Heating (MF)	Home Gas Heat (MF)	Home Gas Heat (SF)	Home Propane Heat (SF)	New Construction (SF)	Weatherization Packages (MF)	Home Oil Heat (MF)	New Construction (MF)	Home Propane Heat (MF)
MACE	1,714,121	1,197,354	852,973	750,121	582,691	388,745	357,869	299,594	256,518	189,906	112,332	103,348
% of MACE	25.19%	17.59%	12.53%	11.02%	8.56%	5.71%	5.26%	4.40%	3.77%	2.79%	1.65%	1.52%

4.2.3 Residential Energy Efficiency Measure Supply Curves

This report also presents results in the form of electric and non-electric energy efficiency supply curves. As noted previously, the advantage of using an energy efficiency supply curve is that it provides a clear, easy-to-understand framework for summarizing a variety of complex information about energy efficiency technologies, their costs, and the potential for energy savings. Properly constructed, an energy-efficiency supply curve avoids the double counting of energy savings across measures by accounting for interactions between measures. The supply curve also provides a simplified framework to compare the costs of energy efficiency measures with the costs of energy supply resources.

The supply curves for residential electric energy efficiency savings are shown in Figure 24 through Figure 29. Supply curves for residential non-electric energy efficiency savings are shown in Figure 30 through Figure 35. These supply curves were built up across individual measures and were sorted on a lowest to highest cost basis per unit of energy saved. As shown in these figures, nearly 12 percent of the projected 2018 residential sector kWh sales could be offset by installing electric efficiency measures at a levelized cost of less than two cents per/kWh (see Figure 29). Nearly eight percent of the projected maximum achievable cost effective savings potential from non-electric efficiency measures could be obtained at a levelized cost of less than three dollars per/MMBTu (see Figure 35).

Figure 24. Residential Electric Energy Efficiency Supply (< $1.10/kWh) Curve for NH – Technical Potential

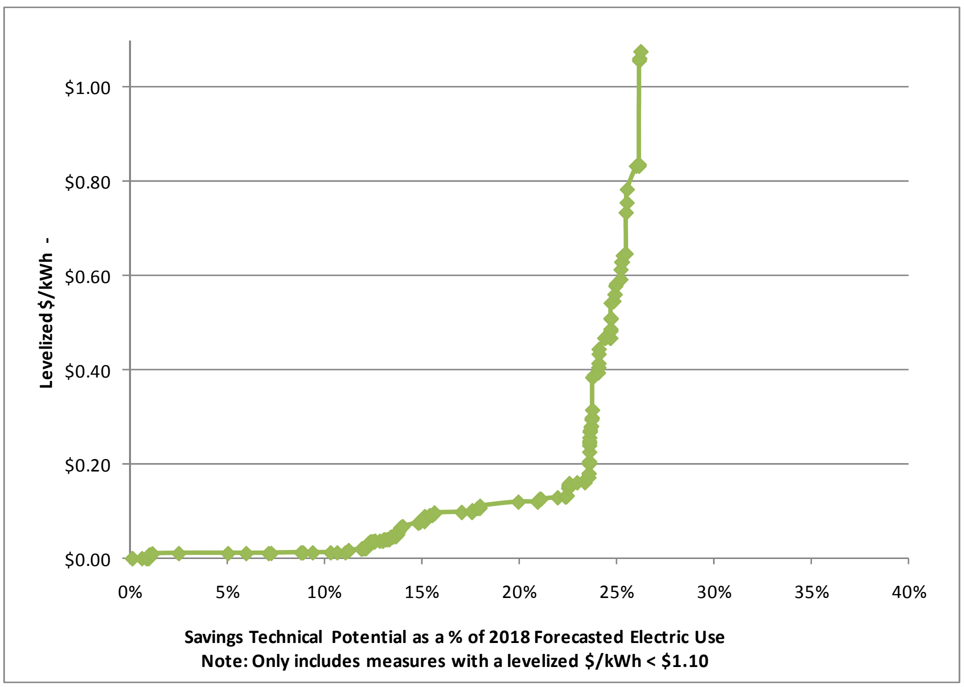


Figure 25. Residential Electric Energy Efficiency Supply (< $0.10/kWh) Curve for NH – Technical Potential

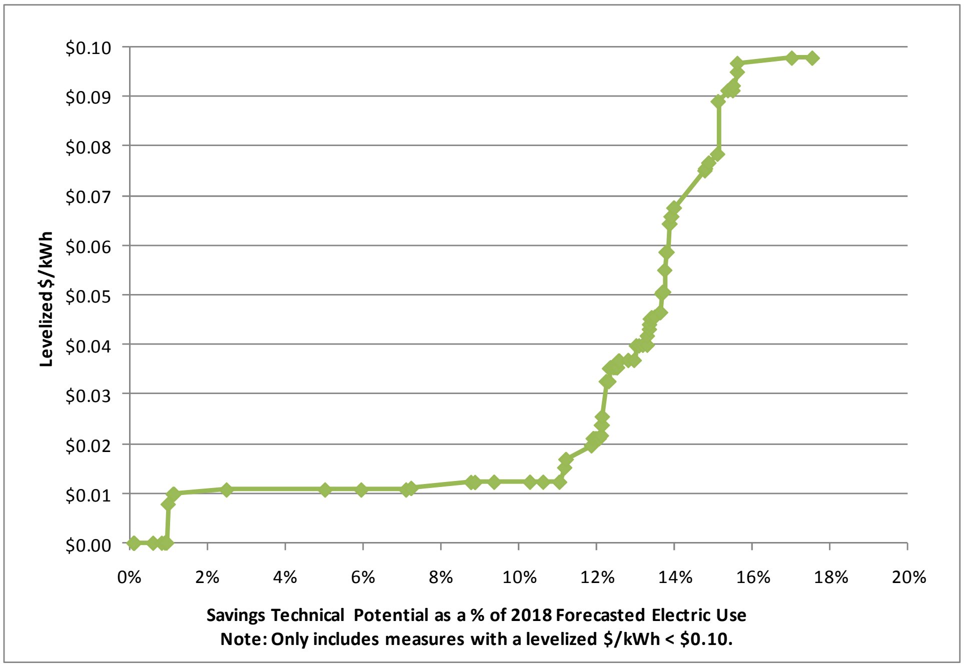


Figure 26. Residential Electric Energy Efficiency Supply (< $1.10/kWh) Curve for NH – Max Achievable

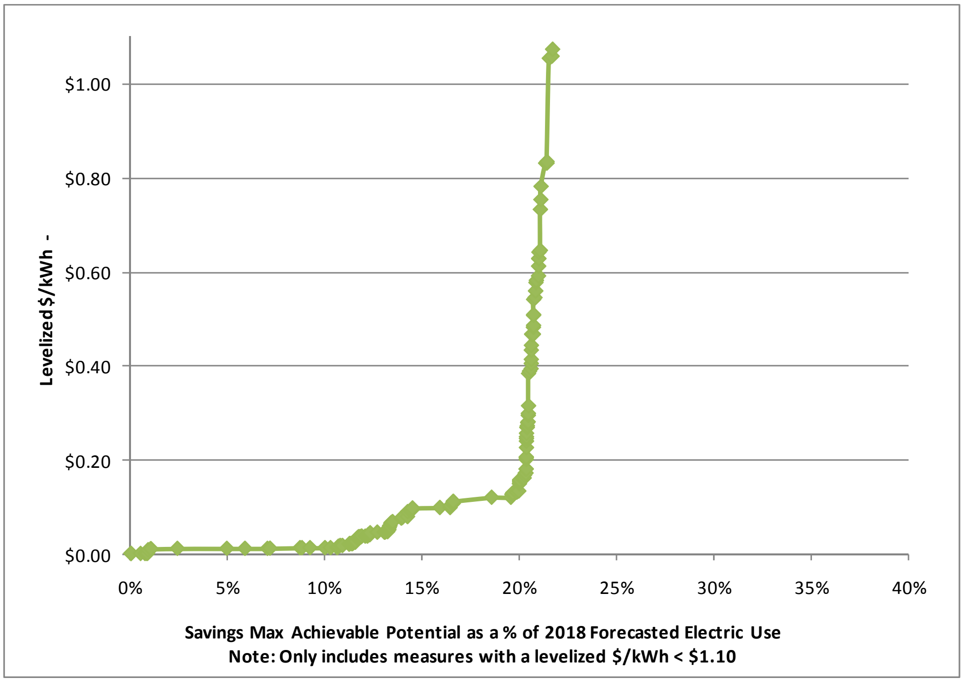


Figure 27. Residential Electric Energy Efficiency Supply (< $0.10/kWh) Curve for NH – Max Achievable

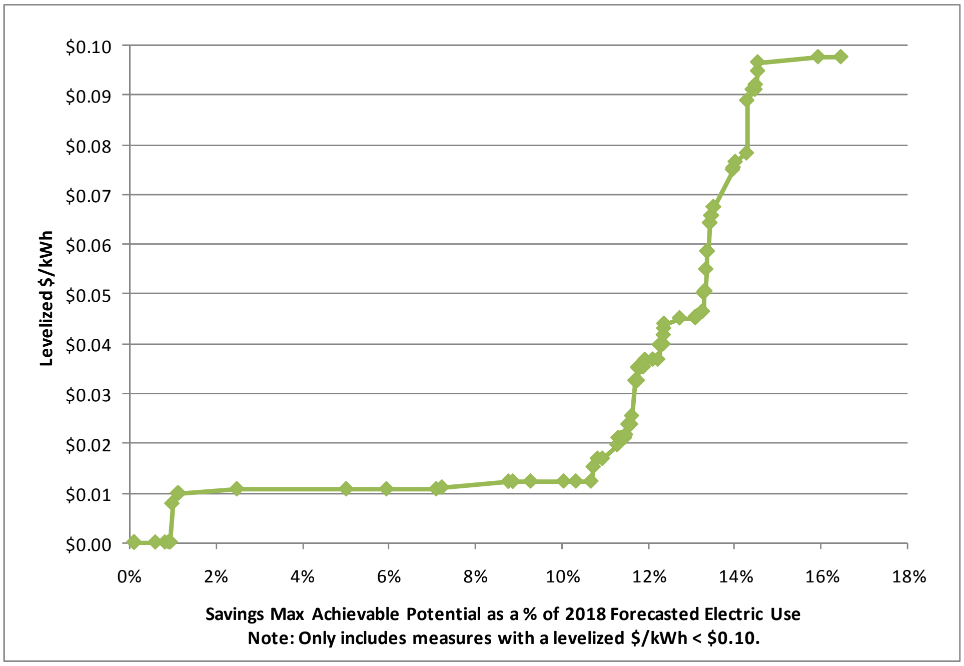


Figure 28. Residential Electric Energy Efficiency Supply (< $1.10/kWh) Curve for NH – M.A.C.E

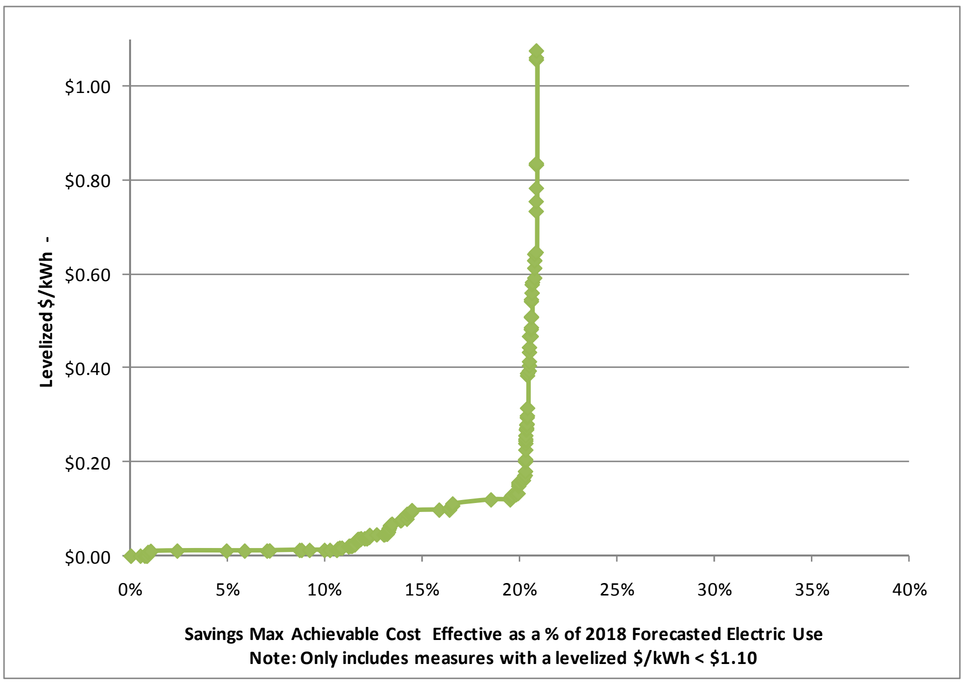


Figure 29. Residential Electric Energy Efficiency Supply (< $0.10/kWh) Curve for NH – M.A.C.E.

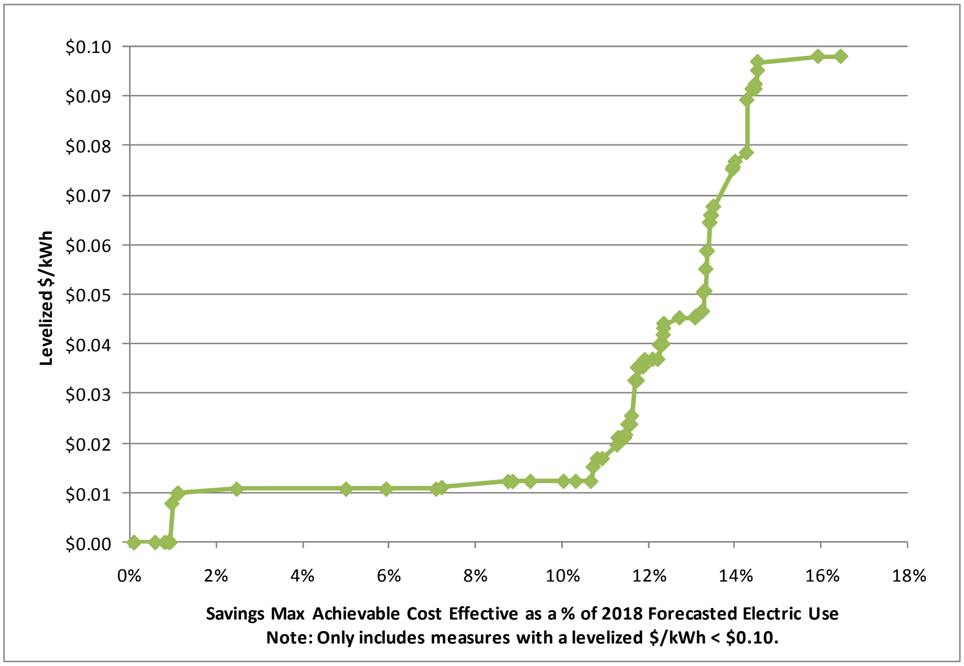


Figure 30. Residential Non-Electric Energy Efficiency Supply (< $10/MMBTu) Curve for NH – Technical

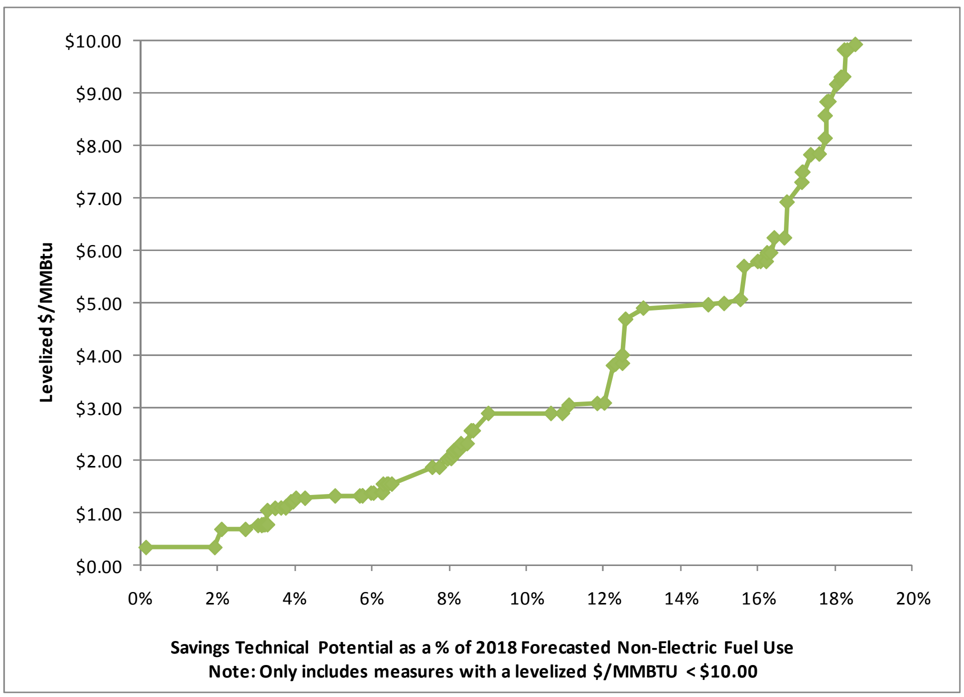


Figure 31. Residential Non-Electric Energy Efficiency Supply (< $5/MMBTu) Curve for NH – Technical

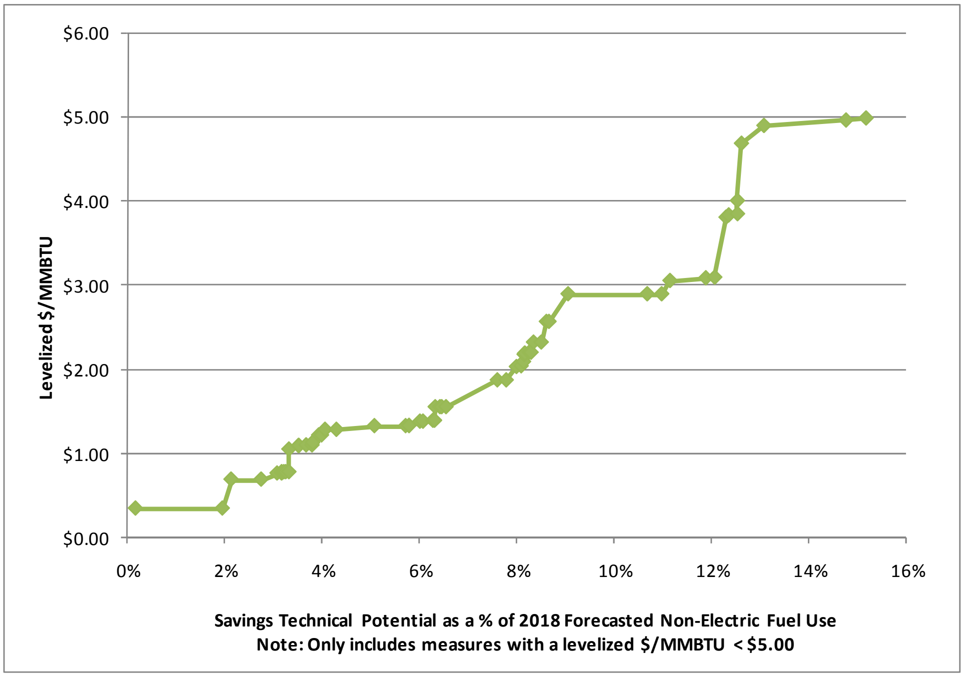


Figure 32. Residential Non-Electric Efficiency Supply (< $10/MMBTu) Curve for NH – Max Achievable

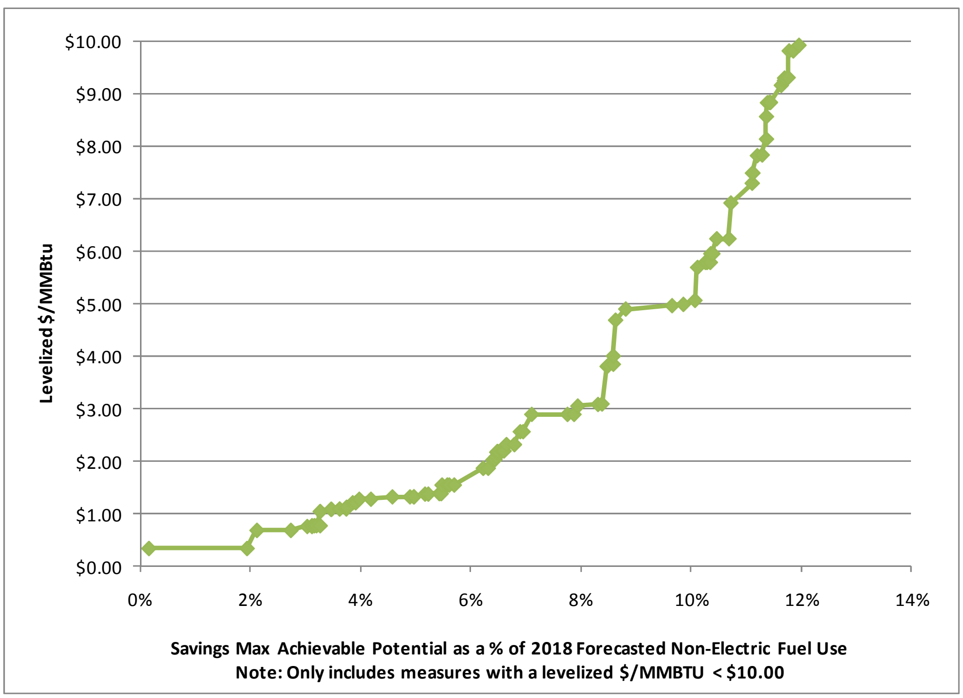


Figure 33. Residential Non-Electric Efficiency Supply (< $5/MMBTu) Curve for NH – Max Achievable

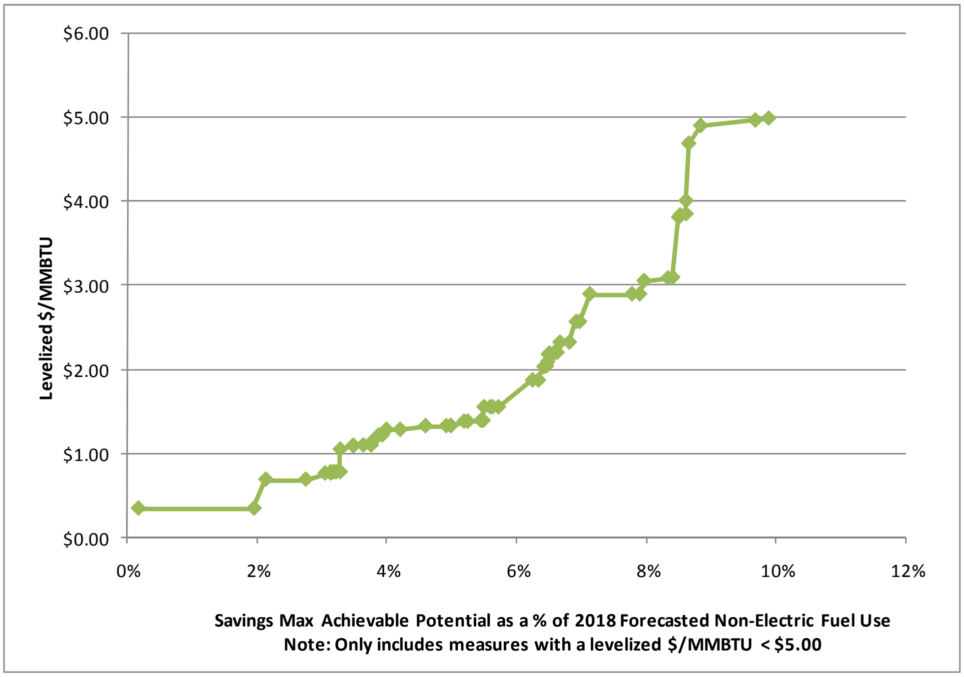


Figure 34. Residential Non-Electric Energy Efficiency Supply (< $10/MMBTu) Curve for NH – M.A.C.E

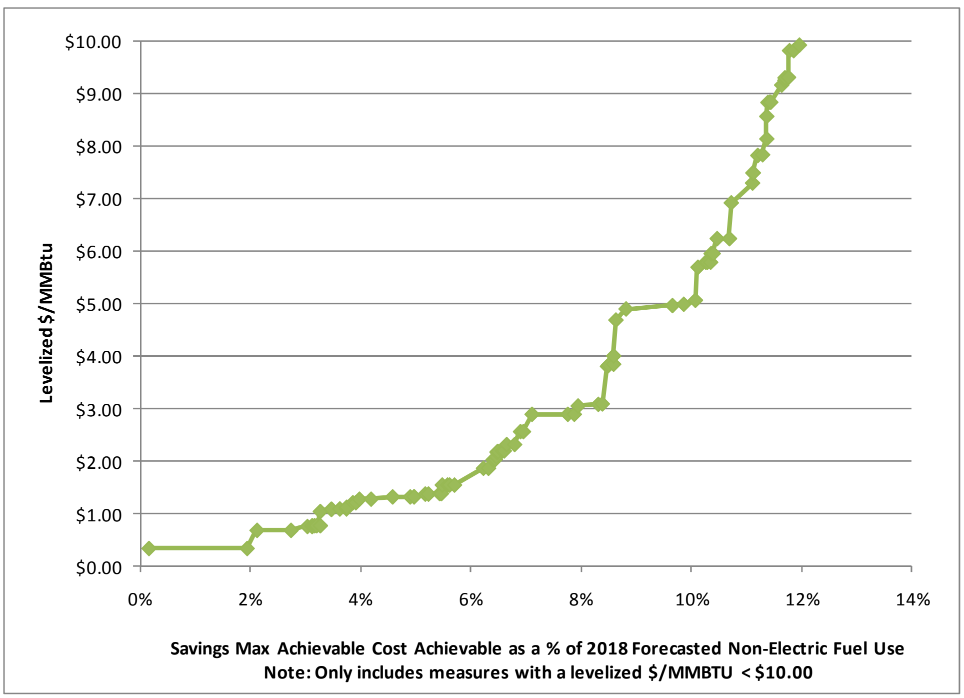
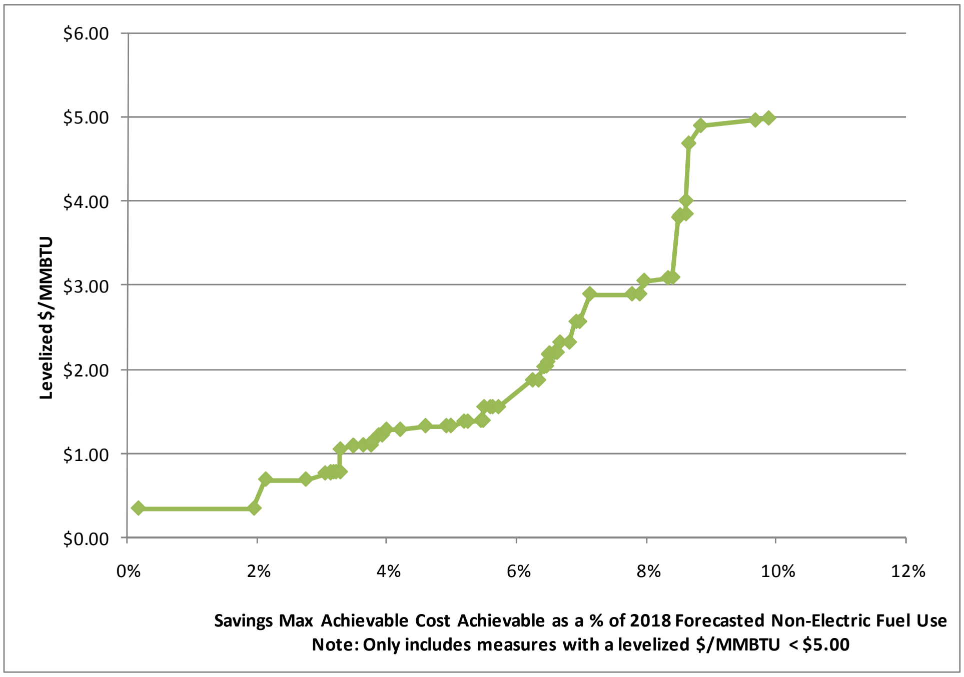


Figure 35. Residential Non-Electric Energy Efficiency Supply (< $5/MMBTu) Curve for NH – M.A.C.E.



It is important to note that these levelized costs per unit of energy saved values exclude the costs for potential marketing, program design, administration and evaluation that would be required to encourage customer participation and to ultimately achieve any portion of this sectors savings potential.

Section 5: Commercial Sector Energy Efficiency Potential

This section of the report presents the estimates of electric and non-electric technical (traditional), maximum achievable, maximum achievable cost effective, and potentially obtainable energy efficiency potential for the existing and new construction market segments of the commercial sector in New Hampshire. More information regarding how these potentials were derived is also presented.

According to this analysis, there is still a large remaining potential for electric and non-electric energy efficiency savings in the commercial sector. Table 46 and Table 47 below summarize the savings by potential type by the year 2018 for commercial electric and non-electric measures respectively (separate potentials are shown for new construction, existing buildings and combined within each table).[40] The estimated total costs to achieve each level of savings by 2018 are also presented in these tables. In addition, Table 46 presents peak demand savings for each potential level of savings associated with the electric energy efficiency measures.[41]

Table 46. Summary of Commercial Sector Electric Energy Efficiency Savings Potential

	Estimated Cumulative Annual Sales by 2018 (kWh)	Estimated Cumulative Annual Savings by 2018 (kWh)	Savings in 2018 as % of Total 2018 Electric Consumption	Estimated Cumulative Annual Demand Savings by 2018 By Sector (MW)	Estimated % of Peak Demand Savings by 2018	Estimated Costs to Achieve 2018 Cummulative Annual Savings ($ 2008 NPV)
COMMERCIAL SECTOR - NEW CONSTRUCTION						
Technical Potential (Traditional)	383,672,438	146,116,211	38.1%	54.0	1.8%	$56,524,486
Max. Achievable Potential		99,371,416	25.9%	36.7	1.2%	$44,385,181
Max. Achievable Cost Effective		81,088,647	21.1%	30.0	1.0%	$22,010,481
Potentially Obtainable		37,713,403	9.8%	13.9	0.5%	$8,926,584
COMMERCIAL SECTOR - EXISTING BUILDINGS						
Technical Potential (Traditional)	4,970,126,508	1,451,916,034	29.2%	422.9	14.2%	$914,692,446
Max. Achievable Potential		1,198,691,188	24.1%	349.1	11.7%	$806,498,673
Max. Achievable Cost Effective		985,683,305	19.8%	287.1	9.6%	$289,826,583
Potentially Obtainable		454,309,206	9.1%	132.3	4.4%	$115,897,185
COMMERCIAL SECTOR - TOTAL						
Technical Potential (Traditional)	5,353,798,946	1,598,032,244	29.8%	476.9	16.0%	$971,216,931
Max. Achievable Potential		1,298,062,604	24.2%	385.9	12.9%	$850,883,854
Max. Achievable Cost Effective		1,066,771,952	19.9%	317.1	10.6%	$311,837,064
Potentially Obtainable		492,022,609	9.2%	146.3	4.9%	$124,823,769

[40] The commercial sector sales forecast for the year 2018 was not available in terms of new and existing construction. As a result, in order to derive the split between new and existing construction, the growth of the sector over the ten (10) year study period was divided in half, and half was attributed to new construction sales, and the remaining half was attributed to growth in the existing sector.

[41] For purposes of this study, a simplifying assumption was used to estimate peak demand savings. Percentage sector peak demand savings are calculated to show savings over the summer coincident peak demand period only and are not broken out separately for summer and winter peak periods.

Table 47. Summary of Commercial Non-Electric Energy Efficiency Savings Potential

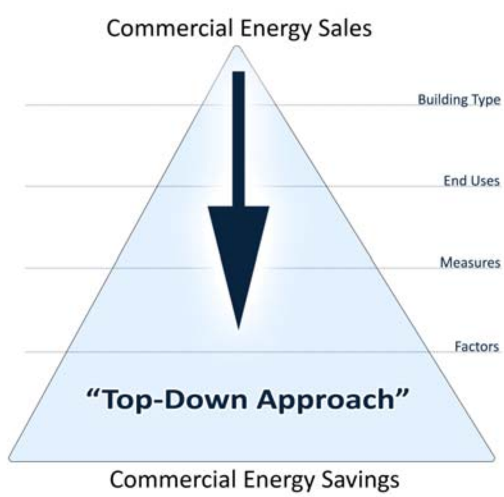
	Estimated Cumulative Annual Sales by 2018 (MMBtu)	Estimated Cumulative Annual Savings by 2018 (MMBtu)	Savings in 2018 as % of Total 2018 Gas Consumption	Estimated Costs to Achieve 2018 Cummulative Annual Savings ($ 2008 NPV)
COMMERCIAL SECTOR - NEW CONSTRUCTION				
Technical Potential	5,793,062	1,696,543	29%	$174,415,757
Achievable Potential		1,143,559	20%	$109,001,402
Achievable Cost Effective Potential		992,356	17%	$58,593,673
Potentially Obtainable		401,855	7%	$18,382,602
COMMERCIAL SECTOR - EXISTING BUILDINGS				
Technical Potential	39,536,853	10,284,474	26%	$1,047,661,444
Achievable Potential		8,932,119	23%	$927,481,632
Achievable Cost Effective Potential		6,717,981	17%	$266,103,608
Potentially Obtainable		2,850,349	7%	$83,851,626
COMMERCIAL SECTOR - TOTAL				
Technical Potential	45,329,915	11,981,017	26%	$1,222,077,201
Achievable Potential		10,075,678	22%	$1,036,483,035
Achievable Cost Effective Potential		7,710,337	17%	$324,697,281
Potentially Obtainable		3,252,204	7%	$102,234,228

On the electric side, the combined existing and new buildings maximum achievable cost effective potential in the commercial sector in 2018 is nearly 1 million kWh, just under 20 percent of the New Hampshire commercial sector sales forecast in 2018. With regard to non-electric potential for new and existing buildings combined, the maximum achievable cost effective potential in the commercial sector is over 7.7 million MMBTu, or 17% of the New Hampshire commercial sector fossil fuel (natural gas, oil and propane) sales forecast in 2018. The lists of measures that make up the savings for each of these levels are shown in Table 52 through Table 55 in Section 5.2.1 below.

5.1 Commercial Sector Savings Methodology Overview

The commercial sector analysis was modeled using what is considered a “top-down approach”. This methodology, shown visually in Figure 36 below:

Figure 36. Commercial Sector Savings Methodology – Top Down Approach



As shown in this figure, the methodology is started at the top with the total projected 2018 kWh sales for the commercial sector. Those sales are then split up by building type using SIC codes of actual customer data (provided to us by project sponsors). After the sales are distributed across the building types, they are broken down further to end-uses (e.g. lighting, space heating, appliances) within each of the building types. From the end-use level, the energy is then applied to each of the measures using applicability factors. The base case factor is applied first, to inform the model regarding how much of the sales in a particular end use was applicable to the specific measure in question. After identifying how much energy each measure uses within that end use (i.e., what degree of the end use sales is going to each measure), then models then look at the remaining factor. As discussed in Section 3, the remaining factor identifies what percentage of the building type in question already has the efficient measure. The remaining factor is then one minus that penetration – resulting in the percentage, by building type, of each measure that can still be installed in within the commercial sector. The model then considers the savings factor, which is defined is the percentage savings achievable from moving from a standard efficiency measure to a high efficiency measure. Finally, adjustments are made for any technical limitations that would prevent the measure from being installed in certain applications via the convertible factor (engineering adjustment). This scenario is repeated for every measure within every building type, for new and existing construction, and for electric measures, and non-electric measures. The formula that has just been explained to calculate savings at the measure level is displayed below graphically.

Technical Potential of Efficient Measure = **Total End Use kWh Sales by Building Type** X **Base Case Factor** X **Remaining Factor** X **Convertible Factor** X **Savings Factor**

Measure interactivity is also considered so as to prevent overstating (double-counting) of savings. To better illustrate this point, in the case of lighting, consider the upgrade of a T-12 fixture to a T-8, and then the installation of an occupancy control. In such a case, the occupancy control is only able to save the amount of energy left after the upgrade has taken place. Through functionality included within the GDS supply curve model, measures are ranked by benefit cost ratio (highest to lowest) as a proxy to determine the order by which measures are installed. Through a combination of the proper classification of the base case factors, and the rankings in the supply curve model, the potential for double-counting is methodically eliminated.

The supply curve model is designed in a manner that allows for each measure to have independent base, remaining, savings, and convertible factors for all of the nine (9) building types. In addition, every building type has its own energy consumption profile that defines how energy consumption within that building type is distributed among the end uses (e.g. lighting, water heating, appliances, etc) within the building type. This allows the model to run savings analyses on building specific energy consumption profiles and building specific energy savings profiles simultaneously in order to yield the most accurate and realistic savings potential estimates possible. In addition, individual models are run for commercial existing construction, and commercial new-construction for both electric and non-electric yielding a total of four unique (4) commercial supply curve models. The commercial electric models (existing and new construction) were based on kWh sales in the year 2018, while the commercial non-electric model used 2018 MMBTu sales for natural gas, oil, and propane combined.[42]

The measures within each building type are organized and grouped by the end use energy consumption pools that they have the ability to potentially save energy from. Lighting measures for instance are all working off of the lighting energy sales in the year 2018 as a basis or starting point for the energy savings potential within a particular building type. The ordering of the lighting related measures within this grouping is determined by benefit cost ratio. Measures with higher benefit cost ratios are assumed to be installed first, and then ranked in descending order on down the line. As a measure is installed, the model reduces the remaining sales left to be saved for the next measure (the actual algorithm for how this happens within the model on a measure to measure basis is more complex than what is being described here). So if a lighting fixture is upgraded, and then a control is installed, the control has less potential energy to save since the light it is controlling has already been upgraded to a more efficient version. This process is repeated until all measures within each end use are exhausted in order to yield the savings potential at the measure level, end-use level, and the building-type level.

The costs to achieve savings potential estimates within the commercial sector are calculated on a measure by measure basis using the levelized cost ($/kWh in the electric model and $/MMBTu within the non-electric model) for each measure. These levelized costs represent the cost to save a unit of energy. These levelized costs are then taken and multiplied (again at the measure level) by the 2018 annual savings associated with the potential level we are attempting to capture (technical potential, maximum achievable, etc.). A net present value (NPV) formula is then used in conjunction with each measure's measure life and an overall discount rate to determine the $ cost per first year kWh (or MMBTu) saved for each measure. The cost per first year savings figure is then multiplied by the savings potential estimate being evaluated in order to yield the cost to achieve the savings potential being quoted in the year 2018 at the measure level. Each measure is then summed up at each potential level to yield the total cost to achieve savings in the commercial sector (within the potential level being analyzed) to represent the cost to achieve the potential savings level by the year 2018. This number can then be divided by the study length (10 years) in order to yield an estimate of annual spending needed to reach the potential level target in question.

In addition, the model includes a number of measures that save energy across multiple end-use categories. Examples include retrocommissioning which can saves heating, cooling, and ventilation energy, and insulation which can provide both heating and cooling savings. As a result, these types of measure are placed within the model in a manner so that they can claim their proper savings within each one of the appropriate end-uses. A complexity occurs when attempting to properly estimate the cost for these measures. In order to avoid overstating the cost to install a measure like retrocommissioning, the cost needs to be divided across the different end-uses it affects. To simplify the modeling, it is assumed that the costs would be divided by the number of end-uses the measure effects. If the full cost for each end-use is applied, it would be inaccurate (i.e., for retrocommissioning, if the end-user is only paying for an engineer to walk-through the facility and assess and assist with implementation of identified savings opportunities in a single visit; the end-user will typically receive a single invoice for the combined retrocommissioning service, as opposed to multiple invoices being sent for implementation of each type of savings identified by the engineer). This approach is also used

[42] We were only provided actual sales forecasts through 2018 from the natural gas utilities. In order to determine the projected forecasts for oil and propane in MMBTu, we extrapolated based on the results of the commercial telephone survey (Question #16: What is the main energy source for heating?). The results of which yielded commercial customers in NH using natural gas to be 28%, oil at 46%, and bottled gas/propane at 26%. This allowed us to accurately estimate the year by year forecasts (particularly 2018) for all non-electric fuels combined.

in the model for many of the building envelope and HVAC controls measures, as they often affect more than one end-use when installed. This approach is due mainly to GDS's technical potential model's functionality. The description above, is provided to explain to readers how the model, within its existing framework, has been used to ensure that double counting of costs is avoided for these types of measures.

Table 48 and Figure 37 illustrate the commercial sector electricity sales based segmentation. This segmentation is based on 2009 commercial sales data by SIC code as provided by project sponsors.

Table 48. Commercial Sector Segmentation by Industry Type - Electric

	Industry Type	Commercial kWh	Percent of kWh Sales*	Business Categories
1	Warehouse	22,943,600	0.46%	Wholesale Trade & Warehouse
2	Retail	1,305,235,571	26.26%	Other Retail Trade
3	Grocery	843,032,754	16.96%	Food/Grocery
4	Office	1,175,866,515	23.66%	Business/Financial Services, Social Services, US Post Office, Government, Communications, Utilities, Transportation
5	Lodging	280,529,174	5.64%	Lodging
6	Health	437,017,809	8.79%	Hospitals, Other Nursing & Care, Medical Offices & Other
7	Education	536,887,562	10.80%	Elementary & Secondary Schools, Colleges & Education - Other
8	Restaurant	96,579,427	1.94%	Restaurants, Eating & Drinking Establishments
9	Other	272,034,096	5.47%	Agriculture, Forestries & Fishing, Mining & Construction, Water & Wastewater, Entertainment
	Total	4,970,126,508	100.00%	

** Based on NH Utilities 2008 - 2017 Forecast and allocations from actual Sales Data by SIC code categories*

Figure 37. Commercial Sector Segmentation by Industry Type - Electric

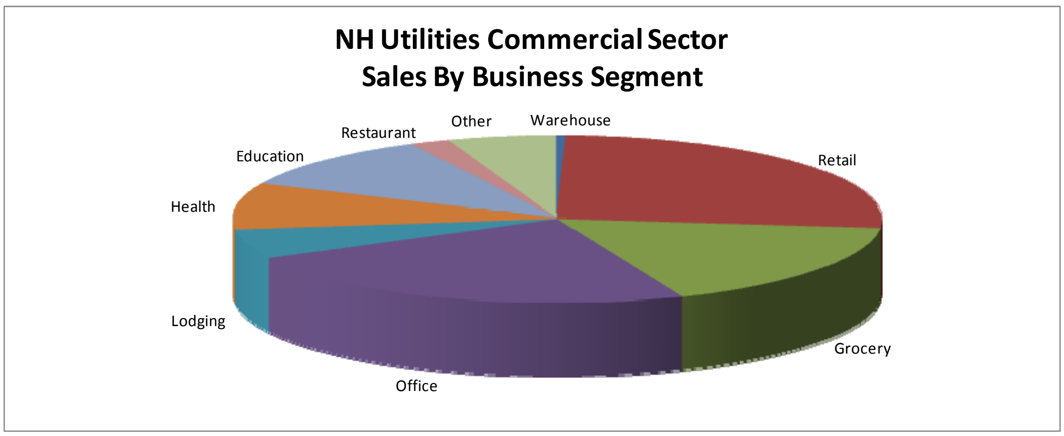


Table 49 and Figure 38 illustrate the commercial sector non-electric sales based segmentation. This segmentation is based on 2009 commercial sales data by SIC code as provided by project sponsors.

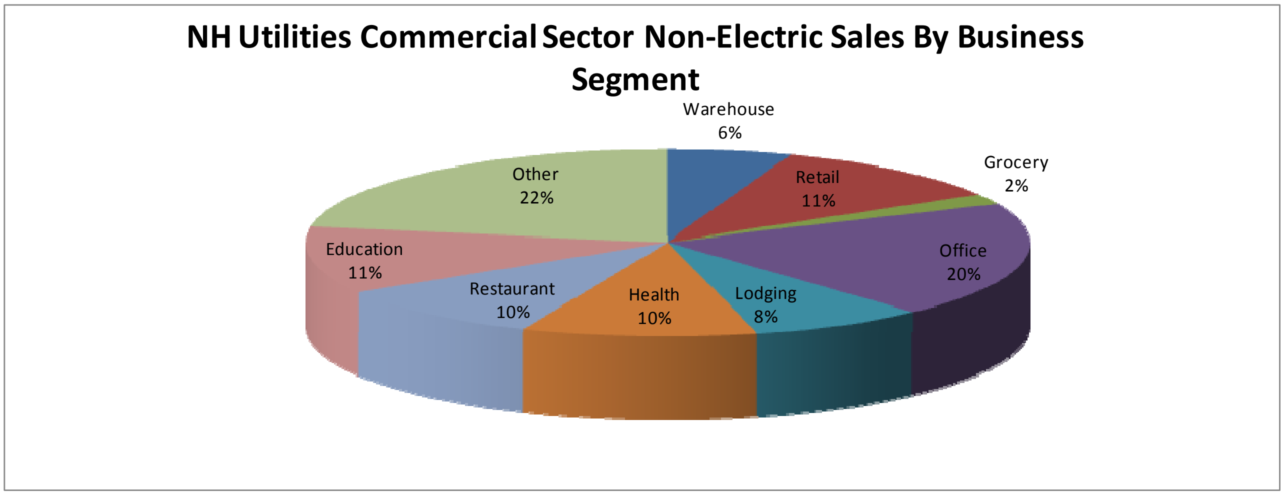
Table 49. Commercial Sector Segmentation by Industry Type – Non-Electric

	Industry Type	Percent of Non-Electric Sales*	Business Categories
1	Warehouse	5.58%	Wholesale Trade & Warehouse
2	Retail	10.94%	Other Retail Trade
3	Grocery	1.82%	Food/Grocery
4	Office	19.87%	Business/Financial Services, Social Services, US Post Office, Government, Communications, Utilities, Transportation
5	Lodging	7.81%	Lodging
6	Health	10.49%	Hospitals, Other Nursing & Care, Medical Offices & Other
7	Restaurant	9.67%	Elementary & Secondary Schools, Colleges & Education - Other
8	Education	11.38%	Restaurants, Eating & Drinking Establishments
9	Other	22.44%	Agriculture, Forestries & Fishing, Mining & Construction, Water & Wastewater, Entertainment
	Total	100.00%	

** Based on US DOE, Energy Information Administration (EIA), 2003 Commercial Buildings Energy Consumption Survey, Tables C23A and C25A*

Natural Gas Energy Efficiency Resource Development Potential in New York, Prepared for New York Energy Research and Development Authority, by OPTIMAL ENERGY, INC., AMERICAN COUNCIL FOR AN ENERGY-EFFICIENT ECONOMY, VERMONT ENERGY INVESTMENT CORPORATION, RESOURCE INSIGHT, INC., ENERGY AND ENVIRONMENTAL ANALYSIS, INC., October 31, 2006

Figure 38. Commercial Sector Segmentation by Industry Type – Non-Electric



5.3 Commercial Sector End-Use Breakdowns

Table 50 and Table 51 illustrate the commercial sector energy sales based segmentation. The breakdown of commercial electricity use by end-use and industry type was developed based on data included in the 2003 New York Technical Potential Study while the breakdown for non-electric was based on a similar New York Technical Potential Study[43] conducted in 2006. This study divided New York into regions and the Albany region (Region F) was used as a reasonable representation of the commercial sector in New Hampshire.

Table 50. Commercial Sector End Use Breakdowns Allocation Table – Electric

	Warehouse	Retail	Grocery	Office	Lodging	Health	Restaurant	Education	Other	TOTAL
Indoor Lighting	18%	25%	50%	38%	24%	28%	20%	43%	17%	29%
Outdoor Lighting	3%	2%	6%	4%	5%	2%	6%	4%	2%	4%
Cooling	2%	21%	18%	13%	13%	21%	10%	10%	8%	12%
Ventilation	10%	20%	10%	10%	18%	9%	7%	18%	6%	11%
Water Heating	1%	5%	5%	2%	8%	6%	16%	6%	4%	5%
Refrigeration	58%	9%	1%	1%	3%	3%	32%	2%	20%	13%
Space Heating	4%	12%	4%	13%	20%	9%	4%	9%	3%	8%
Office Equipment	2%	2%	2%	11%	3%	2%	1%	4%	2%	4%
Miscellaneous	3%	3%	3%	8%	5%	21%	3%	4%	38%	14%
TOTAL	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table 51. Commercial Sector End Use Breakdowns Allocation Table – Non-Electric

Non-Electric	Warehouse	Retail	Grocery	Office	Lodging	Health	Restaurant	Education	Other
Space Heating	76%	62%	56%	72%	53%	45%	34%	60%	48%
Water Heating	16%	22%	25%	26%	34%	37%	27%	24%	29%
Cooking	3%	15%	17%	0%	9%	15%	37%	13%	20%
Other	5%	1%	2%	2%	4%	4%	2%	3%	3%
Blank	0%	0%	0%	0%	0%	0%	0%	0%	0%

5.4 Commercial Sector – Energy Efficiency Potential Results

One-hundred-twenty-five (125) commercial electric, and sixty seven (67) commercial non-electric energy efficiency measures were included in the analysis for the commercial sector. In order to develop the list of energy efficiency measures to be examined, GDS worked closely

[43] Natural Gas Energy Efficiency Resource Development Potential in New York, Prepared for New York Energy Research and Development Authority, by OPTIMAL ENERGY, INC., AMERICAN COUNCIL FOR AN ENERGY-EFFICIENT ECONOMY, VERMONT ENERGY INVESTMENT CORPORATION, RESOURCE INSIGHT, INC., ENERGY AND ENVIRONMENTAL ANALYSIS, INC., October 31, 2006

with project sponsors and reviewed recent measure life, savings and cost assumption studies including a Measure Life Report prepared by GDS for the New England State Program Working Group in June 2007 and a GasNetworks measures assumptions update project completed by GDS during the summer 2008. In addition, GDS reviewed other related electric and non-electric commercial sector energy efficiency measure-specific data sources and technical potential studies that have been conducted recently in the US. Focus was for comprehensiveness on the electric and natural gas measures, less so for fuel oil and propane. Even within electric and natural gas some measure limitations were required (e.g., Data Center/IT, etc.).

The set of energy efficiency measures considered was pre-screened to mainly those measures that are currently commercially available (or were estimated to be cost effective within the ten year study period). Thus, emerging technologies not currently in the marketplace that had benefit cost ratios below 0.9 were not included in the analysis. The portfolio of measures includes retrofit and replace on burnout programmatic approaches to achieve energy efficiency savings.

5.2.1 Characteristics of Energy Efficiency Measures

GDS collected data on the energy savings, incremental costs, useful lives and other key "per unit" characteristics of each of the commercial electric and non-electric energy efficiency measures, this data is available in Appendix F for the commercial sector. Estimates of the size of the eligible market were also developed for each efficiency measure. For example, electric T-5 lighting efficiency measures are only applicable to those commercial building types in New Hampshire that have the potential to use that lighting technology in their building space.

The commercial sector analysis was based on the most recent sales forecasts for New Hampshire for the years 2009 to 2018.[44] For the commercial new construction market segment, GDS calculated a forecast of the new construction sales estimated to be built each year based on looking at the growth of the sector over the 10 year period, and making the assumption that half of that growth is from new construction, while the other half is coming from growth of existing buildings. This assumption was approved by the project sponsors, and has been used in previous technical potential projects around the US. The sizes of various end-use market segments were informed based on project primary data collection efforts.

Energy-efficiency measures were analyzed for the most important electric and non-electric consuming end uses in the Commercial sector including:

- Space heating
- Water heating
- Air conditioning
- Lighting
- Appliances
- Pools
- Cooking
- Motors
- Transformers
- Ventilation

[44] This Commercial sector load forecast was provided to GDS by project sponsors.

Tables[45] 52 through 55 below list the commercial sector electric and non-electric energy efficiency measures included in the technical (traditional), maximum achievable, maximum achievable cost effective, and potentially obtainable potential analyses. The portfolio of measures includes retrofit, and replace on burnout programmatic approaches to achieve energy efficiency savings. More information regarding measure-specific savings, cost and measure life assumptions can be found in Appendix F.

Table 52. Commercial Electric Savings Potential by Measure – Existing Buildings

Measure	Tech. Pot.	Max. Achievable	MACE	% of MACE	Potentially Obtainable
Retrocommissioning	101,979,593	101,979,593	101,979,593	10.3%	49,256,143
Fluorescent Fixtures with Reflectors	90,751,384	81,668,048	81,668,048	8.3%	39,445,667
Switch Mounted Occupancy Sensor	56,342,676	56,342,676	56,342,676	5.7%	27,213,512
Floating Head Pressure Control	44,029,506	44,029,506	44,029,506	4.5%	21,266,252
Remote Mounted Occupancy Sensor - Non HIF	38,785,725	38,785,725	38,785,725	3.9%	18,733,505
CFL Screw-in	33,169,264	33,169,264	33,169,264	3.4%	16,020,754
Energy Efficient Windows (Replace on Burnout)	92,440,699	30,813,566	30,813,566	3.1%	14,882,953
Variable Frequency Drives (VFD)	40,501,683	27,001,122	27,001,122	2.7%	13,041,542
Ductless (mini split)	26,993,752	26,993,752	26,993,752	2.7%	6,518,991
Evaporator Fan Motor Controls	33,045,375	22,030,250	22,030,250	2.2%	5,320,305
Specialty Fixtures - Induction Fluorescent 23W	28,592,536	21,994,259	21,994,259	2.2%	10,623,227
Zero-Energy Doors - Freezers	19,520,429	19,520,429	19,520,429	2.0%	9,428,367
Replace Exterior Quartz Halogen w/PSMH or HPS	28,942,152	19,294,768	19,294,768	2.0%	9,319,373
EMS install	18,864,017	18,864,017	18,864,017	1.9%	9,111,320
Commercial Reach-In Cooler	15,924,806	15,924,806	15,924,806	1.6%	7,691,681
Replace Exterior Metal Halide w/PSMH	23,003,335	15,335,557	15,335,557	1.6%	7,407,074
Energy Efficient "Smart" Power Strip for PC/Monitor/Printer	15,243,813	15,243,813	15,243,813	1.5%	7,362,762
Demand-Controlled Ventilation (CO2 vent control)	20,968,521	13,979,014	13,979,014	1.4%	6,751,864
ECM Motors	13,676,783	13,676,783	13,676,783	1.4%	6,605,886
Water Source Heat Pump	19,613,800	13,075,867	13,075,867	1.3%	6,315,644
Zero-Energy Doors - Coolers	12,230,015	12,230,015	12,230,015	1.2%	5,907,097
Discuss Compressor	11,935,928	11,935,928	11,935,928	1.2%	5,765,053
Comprehensive Track Proper HVAC Sizing	17,165,741	11,443,827	11,443,827	1.2%	5,527,369
LEC Exit Sign	11,440,019	11,440,019	11,440,019	1.2%	5,525,529
High Efficiency AC - Unitary & Split AC Systems (Tier 3)	17,145,155	11,430,103	11,430,103	1.2%	5,520,740
Door Heater Controls	10,931,822	10,931,822	10,931,822	1.1%	5,280,070
Scroll Compressor	12,940,781	9,954,447	9,954,447	1.0%	4,807,998
High Intensity Fluorescent Fixtures (replacing HID) - Hi & Low Bay	14,430,291	9,620,194	9,620,194	1.0%	4,646,554
High Efficiency Fluorescent Fixtures (HP T8 Troffer Replacing T12)	14,285,071	9,523,381	9,523,381	1.0%	4,599,793
Lamp & Ballast Retrofit (HP T8 Replacing T12)	14,285,071	9,523,381	9,523,381	1.0%	4,599,793
High Efficiency Fluorescent Fixtures (Low Glare Troffer HPT8/T5 Replacing T12)	14,196,345	9,464,230	9,464,230	1.0%	4,571,223
Variable Speed Drive Control, 5 HP	14,125,965	9,417,310	9,417,310	1.0%	4,548,561
Solar Water Heating System	9,213,272	9,213,272	9,213,272	0.9%	2,225,005
HID Fixture - Pulse Start Metal Halide (Interior)	11,619,517	8,938,090	8,938,090	0.9%	4,317,098
Energy Star office equipment including computers, monitors, copiers, multi-function machines.	8,571,331	8,571,331	8,571,331	0.9%	2,069,976
LED Exit Sign	7,604,134	7,604,134	7,604,134	0.8%	1,836,398
Commercial Reach-In Freezer	7,569,524	7,569,524	7,569,524	0.8%	3,656,080
Cold Cathode Screw In	7,527,043	7,527,043	7,527,043	0.8%	3,635,562
Low Flow Pre-Rinse Spray Nozzle (Included in 2006 Federal Standards) (Electric HW)	7,380,898	7,380,898	7,380,898	0.7%	3,564,974
High Efficiency AC - Unitary and Split Systems (Tier 2)	11,049,100	7,366,067	7,366,067	0.7%	3,557,810
Specialty Fixtures - Halogen Infra-Red Bulb	9,026,178	6,943,214	6,943,214	0.7%	3,353,572
Programmable Thermostat	6,929,023	6,929,023	6,929,023	0.7%	3,346,718
Energy Efficient Transformers	20,009,659	6,669,886	6,669,886	0.7%	3,221,555
CFL Fixture	6,564,217	6,564,217	6,564,217	0.7%	3,170,517
Improved Duct Sealing	9,283,367	6,188,911	6,188,911	0.6%	2,989,244
Centrifugal Chiller, 0.51 kW/ton, 300 tons	11,934,809	5,967,405	5,967,405	0.6%	2,882,256
Centrifugal Chiller, 0.51 kW/ton, 500 tons	11,934,809	5,967,405	5,967,405	0.6%	2,882,256
H.E. Evaporative Fan Motors	8,828,201	5,885,467	5,885,467	0.6%	2,842,681
Fan Motor, 5hp, 1800rpm, 90.4%	5,770,503	5,770,503	5,770,503	0.6%	1,393,576
Heat Pump Water Heater	7,763,401	5,545,286	5,545,286	0.6%	2,678,373
LED Screw In	7,084,276	5,449,443	5,449,443	0.6%	2,632,081
Specialty Fixtures - Integrated Ballast 25W MH	6,579,154	5,060,888	5,060,888	0.5%	2,444,409
Lamp & Ballast Retrofit (HP T8 Replacing Standard T8)	7,331,124	4,887,416	4,887,416	0.5%	2,360,622
Energy Star Compliant Single Door Refrigerator	6,179,517	4,753,474	4,753,474	0.5%	2,295,928
Refrigerated Case Covers	4,428,568	4,428,568	4,428,568	0.4%	2,138,998
Chiller Tune Up/Diagnostics - 500 ton	4,274,752	4,274,752	4,274,752	0.4%	2,064,705
Specialty Fixtures - Metal Halide Track	4,270,022	4,270,022	4,270,022	0.4%	2,062,421
Chiller Tune Up/Diagnostics - 300 ton	4,065,300	4,065,300	4,065,300	0.4%	981,770
Variable Speed Drive Control, 15 HP	5,782,153	3,854,769	3,854,769	0.4%	1,861,853
Heat Recovery	8,685,502	3,776,305	3,776,305	0.4%	911,978
Air Curtains (replacing electric door heaters)	3,140,876	3,140,876	3,140,876	0.3%	1,517,043
Efficient Motors	6,046,377	3,023,189	3,023,189	0.3%	1,460,200
Electronically-Commutated Permanent Magnet Motors (ECPMs)	5,953,879	2,976,939	2,976,939	0.3%	1,437,862
Variable Refrigerant Volume/Flow	4,443,727	2,962,485	2,962,485	0.3%	1,430,558
Commercial Ice-makers	2,893,273	2,893,273	2,893,273	0.3%	1,397,451
High Efficiency Heat Pump	4,182,891	2,788,594	2,788,594	0.3%	1,346,891

Table 52. Commercial Electric Savings Potential by Measure – Existing Buildings (continued)

Measure	Tech. Pot.	Max. Achievable	MACE	% of MACE	Potentially Obtainable
LED Christmas type - decorative lighting	2,781,714	2,781,714	2,781,714	0.3%	1,343,568
Controls for HIF- Remote Mount Occupancy Sensor	2,699,558	2,699,558	2,699,558	0.3%	1,303,886
LED Traffic / Pedestrian Signals	3,394,308	2,611,006	2,611,006	0.3%	1,261,116
Dual Enthalpy Economizer - from Fixed Damper	2,535,028	2,535,028	2,535,028	0.3%	1,224,419
Commercial Dishwasher (Under Counter Hi-Temp, Electric DHW)	2,479,353	2,479,353	2,479,353	0.3%	1,197,528
Hotel Guest Room Occupancy Control System	2,349,956	2,349,956	2,349,956	0.2%	1,135,029
Variable Pitch Fans	4,539,516	2,269,758	2,269,758	0.2%	1,096,293
Ozone Commercial Laundry System (Electric HW)	2,182,663	2,182,663	2,182,663	0.2%	1,054,226
Heat Pump Pool Heater	2,052,422	2,052,422	2,052,422	0.2%	991,320
Pool Cover	1,958,722	1,958,722	1,958,722	0.2%	946,063
High Efficiency Electric Water Heater	2,478,116	1,906,243	1,906,243	0.2%	920,715
Vending Miser for Non-Refrigerated Machines	1,550,737	1,550,737	1,550,737	0.2%	749,006
Vending Miser for Soft Drink Vending Machines	1,550,737	1,550,737	1,550,737	0.2%	749,006
Dual Enthalpy Economizer - from Dry Bulb	1,489,396	1,489,396	1,489,396	0.2%	719,378
HE Combination Oven	1,446,585	1,446,585	1,446,585	0.1%	349,350
Compressed Air – Non-Controls	1,376,113	1,376,113	1,376,113	0.1%	664,663
System/Component Diagnostics	1,954,450	1,302,967	1,302,967	0.1%	629,333
HE Holding Cabinet	1,068,185	890,154	890,154	0.1%	429,944
Fan Motor, 15hp, 1800rpm, 92.8%	830,981	830,981	830,981	0.1%	401,364
Variable Speed Drive Control, 40 HP	1,185,477	790,318	790,318	0.1%	381,724
Commercial Dishwasher (Single Tank Conveyor Hi-Temp, - Electric DHW)	1,350,477	675,239	675,239	0.1%	326,140
Energy Efficient Pool Pump with controls	476,912	476,912	476,912	0.0%	115,174
Liquid Pool Cover	430,788	430,788	430,788	0.0%	208,071
Solar Pool Heater	364,875	364,875	364,875	0.0%	176,235
HE Steamer	294,016	294,016	294,016	0.0%	142,010
Fan Motor, 40hp, 1800rpm, 94.1%	219,392	219,392	219,392	0.0%	52,983
Radiant Ceiling Cooling	321,497	214,332	214,332	0.0%	103,522
High efficiency spas/hot tubs	69,896	69,896	69,896	0.0%	33,760
Temperature Control	38,002	38,002	38,002	0.0%	18,355
Controls for HID - Hi/Lo	1,900,683	1,900,683	0	0.0%	0
EZ Save Monitor Power Management Software	2,953,351	2,953,351	0	0.0%	0
Compressed Air – Controls	885,013	885,013	0	0.0%	0
Ground Source Heat Pump	24,965,328	16,643,552	0	0.0%	0
Booster Water Heater	1,334,754	1,334,754	0	0.0%	0
Demand Ventilation Control	990,421	825,351	0	0.0%	0
HE Fryer - Electric	176,409	147,008	0	0.0%	0
HVAC Advanced Tune-Up	5,051,322	5,051,322	0	0.0%	0
Refrigeration Economizer	11,470,481	11,470,481	0	0.0%	0
Ground Source Heat Pump - Cooling	10,434,052	6,956,034	0	0.0%	0
Induction Cooktops	237,374	215,795	0	0.0%	0
Interior Storm Windows (Low-e or double clear film)	38,334,933	38,334,933	0	0.0%	0
Commercial Clothes washers (Hotels, Laundromats, Restaurants, etc.) (w/ Electric DHW)	1,858,358	1,858,358	0	0.0%	0
Daylight Controlled Dimming Ballast	103,310,140	103,310,140	0	0.0%	0
Point of Use Water Heater	655,459	655,459	0	0.0%	0
TVs - Energy Star over standard	3,993,912	3,993,912	0	0.0%	0
LED lighting retrofits in refrigeration end-uses/display cases	14,839,707	14,839,707	0	0.0%	0
EMS Optimization	1,632,031	1,632,031	0	0.0%	0
Grand Total	**1,451,916,034**	**1,198,691,188**	**985,683,305**	**100.00%**	**454,309,206**

Table 53. Commercial Electric Savings Potential by Measure – New Construction

Measure	Tech. Pot.	Max. Achievable	MACE	% of MACE	Potentially Obtainable
30% More Efficient Design - New Construction	37,451,152	24,967,435	24,967,435	30.8%	12,059,271
Integrated Building Design (Envelope Only)	26,398,145	8,799,382	8,799,382	10.9%	4,250,101
15% More Efficient Design - New Construction	13,041,633	8,694,422	8,694,422	10.7%	4,199,406
Floating Head Pressure Control	3,398,889	3,398,889	3,398,889	4.2%	1,641,663
Variable Frequency Drives (VFD)	3,126,556	2,084,371	2,084,371	2.6%	1,006,751
Ductless (mini split)	2,083,802	2,083,802	2,083,802	2.6%	503,238
Underfloor Air distribution	3,119,314	2,079,543	2,079,543	2.6%	1,004,419
Evaporator Fan Motor Controls	2,550,961	1,700,641	1,700,641	2.1%	410,705
Centrifugal Chiller, Optimal Design, 0.4 kW/ton, 500 tons	3,245,755	1,622,878	1,622,878	2.0%	783,631
Zero-Energy Doors - Freezers	1,506,893	1,506,893	1,506,893	1.9%	727,830
Commercial Reach-In Cooler	1,229,327	1,229,327	1,229,327	1.5%	593,765
Energy Efficient "Smart" Power Strip for PC/Monitor/Printer	1,176,757	1,176,757	1,176,757	1.5%	568,374
EMS install	1,159,363	1,159,363	1,159,363	1.4%	559,972
ECM Motors	1,055,789	1,055,789	1,055,789	1.3%	509,946
Demand-Controlled Ventilation (CO2 vent control)	1,514,865	1,009,910	1,009,910	1.2%	487,787
Water Source Heat Pump	1,514,101	1,009,401	1,009,401	1.2%	487,541
Zero-Energy Doors - Coolers	944,105	944,105	944,105	1.2%	456,003
Discuss Compressor	921,402	921,402	921,402	1.1%	445,037
High Efficiency AC - Unitary & Split AC Systems (Tier 3)	1,323,532	882,355	882,355	1.1%	426,177
Door Heater Controls	843,890	843,890	843,890	1.0%	407,599
Scroll Compressor	998,973	768,441	768,441	0.9%	371,157
Comprehensive Track Proper HVAC Sizing	1,108,285	738,857	738,857	0.9%	356,868
Variable Speed Drive Control, 5 HP	1,090,464	726,976	726,976	0.9%	351,129
Solar Water Heating System	711,225	711,225	711,225	0.9%	171,761
Energy Star office equipment including computers, monitors, copiers, multi-function machines.	661,670	661,670	661,670	0.8%	159,793
Commercial Reach-In Freezer	584,335	584,335	584,335	0.7%	282,234
Low Flow Pre-Rinse Spray Nozzle (Included in 2006 Federal Standards) (Electric HW)	569,774	569,774	569,774	0.7%	275,201
High Efficiency AC - Unitary and Split Systems (Tier 2)	852,943	568,629	568,629	0.7%	274,648
Programmable Thermostat	531,552	531,552	531,552	0.7%	256,740
Energy Efficient Transformers	1,544,660	514,887	514,887	0.6%	248,690
Centrifugal Chiller, 0.51 kW/ton, 500 tons	921,316	460,658	460,658	0.6%	222,498
Centrifugal Chiller, 0.51 kW/ton, 300 tons	921,316	460,658	460,658	0.6%	222,498
H.E. Evaporative Fan Motors	681,499	454,333	454,333	0.6%	219,443
Fan Motor, 5hp, 1800rpm, 90.4%	445,458	445,458	445,458	0.5%	107,578
Heat Pump Water Heater	599,301	428,072	428,072	0.5%	206,759
Dedicated Outdoor Air System	574,004	382,669	382,669	0.5%	184,829
Energy Star Compliant Single Door Refrigerator	477,032	366,948	366,948	0.5%	177,236
Refrigerated Case Covers	341,866	341,866	341,866	0.4%	165,122
Variable Speed Drive Control, 15 HP	446,357	297,572	297,572	0.4%	143,727
Heat Recovery	563,318	244,921	244,921	0.3%	59,148
Air Curtains (replacing electric door heaters)	242,462	242,462	242,462	0.3%	117,109
Efficient Motors	466,754	233,377	233,377	0.3%	112,721
Electronically-Commutated Permanent Magnet Motors (ECPMs)	459,614	229,807	229,807	0.3%	110,997
Commercial Ice-makers	223,348	223,348	223,348	0.3%	107,877
High Efficiency Heat Pump	322,901	215,267	215,267	0.3%	103,974
Commercial Dishwasher (Under Counter Hi-Temp, Electric DHW)	191,395	191,395	191,395	0.2%	92,444

Table 53. Commercial Electric Savings Potential by Measure – New Construction (continued)

Measure	Tech. Pot.	Max. Achievable	MACE	% of MACE	Potentially Obtainable
Hotel Guest Room Occupancy Control System	180,649	180,649	180,649	0.2%	87,253
Variable Pitch Fans	350,431	175,216	175,216	0.2%	84,629
Ozone Commercial Laundry System (Electric HW)	168,492	168,492	168,492	0.2%	81,382
Variable Refrigerant Volume/Flow	239,991	159,994	159,994	0.2%	77,255
Heat Pump Pool Heater	158,438	158,438	158,438	0.2%	76,526
Pool Cover	151,205	151,205	151,205	0.2%	73,032
Dual Enthalpy Economizer - from Fixed Damper	147,662	147,662	147,662	0.2%	71,321
High Efficiency Electric Water Heater	191,300	147,154	147,154	0.2%	71,075
Vending Miser for Soft Drink Vending Machines	119,710	119,710	119,710	0.1%	57,820
Vending Miser for Non-Refrigerated Machines	119,710	119,710	119,710	0.1%	57,820
HE Combination Oven	111,670	111,670	111,670	0.1%	26,968
Compressed Air – Non-Controls	106,230	106,230	106,230	0.1%	51,309
Dual Enthalpy Economizer - from Dry Bulb	86,322	86,322	86,322	0.1%	41,693
System/Component Diagnostics	122,737	81,825	81,825	0.1%	39,521
HE Holding Cabinet	82,459	68,716	68,716	0.1%	33,190
Fan Motor, 15hp, 1800rpm, 92.8%	64,148	64,148	64,148	0.1%	30,984
Variable Speed Drive Control, 40 HP	91,514	61,009	61,009	0.1%	29,467
Commercial Dishwasher (Single Tank Conveyor Hi-Temp, - Electric DHW)	104,251	52,126	52,126	0.1%	25,177
Energy Efficient Pool Pump with controls	36,816	36,816	36,816	0.0%	8,891
Liquid Pool Cover	33,255	33,255	33,255	0.0%	16,062
Solar Pool Heater	28,167	28,167	28,167	0.0%	13,605
HE Steamer	22,697	22,697	22,697	0.0%	10,963
Fan Motor, 40hp, 1800rpm, 94.1%	16,936	16,936	16,936	0.0%	4,090
Radiant Ceiling Cooling	24,694	16,463	16,463	0.0%	7,952
High efficiency spas/hot tubs	5,396	5,396	5,396	0.0%	2,606
Temperature Control	2,934	2,934	2,934	0.0%	1,417
LED lighting retrofits in refrigeration end-uses/display cases	1,145,562	1,145,562	0	0.0%	0
Commercial Clothes washers (Hotels, Laundromats, Restaurants, etc.) (w/ Electric DHW)	143,457	143,457	0	0.0%	0
Refrigeration Economizer	885,472	885,472	0	0.0%	0
Point of Use Water Heater	50,599	50,599	0	0.0%	0
Ground Source Heat Pump	1,927,216	1,284,811	0	0.0%	0
Commercial Clothes washers (Hotels, Laundromats, Restaurants, etc.) (w/ Non-Electric DHW)	0	0	0	0.0%	0
Induction Cooktops	18,324	16,658	0	0.0%	0
EZ Save Monitor Power Management Software	227,986	227,986	0	0.0%	0
Demand Ventilation Control	76,456	63,714	0	0.0%	0
Daylight Dimming - New Construction	13,436,518	13,436,518	0	0.0%	0
Ground Source Heat Pump - Cooling	805,464	536,976	0	0.0%	0
HE Fryer - Electric	13,618	11,348	0	0.0%	0
Compressed Air – Controls	68,319	68,319	0	0.0%	0
Booster Water Heater	103,037	103,037	0	0.0%	0
TVs - Energy Star over standard	308,313	308,313	0	0.0%	0
Grand Total	**146,116,211**	**99,371,416**	**81,088,647**	**100.00%**	**37,713,403**

Table 54. Commercial Non-Electric Savings Potential by Measure – Existing Construction

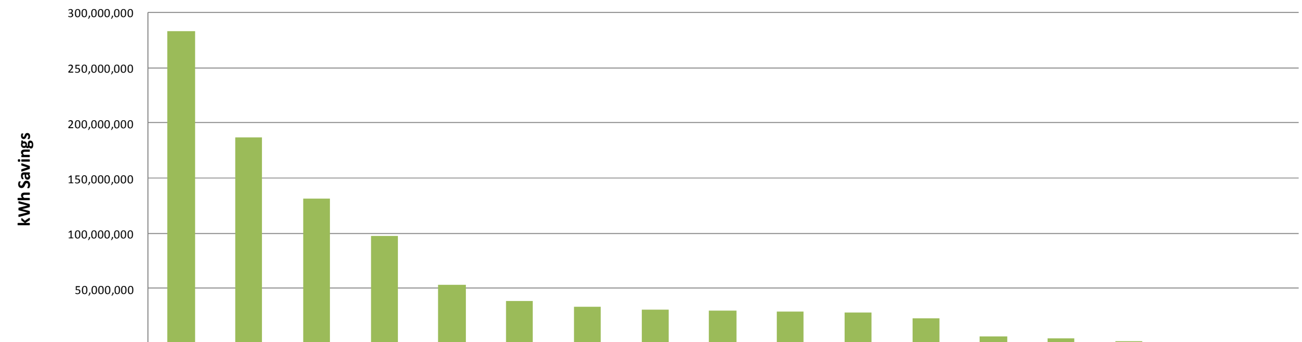
Measure	Tech. Potential (MMBtu)	Max. Achievable (MMBtu)	MACE (MMBtu)	% of MACE	Pot. Obtainable
Condensing Boiler	759,394	759,394	759,394	8.5%	183,394
Retrocommissioning	632,588	632,588	632,588	7.1%	305,540
Boiler Reset Controls	522,553	522,553	522,553	5.9%	252,393
Destratification Fans	416,537	416,537	416,537	4.7%	201,187
Programmable Thermostat	380,314	380,314	380,314	4.3%	183,692
Filter replacement	319,077	319,077	319,077	3.6%	154,114
Roof Insulation (only when re-roofing)	287,347	287,347	287,347	3.2%	134,182
Ozone Commercial Laundry System	265,156	265,156	265,156	3.0%	57,166
Tank Insulation	249,847	249,847	249,847	2.8%	120,676
Faucet Aerator	231,579	231,579	231,579	2.6%	111,853
High Efficiency Furnace (AFUE>=92%)	377,571	188,785	188,785	2.1%	91,183
Pool Cover	181,651	181,651	181,651	2.0%	76,112
Insulated Overhead Doors	345,603	172,802	172,802	1.9%	48,696
ECM - 92% (packaged with a high efficiency furnace)	256,436	142,465	142,465	1.6%	66,805
Demand-Controlled Ventilation (CO2 vent control)	203,741	135,827	135,827	1.5%	55,614
Indirect Fired Water Heating Systems	187,984	125,323	125,323	1.4%	60,531
Loading dock Seals	125,179	125,179	125,179	1.4%	51,059
EMS install	124,705	124,705	124,705	1.4%	58,247
Low Flow Shower Heads	111,991	111,991	111,991	1.3%	54,092
Exhaust hood makeup air	105,610	105,610	105,610	1.2%	48,186
Steam trap maintenance	100,813	100,813	100,813	1.1%	48,693
Dedicated Outdoor Air Systems (DOAS) (reduces both AC & htg)	133,360	88,907	88,907	1.0%	23,528
Energy Efficient Windows	212,826	85,131	85,131	1.0%	41,118
Boiler- Heating Pipe Insulation	81,795	81,795	81,795	0.9%	39,507
High Efficiency Steam Boiler	156,360	78,180	78,180	0.9%	37,761
Boiler Tune-Up	75,435	75,435	75,435	0.8%	36,435
Demand Ventilation Control	111,159	74,106	74,106	0.8%	35,793
Energy and Heat Recovery Ventilators (ERV/HRV)	65,985	65,985	65,985	0.7%	15,935
High Efficiency Hot Water Boiler(AFUE>=85%)	112,817	56,408	56,408	0.6%	27,245
Energy Star Fryer	53,993	53,993	53,993	0.6%	26,079
Efficient Furnace Fan (Non-Electric Furnace)	87,466	48,592	48,592	0.5%	11,735
Low Flow Pre-Rinse Spray Nozzle	45,589	45,589	45,589	0.5%	21,985
High Efficiency Clothes Washer	44,790	44,790	44,790	0.5%	21,423
High Efficiency Gas Steamer	40,495	40,495	40,495	0.5%	19,559
Refrigeration waste heat recovery	49,503	33,002	33,002	0.4%	15,940
Infrared Heater	54,781	32,224	32,224	0.4%	13,108
High Efficiency (95%) Gas Pool Water Heater	30,073	30,073	30,073	0.3%	11,574
High Efficiency Spa/Hot Tub Heater	26,633	26,633	26,633	0.3%	10,918
Pipe Insulation	26,592	26,592	26,592	0.3%	12,844
Solar Pool Heater	24,852	24,852	24,852	0.3%	6,017
High Efficiency Gas Rack Oven	16,873	16,873	16,873	0.2%	7,985
High Efficiency Gas Conveyer Oven	16,873	16,873	16,873	0.2%	8,150
Power Burner Oven	16,367	16,367	16,367	0.2%	7,746
High Efficiency Gas Convection Oven	15,523	15,523	15,523	0.2%	7,498
High Efficiency Gas Broiler	12,149	12,149	12,149	0.1%	5,868
High Efficiency Gas Combination Oven	10,124	10,124	10,124	0.1%	4,890
Stack Heat Exchanger	17,956	8,978	8,978	0.1%	4,336
On Demand Water Heater	7,623	7,623	7,623	0.1%	1,744
Repair malfunctioning steam traps	7,387	7,387	7,387	0.1%	3,568
High Efficiency Water Heater>=62%	6,282	6,282	6,282	0.1%	3,034
Boiler blowdown heat exchanger (steam)	3,850	3,850	3,850	0.0%	1,859
Boiler O2 Trim Controls	3,630	3,630	3,630	0.0%	1,753
Interior Storm Windows (Low-e or double clear film)	0	0	0	0.0%	0
Improved Duct Sealing	874,830	583,220	0	6.5%	0
Heat Recovery from Air to Air	69,807	69,807	0	0.8%	0
Integrated Building Design, Envelope Only (30% > code)	0	0	0	0.0%	0
Wall Insulation	765,976	765,976	0	8.6%	0
Enthalpy/Energy Recovery Heat Exchangers for Ventilation	71,730	47,820	0	0.5%	0
Solar Water Heating System	355,820	355,820	0	4.0%	0
Air curtains	130,672	130,672	0	1.5%	0
Improved Duct Sealing (also for heating & cooling)	0	0	0	0.0%	0
Exterior Door Insulation	191,491	191,491	0	2.1%	0
EMS Optimization	4,541	4,541	0	0.1%	0
Commissioning	0	0	0	0.0%	0
High Efficiency Gas Griddle	64,792	64,792	0	0.7%	0
Grand Total	**10,284,474**	**8,932,119**	**6,717,981**	**100.0%**	**2,850,349**

Table 55. Commercial Non-Electric Savings Potential by Measure – New Construction

Measure	Tech. Potential (MMBtu)	Max. Achievable (MMBtu)	MACE (MMBtu)	% of MACE	Pot. Obtainable
Condensing Boiler	759,394	759,394	759,394	11.8%	183,394
Boiler Reset Controls	522,553	522,553	522,553	8.1%	252,393
Destratification Fans	416,537	416,537	416,537	6.5%	201,187
Programmable Thermostat	380,314	380,314	380,314	5.9%	183,692
Filter replacement	319,077	319,077	319,077	5.0%	154,114
Ozone Commercial Laundry System	265,156	265,156	265,156	4.1%	57,166
Tank Insulation	249,847	249,847	249,847	3.9%	120,676
Faucet Aerator	231,579	231,579	231,579	3.6%	111,853
High Efficiency Furnace (AFUE>=92%)	377,571	188,785	188,785	2.9%	91,183
Pool Cover	181,651	181,651	181,651	2.8%	76,112
ECM - 92% (packaged with a high efficiency furnace)	256,436	142,465	142,465	2.2%	66,805
Demand-Controlled Ventilation (CO2 vent control)	203,741	135,827	135,827	2.1%	55,614
Indirect Fired Water Heating Systems	187,984	125,323	125,323	1.9%	60,531
EMS install	124,705	124,705	124,705	1.9%	58,247
Low Flow Shower Heads	111,991	111,991	111,991	1.7%	54,092
Steam trap maintenance	100,813	100,813	100,813	1.6%	48,693
Dedicated Outdoor Air Systems (DOAS) (reduces both AC & htg)	133,360	88,907	88,907	1.4%	23,528
Boiler- Heating Pipe Insulation	81,795	81,795	81,795	1.3%	39,507
High Efficiency Steam Boiler	156,360	78,180	78,180	1.2%	37,761
Boiler Tune-Up	75,435	75,435	75,435	1.2%	36,435
Demand Ventilation Control	111,159	74,106	74,106	1.2%	35,793
Energy and Heat Recovery Ventilators (ERV/HRV)	65,985	65,985	65,985	1.0%	15,935
High Efficiency Hot Water Boiler(AFUE>=85%)	112,817	56,408	56,408	0.9%	27,245
Energy Star Fryer	53,993	53,993	53,993	0.8%	26,079
Efficient Furnace Fan (Non-Electric Furnace)	87,466	48,592	48,592	0.8%	11,735
Low Flow Pre-Rinse Spray Nozzle	45,589	45,589	45,589	0.7%	21,985
High Efficiency Clothes Washer	44,790	44,790	44,790	0.7%	21,423
High Efficiency Gas Steamer	40,495	40,495	40,495	0.6%	19,559
Refrigeration waste heat recovery	49,503	33,002	33,002	0.5%	15,940
Infrared Heater	54,781	32,224	32,224	0.5%	13,108
High Efficiency (95%) Gas Pool Water Heater	30,073	30,073	30,073	0.5%	11,574
High Efficiency Spa/Hot Tub Heater	26,633	26,633	26,633	0.4%	10,918
Pipe Insulation	26,592	26,592	26,592	0.4%	12,844
Solar Pool Heater	24,852	24,852	24,852	0.4%	6,017
High Efficiency Gas Rack Oven	16,873	16,873	16,873	0.3%	7,985
High Efficiency Gas Conveyer Oven	16,873	16,873	16,873	0.3%	8,150
Power Burner Oven	16,367	16,367	16,367	0.3%	7,746
High Efficiency Gas Convection Oven	15,523	15,523	15,523	0.2%	7,498
High Efficiency Gas Broiler	12,149	12,149	12,149	0.2%	5,868
High Efficiency Gas Combination Oven	10,124	10,124	10,124	0.2%	4,890
Stack Heat Exchanger	17,956	8,978	8,978	0.1%	4,336
On Demand Water Heater	7,623	7,623	7,623	0.1%	1,744
Repair malfunctioning steam traps	7,387	7,387	7,387	0.1%	3,568
High Efficiency Water Heater>=62%	6,282	6,282	6,282	0.1%	3,034
Boiler blowdown heat exchanger (steam)	3,850	3,850	3,850	0.1%	1,859
Boiler O2 Trim Controls	3,630	3,630	3,630	0.1%	1,753
Solar Water Heating System	355,820	355,820	0	5.5%	0
Heat Recovery from Air to Air	69,807	69,807	0	1.1%	0
Improved Duct Sealing	874,830	583,220	0	9.1%	0
Enthalpy/Energy Recovery Heat Exchangers for Ventilation	71,730	47,820	0	0.7%	0
High Efficiency Gas Griddle	64,792	64,792	0	1.0%	0
Grand Total	**7,482,642**	**6,430,785**	**5,309,326**	**100.0%**	**2,221,568**

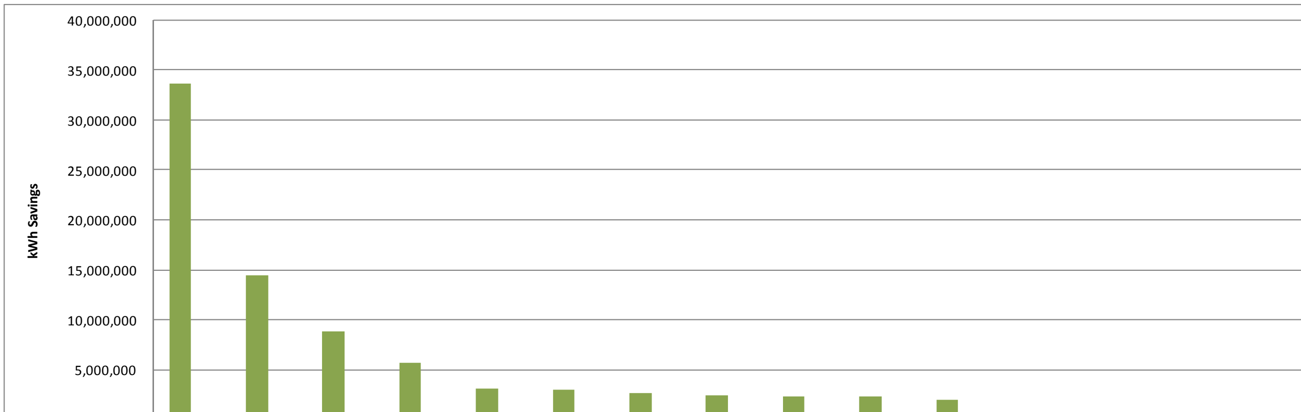
The distribution of commercial sector electric and non-electric savings by end use is shown below in Figure 39 through Figure 42 for existing and new buildings. On the electric side, for the commercial sector in New Hampshire, the electric lighting end use still represents the largest savings potential in absolute terms for both energy and peak demand, despite the significant adoption of high-efficiency lighting since the 1990's. Refrigeration represents the second largest end-use category for kWh savings and space heating and cooling makes up the third largest category for kWh savings. On the non-electric side, for the commercial sector in New Hampshire, the space-heating end use represents the largest savings potential (nearly 75%). Space heating is followed up by water heating, and the remainder is brought up by cooking, pools, and ventilation.

Figure 39. Commercial Electric Max. Achievable Cost Effective Savings By End Use – Existing



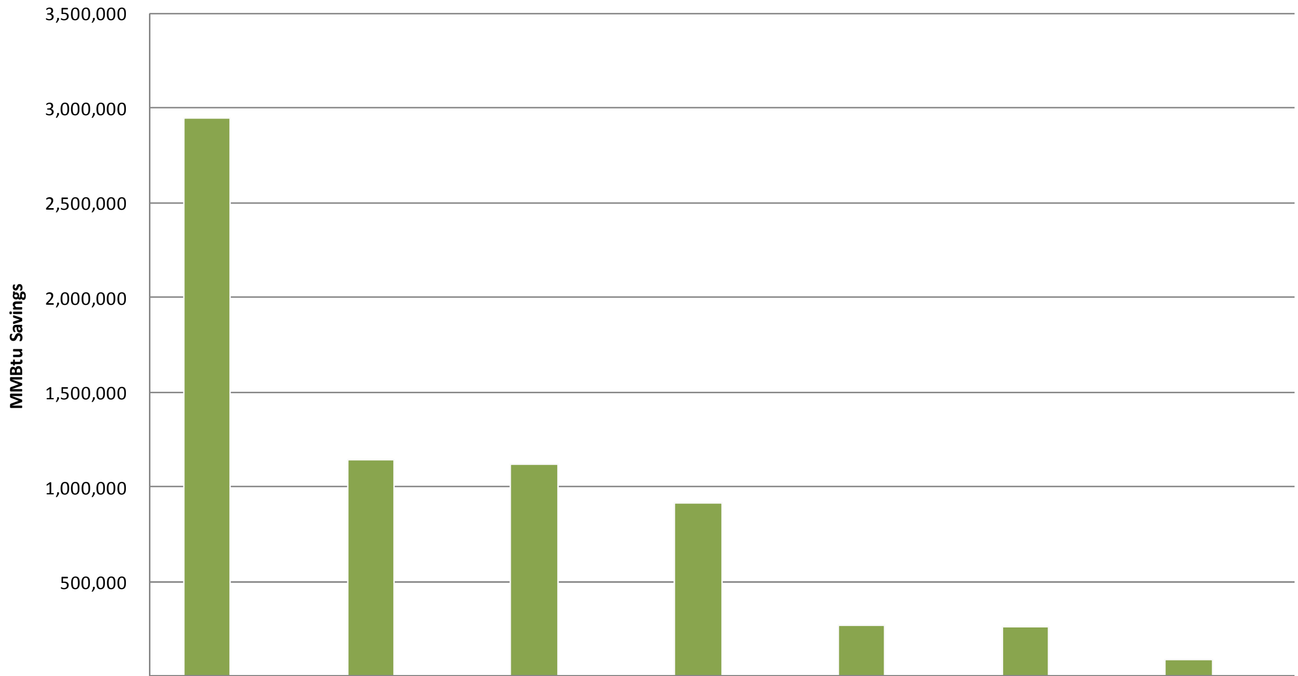
	Lighting	Refrigeration	HVAC Controls	Lighting Controls	Ventilation	Space Cooling - Unitary and Split AC	Space Heating	Building Envelope	Non-HVAC Motors	Water Heating	Appliances, Computers, Office Equipment	Space Cooling - Chillers	Transformers	Pools	Cooking	Compressed Air	Lighting Design
Total	283,670,28	187,253,17	131,425,55	97,827,958	54,098,624	39,271,838	34,040,704	30,813,566	30,024,310	29,382,954	28,568,618	23,237,346	6,669,886	5,391,617	2,630,755	1,376,113	-

Figure 40. Commercial Electric Max. Achievable Cost Effective Savings By End Use – New



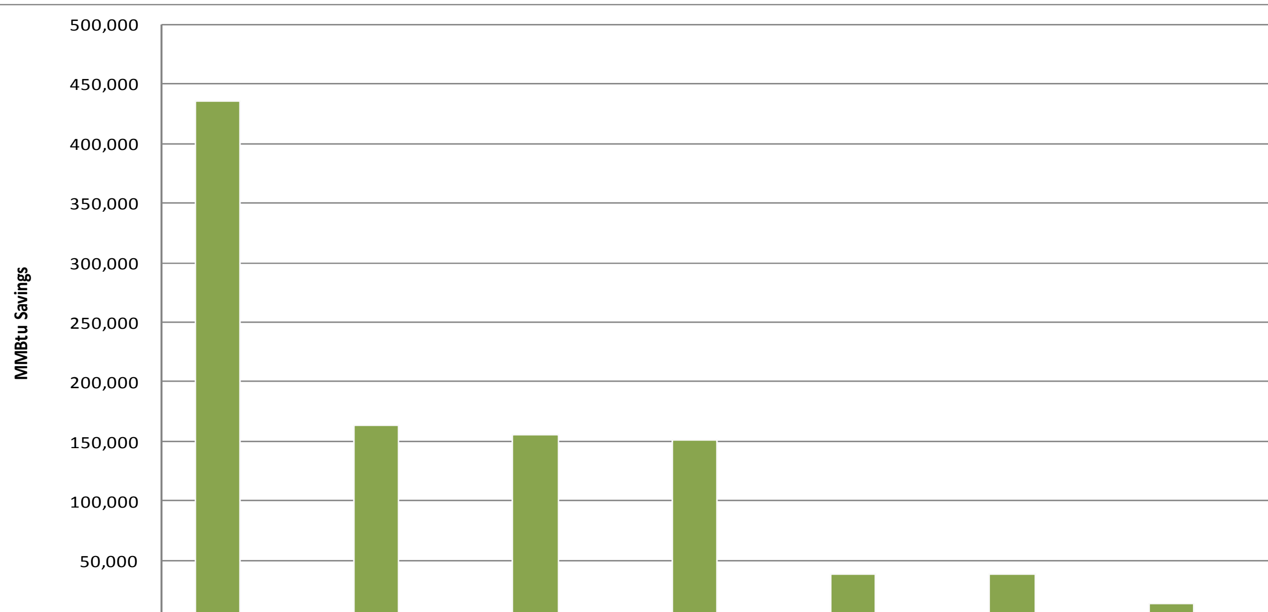
	Lighting Design	Refrigeratio n	Building Envelope	Ventilation	Space Cooling - Chillers	Space Cooling - Unitary and Split AC	Space Heating	Non-HVAC Motors	Water Heating	Appliances, Computers, Office Equipment	HVAC Controls	Transforme rs	Pools	Cooking	Compressed Air
MACE kWh Savings	33,661,856	14,455,141	8,799,382	5,585,479	2,995,167	2,978,667	2,627,796	2,317,748	2,268,238	2,205,375	1,953,389	514,887	416,210	203,083	106,230
% of MACE	41.5%	17.8%	10.9%	6.9%	3.7%	3.7%	3.2%	2.9%	2.8%	2.7%	2.4%	0.6%	0.5%	0.3%	0.1%

Figure 41. Commercial Max. Achievable Cost Effective Non-Electric Savings By End Use – Existing



	Space Heating	HVAC Controls	Water Heating	Building Envelope	Pools	Cooking	Ventilation
MACE	2,945,089	1,137,607	1,114,772	911,895	263,209	256,502	88,907
% of MACE	43.8%	16.9%	16.6%	13.6%	3.9%	3.8%	1.3%

Figure 42. Commercial Max. Achievable Cost Effective Non-Electric Savings By End Use – New



	Space Heating	Water Heating	Building Envelope	HVAC Controls	Pools	Cooking	Ventilation
MACE Savings	435,153	163,340	154,646	150,041	38,566	37,583	13,027
% of MACE	43.9%	16.5%	15.6%	15.1%	3.9%	3.8%	1.3%

5.2.2 Commercial Energy Efficiency Measure Supply Curves

This report also presents results in the form of electric and non-electric energy efficiency supply curves. Figure 43 through Figure 48 present the electric existing and new construction supply curves under each scenario (technical potential, maximum achievable, maximum achievable cost effective). Figure 49 through Figure 54 present supply curves for the non-electric existing and new construction scenario (technical potential, maximum achievable, maximum achievable cost effective). As in the residential sector, these supply curves were built up across individual measures and were sorted on a lowest to highest cost basis per unit of energy saved.

Figure 43. Commercial Electric Supply Curve: Existing Buildings – Technical Potential Scenario

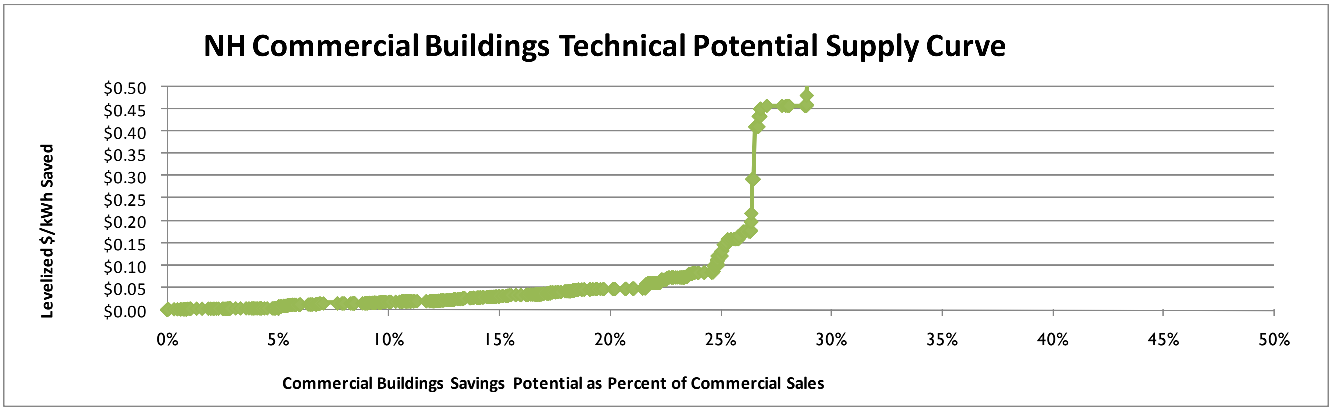


Figure 44. Commercial Electric Supply Curve: Existing Buildings – Max. Maximum Achievable

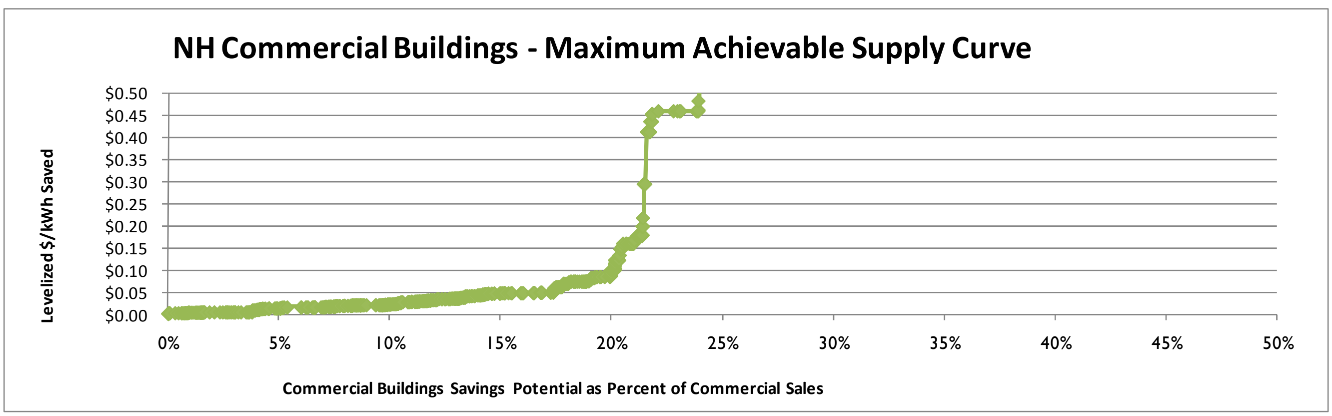


Figure 45. Commercial Electric Supply Curve: Existing Buildings – Max. Achievable Cost Effective

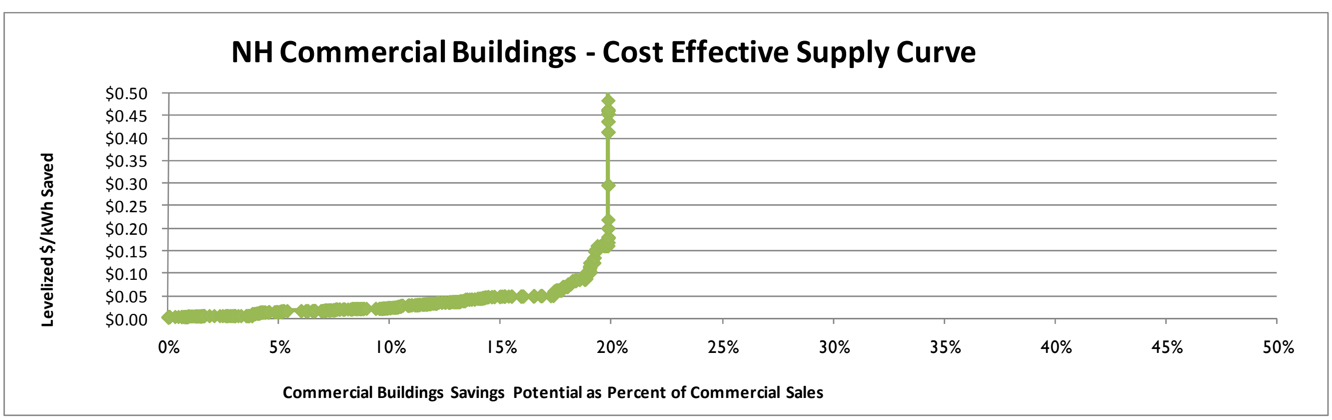


Figure 46. Commercial Electric Supply Curve: New Buildings – Technical Potential Scenario

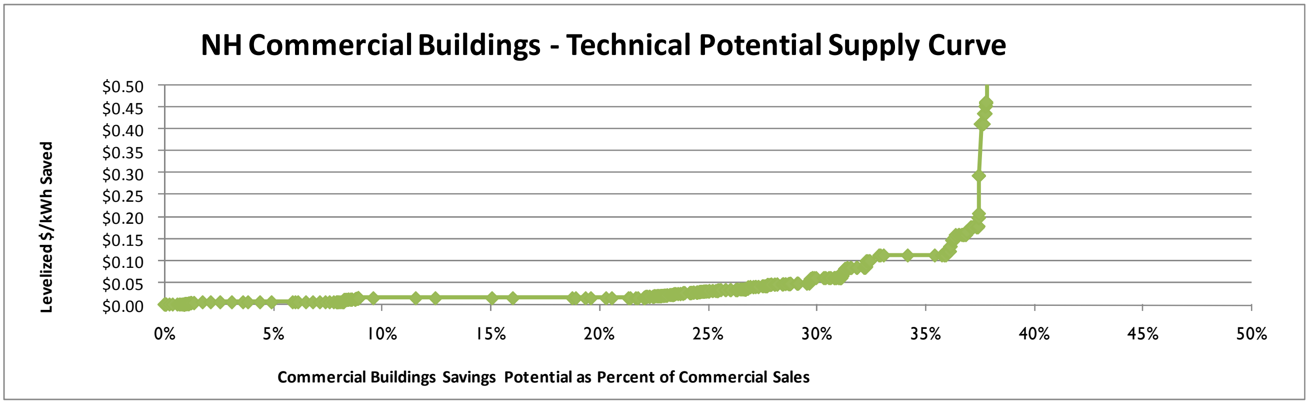


Figure 47. Commercial Electric Supply Curve: New Buildings – Max. Achievable

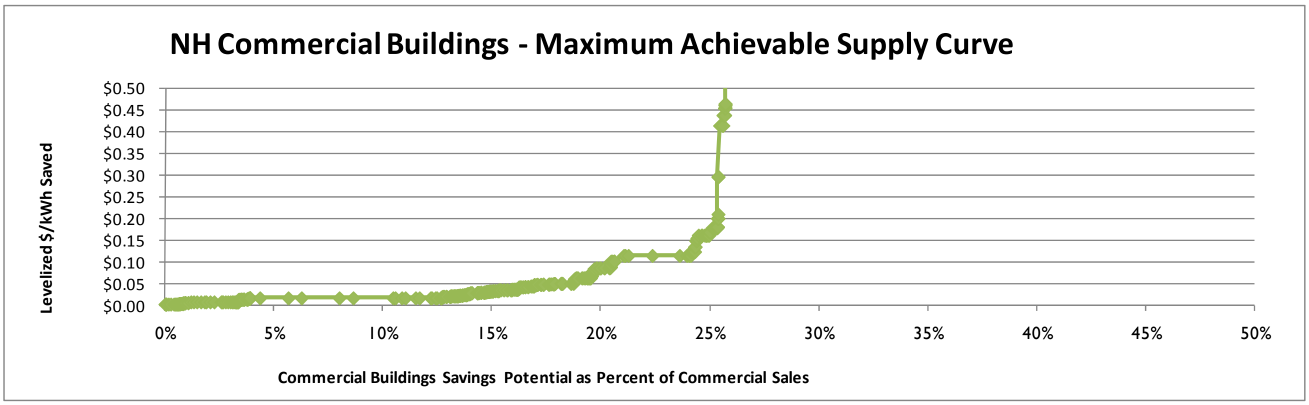


Figure 48. Commercial Electric Supply Curve: New Buildings – Max. Achievable Cost Effective

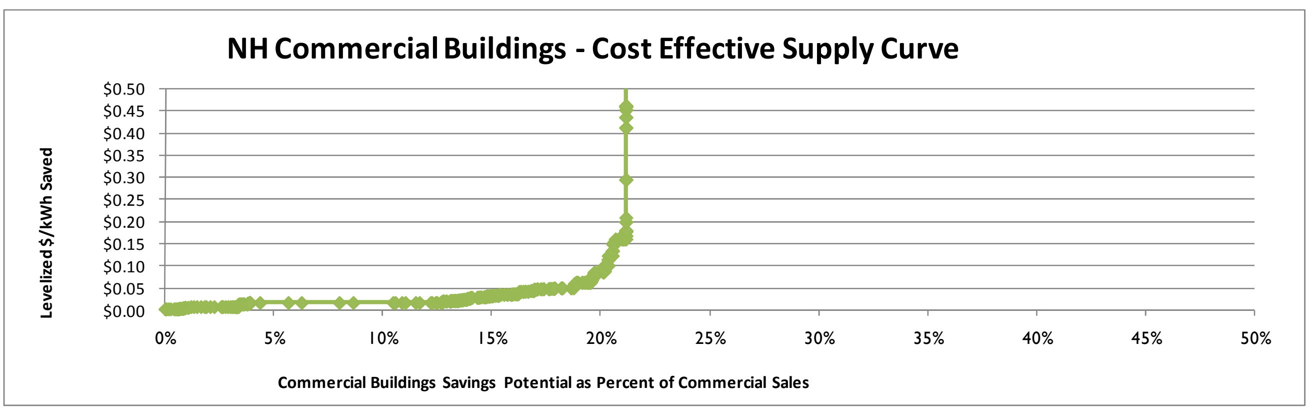


Figure 49. Commercial Non-Electric Supply Curve: Existing Buildings – Technical Potential

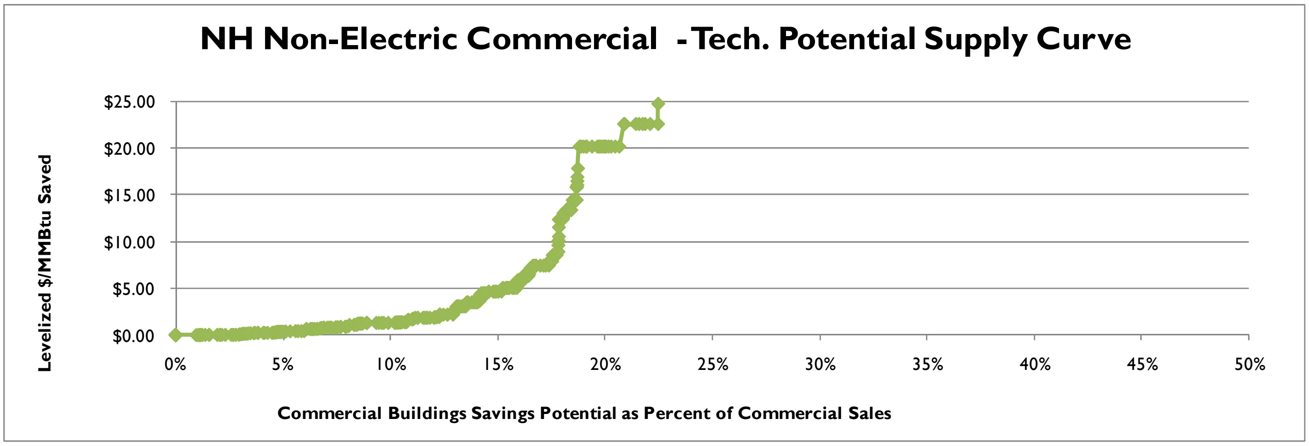


Figure 50. Commercial Non-Electric Supply Curve: Existing Buildings – Max. Achievable

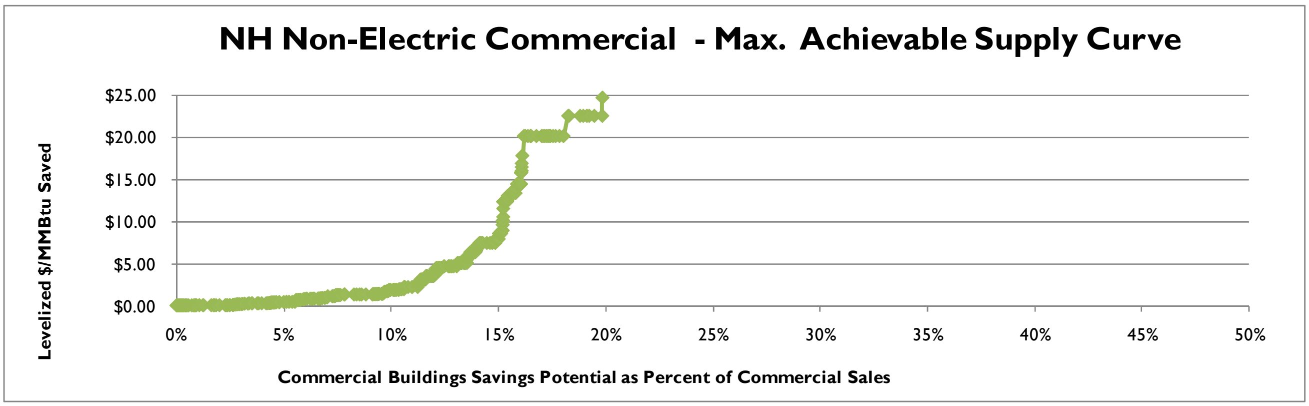


Figure 51. Commercial Non-Electric Supply Curve: Existing Buildings – Max. Achievable Cost Effective

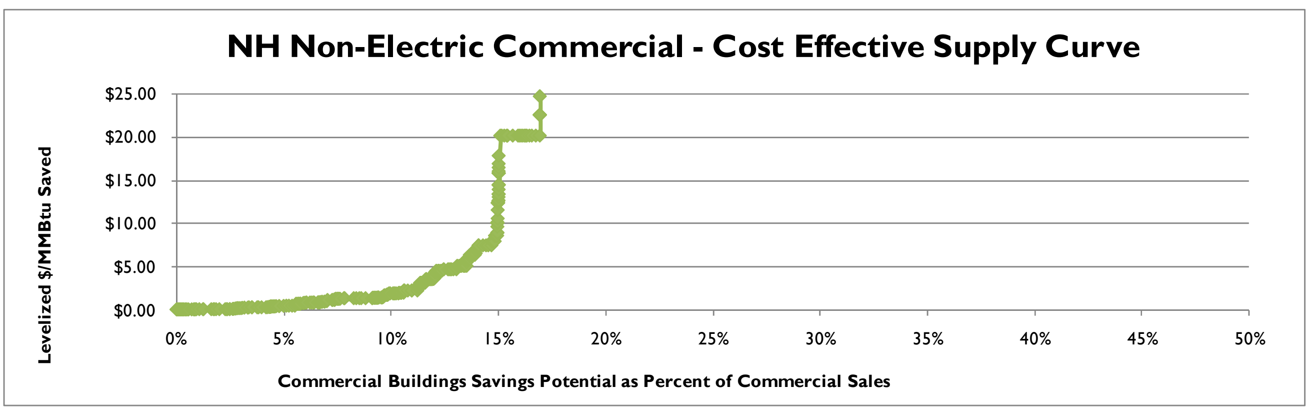


Figure 52. Commercial Non-Electric Supply Curve: New Buildings – Technical Potential

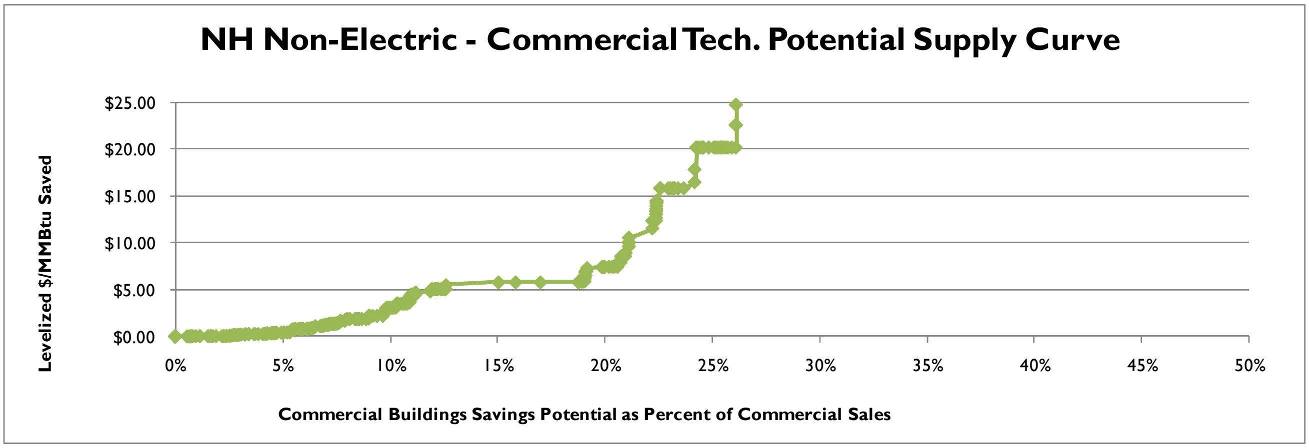


Figure 53. Commercial Non-Electric Supply Curve: New Buildings – Max. Achievable

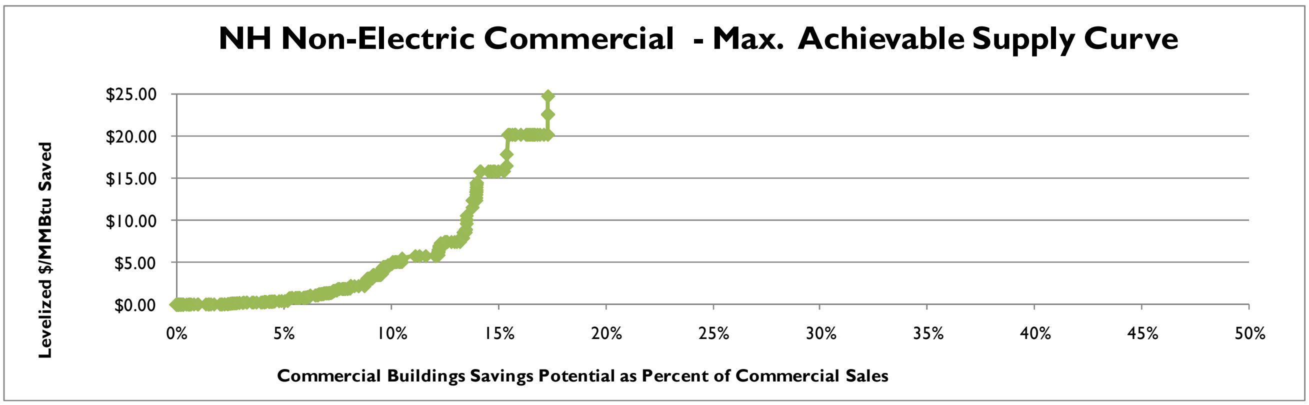
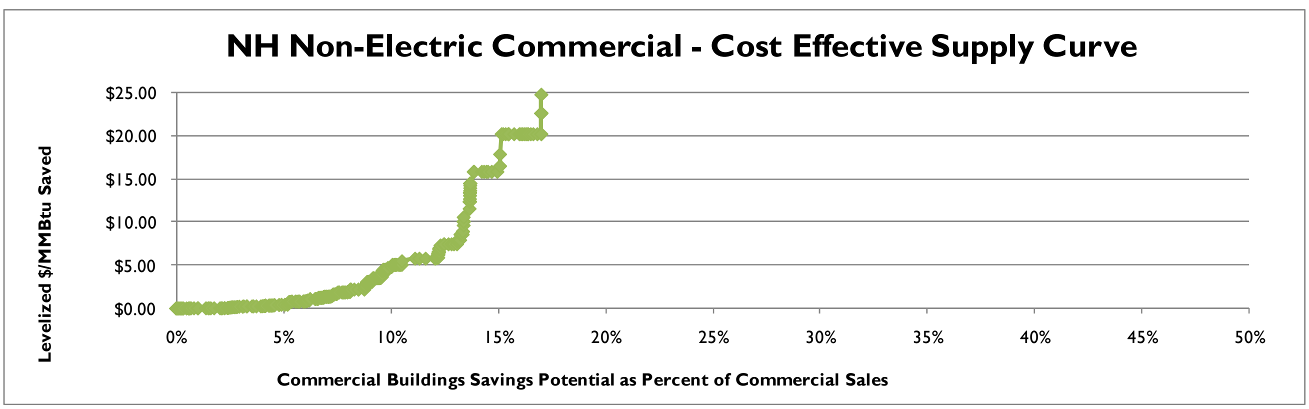


Figure 54. Commercial Non-Electric Supply Curve: New Buildings – Max. Achievable Cost Effective



Section 6: Industrial Sector Energy Efficiency Potential

This section of the report presents the estimates of electric and non-electric technical (traditional), maximum achievable, maximum achievable cost effective, and potentially obtainable energy efficiency potential for the existing and new construction market segments of the industrial sector in New Hampshire. More information regarding how these potentials were derived is also presented.

According to this analysis, there is still a large remaining potential for electric and non-electric energy efficiency savings in the industrial sector. Table 56 and Table 57 below summarize the savings by potential type by the year 2018. In addition, Table 56 presents peak demand savings for each potential level of savings associated with the electric energy efficiency measures.[45]

On the electric side, the combined existing and new buildings maximum achievable cost effective potential in the industrial sector is over 440 million kWh, or 21 percent of the New Hampshire industrial sector sales forecast in 2018. With regard to non-electric potential, the maximum achievable cost effective potential in the industrial sector is 1.4 million MMBTu, or 9 percent of projected New Hampshire industrial sector natural gas, oil and propane sales in 2018.

The results on both the electric and non-electric tables below display the Maximum Achievable being equal to the Maximum Achievable Cost Effective potential. This is due to the end-uses being screened in a combined manner, rather than at the measure level. While there is a high likelihood that some measures within each of the end-uses would screen as not cost-effective, given that this analysis was done at the end-use level, modeling limitations prevented consideration of such measure-specific results.

Table 56. Summary of Industrial Sector Electric Energy Efficiency Savings Potential

	Estimated Annual Sales by 2018 (kWh)	Estimated Annual Savings by 2018 (kWh)	Savings in 2018 as % of Sector 2018 Electric Consumption	Savings in 2018 as % of Total 2018 Electric Consumption	Estimated Annual Sales by 2018 (MW)	Estimated Annual Demand Savings by 2018 By Sector (MW)	Estimated Savings as % of Peak Sector Demand by 2018	Estimated Savings as % of Total Peak Demand by 2018	Estimated Costs to Achieve 2018 Annual Savings (10 Year Cumulative) ($2008 NPV)	Total Estimated Annual Benefits Associated W/Combined Savings in 2018 ($2008 NPV)	Simple Payback (NPV Total Costs / NPV Annual Savings)
INDUSTRIAL SECTOR											
Technical Potential (Traditional)	2,102,729,959	515,485,621	24.5%	4.0%	498	109.7	22.0%	3.7%	$133,914,929	$ 46,000,232	2.9
Max. Achievable Potential		442,671,155	21.1%	3.4%		94.2	18.9%	3.2%	$114,998,894	$ 39,502,510	2.9
Max. Achievable Cost Effective		442,671,155	21.1%	3.4%		94.2	18.9%	3.2%	$114,998,894	$ 39,502,510	2.9
Potentially Obtainable		213,810,168	10.2%	1.6%		81.9	16.5%	2.7%	$55,544,466	$ 19,079,712	2.9

[45] For purposes of this study, a simplifying assumption was used to estimate peak demand savings. Percentage sector peak demand savings are calculated to show savings over the summer coincident peak demand period only and are not broken out separately for summer and winder peak periods.

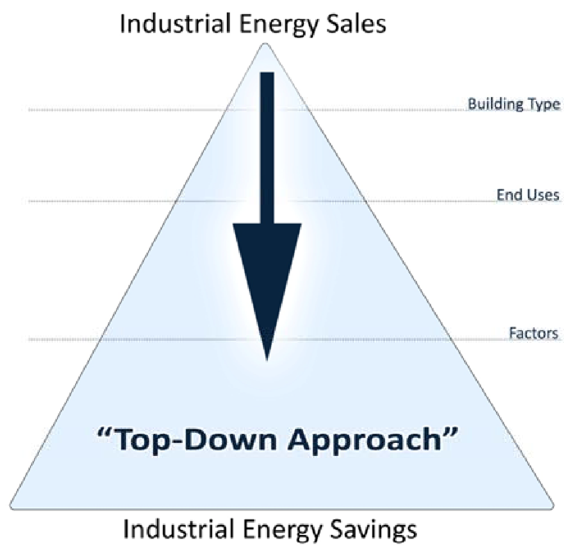
Table 57. Summary of Industrial Sector Non-Electric Energy Efficiency Savings Potential

	Estimated Annual Sales by 2018 (MMBtu)	Estimated Annual Savings by 2018 (MMBtu)	Savings in 2018 as % of Sector 2018 Non-Electric Fuel Consumption	Savings in 2018 as % of Total 2018 Non-Electric Fuel Consumption	Estimated Costs to Achieve 2018 Annual Savings (10 Year Cumulative) ($2008 NPV)	Total Estimated Annual Benefits Associated W/Combined Savings in 2018 ($2008 NPV)	Simple Payback (NPV Total Costs / NPV Annual Savings)
INDUSTRIAL SECTOR							
Technical Potential (Traditional)	15,673,818	1,755,089	11.2%	1.9%	$ 19,467,779	$ 16,623,765	1.2
Max. Achievable Potential		1,415,809	9.0%	1.5%	$ 15,704,417	$ 13,410,187	1.2
Max. Achievable Cost Effective		1,415,809	9.0%	1.5%	$ 15,704,417	$ 13,410,187	1.2
Potentially Obtainable		683,836	4.4%	0.7%	$ 7,585,234	$ 6,477,120	1.2

6.1 Industrial Sector Savings Methodology Overview

The Industrial sector analysis was modeled using what is considered a “top-down approach”. This methodology, shown visually in Figure 55 below:

Figure 55. Industrial Sector Savings Methodology – Top Down Approach



Similar to the commercial sector, this top-down methodology starts with the total projected 2018 kWh sales for the industrial sector, and then splits those sales up by industry type using SIC codes of actual customer data (provided to GDS by project sponsors). After the sales are distributed across the industry types, they are broken down further to specific end-uses (e.g. lighting, space heating, appliances) within each of the building types. This was done using the 2002 Mechanical Energy Consumption Survey data (MECS)[46] for the New England Region. Given that the industrial sector equipment stock consists of highly specialized custom equipment, this sector was modeled at the end-use level as opposed to the detailed measure level. The end-uses being modeled in the Industrial sector include the following:

- Conventional Boiler Use
- CHP and/or Cogeneration Process
- Process Heating
- Process Cooling and Refrigeration
- Machine Drive
- Electro-Chemical Processes

[46] 2002 Manufacturing Energy Consumption Survey (MECS) Data (http://www.eia.doe.gov/emeu/mecs/mecs2002/)

- Other Process Use
- Facility HVAC
- Facility Lighting
- Other Facility Support
- Onsite Transportation
- Compressed Air
- Sensors & Controls
- End Use Not Reported

Once sales is applied to each of the end-uses in both the electric models and the non-electric models, an all-inclusive applicability factor is applied to each end-use within each of the industry types to determine industry specific savings by end-use. This all inclusive applicability factor is applied to the end-use sales by industry type and takes into account the four (4) factors that have been used throughout this study (i.e., the base case factor, remaining factor, savings factor, and convertible factor). Detailed measure end-use specific factors and related information can be found within Appendix G of this report.

The cost to achieve savings estimates within the industrial sector are calculated by multiplying the levelized cost per first year kWh or MMBTu savings within each measure category (e.g. machine drive, facility lighting, etc.) by the kWh or MMBTu savings in 2018 for the potential level being evaluated (e.g. technical potential, maximum achievable, etc.). The result of which is the cost to achieve the savings potential being quoted in the year 2018. This number can then be divided by the study length (10 years) in order to yield an estimate of annual spending needed to reach the potential level target in question.

New Hampshire-specific industry types identified and used in the industrial models included the following:

- Apparel And Other Finished Products Made From Fabrics And Similar Materials
- Chemicals And Allied Products
- Electronic And Other Electrical Equipment And Components, Except Computer Equipment
- Fabricated Metal Products, Except Machinery And Transportation Equipment
- Food And Kindred Products
- Furniture And Fixtures
- Industrial And Commercial Machinery And Computer Equipment
- Leather And Leather Products
- Lumber And Wood Products, Except Furniture
- Measuring, Analyzing, And Controlling Instruments; Photographic, Medical, And Optical Goods; Watches And Clocks
- Miscellaneous Manufacturing Industries
- Paper And Allied Products
- Petroleum Refining And Related Industries
- Primary Metal Industries
- Printing, Publishing, And Allied Industries
- Rubber And Miscellaneous Plastics Products
- Stone, Clay, Glass, And Concrete Products
- Textile Mill Products
- Tobacco Products
- Transportation Equipment

More information on the distribution of energy usage within each of these industrial building type categories is presented in the following section.

6.2 Industrial Sector Segmentation

Table 58 and Table 59 illustrate the industrial sector electricity and non-electric sales based segmentation. This segmentation is based on 2009 Industrial sales data by SIC code as provided by project sponsors.

Table 58. Industrial Sector Segmentation by Industry Type - Electric

Industry	% Of Sales	2018 kWh Sales
Apparel And Other Finished Products Made From Fabrics And Similar Materials	0.23%	4,841,139
Chemicals And Allied Products	0.98%	20,537,715
Electronic And Other Electrical Equipment And Components, Except Computer Equipment	15.58%	327,660,088
Fabricated Metal Products, Except Machinery And Transportation Equipment	5.74%	120,602,372
Food And Kindred Products	8.88%	186,807,201
Furniture And Fixtures	0.56%	11,827,540
Industrial And Commercial Machinery And Computer Equipment	10.22%	215,000,038
Leather And Leather Products	0.68%	14,208,070
Lumber And Wood Products, Except Furniture	4.03%	84,834,419
Measuring, Analyzing, And Controlling Instruments; Photographic, Medical, And Optical Goods; Watches And Clocks	6.07%	127,539,458
Miscellaneous Manufacturing Industries	3.73%	78,459,698
Paper And Allied Products	6.66%	140,041,116
Petroleum Refining And Related Industries	0.94%	19,849,417
Primary Metal Industries	9.93%	208,709,932
Printing, Publishing, And Allied Industries	3.14%	66,122,451
Rubber And Miscellaneous Plastics Products	14.25%	299,645,250
Stone, Clay, Glass, And Concrete Products	3.98%	83,769,711
Textile Mill Products	2.18%	45,780,294
Tobacco Products	0.04%	761,224
Transportation Equipment	2.17%	45,732,822
Totals:	**100.00%**	**2,102,729,959**

Table 59. Industrial Sector Segmentation by Industry Type – Non-Electric

Industry	% Of Sales	2018 Therms Sales
Apparel And Other Finished Products Made From Fabrics And Similar Materials	0.27%	153,399
Chemicals And Allied Products	0.95%	542,309
Electronic And Other Electrical Equipment And Components, Except Computer Equipment	2.73%	1,557,367
Fabricated Metal Products, Except Machinery And Transportation Equipment	5.59%	3,184,570
Food And Kindred Products	15.00%	8,550,090
Furniture And Fixtures	0.26%	149,910
Industrial And Commercial Machinery And Computer Equipment	1.71%	973,233
Leather And Leather Products	0.79%	450,206
Lumber And Wood Products, Except Furniture	1.89%	1,075,247
Measuring, Analyzing, And Controlling Instruments; Photographic, Medical, And Optical Goods; Watches And Clocks	8.18%	4,663,035
Miscellaneous Manufacturing Industries	1.45%	828,708
Paper And Allied Products	20.96%	11,946,935
Petroleum Refining And Related Industries	7.62%	4,342,829
Primary Metal Industries	19.34%	11,022,195
Printing, Publishing, And Allied Industries	1.38%	785,699
Rubber And Miscellaneous Plastics Products	4.54%	2,589,478
Stone, Clay, Glass, And Concrete Products	3.88%	2,211,984
Textile Mill Products	2.55%	1,450,624
Tobacco Products	0.06%	34,841
Transportation Equipment	0.85%	483,040
Totals:	**100.00%**	**56,995,702**

6.3 Industrial Sector End-Use Breakdowns

Table 60 and Table 61 illustrate the Industrial sector energy sales based segmentation across end uses. The breakdown of Industrial electricity use by end-use and industry type was developed based on the 2002 Mechanical Energy Consumption Survey (MECS[47]) data for the New England region.

[47] 2002 Manufacturing Energy Consumption Survey (MECS) Data (http://www.eia.doe.gov/emeu/mecs/mecs2002/)

Table 60. Industrial Sector End Use Breakdowns by Industry Type – Electric

		% kWh Sales by Industry & End Use												
2018 kWh Sales	New Hampshire Specific Industry	Conventional Boiler Use	CHP and/or Cogeneration Process	Process Heating	Process Cooling and Refrigeration	Machine Drive	Electro-Chemical Processes	Other Process Use	Facility HVAC	Facility Lighting	Other Facility Support	Onsite Transportation	Compressed Air	End Use Not Reported
4,841,139	Apparel And Other Finished Products Made From Fabrics And Similar Materials	0%	0%	4%	4%	36%	0%	0%	23%	15%	3%	0%	14%	2%
20,537,715	Chemicals And Allied Products	0%	0%	4%	9%	57%	14%	0%	6%	5%	1%	0%	2%	0%
327,660,088	Electronic And Other Electrical Equipment And Components, Except Computer Equipment	0%	0%	19%	4%	36%	3%	1%	17%	13%	3%	0%	4%	0%
120,602,372	Fabricated Metal Products, Except Machinery And Transportation Equipment	0%	0%	23%	3%	44%	1%	0%	10%	9%	2%	0%	7%	1%
186,807,201	Food And Kindred Products	0%	0%	3%	27%	48%	0%	0%	7%	7%	1%	0%	6%	1%
11,827,540	Furniture And Fixtures	1%	0%	6%	3%	53%	0%	0%	8%	18%	0%	0%	10%	1%
215,000,038	Industrial And Commercial Machinery And Computer Equipment	0%	0%	7%	3%	49%	1%	1%	18%	14%	3%	0%	4%	0%
14,208,070	Leather And Leather Products	0%	0%	3%	27%	38%	0%	0%	11%	12%	2%	0%	7%	1%
84,834,419	Lumber And Wood Products, Except Furniture	0%	0%	5%	1%	72%	0%	0%	8%	9%	0%	0%	5%	0%
127,539,458	Measuring, Analyzing, And Controlling Instruments; Photographic, Medical, And Optical Goods; Watches And Clocks	0%	0%	12%	7%	50%	9%	0%	9%	7%	2%	0%	3%	0%
78,459,698	Miscellaneous Manufacturing Industries	0%	0%	9%	6%	36%	0%	0%	20%	14%	4%	0%	8%	1%
140,041,116	Paper And Allied Products	0%	1%	2%	2%	82%	1%	0%	4%	4%	1%	0%	2%	0%
19,849,417	Petroleum Refining And Related Industries	1%	0%	8%	4%	81%	0%	0%	3%	3%	0%	0%	0%	0%
208,709,932	Primary Metal Industries	0%	0%	29%	1%	30%	32%	0%	4%	3%	1%	0%	1%	0%
66,122,451	Printing, Publishing, And Allied Industries	0%	0%	2%	4%	49%	0%	0%	18%	11%	3%	0%	11%	1%
299,645,250	Rubber And Miscellaneous Plastics Products	0%	0%	14%	8%	52%	0%	1%	10%	8%	3%	0%	3%	0%
83,769,711	Stone, Clay, Glass, And Concrete Products	0%	0%	20%	4%	59%	0%	1%	6%	5%	1%	0%	3%	0%
45,780,294	Textile Mill Products	0%	0%	10%	9%	58%	0%	0%	8%	7%	2%	0%	5%	1%
761,224	Tobacco Products	0%	0%	3%	14%	44%	0%	1%	27%	9%	0%	0%	2%	0%
45,732,822	Transportation Equipment	0%	0%	9%	4%	43%	1%	1%	19%	15%	3%	1%	3%	0%
2,102,729,959	*Source: 2002 Manufacturing Energy Consumption Survey (MECS) Data (http://www.eia.doe.gov/emeu/mecs/mecs2002/)*													

Table 61. Industrial Sector End Use Breakdowns by Industry Type – Non-Electric

		% Gas Sales by Industry & End Use							
2018 Therms Sales	New Hampshire Specific Industry	Conventional Boiler Use	CHP and/or Cogeneration Process	Process Heating	Process Cooling and Refrigeration	Machine Drive	Other Process Use	Facility HVAC	Facility Lighting
153,399	Apparel And Other Finished Products Made From Fabrics And Similar Materials	25%	0%	25%	0%	0%	0%	19%	0%
542,309	Chemicals And Allied Products	27%	28%	35%	2%	3%	2%	2%	0%
1,557,367	Electronic And Other Electrical Equipment And Components, Except Computer Equipment	12%	0%	53%	0%	0%	0%	29%	0%
3,184,570	Fabricated Metal Products, Except Machinery And Transportation Equipment	4%	0%	62%	0%	1%	0%	21%	0%
8,550,090	Food And Kindred Products	41%	7%	38%	0%	2%	1%	7%	0%
149,910	Furniture And Fixtures	4%	0%	42%	0%	0%	0%	46%	0%
973,233	Industrial And Commercial Machinery And Computer Equipment	16%	1%	36%	0%	3%	0%	36%	0%
450,206	Leather And Leather Products	75%	0%	0%	0%	0%	0%	25%	0%
1,075,247	Lumber And Wood Products, Except Furniture	27%	0%	48%	0%	2%	2%	14%	0%
4,663,035	Measuring, Analyzing, And Controlling Instruments; Photographic, Medical, And Optical Goods; Watches And Clocks	23%	15%	47%	1%	2%	1%	8%	0%
828,708	Miscellaneous Manufacturing Industries	29%	0%	26%	0%	0%	0%	32%	0%
11,946,935	Paper And Allied Products	29%	32%	26%	1%	4%	0%	5%	0%
4,342,829	Petroleum Refining And Related Industries	18%	15%	60%	0%	1%	0%	2%	0%
11,022,195	Primary Metal Industries	6%	5%	79%	1%	0%	0%	7%	0%
785,699	Printing, Publishing, And Allied Industries	13%	0%	40%	0%	2%	0%	33%	0%
2,589,478	Rubber And Miscellaneous Plastics Products	37%	2%	29%	1%	1%	1%	19%	0%
2,211,984	Stone, Clay, Glass, And Concrete Products	3%	1%	85%	0%	0%	0%	5%	0%
1,450,624	Textile Mill Products	21%	0%	39%	0%	3%	0%	21%	0%
34,841	Tobacco Products	50%	0%	25%	0%	0%	0%	25%	0%
483,040	Transportation Equipment	26%	2%	32%	1%	1%	0%	31%	0%
56,995,702	*Source: 2002 Manufacturing Energy Consumption Survey (MECS) Data (http://www.eia.doe.gov/emeu/mecs/mecs2002/)*								

6.4 Industrial Sector – Energy Efficiency Potential Results

Fourteen (14) industrial specific end-uses were included in the analysis for the industrial sector. In order to develop the list of energy efficiency end-uses examined, GDS worked closely with project sponsors as well reviewed other related electric and non-electric energy efficiency technical potential studies that have been conducted recently in the US.

Figure 56 and Figure 57 display a graphical comparison of the maximum achievable cost effective energy efficiency savings potential results by end use within the industrial sector (for electric and non-electric measures respectively). As shown in these figures, 40 percent of the electric savings comes from motors, followed by sensors and controls at 16 percent, facility lighting at 15 percent, and process heating at 13 percent. The remainder is made-up by compressed air and process cooling and refrigeration. With regard to savings from non-electric end-uses, process heating contributes the most at 52 percent of the savings, followed by conventional boiler use at 33 percent, facility HVAC at 13 percent, and the remaining 2 percent being classified as end-use not reported. Electric and non-electric savings allocations by building type are shown in Figure 58 and Figure 59 respectively.

Figure 56. Industrial Max. Achievable Cost Effective <u>Electric</u> Savings by End Use

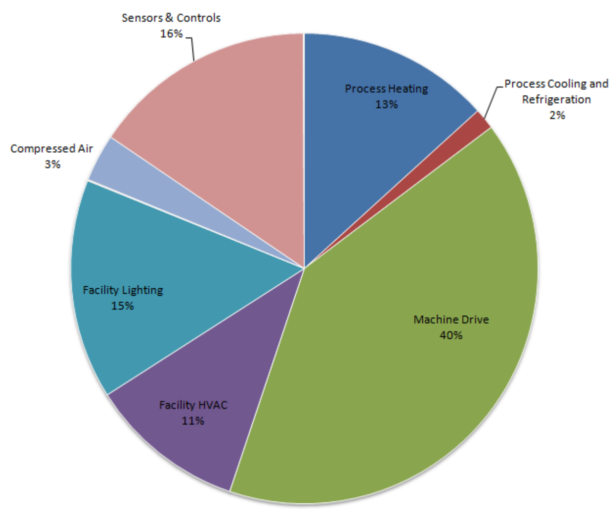


Figure 57. Industrial Max. Achievable Cost Effective <u>Non-Electric</u> Savings by End Use

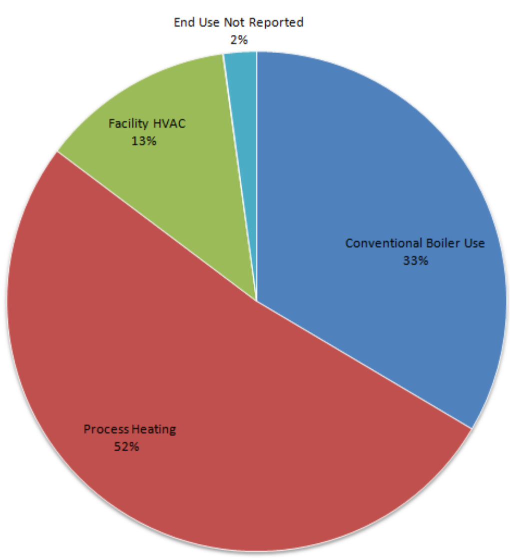


Figure 58. Industrial Max. Achievable Cost Effective Electric Savings by Building Type

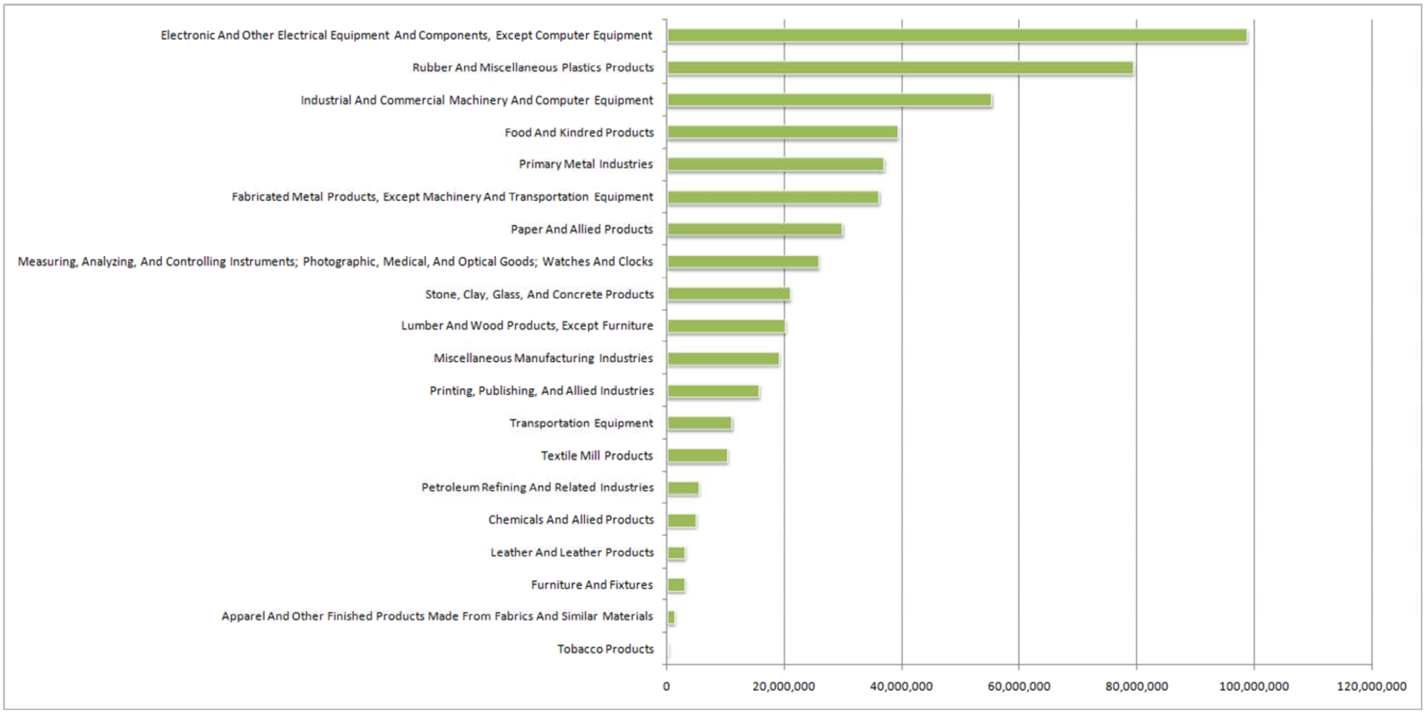
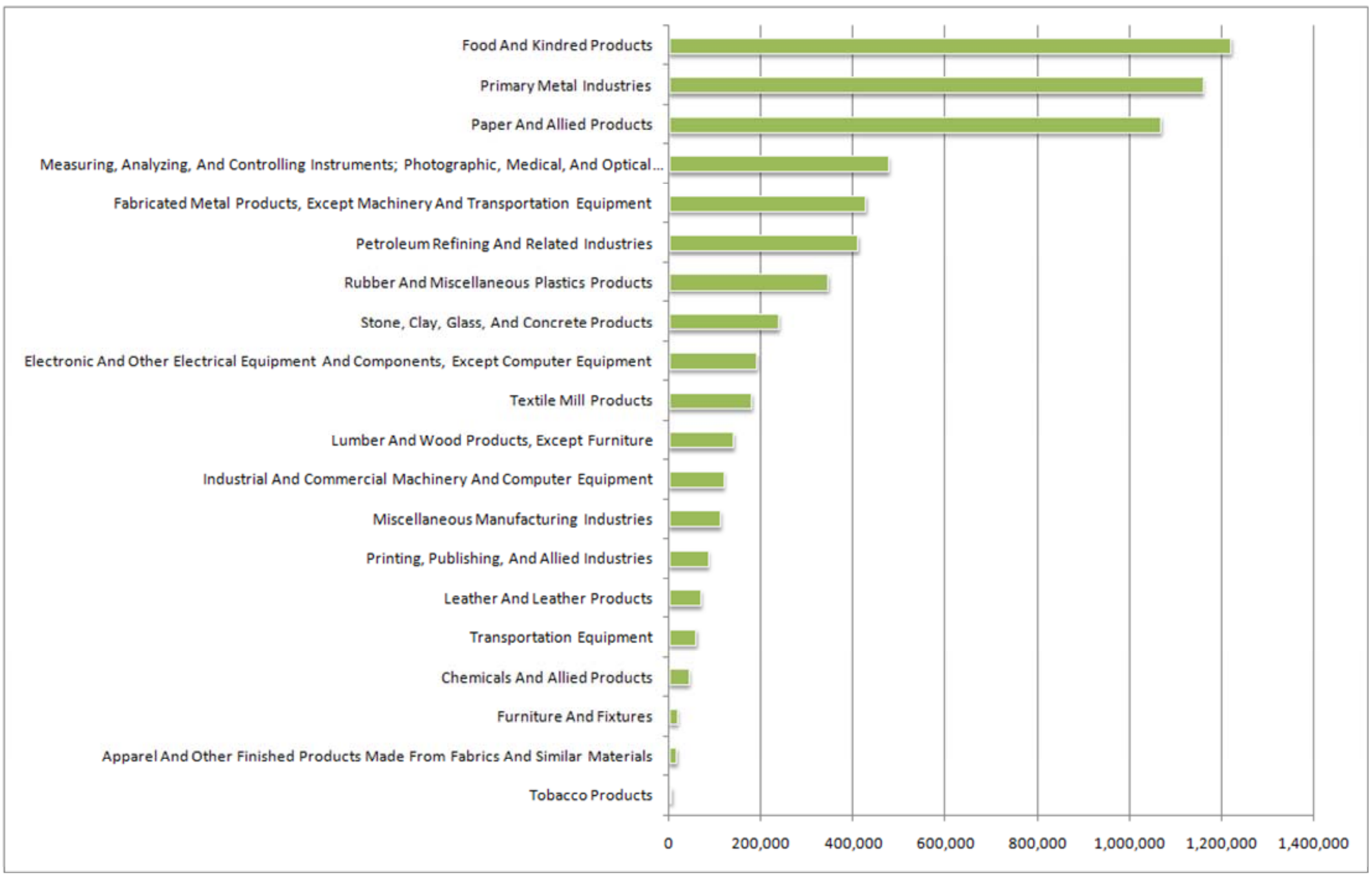


Figure 59. Industrial Max. Achievable Cost Effective Non-Electric Savings by Building Type



Section 7: Primary Data Collection Highlights

This project included a major enhancement to most of the technical potential studies that have been conducted across the country in the past. Rather than relying on best available information from existing secondary sources to estimate current levels of energy using equipment saturations and penetration of energy efficiency measures, significant primary data collection efforts were undertaken to help inform and derive New Hampshire-specific values where possible. The focus of this Section is to provide information on how the results from this project's primary data collection efforts were used to help derive New Hampshire sector-specific estimates of energy using equipment saturations (base factors) and the penetration of energy efficiency measures (remaining factors). These factors were required inputs to the project's energy efficiency potential assessment models.

As highlighted below, a substantial amount of detailed information was gathered in the primary data collection efforts for this project. Although not all information collected was directly applied as model inputs, the data will serve as a valuable resource for future studies. The information obtained from the data collected includes the following:

<u>Ownership Characteristics</u>: The telephone surveys and site visits collected information on whether the facilities were owned or leased, the building type, the approximate age and size of the buildings, the number of employees, and building schedules (i.e. hours of operation). Results are summarized in Appendix J**.**

<u>Fuel Usage</u>: Information was collected on the primary types of fuel usage (i.e. oil, natural gas, etc.) as well as the specific gas and electric utility providers for each facility. This information was useful in developing cross tabulations of other data to determine trends within groups of customer types. The surveys were also used to determine whether any facilities had on-site power generation and to identify the capacity and uses of such on-site generation.

<u>Efficiency Attitudes</u>: Valuable information regarding customer attitudes towards energy efficiency and utility sponsored programs was collected, including primary motivations and barriers to participating in currently offered programs. Results were summarized in detail in Section 3.3 of this report.

<u>Heating and Cooling</u>: The surveys collected data on the types of heating and cooling systems employed in each facility. The site visits, in particular, collected detailed information on the systems including but not limited to run times, heating and cooling capacity, motor horsepower and efficiency, humidity control, presence of outside air economizers, presence of variable air volume control, heat recovery, fuel used, and the approximate age and condition of the systems.

<u>Building Envelope</u>: The site surveys gathered information on the general condition of building envelopes including wall types, insulation types, roof and floor construction, interior and exterior finish and color, and building fenestration (windows).

<u>Water Heating</u>: Much of the survey information regarding water heating was directly applicable to the energy efficiency assessment potential models. The site surveys also collected detailed information on the types of water heating storage and distribution systems, areas served, capacities, insulation, process heating, and the relative age and condition of the systems.

Motors: Substantial information regarding motors was collected including the total number of units, service, types of control, drive type, run hours per week, and the approximate age and condition of the motors.

Refrigeration Equipment: The surveys collected detailed information on the number and type of both commercial and non-commercial refrigeration equipment. Other valuable information collected included the amperage draw of commercial equipment, whether the equipment was ENERGY STAR, defrost control types, number, size and efficiency of compressors and condensers, and the relative condition of the systems in each facility.

Compressed Air: The site surveys gathered information on all compressed air systems, including the type and application of each compressor, the control type, size (horsepower), total number of units, nominal efficiencies, drive types, average age, run hours per week, and manufacturer and model numbers. The site surveys were also used to determine whether the facilities had a leak reduction maintenance program and to assess the overall condition of the compressed air systems.

Process Heating: The site surveys gathered information on all process heating systems, including the type of process, the products produced, the number of machines, rated heat inputs, whether waste heat recovery is utilized, primary fuel used, the average age of equipment, and the average run hours per week. The condition of process heating systems at each facility was also assessed.

Cooking & Food Service Equipment: Where applicable, the site surveys gathered information on cooking and food service equipment. Information gathered included the total number of both electric and gas fueled units and the average fuel usage for each type of equipment.

As discussed in more detail in Sections 7.1 and 7.2 below, where applicable, elements from this information were used to develop model-required base and remaining factors.

7.1 Data Summary and Analysis

The primary data collection efforts were summarized in Section 3.1 of this report, and included conducting 400 telephone surveys of residential customers, 200 telephone surveys of small commercial and industrial customers, and 200 site visits of large commercial and industrial customers. The methodologies utilized to create the survey instruments and sampling plans were outlined in detail in Sections 3.1.1 and 3.1.2, respectively. Data obtained from the surveys and site visits were coupled with secondary data collection and analysis where necessary, to develop New Hampshire-specific values for saturations and penetrations used in the GDS Team's sector-specific energy efficiency potential calculation models (referred to in the models as base and remaining factors). These primary data collection efforts were also used to assess customer attitudes towards energy efficiency programs and practices, including awareness, motivations and barriers, results of which were summarized earlier in Section 3.3 of this report.

Data collected from the residential and small commercial and industrial telephone surveys were analyzed by Research Into Action (RIA) using SPSS statistical software.[48] During this process, GDS worked with RIA to identify the specific survey questions and develop the cross tabulations needed to derive base and remaining factors for use in the models. Data collected from the large commercial and industrial site visits were recorded in paper files and entered manually into an analyzable Excel spreadsheet file. The data was organized and sorted by relevant

[48] Further information regarding the SPSS program can be found at www.spss.com

measure types, using pivot tables, to obtain information that helped inform the base and remaining values for specific efficiency measures needed for the models.

It is important to note that sample sizes were designed at project outset to ensure statistical validity at the aggregate residential, commercial and industrial sector levels only. However, attempts were made to mine the data, where possible, to support determination of base and remaining factors for specific measures at the building-type level as described in more detail below.

7.1.1 Residential Survey Data

Prior to the detailed evaluation of residential telephone survey data, responses were categorized as either single or multi-family homes. In total, 269 single family responses and 135 multi-family responses were recorded. Of those 404 total responses, the data collection effort focused on the 253 single family and 127 multi-family homes that were classified as permanent residences as opposed to seasonal residences. Separate evaluation of the survey data was then performed for each type of home. Based on a total population of approximately 600,000 housing units in New Hampshire, the margin of error for proportional results obtained from the single family surveys (253 total) was 6.2% with 95% confidence. The margin of error for proportional results obtained from the multi-family surveys (127 total) was 8.7% with 95% confidence.

7.1.2 Commercial and Industrial Survey Data

Data from the 200 small commercial and industrial phone surveys and the 200 large commercial and industrial site visits were analyzed on several levels. The most basic level of evaluation was to separate the commercial properties data from the industrial properties data. The breakdown of commercial versus industrial facilities for each survey is shown in Table 62 below.

Table 62. Number of Commercial and Industrial Facilities Surveyed

	Small C/I Phone Surveys	Large C/I Site Surveys
Commercial	177	100
Industrial	23	100
Total	**200**	**200**

The small and large commercial properties were further categorized by model-defined building types, as shown below in Table 63.

Table 63. Small Commercial vs. Large Commercial Surveys by Building Type

Model Building Type	Small Commercial Phone Surveys	Large Commercial Site Surveys
Warehouse	4	5
Retail	23	7
Grocery	13	7
Office	56	22
Lodging	6	14
Health	14	12
Restaurant	10	4
Education	5	16
Other - unclassified	46	13
Total	**177**	**100**

The GDS Team established a minimum sample size of 30 respondents as the threshold for collecting and reporting data at the building type-specific level for both small and large commercial buildings. This would ensure statistically valid results at a 15 percent margin of error and 90 percent confidence. As shown in the table above, based on this threshold, results from the small commercial phone surveys provided sufficient data to derive base and remaining factors for measures within both *office* (56) and *other* (46) building types. For the remaining building types, measure specific data was collected and reported based on the aggregate responses within the small commercial sector. Similarly in the large commercial sector, due to the limited number of responses within specific building types, a majority of the measure-specific base and remaining factors derived from the site visits were based on aggregate responses across the entire large commercial building stock. In some instances where a substantial amount of site visit data was available for a specific measure, base and remaining factors were determined at the building type level. An example is facility lighting, where a substantial volume of information was recorded during the site visits. It was the opinion of GDS that the data illuminated trends in lighting characteristics among the building types and warranted inclusion in the energy efficiency potential assessment models.

Industrial properties were also categorized by building type. The large industrial properties were broken down into ten specific building types as listed in Table 64 below. The small[49] industrial properties, where data was collected through a total of 23 phone surveys, were viewed as a single group (i.e., results were aggregated across all building types since the combined number of respondents was less than the 30 building type threshold required to ensure statistical validity).

Table 64. Small Industrial vs. Large Industrial Surveys by Building Type

Model Building Type	Small Industrial Phone Surveys	Large Industrial Site Surveys
Electronic and Other Electrical Equipment	-	15
Fabricated Metals	-	23
I & C Machinery and Computer Equipment	-	1
Lumber and Wood Products	-	14
Other Assembly / Light Manufacturing	-	13
Other Medium/Heavy Equipment Manufacturing	-	6
Paper and Allied Products	-	2
Printing, Publishing and Allied Ind.	-	7
Rubber and Miscellaneous Plastics Production	-	9
Other – not classified	-	10
Total	**23**	**100**

As described elsewhere in this report, the industrial supply model requires single savings factors for specific end uses (e.g., lighting, process heating, etc.) and recognizes that these factors can vary depending on the type of industry being assessed. Therefore, the information mined from the large industrial property site visits was analyzed to identify New Hampshire-specific equipment, system and process practices and trends that could be used to support adjustment of the original model assumptions which had initially been based only on secondary data sources from previous studies and prior experience.

[49] The 23 small industrial survey respondents consist of Seven (7) Industrial Metals Machining, Four (4) Industrial Parts Assembly, and Twelve (12) Industrial Other

7.1.3 Weighting of Small and Large Commercial Survey Data

In both the commercial electric and the commercial gas energy efficiency potential analysis models, small (less than 100 kW or 300,000 kWh annual consumption) and large (greater than 100 kW or 300,000 kWh annual consumption) commercial facilities have been treated as a single sector. Therefore, weighted averages were developed for the measure-specific base and remaining factors using results from both the small and large facilities data collection efforts.

The method used for calculating these weighted averages was based on 2007 total kWh consumption data provided by the utilities for their customers classified as small commercial/industrial and large commercial/industrial. In total, the small commercial customers consumed 2,100,349,654 cumulative kWh of energy in 2007 and the large commercial customers consumed a total of 2,643,763,935 kWh of energy. Based on these values, small commercial customers consumed 44.3 percent of commercial energy usage in 2007 and the large commercial customers consumed 55.7 percent. These ratios were used, where applicable, to derive weighted average commercial sector and building specific end-use measure saturation (base factor) and energy efficiency equipment penetration (remaining factor) values for use in the commercial models.

In several instances, survey data was available only from the small commercial facilities phone surveys, or from the large commercial facilities site visits, or from neither depending on the specific measure. If penetration and saturation values obtained from survey data were available for either the small commercial or large commercial facilities, but not both, an un-weighted survey value was utilized in the model. If values obtained from the surveys were not available for a specific measure, the original assumptions (based on existing secondary data) were utilized in the models and all applicable references that formed the basis for such assumptions were noted.

7.2 Application of Survey Data

As noted previously, a substantial amount of useful New Hampshire-specific information was collected on energy end use equipment saturations and energy efficiency measure penetrations for a number of residential, commercial, and industrial measures. In cases where such New Hampshire customer-specific information could not be collected from the phone surveys and site visits, the most prevalent barrier to obtaining that information tended to be the extremely specific nature of some measures and the time constraints existing for conducting the surveys and site visits. Wherever possible, when secondary sources were required to be used as the basis for base and remaining factors in the models, they were verified for reasonableness, or modified based on results obtained through the project's primary data collection activities.

The greatest percentage of model values that relied on primary survey data occurred in the residential sector, where nearly 70 percent of the model's required base and remaining factors for efficiency measures came directly from survey information. In the commercial electric model, 36 percent of the measures' base and remaining factors were also derived directly from this project's primary data collection activities. In the commercial non-electric model, 24 percent of the measures were based on survey information. This large variation between the percentages of survey data applicable in the residential (70%) versus commercial sectors (24 to 36%) is in part attributable to the complexity and specificity of the commercial measures compared to the residential measures. A more detailed analysis of the survey data application is provided in the following sections.

7.2.1 Residential Sector

The measure end-use categories that were most informed by the residential sector telephone surveys were appliances and water heating. Overall, customers appeared knowledgeable and provided potentially useful information regarding the types of appliances they owned (i.e. refrigerators, ranges, water heaters, etc.) and whether the appliances were ENERGY STAR rated.[50] The total number of responses used to derive base and remaining factors for use in the residential models in these end use categories was also very high since these end uses are quite common in across all residences.

The measure end use categories of lighting and space conditioning were also fairly well informed by the surveys. Information on standard measures such as CFL bulbs, fixtures and programmable thermostats was readily available and was used to derive reliable base and remaining factors. Information on measures that were less well known to the general public, such as heat pumps, duct sealing, and photocell controlled outdoor lighting, proved to be less reliable (with little to no survey data responses) and were therefore supplemented in the model by secondary data sources.

A complete list of the base and remaining factors derived through information collected in this project's telephone surveys for each measure assessed within both single and multifamily homes is provided in Appendix K, along with links to specific survey questions and data sources.

7.2.1.1 Residential Sector Example

Programmable thermostats provide a good example as to how the base and remaining factors were derived from this project's telephone surveys. In the residential models, programmable thermostats are applied as energy efficiency measures within homes using electric heat, gas furnaces, gas boilers, and oil boilers. The measures are further categorized by systems for heating only and for systems with both heating and central air conditioning. In addition programmable thermostats are broken out by single family homes and multifamily homes and recognize that the savings associated with use of programmable thermostats will differ based on all of these factors. In the following example, the derivation of base and remaining factors for programmable thermostats is described within the context of single family homes without central air conditioning that heat with oil boilers.

The first step in the analysis was to derive the end use saturation (base case factor) for each sub-category of the measure. The end use saturation is defined as the percentage of total single family homes that contain the end use or measure. For this example, the end use saturation is the percentage of single family homes that have oil-fueled boiler heating (heating only, no central air conditioning) and was derived from survey questions SH2, SH3 and SC1. Question SC1 was used to determine whether homes had central air conditioning. As illustrated in the summary table below, a total of 214 respondents did not have central air conditioning.

SC1: Do you have central air conditioning? * UTILITY Crosstabulation

			UTILITY				
			Granite State Electric	NH Elec CoOp	PSNH	Unitil	Total
SC1: Do you have central air conditioning?	Yes	Count	5	3	25	6	39
		% within UTILITY	17.9%	6.5%	18.5%	13.6%	15.4%
	No	Count	23	43	110	38	214
		% within UTILITY	82.1%	93.5%	81.5%	86.4%	84.6%
	Total	Count	28	46	135	44	253
		% within UTILITY	100.0%	100.0%	100.0%	100.0%	100.0%

Of the 214 single family respondents who did not have air conditioning, a summary table was developed that combined the responses to questions SH2 and SH3. SH2 was used to identify

[50] It is important to note however, that past studies have shown as many people incorrectly identify products as being ENERGY STAR as do those that do not think their products are ENERGY STAR when in fact they are.

the primary type of heating fuel utilized and Question SH3 was used to identify the primary types of heating systems. The responses to Question SH2 (fuel type) were used as the cross-tab headings for the Question SH3 summary table shown below. A total of 36 responses are missing because they reported wood or electricity as the primary fuel used for heating and were excluded from this question.

SH3: What type of heating system is your main source of heat? * SH2: What is the main fuel you use to heat this home? Crosstabulation

			SH2: What is the main fuel you use to heat this home?				
			Natural gas purchased from	Bottled gas or propane: [CONFIRM: DELIVERED BY TRUCK?]	Oil	Kerosene	Total
SH3: What type of heating system is your main source of heat?	Furnace: central forced air furnace (aka forced hot air)	Count	12	12	48	1	73
		% within SH2: What is the main fuel you use to heat this home?	46.2%	42.9%	39.3%	50.0%	41.0%
	Boiler + Radiator + Hot Water (aka forced hot water)	Count	4	9	28	0	41
		% within SH2: What is the main fuel you use to heat this home?	15.4%	32.1%	23.0%	.0%	23.0%
	Boiler + Baseboard + Hot Water (forced hot water)-OR JUST BASEBOARD	Count	3	2	34	0	39
		% within SH2: What is the main fuel you use to heat this home?	11.5%	7.1%	27.9%	.0%	21.9%
	Boiler + Radiator + Steam	Count	1	2	3	0	6
		% within SH2: What is the main fuel you use to heat this home?	3.8%	7.1%	2.5%	.0%	3.4%
	Radiator + DK (i.e., other components unknown)	Count	0	0	4	0	4
		% within SH2: What is the main fuel you use to heat this home?	.0%	.0%	3.3%	.0%	2.2%
	Could Identify Fuel, But Not Equipment	Count	1	0	1	1	3
		% within SH2: What is the main fuel you use to heat this home?	3.8%	.0%	.8%	50.0%	1.7%
	Other (please specify)	Count	2	1	1	0	4
		% within SH2: What is the main fuel you use to heat this home?	7.7%	3.6%	.8%	.0%	2.2%
	DON'T KNOW	Count	1	0	3	0	4
		% within SH2: What is the main fuel you use to heat this home?	3.8%	.0%	2.5%	.0%	2.2%
	REFUSAL	Count	2	2	0	0	4
		% within SH2: What is the main fuel you use to heat this home?	7.7%	7.1%	.0%	.0%	2.2%
	Total	Count	26	28	122	2	178
		% within SH2: What is the main fuel you use to heat this home?	100.0%	100.0%	100.0%	100.0%	100.0%

The end use saturation of homes with oil boilers, heating only, was calculated by summing the number of oil using respondents with boilers (28 + 34 + 3 + 4 = 69) and dividing it by the total number single family respondents (253). The total number of single family homes was used in the calculation because the end use saturation is defined as the percentage of all single family homes with oil boilers and no central air conditioning. The percentage of oil customers with boilers for heating only (i.e. end use saturation) was then 69/253 = 27.3%.

The next step was to derive the energy efficiency measure penetration for programmable thermostats. The penetration is defined as the fraction of the end use energy that is already energy efficient. For this example, the penetration is the percentage of homes that already have programmable thermostats and was derived from survey question SH14 which specifically asked whether the customers have a programmable thermostat. The cross tabulated responses, by primary fuel type (question SH2), are shown below for reference.

			Main heating fuel						
			natural gas	electricity	propane	oil	kerosene	wood	Total
SH14: Do you have a programmable thermostat?	Yes	Count	26	0	26	77	1	14	144
		% within Main heating fuel	76.50%	0.00%	68.40%	51.00%	50.00%	35.00%	53.50%
	No	Count	8	4	12	73	1	26	124
		% within Main heating fuel	23.50%	100.00%	31.60%	48.30%	50.00%	65.00%	46.10%
	DON'T KNOW	Count	0	0	0	1	0	0	1
		% within Main heating fuel	0.00%	0.00%	0.00%	0.70%	0.00%	0.00%	0.40%
	Total	Count	34	4	38	151	2	40	269
		% within Main heating fuel	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

As illustrated in the table above, 51.3% (77/150) of customers indicated that they have programmable thermostats after discounting the "Don't Know" response. Thus, the penetration for this measure is 51.3%. The remaining factor, defined as the percentage of homes in which this measure can be installed, is 1 minus the penetration, or 48.7% for this example. The resulting end use saturations (base case factors) and remaining factors were used in the residential model to calculate the potential for savings from this efficiency measure. Refer to Section 4.1 above for the actual equations used in the model to calculate potential savings.

7.2.2 Commercial Sector

Valuable information was gathered from both the telephone surveys and site visits to help derive base and remaining factors use in the commercial sector electric and gas models. In the commercial electric model, 36% of the measure remaining factors were directly attributable to the survey data. In the commercial gas model, 24% of the measure remaining factors were directly attributable to the survey data. The measure end-use categories that were most informed by the surveys and site visits were lighting, refrigeration, appliances, compressed air, motors and water heating. The measure end-use categories that were least influenced by the primary data collection activities were space cooling (chillers), space cooling (unitary and split AC), and cooking.

In the *Lighting* end use category for example, the base case factors were developed by first identifying sub-categories such as fluorescent tube lighting, screw-in incandescent/CFL lighting, high-bay lighting, exit signs and other specialty lighting. Then, the total number of fixtures reported in each sub-category from the site visits was tabulated and the relative percentages of each sub-category were calculated. Fixture counts were utilized to formulate the base case factors due to incomplete data on the wattage and run hours for all fixtures. These relative percentages, based on total fixture counts, were applied as base case factors for each building type to reflect the percentage of energy attributable to each sub-category. The site visits then provide useful information regarding the penetration of energy efficient lighting within each sub-category so remaining factors could be developed for each measure.

Substantial data was also compiled for the commercial non-electric model. Measure end use categories that were the most well informed by the phone surveys and site visits included water heating, pools, HVAC controls, and cooking. Measure end use categories that were least informed by the surveys were ventilation, building envelope, and space heating.

A complete list of base and remaining factors used in the commercial models is provided in Appendix L to this report. Factors that have been informed by data collected through the telephone and site visits conducted through primary data collection elements of this project have been highlighted for ease of reference. The survey instruments for the phone and site surveys are provided in Appendices B and C, respectively. Appendix L includes a summary sheet that identifies the questions used to derive the factors.

7.2.2.1 Commercial Sector Example

As with the residential sector, programmable thermostats provide a good example of how base and remaining factors were derived from survey data collected in the small commercial sector. To start, nearly all commercial customers were found to have thermostat-controlled heating systems as shown in the cross tabulation for Question 20 below. 90% of respondents indicated that they had control over the heating, while 10% did not have control, or did not know.

Q20: Do you have control over the temperature of the heating? * Building type_recoded2 Crosstabulation

			Building type_recoded2										
			Warehouse	Retail	Grocery	Office	Lodging	Health	Education	Industrial	Restaurant	Other	Total
Q20: Do you have control over the temperature of the heating?	Yes	Count	2	22	12	50	6	14	4	19	8	43	180
		% within Building type_recoded2	50.0%	95.7%	92.3%	89.3%	100.0%	100.0%	80.0%	82.6%	80.0%	93.5%	90.0%
	No	Count	2	1	1	6	0	0	1	3	2	3	19
		% within Building type_recoded2	50.0%	4.3%	7.7%	10.7%	.0%	.0%	20.0%	13.0%	20.0%	6.5%	9.5%
	DON'T KNOW	Count	0	0	0	0	0	0	0	1	0	0	1
		% within Building type_recoded2	.0%	.0%	.0%	.0%	.0%	.0%	.0%	4.3%	.0%	.0%	.5%
	Total	Count	4	23	13	56	6	14	5	23	10	46	200
		% within Building type_recoded2	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

It was assumed that the percentage of respondents without control of the temperature of the heating is largely attributable to tenant or landlord circumstances, thus the base case factor for this end use was determined to be 100 percent. For the small commercial phone surveys, Question 21 specifically asked whether respondents had a programmable thermostat. The cross tabulated summary table is provided below for reference.

Q21: Do you have a programmable thermostat? * Building type_recoded2 Crosstabulation

			Building type_recoded2										
			Warehouse	Retail	Grocery	Office	Lodging	Health	Education	Industrial	Restaurant	Other	Total
Q21: Do you have a programmable thermostat?	Yes	Count	1	11	6	31	3	7	3	8	5	20	95
		% within Building type_recoded2	50.0%	50.0%	50.0%	62.0%	50.0%	50.0%	75.0%	42.1%	62.5%	46.5%	52.8%
	No	Count	1	10	6	18	3	6	1	11	3	21	80
		% within Building type_recoded2	50.0%	45.5%	50.0%	36.0%	50.0%	42.9%	25.0%	57.9%	37.5%	48.8%	44.4%
	DON'T KNOW	Count	0	1	0	1	0	1	0	0	0	2	5
		% within Building type_recoded2	.0%	4.5%	.0%	2.0%	.0%	7.1%	.0%	.0%	.0%	4.7%	2.8%
	Total	Count	2	22	12	50	6	14	4	19	8	43	180
		% within Building type_recoded2	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

The energy efficient measure penetration, defined as the percentage that is already efficient, was calculated by dividing the total number of positive responses among non-industrial building types (95 total "yes" responses minus 8 "yes responses from the "industrial" building type = 87 commercial "yes" responses) by the total number of non-industrial respondents, excluding "don't know" responses (156). The average penetration for this measure was thus determined to be 55.8%. The remaining factor was simply calculated as 1 minus the penetration, or 44.2% for this example.

As can be seen from the cross tabulation table above, more than 30 total responses were received in both the *Office* and *Other* building type categories. Therefore, the remaining factors for programmable thermostats were derived at the building-specific level for each of these two building types. For example, the remaining factor for programmable thermostats in the *Office* building type was 36.7% and 51.2% for the *Other* building type category. For all remaining commercial building types, the 44.2% remaining factor (calculated in aggregate across all building types) was applied to maintain statistical validity in the data with reasonable confidence.

Programmable thermostats were not included in the survey for the large commercial surveys due to a larger prevalence of EMS systems as the primary means for temperature controls in these facilities and because larger facilities that use thermostatic control often have a large number of thermostats, or a mix of programmable and manual thermostats. This makes the quantification of programmable thermostats in larger commercial facilities very difficult. Since no large commercial data was available for programmable thermostats, the data from the small commercial surveys was applied without weighting. It is important to note that once the weightings were completed, the remaining factor for each measure was qualitatively assessed for reasonableness and adjusted if necessary. It was felt that applying the small commercial remaining factor overall was reasonable for this application based on industry experience.

7.2.3 Industrial Sector

The industrial model varies from the residential and commercial models in that energy end-use areas are assessed from a top-down (end-use category) perspective vs. bottom-up (a measure specific assessment approach). Therefore, the base case, remaining and other factors that were considered independently (by measure) in the residential and commercial models, are combined into a single savings factor in the industrial model. Initial values for each industrial end-use category savings factor were based upon secondary data that was developed previously by the American Council for an Energy Efficient Economy (ACEEE)[51] and used in other GDS technical potential studies in the region. These factors were then adjusted, where appropriate, based upon the New Hampshire industrial sector-specific survey results. Adjustments to the savings factor based upon this project's primary data collection efforts are summarized in Table 65 and Table 66 below.

Table 65. Industrial Electric End-Uses Informed by Primary Data

Industry	End Use Area	Adjustment
Electronic and Other Electrical Equipment	Process Heating	The savings factor was raised 10% to 30% total because this industry type had the largest number of process heat machines and lower MECS data percentage than other industry types with fewer machines (19%)
Electronic and Other Electrical Equipment	Process Cooling and Refrigeration	The savings factor was raised 5% to 10% total because this industry type had the largest number of both commercial and non-commercial refrigeration units and a low relative MECS percentage (4%)
Electronic and Other Electrical Equipment	Facility Lighting	The savings factor was raised 9% due to the disproportional ratio of T12 to T8 lighting in this industry type.
Fabricated Metals	Process Cooling and Refrigeration	The savings factor was increased 2% to 7% total because this industry type had the second highest total of both commercial and non-commercial refrigeration units and a low relative MECS percentage (3%)
Fabricated Metals	Machine Drive	The savings factor was increased 7% to 26% total because this industry type had the 2nd highest number of motors, and the most number of motors that run for 40 hours per week or more. The MECS percentage for this industry type (44%) was also at the low range for this measure category (36% - 82%)
Measuring, Analyzing, and Controlling Instruments	Facility Lighting	The savings factor was increased 9% to 49% total due to a disproportionally high percentage of incandescent lighting fixtures in this industry type compared to other types
Paper and Allied Products	Machine Drive	The savings factor was decreased 9% to 17% total due to the low number of machine drive processes compared to other industry types. The MECS data for this industry type was also high (82%) compared to other industry types
Printing, Publishing and Allied Industries	Process Heating	The savings factor was reduced 10% to 20% total. This industry type had a 50th percentile number of process heating applications so the savings factor was adjusted to represent the 50th percentile of factors for this end use area. The MECS data for this industry type was also the lowest of any industry type (2%)
Rubber and Miscellaneous Plastics Products	Machine Drive	The savings factor was increased 6% to 23% total due to an average number of machine driven equipment, but a relatively high number of motors that run more than 40 hours per week. The MECS data for this industry type was also lower than average (52%) for this measure category
Rubber and Miscellaneous Plastics Products	Facility Lighting	The savings factor was decreased 5% to 35% total due to a large percentage (97%) of fluorescent tube lighting already being T8 fixtures. Fluorescent

[51] *Sources: Connecticut Efficiency Potential Analysis (GDS), EPRI Potential Study Webinar, Resource Assessment for Energy Trust of Oregon, California Industrial Energy Efficiency Potential (Ernest Orlando Lawrence, Berkeley National Laboratory), ACEEE Potential Studies (Vermont, Florida, Texas and Fan & Pump Analyses), Reading Industrial Tech Potential Analysis (GDS), Vermont Electric Energy Efficiency Potential Study (GDS).*

		lighting comprised over 60% of all lighting in this industry type
All	Sensors and Controls	The savings factors were increased uniformly 3% to 4% total to account for the low number of occupancy sensors currently in place, and the low number of reported energy management systems

Table 66. Industrial Non-Electric End-Uses Informed by Primary Data

Industry	End Use Area	Adjustment
Electronic and Other Electrical Equipment	Conventional Boiler Use	The savings factor was raised 4% to 20% total because this industry type reported the largest number of conventional boilers and a low MECS percentage (12%) relative to other industry types
Electronic and Other Electrical Equipment	Facility HVAC	The savings factor was decreased 2% to 11% total due to a high reported incidence of outside air economizers and EMS systems in this industry type
Fabricated Metals	Facility HVAC	The savings factor was increased 4% to 17% total due to a lower than average number of outside air economizers, EMS systems, and heat recovery systems
Lumber and Wood Products	Facility HVAC	The savings factor was increased 7% to 20% total due to the lowest reported number of outside air economizers, EMS systems, and heat recovery systems. This industry type also had a lower than average MECS percentage (14%)
Petroleum Refining and Related Industries	Process Heating	The savings factor was decreased 2% to 11% total due to the lowest number of reported gas-fired process heating applications. This industry type also had a higher than average MECS percentage (60% in this measure category
Petroleum Refining and Related Industries	Facility HVAC	The savings factor was increased 3% to 16% total due to a lower than average number of outside air economizers, EMS systems, and heat recovery systems. This industry type also had the lowest MECS percentage (2%) in this measure category

The adjustments summarized above were made by compiling all relevant data for each end-use area by industry type and looking for trends in the data. As examples, industry types that were found to have disproportionate amounts of processes (i.e. process heating applications), or fixtures (i.e. T8 fluorescent tubes versus T12 fluorescent tubes) were adjusted to reflect the trends noted within that industry type. Trends noted from the surveys were also reviewed with respect to the MECS data. The MECS data was used to determine energy distribution among various processes in each facility. Using the example above, the industry type Electronics and Other Electrical Equipment had the highest number of process heating machines but a lower MECS percentage for process heating than other industry types. In this example, the savings factor for this industry type was increased to reflect the trend noted in the site surveys. In some instances, such as the end use area *Sensors and Controls*, a uniform adjustment was made to reflect what appeared to be increased potential for savings beyond the initial assumptions.

A complete list of savings factors for all end use categories and industry types is provided in Appendix M. In the electric model, 10 of 180 (5.5%) of the factors were adjusted based on survey results. In the non-electric model, 6 of 80 (7.5%) were adjusted. Specific factors that have been amended based on survey data are highlighted for reference.

7.3 Summary and Recommendations

The primary data collection effort for this project gathered an abundance of information relating to the saturation of electric and non-electric (natural gas, oil and propane) energy end uses and the penetration of energy efficiency measures across New Hampshire's residential, commercial, and industrial sectors. These data were used, where applicable, to help derive base and remaining factors applied to the energy efficiency potential assessment models employed for this specific study and will serve as a valuable starting reference for New Hampshire-specific energy end use saturations and efficient equipment penetrations going forward.

Beyond survey information used to derive critical model inputs, a wealth of additional customer and energy usage data was obtained through the telephone surveys and site visits conducted as part of this project. Considerable information regarding customer attitudes towards energy efficiency concepts and programs was acquired, as well as the main motivations and barriers considered by customers with respect to their participation in efficiency programs. Other data such as the distribution of heating fuel usage, facility information, and process information was also collected and will be a valuable resource for future studies.

A number of lessons have been learned through this initial primary data collection effort which might help to increase the effectiveness and value of subsequent efforts. Following is a brief listing of the top three recommendations:

1. Begin with the end in mind – Documenting and communicating a clear vision of the required results from the data collection effort and how those results will be used is a vital first step to ensuring success. This is especially important given the large number of project sponsors, consultant team data collection/evaluation staff, and other parties interested and involved in the process and outcomes from a project of this magnitude. For this current project, written work scopes were developed, discussed, refined and shared with all project participants.

2. Set realistic expectations – It is important to set realistic expectations regarding the amount of measure-specific information that can be collected through a phone survey or site visit. Prioritizing measures and consolidating multiple measures within common end-use categories, up front, will help to maximize survey instrument effectiveness. For this project, multiple discussions and drafts of survey and site visit instruments were developed for this purpose. Results from this report identify measures within each sector that have the greatest potential for savings. Going forward, review of the base and remaining factors associated with these measures will identify clear areas where refined New Hampshire-specific information would be most valuable.

3. Allot sufficient time for data collection and analysis – When large amounts of data are being collected, it is critical that sufficient time be made available, not only for the data collection phase of the project, but more importantly for data analysis. Time to enter, verify, clean and analyze data results is needed to ensure that the most value is mined out of the efforts expended. For this project, as discussed throughout this section of the report, substantial information from this primary data collection effort was used to help inform development of base and remaining factors and to identify customer behaviors and barriers. Going forward, additional review of the data collected through this project could yield further insights and value to the project sponsors.

Section 8: Past Program Capture and Recommendations

This section summarizes results from evaluation of the penetration of energy efficiency savings (electric and natural gas) associated with past and current utility-sponsored program activities. A review of the utilities' annual Core New Hampshire Program Highlights reports formed the basis for this evaluation, along with estimated savings for prior years not posted on the New Hampshire Public Utilities Commission website[52]. Results are presented from both a cumulative savings as a percent of sales perspective, and on a number of customers served as a percent of population basis. Recommendations for potential modifications to program and measure offerings that could increase the likelihood of achieving identified potentials are made and have been developed mainly through information on barriers collected directly from New Hampshire utility customers (through this project's telephone surveys and site visits) and supplemented by the GDS Team's experience with looking at programs from a logic-modeling perspective, and extensive knowledge of other local, regional and national programs and best practices.[53]

Energy efficiency programs offered in New Hampshire include both electric and gas efficiency measures and serve all customer sectors; residential (including low income), commercial and industrial. The electric efficiency programs are comprised of CORE programs offered jointly by the four electric utility providers, and additional efficiency programs offered by the individual utilities. The gas efficiency programs are offered through the individual utility providers.

The CORE programs were formally launched in June 2002, although efficiency programs have been offered by the utilities for quite some time prior. As shown in Table 67, since the formal inception of the CORE programs in June 2002, an estimated total of 557,274 MWh (annual) have been saved.[54] This savings value is based on the estimated annual savings for each year since 2002 added together. In other words, this savings value is calculated by adding the annual savings from the 2003 programs to the annual savings from the 2004 programs to the annual savings from the 2005 programs and so on. This value does not consider the fact that the annual savings from the programs are actually realized every year over the lifetime of the measures. The total annual savings were calculated in this manner to provide a useful comparison to the forecast sales in 2008.

This total savings represents five percent of the total forecasted electric usage for New Hampshire in 2008. Nearly four percent of this savings has been achieved within the commercial industrial sector, with slightly more than one percent of the savings coming from the residential sector.

[52] http://www.puc.state.nh.us/Electric/coreenergyefficiencyprograms.htm

[53] Assessments based on a logic-modeling perspective recognize current program resources (dollars, staffing, etc.) and activities (measure installations, promotional rebates/incentives, marketing/outreach, education/training, etc.) and seek to identify their causal links to anticipated outputs (measures installed, in-program energy and capacity savings, # of customers served, market actors trained, etc.), short-, intermediate- and long-term outcomes (changes in awareness and behavior, market-wide/sustainable energy, economic and environmental benefits, etc.). In addition, logic models recognize the existence and potential impacts of external influences (price of energy, state of the local and regional economy, federal tax incentives, other non-program sponsored activities, etc.).

[54] Estimate is based on reported lifetime savings from 2005-2008 available on NHPUC website, GDS estimates for program measure lives, and extrapolated kWh savings estimates for 2002-2004

Table 67. Energy Efficiency Program Savings as Percent of 2008 Sales: 2002-2008 – Electric Utilities

Sector	Total Annual Savings Since 2002 (MWh)	Forecasted Sales 2008 (MWh)	Cummulative Annual Savings as a Percent of 2008 Sector Sales	Cummulative Annual Savings as a Percent of 2008 Total Sales
Residential	120,064	4,537,480	2.6%	1.1%
Commercial/Industrial	437,210	6,650,732	6.6%	3.9%
Total	**557,274**	**11,188,212**		**5.0%**

It is important to note that the above figure is conservative in several ways. First, the utility providers have been actively offering efficiency programs since well before 2002 so the total amount of energy saved since the inception of efficiency programs is much higher. Second, this figure considers only a single year of annual savings. In reality, annual savings are realized every year over the assumed measure life of the programs. The data was reported in the above manner to provide an appropriate comparison to the forecast 2008 usage.

New Hampshire's natural gas utilities offered energy efficiency programs from 1993 through 1999, at which time the programs were suspended in light of gas industry restructuring and investigation of the electric industry's development of energy efficiency programs. The natural gas utilities began offering the energy efficiency programs again on January 1, 2003, and since that time have saved an estimated total of nearly 250,000 decatherms (annual).[55] This value was again calculated by adding the estimated annual savings for each year since 2003. This value does not consider the cumulative savings over the life of the measures installed in the programs each year (i.e. only one annual year of savings from 2003 programs). As shown in Table 68, this savings represents 1.1 percent of the total forecasted therm sales for New Hampshire in 2008.

Table 68. Energy Efficiency Program Savings as Percent of 2008 Sales: 2003-2008 – Natural Gas Utilities

Sector	Total Annual Savings Since 2003 (decatherms)	Forecasted Sales 2008 (decatherms)	Cummulative Annual Savings as a Percent of 2008 Sector Sales	Cummulative Annual Savings as a Percent of 2008 Total Sales
Residential	95,387	8,435,900	1.1%	0.4%
Commercial/Industrial	150,248	14,267,000	1.1%	0.7%
Total	**245,635**	**22,702,900**		**1.1%**

Overall since 2003, a substantial amount of energy has been saved in both the residential and commercial/industrial sectors. The values presented above are also conservative as they do not reflect the efficiency efforts of the utility providers prior to 2003, nor do they consider the cumulative annual savings of the programs since 2003. The following sections discuss the programs in more detail, including customer participation, benefit cost ratios, and expansion potential.

8.1 Electric Utility Energy Efficiency Programs

The electric utility energy efficiency programs assessed in this section include the CORE programs and other utility-specific programs being offered by National Grid, the New Hampshire Electric Cooperative, Public Service Company of New Hampshire, and Unitil Energy Systems. Any programs being offered by New Hampshire's municipal electric utilities or through conservation and educational programs that do not have reportable energy savings have not been included in this summary. Table 69 presents a listing of the programs and sponsoring

[55] Estimate based on reported savings from 2003-2007 and GDS estimates for program measure lives

utilities included in this past and current electric utility energy efficiency program savings capture assessment. More detailed information on these programs can be found on the NHPUC website at http://www.puc.state.nh.us/Electric/coreenergyefficiencyprograms.htm.

Table 69. New Hampshire Electric Utility Core and Additional Programs

Program Name	Utility Sponsor
ENERGY STAR Home Program	CORE Program – NH Electric Providers
Home Energy Solutions	CORE Program – NH Electric Providers
Home Energy Assistance Program	CORE Program – NH Electric Providers
ENERGY STAR Lighting Program	CORE Program – NH Electric Providers
ENERGY STAR Appliance Program	CORE Program – NH Electric Providers
Small Business Energy Solutions	CORE Program – NH Electric Providers
Large Business Energy Solutions	CORE Program – NH Electric Providers
New Equipment and Construction	CORE Program – NH Electric Providers
NHEC High Efficiency Heat Pump Program	New Hampshire Electric Cooperative (NHEC)
PSNH ENERGY STAR Homes - geothermal	Public Service Company of New Hampshire (PSNH)
PSNH C&I RFP Pilot Program	Public Service Company of New Hampshire (PSNH)

8.1.1 Program Participation

The number of customers participating in the CORE programs has remained relatively constant since 2005. Some programs, such as the Home Energy Solutions and the Home Energy Assistance programs have decreased slightly in participation since 2005. Participation in these programs is somewhat limited under current program design, as they serve limited markets (i.e., homes with electric heat and low income homes, respectively). Homes with electric heat as the main fuel source represent approximately 4 percent of all residences in the state.[56] Low-income homes represent approximately 5.5 percent of all residences in New Hampshire. Since 2005, the total customer participation in the Home Energy Solutions and Home Energy Assistance programs is summarized in Table 70 below:

Table 70. Customer Served Through Utility HES and HEA Programs: 2005-2008

	Customers Served (2005-2008)	Total Population	Saturation
Home Energy Solutions	5,087	20,849	24.3%
Home Energy Assistance Program	4,143	28,668	14.5%

Given that the CORE programs have been in effect since June 2002, the actual saturation of these two markets is likely greater than the totals shown above. It is important to note however, that there are over 16,000 households on the waiting list for the Home Energy Assistance programs that serves low-income households[57] – therefore, there remains substantial demand for this program for the foreseeable future.,

[56] Figure based on residential phone survey data for both single family and multi-family

[57] Based on recent testimony by PSNH in CORE docket hearings (DE 08-120). Also, the low-income subgroup of the CORE docket produced an estimate that there are about 87,000 low-income households in New Hampshire, almost one-fifth of the total housing stick, that still need energy efficiency services (Low Income Report entered as Appendix B to the CORE Settlement Agreement filed on December 11, 2008 in DE 08-120.

Participation in the ENERGY STAR lighting and appliance programs has remained mostly steady since 2005, with spikes in participation in the lighting program in 2007 and the highest participation rate for the appliance program in 2006. These two programs have consistently maintained a good return of lifetime kWh saved per unit of cost. Since these programs target individual appliances and fixtures, and not individual homes per se, it is difficult to assess the extent to which the available market for these programs has diminished since the inception of the programs.

Participation in the ENERGY STAR Homes program has remained relatively stable since 2006 likely due to an overall downturn in the real estate market. In 2007, 524 builders (i.e. 524 homes) participated in New Hampshire's ENERGY STAR Homes programs out of a total of 3,772 single-family residential building permits[58]. This represents a saturation of 13.9 percent of ENERGY STAR homes among the residential new construction market in 2007.

Since 2005, a total of 3,110 small businesses have participated in the Small Business Energy Solutions program and a total of 1,008 large businesses have participated in the Large C&I Retrofit Program. These participation rates cannot be directly correlated to program saturation rates because many of the large businesses may have participated more than once. It is clear from this data, however, that the saturation of the large business programs has been much greater than in the small business programs.

In 2007, 194 builders or clients participated in the New Equipment and Construction program representing 24.6 percent of commercial/industrial building permits.

With respect to the three utility specific programs reviewed[59], total number of participants and total expenditures are far less than the CORE programs.

8.1.2 Program Awareness

Customer attitudes towards energy efficiency practices and programs were obtained from sector-specific site visits and phone surveys and were summarized in detail in Section 3.3 of this report. It seems relevant to this discussion to reiterate the findings relative to customer awareness of existing energy efficiency programs offered by the utilities. From the site and phone surveys, the percentages of customers who reported being aware of the programs offered are summarized in Table 71. As shown in this table New Hampshire's large commercial and industrial customers reported being most aware utility efficiency programs (over 85%). Residential customers were the least aware, at less than 50 percent. Nearly 60 percent of small commercial/industrial customers were aware of the utilities' programs.

Table 71. Percent of Customers Aware of Utility Efficiency Programs

	% Aware of Efficiency Programs Offered
Residential	49.4%
Small Commercial/Industrial	59.6%
Large Commercial/Industrial	85.9%

Although less than half of the 400 residential customers surveyed were aware that their utility providers offered energy efficiency programs, over 90 percent of all residential survey

[58] http://www.bos.frb.org/
[59] NHEC's *High Efficiency Heat Pump Program,* PSNH's *Energy Star Homes Geothermal Program,* and PSNH's *C&I RFP Pilot Program*

respondents indicated that they would incorporate energy efficient features in future renovations. This data indicates the potential for much greater participation in the residential marketplace with increased awareness. Similar opportunities exist with small commercial/industrial customers, although these customers are often the most hard to reach and to encourage to take action.

8.1.3 Efficiency Measures *Not* Included in Current Programs

This New Hampshire Additional Energy Efficiency Opportunities Potential Assessment study identified an abundance of energy efficiency measures that were cost effective and represent potential energy savings for New Hampshire in the next 10 years. Many of the most cost effective measures such as lighting, programmable thermostats and ENERGY STAR appliances are already included in the current energy efficiency programs sponsored by the electric and natural gas utilities. The efficiency measures discussed in Table 72 below are not included in the current programs and may represent opportunities for program expansion upon further review. It is important to note that the table below is by no means comprehensive, it is intended to be illustrative of areas with potential for expansion.

Table 72. Residential Measures Not Included in Current Programs

Efficiency Measure	Measure End Use	Comments
Programmable thermostat	Space heating and cooling	For homes with Oil or Propane heating. Programmable thermostats are included in the Home Energy Solutions (HES) program for homes with electric heat and offered by the gas utilities for homes with gas heat. The Home Energy Assistance (HEA) offers them for low income customers
Energy Efficient Windows	Space heating and cooling	For homes with Oil or Propane heating. The HEA low income program offers windows replacement for all fuels when cost-effective. The gas utilities offer a rebate for high efficiency window replacement for customers with gas heat.
Duct Sealing	Space heating and cooling	For homes with Oil or Propane heating. Duct sealing is included in the Home Energy Solutions program for homes with electric heat and the Weatherization program for homes with gas heat.
High efficiency heat pumps	Space heating and cooling	This measure is included in NHEC's specific program but not in the CORE programs for existing residential homes
Ground source heat pumps	Space heating and cooling	This measure is included in NHEC's specific program but not in the CORE programs for existing residential homes. PSNH offers this measure for residential new construction
Low flow shower heads/faucets	Water heating	For homes with Oil or Propane heating. Low flow shower heads and faucets are included in the Home Energy Solutions program for homes with electric heating (and also in the gas utility efficiency programs)
Water Heating measures	Water heating	For homes with Oil or Propane heating. Low flow shower heads and faucets are included in the Home Energy Solutions program for homes with electric heating, HES for all fuels and in the gas Weatherization program. Water heater wraps are offered for older water heaters in the HES program.
New water heater (efficient, tank less, heat pump)	Water heating	For all homes. Incentives are offered by the gas utilities
ENERGY STAR Refrigerator	Appliances	For all homes, not currently included in ENERGY STAR Appliances program. Available in HEA & HES programs if qualification criterion are met.
ENERGY STAR Freezer	Appliances	For all homes, not currently included in ENERGY STAR Appliances program. Available in HEA & HES programs if qualification criterion are met.
ENERGY STAR Dehumidifier	Appliances	For all homes, not currently included in ENERGY STAR Appliances program. Available in HEA if qualification criterion are met but none have been done.
ENERGY STAR Dishwasher	Appliances	For all homes, not currently included in ENERGY STAR Appliances program. Available in HEA if qualification criterion are met but none have been done.

Many of the efficiency measures identified above are efficiency measures that are cost effective and to date have been included only in programs serving homes with electric or natural gas heating. Homes with electric heat comprise approximately 4 percent of all residences based on the survey data whereas homes with natural gas, propane or oil heat comprise approximately 84 percent of homes. The appliances noted consume a significant amount of electricity and are not currently included in the ENERGY STAR appliances program for existing residences. Table 73 provides similar information regarding measures not currently included in the utilities' commercial/industrial programs.

Table 73. Commercial/Industrial Measures Not Included in Current Programs

Efficiency Measure	Measure End Use	Comments
Dishwasher, clothes washers, refrigeration, etc.	Appliances	Energy efficient appliances represents a potential for small and large businesses to conserve energy with small incremental costs, but is currently included only in the Small Business Energy Solutions Program
Ground source heat pumps	Space heating and cooling	Ground source heat pumps represent both a significant initial cost as well as a significant payback in terms of energy savings
General water heating measures	Water heating	Water heating measures such as low flow faucets and shower heads, efficient water heaters, water heater blankets, and similar water heating measures are only included in the Small Business Energy Solutions Program but represent a potential for energy savings in other facilities using electric hot water heating

8.2 Gas Efficiency Programs

Gas efficiency programs are offered independently in New Hampshire by the two gas utilities, National Grid and Northern Utilities. The gas efficiency programs were offered from 1993 through 1999, at which time the programs were suspended in light of gas industry restructuring and investigation of the electric industry's development of energy efficiency programs. The natural gas utilities began offering the energy efficiency programs again on January 1, 2003. The programs offered since 2003 are the programs evaluated in this analysis, and include the following (Table 74).

Table 74. Gas Efficiency Programs Evaluated

Program Name	Utility Sponsor
Residential custom measures	Northern Utilities (Gas)
Residential Low Income custom measures	Northern Utilities (Gas)
residential high efficiency heating equipment	Northern Utilities (Gas)
High efficiency water heating	Northern Utilities (Gas)
ENERGY STAR homes	Northern Utilities (Gas)
ENERGY STAR Programmable thermostats	Northern Utilities (Gas)
ENERGY STAR Windows	Northern Utilities (Gas)
Weatherization	Northern Utilities (Gas)
Multifamily custom measures	Northern Utilities (Gas)
Small commercial and Industrial Custom Measures	Northern Utilities (Gas)
Med and large C/I custom measures	Northern Utilities (Gas)
Commercial high efficiency heating program	Northern Utilities (Gas)
Infrared heating program	Northern Utilities (Gas)
Commercial ENERGY STAR Thermostats	Northern Utilities (Gas)

Program Name	Utility Sponsor
Low Income	National Grid (Gas)
Residential High Efficiency heating	National Grid (Gas)
ENERGY STAR Windows	National Grid (Gas)
Residential Weatherization	National Grid (Gas)
ENERGY STAR Thermostats	National Grid (Gas)
Residential High Efficiency Water Heating	National Grid (Gas)
ENERGY STAR Homes	National Grid (Gas)
Commercial Energy Efficiency Program	National Grid (Gas)
Economic Redevelopment	National Grid (Gas)
Commercial High Efficiency Heating	National Grid (Gas)
Multifamily Housing	National Grid (Gas)

Programs that do not have reportable therm savings such as the online audit and educational programs have been excluded from this list. A complete list of efficiency programs offered by the New Hampshire natural gas utilities may be found on the NHPUC website. [60]

8.2.1 Program Participation

Program summary sheets reviewed for the gas efficiency programs did not report the total number of actual participants for each program on a yearly basis. Based on the design goals for each program, the total number of participants has increased each year since 2003 with the largest increase in targeted users occurring between 2005 and 2006.

The design goal participation in several programs has increased steadily since 2003. Efficiency programs with notable increases in design goal participations since 2003 include the following:

- ENERGY STAR Homes
- ENERGY STAR Programmable Thermostats
- ENERGY STAR Windows
- Residential Weatherization
- Commercial High Efficiency Heating

GDS estimated the saturation of natural gas efficiency programs in the residential and commercial/industrial marketplace by calculating the cumulative number of design goal participants for each program since 2003 and comparing that number to the total number of potential users. The number of actual participants was not available from the documents posted to the NHPUC website. Potential users were determined by applying the percentage of natural gas users from the phone surveys, to the overall number of end use customers in each sector. For the purpose of estimating saturations, participation in programs offered by both utilities has been added together. The saturations presented in Table 75 below do not account for homes and facilities already equipped with the efficiency measure (i.e. homes already with programmable thermostats) and are intended only to reflect the percentage of the marketplace reached by the individual programs[61].

[60] http://www.puc.state.nh.us/Gas-Steam/energyefficiencyprograms.htm

[61] It is also important to note that many of the programs are time of replacement, so the saturations may be misleading because the total population is actually the number of customers in need of a heating system replacement and that number is constantly changing.

Table 75. Customer Served Through Natural Gas Utility Programs: 2005-2008

	Customers Served (2005-2008)	Total Population[62]	Saturation
Residential Conservation Services	2,245	45,279	5.0%
Residential Custom Measures	580	45,279	1.3%
Residential Low Income Custom Measures	621	2,402	25.9%
Residential High Efficiency Heating Equipment	2,912	45,279	6.4%
ENERGY STAR Homes	307	15,088[63]	2.0%
ENERGY STAR Programmable Thermostats	2,054	45,279	4.5%
Multi-Family Custom Measures	56	84,989	0.1%
C&I Custom Measures	375	33,481	1.1%
Commercial High Efficiency Heating Program	437	34,400	1.3%
Infrared Heating Program	28	34,440	0.1%
Commercial ENERGY STAR Thermostats	220	34,440	0.6%
Commercial Food Service Program	18	3,851	0.5%

The summary table above indicates that the gas efficiency programs since 2003 have penetrated the residential market to a greater extent than the commercial and industrial market. It appears that there is substantial opportunity for further penetration in all customer sectors.

8.2.2 Program Awareness

Customer awareness of utility sponsored efficiency programs is summarized in Sections 3.3 and 8.1.2 of this report. Of importance to this discussion of gas efficiency programs is the finding that less than half of residential customers are aware that programs are offered by their utility providers. More than 40 percent of small commercial and industrial customers are not aware of the programs offered by the utility providers. Increasing customer awareness will be an important barrier to overcome.

8.2.3 Efficiency Measures *Not* Included in Current Programs

A significant majority of the efficiency measures identified in the technical potential study have already been incorporated in the programs offered by the natural gas utilities. Several measures that are cost effective and are not currently included in the efficiency programs offered by the utility providers are summarized in Table 76 below. It is important to note that the current program designs do not permit the utility providers to pay for programs for oil/propane measures because the programs are funded by electric and gas ratepayers.

[62] Total population estimates are based on the total number of available properties by program type, times the percentage of facilities reporting the usage of natural gas from the site and phone surveys

[63] Estimate is number of 2007 single family building permits (3,772) times four years

Table 76. Measures Not Included in Current Natural Gas Efficiency Programs

Efficiency Measure	Measure End Use	Comments
ENERGY STAR Dishwashers	Appliances / Water heating	In homes with natural gas water heating
ENERGY STAR Clothes Washers	Appliances / Water heating	In homes with natural gas water heating
Boiler Tune up	Water Heating	In homes with natural gas supplied boilers
High efficiency cooking equipment	Cooking	High efficiency cooking equipment represents a potential for substantial savings. Northern Utilities and National Grid currently offer rebates for high-efficiency fryers and steamers.

Both of New Hampshire's natural gas utilities offer basic or prescriptive rebates for incorporating general energy efficiency products such as space heating equipment and water heaters. For small and large commercial and industrial customers, both utilities offer energy audit services and the potential for custom energy efficiency programs tailored to the specific facility. The audit and custom approach to efficiency programs in the commercial and industrial sector incorporate the potential for a wealth of energy efficiency measures to be incorporated at a specific facility.

8.3 Summary and Recommendations

To date, the efficiency programs offered in New Hampshire by the state's four largest electric utilities and two natural gas distribution companies have been successful and have saved a substantial amount of energy. Many of the programs have and are continuing to perform quite well in terms of cost per unit of energy saved and customer participation. Several other programs have shown positive trends becoming more cost effective on a yearly basis.

For all programs, but most notably in the electric market, the cost per kWh saved in the commercial and industrial sectors has been better than in the residential market. This might explain why in general, commercial and industrial customers have indicated a higher awareness of the utilities' efficiency programs available to them as well as an increased likelihood of participation compared to residential customers. Given the scale of energy consumption in the commercial and industrial sectors, these customers continue to represent a substantial area for potential energy savings in the upcoming years. Additional penetration can be achieved through increased outreach to small commercial/industrial customers and by expanding current program offerings to include other cost effective measures not currently included in the companies' CORE and utility-specific programs.

Residential customer participation in the state's electric and natural gas energy efficiency programs has met or exceeded program expectations on a yearly basis. However, in the phone surveys more than half of respondents indicated that they were not aware of the programs offered by their utilities, or that they were even eligible. Of the customers who were aware of the programs, a high percentage participated and indicated they would participate in the future. This data underscores the importance of increasing consumer education on the programs available to residential customers and of the associated benefits.

One final finding from the study is that nearly all of the most cost effective energy efficiency measures are included in current programs in some manner. In several programs, however, the cost effective measures are targeted to a small percentage of consumers. The best example of this is the *Home Energy Solutions* program which targets consumers with 65 percent or greater electric heating. Customers with primarily electric heat represent approximately 4 percent of the total population based on the phone surveys. Customers with 65% or more electric heat likely represent a larger percentage of the total population but are nonetheless a small percentage of all customers. Adding more comprehensive programs and expanding the depth, breadth and promotion of the current programs to include a larger number of potential participants may lead to increased overall energy savings. It is important to recognize that such expansion would require providing services to customers that heat with fuels other than electric or natural gas. Issues regarding who would pay for the provision of services to such customers would need to be addressed.

Appendix A

Appendix B

Appendix C

Appendix D

Appendix E

Appendix F

Appendix G

Appendix H

Appendix I

Appendix J

Appendix K

Appendix L

Appendix M