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FINAL REPORT

MAY 2015

Potential for Energy Savings in Affordable Multifamily Housing

PREPARED FOR NATURAL RESOURCES DEFENSE COUNCIL BY OPTIMAL ENERGY

NRDC NATURAL RESOURCES DEFENSE COUNCIL

ENERGY EFFICIENCY FOR ALL

Optimal ENERGY

Integrated Energy Resources

Acknowledgments

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The primary author of this Study are Phil Mosenthal and Matt Socks of Optimal Energy. Glenn Reed of Energy Futures Group provided critical support and input. The contents of this Study include and reflect the original ideas and contributions of Michael Bodaken and Todd Nedwick of the National Housing Trust, Abigail Corso and her team at Elevate Energy, and the experience and input of NRDC's team including Dylan Sullivan, Raya Salter, Rebecca Stanfield, and Cai Steger.

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INTRODUCTION

BACKGROUND AND PURPOSE OF STUDY

The Natural Resources Defense Council (NRDC), National Housing Trust (NHT), Energy Foundation, Elevate Energy, and New Ecology are conducting a multistate and multiyear Energy Efficiency for All affordable multifamily housing efficiency project with the goal of cost effectively reducing energy consumption as a means of maintaining housing affordability, creating healthier and more comfortable living environments for moderate- and low-income families, and reducing pollution. The project aim is to encourage electric and gas utilities to spearhead programs designed to capture all cost-effective energy efficiency within the affordable multifamily housing sector, significantly benefiting low-income families and building owners as well as utilities.

NRDC and the project partners commissioned this study to estimate the potential energy savings from the implementation of efficiency measures in affordable multifamily housing in nine states — Georgia, Illinois, Maryland, Michigan, Missouri, New York, North Carolina, Pennsylvania, and Virginia. For this study, affordable multifamily housing is defined as households in buildings with five or more units occupied by people with household incomes at or below 80% of the area median income.

The analysis includes savings for electricity, natural gas, and fuel oil over a 20-year period, 2015 to 2034. A 3% real discount rate is assumed for estimating the future value of costs and benefits. The study provides two types of potential estimates:

- Economic potential — savings that can be realized if all cost-effective efficiency measures are implemented
- Maximum achievable potential — savings that can be realized if all cost-effective efficiency measures are implemented given existing market barriers

"Potential" here refers to the savings that would result from the adoption of energy-efficient technologies that would not occur without funded programs to promote their adoption.

STUDY OVERVIEW

The focus of this study is the energy efficiency potential in affordable multifamily housing. The study includes the following key components:

- Economic potential and maximum achievable potential for the 20-year period from 2015-2034
- Potential estimates for electricity, natural gas, and fuel oil. The assessment of fuel oil potential is limited to opportunities in New York State.[1]
- Sensitivity analyses to assess the impacts of including various levels of non-energy benefits (NEBs) on the potential

The "Base Case" potential estimates presented in this report consider the benefits associated with energy, water, and operation and maintenance savings; however, there are other non-energy benefits associated with efficiency improvements that can significantly increase the cost-effectiveness of a given measure. For this study, non-energy benefits include reduced arrearages, reduced customer calls and collection activities, reduced safety-related emergency calls, higher comfort levels, increased housing property values, health-related benefits, and other impacts not captured in the Base Case potential scenario. We developed sensitivity scenarios reflecting two levels of NEBs impacts. These are compared with the Base Case potential scenarios which assume zero NEBs. These sensitivity scenarios are described in Table 1 below and in further detail in the Non-Energy Benefits and Discount Rate Sensitivity Analyses section of this report.

While the Base Case presented in this report assumes no benefits beyond those associated with energy, water, and operation and maintenance savings, it is generally acknowledged that other NEBs are significant and represent considerable benefits to society. Utilities, program administrators, and regulators are urged to include the impact of NEBs in their internal analyses to the fullest extent possible.

The study scope is limited in the following respects:

- Relies primarily on secondary sources, in some cases outside of the study states
- Uses aggregate or representative measures, in some cases, to approximate more diverse opportunities and streamline the analysis

TABLE 1. SUMMARY OF SENSITIVITY ANALYSES PERFORMED

Scenario	Scenario Description
Base Case	Maximum achievable potential scenario. Benefits assessed limited to reduced energy, water, and operation and maintenance costs (i.e., does not include the impact of other non-energy benefits)
Low Non-Energy Benefits	Maximum achievable potential including the impact of low non-energy benefits
High Non-Energy Benefits	Maximum achievable potential including the impact of high non-energy benefits

- Relies on a limited set of location-dependent parameters to reflect differences between utility service territories
- Does not include opportunities in the new construction market
- Does not include demand response or fuel-switching measures
- Includes inherent conservatisms as the cost-effectiveness screening was performed at the measure-level rather than at the program or portfolio level. In other words, measures that are not cost-effective are not included in the estimated potential. If this were an assessment of program potential[2] there would be greater opportunity to address the inclusion of non-cost effective measures. It is recommended that utilities and program administrators perform the cost-effectiveness screening at the portfolio or program level to encourage the development of comprehensive efficiency projects.

The basic methodology for assessing the economic and maximum achievable potential entails the following steps:

- Estimate the number of affordable multifamily housing units by state and utility service territory
- Estimate baseline energy consumption for the period 2015-2034
- Characterize efficiency measures (e.g. costs, savings, lifetimes)
- Identify location-dependent parameters for each electric utility service territory
- Develop measure penetrations (i.e., the extent to which each measure is implemented)
- Estimate avoided energy supply costs and screen measures for cost-effectiveness using the Total Resource Costs test
- Establish incentive and non-incentive program costs (i.e., both the costs associated with direct financial assistance to participants and the administrative, marketing, and other costs associated with running a program to pursue the potential)
- Adjust for measure interactions

A total of 182 measures were characterized for up to two applicable markets (natural replacement/renovation and retrofit). For each measure, we analyzed each measure/market combination for each building size and utility service territory. In total, we modeled more than 13,000 distinct combinations of measure, market, building size, and utility service territory for each year of the analysis. The Methodology section later in this report provides a detailed discussion of the methods and assumptions used in the analysis.

Several notes related to the analysis and presentation of results in this report are listed below.

- Unless otherwise noted, all dollar values are in real 2015 dollars.
- When savings are presented for a specific year, they reflect the cumulative annual savings in that year, accounting for measures that have been implemented and/or have expired in previous years.
- When costs and benefits are presented, they reflect the cumulative present value for the years 2015-2034.
- Electric savings are quantified at the point of consumption, that is, "at meter," as opposed to the point of generation.
- While quantified, the natural gas and fuel oil savings do not reflect the interactive effects between space heating and efficient lighting;[3] however, these impacts are reflected in the benefits presented and used for the cost-effectiveness screening. Where the primary space heating fuel is electricity, the electric savings do reflect interactive effects. Finally, where electric cooling is present, the electric savings reflect interactions between cooling and efficient lighting.[4]
- Unless otherwise noted, the potential estimates presented reflect the results of the Base Case non-energy benefits sensitivity scenario (i.e., only benefits associated with energy, water, and operation and maintenance savings are considered).

SUMMARY OF RESULTS

Scenario Summaries

This section presents a summary of the study results, comparing outputs from the different potential scenarios and sensitivity analyses assessed in the study. This study analyzed two levels of potential:

- Economic potential — savings that can be realized if all cost-effective efficiency measures are implemented
- Maximum achievable potential — savings that can be realized if all cost-effective efficiency measures are implemented given existing market barriers

Comparing different potential types is useful for understanding the boundaries of what can be achieved. Following the state level economic and maximum achievable results, we present more detailed results for the maximum achievable potential, including savings and cost-benefit analyses.

Table 2 provides a summary of the economic and maximum achievable potential for the Base Case sensitivity scenario (i.e., only benefits associated with energy, water, and operation and maintenance savings are considered) for each fuel relative to the baseline forecasted sales if no measures were implemented. Overall, statewide economic potential for electricity ranges from 23% to 37% of the forecasted load by 2034 depending on the state. Maximum achievable potential for electricity ranges from 15% to 26% by 2034, averaging roughly 69% of the economic potential. The economic potential for natural gas ranges from 18% to 36% relative to forecasted load in 2034. The maximum achievable potential for natural gas is lower than electricity, ranging from 10% to 22% by 2034, averaging 58% of the economic potential. Fuel oil maximum achievable potential, limited to New York State, is estimated at 15% by 2034.

Table 2 does not reveal any clear trend between climate and the estimated potential. While one might expect warmer climates to have higher electric potential and lower natural gas potential as compared to other states, this is not the case. There are several reasons for this. First, the electric avoided costs for southern states are generally lower than those of other states. This results in lower economic benefits for electric efficiency measures reducing the overall amount of cost-effective potential. Second, while warmer climates and higher cooling degree days may suggest more electric savings potential,

TABLE 2. CUMULATIVE BASE CASE POTENTIAL RELATIVE TO SALES FORECAST, 2034

State	Scenario	Electric	Natural Gas	Fuel Oil
Georgia	Max Achievable Potential	17%	13%	-
	Economic Potential	26%	22%	-
Illinois	Max Achievable Potential	22%	16%	-
	Economic Potential	32%	26%	-
Maryland	Max Achievable Potential	19%	18%	-
	Economic Potential	28%	30%	-
Michigan	Max Achievable Potential	26%	11%	-
	Economic Potential	37%	18%	-
Missouri	Max Achievable Potential	15%	17%	-
	Economic Potential	23%	29%	-
New York	Max Achievable Potential	24%	13%	15%
	Economic Potential	34%	23%	26%
North Carolina	Max Achievable Potential	19%	22%	-
	Economic Potential	29%	36%	-
Pennsylvania	Max Achievable Potential	20%	10%	-
	Economic Potential	29%	18%	-
Virginia	Max Achievable Potential	21%	13%	-
	Economic Potential	30%	23%	-

TABLE 3. CUMULATIVE BASE CASE MAXIMUM ACHIEVABLE POTENTIAL BY STATE, 2034

	Cumulative Savings 2034	% of Sales Forecast
Electric (GWh)		
Georgia	804	17%
Illinois	744	22%
Maryland	578	19%
Michigan	529	26%
Missouri	358	15%
New York	1,981	24%
North Carolina	629	19%
Pennsylvania	532	20%
Virginia	620	21%
Natural Gas (BBtu)		
Georgia	1,175	13%
Illinois	3,311	16%
Maryland	1,716	18%
Michigan	2,440	11%
Missouri	590	17%
New York	8,019	13%
North Carolina	362	22%
Pennsylvania	1,614	10%
Virginia	1,059	13%
Fuel Oil (BBtu)		
New York	5,258	15%

warmer climates also mean higher cooling energy consumption. Therefore, while cooling energy savings may be higher in warmer climates, when the potential is expressed as a percentage of forecasted load, the impact is less significant.

MAXIMUM ACHIEVABLE POTENTIAL

The results presented in this section as well as in all state- and utility-level results sections correspond to the maximum achievable potential. (Economic potential results, by utility, can be found in Appendix A). We focus on this scenario because it most closely reflects what could theoretically be captured through exemplary energy efficiency programs for the affordable multifamily housing sector designed to overcome market barriers to the extent possible.[5] Results in this section are broken out by state and fuel. Further breakdowns of the state totals can be found in the Utility-Level Summary section.

Savings

Table 3 provides a summary of the Base Case cumulative savings in 2034, by state and fuel, in both absolute terms and relative to the baseline sales forecast. The maximum achievable potential varies significantly by state, reflecting differences in avoided energy supply costs, the mix of fuels used (fuel shares), equipment saturations, climate, measure costs, and other factors.[6] The study finds significant potential in the affordable multifamily sector in all states. In absolute units of energy saved, the potential is highest in New York due primarily to the enormous number of affordable multifamily units in New York City.

TABLE 4. CUMULATIVE MAXIMUM ACHIEVABLE POTENTIAL BY NEBS SENSITIVITY SCENARIO AND STATE, 2034

State	Base Case % of Sales Forecast	Low NEBs Sensitivity Scenario % of Sales Forecast	High NEB Sensitivity Scenario % of Sales Forecast
Electric (GWh)			
Georgia	17%	20%	23%
Illinois	22%	26%	26%
Maryland	19%	22%	25%
Michigan	26%	27%	32%
Missouri	15%	19%	20%
New York	24%	27%	31%
North Carolina	19%	23%	26%
Pennsylvania	20%	23%	25%
Virginia	21%	25%	28%
Natural Gas (BBtu)			
Georgia	13%	17%	17%
Illinois	16%	20%	21%
Maryland	18%	20%	21%
Michigan	11%	14%	15%
Missouri	17%	23%	24%
New York	13%	18%	18%
North Carolina	22%	28%	28%
Pennsylvania	11%	13%	13%
Virginia	13%	18%	19%
Petroleum Fuel (BBtu)			
New York	15%	15%	15%

TABLE 5. BASE CASE MAXIMUM ACHIEVABLE POTENTIAL COSTS AND BENEFITS BY FUEL AND STATE

	Costs ($Million)	Benefits ($Million)	Net Benefits ($Million)	BCR
Electric				
Georgia	$332	$699	$367	2.1
Illinois	$336	$617	$281	1.8
Maryland	$278	$698	$420	2.5
Michigan	$246	$597	$352	2.4
Missouri	$178	$336	$158	1.9
New York	$976	$2,169	$1,193	2.2
North Carolina	$272	$577	$305	2.1
Pennsylvania	$252	$526	$274	2.1
Virginia	$277	$551	$274	2.0
Natural Gas				
Georgia	$73	$172	$99	2.4
Illinois	$235	$481	$246	2.0
Maryland	$112	$242	$129	2.2
Michigan	$171	$354	$182	2.1
Missouri	$35	$66	$31	1.9
New York	$586	$1,240	$654	2.1
North Carolina	$21	$49	$28	2.3
Pennsylvania	$117	$247	$130	2.1
Virginia	$65	$146	$81	2.2
Fuel Oil				
New York	$616	$1,884	$1,268	3.1

Table 4 provides a summary of the cumulative savings in 2034, relative to the baseline sales forecast, for the Base Case, Low NEBs, and High NEBs sensitivity scenarios. For the Low NEBs sensitivity, total cumulative electric savings in 2034 for all nine states are 14% higher than in the Base Case. Natural gas savings are 29% higher. Savings for fuel oil are unchanged as no additional measures pass the cost-effectiveness screening. For the High NEBs sensitivity, total cumulative electric savings are 28% higher than in the Base Case. Natural gas savings are 33% higher. As in the Low NEBs scenario, savings for fuel oil in the High NEBs scenario are virtually unchanged from the Base Case.

Costs, Benefits, and Cost-Effectiveness

We found that the total benefits to society, as defined by the Total Resource Cost test, from pursing energy efficiency substantially exceed the costs. Table 5 shows the cumulative impacts to each state's economy that would result from capturing the Base Case maximum achievable potential through 2034. The maximum achievable potential scenarios for all states and fuels are highly cost-effective from a Total Resource Cost Test perspective. Statewide benefit-to-cost ratios (BCR) range from 1.8 to 3.1 depending on the state and fuel. In Georgia, for example, total benefits from all fuels amount to $871 million from an investment of $405 million,

resulting in net benefits of approximately $466 million. The ratio of benefits to costs is such that the energy efficiency spending would return $2.15 to the Georgia economy for every dollar invested. The variation in the BCRs from state to state is largely driven by differences in avoided costs between the utility territories.

Table 6 shows the maximum achievable potential net benefits by state for all fuels for the Base Case, Low NEBs, and High NEBs sensitivity scenarios. For the Low NEBs sensitivity, total net benefits for all states and fuels increase by 122% from $6.5 billion to $14.4 billion. The overall BCR changes from 2.2 to 3.0. For the High NEBs sensitivity, total net benefits increase by 253% from $6.5 billion to $22.9 billion and the overall BCR changes from 2.2 to 3.3.

TABLE 6. MAXIMUM ACHIEVABLE POTENTIAL NET BENEFITS BY NEBS SENSITIVITY SCENARIO AND STATE, ALL FUELS

State	Base Case	Benefits ($Million)	Net Benefits ($Million)
Georgia	$467	$1,223	$2,048
Illinois	$527	$1,344	$2,276
Maryland	$550	$1,132	$1,755
Michigan	$534	$1,111	$1,724
Missouri	$190	$511	$894
New York	$3,114	$6,291	$9,552
North Carolina	$332	$893	$1,508
Pennsylvania	$404	$938	$1,522
Virginia	$354	$941	$1,579
Total	**$6,472**	**$14,384**	**$22,858**

TABLE 7. COMPARATIVE POTENTIAL FROM OTHER RESIDENTIAL STUDIES

State	Utility	Source	Study Period (Years)	Scenario	Energy Efficiency Potential: Final Study Year % Sales Forecast – Electric	Final Study Year % Sales Forecast – Natural Gas	Average Annual % Sales Forecast – Electric	Average Annual % Sales Forecast – Natural Gas
Illinois	ComEd	ICF 2013	6	Economic	41%	-	6.8%	-
				Max Achievable	8%	-	1.3%	-
Pennsylvania	Statewide	GDS 2012	10	Economic	36%	-	3.6%	-
				Max Achievable	19%	-	1.9%	-
Michigan	Statewide	GDS 2013	10	Economic	34%	22%	3.4%	2.2%
				Max Achievable	14%	14%	1.4%	1.4%
Illinois	Ameren	ENERNOC 2013	3	Economic	9%	4%	3.1%	1.2%
				Max Achievable	4%	2%	1.3%	0.5%
New York	ConEd	GEP 2010	9	Economic	17%	20%	1.9%	2.2%
				Max Achievable	12%	15%	1.4%	1.6%
Virginia	Statewide	ACEEE 2008	18	Economic	24%	-	1.3%	-
				Max Achievable	-	-	-	-
Missouri	Ameren	GEP 2010	22	Economic	21%	-	1.0%	-
				Max Achievable	-	-	-	-
Massachusetts	Statewide	Cadmus 2012	21	Economic	15%	24%	0.7%	1.1%
				Max Achievable	12%	19%	0.5%	0.9%

COMPARATIVE INFORMATION FROM OTHER JURISDICTIONS

To provide a basis for comparison for our data, we gathered information from several other recent studies investigating energy efficiency potential in the residential sector. Table 7 presents both economic and maximum achievable potential estimates from other studies for utility service territories in each state. While such comparisons are generally useful to establish some perspective on the magnitude of the potential, it is important to understand that most of the referenced studies reflect differing purposes, analysis periods, assumptions, levels of comprehensiveness, and degree of focus on the multifamily sector. Any one of these variables could greatly affect the estimates. For example, the 2013 study of potential in the Ameren Illinois service territory yields the lowest potential estimate in the final study year, but only looks at a 3-year period.

Estimates of electric economic energy efficiency potential range from 9% to 41% of forecasted electric load in the respective studies' final year of analysis. Maximum achievable potential ranges from 4% to 19% by the final analysis year. Natural gas economic potential ranges from 4% to 24%, and maximum achievable potential ranges from 2% to 19%. For comparison purposes, the potential estimates are also presented as the average annual savings over the respective study periods.[7] On an annual basis, electric economic potential ranges from 0.7% to 6.8%, and maximum achievable potential ranges from 0.5% to 1.9%. Natural gas economic potential ranges from 1.1% to 2.2%, and maximum achievable potential ranges from 0.5% to 1.6%.

While the ranges of potential presented in our study are on the higher end of the estimates in the comparison studies, there is significant overlap. Given the variables discussed above, what is significant is not so much that our estimates are high or low but rather that they are of similar magnitude to estimates presented in other recent studies investigating potential in the residential sector.

Endnotes:

[1] Per the study scope, the assessment of "delivered fuels" (i.e., fuel oil, propane, and wood) was limited to cases where a given delivered fuel represented more than 5% of the total residential heating fuel market share in a given state. Fuel oil in New York was the only delivered fuel that satisfied this criterion.

[2] Program potential refers to the efficiency potential possible given specific program funding levels and designs. Often, program potential studies are referred to as "achievable" in contrast to "maximum achievable." In effect, they estimate the achievable potential from a given set of programs and funding.

[3] Lighting produces some "waste heat" that contributes to space heating during the heating season and, where cooling equipment is present, must be removed during the cooling season. Since efficient lighting generally reduces the amount of waste heat produced, some additional space heating must be provided whereas some cooling can be avoided.

[4] This reporting convention is used to avoid understating the natural gas and fuel oil potential due to the impact of aggressively pursuing efficient lighting. In cases where efficiency programs are not integrated across fuel types, this is especially important.

[5] Program design best practices for achieving cost-effective efficiency potential in affordable multifamily housing are presented in NRDC (Natural Resources Defense Council), National Housing Trust, the Energy Foundation, and Elevate Energy. 2015. Program Design Guide: Energy Efficiency Programs in Multifamily Affordable Housing.

[6] Equipment saturation refers to the fraction of housing units that employ a particular equipment type. For example, if half of all units use window air-conditioners, one quarter of units have central air-conditioning systems, and the remaining quarter have no cooling equipment, the equipment saturations for window air-conditioners and central air-conditioners would be 50% and 25%, respectively.

MAXIMUM ACHIEVABLE POTENTIAL DETAILED RESULTS

This section presents detailed results from our analysis of the maximum achievable potential scenario. We focus on this scenario because it provides the best indication of what could theoretically be captured through exemplary energy efficiency programs in the affordable multifamily housing sector. Potential estimates and the associated cost-benefit analyses are presented by fuel, to reflect the fact that program offerings may not be integrated across fuels in all jurisdictions. We present the savings for each state as well as a breakdown of the total potential across all nine states by fuel and end use. Finally, maximum achievable potential savings, costs, and benefits are presented by fuel at the electric utility service territory level. All estimates presented in this section represent the Base Case scenario, which only reflects benefits associated with energy, water, and operation and maintenance savings.

STATE-LEVEL SUMMARY

Savings

Cumulative results through 2034 for the affordable multifamily housing sector are presented by state and fuel in Table 8 below. The maximum achievable potential varies significantly by state because of differences in avoided energy supply costs, fuel shares, equipment saturations, climate, measure costs, and other factors.

Some electric measures, especially indoor lighting, impose a "heating penalty." Since efficient indoor lighting tends to produce less waste heat than the less efficient lighting it replaces, a lighting retrofit can increase a building's heating load. The heating penalty can offset a significant portion of the savings of natural gas efficiency measures. However, in the natural gas savings presented in tables below, and in all tables in this report, we do not include the increased natural gas usage to make up for efficient electric equipment. The negative impacts are, however, reflected in the benefits presented and used for the cost-effectiveness screening. We used the same approach for petroleum fuels.

End Use Electric Savings

Figure 1 highlights the key role that measures reducing heating and cooling energy use play in reaching the maximum achievable potential. The heating and cooling end uses (i.e., heating/cooling, space heating, and cooling) contribute a combined 49% of total electric energy savings by 2034.[8] The savings potential is achieved primarily through the introduction of Wi-Fi thermostats, efficient windows, and air sealing. Equipment plugged directly into an outlet (plug load), of which consumer electronics are a major part, contributes a significant 21% of the total potential. Advanced power strips account for the bulk of these savings, reflecting their low costs, accessibility, and relatively low current penetrations in the multifamily market segment. Energy efficiency measures for lighting contribute 18% of the electric potential. This is surprising because other potential studies estimate that lighting contributes a much higher fraction of total electric potential. However, compliance with recent federal standards (e.g., the Energy Independence and Security Act of 2007) has greatly reduced the potential incremental savings for both general service lamps and linear fluorescents as baseline efficiencies have improved. It is assumed that during the 20-year analysis period of this study, the cost of light emitting diodes (LEDs) will decline and LEDs will represent the bulk of the future efficient lighting market, supplanting contributions from compact fluorescent lamps (CFLs). Standard LED general service lamps in both

TABLE 8. CUMULATIVE BASE CASE MAXIMUM ACHIEVABLE POTENTIAL BY STATE, 2034

	Cumulative Savings 2034	% of Sales Forecast
Electric (GWh)		
Georgia	804	17%
Illinois	744	22%
Maryland	578	19%
Michigan	529	26%
Missouri	358	15%
New York	1,981	24%
North Carolina	629	19%
Pennsylvania	532	20%
Virginia	620	21%
Natural Gas (BBtu)		
Georgia	1,175	13%
Illinois	3,311	16%
Maryland	1,716	18%
Michigan	2,440	11%
Missouri	590	17%
New York	8,019	13%
North Carolina	362	22%
Pennsylvania	1,614	11%
Virginia	1,059	13%
Fuel Oil (BBtu)		
New York	5,258	15%

FIGURE 1. CUMULATIVE ELECTRIC ENERGY SAVINGS BY END USE, 2034

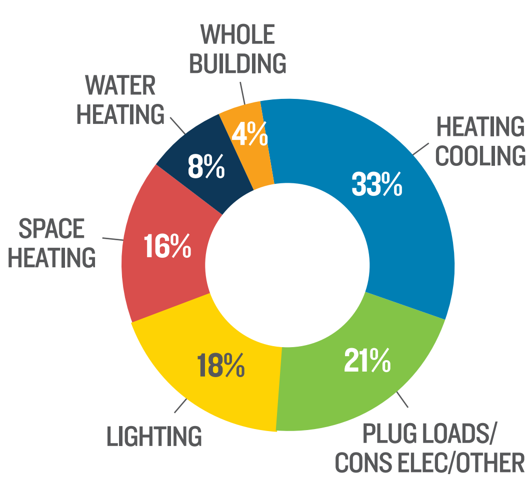
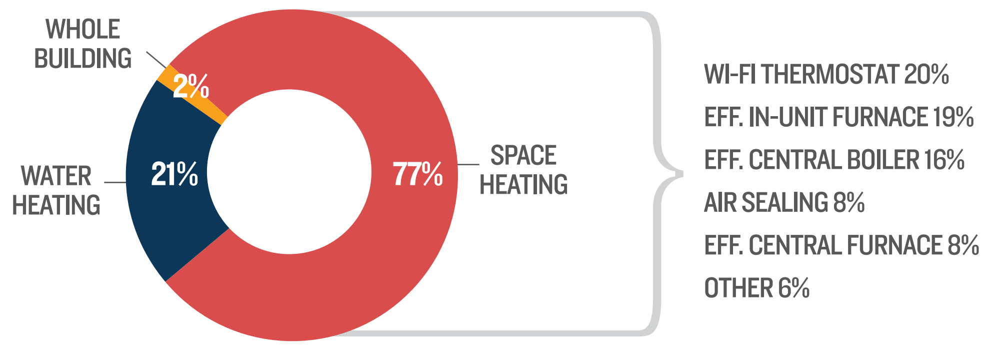


FIGURE 2. CUMULATIVE NATURAL GAS SAVINGS BY END USE, 2034



in-unit and common area applications represent 16% of the total electric potential.

After lighting, the next largest end use savings contributions come from improvements in water heating (8%) and whole-building measures (4%), such as behavioral initiatives and making improvements in existing equipment (retrocommissioning). Measures increasing the efficiency of refrigerators and some other appliances (namely, freezers and efficient electric dryers) do not pass the cost-effectiveness hurdle for inclusion in our potential estimates in any utility service territory, primarily because recent federal standards for appliances have already significantly raised efficiency levels of baseline equipment.[9]

End Use Natural Gas Savings

Natural gas usage in the affordable multifamily housing sector, as in the overall residential sector, is largely limited to space heating, water heating, and cooking. Figure 2 shows that space heating accounts for 77% of the gas savings, with an additional 21% from water heating measures. The remaining 2% are from retrocommissioning activities. Wi-Fi thermostats, efficient in-unit and central furnaces, central boilers, and air sealing contribute the vast majority of space heating savings. Commercial clothes washers, water heater pipe wrap, and low-flow showerheads and faucet aerators are the principal measures contributing to gas water heating savings.

End Use Fuel Oil Savings

As shown in Figure 3, we found that space heating accounts for more than three-fourths of fuel oil savings potential (76% of cumulative savings by 2034) due to its nearly exclusive use as a heating fuel (As above, fuel oil potential was estimated only in New York State). The remaining 24% of savings are split between water heating measures (15%) and whole building measures (9%). The mix of fuel oil measures is somewhat different from natural gas due in large part to the significantly higher avoided costs for fuel oil. Efficient central boilers (25%), Wi-Fi thermostats (16%), efficient windows (14%), and wall insulation (11%) contribute the majority of space heating savings, while high efficiency oil water heaters (7%) contribute the majority of water-heating savings.

Costs, Benefits, and Cost-Effectiveness

Table 9 shows the cumulative costs and benefits by state realized from capturing the maximum achievable potential through 2034. The maximum achievable potential scenarios for all states and fuels are highly cost-effective from a Total Resource Cost Test perspective; that is, the total resource benefits of energy efficiency substantially exceed the costs. Statewide benefit-to-cost ratios (BCR) range from 1.8 to 2.8 depending on the state and fuel. In North Carolina, for example, total benefits (from all fuels) amount to $626 million from an investment of $293 million, resulting in net benefits of approximately $333 million. This means that the energy efficiency spending would return $2.14 to the North Carolina economy for every dollar invested.

FIGURE 3. CUMULATIVE FUEL OIL SAVINGS BY END USE, 2034

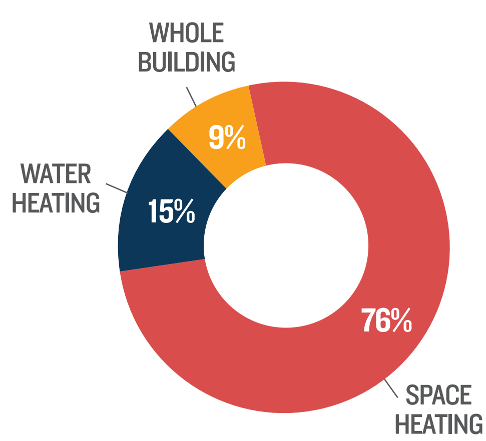


TABLE 9. BASE CASE MAXIMUM ACHIEVABLE POTENTIAL COSTS AND BENEFITS BY FUEL AND STATE				
	Costs ($Million)	Benefits ($Million)	Net Benefits ($Million)	BCR
Electric				
Georgia	$332	$699	$367	2.1
Illinois	$336	$617	$281	1.8
Maryland	$278	$698	$420	2.5
Michigan	$246	$597	$352	2.4
Missouri	$178	$336	$158	1.9
New York	$976	$2,169	$1,193	2.2
North Carolina	$272	$577	$305	2.1
Pennsylvania	$252	$526	$274	2.1
Virginia	$277	$551	$274	2.0
Natural Gas				
Georgia	$73	$172	$99	2.4
Illinois	$235	$481	$246	2.0
Maryland	$112	$242	$129	2.2
Michigan	$171	$354	$182	2.1
Missouri	$35	$66	$31	1.9
New York	$586	$1,240	$654	2.1
North Carolina	$21	$49	$28	2.3
Pennsylvania	$117	$247	$130	2.1
Virginia	$65	$146	$81	2.2
Fuel Oil				
New York	$616	$1,884	$1,268	3.1

UTILITY-LEVEL SUMMARY

Savings

Cumulative results through 2034 by state and utility for the affordable multifamily housing sector are presented in Table 10 through Table 18 below. Utilities are presented by state and fuel in order of decreasing electric potential. The magnitude of the maximum achievable potential varies significantly by utility because of differences in the number of affordable multifamily housing units serviced in each territory.

TABLE 10. GEORGIA CUMULATIVE BASE CASE MAXIMUM ACHIEVABLE POTENTIAL BY UTILITY SERVICE TERRITORY, 2034		
Utility	**Electric (GWh)**	**Natural Gas (BBtu)**
Georgia Power	654	955
All Coops	66	97
All Munis/Public Power	57	84
Savannah Electric & Power Company	25	37
Other	1	2
Total	**804**	**1,175**

TABLE 11. ILLINOIS CUMULATIVE BASE CASE MAXIMUM ACHIEVABLE POTENTIAL BY UTILITY SERVICE TERRITORY, 2034

Utility	Electric (GWh)	Natural Gas (BBtu)
Commonwealth Edison Company	548	2,447
Ameren Services	132	581
MidAmerican Energy Company	13	60
Other	52	223
Total	**744**	**3,311**

TABLE 12. MARYLAND CUMULATIVE BASE CASE MAXIMUM ACHIEVABLE POTENTIAL BY UTILITY SERVICE TERRITORY, 2034

Utility	Electric (GWh)	Natural Gas (BBtu)
Baltimore Gas and Electric Company	258	763
Potomac Electric Power Co.	214	641
Potomac Edison	36	108
Delmarva Power	27	79
Southern Maryland Electric Cooperative	15	43
Other	28	84
Total	**578**	**1,716**

TABLE 13. MICHIGAN CUMULATIVE BASE CASE MAXIMUM ACHIEVABLE POTENTIAL BY UTILITY SERVICE TERRITORY, 2034

Utility	Electric (GWh)	Natural Gas (BBtu)
DTE Energy Company	278	1,282
Consumers Energy	180	829
Indiana Michigan Power	10	47
Other Investor Owned Utilities (IOUs)	5	21
Other	57	261
Total	**529**	**2,440**

TABLE 14. MISSOURI CUMULATIVE BASE CASE MAXIMUM ACHIEVABLE POTENTIAL BY UTILITY SERVICE TERRITORY, 2034

Utility	Electric (GWh)	Natural Gas (BBtu)
Ameren Missouri	147	239
Kansas City Power & Light	110	184
City Utilities of Springfield	24	40
Empire District	15	24
Other	62	102
Total	**358**	**590**

TABLE 15. NEW YORK CUMULATIVE BASE CASE MAXIMUM ACHIEVABLE POTENTIAL BY UTILITY SERVICE TERRITORY, 2034

Utility	Electric (GWh)	Natural Gas (BBtu)	Fuel Oil (BBtu)
Con Edison of NY	1,645	6,525	4,284
Niagara Mohawk	145	633	406
Long Island Power Authority	55	251	185
New York State Electric & Gas Corp.	47	206	127
Rochester Gas & Electric	39	169	113
Central Hudson Gas & Electric Corp.	22	104	63
Orange and Rockland Utilities	17	83	49
Other	11	49	30
Total	**1,981**	**8,019**	**5,258**

TABLE 16. NORTH CAROLINA CUMULATIVE BASE CASE MAXIMUM ACHIEVABLE POTENTIAL BY UTILITY SERVICE TERRITORY, 2034

Utility	Electric (GWh)	Natural Gas (BBtu)
Duke Energy Carolinas, LLC	271	158
Carolina Power & Light	190	108
Virginia Electric and Power Company	13	7
EnergyUnited	10	5
Other	145	83
Total	**629**	**362**

TABLE 17. PENNSYLVANIA CUMULATIVE BASE CASE MAXIMUM ACHIEVABLE POTENTIAL BY UTILITY SERVICE TERRITORY, 2034

Utility	Electric (GWh)	Natural Gas (BBtu)
PECO Energy Company	161	471
PPL Electric Utilities	117	369
Duquesne Light	85	220
Pennsylvania Electric Company	58	192
West Penn Power Company	52	173
Metropolitan Edison Company	34	114
Pennsylvania Power Co.	10	34
Other	14	41
Total	**532**	**1,614**

Costs, Benefits, and Cost-Effectiveness

Table 19 through Table 27 show the cumulative costs and benefits by state and utility that would be realized from capturing the maximum achievable potential through 2034. Utilities are presented by state and fuel in order of decreasing net benefits. The maximum achievable potential scenarios for all utilities and fuels are highly cost-effective from a Total Resource Cost Test perspective. The benefit-to-cost ratios (BCR) for individual utilities within each given state are fairly close. Differences result primarily from differences in assumed avoided costs by electric utility service territory.

TABLE 18. VIRGINIA CUMULATIVE BASE CASE MAXIMUM ACHIEVABLE POTENTIAL BY UTILITY SERVICE TERRITORY, 2034

Utility	Electric (GWh)	Natural Gas (BBtu)
Dominion	474	801
Appalachian Power	59	110
All Munis/Public Power	38	64
NOVEC	27	45
All Coops except NOVEC/Rappahannock	8	14
Potomac Edison (VA only)	7	12
Rappahannock Electric Cooperative	3	5
Kentucky Utilities Co. (Old Dominion/PPL)	2	5
PEPCO Delmarva (VA only)	1	1
Other	2	3
Total	**620**	**1,059**

TABLE 19. GEORGIA BASE CASE MAXIMUM ACHIEVABLE POTENTIAL COSTS AND BENEFITS BY UTILITY SERVICE TERRITORY

Utility	Costs ($Million)	Benefits ($Million)	Net Benefits ($Million)	BCR
Electric				
Georgia Power	$270	$569	$299	2.1
All Coops	$27	$58	$30	2.1
All Munis/Public Power	$23	$49	$26	2.1
Savannah Electric & Power Company	$11	$22	$12	2.1
Other	$1	$1	$1	2.1
Electric Total	**$332**	**$699**	**$367**	**2.1**
Natural Gas				
Georgia Power	$59	$140	$81	2.4
All Coops	$6	$14	$8	2.4
All Munis/Public Power	$5	$12	$7	2.4
Savannah Electric & Power Company	$2	$5	$3	2.4
Other	$0	$0	$0	2.3
Natural Gas Total	**$73**	**$172**	**$99**	**2.4**

TABLE 20. ILLINOIS BASE CASE MAXIMUM ACHIEVABLE POTENTIAL COSTS AND BENEFITS BY UTILITY SERVICE TERRITORY

Utility	Costs ($Million)	Benefits ($Million)	Net Benefits ($Million)	BCR
Electric				
Commonwealth Edison Company	$248	$454	$207	1.8
Ameren Services	$60	$110	$50	1.8
MidAmerican Energy Company	$5	$10	$5	2.0
Other	$23	$43	$19	1.8
Electric Total	**$336**	**$617**	**$281**	**1.8**
Natural Gas				
Commonwealth Edison Company	$174	$355	$182	2.0
Ameren Services	$41	$85	$43	2.0
MidAmerican Energy Company	$4	$8	$4	2.1
Other	$16	$33	$17	2.0
Natural Gas Total	**$235**	**$481**	**$246**	**2.0**

TABLE 21. MARYLAND BASE CASE MAXIMUM ACHIEVABLE POTENTIAL COSTS AND BENEFITS BY UTILITY SERVICE TERRITORY

Utility	Costs ($Million)	Benefits ($Million)	Net Benefits ($Million)	BCR
Electric				
Baltimore Gas and Electric Company	$125	$312	$187	2.5
Potomac Electric Power Co.	$104	$259	$156	2.5
Potomac Edison	$17	$43	$26	2.5
Delmarva Power	$12	$32	$20	2.7
Southern Maryland Electric Cooperative	$7	$18	$11	2.5
Other	$13	$34	$20	2.5
Electric Total	**$278**	**$698**	**$420**	**2.5**
Natural Gas				
Baltimore Gas and Electric Company	$50	$108	$57	2.1
Potomac Electric Power Co.	$42	$90	$48	2.1
Potomac Edison	$7	$15	$8	2.1
Delmarva Power	$5	$11	$6	2.4
Southern Maryland Electric Cooperative	$3	$6	$3	2.1
Other	$5	$12	$6	2.1
Natural Gas Total	**$112**	**$242**	**$129**	**2.2**

TABLE 22. MICHIGAN BASE CASE MAXIMUM ACHIEVABLE POTENTIAL COSTS AND BENEFITS BY UTILITY SERVICE TERRITORY

Utility	Costs ($Million)	Benefits ($Million)	Net Benefits ($Million)	BCR
Electric				
DTE Energy Company	$137	$315	$177	2.3
Consumers Energy	$78	$202	$125	2.6
Indiana Michigan Power	$4	$11	$7	2.6
Other Investor Owned Utilities (IOUs)	$2	$5	$3	2.6
Other	$24	$64	$39	2.6
Electric Total	**$246**	**$597**	**$352**	**2.4**
Natural Gas				
DTE Energy Company	$98	$186	$88	1.9
Consumers Energy	$52	$120	$68	2.3
Indiana Michigan Power	$3	$7	$4	2.3
Other Investor Owned Utilities (IOUs)	$1	$3	$2	2.3
Other	$16	$38	$21	2.3
Natural Gas Total	**$171**	**$354**	**$182**	**2.1**

TABLE 23. MISSOURI BASE CASE MAXIMUM ACHIEVABLE POTENTIAL COSTS AND BENEFITS BY UTILITY SERVICE TERRITORY

Utility	Costs ($Million)	Benefits ($Million)	Net Benefits ($Million)	BCR
Electric				
Ameren Missouri	$75	$139	$64	1.9
Kansas City Power & Light	$56	$104	$48	1.9
City Utilities of Springfield	$11	$22	$11	2.0
Empire District	$7	$14	$7	2.0
Other	$29	$57	$28	2.0
Electric Total	$178	$336	$158	1.9
Natural Gas				
Ameren Missouri	$15	$27	$12	1.8
Kansas City Power & Light	$11	$21	$9	1.8
City Utilities of Springfield	$2	$4	$2	2.2
Empire District	$1	$3	$1	2.2
Other	$5	$11	$6	2.2
Natural Gas Total	**$35**	**$66**	**$31**	**1.9**

TABLE 24. NEW YORK BASE CASE MAXIMUM ACHIEVABLE POTENTIAL COSTS AND BENEFITS BY UTILITY SERVICE TERRITORY

Utility	Costs ($Million)	Benefits ($Million)	Net Benefits ($Million)	BCR
Electric				
Con Edison of NY	$838	$1,890	$1,051	2.3
Niagara Mohawk	$56	$119	$62	2.1
Long Island Power Authority	$25	$48	$22	1.9
New York State Electric & Gas Corp.	$18	$38	$20	2.1
Rochester Gas & Electric	$15	$32	$17	2.1
Central Hudson Gas & Electric Corp.	$10	$19	$9	1.9
Orange and Rockland Utilities	$8	$15	$7	1.9
Other	$5	$9	$4	1.9
Electric Total	**$976**	**$2,169**	**$1,193**	**2.2**
Natural Gas				
Con Edison of NY	$487	$1,030	$543	2.1
Niagara Mohawk	$39	$86	$47	2.2
Long Island Power Authority	$19	$39	$20	2.0
New York State Electric & Gas Corp.	$13	$28	$15	2.2
Rochester Gas & Electric	$10	$23	$13	2.2
Central Hudson Gas & Electric Corp.	$8	$16	$8	2.0
Orange and Rockland Utilities	$6	$12	$6	2.0
Other	$4	$7	$3	1.8
Natural Gas Total	**$586**	**$1,240**	**$654**	**2.1**
Fuel Oil				
Con Edison of NY	$513	$1,536	$1,023	3.0
Niagara Mohawk	$40	$145	$105	3.6
Long Island Power Authority	$22	$66	$43	3.0
New York State Electric & Gas Corp.	$13	$46	$33	3.6
Rochester Gas & Electric	$11	$40	$29	3.6
Central Hudson Gas & Electric Corp.	$8	$22	$15	3.0
Orange and Rockland Utilities	$6	$17	$12	3.0
Other	$4	$11	$7	3.0
Fuel Oil Total	**$616**	**$1,884**	**$1,268**	**3.1**

TABLE 25. NORTH CAROLINA BASE CASE MAXIMUM ACHIEVABLE POTENTIAL COSTS AND BENEFITS BY UTILITY SERVICE TERRITORY

Utility	Costs ($Million)	Benefits ($Million)	Net Benefits ($Million)	BCR
Electric				
Duke Energy Carolinas, LLC	$117	$248	$131	2.1
Carolina Power & Light	$82	$175	$92	2.1
Virginia Electric and Power Company	$6	$12	$6	2.1
EnergyUnited	$4	$9	$5	2.1
Other	$63	$133	$70	2.1
Electric Total	$272	$577	$305	2.1
Natural Gas				
Duke Energy Carolinas, LLC	$9	$21	$12	2.3
Carolina Power & Light	$6	$15	$8	2.3
Virginia Electric and Power Company	$0	$1	$1	2.3
EnergyUnited	$0	$1	$0	2.3
Other	$5	$11	$6	2.3
Natural Gas Total	**$21**	**$49**	**$28**	**2.3**

TABLE 26. PENNSYLVANIA BASE CASE MAXIMUM ACHIEVABLE POTENTIAL COSTS AND BENEFITS BY UTILITY SERVICE TERRITORY

Utility	Costs ($Million)	Benefits ($Million)	Net Benefits ($Million)	BCR
Electric				
PPL Electric Utilities	$55	$139	$83	2.5
PECO Energy Company	$77	$141	$64	1.8
Duquesne Light	$46	$102	$55	2.2
Pennsylvania Electric Company	$25	$49	$24	2.0
West Penn Power Company	$23	$44	$22	2.0
Metropolitan Edison Company	$15	$29	$14	2.0
Pennsylvania Power Co.	$4	$9	$4	2.0
Other	$7	$13	$6	1.8
Electric Total	**$252**	**$526**	**$274**	**2.1**
Natural Gas				
PECO Energy Company	$36	$74	$38	2.0
PPL Electric Utilities	$25	$55	$30	2.2
Duquesne Light	$17	$36	$19	2.1
Pennsylvania Electric Company	$13	$28	$15	2.1
West Penn Power Company	$12	$25	$14	2.1
Metropolitan Edison Company	$8	$17	$9	2.1
Pennsylvania Power Co.	$2	$5	$3	2.1
Other	$3	$6	$3	2.0
Natural Gas Total	**$117**	**$247**	**$130**	**2.1**

TABLE 27. VIRGINIA BASE CASE MAXIMUM ACHIEVABLE POTENTIAL COSTS AND BENEFITS BY UTILITY SERVICE TERRITORY

Utility	Costs ($Million)	Benefits ($Million)	Net Benefits ($Million)	BCR
Electric				
Dominion	$213	$421	$208	2.0
Appalachian Power	$24	$52	$28	2.1
All Munis/Public Power	$17	$33	$16	2.0
NOVEC	$12	$24	$12	2.0
All Coops except NOVEC/ Rappahannock	$4	$7	$3	2.0
Potomac Edison (VA only)	$3	$6	$3	2.0
Rappahannock Electric Cooperative	$1	$3	$1	2.0
Kentucky Utilities Co. (Old Dominion/PPL)	$1	$2	$1	2.1
PEPCO Delmarva (VA only)	$0	$0	$0	2.1
Other	$1	$2	$1	2.0
Electric Total	**$277**	**$551**	**$274**	**2.0**
Natural Gas				
Dominion	$50	$111	$61	2.2
Appalachian Power	$6	$14	$8	2.3
All Munis/Public Power	$4	$9	$5	2.2
NOVEC	$3	$6	$3	2.2
All Coops except NOVEC/ Rappahannock	$1	$2	$1	2.2
Potomac Edison (VA only)	$1	$2	$1	2.2
Rappahannock Electric Cooperative	$0	$1	$0	2.2
Kentucky Utilities Co. (Old Dominion/PPL)	$0	$1	$0	2.3
PEPCO Delmarva (VA only)	$0	$0	$0	2.3
Other	$0	$0	$0	2.2
Natural Gas Total	**$65**	**$146**	**$81**	**2.2**

Endnote:

[8] Note that the heating/cooling, space heating, and cooling end uses may appear redundant but are necessary. End use savings in the figures below are presented by primary end use. Measures may save energy across multiple end uses. For example, consider an efficient clothes washer in a building with natural gas water heating. As the most significant impact of this measure is reduced water heating energy, the primary end use is water heating; however, the measure also reduces the electric energy required to operate the washer. The secondary end use is classified as "appliances." In some cases, the primary and secondary end uses affect the same fuel type. This is the case for many envelope and HVAC measures installed in buildings with electric space heat and cooling. In such cases, the "heating/cooling" end use is applied.

NON-ENERGY BENEFITS AND DISCOUNT RATE SENSITIVITY ANALYSES

The inclusion of non-energy benefits (NEBs) can have a significant impact on maximum achievable potential, especially for the affordable multifamily housing sector. We conducted sensitivity analyses, which assess the impacts of changes in certain key input variables, to examine the impact of NEBs on the maximum achievable potential.

TABLE 28. SUMMARY OF SENSITIVITY ANALYSES PERFORMED	
Scenario	**Scenario Description**
Base Case	Maximum achievable potential scenario. Benefits assessed limited to reduced energy, water, and operation and maintenance costs (i.e., does not include the impact of other non-energy benefits)
Low Non-Energy Benefits	Maximum achievable potential including the impact of low non-energy benefits
High Non-Energy Benefits	Maximum achievable potential including the impact of high non-energy benefits

Table 28 shows the sensitivity analyses performed.

Several efficiency programs account for the impacts of additional benefits beyond reduced energy and water consumption and reduced operation and maintenance costs. Massachusetts has studied these impacts extensively in the residential sector, and has quantified NEBs specifically for low-income participants.[10] The benefits that warrant quantification include the following:[11]

- Reduced arrearages
- Reduced customer calls and collection activities
- Reduced safety related emergency calls
- Higher comfort levels
- Increased housing property values
- Health related benefits

For the sensitivity analyses, we have assumed NEBs values derived from the actual non-energy benefits claimed for low income residential programs implemented by the Massachusetts programs administrators in 2012 and 2013. The statewide study, on which these values are based, are provided on a per-housing unit basis by measure type; our simplified approach assumes the ratio of overall non-energy benefits to energy benefits claimed by the Massachusetts low-income residential programs can be applied to the avoided costs used in this study to estimate the impact of NEBs. Because the avoided costs in Massachusetts vary significantly in some cases from those used in this study, our ratios are adjusted such that the resulting value of the non-energy benefits per unit of energy saved are approximately equal regardless of actual avoided costs in the specific utility territory assessed. The Low NEBs scenario assumed non-energy benefits equivalent

TABLE 29. SENSITIVITY FOR LOW NON-ENERGY BENEFITS, CUMULATIVE MAXIMUM ACHIEVABLE POTENTIAL BY STATE, 2034

	Low NEBs Sensitivity Scenario		Base Case	
	Cumulative Savings, 2034	% of Sales Forecast	Cumulative Savings, 2034	% of Sales Forecast
Electric (GWh)				
Georgia	931	20%	804	17%
Illinois	871	26%	744	22%
Maryland	644	22%	578	19%
Michigan	551	27%	529	26%
Missouri	438	19%	358	15%
New York	2,177	27%	1,981	24%
North Carolina	749	23%	629	19%
Pennsylvania	607	23%	532	20%
Virginia	731	25%	620	21%
Natural Gas (BBtu)				
Georgia	1,525	17%	1,175	13%
Illinois	4,324	20%	3,311	16%
Maryland	1,932	20%	1,716	18%
Michigan	3,162	14%	2,440	11%
Missouri	774	23%	590	17%
New York	10,587	18%	8,019	13%
North Carolina	463	28%	362	22%
Pennsylvania	1,992	13%	1,614	11%
Virginia	1,464	18%	1,059	13%
Petroleum Fuel (BBtu)				
New York	5,258	15%	5,258	15%

to 50% of the Massachusetts values whereas the High NEBs scenario assumes values equivalent to 100% of the Massachusetts values.

When assessing the cost-effectiveness and net benefits of efficiency measures, including the non-energy benefits is equivalent to assuming higher avoided energy costs. Avoided energy supply costs (or simply, avoided costs), are energy supply costs that will be avoided by reducing consumption of electricity, natural gas, and fuel oil. Including the impacts of NEBs in the avoided costs results in an increase of 60% to 261% relative to the avoided costs assumed in the Base Case for this study — depending on the sensitivity scenario, utility service territory, and fuel. The complete set of NEB factors used in this study is presented in Appendix H. Given the magnitude of the non-energy benefits in the affordable multifamily housing sector, including these benefits, in many cases, changes

TABLE 30. SENSITIVITY FOR HIGH NON-ENERGY BENEFITS, CUMULATIVE MAXIMUM ACHIEVABLE POTENTIAL BY STATE, 2034

	High NEB Sensitivity Scenario		Base Case	
	Cumulative Savings 2034	% of Sales Forecast	Cumulative Savings 2034	% of Sales Forecast
Electric (GWh)				
Georgia	1,071	23%	804	17%
Illinois	879	26%	744	22%
Maryland	739	25%	578	19%
Michigan	649	32%	529	26%
Missouri	459	20%	358	15%
New York	2,513	31%	1,981	24%
North Carolina	852	26%	629	19%
Pennsylvania	671	25%	532	20%
Virginia	838	28%	620	21%
Natural Gas (BBtu)				
Georgia	1,562	17%	1,175	13%
Illinois	4,390	21%	3,311	16%
Maryland	1,978	21%	1,716	18%
Michigan	3,410	15%	2,440	11%
Missouri	827	24%	590	17%
New York	10,765	18%	8,019	13%
North Carolina	474	28%	362	22%
Pennsylvania	2,028	13%	1,614	11%
Virginia	1,497	19%	1,059	13%
Petroleum Fuel (BBtu)				
New York	5,271	15%	5,258	15%

whether individual measures pass or fail cost-effectiveness screening. Therefore, the impact on overall savings can be significant.

Table 29 and Table 30 show the maximum achievable potential by state and fuel for both sensitivity scenarios. For the Low NEBs sensitivity, total cumulative electric savings in 2034 for all nine states are 14% higher than in the Base Case. Natural gas savings are 29% higher. Savings for fuel oil are unchanged as no additional measures pass the cost-effectiveness screening. For the High NEBs sensitivity, total cumulative electric savings are 28% higher than in the Base Case. Natural gas savings are 33% higher. As in the Low NEBs scenario, savings for fuel oil in the High NEBs scenario are virtually unchanged from the Base Case.

For a given state, the degree to which the inclusion of non-energy benefits increases the savings potential depends on how many measures are nearly cost-effective without the inclusion of NEBs. If the level of NEBs is sufficient, these nearly cost-effective measures are pushed over the cost-effectiveness hurdle and included in the potential estimates in the sensitivity scenarios. In

TABLE 31. SENSITIVITY FOR LOW NON-ENERGY BENEFITS, MAXIMUM ACHIEVABLE POTENTIAL COSTS AND BENEFITS, ALL FUELS

	Low NEBs Sensitivity Scenario				Base Case			
State	**Costs ($Million)**	**Benefits ($Million)**	**Net Benefits ($Million)**	**Costs ($Million)**	**Costs ($Million)**	**Benefits ($Million)**	**Net Benefits ($Million)**	**BCR**
Georgia	$575	$1,799	$1,223	$405	$872	$467	2.2	2.2
Illinois	$866	$2,210	$1,344	$571	$1,098	$527	1.9	1.9
Maryland	$500	$1,632	$1,132	$391	$940	$550	2.4	2.4
Michigan	$531	$1,642	$1,111	$417	$951	$534	2.3	2.3
Missouri	$335	$845	$511	$213	$402	$190	1.9	1.9
New York	$2,764	$9,055	$6,291	$2,178	$5,293	$3,114	2.4	2.4
North Carolina	$430	$1,324	$893	$293	$625	$332	2.1	2.1
Pennsylvania	$515	$1,453	$938	$369	$773	$404	2.1	2.1
Virginia	$520	$1,461	$941	$342	$697	$354	2.0	2.0
Total	**$7,036**	**$21,421**	**$14,384**	**$5,179**	**$11,651**	**$6,472**	**2.2**	**2.2**

TABLE 32. SENSITIVITY FOR HIGH NON-ENERGY BENEFITS, MAXIMUM ACHIEVABLE POTENTIAL COSTS AND BENEFITS, ALL FUELS

	High NEB Sensitivity Scenario				Base Case			
State	**Costs ($Million)**	**Benefits ($Million)**	**Net Benefits ($Million)**	**Costs ($Million)**	**Costs ($Million)**	**Benefits ($Million)**	**Net Benefits ($Million)**	**BCR**
Georgia	$926	$2,975	$2,048	3.2	$405	$872	$467	2.2
Illinois	$915	$3,190	$2,276	3.5	$571	$1,098	$527	1.9
Maryland	$775	$2,530	$1,755	3.3	$391	$940	$550	2.4
Michigan	$860	$2,584	$1,724	3.0	$417	$951	$534	2.3
Missouri	$412	$1,305	$894	3.2	$213	$402	$190	1.9
New York	$3,883	$13,435	$9,552	3.5	$2,178	$5,293	$3,114	2.4
North Carolina	$688	$2,197	$1,508	3.2	$293	$625	$332	2.1
Pennsylvania	$708	$2,230	$1,522	3.2	$369	$773	$404	2.1
Virginia	$813	$2,392	$1,579	2.9	$342	$697	$354	2.0
Total	**$9,980**	**$32,838**	**$22,858**	**3.3**	**$5,179**	**$11,651**	**$6,472**	**2.2**

general, states with lower avoided energy costs are more significantly affected by the inclusion of NEBs as fewer measures pass cost-effectiveness in the Base Case. For the electric potential, NEBs have the most significant impact in Virginia, North Carolina, and Georgia. For the natural gas potential, NEBs have the largest impact in Virginia, Michigan, and Missouri.

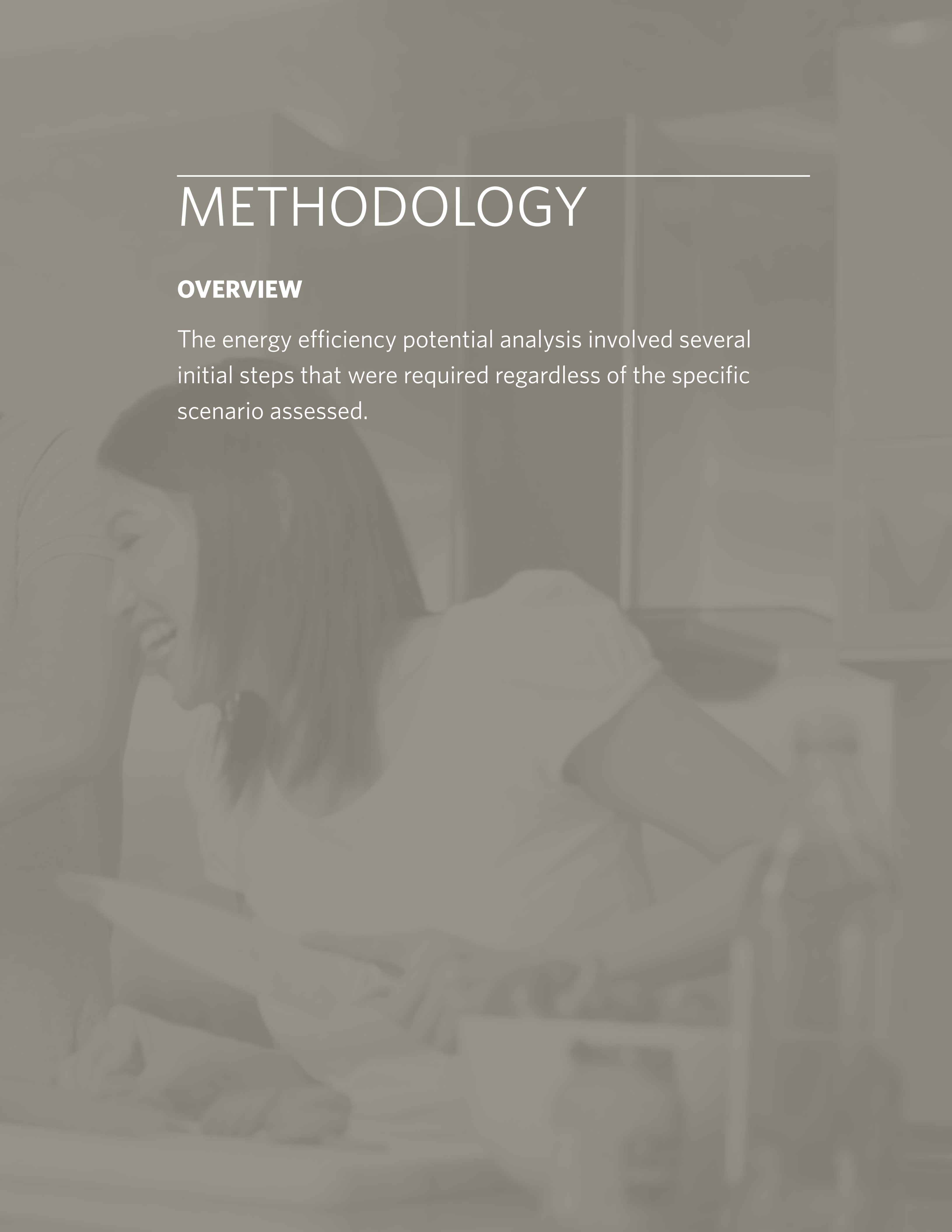
Table 31 and Table 32 show the maximum achievable potential costs and benefits by state for all fuels for both sensitivity scenarios. For the Low NEBs sensitivity, total net benefits for all states and fuels increase by 122% from $6.5 billion to $14.4 billion. The overall BCR changes from 2.2 to 3.0. For the High NEBs sensitivity, total net benefits increase by 253% from $6.5 billion to $22.9 billion and the overall BCR changes from 2.2 to 3.3.

Finally, a second sensitivity analysis was conducted to investigate the impact of the discount rate on the potential. Increasing the discount rate decreases the present value of future costs incurred and benefit streams. The maximum achievable Base Case non-energy benefits scenario was reexamined assuming a 1%, 3%, and 5% real discount rate. The results of the analyses showed that the potential estimates are fairly insensitive to such small changes in the discount rate. On average across all states, the maximum achievable electric potential drops by only 0.2 percentage points between the 3% and 5% real discount rate cases. The maximum achievable natural gas potential drops by 0.9 percentage points between the same two cases. When the discount rate is reduced to 1%, the average maximum achievable electric potential across all nine states increases by 0.1 percentage points relative to the 3% real discount rate case, and the maximum achievable natural gas potential increases by 1.6 percentage points. Because of the relative insensitivity of the model to small changes in discount rate, the detailed results of the sensitivity analysis are not presented.

Endnotes:

[10] NMR Group. 2011. Massachusetts Special and CrossSector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation

[11] The referenced Massachusetts study does not quantify all NEBs investigated. Reasons for which a given non-energy benefit was not quantified include the following: "[t]he [NEB] is too hard to quantify meaningfully, [q]uantifying the [NEB] would amount to double counting as the NEB is already accounted for, [t]here is insufficient evidence in the literature for its existence, [and] [t]he [NEB] is too intangible."



METHODOLOGY

OVERVIEW

The energy efficiency potential analysis involved several initial steps that were required regardless of the specific scenario assessed.

These steps include the following:

- Estimating the number of affordable multifamily housing units by state, electric utility service territory, building size (i.e., buildings with 5 to 49 units and buildings with 50 or more units), and subsidy type (i.e., unsubsidized affordable, subsidized affordable, and public housing authority-owned)
- Estimating baseline energy consumption for affordable multifamily housing units
- Characterizing efficiency measures, including estimated costs, savings, and lifetimes
- Identifying location-dependent parameters for each electric utility service territory, including climate, lighting hours of use, measure cost adjustment factors, and avoided energy supply costs.
- Developing, for each electric utility service territory, a comprehensive measure list representing all pertinent combinations of measures, market, building size, and all location-dependent parameters to make possible the analysis used to quantify the economic and maximum achievable potential

Developing the two potential scenarios required additional steps specific to the assumptions in each scenario. These steps include the following:

- Screening all measures for cost-effectiveness by applying the Total Resource Cost test to determine whether total lifetime benefits exceed lifetime costs. All failing measures are removed from the analysis.
- Developing penetration profiles for both the economic and maximum achievable scenarios
- Establishing incentive levels and non-incentive program costs for the maximum achievable scenario.

Optimal Energy characterized a comprehensive list of energy efficiency technologies and practices. Measures addressing each primary residential end use (e.g., space heating, cooling, and lighting) were represented. They included building envelope improvements, efficient lighting systems and controls, efficient appliances and consumer electronics, efficient heating and cooling systems and controls, and behavioral programs. Efficiency opportunities both in common areas and within individual housing units were considered.

Measure costs and savings were characterized per housing unit and then screened for cost-effectiveness. We used the Total Resource Cost (TRC) Test to estimate the costs of achieving efficiency savings and benefits that result from these measures. The TRC test includes all costs incurred by participants and program administrators, including incentives, participant share of measure costs, and program administrative costs. The benefits include the value of all electric energy and capacity, natural gas, and fuel oil savings as well as any other resource savings (e.g., water) and operation and maintenance savings.

Making appropriate adjustments for measure applicability and taking into consideration the portion of the market that has already converted to efficient equipment and practices, or is projected to in the future absent any program intervention, the total potential was estimated by applying the measure-level costs and savings to the population of affordable multifamily housing units both statewide and by electric utility service territory.

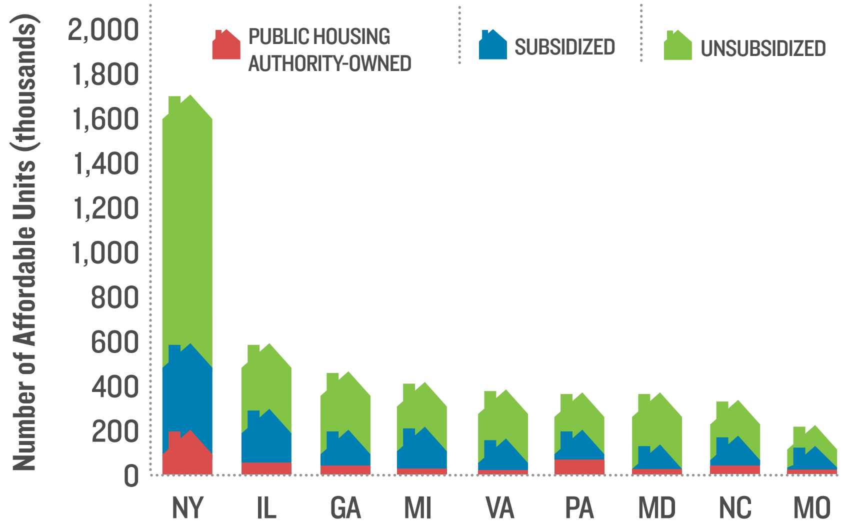
To estimate the economic and maximum achievable potentials, we used the following two approaches:

- **Economic potential scenario.** We generally assumed that all cost-effective measures (i.e., those that pass the TRC test) would be taken at the rate of turnover for market-driven measures such as for major renovation and natural replacement. For retrofit measures, as the economic potential is somewhat hypothetical, we neglect practical constraints and assume all cost-effective retrofit measures are taken immediately.
- **Maximum achievable scenario.** This scenario is based on the economic potential (in that it only includes measures that pass the TRC test) but accounts for real-world market barriers. We assumed that efficiency programs would provide incentives to cover 100% of the incremental costs of efficiency measures, so that program participants would have no out-of-pocket costs relative to standard baseline equipment. Measure penetration rates were then estimated assuming optimal program delivery, but recognizing that market barriers still remain even when measure incremental costs are fully offset by program incentives.

UNIT COUNTS

Project partners Elevate Energy and the National Housing Trust provided estimates of multifamily housing unit counts by state, electric utility service territory, building size, and subsidy type. The affordable housing market was subdivided in two ways: by the number of units in

FIGURE 4. AFFORDABLE MULTIFAMILY HOUSING UNITS BY STATE AND SUBSIDY TYPE



the building (i.e., 5-49 units and 50 or more units) and its affordability (i.e., unsubsidized affordable, subsidized, and public housing authority-owned). This allows for six possible combinations. Figure 4 presents the unit counts by state and subsidy type.

All information on subsidy type was pulled from the National Housing Preservation Database (NHPD) from the Public and Affordable Housing Research Corporation, and the National Low Income Housing Coalition. This includes any property that has received at least one subsidy of any sort, including HUD, USDA Rural, LIHTC, PHA, and FHA. The "unsubsidized affordable" units are any units in low/moderate income census tracts, designated by the New Market Tax Credits, which do not have subsidies. These amounts are calculated based on a combination of the five year estimate of total unit counts of the U.S. Census Bureau's American Community Survey 2012 and the tract-level unit counts from NHPD. In some areas, the census estimates credited fewer total units in a tract than did the NHPD subsidized unit records. In these cases, geocoded NHPD counts were used for total counts, so final unit estimates were slightly higher in some areas than the census data.

After unit counts were determined at the census tract level, they were aggregated up to electric utility territories with 2014 Platts geospatial data for any service territory with 100,000 or more residential customers. Unit counts by state, utility territory, building size, and subsidy are presented in Appendix C.

BASELINE ENERGY CONSUMPTION

For this study, we developed annual energy consumption estimates for typical affordable multifamily housing units for each energy type (i.e., electricity, natural gas, and fuel oil) and state.[12] Energy consumption in affordable multifamily residences, in contrast to other subsectors, has not been well studied. Our electric, natural gas, and fuel oil consumption estimates were primarily based on data from the U.S. Energy Information Administration's (EIA) 2009 Residential Energy Consumption Survey (RECS). RECS "microdata" at the housing-unit level, was used to get information specifically for residential buildings with five or more units in each state. Because of limited sample sizes, differentiation based on household income and building size was not possible while maintaining statistical significance. While the baseline consumption estimates used are not specific to the affordable sector, they are reasonably consistent with affordable housing energy estimates presented in Fannie Mae's 2014 *Transforming Multifamily Housing: Fannie Mae's Green Initiative and Energy Star for Multifamily* and the 2014 *New York City Local Law 84 Benchmarking Report*.

One drawback of the RECS data is that it does not include common-area consumption. Based on several other recent studies that specifically quantified common-area characteristics, we estimated that an additional 10% of space heating, cooling, and water heating end use energy is consumed in common area spaces.

Also, due to the impact of the Energy Independence and Security Act of 2007 on lighting efficiency standards, the RECS data do not adequately reflect current lighting energy consumption. To address this, we estimated lighting consumption, both within housing units and common areas, by multiplying the typical type, number, and wattage of lighting fixtures per unit by the assumed hours of use in each utility territory. Hours of use assumptions were derived from the NMR Group's 2014 *Northeast Residential Lighting Hours-of-Use Study*. Lighting fixture types, counts, and wattages were developed from the measure characterization data sources described below.

The per-housing-unit consumption estimates were then multiplied by number of units to estimate total baseline energy consumption by state and electric utility service territory. The per-unit baseline consumption estimates by state and fuel are presented in Appendix D. The baseline consumption estimates are used both to inform our measure characterizations and for reporting the potential estimates as a percentage of total load.

MEASURE CHARACTERIZATION

A key early step in the analysis was to generate the measure list and characterize measures in terms of costs, savings, useful lives, and other baseline assumptions. We collaborated with NRDC to develop a comprehensive list of measures representing all major efficiency opportunities in affordable multifamily housing. The analysis addresses all in-unit measures usually characterized in efficiency studies but, due to budget constraints, limits the assessment of consumer electronics and other devices plugged directly into outlets (small-plug loads) and behavioral measures. The assessment of small-plug loads was limited to advanced power strips and efficient set-top boxes. Behavioral measures were assessed as a single package assuming residents receive periodic feedback on energy usage and advice for improving their energy performance. The final list of measures and associated characteristics considered in the analysis is presented in Appendix E.

All measures were characterized on a per-housing-unit basis. A single set of base national-level per-unit measure characterizations for each of the two building segments (i.e., 5-49 units and 50 or more units) was developed. This approach allows the per-unit impacts and costs to be adjusted based on significant factors such as climate but still enables us to estimate total population level potential by utility territory based on the number of affordable housing units within each territory.

All in-unit measures (i.e., measures installed within individual housing units) are generally consistent across both building sizes and reflect the average number of those measures per apartment unit. To preserve the per-housing-unit approach, we allocated all central system efficiency measures at the unit level for each of the two building-size segments. As a result, a large central heating plant would be screened based on the portion of a typical heating plant allocated to a single housing unit.

This approach ensured that all measure-level data was consistent for all comparable units and could be easily applied to different territories based on unit populations.

A total of 182 measures were characterized for up to two applicable markets (i.e. the natural replacement and renovation market and the retrofit market). This is important because the costs and savings of a given measure can vary depending on the market to which it is applied. For example, a retrofit or early retirement of operating but inefficient equipment entails covering the costs of entirely new equipment and the labor to install it and dispose of the old equipment. For market-driven opportunities, installing new high efficiency equipment may entail only the incremental cost of a high efficiency piece of equipment versus a standard efficiency one, as similar labor costs would be incurred in either case. Similarly, on the savings side, retrofit measures can initially save more when performance is compared with older existing equipment, while market-driven measure savings reflect only the incremental savings over current standard efficiency purchases. For retrofit measures, we model a "baseline efficiency shift" at the time when the equipment to be retrofitted would have needed to be replaced anyway.

In general, measure characterizations include defining the following for each combination of measure, market, and, if necessary, building size:

- Savings (relative to baseline equipment)
- Cost (incremental or full installed depending on market)
- Lifetime (both baseline and high efficiency options if different)
- Operation and maintenance (O&M) impacts (relative to baseline equipment)
- Water impacts (relative to baseline equipment).

For each technology, measure savings were primarily drawn from secondary sources, such as technical reference manuals (TRMs) and existing potential studies. For more complex measures not addressed by these sources, engineering calculations were used based on the best available data about current baselines in the study states and the performance impacts of high efficiency equipment or practices. Measure costs were drawn from the sources mentioned above as well as from baseline studies, incremental cost studies, and direct pricing research. Measure lifetimes, operation and maintenance impacts (e.g., reduced replacement lamp purchases for new high efficiency fixtures), and water impacts were generally developed from technical reference manuals and potential studies.

Table 33 provides an overview of some of the state-specific sources referenced for developing measure characteristics. To the extent possible, these sources were used to develop the base national-level characterizations, including estimates of measure applicability.[13] It should be noted that no recent studies were available for Georgia and Virginia; however, since the sources were used in total to inform the national-level characterizations, these data gaps did not represent an insurmountable obstacle. Location-dependent parameters, as discussed below, were used to capture the primary differences between analysis regions. Primary sources include the recent potential studies in Massachusetts, Michigan, New York, and Pennsylvania and the Illinois Technical Reference Manual. The final list of measures, associated characteristics, and sources considered in the analysis are presented in Appendix E. See Appendix B for full citations for all referenced documents.

TABLE 33. MEASURE CHARACTERIZATION DATA SOURCES

State	Market/ Baseline Study	Potential Study	Technical Reference Manual
Study States			
Georgia			
Illinois		✓	✓
Maryland	✓		✓
Michigan	✓	✓	✓
Missouri		✓	
New York		✓	✓
North Carolina		✓	
Pennsylvania	✓	✓	✓
Virginia			
Other States/Regions			
California	✓		
Massachusetts		✓	✓
Minnesota	✓		
Pacific Northwest	✓		✓

LOCATION-DEPENDENT PARAMETERS

While the analysis was based on a single set of base national-level measure characterizations, we apply utility territory-level adjustments to account for variations in climate, equipment and labor costs, and lighting hours of use. Given the scope of the study (i.e., 56 unique utility service territories in nine states), customized analysis of each utility territory was not feasible. But, we believe that adjusting these key parameters significantly improves the accuracy of the utility-level results over those of a simpler parsing of statewide data.

To make these adjustments, we studied variations in location-dependent parameters across the nine states. The range of values for the parameters was then divided into two to four representative "bins," with the number of bins depending on the degree of variation we found for each parameter. Each utility service territory was then categorized according to these bins to facilitate the regionalized analysis. Avoided energy supply costs, which are functionally treated as location dependent parameters, are discussed in the cost-effectiveness section below. All location-dependent parameters are described in Appendix F.

Climate data for each of the states was collected and consolidated into four representative categories. These categories differ primarily by degree days and full load hours of use assumptions (i.e., the equivalent number of hours a piece of heating or cooling equipment would have to operate at maximum capacity to satisfy annual heating or cooling requirements).

The costs of efficiency measures can also vary significantly by area. For example, the costs of retrofitting a building in New York City will be quite different from those in rural Missouri. As a result, we also collected location-specific cost adjustment factors for the states and defined high-, medium-, and low-cost adjustment factors. These adjustment factors are applied to national average measure costs to estimate costs at the utility territory level.

Finally, recent studies suggest that lighting hours of use in downstate New York, essentially limited to the Consolidated Edison service territory, are considerably higher than all other areas studied. As 29% of all affordable multifamily housing units considered in this study are located in Consolidated Edison's territory, the characteristics of this region warrant special attention. So, high and low lighting hours of use assumptions are used to reflect differences in usage patterns.

COST-EFFECTIVENESS ANALYSIS

Another key step in the process was to develop a list of all measure permutations necessary to screen the measures for cost-effectiveness in each territory. For each measure, we analyzed each measure/market combination for each building size and utility service territory. This took into account differences in climate, measure costs, lighting hours of use, and avoided costs. In total, we modeled more than 13,000 distinct combinations of measures, market, building size, and utility service territory for each year of the analysis.

Cost-Effectiveness Tests

The study applied the Total Resource Cost (TRC) Test to determine measure cost-effectiveness. The TRC test considers the costs and benefits of efficiency measures from the perspective of society as a whole. The principles of this cost test are described in the *California Standard Practice Manual*.[14] Efficiency measure costs for market-driven measures represent the incremental cost between a standard baseline (non-efficient) piece of equipment or practice and the high efficiency measure. For retrofit markets, the full cost of equipment and labor was used because it is assumed that without efficiency program intervention, no action would be taken by the household or building owner. Measure benefits are primarily energy savings over the measure lifetime, but can also include other benefits, such as water and operation and maintenance savings.[15] The energy impacts may be derived from multiple fuels and end uses. For example,

TABLE 34. OVERVIEW OF THE TOTAL RESOURCE COST TEST

Monetized Benefits / Costs	Total Resource Cost (TRC)
Measure cost (incremental over baseline)	Cost
Program Administrator incentives	Transfer/Excluded*
Program Administrator non-incentive program costs	Cost
Energy & electric demand savings	Benefit
Fossil fuel increased usage	Cost
Operations & Maintenance savings	Benefit
Water savings	Benefit
Deferred replacement credit**	Benefit

* Program Administrator incentives reflect a transfer payment from utilities to customers. Because incentives represent a cost to the program administrator and a benefit to participants, they effectively cancel each other out and are therefore excluded from the calculation of TRC.

** The Deferred Replacement Credit is available for early-retirement retrofit measures, measures that obviate or delay the need for the replacement of existing equipment.

efficient lighting reduces waste heat, which in turn reduces the cooling load, but increases the heating load. All of these impacts are accounted for in the estimation of a measure's costs and benefits over its lifetime.

Table 34 provides the costs and benefits considered in the TRC test.

Avoided Energy Supply Costs

Overview

Avoided energy supply costs (or simply, avoided costs) are used to assess the value of energy savings (or increased usage). Detailed estimation of avoided costs for all nine states was outside the scope of the project, so a simplified approach was used to capture the impacts of regional variations in avoided costs. The avoided costs used in this study reflect the following limitations:

- We have not included costs for externalities, such as air quality or reduced greenhouse gas emissions.[16]
- We have not included the avoided costs of price suppression, or demand reduction induced price effects.

The above factors are included in the avoided costs of many efficiency programs and may be considered for inclusion for future efficiency programs. This study can be considered conservative in this respect.

A discrete set of avoided costs were developed that reflect the continuum of avoided costs usually found in the study states. We reviewed public data sources including regulatory filings, integrated resource plans, potential studies, and specific avoided cost studies. These sources were sufficient to develop a reasonable set of illustrative avoided costs. We then assigned these values to each individual utility territory, as appropriate. The avoided costs used in this study are presented in Appendix G.

Electricity

There are two aspects of electric efficiency savings: annual energy and coincident peak demand. The former refers to the reductions in actual energy usage, which usually account for the greatest share of electric economic benefits. However, because it is difficult to store electricity, the total reduction in the system peak demand is also an important impact. Power producers need to ensure adequate capacity to meet system peak demand, even if that peak is only reached a few hours each year. As a result, substantial economic benefits can accrue from reducing the system peak demand, even if little energy is saved during other hours. The electric benefits reported in this study reflect both electric energy savings (kWh) and peak demand reductions (kW) from efficiency measures.

Detailed electric load shapes[17] were not developed by measure, as these vary significantly by territory. Rather, we developed average avoided costs per kWh that incorporate all avoided cost energy and demand components. In order to reflect the differences between measures whose effect on peak demand varies (i.e., those that exhibit high and low peak coincidence), we further disaggregated the electric avoided costs into low coincidence and high coincidence categories. Therefore, four distinct average electric avoided costs per kWh saved were developed (i.e., low costs/low coincidence, low costs/high coincidence, high costs/low coincidence, high costs/high coincidence). Electric avoided costs were assumed to escalate at 1% annually over the study period. For reference, the U.S. Energy Information's *Annual Energy Outlook 2014* projects an annual growth rate of 0.4% for electricity prices from 2012-2040.

Natural Gas

Because of the observed variation, we developed both a high and low set of natural gas avoided costs. Natural gas avoided costs were primarily informed by potential studies, specific avoided cost studies, and so-called "citygate" prices from the U.S. Energy Information Administration. Citygate refers to a point at which a distributing gas utility receives gas from a natural gas pipeline company or transmission system. As with electricity, natural gas avoided costs were assumed to escalate at 1% annually over the study period. For reference, the U.S. Energy Information's *Annual Energy Outlook 2014* projects an annual growth rate of 1.6% for natural gas prices from 2012 to 2040.

Fuel Oil

Because the analysis of fuel oil potential was limited to New York State, the avoided energy supply costs for fuel oil were adopted from the *Energy Efficiency and Renewable Energy Potential Study of New York State Volume 4: Energy Efficiency Technical Appendices.* A single set of fuel oil avoided costs were assumed in the analysis. Cost escalation assumptions are embedded in the oil avoided cost values from the referenced study and average approximately 1% annually over the study period.

Discounting the Future Value of Money

Future costs and benefits are discounted to the present using a real discount rate of 3%. The U.S. Department of Energy recommends a real discount rate of 3% for projects related to energy conservation, renewable energy, and water conservation as of 2010, which is consistent with the Federal Energy Management Program (FEMP).[18]

ECONOMIC POTENTIAL ANALYSIS

Once all measure permutations were screened for cost-effectiveness, we applied the housing units and a number of other factors to derive the total economic potential by state and utility service territory. In addition to unit counts, the analysis applies applicability, space and water heating fuel shares, and cooling equipment saturations, and not complete factor. All of these factors serve to reduce the total number of housing units in a given utility territory to only those units where the measure of interest could be applied. These factors are described in more detail below:

- **Applicability** is the fraction of housing units for which a given measure represents a realistic option. For example, duct sealing measures are only applicable to housing units with ducted HVAC systems.
- **Space Heating Fuel Shares** are the percentages of housing units using electricity, natural gas, or fuel oil for space heating. For example, a Wi-Fi thermostat measure characterized to estimate gas savings should only be applied to the fraction of housing units using gas as their space heating fuel.
- **Water Heating Fuel Shares** are the percentages of housing units using electricity, natural gas, or fuel oil for water heating. Both space and water heating fuel shares for each study state were provided by project partner Elevate Energy.
- **Cooling Equipment Saturations** are the percentages of housing units using window/room air-conditioners or central air-conditioners. For example, central air-conditioner tune-up measures should only be applied to housing units with central AC.
- **Not Complete** is the percentage of housing units with equipment that already represents the high-efficiency option. This only applies to retrofit markets. For example, if 5% of sockets already have LED lamps, then the not complete factor for LEDs would be 5% (1.0-0.95), reflecting that only 95% of the total potential from LEDs remains.

The product of all these factors and the total housing units by service territory is the total economic potential for each measure permutation. Total measure-level savings and costs are both derived using the same approach. However, the total economic potential is less than the sum of each separate measure potential. This is because of interactions between measures and competition between measures. Interactions result from installation of multiple measures in the same facility. For example, if one insulates a building, the heating load is reduced. As a result, if one then installs a high efficiency furnace, savings from the furnace will be lower because the overall heating needs of the building have been lowered. As a result, interactions between measures should be taken into account to avoid over-estimating savings potential. Because the economic potential assumes all possible measures are adopted, in adjusting for interactions, we assume every building does all applicable measures. In some cases, measures with marginal savings may not pass the cost-effectiveness test after all interactions are accounted for.

To estimate the economic potential, we generally assumed 100% installation of retrofit and market-driven (natural replacement/renovation) measures. As the economic potential is somewhat hypothetical, we neglect

practical constraints and assume all retrofit measures can be installed immediately. For measures that are market-driven only, it is assumed that measures are implemented at the rate of turnover. Turnover is the percentage of existing equipment that will be naturally replaced each year due to failure, remodeling, or renovation. In general, turnover factors are assumed to be 1 divided by the baseline equipment measure life. For example, we assume that that 5% or 1/20th of existing equipment is replaced each year for a measure with a 20-year estimated life.

The estimated economic potential does not differentiate by subsidy type. We believe this approach is appropriate because economic potential assumes 100% measure adoption and does not need to reflect differing program strategies that might be used or penetration rates achieved. While there may be some systematic differences in variables like housing unit size or number of occupants based on subsidy type, we do not expect these to be very large and available data is not sufficient to quantify these distinctions.

MAXIMUM ACHIEVABLE POTENTIAL ANALYSIS

The achievable potential was estimated by first developing program budgets and penetration rates for application to the economic potential results. For budgets, we estimated non-incentive costs using "overhead adders" expressed as a percentage of incentive costs, based on the experience of leading programs serving the low-income residential sector. Because the study is limited to affordable housing and the focus is estimating maximum achievable potential, we assume that incentives cover 100% of measure costs.

Measure Incentives and Penetration Rates

As it is extremely unlikely that any existing program has captured the maximum achievable potential in the affordable housing market, penetrations from such programs are not particularly instructive when attempting to establish maximum achievable penetration rates. We base our assumptions for penetration rates primarily on projections made in the Electric Power Research Institute's (EPRI) *Assessment of Achievable Potential from Energy Efficiency and Demand Response Programs in the U.S. (2010—2030)* study coupled with professional judgment to reflect the nuances of the affordable multifamily housing sector. Since the EPRI study was limited to electric measures, this required extrapolating the penetrations to gas and fuel oil measures by end use. For market-driven replacements, penetration rates are multiplied by a turnover rate (i.e., the reciprocal of measure lifetimes) to estimate the eligible market in each year. The resulting penetration rates were reviewed for appropriateness by Energy Efficiency for All project partners.

Initial penetrations for replacement measures in year 2015 range from 10% to 50% and ramp up to between 60% and 75% by the final year of analysis. This large range of initial penetration values reflects differing levels of market barriers (e.g., initial costs, measure complexity). For example, initial penetrations are low for complex, capital intensive whole-building HVAC system replacements but much higher for lighting replacements where barriers and required levels of investment are typically lower. Penetrations for retrofit measures are considerably lower than the replacement penetrations as they are multiplied by the entire population of applicable housing units to estimate potential, not just the turnover rate in each year. A notable exception is that penetration rates for behavioral measures are assumed fixed at 100% for all years of the study. As behavioral programs represent well-developed initiatives, it is assumed that they could be initiated immediately. The maximum achievable penetrations are provided in Appendix I.

We modeled a single set of maximum achievable penetration rates for all three subsidy types. While clearly there are a great many differences in institutional and other barriers between these segments, it is not entirely clear how penetrations might vary. For example, while it is undoubtedly more difficult to get individual tenants in public housing to participate in a program compared with market-rate tenants, it is also possible that by working directly with public housing authorities, one could obtain a level of buy-in to a program that guarantees a much higher level of participation than would be possible without this central coordination.

For each measure, the model multiplies the incentive by the penetration rate to establish the overall incentive cost in each year. Non-incentive program budgets are then estimated relative to incentive spending, as described in the following section.

Non-Incentive Program Budgets

Non-incentive costs were set at the portfolio level. These include the costs of general administration; technical assistance; marketing; evaluation, measurement and verification and performance incentives. First, we estimated the distribution of total program costs into incentives and non-incentive costs from existing efficiency programs in other jurisdictions, including programs in Massachusetts and Rhode Island. This research suggests that non-incentive budgets are generally 20% of incentive spending. Finally, we applied this ratio to the estimated incentives at the measure level for all measures in this study to determine the non-incentive costs.

Endnotes:

[12] Because the lighting hours of use assumptions used for the Consolidated Edison service territory in New York State were significantly higher than the values used elsewhere, the total electric consumption for this service territory was estimated separately from the rest of the state.

[13] Measure applicability is the fraction of housing units for which a given measure represents a realistic option. For example, duct sealing measures are only applicable to housing units with ducted HVAC systems. This is discussed in further detail in the Economic Potential Analysis section below.

[14] California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects, July 2002; Governor's Office of Planning and Research, State of California; http://www.calmac.org/events/SPM_9_20_02.pdf

[15] For the sensitivity analyses, these benefits also include other non-energy benefits.

[16] Energy savings in affordable multifamily housing will reduce carbon emissions and contribute to state efforts to comply with section 111(d) of the Clean Air Act. The potential estimates from this study can be used with appropriate emissions factors to develop preliminary estimates of carbon pollution reduction potential.

[17] Avoided energy supply costs are typically differentiated by energy costing period (e.g., summer on-peak, summer off-peak, winter on-peak, winter off-peak). In order to calculate the benefits of a measure using these avoided costs, one needs to know how the energy savings are distributed across these energy costing periods. The load shapes provide this distribution.

APPENDICES

APPENDIX A: UTILITY-LEVEL ECONOMIC POTENTIAL

Savings

TABLE A1. GEORGIA CUMULATIVE BASE CASE ECONOMIC POTENTIAL BY UTILITY SERVICE TERRITORY, 2034

Utility	Electric (GWh)	Natural Gas (BBtu)
Georgia Power	976	1,616
All Coops	99	164
All Munis/Public Power	84	142
Savannah Electric & Power Company	38	62
Other	2	4
Total	**1,200**	**1,987**

TABLE A2. ILLINOIS CUMULATIVE BASE CASE ECONOMIC POTENTIAL BY UTILITY SERVICE TERRITORY, 2034

Utility	Electric (GWh)	Natural Gas (BBtu)
Commonwealth Edison Company	799	4,118
Ameren Services	193	978
MidAmerican Energy Company	18	102
Other	75	375
Total	**1,085**	**5,574**

TABLE A3. MARYLAND CUMULATIVE BASE CASE ECONOMIC POTENTIAL BY UTILITY SERVICE TERRITORY, 2034

Utility	Electric (GWh)	Natural Gas (BBtu)
Baltimore Gas and Electric Company	378	1,287
Potomac Electric Power Co.	313	1,080
Potomac Edison	52	182
Delmarva Power	39	133
Southern Maryland Electric Cooperative	22	72
Other	41	141
Total	**846**	**2,894**

TABLE A4. MICHIGAN CUMULATIVE BASE CASE ECONOMIC POTENTIAL BY UTILITY SERVICE TERRITORY, 2034

Utility	Electric (GWh)	Natural Gas (BBtu)
DTE Energy Company	399	2,187
Consumers Energy	259	1,415
Indiana Michigan Power	15	80
Other Investor Owned Utilities (IOUs)	7	36
Other	81	445
Total	**761**	**4163**

TABLE A5. MISSOURI CUMULATIVE BASE CASE ECONOMIC POTENTIAL BY UTILITY SERVICE TERRITORY, 2034

Utility	Electric (GWh)	Natural Gas (BBtu)
Ameren Missouri	218	400
Kansas City Power & Light	164	309
City Utilities of Springfield	35	68
Empire District	22	41
Other	91	172
Total	**530**	**990**

TABLE A6. NEW YORK CUMULATIVE BASE CASE ECONOMIC POTENTIAL BY UTILITY SERVICE TERRITORY, 2034

Utility	Electric (GWh)	Natural Gas (BBtu)	Fuel Oil (BBtu)
Con Edison of NY	2292	11,495	7,379
Niagara Mohawk	204	1,113	700
Long Island Power Authority	79	443	317
New York State Electric & Gas Corp.	66	362	220
Rochester Gas & Electric	55	298	194
Central Hudson Gas & Electric Corp.	31	182	108
Orange and Rockland Utilities	25	144	84
Other	15	86	52
Total	**2,768**	**14,123**	**9,055**

TABLE A7. NORTH CAROLINA CUMULATIVE BASE CASE ECONOMIC POTENTIAL BY UTILITY SERVICE TERRITORY, 2034

Utility	Electric (GWh)	Natural Gas (BBtu)
Duke Energy Carolinas, LLC	407	266
Carolina Power & Light	286	182
Virginia Electric and Power Company	19	12
EnergyUnited	15	9
Other	218	139
Total	**946**	**607**

TABLE A8. PENNSYLVANIA CUMULATIVE BASE CASE ECONOMIC POTENTIAL BY UTILITY SERVICE TERRITORY, 2034

Utility	Electric (GWh)	Natural Gas (BBtu)
PECO Energy Company	236	798
PPL Electric Utilities	170	624
Duquesne Light	124	375
Pennsylvania Electric Company	83	326
West Penn Power Company	75	293
Metropolitan Edison Company	50	194
Pennsylvania Power Co.	15	57
Other	21	70
Total	**774**	**2,737**

TABLE A9. VIRGINIA CUMULATIVE BASE CASE ECONOMIC POTENTIAL BY UTILITY SERVICE TERRITORY, 2034

Utility	Electric (GWh)	Natural Gas (BBtu)
Dominion	690	1,364
Appalachian Power	87	184
All Munis/Public Power	55	109
NOVEC	39	77
All Coops except NOVEC/Rappahannock	12	23
Potomac Edison (VA only)	10	21
Rappahannock Electric Cooperative	4	8
Kentucky Utilities Co. (Old Dominion/PPL)	4	8
PEPCO Delmarva (VA only)	1	2
Other	3	5
Total	**905**	**1,800**

Costs, Benefits, and Cost-Effectiveness

TABLE A10. GEORGIA BASE CASE ECONOMIC POTENTIAL COSTS AND BENEFITS BY UTILITY SERVICE TERRITORY

Utility	Costs ($Million)	Benefits ($Million)	Net Benefits ($Million)	BCR
Electric				
Georgia Power	$458	$1,137	$679	2.5
All Coops	$46	$115	$69	2.5
All Munis/Public Power	$40	$98	$59	2.5
Savannah Electric & Power Company	$18	$44	$26	2.5
Other	$1	$3	$2	2.5
Electric Total	**$563**	**$1,398**	**$835**	**2.5**
Natural Gas				
Georgia Power	$113	$329	$216	2.9
All Coops	$11	$33	$22	2.9
All Munis/Public Power	$10	$29	$19	2.9
Savannah Electric & Power Company	$4	$13	$8	2.9
Other	$0	$1	$1	2.9
Natural Gas Total	**$139**	**$405**	**$266**	**2.9**

TABLE A11. ILLINOIS BASE CASE ECONOMIC POTENTIAL COSTS AND BENEFITS BY UTILITY SERVICE TERRITORY

Utility	Costs ($Million)	Benefits ($Million)	Net Benefits ($Million)	BCR
Electric				
Commonwealth Edison Company	$411	$875	$464	2.1
Ameren Services	$99	$211	$112	2.1
MidAmerican Energy Company	$9	$20	$11	2.3
Other	$39	$82	$44	2.1
Electric Total	**$557**	**$1,188**	**$630**	**2.1**
Natural Gas				
Commonwealth Edison Company	$342	$850	$508	2.5
Ameren Services	$82	$203	$121	2.5
MidAmerican Energy Company	$7	$19	$12	2.6
Other	$31	$78	$47	2.5
Natural Gas Total	**$462**	**$1,150**	**$688**	**2.5**

TABLE A12. MARYLAND BASE CASE ECONOMIC POTENTIAL COSTS AND BENEFITS BY UTILITY SERVICE TERRITORY

Utility	Costs ($Million)	Benefits ($Million)	Net Benefits ($Million)	BCR
Electric				
Baltimore Gas and Electric Company	$213	$623	$409	2.9
Potomac Electric Power Co.	$177	$517	$340	2.9
Potomac Edison	$30	$87	$57	2.9
Delmarva Power	$20	$63	$44	3.2
Southern Maryland Electric Cooperative	$12	$36	$24	2.9
Other	$23	$67	$44	2.9
Electric Total	**$475**	**$1,392**	**$917**	**2.9**
Natural Gas				
Baltimore Gas and Electric Company	$93	$249	$156	2.7
Potomac Electric Power Co.	$78	$208	$130	2.7
Potomac Edison	$13	$35	$22	2.7
Delmarva Power	$8	$25	$17	3.0
Southern Maryland Electric Cooperative	$5	$14	$9	2.7
Other	$10	$27	$17	2.7
Natural Gas Total	**$207**	**$558**	**$350**	**2.7**

TABLE A13. MICHIGAN BASE CASE ECONOMIC POTENTIAL COSTS AND BENEFITS BY UTILITY SERVICE TERRITORY

Utility	Costs ($Million)	Benefits ($Million)	Net Benefits ($Million)	BCR
Electric				
DTE Energy Company	$233	$607	$375	2.6
Consumers Energy	$130	$391	$260	3.0
Indiana Michigan Power	$7	$22	$15	3.0
Other Investor Owned Utilities (IOUs)	$3	$10	$7	3.0
Other	$41	$123	$82	3.0
Electric Total	**$415**	**$1,153**	**$738**	**2.8**
Natural Gas				
DTE Energy Company	$196	$446	$251	2.3
Consumers Energy	$104	$285	$181	2.7
Indiana Michigan Power	$6	$16	$10	2.7
Other Investor Owned Utilities (IOUs)	$3	$7	$5	2.7
Other	$33	$90	$57	2.7
Natural Gas Total	**$341**	**$845**	**$503**	**2.5**

TABLE A14. MISSOURI BASE CASE ECONOMIC POTENTIAL COSTS AND BENEFITS BY UTILITY SERVICE TERRITORY

Utility	Costs ($Million)	Benefits ($Million)	Net Benefits ($Million)	BCR
Electric				
Ameren Missouri	$114	$266	$152	2.3
Kansas City Power & Light	$85	$200	$115	2.3
City Utilities of Springfield	$19	$44	$25	2.3
Empire District	$12	$28	$16	2.3
Other	$49	$115	$66	2.3
Electric Total	**$279**	**$653**	**$374**	**2.3**
Natural Gas				
Ameren Missouri	$28	$62	$34	2.2
Kansas City Power & Light	$21	$47	$26	2.2
City Utilities of Springfield	$4	$11	$6	2.5
Empire District	$3	$6	$4	2.5
Other	$11	$27	$16	2.5
Natural Gas Total	**$67**	**$154**	**$87**	**2.3**

TABLE A15. NEW YORK BASE CASE ECONOMIC POTENTIAL COSTS AND BENEFITS BY UTILITY SERVICE TERRITORY

Utility	Costs ($Million)	Benefits ($Million)	Net Benefits ($Million)	BCR
Electric				
Con Edison of NY	$1,381	$3,576	$2,195	2.6
Niagara Mohawk	$96	$227	$131	2.4
Long Island Power Authority	$42	$89	$47	2.1
New York State Electric & Gas Corp.	$31	$73	$42	2.4
Rochester Gas & Electric	$26	$61	$35	2.4
Central Hudson Gas & Electric Corp.	$16	$35	$19	2.1
Orange and Rockland Utilities	$13	$28	$15	2.1
Other	$8	$17	$9	2.2
Electric Total	**$1,613**	**$4,106**	**$2,493**	**2.5**
Natural Gas				
Con Edison of NY	$1,020	$2,535	$1,515	2.5
Niagara Mohawk	$81	$208	$127	2.6
Long Island Power Authority	$40	$96	$56	2.4
New York State Electric & Gas Corp.	$26	$67	$41	2.6
Rochester Gas & Electric	$22	$56	$34	2.6
Central Hudson Gas & Electric Corp.	$16	$39	$23	2.4
Orange and Rockland Utilities	$13	$31	$18	2.4
Other	$7	$16	$9	2.2
Natural Gas Total	**$1,225**	**$3,048**	**$1,823**	**2.5**
Fuel Oil				
Con Edison of NY	$1,011	$3,779	$2,768	3.7
Niagara Mohawk	$79	$357	$278	4.5
Long Island Power Authority	$44	$161	$118	3.7
New York State Electric & Gas Corp.	$25	$112	$87	4.5
Rochester Gas & Electric	$22	$99	$77	4.5
Central Hudson Gas & Electric Corp.	$15	$55	$40	3.7
Orange and Rockland Utilities	$12	$43	$32	3.7
Other	$7	$27	$20	3.7
Fuel Oil Total	**$1,214**	**$4,634**	**$3,420**	**3.8**

TABLE A16. NORTH CAROLINA BASE CASE ECONOMIC POTENTIAL COSTS AND BENEFITS BY UTILITY SERVICE TERRITORY

Utility	Costs ($Million)	Benefits ($Million)	Net Benefits ($Million)	BCR
Electric				
Duke Energy Carolinas, LLC	$200	$502	$301	2.5
Carolina Power & Light	$141	$353	$212	2.5
Virginia Electric and Power Company	$9	$24	$14	2.5
EnergyUnited	$7	$19	$11	2.5
Other	$107	$268	$161	2.5
Electric Total	**$465**	**$1,164**	**$700**	**2.5**
Natural Gas				
Duke Energy Carolinas, LLC	$17	$49	$32	2.8
Carolina Power & Light	$12	$34	$22	2.9
Virginia Electric and Power Company	$1	$2	$1	2.9
EnergyUnited	$1	$2	$1	2.9
Other	$9	$26	$17	2.9
Natural Gas Total	**$40**	**$113**	**$74**	**2.9**

TABLE A17. PENNSYLVANIA BASE CASE ECONOMIC POTENTIAL COSTS AND BENEFITS BY UTILITY SERVICE TERRITORY

Utility	Costs ($Million)	Benefits ($Million)	Net Benefits ($Million)	BCR
Electric				
PPL Electric Utilities	$93	$274	$180	2.9
PECO Energy Company	$123	$271	$148	2.2
Duquesne Light	$80	$202	$122	2.5
Pennsylvania Electric Company	$42	$97	$55	2.3
West Penn Power Company	$38	$88	$50	2.3
Metropolitan Edison Company	$25	$58	$33	2.3
Pennsylvania Power Co.	$8	$17	$10	2.3
Other	$11	$24	$13	2.2
Electric Total	**$420**	**$1,032**	**$611**	**2.5**
Natural Gas				
PECO Energy Company	$71	$178	$107	2.5
PPL Electric Utilities	$47	$127	$80	2.7
Duquesne Light	$34	$87	$53	2.6
Pennsylvania Electric Company	$24	$66	$41	2.7
West Penn Power Company	$22	$59	$37	2.7
Metropolitan Edison Company	$15	$39	$24	2.7
Pennsylvania Power Co.	$4	$12	$7	2.7
Other	$6	$16	$9	2.5
Natural Gas Total	**$223**	**$583**	**$360**	**2.6**

TABLE A18. VIRGINIA BASE CASE ECONOMIC POTENTIAL COSTS AND BENEFITS BY UTILITY SERVICE TERRITORY

Utility	Costs ($Million)	Benefits ($Million)	Net Benefits ($Million)	BCR
Electric				
Dominion	$364	$844	$480	2.3
Appalachian Power	$41	$104	$62	2.5
All Munis/Public Power	$29	$67	$38	2.3
NOVEC	$21	$48	$27	2.3
All Coops except NOVEC/Rappahannock	$6	$14	$8	2.3
Potomac Edison (VA only)	$5	$13	$7	2.3
Rappahannock Electric Cooperative	$2	$5	$3	2.3
Kentucky Utilities Co. (Old Dominion/PPL)	$2	$4	$3	2.5
PEPCO Delmarva (VA only)	$0	$1	$1	2.5
Other	$2	$4	$2	2.3
Electric Total	**$473**	**$1,104**	**$631**	**2.3**
Natural Gas				
Dominion	$100	$266	$166	2.7
Appalachian Power	$12	$33	$22	2.8
All Munis/Public Power	$8	$21	$13	2.7
NOVEC	$6	$15	$9	2.7
All Coops except NOVEC/Rappahannock	$2	$4	$3	2.7
Potomac Edison (VA only)	$2	$4	$3	2.7
Rappahannock Electric Cooperative	$1	$2	$1	2.7
Kentucky Utilities Co. (Old Dominion/PPL)	$0	$1	$1	2.8
PEPCO Delmarva (VA only)	$0	$0	$0	2.8
Other	$0	$1	$1	2.7
Natural Gas Total	**$130**	**$348**	**$218**	**2.7**

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APPENDIX C: UNIT COUNTS

The table below presents the estimates of the number of affordable multifamily housing units by state, electric utility service territory, building size, and subsidy type. Note that "PHA" denotes public housing authority-owned, "SA" denotes subsidized affordable, and "UA" unsubsidized affordable.

TABLE C1. AFFORDABLE MULTIFAMILY HOUSING UNIT COUNTS BY STATE, UTILITY, BUILDING SIZE, AND SUBSIDY TYPE

		Buildings with 5-49 units			Buildings with 50 or more units		
State	**Utility**	**PHA**	**SA**	**UA**	**PHA**	**SA**	**UA**
NY	New York State Electric & Gas Corp.	127	5,558	18,208	2,528	15,540	1,759
NY	Rochester Gas & Electric	168	2,808	12,953	2,465	16,111	2,135
NY	Orange and Rockland Utilities	0	1,006	8,565	281	6,137	926
NY	Niagara Mohawk	327	10,579	55,753	17,673	43,648	7,649
NY	Long Island Power Authority	40	1,460	11,889	8,021	21,941	11,473
NY	Con Edison of NY	0	24,417	622,874	159,059	235,970	365,290
NY	Central Hudson Gas & Electric Corp.	31	1,526	10,024	1,070	7,693	1,114
NY	Other	32	783	4,807	872	3,467	437
IL	Commonwealth Edison Company	359	10,285	230,189	34,021	139,831	32,195
IL	Ameren Services	362	8,088	41,912	17,987	34,882	4,260
IL	MidAmerican Energy Company	0	437	3,078	1,463	4,471	208
IL	Other	166	4,053	11,897	5,758	17,432	2,531
MD	Potomac Edison	93	1,309	13,557	1,487	5,802	851
MD	Potomac Electric Power Co.	91	1,532	84,253	1,742	32,250	17,957
MD	Baltimore Gas and Electric Company	274	3,610	88,739	14,143	48,036	11,117
MD	Delmarva Power	25	2,084	7,244	1,008	6,485	51
MD	Southern Maryland Electric Cooperative	0	644	2,960	124	5,768	50
MD	Other	0	433	11,389	1,036	2,448	2,594
MI	Consumers Energy	302	14,434	57,705	6,573	56,241	5,258
MI	DTE Energy Company	274	6,448	96,009	10,961	83,045	21,254
MI	Indiana Michigan Power	0	970	3,024	1,020	2,901	67
MI	Other Investor Owned Utilities (IOUs)	152	429	1,543	715	685	13
MI	Other	192	3,124	18,392	3,953	16,462	2,140
MO	Ameren Missouri	490	10,620	32,273	7,888	37,767	2,494
MO	Kansas City Power & Light	245	8,045	28,756	3,764	24,482	3,712
MO	Empire District	166	2,350	2,490	684	3,260	84
MO	City Utilities of Springfield	0	668	9,005	653	3,184	847
MO	Other	237	8,364	13,488	4,133	10,418	923
NC	Carolina Power & Light	259	13,679	43,964	10,241	34,172	1,745
NC	Virginia Electric and Power Company	0	1,305	2,016	1,566	1,987	85
NC	Duke Energy Carolinas, LLC	324	8,378	91,567	13,873	30,248	3,718
NC	EnergyUnited	0	771	479	319	3,945	0
NC	Other	404	13,552	30,842	10,242	22,683	1,332
PA	Duquesne Light	497	3,980	20,937	9,849	18,828	3,251
PA	PECO Energy Company	939	6,145	48,264	17,233	25,923	19,551
PA	Metropolitan Edison Company	151	2,525	9,110	4,055	7,664	772

		Buildings with 5-49 units			Buildings with 50 or more units		
State	**Utility**	**PHA**	**SA**	**UA**	**PHA**	**SA**	**UA**
PA	Pennsylvania Electric Company	159	4,517	15,517	6,912	12,023	1,639
PA	PPL Electric Utilities	127	5,219	32,792	13,014	21,364	5,628
PA	Pennsylvania Power Co.	34	811	1,606	1,614	3,195	24
PA	West Penn Power Company	298	3,153	13,433	5,808	11,884	2,187
PA	Other	0	444	3,147	2,688	3,176	979
GA	Georgia Power	995	10,174	216,369	31,956	110,922	14,147
GA	All Coops	361	3,037	19,914	5,351	9,361	969
GA	All Munis/Public Power	79	882	20,390	4,151	7,154	623
GA	Savannah Electric & Power Company	52	352	7,789	1,941	4,412	414
GA	Other	0	0	746	0	111	16
VA	Appalachian Power	53	2,671	19,600	2,443	10,340	942
VA	Dominion	424	6,658	156,636	14,621	87,881	29,268
VA	Kentucky Utilities Co. (Old Dominion/ PPL)	76	208	622	275	282	21
VA	NOVEC	0	82	9,072	0	3,870	3,677
VA	PEPCO Delmarva (VA only)	0	206	0	0	128	0
VA	Potomac Edison (VA only)	0	364	2,945	0	832	305
VA	Rappahannock Electric Cooperative	0	231	38	0	1,498	37
VA	All Munis/Public Power	114	976	12,982	934	7,780	652
VA	All Coops except NOVEC/Rappahannock	0	948	2,107	0	1,779	113
VA	Other	0	216	0	400	636	0

APPENDIX D: BASELINE SALES FORECAST

The table below presents the baseline sales forecast by state. As this study does not include new construction, the analysis is simplified by assuming that the baseline forecasted load over the analysis period, 2015-2034, does not vary by year.

TABLE D1. BASELINE SALES FORECAST BY STATE AND FUEL

State	Electricity (MWh)	Natural Gas (MMBtu)	Fuel Oil (MMBtu)
New York	8,146,133	60,243,452	35,266,349
Pennsylvania	2,664,354	15,437,243	-
Illinois	3,393,174	21,291,584	-
Michigan	2,062,361	22,644,168	-
Missouri	2,338,392	3,399,183	-
Virginia	2,984,800	7,963,346	-
Maryland	2,993,320	9,626,602	-
Georgia	4,644,688	9,065,535	-
North Carolina	3,266,660	1,667,049	-

APPENDIX E: MEASURE CHARACTERIZATIONS

The tables below present the measure characteristics used in the analysis. Note that the location dependent parameters affect measure-level savings. For illustrative purposes, the characteristics for a region with a "Medium" climate factor and "Low" lighting hours of use are presented below.

TABLE E1. MEASURE CHARACTERISTICS

Meas ID	Measure Name	Category	Market	Primary Fuel (E, G, O)	Secondary Fuel (E, G, O)	Building Type (S,L,B)	Number Per Apartment Unit	Number Per Apartment Source	Primary End-Use	Secondary End-Use
1	Commercial Clothes Washer (Common Area) - Elec DHW/ Elec Dryer	Appliances	REPL	E		B	0.16	Energy Center of Wisconsin 2013, p.42	Water Heating	
2	Commercial Clothes Washer (Common Area) - Elec DHW/ Gas Dryer	Appliances	REPL	E	G	B	0.16	Energy Center of Wisconsin 2013, p.42	Water Heating	Other
3	Commercial Clothes Washer (Common Area) - Gas DHW/ Elec Dryer	Appliances	REPL	G	E	B	0.16	Energy Center of Wisconsin 2013, p.42	Water Heating	Appliances
4	Commercial Clothes Washer (Common Area) - Gas DHW/ Gas Dryer	Appliances	REPL	G	E	B	0.16	Energy Center of Wisconsin 2013, p.42	Water Heating	Appliances
5	Commercial Clothes Washer (Common Area) - Oil DHW/ Elec Dryer	Appliances	REPL	O	E	B	0.16	Energy Center of Wisconsin 2013, p.42	Water Heating	Appliances
6	Commercial Clothes Washer (Common Area) - Elec DHW/ Elec Dryer	Appliances	RET	E		B	0.16	Energy Center of Wisconsin 2013, p.42	Water Heating	
7	Commercial Clothes Washer (Common Area) - Elec DHW/ Gas Dryer	Appliances	RET	E	G	B	0.16	Energy Center of Wisconsin 2013, p.42	Water Heating	Other
8	Commercial Clothes Washer (Common Area) - Gas DHW/ Elec Dryer	Appliances	RET	G	E	B	0.16	Energy Center of Wisconsin 2013, p.42	Water Heating	Appliances
9	Commercial Clothes Washer (Common Area) - Gas DHW/ Gas Dryer	Appliances	RET	G	E	B	0.16	Energy Center of Wisconsin 2013, p.42	Water Heating	Appliances
10	Commercial Clothes Washer (Common Area) - Oil DHW/ Elec Dryer	Appliances	RET	O	E	B	0.16	Energy Center of Wisconsin 2013, p.42	Water Heating	Appliances
11	Clothes Washer (In-unit) - Elec DHW/ Elec Dryer	Appliances	REPL	E		B	1.00		Water Heating	
12	Clothes Washer (In-unit) - Elec DHW/ Gas Dryer	Appliances	REPL	E	G	B	1.00		Water Heating	Other
13	Clothes Washer (In-unit) - Gas DHW/ Elec Dryer	Appliances	REPL	G	E	B	1.00		Water Heating	Appliances
14	Clothes Washer (In-unit) - Gas DHW/ Gas Dryer	Appliances	REPL	G		B	1.00		Water Heating	
15	Clothes Washer (In-unit) - Oil DHW/ Elec Dryer	Appliances	REPL	O	G	B	1.00		Water Heating	Other
16	Electric Dryer with Moisture Sensor (In-unit)	Appliances	REPL	E		B	1.00		Appliances	

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17	Gas Dryer with Moisture Sensor (In-unit)	Appliances	REPL	G		B	1.00		Other	
18	Refrigerator (ENERGY STAR)	Appliances	REPL	E		B	1.01	Cadmus 2012	Refrigerators	
19	Refrigerator (ENERGY STAR)	Appliances	RET	E		B	1.01	Cadmus 2012	Refrigerators	
20	Refrigerator (ENERGY STAR)	Appliances	RET	E		B	1.01	Cadmus 2012	Refrigerators	
21	Refrigerator (CEE Tier 3)	Appliances	REPL	E		B	1.01	Cadmus 2012	Refrigerators	
22	Refrigerator (CEE Tier 3)	Appliances	RET	E		B	1.01	Cadmus 2012	Refrigerators	
23	Refrigerator (CEE Tier 3)	Appliances	RET	E		B	1.01	Cadmus 2012	Refrigerators	
24	Freezer	Appliances	REPL	E		B	1.00		Appliances	
25	Freezer	Appliances	RET	E		B	1.00		Appliances	
26	Dishwasher	Appliances	REPL	E		B	1.00		Water Heating	
27	Dishwasher	Appliances	REPL	G	E	B	1.00		Water Heating	Appliances
28	Dishwasher	Appliances	REPL	O	E	B	1.00		Water Heating	Appliances
29	Dishwasher	Appliances	RET	E		B	1.00		Water Heating	
30	Dishwasher	Appliances	RET	G	E	B	1.00		Water Heating	Appliances
31	Dishwasher	Appliances	RET	O	E	B	1.00		Water Heating	Appliances
32	Dehumidifier	Appliances	REPL	E		B	1.00		Plug Loads/ Cons Elec/ Other	
33	Dehumidifier	Appliances	RET	E		B	1.00		Plug Loads/ Cons Elec/ Other	
34	Standard LED (In-Unit), 2015-2019 - Elec Heat/Cool	Lighting	REPL	E	E	B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	Space Heating
35	Standard LED (In-Unit), 2015-2019 - Gas Heat/Cool	Lighting	REPL	E	G	B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	Space Heating
36	Standard LED (In-Unit), 2015-2019 - Oil Heat/Cool	Lighting	REPL	E	O	B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	Space Heating
37	Standard LED (In-Unit), 2015-2019 - No Heat/Cool	Lighting	REPL	E		B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	
38	Standard LED (In-Unit), 2015-2019 - Elec Heat/No Cool	Lighting	REPL	E	E	B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	Space Heating

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39	Standard LED (In-Unit), 2015-2019 - Gas Heat/No Cool	Lighting	REPL	E	G	B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	Space Heating
40	Standard LED (In-Unit), 2015-2019 - Oil Heat/No Cool	Lighting	REPL	E	O	B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	Space Heating
41	Standard LED (In-Unit), 2015-2019 - No Heat/No Cool	Lighting	REPL	E		B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	
42	Standard LED (In-Unit), 2020-2034 - Elec Heat/Cool	Lighting	REPL	E	E	B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	Space Heating
43	Standard LED (In-Unit), 2020-2034 - Gas Heat/Cool	Lighting	REPL	E	G	B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	Space Heating
44	Standard LED (In-Unit), 2020-2034 - Oil Heat/Cool	Lighting	REPL	E	O	B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	Space Heating
45	Standard LED (In-Unit), 2020-2034 - No Heat/Cool	Lighting	REPL	E		B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	
46	Standard LED (In-Unit), 2020-2034 - Elec Heat/No Cool	Lighting	REPL	E	E	B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	Space Heating
47	Standard LED (In-Unit), 2020-2034 - Gas Heat/No Cool	Lighting	REPL	E	G	B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	Space Heating
48	Standard LED (In-Unit), 2020-2034 - Oil Heat/No Cool	Lighting	REPL	E	O	B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	Space Heating
49	Standard LED (In-Unit), 2020-2034 - No Heat/No Cool	Lighting	REPL	E		B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	

Meas ID	Measure Name	Category	Market	Primary Fuel (E, G, O)	Secondary Fuel (E, G, O)	Building Type (S,L,B)	Number Per Apartment Unit	Number Per Apartment Source	Primary End-Use	Secondary End-Use
50	Specialty Lighting (In-Unit), 2015-2019 - Elec Heat/Cool	Lighting	REPL	E	E	B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	Space Heating
51	Specialty Lighting (In-Unit), 2015-2019 - Gas Heat/Cool	Lighting	REPL	E	G	B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	Space Heating
52	Specialty Lighting (In-Unit), 2015-2019 - Oil Heat/Cool	Lighting	REPL	E	O	B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	Space Heating
53	Specialty Lighting (In-Unit), 2015-2019 - No Heat/Cool	Lighting	REPL	E		B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	
54	Specialty Lighting (In-Unit), 2015-2019 - Elec Heat/No Cool	Lighting	REPL	E	E	B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	Space Heating
55	Specialty Lighting (In-Unit), 2015-2019 - Gas Heat/No Cool	Lighting	REPL	E	G	B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	Space Heating
56	Specialty Lighting (In-Unit), 2015-2019 - Oil Heat/No Cool	Lighting	REPL	E	O	B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	Space Heating
57	Specialty Lighting (In-Unit), 2015-2019 - No Heat/No Cool	Lighting	REPL	E		B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	
58	Specialty Lighting (In-Unit), 2020-2034 - Elec Heat/ Cool	Lighting	REPL	E	E	B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	Space Heating
59	Specialty Lighting (In-Unit), 2020-2034 - Gas Heat/ Cool	Lighting	REPL	E	G	B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	Space Heating
60	Specialty Lighting (In-Unit), 2020-2034 - Oil Heat/ Cool	Lighting	REPL	E	O	B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	Space Heating

Meas ID	Measure Name	Category	Market	Primary Fuel (E, G, O)	Secondary Fuel (E, G, O)	Building Type (S,L,B)	Number Per Apartment Unit	Number Per Apartment Source	Primary End-Use	Secondary End-Use
61	Specialty Lighting (In-Unit), 2020-2034 - No Heat/ Cool	Lighting	REPL	E		B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	
62	Specialty Lighting (In-Unit), 2020-2034 - Elec Heat/ No Cool	Lighting	REPL	E	E	B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	Space Heating
63	Specialty Lighting (In-Unit), 2020-2034 - Gas Heat/ No Cool	Lighting	REPL	E	G	B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	Space Heating
64	Specialty Lighting (In-Unit), 2020-2034 - Oil Heat/No Cool	Lighting	REPL	E	O	B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	Space Heating
65	Specialty Lighting (In-Unit), 2020-2034 - No Heat/No Cool	Lighting	REPL	E		B	19	Estimated number of in-unit lamps; Cadmus 2012, Cadmus 2011, GDS 2014a, Ecotope 2013	Lighting	
66	High Efficiency Common Area Lighting, Linear Fluorescent - Elec Heat/Cool	Lighting	RET	E	E	B	2.70	GDS 2014a, Ecotope 2013	Lighting	Space Heating
67	High Efficiency Common Area Lighting, Linear Fluorescent - Gas Heat/Cool	Lighting	RET	E	G	B	2.70	GDS 2014a, Ecotope 2013	Lighting	Space Heating
68	High Efficiency Common Area Lighting, Linear Fluorescent - Oil Heat/Cool	Lighting	RET	E	O	B	2.70	GDS 2014a, Ecotope 2013	Lighting	Space Heating
69	High Efficiency Common Area Lighting, Linear Fluorescent - No Heat/Cool	Lighting	RET	E		B	2.70	GDS 2014a, Ecotope 2013	Lighting	
70	High Efficiency Common Area Lighting, Linear Fluorescent - Elec Heat/No Cool	Lighting	RET	E	E	B	2.70	GDS 2014a, Ecotope 2013	Lighting	Space Heating
71	High Efficiency Common Area Lighting, Linear Fluorescent - Gas Heat/No Cool	Lighting	RET	E	G	B	2.70	GDS 2014a, Ecotope 2013	Lighting	Space Heating
72	High Efficiency Common Area Lighting, Linear Fluorescent - Oil Heat/No Cool	Lighting	RET	E	O	B	2.70	GDS 2014a, Ecotope 2013	Lighting	Space Heating
73	High Efficiency Common Area Lighting, Linear Fluorescent - No Heat/No Cool	Lighting	RET	E		B	2.70	GDS 2014a, Ecotope 2013	Lighting	

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74	Standard LED (Common Area), 2015-2019 - Elec Heat/Cool	Lighting	REPL	E	E	B	2.70	GDS 2014a, Ecotope 2013	Lighting	Space Heating
75	Standard LED (Common Area), 2015-2019 - Gas Heat/Cool	Lighting	REPL	E	G	B	2.70	GDS 2014a, Ecotope 2013	Lighting	Space Heating
76	Standard LED (Common Area), 2015-2019 - Oil Heat/Cool	Lighting	REPL	E	O	B	2.70	GDS 2014a, Ecotope 2013	Lighting	Space Heating
77	Standard LED (Common Area), 2015-2019 - No Heat/Cool	Lighting	REPL	E		B	2.70	GDS 2014a, Ecotope 2013	Lighting	
78	Standard LED (Common Area), 2015-2019 - Elec Heat/No Cool	Lighting	REPL	E	E	B	2.70	GDS 2014a, Ecotope 2013	Lighting	Space Heating
79	Standard LED (Common Area), 2015-2019 - Gas Heat/No Cool	Lighting	REPL	E	G	B	2.70	GDS 2014a, Ecotope 2013	Lighting	Space Heating
80	Standard LED (Common Area), 2015-2019 - Oil Heat/No Cool	Lighting	REPL	E	O	B	2.70	GDS 2014a, Ecotope 2013	Lighting	Space Heating
81	Standard LED (Common Area), 2015-2019 - No Heat/No Cool	Lighting	REPL	E		B	2.70	GDS 2014a, Ecotope 2013	Lighting	
82	Standard LED (Common Area), 2020-2034 - Elec Heat/Cool	Lighting	REPL	E	E	B	2.70	GDS 2014a, Ecotope 2013	Lighting	Space Heating
83	Standard LED (Common Area), 2020-2034 - Gas Heat/Cool	Lighting	REPL	E	G	B	2.70	GDS 2014a, Ecotope 2013	Lighting	Space Heating
84	Standard LED (Common Area), 2020-2034 - Oil Heat/Cool	Lighting	REPL	E	O	B	2.70	GDS 2014a, Ecotope 2013	Lighting	Space Heating
85	Standard LED (Common Area), 2020-2034 - No Heat/Cool	Lighting	REPL	E		B	2.70	GDS 2014a, Ecotope 2013	Lighting	
86	Standard LED (Common Area), 2020-2034 - Elec Heat/No Cool	Lighting	REPL	E	E	B	2.70	GDS 2014a, Ecotope 2013	Lighting	Space Heating
87	Standard LED (Common Area), 2020-2034 - Gas Heat/No Cool	Lighting	REPL	E	G	B	2.70	GDS 2014a, Ecotope 2013	Lighting	Space Heating
88	Standard LED (Common Area), 2020-2034 - Oil Heat/No Cool	Lighting	REPL	E	O	B	2.70	GDS 2014a, Ecotope 2013	Lighting	Space Heating
89	Standard LED (Common Area), 2020-2034 - No Heat/No Cool	Lighting	REPL	E		B	2.70	GDS 2014a, Ecotope 2013	Lighting	

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90	LED Exit Sign, <50 units - Elec Heat/ Cool	Lighting	RET	E	E	S	0.26	Energy Center of Wisconsin 2013, 2.13 common area lights per unit, 12% of common area lights are exit signs	Lighting	Space Heating
91	LED Exit Sign, <50 units - Gas Heat/ Cool	Lighting	RET	E	G	S	0.26	Energy Center of Wisconsin 2013, 2.13 common area lights per unit, 12% of common area lights are exit signs	Lighting	Space Heating
92	LED Exit Sign, <50 units - Oil Heat/Cool	Lighting	RET	E	O	S	0.26	Energy Center of Wisconsin 2013, 2.13 common area lights per unit, 12% of common area lights are exit signs	Lighting	Space Heating
93	LED Exit Sign, <50 units - No Heat/Cool	Lighting	RET	E		S	0.26	Energy Center of Wisconsin 2013, 2.13 common area lights per unit, 12% of common area lights are exit signs	Lighting	
94	LED Exit Sign, <50 units - Elec Heat/ No Cool	Lighting	RET	E	E	S	0.26	Energy Center of Wisconsin 2013, 2.13 common area lights per unit, 12% of common area lights are exit signs	Lighting	Space Heating
95	LED Exit Sign, <50 units - Gas Heat/ No Cool	Lighting	RET	E	G	S	0.26	Energy Center of Wisconsin 2013, 2.13 common area lights per unit, 12% of common area lights are exit signs	Lighting	Space Heating
96	LED Exit Sign, <50 units - Oil Heat/No Cool	Lighting	RET	E	O	S	0.26	Energy Center of Wisconsin 2013, 2.13 common area lights per unit, 12% of common area lights are exit signs	Lighting	Space Heating
97	LED Exit Sign, <50 units - No Heat/No Cool	Lighting	RET	E		S	0.26	Energy Center of Wisconsin 2013, 2.13 common area lights per unit, 12% of common area lights are exit signs	Lighting	
98	LED Exit Sign, 50+ units - Elec Heat/ Cool	Lighting	RET	E	E	L	0.38	Energy Center of Wisconsin 2013, 3.2 common area lights per unit, 12% of common area lights are exit signs.	Lighting	Space Heating
99	LED Exit Sign, 50+ units - Gas Heat/ Cool	Lighting	RET	E	G	L	0.38	Energy Center of Wisconsin 2013, 3.2 common area lights per unit, 12% of common area lights are exit signs.	Lighting	Space Heating
100	LED Exit Sign, 50+ units - Oil Heat/Cool	Lighting	RET	E	O	L	0.38	Energy Center of Wisconsin 2013, 3.2 common area lights per unit, 12% of common area lights are exit signs.	Lighting	Space Heating

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101	LED Exit Sign, 50+ units - No Heat/Cool	Lighting	RET	E		L	0.38	Energy Center of Wisconsin 2013, 3.2 common area lights per unit, 12% of common area lights are exit signs.	Lighting	
102	LED Exit Sign, 50+ units - Elec Heat/ No Cool	Lighting	RET	E	E	L	0.38	Energy Center of Wisconsin 2013, 3.2 common area lights per unit, 12% of common area lights are exit signs.	Lighting	Space Heating
103	LED Exit Sign, 50+ units - Gas Heat/ No Cool	Lighting	RET	E	G	L	0.38	Energy Center of Wisconsin 2013, 3.2 common area lights per unit, 12% of common area lights are exit signs.	Lighting	Space Heating
104	LED Exit Sign, 50+ units - Oil Heat/No Cool	Lighting	RET	E	O	L	0.38	Energy Center of Wisconsin 2013, 3.2 common area lights per unit, 12% of common area lights are exit signs.	Lighting	Space Heating
105	LED Exit Sign, 50+ units - No Heat/No Cool	Lighting	RET	E		L	0.38	Energy Center of Wisconsin 2013, 3.2 common area lights per unit, 12% of common area lights are exit signs.	Lighting	
106	Outdoor Area/ Parking Lighting	Lighting	REPL	E		B	0.08	Navigant 2012, 20 parking spaces per lamp. Assumes 1.5 parking spaces per apartment unit.	Lighting	
107	Lighting Controls, Common Area	Lighting	RET	E		B	2.70	GDS 2014a, Ecotope 2013	Lighting	
108	Low Flow Showerheads - Elec DHW	Water Heating	RET	E		B	1.30	Cadmus 2011	Water Heating	
109	Low Flow Showerheads - Gas DHW	Water Heating	RET	G		B	1.30	Cadmus 2011	Water Heating	
110	Low Flow Showerheads - Oil DHW	Water Heating	RET	O		B	1.30	Cadmus 2011	Water Heating	
111	Low Flow Bathroom Faucet Aerator - Elec DHW	Water Heating	RET	E		B	1.40	GDS 2014a, assumes 2.4 faucets per multifamily unit less 1.0 faucet for kitchens.	Water Heating	
112	Low Flow Bathroom Faucet Aerator - Gas DHW	Water Heating	RET	G		B	1.40	GDS 2014a, assumes 2.4 faucets per multifamily unit less 1.0 faucet for kitchens.	Water Heating	
113	Low Flow Bathroom Faucet Aerator - Oil DHW	Water Heating	RET	O		B	1.40	GDS 2014a, assumes 2.4 faucets per multifamily unit less 1.0 faucet for kitchens.	Water Heating	

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114	Low Flow Kitchen Faucet Aerator - Elec DHW	Water Heating	RET	E		B	1.00	OEI Assumptions	Water Heating	
115	Low Flow Kitchen Faucet Aerator - Gas DHW	Water Heating	RET	G		B	1.00	OEI Assumptions	Water Heating	
116	Low Flow Kitchen Faucet Aerator - Oil DHW	Water Heating	RET	O		B	1.00	OEI Assumptions	Water Heating	
117	Heat pump water heater - In-unit	Water Heating	REPL	E		B			Water Heating	
118	Pipe Wrap - In-unit water heating	Water Heating	RET	G		B			Water Heating	
119	Pipe Wrap - In-unit water heating	Water Heating	RET	E		B			Water Heating	
120	Pipe Wrap - In-unit water heating	Water Heating	RET	O		B			Water Heating	
121	Water Heater Tank Wrap - In-unit water heating	Water Heating	RET	E		B			Water Heating	
122	Water Heater Tank Wrap - In-unit water heating	Water Heating	RET	G		B			Water Heating	
123	Water Heater Tank Wrap - In-unit water heating	Water Heating	RET	O		B			Water Heating	
124	High Efficiency Gas Water Heater - In-unit	Water Heating	REPL	G		B	1.00		Water Heating	
125	High Efficiency Electric Water Heater - In-unit	Water Heating	REPL	E		B	1.00		Water Heating	
126	High Efficiency Oil Water Heater - In-unit	Water Heating	REPL	O		B	1.00		Water Heating	
127	Air Sealing - Electric Heat	Envelope	RET	E		B			Heating/ Cooling	
128	Air Sealing - Gas Heat	Envelope	RET	G	E	B			Space Heating	Cooling
129	Air Sealing - Oil Heat	Envelope	RET	O	E	B			Space Heating	Cooling
130	Wall Insulation - Electric Heat	Envelope	RET	E		B			Heating/ Cooling	
131	Wall Insulation - Gas Heat	Envelope	RET	G	E	B			Space Heating	Cooling
132	Wall Insulation - Oil Heat	Envelope	RET	O	E	B			Space Heating	Cooling
133	Duct Sealing/ Insulation - Electric Heat	Envelope	RET	E		B			Heating/ Cooling	
134	Duct Sealing/ Insulation - Gas Heat	Envelope	RET	G	E	B			Space Heating	Cooling
135	Duct Sealing/ Insulation - Oil Heat	Envelope	RET	O	E	B			Space Heating	Cooling
136	Basement Wall Insulation - Electric Heat	Envelope	RET	E		B			Heating/ Cooling	
137	Basement Wall Insulation - Gas Heat	Envelope	RET	G	E	B			Space Heating	Cooling
138	Basement Wall Insulation - Oil Heat	Envelope	RET	O	E	B			Space Heating	Cooling
139	Efficient Windows - Electric Heat	Envelope	REPL	E	E	B			Space Heating	Cooling
140	Efficient Windows - Gas Heat	Envelope	REPL	G	E	B			Space Heating	Cooling
141	Efficient Windows - Oil Heat	Envelope	REPL	O	E	B			Space Heating	Cooling

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142	Window Film - Gas Heat	Envelope	RET	E	G	B			Cooling	Space Heating
143	Window Film - Oil Heat	Envelope	RET	E	O	B			Cooling	Space Heating
144	Cool Roofs - Gas Heat	Envelope	RET	E	G	B			Cooling	Space Heating
145	Cool Roofs - Oil Heat	Envelope	RET	E	O	B			Cooling	Space Heating
146	Behavior Program: Home Energy Reports - Electric Heat	Behavior	REPL	E	E	B			Whole Building	Space Heating
147	Behavior Program: Home Energy Reports - Gas Heat	Behavior	REPL	E	G	B			Whole Building	Space Heating
148	Behavior Program: Home Energy Reports - Oil Heat	Behavior	REPL	E	O	B			Whole Building	Space Heating
149	Retrocommissioning (HVAC Controls)	HVAC	RET	E		B			Whole Building	Space Heating
150	Retrocommissioning (HVAC Controls)	HVAC	RET	G		B			Whole Building	Space Heating
151	Retrocommissioning (HVAC Controls)	HVAC	RET	O		B			Whole Building	Space Heating
152	Advanced Power Strip	Plug Loads	REPL	E		B	2.00		Plug Loads/ Cons Elec/ Other	
153	High-efficiency Set-Top Cable Box/DVR	Consumer Electronics	REPL	E		B	2.23		Plug Loads/ Cons Elec/ Other	
154	High-efficiency Set-Top Satellite Box	Consumer Electronics	REPL	E		B	1.56		Plug Loads/ Cons Elec/ Other	
155	Central AC Tune-Up	HVAC	RET	E		B			Cooling	
156	Central HP Tune-Up	HVAC	RET	E	E	B			Heating/ Cooling	
157	Efficient Room AC	HVAC	RET	E		B			Cooling	
158	Efficient Room AC	HVAC	REPL	E		B			Cooling	
159	Efficient In-Unit Central AC	HVAC	REPL	E		B			Cooling	
160	Efficient In-Unit Central HP (Air-Source)	HVAC	REPL	E		B			Heating/ Cooling	
161	Proper Central AC Sizing	HVAC	REPL	E		B			Cooling	
162	Proper Central HP Sizing	HVAC	REPL	E		B			Cooling	
163	Efficient Central Boiler	HVAC	REPL	G		S			Space Heating	
164	Efficient Central Boiler	HVAC	REPL	G		L			Space Heating	
165	Efficient Central Boiler	HVAC	REPL	O		S			Space Heating	
166	Efficient Central Boiler	HVAC	REPL	O		L			Space Heating	
167	Efficient In-Unit Furnace	HVAC	REPL	G		B			Space Heating	
168	Efficient Central Furnace	HVAC	REPL	G		B			Space Heating	
169	Programmable Thermostat	HVAC	RET	G		B			Space Heating	
170	Programmable Thermostat	HVAC	RET	O		B			Space Heating	
171	Programmable Thermostat	HVAC	RET	E		B			Space Heating	
172	Boiler Economizer	HVAC	RET	G		B			Space Heating	

Meas ID	Measure Name	Category	Market	Primary Fuel (E, G, O)	Secondary Fuel (E, G, O)	Building Type (S,L,B)	Number Per Apartment Unit	Number Per Apartment Source	Primary End-Use	Secondary End-Use
173	Boiler Economizer	HVAC	RET	O		B			Space Heating	
174	Wi-Fi Thermostat, no cooling	HVAC	RET	G		B			Space Heating	
175	Wi-Fi Thermostat, no cooling	HVAC	RET	O		B			Space Heating	
176	Wi-Fi Thermostat, no cooling	HVAC	RET	E		B			Space Heating	
177	Wi-Fi Thermostat, with cooling	HVAC	RET	G	E	B			Space Heating	Cooling
178	Wi-Fi Thermostat, with cooling	HVAC	RET	O	E	B			Space Heating	Cooling
179	Wi-Fi Thermostat, with cooling	HVAC	RET	E		B			Heating/ Cooling	
180	Efficient Furnace Fans	HVAC	REPL	E	G	B			Plug Loads/ Cons Elec/ Other	Space Heating
181	Efficient Furnace Fans	HVAC	REPL	E	O	B			Plug Loads/ Cons Elec/ Other	Space Heating
182	Boiler Pipe Insulation	HVAC	RET	G		B			Space Heating	

Meas ID	Efficient Equipment Description	Baseline Equipment Description	Energy Savings (kWh)	Peak Coinc. Factor (H, A)	End-Use Fuel Savings (MMBtu)	Water Savings (gal)
1	ENERGY STAR (v6.1) qualified commercial clothes washer in multifamily with MEF >= 2.2 and a WF <=4.5.	Standard commercial clothes washer meeting current (as of 1/8/2013) federal standards. "Energy conservation standards and their effective dates." 10 CFR 431.156. Assumes modified energy factor (MEF) of 2.00 and a water factor (WF) of 5.5.	95	A	0	2516
2	ENERGY STAR (v6.1) qualified commercial clothes washer in multifamily with MEF >= 2.2 and a WF <=4.5.	Standard commercial clothes washer meeting current (as of 1/8/2013) federal standards. "Energy conservation standards and their effective dates." 10 CFR 431.156. Assumes modified energy factor (MEF) of 2.00 and a water factor (WF) of 5.5.	73	A	0.08	2516
3	ENERGY STAR (v6.1) qualified commercial clothes washer in multifamily with MEF >= 2.2 and a WF <=4.5.	Standard commercial clothes washer meeting current (as of 1/8/2013) federal standards. "Energy conservation standards and their effective dates." 10 CFR 431.156. Assumes modified energy factor (MEF) of 2.00 and a water factor (WF) of 5.5.	37	A	0.27	2516
4	ENERGY STAR (v6.1) qualified commercial clothes washer in multifamily with MEF >= 2.2 and a WF <=4.5.	Standard commercial clothes washer meeting current (as of 1/8/2013) federal standards. "Energy conservation standards and their effective dates." 10 CFR 431.156. Assumes modified energy factor (MEF) of 2.00 and a water factor (WF) of 5.5.	15	A	0.34	2516
5	ENERGY STAR (v6.1) qualified commercial clothes washer in multifamily with MEF >= 2.2 and a WF <=4.5.	Standard commercial clothes washer meeting current (as of 1/8/2013) federal standards. "Energy conservation standards and their effective dates." 10 CFR 431.156. Assumes modified energy factor (MEF) of 2.00 and a water factor (WF) of 5.5.	37	A	0.27	2516
6	ENERGY STAR (v6.1) qualified commercial clothes washer in multifamily with MEF >= 2.2 and a WF <=4.5.	Existing commercial clothes washer meeting previous (1/1/2007 to 1/8/2013) federal standards. "Energy conservation standards and their effective dates." 10 CFR 431.156. Assumes modified energy factor (MEF) of 1.26 and a water factor (WF) of 9.5.	190	A	0.00	2796
7	ENERGY STAR (v6.1) qualified commercial clothes washer in multifamily with MEF >= 2.2 and a WF <=4.5.	Existing commercial clothes washer meeting previous (1/1/2007 to 1/8/2013) federal standards. "Energy conservation standards and their effective dates." 10 CFR 431.156. Assumes modified energy factor (MEF) of 1.26 and a water factor (WF) of 9.5.	106	A	0.28	2796
8	ENERGY STAR (v6.1) qualified commercial clothes washer in multifamily with MEF >= 2.2 and a WF <=4.5.	Existing commercial clothes washer meeting previous (1/1/2007 to 1/8/2013) federal standards. "Energy conservation standards and their effective dates." 10 CFR 431.156. Assumes modified energy factor (MEF) of 1.26 and a water factor (WF) of 9.5.	104	A	0.39	2796
9	ENERGY STAR (v6.1) qualified commercial clothes washer in multifamily with MEF >= 2.2 and a WF <=4.5.	Existing commercial clothes washer meeting previous (1/1/2007 to 1/8/2013) federal standards. "Energy conservation standards and their effective dates." 10 CFR 431.156. Assumes modified energy factor (MEF) of 1.26 and a water factor (WF) of 9.5.	21	A	0.67	2796
10	ENERGY STAR (v6.1) qualified commercial clothes washer in multifamily with MEF >= 2.2 and a WF <=4.5.	Existing commercial clothes washer meeting previous (1/1/2007 to 1/8/2013) federal standards. "Energy conservation standards and their effective dates." 10 CFR 431.156. Assumes modified energy factor (MEF) of 1.26 and a water factor (WF) of 9.5.	104	A	0.39	2796
11	ENERGY STAR (v6.1) qualified clothes washer with an MEF >= 2.2 and a WF <=6.0.	Standard clothes washer meeting current (as of 1/1/2007) federal standards. "Energy and water conservation standards and their compliance dates" 10 CFR 430.32(g). Assumes modified energy factor (MEF) of 1.26 and a water factor (WF) of 9.5.	284	A	0.00	3385

Meas ID	Efficient Equipment Description	Baseline Equipment Description	Energy Savings (kWh)	Peak Coinc. Factor (H, A)	End-Use Fuel Savings (MMBtu)	Water Savings (gal)
12	ENERGY STAR (v6.1) qualified clothes washer with an MEF >= 2.2 and a WF <=6.0.	Standard clothes washer meeting current (as of 1/1/2007) federal standards. "Energy and water conservation standards and their compliance dates" 10 CFR 430.32(g). Assumes modified energy factor (MEF) of 1.26 and a water factor (WF) of 9.5.	184	A	0.34	3385
13	ENERGY STAR (v6.1) qualified clothes washer with an MEF >= 2.2 and a WF <=6.0.	Standard clothes washer meeting current (as of 1/1/2007) federal standards. "Energy and water conservation standards and their compliance dates" 10 CFR 430.32(g). Assumes modified energy factor (MEF) of 1.26 and a water factor (WF) of 9.5.	137	A	0.67	3385
14	ENERGY STAR (v6.1) qualified clothes washer with an MEF >= 2.2 and a WF <=6.0.	Standard clothes washer meeting current (as of 1/1/2007) federal standards. "Energy and water conservation standards and their compliance dates" 10 CFR 430.32(g). Assumes modified energy factor (MEF) of 1.26 and a water factor (WF) of 9.5.	37	A	1.01	3385
15	ENERGY STAR (v6.1) qualified clothes washer with an MEF >= 2.2 and a WF <=6.0.	Standard clothes washer meeting current (as of 1/1/2007) federal standards. "Energy and water conservation standards and their compliance dates" 10 CFR 430.32(g). Assumes modified energy factor (MEF) of 1.26 and a water factor (WF) of 9.5.	137	A	0.67	3385
16	ENERGY STAR (v1.0) qualified electric clothes dryer with moisture sensor installed in a multifamily unit.	Standard electric clothes dryer	77	A	0.00	
17	ENERGY STAR (v1.0) qualified gas clothes dryer with moisture sensor installed in a multifamily unit.	Standard gas clothes dryer		A	0.26	
18	ENERGY STAR (v5.0) refrigerator with top-mounted freezer with automatic defrost and without automatic icemaker with Adjusted Volume (AV) of 17.5 CF.	Standard refrigerator meeting current (as of 9/14/2014) federal standards. "Energy and water conservation standards and their compliance dates" 10 CFR 430.32(a). Assumes top-mounted freezer with automatic defrost and without automatic icemaker with Adjusted Volume (AV) of 17.5 CF.	38	A	0.00	
19	ENERGY STAR (v5.0) refrigerator with top-mounted freezer with automatic defrost and without automatic icemaker with Adjusted Volume (AV) of 17.5 CF.	Existing refrigerator meeting previous (7/1/2001 to 9/15/2014) federal standards. "Energy and water conservation standards and their compliance dates" 10 CFR 430.32(a). Assumes top-mounted freezer with automatic defrost and without automatic icemaker with Adjusted Volume (AV) of 17.5 CF.	111	A	0.00	
20	ENERGY STAR (v5.0) refrigerator with top-mounted freezer with automatic defrost and without automatic icemaker with Adjusted Volume (AV) of 17.5 CF.	Existing refrigerator meeting previous (Pre-7/1/2001) federal standards. Assumes top-mounted freezer with automatic defrost and without automatic icemaker with Adjusted Volume (AV) of 17.5 CF.	255	A	0.00	
21	CEE Tier 3 refrigerator with top-mounted freezer with automatic defrost and without automatic icemaker with Adjusted Volume (AV) of 17.5 CF.	Standard refrigerator meeting current (as of 9/14/2014) federal standards. "Energy and water conservation standards and their compliance dates" 10 CFR 430.32(a). Assumes top-mounted freezer with automatic defrost and without automatic icemaker with Adjusted Volume (AV) of 17.5 CF.	76	A	0.00	
22	CEE Tier 3 refrigerator with top-mounted freezer with automatic defrost and without automatic icemaker with Adjusted Volume (AV) of 17.5 CF.	Existing refrigerator meeting previous (7/1/2001 to 9/15/2014) federal standards. "Energy and water conservation standards and their compliance dates" 10 CFR 430.32(a). Assumes top-mounted freezer with automatic defrost and without automatic icemaker with Adjusted Volume (AV) of 17.5 CF.	149	A	0.00	
23	CEE Tier 3 refrigerator with top-mounted freezer with automatic defrost and without automatic icemaker with Adjusted Volume (AV) of 17.5 CF.	Existing refrigerator meeting previous (Pre-7/1/2001) federal standards. Assumes top-mounted freezer with automatic defrost and without automatic icemaker with Adjusted Volume (AV) of 17.5 CF.	293	A	0.00	

Meas ID	Efficient Equipment Description	Baseline Equipment Description	Energy Savings (kWh)	Peak Coinc. Factor (H, A)	End-Use Fuel Savings (MMBtu)	Water Savings (gal)
24	ENERGY STAR (v5.0) compact upright freezer with manual defrost, Adjusted Volume (AV) of 5.2 CF.	Standard freezer meeting current (as of 9/14/2014) federal standards. "Energy and water conservation standards and their compliance dates" 10 CFR 430.32(a). Assumes compact upright freezer with manual defrost with Adjusted Volume (AV) of 5.2 CF.	27	A	0.00	
25	ENERGY STAR (v5.0) compact upright freezer with manual defrost, Adjusted Volume (AV) of 5.2 CF.	Existing freezer meeting previous (7/1/2001 to 9/15/2014) federal standards. "Energy and water conservation standards and their compliance dates" 10 CFR 430.32(a). Assumes compact upright freezer with manual defrost with Adjusted Volume (AV) of 5.2 CF.	58	A	0.00	
26	ENERGY STAR dishwasher (v5.2) with maximum 245 kWh/year and maximum 2.5 gallons/cycle	Standard dishwasher meeting current (as of 5/21/2013) federal standards. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(f)(2). Assumes 307 kWh/year and 5 gallons/cycle.	60	A	0.00	520
27	ENERGY STAR dishwasher (v5.2) with maximum 245 kWh/year and maximum 2.5 gallons/cycle	Standard dishwasher meeting current (as of 5/21/2013) federal standards. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(f)(2). Assumes 307 kWh/year and 5 gallons/cycle.	26	A	0.15	520
28	ENERGY STAR dishwasher (v5.2) with maximum 245 kWh/year and maximum 2.5 gallons/cycle	Standard dishwasher meeting current (as of 5/21/2013) federal standards. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(f)(2). Assumes 307 kWh/year and 5 gallons/cycle.	26	A	0.15	520
29	ENERGY STAR dishwasher (v5.2) with maximum 245 kWh/year and maximum 2.5 gallons/cycle	Existing dishwasher meeting previous (5/14/1994 to 1/1/2010) federal standards. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(f)(2). Assumes energy factor (EF) or cycles/kWh of 0.46.	200	A	0.00	520
30	ENERGY STAR dishwasher (v5.2) with maximum 245 kWh/year and maximum 2.5 gallons/cycle	Existing dishwasher meeting previous (5/14/1994 to 1/1/2010) federal standards. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(f)(2). Assumes energy factor (EF) or cycles/kWh of 0.46.	88	A	0.51	520
31	ENERGY STAR dishwasher (v5.2) with maximum 245 kWh/year and maximum 2.5 gallons/cycle	Existing dishwasher meeting previous (5/14/1994 to 1/1/2010) federal standards. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(f)(2). Assumes energy factor (EF) or cycles/kWh of 0.46.	88	A	0.52	520
32	ENERGY STAR dehumidifier (v3.0) with capacity >35 and <=45 pints/day at 1.85 L/kWh	Standard dehumidifier meeting current (as of 10/1/2012) federal standards. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(v). Assumes unit with capacity >35 and <=45 pints/day at 1.5 L/kWh	161	A	0.00	0
33	ENERGY STAR dehumidifier (v3.0) with capacity >35 and <=45 pints/day at 1.85 L/kWh	Existing dehumidifier meeting previous (10/1/2007 to 10/1/2012) federal standards. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(v). Assumes unit with capacity >35 and <=45 pints/day at 1.3 L/kWh	292	A	0.00	0
34	ENERGY STAR LED general service lamp (v1.1); assumes 15.6W per lamp.	Standard general service halogen incandescent lamp meeting current (as of 1/1/2014) federal standards. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(x)(1). Assumes 41W.	286	A		
35	ENERGY STAR LED general service lamp (v1.1); assumes 15.6W per lamp.	Standard general service halogen incandescent lamp meeting current (as of 1/1/2014) federal standards. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(x)(1). Assumes 41W.	526	A	-1.09	

Meas ID	Efficient Equipment Description	Baseline Equipment Description	Energy Savings (kWh)	Peak Coinc. Factor (H, A)	End-Use Fuel Savings (MMBtu)	Water Savings (gal)
36	ENERGY STAR LED general service lamp (v1.1); assumes 15.6W per lamp.	Standard general service halogen incandescent lamp meeting current (as of 1/1/2014) federal standards. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(x)(1). Assumes 41W.	526	A	-1.09	
37	ENERGY STAR LED general service lamp (v1.1); assumes 15.6W per lamp.	Standard general service halogen incandescent lamp meeting current (as of 1/1/2014) federal standards. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(x)(1). Assumes 41W.	526	A		
38	ENERGY STAR LED general service lamp (v1.1); assumes 15.6W per lamp.	Standard general service halogen incandescent lamp meeting current (as of 1/1/2014) federal standards. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(x)(1). Assumes 41W.	271	A		
39	ENERGY STAR LED general service lamp (v1.1); assumes 15.6W per lamp.	Standard general service halogen incandescent lamp meeting current (as of 1/1/2014) federal standards. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(x)(1). Assumes 41W.	510	A	-1.09	
40	ENERGY STAR LED general service lamp (v1.1); assumes 15.6W per lamp.	Standard general service halogen incandescent lamp meeting current (as of 1/1/2014) federal standards. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(x)(1). Assumes 41W.	510	A	-1.09	
41	ENERGY STAR LED general service lamp (v1.1); assumes 15.6W per lamp.	Standard general service halogen incandescent lamp meeting current (as of 1/1/2014) federal standards. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(x)(1). Assumes 41W.	510	A		
42	Post-2020 LED general service lamp; assumes 9.4W per lamp.	Standard general service lamp meeting minimum "backstop requirement" of the Energy Independence and Security Act of 2007, Sec. 321 (a)(3).	143	A		
43	Post-2020 LED general service lamp; assumes 9.4W per lamp.	Standard general service lamp meeting minimum "backstop requirement" of the Energy Independence and Security Act of 2007, Sec. 321 (a)(3).	262	A	-0.54	
44	Post-2020 LED general service lamp; assumes 9.4W per lamp.	Standard general service lamp meeting minimum "backstop requirement" of the Energy Independence and Security Act of 2007, Sec. 321 (a)(3).	262	A	-0.54	
45	Post-2020 LED general service lamp; assumes 9.4W per lamp.	Standard general service lamp meeting minimum "backstop requirement" of the Energy Independence and Security Act of 2007, Sec. 321 (a)(3).	262	A		
46	Post-2020 LED general service lamp; assumes 9.4W per lamp.	Standard general service lamp meeting minimum "backstop requirement" of the Energy Independence and Security Act of 2007, Sec. 321 (a)(3).	135	A		
47	Post-2020 LED general service lamp; assumes 9.4W per lamp.	Standard general service lamp meeting minimum "backstop requirement" of the Energy Independence and Security Act of 2007, Sec. 321 (a)(3).	254	A	-0.54	
48	Post-2020 LED general service lamp; assumes 9.4W per lamp.	Standard general service lamp meeting minimum "backstop requirement" of the Energy Independence and Security Act of 2007, Sec. 321 (a)(3).	254	A	-0.54	
49	Post-2020 LED general service lamp; assumes 9.4W per lamp.	Standard general service lamp meeting minimum "backstop requirement" of the Energy Independence and Security Act of 2007, Sec. 321 (a)(3).	254	A		
50	ENERGY STAR CFL specialty lamp (v1.1) (e.g., candelabra, 3-way, globe); assumes 15W per lamp.	Assumes 60W standard incandescent specialty lamp	508	A		
51	ENERGY STAR CFL specialty lamp (v1.1) (e.g., candelabra, 3-way, globe); assumes 15W per lamp.	Assumes 60W standard incandescent specialty lamp	933	A	-1.93	

Meas ID	Efficient Equipment Description	Baseline Equipment Description	Energy Savings (kWh)	Peak Coinc. Factor (H, A)	End-Use Fuel Savings (MMBtu)	Water Savings (gal)
52	ENERGY STAR CFL specialty lamp (v1.1) (e.g., candelabra, 3-way, globe); assumes 15W per lamp.	Assumes 60W standard incandescent specialty lamp	933	A	-1.93	
53	ENERGY STAR CFL specialty lamp (v1.1) (e.g., candelabra, 3-way, globe); assumes 15W per lamp.	Assumes 60W standard incandescent specialty lamp	933	A		
54	ENERGY STAR CFL specialty lamp (v1.1) (e.g., candelabra, 3-way, globe); assumes 15W per lamp.	Assumes 60W standard incandescent specialty lamp	480	A		
55	ENERGY STAR CFL specialty lamp (v1.1) (e.g., candelabra, 3-way, globe); assumes 15W per lamp.	Assumes 60W standard incandescent specialty lamp	905	A	-1.93	
56	ENERGY STAR CFL specialty lamp (v1.1) (e.g., candelabra, 3-way, globe); assumes 15W per lamp.	Assumes 60W standard incandescent specialty lamp	905	A	-1.93	
57	ENERGY STAR CFL specialty lamp (v1.1) (e.g., candelabra, 3-way, globe); assumes 15W per lamp.	Assumes 60W standard incandescent specialty lamp	905	A		
58	Assumes 6.7W LED specialty lamp.	Standard specialty lamp meeting minimum "backstop requirement" of the Energy Independence and Security Act of 2007, Sec. 321 (a)(3). Assumes 15W CFL specialty lamp.	94	A		
59	Assumes 6.7W LED specialty lamp.	Standard specialty lamp meeting minimum "backstop requirement" of the Energy Independence and Security Act of 2007, Sec. 321 (a)(3). Assumes 15W CFL specialty lamp.	173	A	-0.36	
60	Assumes 6.7W LED specialty lamp.	Standard specialty lamp meeting minimum "backstop requirement" of the Energy Independence and Security Act of 2007, Sec. 321 (a)(3). Assumes 15W CFL specialty lamp.	173	A	-0.36	
61	Assumes 6.7W LED specialty lamp.	Standard specialty lamp meeting minimum "backstop requirement" of the Energy Independence and Security Act of 2007, Sec. 321 (a)(3). Assumes 15W CFL specialty lamp.	173	A		
62	Assumes 6.7W LED specialty lamp.	Standard specialty lamp meeting minimum "backstop requirement" of the Energy Independence and Security Act of 2007, Sec. 321 (a)(3). Assumes 15W CFL specialty lamp.	89	A		
63	Assumes 6.7W LED specialty lamp.	Standard specialty lamp meeting minimum "backstop requirement" of the Energy Independence and Security Act of 2007, Sec. 321 (a)(3). Assumes 15W CFL specialty lamp.	168	A	-0.36	
64	Assumes 6.7W LED specialty lamp.	Standard specialty lamp meeting minimum "backstop requirement" of the Energy Independence and Security Act of 2007, Sec. 321 (a)(3). Assumes 15W CFL specialty lamp.	168	A	-0.36	
65	Assumes 6.7W LED specialty lamp.	Standard specialty lamp meeting minimum "backstop requirement" of the Energy Independence and Security Act of 2007, Sec. 321 (a)(3). Assumes 15W CFL specialty lamp.	168	A		
66	Retrofit of standard T8 fixture with high-performance T8 fixture in common area.	Standard T8 fixture; assume 2-lamp F32T8 fixture with electronic ballast (59 watts)	43	A		
67	Retrofit of standard T8 fixture with high-performance T8 fixture in common area.	Standard T8 fixture; assume 2-lamp F32T8 fixture with electronic ballast (59 watts)	79	A	-0.16	
68	Retrofit of standard T8 fixture with high-performance T8 fixture in common area.	Standard T8 fixture; assume 2-lamp F32T8 fixture with electronic ballast (59 watts)	79	A	-0.16	
69	Retrofit of standard T8 fixture with high-performance T8 fixture in common area.	Standard T8 fixture; assume 2-lamp F32T8 fixture with electronic ballast (59 watts)	79	A		
70	Retrofit of standard T8 fixture with high-performance T8 fixture in common area.	Standard T8 fixture; assume 2-lamp F32T8 fixture with electronic ballast (59 watts)	40	A		

Meas ID	Efficient Equipment Description	Baseline Equipment Description	Energy Savings (kWh)	Peak Coinc. Factor (H, A)	End-Use Fuel Savings (MMBtu)	Water Savings (gal)
71	Retrofit of standard T8 fixture with high-performance T8 fixture in common area.	Standard T8 fixture; assume 2-lamp F32T8 fixture with electronic ballast (59 watts)	76	A	-0.16	
72	Retrofit of standard T8 fixture with high-performance T8 fixture in common area.	Standard T8 fixture; assume 2-lamp F32T8 fixture with electronic ballast (59 watts)	76	A	-0.16	
73	Retrofit of standard T8 fixture with high-performance T8 fixture in common area.	Standard T8 fixture; assume 2-lamp F32T8 fixture with electronic ballast (59 watts)	76	A		
74	ENERGY STAR LED general service lamp (v1.1); assumes 15.6W per lamp.	Represents mix of standard general service halogen incandescent lamp meeting current (as of 1/1/2014) federal standards and CFLs. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(x)(1). Assumes 41W.	67	A		
75	ENERGY STAR LED general service lamp (v1.1); assumes 15.6W per lamp.	Represents mix of standard general service halogen incandescent lamp meeting current (as of 1/1/2014) federal standards and CFLs. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(x)(1). Assumes 41W.	123	A	-0.76	
76	ENERGY STAR LED general service lamp (v1.1); assumes 15.6W per lamp.	Represents mix of standard general service halogen incandescent lamp meeting current (as of 1/1/2014) federal standards and CFLs. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(x)(1). Assumes 41W.	123	A	-0.76	
77	ENERGY STAR LED general service lamp (v1.1); assumes 15.6W per lamp.	Represents mix of standard general service halogen incandescent lamp meeting current (as of 1/1/2014) federal standards and CFLs. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(x)(1). Assumes 41W.	123	A		
78	ENERGY STAR LED general service lamp (v1.1); assumes 15.6W per lamp.	Represents mix of standard general service halogen incandescent lamp meeting current (as of 1/1/2014) federal standards and CFLs. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(x)(1). Assumes 41W.	63	A		
79	ENERGY STAR LED general service lamp (v1.1); assumes 15.6W per lamp.	Represents mix of standard general service halogen incandescent lamp meeting current (as of 1/1/2014) federal standards and CFLs. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(x)(1). Assumes 41W.	119	A	-0.76	
80	ENERGY STAR LED general service lamp (v1.1); assumes 15.6W per lamp.	Represents mix of standard general service halogen incandescent lamp meeting current (as of 1/1/2014) federal standards and CFLs. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(x)(1). Assumes 41W.	119	A	-0.76	
81	ENERGY STAR LED general service lamp (v1.1); assumes 15.6W per lamp.	Represents mix of standard general service halogen incandescent lamp meeting current (as of 1/1/2014) federal standards and CFLs. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(x)(1). Assumes 41W.	119	A		
82	Post-2020 LED general service lamp; assumes 9.4W per lamp.	Standard general service lamp meeting minimum "backstop requirement" of the Energy Independence and Security Act of 2007, Sec. 321 (a)(3).	108	A		
83	Post-2020 LED general service lamp; assumes 9.4W per lamp.	Standard general service lamp meeting minimum "backstop requirement" of the Energy Independence and Security Act of 2007, Sec. 321 (a)(3).	199	A	-0.41	
84	Post-2020 LED general service lamp; assumes 9.4W per lamp.	Standard general service lamp meeting minimum "backstop requirement" of the Energy Independence and Security Act of 2007, Sec. 321 (a)(3).	199	A	-0.41	

Meas ID	Efficient Equipment Description	Baseline Equipment Description	Energy Savings (kWh)	Peak Coinc. Factor (H, A)	End-Use Fuel Savings (MMBtu)	Water Savings (gal)
85	Post-2020 LED general service lamp; assumes 9.4W per lamp.	Standard general service lamp meeting minimum "backstop requirement" of the Energy Independence and Security Act of 2007, Sec. 321 (a)(3).	199	A		
86	Post-2020 LED general service lamp; assumes 9.4W per lamp.	Standard general service lamp meeting minimum "backstop requirement" of the Energy Independence and Security Act of 2007, Sec. 321 (a)(3).	102	A		
87	Post-2020 LED general service lamp; assumes 9.4W per lamp.	Standard general service lamp meeting minimum "backstop requirement" of the Energy Independence and Security Act of 2007, Sec. 321 (a)(3).	193	A	-0.41	
88	Post-2020 LED general service lamp; assumes 9.4W per lamp.	Standard general service lamp meeting minimum "backstop requirement" of the Energy Independence and Security Act of 2007, Sec. 321 (a)(3).	193	A	-0.41	
89	Post-2020 LED general service lamp; assumes 9.4W per lamp.	Standard general service lamp meeting minimum "backstop requirement" of the Energy Independence and Security Act of 2007, Sec. 321 (a)(3).	193	A		
90	Exit sign with LED lamps	Incandescent or fluorescent exit sign	26	A		
91	Exit sign with LED lamps	Incandescent or fluorescent exit sign	48	A	-0.10	
92	Exit sign with LED lamps	Incandescent or fluorescent exit sign	48	A	-0.10	
93	Exit sign with LED lamps	Incandescent or fluorescent exit sign	48	A		
94	Exit sign with LED lamps	Incandescent or fluorescent exit sign	25	A		
95	Exit sign with LED lamps	Incandescent or fluorescent exit sign	47	A	-0.10	
96	Exit sign with LED lamps	Incandescent or fluorescent exit sign	47	A	-0.10	
97	Exit sign with LED lamps	Incandescent or fluorescent exit sign	47	A		
98	Exit sign with LED lamps	Incandescent or fluorescent exit sign	40	A		
99	Exit sign with LED lamps	Incandescent or fluorescent exit sign	73	A	-0.15	
100	Exit sign with LED lamps	Incandescent or fluorescent exit sign	73	A	-0.15	
101	Exit sign with LED lamps	Incandescent or fluorescent exit sign	73	A		
102	Exit sign with LED lamps	Incandescent or fluorescent exit sign	37	A		
103	Exit sign with LED lamps	Incandescent or fluorescent exit sign	71	A	-0.15	
104	Exit sign with LED lamps	Incandescent or fluorescent exit sign	71	A	-0.15	
105	Exit sign with LED lamps	Incandescent or fluorescent exit sign	71	A		
106	Outdoor LED parking/area lighting	High pressure sodium or metal halide lamp. Assumes average wattage of 212 W.	27	A		
107	Install bi-level dimming in stairwells	Stairwell lighting without bi-level dimming	194	A		
108	Low flow showerhead 1.5 gpm - electric water heating	Standard showerhead meeting current (as of 1/1/1994) federal standards. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(o). Assumes 2.5 gpm.	174	A		1501.2
109	Low flow showerhead 1.5 gpm - gas water heating	Standard showerhead meeting current (as of 1/1/1994) federal standards. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(o). Assumes 2.5 gpm.		A	0.93	1811.4
110	Low flow showerhead 1.5 gpm - oil water heating	Standard showerhead meeting current (as of 1/1/1994) federal standards. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(o). Assumes 2.5 gpm.		A	0.93	1811.4
111	Low flow bathroom faucet aerator 1.0 gpm - electric water heating	Standard bathroom faucet meeting current (as of 1/1/1994) federal standards. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(o). Assumes 2.2 gpm.	40	A		515.0
112	Low flow bathroom faucet aerator 1.0 gpm - gas water heating	Standard bathroom faucet meeting current (as of 1/1/1994) federal standards. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(o). Assumes 2.2 gpm.		A	0.21	621.4
113	Low flow bathroom faucet aerator 1.0 gpm - oil water heating	Standard bathroom faucet meeting current (as of 1/1/1994) federal standards. "Energy and water conservation standards and their compliance dates." 10 CFR 430.32(o). Assumes 2.2 gpm.		A	0.21	621.4
114	Low flow kitchen faucet aerator 1.0 gpm - elec water heating	Standard kitchen faucet with 2.75 gpm usage	142	A		1479.1

Meas ID	Efficient Equipment Description	Baseline Equipment Description	Energy Savings (kWh)	Peak Coinc. Factor (H, A)	End-Use Fuel Savings (MMBtu)	Water Savings (gal)
115	Low flow kitchen faucet aerator 1.0 gpm - gas water heating	Standard kitchen faucet with 2.75 gpm usage		A	0.75	1784.7
116	Low flow kitchen faucet aerator 1.0 gpm - oil water heating	Standard kitchen faucet with 2.75 gpm usage		A	0.75	1784.7
117	Electric heat pump water heater <55 gallons	Standard efficiency electric resistance water heater, <55 gallons, .90 EF	987			
118	Pipe wrap with R3 insulation for electric water heaters	Uninsulated pipes		A	1.56	
119	Pipe wrap with R3 insulation for gas water heaters	Uninsulated pipes	30.6	A		
120	Pipe wrap with R3 insulation for oil water heaters	Uninsulated pipes		A	1.56	
121	Insulating tank wrap	Uninsulated hot water tank	97	A		
122	Insulating tank wrap	Uninsulated hot water tank		A	0.32	
123	Insulating tank wrap	Uninsulated hot water tank		A	0.32	
124	High efficiency gas water heater 0.70 EF	Standard efficiency gas storage tank water heater		A	1.78	
125	High efficiency electric water heater with a 0.94 energy factor	Standard efficiency electric storage tank water heater	72	A		
126	High efficiency oil water heater 0.70 EF	Standard efficiency oil storage tank water heater		A	1.78	
127	Air sealing in a multifamily unit with electric heat and central AC. Assumes 22% average infiltration reduction.	Multifamily unit with partial or poor air sealing	349	A		
128	Air sealing in a multifamily unit with gas heat and central AC. Assumes 22% average infiltration reduction.	Multifamily unit with partial or poor air sealing	21	H	1.44	
129	Air sealing in a multifamily unit with oil heat and central AC. Assumes 22% average infiltration reduction.	Multifamily unit with partial or poor air sealing	21	H	1.44	
130	Retrofit installation of insulation from R5 to R15 in a multifamily unit with electric heat and central AC	R5 insulation	458	A		
131	Retrofit installation of insulation from R5 to R15 in a multifamily unit with electric heat and central AC	R5 insulation	74	H	2.23	
132	Retrofit installation of insulation from R5 to R15 in a multifamily unit with electric heat and central AC	R5 insulation	74	H	2.23	
133	Duct sealing in a multifamily unit with electric heating and central AC	Multifamily unit with leaky ducts	229	A		
134	Duct sealing in a multifamily unit with gas heating and central AC	Multifamily unit with leaky ducts	28	H	0.76	
135	Duct sealing in a multifamily unit with oil heating and central AC	Multifamily unit with leaky ducts	28	H	0.78	
136	Installation of basement insulation in multifamily buildings with electric heat and central AC	Buildings without basement insulation	568	A		
137	Installation of basement insulation in multifamily buildings with gas heat and central AC	Buildings without basement insulation	-62	H	2.94	
138	Installation of basement insulation in multifamily buildings with oil heat and central AC	Buildings without basement insulation	-62	H	2.94	
139	Installation of Energy STAR windows in multifamily units with electric heating	Standard windows	668	A		
140	Installation of Energy STAR windows in multifamily units with gas heating	Standard windows	-66	H	2.86	
141	Installation of Energy STAR windows in multifamily units with oil heating	Standard windows	-66	H	2.94	
142	Installation of window film to windows in multifamily units with gas heat and central AC	Standard windows	1075	H	-9.63	
143	Installation of window film to windows in multifamily units with oil heat and central AC	Standard windows	1075	H	-9.88	

Meas ID	Efficient Equipment Description	Baseline Equipment Description	Energy Savings (kWh)	Peak Coinc. Factor (H, A)	End-Use Fuel Savings (MMBtu)	Water Savings (gal)
144	Installation of cool roof in a multifamily building with gas heat and central AC	Standard roof	174	H	-0.65	
145	Installation of cool roof in a multifamily building with oil heat and central AC	Standard roof	174	H	-0.67	
146	Implementation of an indirect feedback program on energy habits designed to create a behavior induced reduction in energy usage	No program	94	A		
147	Implementation of an indirect feedback program on energy habits designed to create a behavior induced reduction in energy usage	No program	83	A	0.29	
148	Implementation of an indirect feedback program on energy habits designed to create a behavior induced reduction in energy usage	No program	83	A	0.33	
149	Optimizing energy usage of existing buildings and systems using O&M, control calibration, etc.	Existing building that has not been commissioned	240	A		
150	Optimizing energy usage of existing buildings and systems using O&M, control calibration, etc.	Existing building that has not been commissioned			2.40	
151	Optimizing energy usage of existing buildings and systems using O&M, control calibration, etc.	Existing building that has not been commissioned			2.40	
152	Replacement of standard power strips with Tier 1 advanced power strips, 2 per multifamily unit	Standard power strips	206			
153	Installation of high-efficiency set-top cable boxes. Average of standalone cable box and cable box with DVR function. Assumes 75 kWh a year in annual usage for cable base and 105 kWh for Cable DVR system.	Standard efficiency cable box with 169 kWh annual usage and cable DVR with 243 kWh in annual usage.	212			
154	Installation of high-efficiency satellite set-top box with annual usage of 47 kWh	Standard efficiency satellite set-top box with annual usage of 123 kWh	119			
155		Existing unit residential central air conditioning unit that has not been serviced for at least 3 years.	34	H		
156		Existing unit residential air source heat pump unit that has not been serviced for at least 3 years.	364	H		
157	High-efficiency window AC unit without reverse cycle, with louvered sides, and 12,000 Btu/h, with efficiency of 11.3 EER. Based on a review of available units in the ENERGY STAR qualifying product list.	Existing room air conditioner meeting previous (10/1/2000 to 5/31/2014) federal standards. "Energy and water conservation standards and their compliance dates" 10 CFR 430.32(b). Assuming unit without reverse cycle, with louvered sides, and 12,000 Btu/h, the baseline efficiency is 9.8 EER.	295	H		
158	High-efficiency window AC unit without reverse cycle, with louvered sides, and 12,000 Btu/h, with efficiency of 11.3 EER. Based on a review of available units in the ENERGY STAR qualifying product list.	New room air conditioner meeting current (as of 6/1/2014) federal standard. "Energy and water conservation standards and their compliance dates" 10 CFR 430.32(b). Assuming unit without reverse cycle, with louvered sides, and 12,000 Btu/h, the baseline efficiency is 10.9 EER.	71	H		
159	High-efficiency central air conditioner split system with SEER of 15 and 12.5 EER.	New central air conditioner meeting current (as of 1/23/2006) federal standard. "Energy and water conservation standards and their compliance dates" 10 CFR 430.32(c)(2). Baseline efficiency is 13 SEER, 11.2 EER.	69	H		
160	High-efficiency central air-source heat pump split system with SEER of 15 and 12.5 EER.	New central air-source heat pump meeting current (as of 1/23/2006) federal standard. "Energy and water conservation standards and their compliance dates" 10 CFR 430.32(c)(2). Baseline efficiency is 13 SEER, 11.2 EER, and 7.7 HSPF.	425	H		

Meas ID	Efficient Equipment Description	Baseline Equipment Description	Energy Savings (kWh)	Peak Coinc. Factor (H, A)	End-Use Fuel Savings (MMBtu)	Water Savings (gal)
161	Estimate building peak cooling load and correct system over-sizing when replacing residential central air conditioners.		16	H		
162	Estimate building peak cooling load and correct system over-sizing when replacing residential central heat pumps.		16	H		
163	High-efficiency gas-fired hot water boiler serving multiple apartment units with thermal efficiency of 95%.	New gas-fired hot water boiler serving multiple apartment units meeting current (as of 3/2/2012) federal standard. "Energy conservation standards and their effective dates" 10 CFR 431.87. For baseline efficiency purposes, assumes boiler >=300,000 and <2,500,000 Btu/h with 80% thermal efficiency.	0	A	6.0	
164	High-efficiency gas-fired hot water boiler serving multiple apartment units with thermal efficiency of 95%.	New gas-fired hot water boiler serving multiple apartment units meeting current (as of 3/2/2012) federal standard. "Energy and water conservation standards and their compliance dates" 10 CFR 431.87. For baseline efficiency purposes, assumes boiler <2,500,000 Btu/h with 82% combustion efficiency.	0	A	5.0	
165	High-efficiency oil-fired hot water boiler serving multiple apartment units with thermal efficiency of 95%.	New oil-fired hot water boiler serving multiple apartment units meeting current (as of 3/2/2012) federal standard. "Energy conservation standards and their effective dates" 10 CFR 431.87. For baseline efficiency purposes, assumes boiler >=300,000 and <2,500,000 Btu/h with 82% thermal efficiency.	0	A	5.0	
166	High-efficiency oil-fired hot water boiler serving multiple apartment units with thermal efficiency of 95%.	New oil-fired hot water boiler serving multiple apartment units meeting current (as of 3/2/2012) federal standard. "Energy conservation standards and their effective dates" 10 CFR 431.87. For baseline efficiency purposes, assumes boiler <2,500,000 Btu/h with 84% combustion efficiency.	0	A	4.2	
167	High-efficiency in-unit gas-fired furnace with 95% AFUE.	New gas-fired furnace meeting current federal standard. "Energy and water conservation standards and their compliance dates" 10 CFR 430.32(e)(1)(i) and (e)(2)(i). Baseline efficiency is 78% AFUE.	0	A	6.9	
168	High-efficiency central gas-fired furnace with 95% AFUE.	New gas-fired furnace meeting current (as of 1/1/94) federal standard. "Energy and water conservation standards and their compliance dates" 10 CFR 431.77. Baseline is 80% thermal efficiency.	0	A	6.0	
169	Reduce heating energy consumption by installing (or reprogramming an existing) programmable thermostat to automatically set-back temperature during unoccupied or reduced demand times.	New or existing non-programmable thermostat, or existing programmable thermostat functioning as a manual thermostat.	0	A	2.0	
170	Reduce heating energy consumption by installing (or reprogramming an existing) programmable thermostat to automatically set-back temperature during unoccupied or reduced demand times.	New or existing non-programmable thermostat, or existing programmable thermostat functioning as a manual thermostat.	0	A	2.0	
171	Reduce heating energy consumption by installing (or reprogramming an existing) programmable thermostat to automatically set-back temperature during unoccupied or reduced demand times.	New or existing non-programmable thermostat, or existing programmable thermostat functioning as a manual thermostat.	472	A	0	
172	Install a boiler economizer using exhaust gases to preheat boiler feedwater.	Existing boiler with no installed economizer.	0	A	1.6	

Meas ID	Efficient Equipment Description	Baseline Equipment Description	Energy Savings (kWh)	Peak Coinc. Factor (H, A)	End-Use Fuel Savings (MMBtu)	Water Savings (gal)
173	Install a boiler economizer using exhaust gases to preheat boiler feedwater.	Existing boiler with no installed economizer.	0	A	1.6	
174	Reduce heating energy consumption by installing a "smart" thermostat capable of wi-fi communication to automatically set-back temperature during unoccupied or reduced demand times.	New or existing non-programmable thermostat, or existing programmable thermostat functioning as a manual thermostat.	0	A	3.5	
175	Reduce heating energy consumption by installing a "smart" thermostat capable of wi-fi communication to automatically set-back temperature during unoccupied or reduced demand times.	New or existing non-programmable thermostat, or existing programmable thermostat functioning as a manual thermostat.	0	A	3.5	
176	Reduce heating energy consumption by installing a "smart" thermostat capable of wi-fi communication to automatically set-back temperature during unoccupied or reduced demand times.	New or existing non-programmable thermostat, or existing programmable thermostat functioning as a manual thermostat.	837	A	0	
177	Reduce heating energy consumption by installing a "smart" thermostat capable of wi-fi communication to automatically set-back temperature during unoccupied or reduced demand times.	New or existing non-programmable thermostat, or existing programmable thermostat functioning as a manual thermostat.	68	A	3.5	
178	Reduce heating energy consumption by installing a "smart" thermostat capable of wi-fi communication to automatically set-back temperature during unoccupied or reduced demand times.	New or existing non-programmable thermostat, or existing programmable thermostat functioning as a manual thermostat.	68	A	3.5	
179	Reduce heating energy consumption by installing a "smart" thermostat capable of wi-fi communication to automatically set-back temperature during unoccupied or reduced demand times.	New or existing non-programmable thermostat, or existing programmable thermostat functioning as a manual thermostat.	905	A	0	
180	New furnace with a brushless permanent magnet (BPM) blower motor. This measure characterizes only the electric savings associated with the fan.	New or existing furnace with low efficiency (non-BPM) fan motor.	418	A	-1.42	
181	New furnace with a brushless permanent magnet (BPM) blower motor. This measure characterizes only the electric savings associated with the fan.	New or existing furnace with low efficiency (non-BPM) fan motor.	418	A	-1.42	
182	Install adequate pipe insulation on boiler distribution piping.	Existing poorly insulated or uninsulated boiler distribution piping.	0	A	1.69	

Meas ID	Savings Source	O&M	O&M Source	Incremental Cost	Cost Source
1	EPA 2014; Assumes default assumptions from calculation tool in a multifamily common area application.	0		$ 32	EPA 2014
2	EPA 2014; Assumes default assumptions from calculation tool in a multifamily common area application.	0		$ 32	EPA 2014
3	EPA 2014; Assumes default assumptions from calculation tool in a multifamily common area application.	0		$ 32	EPA 2014
4	EPA 2014; Assumes default assumptions from calculation tool in a multifamily common area application.	0		$ 32	EPA 2014
5	EPA 2014; Assumes default assumptions from calculation tool in a multifamily common area application.	0		$ 32	EPA 2014
6	EPA 2014; Assumes modified baseline assumptions for conventional unit from calculation tool in a multifamily common area application.	0		$ 235	RTF 2014
7	EPA 2014; Assumes modified baseline assumptions for conventional unit from calculation tool in a multifamily common area application.	0		$ 235	RTF 2014
8	EPA 2014; Assumes modified baseline assumptions for conventional unit from calculation tool in a multifamily common area application.	0		$ 235	RTF 2014
9	EPA 2014; Assumes modified baseline assumptions for conventional unit from calculation tool in a multifamily common area application.	0		$ 235	RTF 2014
10	EPA 2014; Assumes modified baseline assumptions for conventional unit from calculation tool in a multifamily common area application.	0		$ 235	RTF 2014
11	EPA 2014; Assumes default assumptions from calculation tool in a residential application.	0		$ 50	EPA 2014
12	EPA 2014; Assumes default assumptions from calculation tool in a residential application.	0		$ 50	EPA 2014
13	EPA 2014; Assumes default assumptions from calculation tool in a residential application.	0		$ 50	EPA 2014
14	EPA 2014; Assumes default assumptions from calculation tool in a residential application.	0		$ 50	EPA 2014
15	EPA 2014; Assumes default assumptions from calculation tool in a residential application.	0		$ 50	EPA 2014
16	EPA 2014; Assumes default assumptions from calculation tool in a residential application. Dryer savings assume 20% reduction in the average dryer consumption when paired with either a conventional or ENERGY STAR qualified residential clothes washer.	0		$ 150	GDS 2013
17	EPA 2014; Assumes default assumptions from calculation tool in a residential application. Dryer savings assume 20% reduction in the average dryer consumption when paired with either a conventional or ENERGY STAR qualified residential clothes washer.	0		$ 150	GDS 2013
18	SAG 2014, energy savings algorithm; Energy Center of Wisconsin 2013, assumes typical 15 CF refrigerator with top-mounted freezer with 11 CF fresh volume and 4 CF freezer volume. Adjusted Volume calculated as follows: 11 (Fresh Volume) + 1.63 x 4 (Freezer Volume) = 17.5 CF.	0		$ 40	SAG 2014
19	SAG 2014, energy savings algorithm; Energy Center of Wisconsin 2013, assumes typical 15 CF refrigerator with top-mounted freezer with 11 CF fresh volume and 4 CF freezer volume. Adjusted Volume calculated as follows: 11 (Fresh Volume) + 1.63 x 4 (Freezer Volume) = 17.5 CF.	0		$ 456	SAG 2014
20	SAG 2014, energy savings algorithm; Energy Center of Wisconsin 2013, assumes typical 15 CF refrigerator with top-mounted freezer with 11 CF fresh volume and 4 CF freezer volume. Adjusted Volume calculated as follows: 11 (Fresh Volume) + 1.63 x 4 (Freezer Volume) = 17.5 CF. LBNL 2004, approximate consumption of 15 CF existing refrigerator (590 kWh).	0		$ 456	SAG 2014
21	CEE 2014, efficient unit consumption; SAG 2014, energy savings algorithm; Energy Center of Wisconsin 2013, assumes typical 15 CF refrigerator with top-mounted freezer with 11 CF fresh volume and 4 CF freezer volume. Adjusted Volume calculated as follows: 11 (Fresh Volume) + 1.63 x 4 (Freezer Volume) = 17.5 CF.	0		$ 141	SAG 2014
22	CEE 2014, efficient unit consumption; SAG 2014, energy savings algorithm; Energy Center of Wisconsin 2013, assumes typical 15 CF refrigerator with top-mounted freezer with 11 CF fresh volume and 4 CF freezer volume. Adjusted Volume calculated as follows: 11 (Fresh Volume) + 1.63 x 4 (Freezer Volume) = 17.5 CF.	0		$ 557	SAG 2014
23	CEE 2014, efficient unit consumption; SAG 2014, energy savings algorithm; Energy Center of Wisconsin 2013, assumes typical 15 CF refrigerator with top-mounted freezer with 11 CF fresh volume and 4 CF freezer volume. Adjusted Volume calculated as follows: 11 (Fresh Volume) + 1.63 x 4 (Freezer Volume) = 17.5 CF. LBNL 2004, approximate consumption of 15 CF existing refrigerator (590 kWh).	0		$ 557	SAG 2014
24	SAG 2014, energy savings algorithm; DOE 2011b, most common compact freezer product class; EPA 2014, assumes typical 3 CF compact upright freezer with manual defrost. Adjusted Volume calculated as follows: 1.73 x 3 (Freezer Volume) = 5.2 CF.	0		$ 35	SAG 2014

Meas ID	Savings Source	O&M	O&M Source	Incremental Cost	Cost Source
25	SAG 2014, energy savings algorithm; DOE 2011b, most common compact freezer product class; EPA 2014, assumes typical 3 CF compact upright freezer with manual defrost. Adjusted Volume calculated as follows: 1.73 x 3 (Freezer Volume) = 5.2 CF.	0		$ 235	OEI 2014
26	EPA 2014; except where noted, assumes default assumptions from calculation tool in a residential application.	0		$ 6	RTF 2014
27	EPA 2014; except where noted, assumes default assumptions from calculation tool in a residential application.	0		$ 6	RTF 2014
28	EPA 2014; except where noted, assumes default assumptions from calculation tool in a residential application.	0		$ 6	RTF 2014
29	EPA 2014; except where noted, assumes default assumptions from calculation tool in a residential application.	0		$ 356	OEI 2014, typical material cost of least expensive unit plus incremental cost of REPL measure. Assume typical installation cost of $100.
30	EPA 2014; except where noted, assumes default assumptions from calculation tool in a residential application.	0		$ 356	OEI 2014, typical material cost of least expensive unit plus incremental cost of REPL measure. Assume typical installation cost of $100.
31	EPA 2014; except where noted, assumes default assumptions from calculation tool in a residential application.	0		$ 356	OEI 2014, typical material cost of least expensive unit plus incremental cost of REPL measure. Assume typical installation cost of $100.
32	SAG 2014	0		$ 60	SAG 2014
33	SAG 2014	0		$ 185	OEI 2014
34	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 57W average incandescent wattage (p.57) scaled to EISA 2007-compliant halogen incandescent with 41W; SAG 2014, energy savings algorithms, LED wattage scaled from nearest entry in TRM. Assumes electric resistance heat and space cooling.	8.9	SAG 2014	$ 206	SAG 2014, assumes year 2015 value
35	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 57W average incandescent wattage (p.57) scaled to EISA 2007-compliant halogen incandescent with 41W; SAG 2014, energy savings algorithms, LED wattage scaled from nearest entry in TRM. Assumes gas heat and space cooling.	8.9	SAG 2014	$ 206	SAG 2014, assumes year 2015 value
36	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 57W average incandescent wattage (p.57) scaled to EISA 2007-compliant halogen incandescent with 41W; SAG 2014, energy savings algorithms, LED wattage scaled from nearest entry in TRM. Assumes oil heat and space cooling.	8.9	SAG 2014	$ 206	SAG 2014, assumes year 2015 value
37	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 57W average incandescent wattage (p.57) scaled to EISA 2007-compliant halogen incandescent with 41W; SAG 2014, energy savings algorithms, LED wattage scaled from nearest entry in TRM. Assumes no heat and space cooling	8.9	SAG 2014	$ 206	SAG 2014, assumes year 2015 value
38	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 57W average incandescent wattage (p.57) scaled to EISA 2007-compliant halogen incandescent with 41W; SAG 2014, energy savings algorithms, LED wattage scaled from nearest entry in TRM. Assumes electric resistance heat and no cooling.	8.9	SAG 2014	$ 206	SAG 2014, assumes year 2015 value

Meas ID	Savings Source	O&M	O&M Source	Incremental Cost	Cost Source
39	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 57W average incandescent wattage (p.57) scaled to EISA 2007-compliant halogen incandescent with 41W; SAG 2014, energy savings algorithms, LED wattage scaled from nearest entry in TRM. Assumes gas heat and no cooling.	8.9	SAG 2014	$ 206	SAG 2014, assumes year 2015 value
40	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 57W average incandescent wattage (p.57) scaled to EISA 2007-compliant halogen incandescent with 41W; SAG 2014, energy savings algorithms, LED wattage scaled from nearest entry in TRM. Assumes oil heat and no cooling.	8.9	SAG 2014	$ 206	SAG 2014, assumes year 2015 value
41	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 57W average incandescent wattage (p.57) scaled to EISA 2007-compliant halogen incandescent with 41W; SAG 2014, energy savings algorithms, LED wattage scaled from nearest entry in TRM. Assumes no heat and no cooling	8.9	SAG 2014	$ 206	SAG 2014, assumes year 2015 value
42	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 22W EISA 2007 "backstop requirement"-compliant scaled from EISA 2007-compliant halogen incandescent with 41W using efficacy and maximum wattage requirements; SAG 2014, energy savings algorithms, LED wattage scaled based on efficacy projections from PNNL 2013. Assumes electric resistance heat and space cooling.	8.9	SAG 2014	$ 100	SAG 2014, assumes year 2015 value adjusted using "$/klm" projections from PNNL 2013
43	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 22W EISA 2007 "backstop requirement"-compliant scaled from EISA 2007-compliant halogen incandescent with 41W using efficacy and maximum wattage requirements; SAG 2014, energy savings algorithms, LED wattage scaled based on efficacy projections from PNNL 2013. Assumes gas heat and space cooling.	8.9	SAG 2014	$ 100	SAG 2014, assumes year 2015 value adjusted using "$/klm" projections from PNNL 2013
44	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 22W EISA 2007 "backstop requirement"-compliant scaled from EISA 2007-compliant halogen incandescent with 41W using efficacy and maximum wattage requirements; SAG 2014, energy savings algorithms, LED wattage scaled based on efficacy projections from PNNL 2013. Assumes oil heat and space cooling.	8.9	SAG 2014	$ 100	SAG 2014, assumes year 2015 value adjusted using "$/klm" projections from PNNL 2013
45	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 22W EISA 2007 "backstop requirement"-compliant scaled from EISA 2007-compliant halogen incandescent with 41W using efficacy and maximum wattage requirements; SAG 2014, energy savings algorithms, LED wattage scaled based on efficacy projections from PNNL 2013. Assumes no heat and space cooling	8.9	SAG 2014	$ 100	SAG 2014, assumes year 2015 value adjusted using "$/klm" projections from PNNL 2013
46	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 22W EISA 2007 "backstop requirement"-compliant scaled from EISA 2007-compliant halogen incandescent with 41W using efficacy and maximum wattage requirements; SAG 2014, energy savings algorithms, LED wattage scaled based on efficacy projections from PNNL 2013. Assumes electric resistance heat and no cooling.	8.9	SAG 2014	$ 100	SAG 2014, assumes year 2015 value adjusted using "$/klm" projections from PNNL 2013
47	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 22W EISA 2007 "backstop requirement"-compliant scaled from EISA 2007-compliant halogen incandescent with 41W using efficacy and maximum wattage requirements; SAG 2014, energy savings algorithms, LED wattage scaled based on efficacy projections from PNNL 2013. Assumes gas heat and no cooling.	8.9	SAG 2014	$ 100	SAG 2014, assumes year 2015 value adjusted using "$/klm" projections from PNNL 2013

Meas ID	Savings Source	O&M	O&M Source	Incremental Cost	Cost Source
48	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 22W EISA 2007 "backstop requirement"-compliant scaled from EISA 2007-compliant halogen incandescent with 41W using efficacy and maximum wattage requirements; SAG 2014, energy savings algorithms, LED wattage scaled based on efficacy projections from PNNL 2013. Assumes oil heat and no cooling.	8.9	SAG 2014	$ 100	SAG 2014, assumes year 2015 value adjusted using "$/klm" projections from PNNL 2013
49	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 22W EISA 2007 "backstop requirement"-compliant scaled from EISA 2007-compliant halogen incandescent with 41W using efficacy and maximum wattage requirements; SAG 2014, energy savings algorithms, LED wattage scaled based on efficacy projections from PNNL 2013. Assumes no heat and no cooling	8.9	SAG 2014	$ 100	SAG 2014, assumes year 2015 value adjusted using "$/klm" projections from PNNL 2013
50	SAG 2014, energy savings algorithms, savings assume measure defaults and "Specialty - Generic" category. Assumes electric resistance heat and space cooling.	71.4	SAG 2014	$ 257	SAG 2014, assumes Direct Install program approach
51	SAG 2014, energy savings algorithms, savings assume measure defaults and "Specialty - Generic" category. Assumes gas heat and space cooling.	71.4	SAG 2014	$ 257	SAG 2014, assumes Direct Install program approach
52	SAG 2014, energy savings algorithms, savings assume measure defaults and "Specialty - Generic" category. Assumes oil heat and space cooling.	71.4	SAG 2014	$ 257	SAG 2014, assumes Direct Install program approach
53	SAG 2014, energy savings algorithms, savings assume measure defaults and "Specialty - Generic" category. Assumes no heat and space cooling.	71.4	SAG 2014	$ 257	SAG 2014, assumes Direct Install program approach
54	SAG 2014, energy savings algorithms, savings assume measure defaults and "Specialty - Generic" category. Assumes electric resistance heat and no cooling.	71.4	SAG 2014	$ 257	SAG 2014, assumes Direct Install program approach
55	SAG 2014, energy savings algorithms, savings assume measure defaults and "Specialty - Generic" category. Assumes gas heat and no cooling.	71.4	SAG 2014	$ 257	SAG 2014, assumes Direct Install program approach
56	SAG 2014, energy savings algorithms, savings assume measure defaults and "Specialty - Generic" category. Assumes oil heat and no cooling.	71.4	SAG 2014	$ 257	SAG 2014, assumes Direct Install program approach
57	SAG 2014, energy savings algorithms, savings assume measure defaults and "Specialty - Generic" category. Assumes no heat and no cooling.	71.4	SAG 2014	$ 257	SAG 2014, assumes Direct Install program approach
58	SAG 2014, energy savings algorithms, savings assume measure defaults and "Specialty - Generic" category. Assumes electric resistance heat and space cooling.	71.4	SAG 2014	$ 257	SAG 2014, assumes Direct Install program approach
59	SAG 2014, energy savings algorithms, savings assume measure defaults and "Specialty - Generic" category. Assumes gas heat and space cooling.	71.4	SAG 2014	$ 257	SAG 2014, assumes Direct Install program approach

Meas ID	Savings Source	O&M	O&M Source	Incremental Cost	Cost Source
60	SAG 2014, energy savings algorithms, savings assume measure defaults and "Specialty - Generic" category. Assumes oil heat and space cooling.	71.4	SAG 2014	$ 257	SAG 2014, assumes Direct Install program approach
61	SAG 2014, energy savings algorithms, savings assume measure defaults and "Specialty - Generic" category. Assumes no heat and space cooling.	71.4	SAG 2014	$ 257	SAG 2014, assumes Direct Install program approach
62	SAG 2014, energy savings algorithms, savings assume measure defaults and "Specialty - Generic" category. Assumes electric resistance heat and no cooling.	71.4	SAG 2014	$ 257	SAG 2014, assumes Direct Install program approach
63	SAG 2014, energy savings algorithms, savings assume measure defaults and "Specialty - Generic" category. Assumes gas heat and no cooling.	71.4	SAG 2014	$ 257	SAG 2014, assumes Direct Install program approach
64	SAG 2014, energy savings algorithms, savings assume measure defaults and "Specialty - Generic" category. Assumes oil heat and no cooling.	71.4	SAG 2014	$ 257	SAG 2014, assumes Direct Install program approach
65	SAG 2014, energy savings algorithms, savings assume measure defaults and "Specialty - Generic" category. Assumes no heat and no cooling.	71.4	SAG 2014	$ 257	SAG 2014, assumes Direct Install program approach
66	SAG 2014, baseline assumes 2-lamp F32T8 fixture with electronic ballast (59 watts). Saving estimated on a per lamp basis. Assumes electric resistance heat and space cooling.	-11.1	SAG 2014	$ 74	SAG 2014
67	SAG 2014, baseline assumes 2-lamp F32T8 fixture with electronic ballast (59 watts). Saving estimated on a per lamp basis. Assumes gas heat and space cooling.	-11.1	SAG 2014	$ 74	SAG 2014
68	SAG 2014, baseline assumes 2-lamp F32T8 fixture with electronic ballast (59 watts). Saving estimated on a per lamp basis. Assumes oil heat and space cooling.	-11.1	SAG 2014	$ 74	SAG 2014
69	SAG 2014, baseline assumes 2-lamp F32T8 fixture with electronic ballast (59 watts). Saving estimated on a per lamp basis. Assumes no heat and space cooling.	-11.1	SAG 2014	$ 74	SAG 2014
70	SAG 2014, baseline assumes 2-lamp F32T8 fixture with electronic ballast (59 watts). Saving estimated on a per lamp basis. Assumes electric resistance heat and no cooling.	-11.1	SAG 2014	$ 74	SAG 2014
71	SAG 2014, baseline assumes 2-lamp F32T8 fixture with electronic ballast (59 watts). Saving estimated on a per lamp basis. Assumes gas heat and no cooling.	-11.1	SAG 2014	$ 74	SAG 2014
72	SAG 2014, baseline assumes 2-lamp F32T8 fixture with electronic ballast (59 watts). Saving estimated on a per lamp basis. Assumes oil heat and no cooling.	-11.1	SAG 2014	$ 74	SAG 2014
73	SAG 2014, baseline assumes 2-lamp F32T8 fixture with electronic ballast (59 watts). Saving estimated on a per lamp basis. Assumes no heat and no cooling.	-11.1	SAG 2014	$ 74	SAG 2014
74	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 57W average incandescent wattage (p.57) scaled to EISA 2007-compliant halogen incandescent with 41W; SAG 2014, energy savings algorithms, LED wattage scaled from nearest entry in TRM. Assumes electric resistance heat and space cooling.	6.8	SAG 2014, scaled based on ratio of in-unit to common area hours of use.	$ 29	SAG 2014, assumes year 2015 value
75	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 57W average incandescent wattage (p.57) scaled to EISA 2007-compliant halogen incandescent with 41W; SAG 2014, energy savings algorithms, LED wattage scaled from nearest entry in TRM. Assumes gas heat and space cooling.	6.8	SAG 2014, scaled based on ratio of in-unit to common area hours of use.	$ 29	SAG 2014, assumes year 2015 value

Meas ID	Savings Source	O&M	O&M Source	Incremental Cost	Cost Source
76	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 57W average incandescent wattage (p.57) scaled to EISA 2007-compliant halogen incandescent with 41W; SAG 2014, energy savings algorithms, LED wattage scaled from nearest entry in TRM. Assumes oil heat and space cooling.	6.8	SAG 2014, scaled based on ratio of in-unit to common area hours of use.	$ 29	SAG 2014, assumes year 2015 value
77	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 57W average incandescent wattage (p.57) scaled to EISA 2007-compliant halogen incandescent with 41W; SAG 2014, energy savings algorithms, LED wattage scaled from nearest entry in TRM. Assumes no heat and space cooling	6.8	SAG 2014, scaled based on ratio of in-unit to common area hours of use.	$ 29	SAG 2014, assumes year 2015 value
78	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 57W average incandescent wattage (p.57) scaled to EISA 2007-compliant halogen incandescent with 41W; SAG 2014, energy savings algorithms, LED wattage scaled from nearest entry in TRM. Assumes electric resistance heat and no cooling.	6.8	SAG 2014, scaled based on ratio of in-unit to common area hours of use.	$ 29	SAG 2014, assumes year 2015 value
79	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 57W average incandescent wattage (p.57) scaled to EISA 2007-compliant halogen incandescent with 41W; SAG 2014, energy savings algorithms, LED wattage scaled from nearest entry in TRM. Assumes gas heat and no cooling.	6.8	SAG 2014, scaled based on ratio of in-unit to common area hours of use.	$ 29	SAG 2014, assumes year 2015 value
80	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 57W average incandescent wattage (p.57) scaled to EISA 2007-compliant halogen incandescent with 41W; SAG 2014, energy savings algorithms, LED wattage scaled from nearest entry in TRM. Assumes oil heat and no cooling.	6.8	SAG 2014, scaled based on ratio of in-unit to common area hours of use.	$ 29	SAG 2014, assumes year 2015 value
81	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 57W average incandescent wattage (p.57) scaled to EISA 2007-compliant halogen incandescent with 41W; SAG 2014, energy savings algorithms, LED wattage scaled from nearest entry in TRM. Assumes no heat and no cooling	6.8	SAG 2014, scaled based on ratio of in-unit to common area hours of use.	$ 29	SAG 2014, assumes year 2015 value
82	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 22W EISA 2007 "backstop requirement"-compliant scaled from EISA 2007-compliant halogen incandescent with 41W using efficacy and maximum wattage requirements; SAG 2014, energy savings algorithms, LED wattage scaled based on efficacy projections from PNNL 2013. Assumes electric resistance heat and space cooling.	6.8	SAG 2014, scaled based on ratio of in-unit to common area hours of use.	$ 14	SAG 2014, assumes year 2015 value adjusted using "$/klm" projections from PNNL 2013
83	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 22W EISA 2007 "backstop requirement"-compliant scaled from EISA 2007-compliant halogen incandescent with 41W using efficacy and maximum wattage requirements; SAG 2014, energy savings algorithms, LED wattage scaled based on efficacy projections from PNNL 2013. Assumes gas heat and space cooling.	6.8	SAG 2014, scaled based on ratio of in-unit to common area hours of use.	$ 14	SAG 2014, assumes year 2015 value adjusted using "$/klm" projections from PNNL 2013

Meas ID	Savings Source	O&M	O&M Source	Incremental Cost	Cost Source
84	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 22W EISA 2007 "backstop requirement"-compliant scaled from EISA 2007-compliant halogen incandescent with 41W using efficacy and maximum wattage requirements; SAG 2014, energy savings algorithms, LED wattage scaled based on efficacy projections from PNNL 2013. Assumes oil heat and space cooling.	6.8	SAG 2014, scaled based on ratio of in-unit to common area hours of use.	$ 14	SAG 2014, assumes year 2015 value adjusted using "$/klm" projections from PNNL 2013
85	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 22W EISA 2007 "backstop requirement"-compliant scaled from EISA 2007-compliant halogen incandescent with 41W using efficacy and maximum wattage requirements; SAG 2014, energy savings algorithms, LED wattage scaled based on efficacy projections from PNNL 2013. Assumes no heat and space cooling	6.8	SAG 2014, scaled based on ratio of in-unit to common area hours of use.	$ 14	SAG 2014, assumes year 2015 value adjusted using "$/klm" projections from PNNL 2013
86	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 22W EISA 2007 "backstop requirement"-compliant scaled from EISA 2007-compliant halogen incandescent with 41W using efficacy and maximum wattage requirements; SAG 2014, energy savings algorithms, LED wattage scaled based on efficacy projections from PNNL 2013. Assumes electric resistance heat and no cooling.	6.8	SAG 2014, scaled based on ratio of in-unit to common area hours of use.	$ 14	SAG 2014, assumes year 2015 value adjusted using "$/klm" projections from PNNL 2013
87	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 22W EISA 2007 "backstop requirement"-compliant scaled from EISA 2007-compliant halogen incandescent with 41W using efficacy and maximum wattage requirements; SAG 2014, energy savings algorithms, LED wattage scaled based on efficacy projections from PNNL 2013. Assumes gas heat and no cooling.	6.8	SAG 2014, scaled based on ratio of in-unit to common area hours of use.	$ 14	SAG 2014, assumes year 2015 value adjusted using "$/klm" projections from PNNL 2013
88	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 22W EISA 2007 "backstop requirement"-compliant scaled from EISA 2007-compliant halogen incandescent with 41W using efficacy and maximum wattage requirements; SAG 2014, energy savings algorithms, LED wattage scaled based on efficacy projections from PNNL 2013. Assumes oil heat and no cooling.	6.8	SAG 2014, scaled based on ratio of in-unit to common area hours of use.	$ 14	SAG 2014, assumes year 2015 value adjusted using "$/klm" projections from PNNL 2013
89	KEMA 2011, Energy Center of Wisconsin 2013, GDS 2014a, baseline assumes 22W EISA 2007 "backstop requirement"-compliant scaled from EISA 2007-compliant halogen incandescent with 41W using efficacy and maximum wattage requirements; SAG 2014, energy savings algorithms, LED wattage scaled based on efficacy projections from PNNL 2013. Assumes no heat and no cooling	6.8	SAG 2014, scaled based on ratio of in-unit to common area hours of use.	$ 14	SAG 2014, assumes year 2015 value adjusted using "$/klm" projections from PNNL 2013
90	SAG 2014, baseline assumes simple average wattage of fluorescent and incandescent. Assumes electric resistance heat and space cooling.			$ 8	SAG 2014
91	SAG 2014, baseline assumes simple average wattage of fluorescent and incandescent. Assumes gas heat and space cooling.			$ 8	SAG 2014
92	SAG 2014, baseline assumes simple average wattage of fluorescent and incandescent. Assumes oil heat and space cooling.			$ 8	SAG 2014
93	SAG 2014, baseline assumes simple average wattage of fluorescent and incandescent. Assumes no heat and space cooling.			$ 8	SAG 2014
94	SAG 2014, baseline assumes simple average wattage of fluorescent and incandescent. Assumes electric resistance heat and no cooling.			$ 8	SAG 2014
95	SAG 2014, baseline assumes simple average wattage of fluorescent and incandescent. Assumes gas heat and no cooling.			$ 8	SAG 2014
96	SAG 2014, baseline assumes simple average wattage of fluorescent and incandescent. Assumes oil heat and no cooling.			$ 8	SAG 2014
97	SAG 2014, baseline assumes simple average wattage of fluorescent and incandescent. Assumes no heat and no cooling.			$ 8	SAG 2014

Meas ID	Savings Source	O&M	O&M Source	Incremental Cost	Cost Source
98	SAG 2014, baseline assumes simple average wattage of fluorescent and incandescent. Assumes electric resistance heat and space cooling.			$ 12	SAG 2014
99	SAG 2014, baseline assumes simple average wattage of fluorescent and incandescent. Assumes gas heat and space cooling.			$ 12	SAG 2014
100	SAG 2014, baseline assumes simple average wattage of fluorescent and incandescent. Assumes oil heat and space cooling.			$ 12	SAG 2014
101	SAG 2014, baseline assumes simple average wattage of fluorescent and incandescent. Assumes no heat and no cooling.			$ 12	SAG 2014
102	SAG 2014, baseline assumes simple average wattage of fluorescent and incandescent. Assumes electric resistance heat and no cooling.			$ 12	SAG 2014
103	SAG 2014, baseline assumes simple average wattage of fluorescent and incandescent. Assumes gas heat and no cooling.			$ 12	SAG 2014
104	SAG 2014, baseline assumes simple average wattage of fluorescent and incandescent. Assumes oil heat and no cooling.			$ 12	SAG 2014
105	SAG 2014, baseline assumes simple average wattage of fluorescent and incandescent. Assumes no heat and no cooling.			$ 12	SAG 2014
106	Navigant 2012, baseline assumes weighted average wattage of HPS and MH lamps in parking applications (212W), 16 hours of use per day; SAG 2012, efficient wattage scaled based on ratio of baseline and efficient wattage for "LED Outdoor Pole/Arm Mounted Parking/Roadway, 30W - 75W" measure.	$ 3.33	SAG 2014	$ 19	SAG 2014, assumes $250 per fixture
107	CEC 2005			$ 119	CEC 2005
108	GDS 2013			$ 24	GDS 2013
109	GDS 2013			$ 24	GDS 2013
110	GDS 2013			$ 24	GDS 2013
111	GDS 2013			$ 13	GDS 2013
112	GDS 2013			$ 13	GDS 2013
113	GDS 2013			$ 13	GDS 2013
114	GDS 2013			$ 10	GDS 2013
115	GDS 2013			$ 10	GDS 2013
116	GDS 2013			$ 10	GDS 2013
117	ODC 2012			$ 950	ODC 2012
118	GDS 2013			$ 5	GDS 2013
119	GDS 2013			$ 5	GDS 2013
120	GDS 2013			$ 5	GDS 2013
121	GDS 2014b			$ 35	GDS 2013
122	GDS 2013			$ 35	GDS 2013
123	GDS 2013			$ 35	GDS 2013
124	GDS 2013			$ 235	GDS 2013
125	GDS 2014b			$ 99	GDS 2014b
126	GDS 2013			$ 235	GDS 2013
127	GDS 2013			$ 111	GDS 2013
128	GDS 2013			$ 111	GDS 2013
129	GDS 2013			$ 111	GDS 2013
130	SAG 2014			$ 1,416	GDS 2014b
131	SAG 2014			$ 1,416	GDS 2014b
132	SAG 2014			$ 1,416	GDS 2014b
133	GDS 2014b			$ 245	GDS 2014b
134	GDS 2014b			$ 245	GDS 2014b
135	GDS 2014b			$ 245	GDS 2014b
136	GDS 2013			$ 640	GDS 2013
137	GDS 2013			$ 640	GDS 2013
138	GDS 2013			$ 640	GDS 2013
139	GDS 2014b			$ 426	GDS 2014b
140	GDS 2014b			$ 426	GDS 2014b
141	GDS 2014b			$ 426	GDS 2014b
142	GDS 2013			$ 296	GDS 2013
143	GDS 2013			$ 296	GDS 2013
144	GDS 2013			$ 710	GDS 2013
145	GDS 2013			$ 710	GDS 2013
146	GDS 2013, assumes percent savings applied to total consumption for EIA 2013 analysis			$ 7	GDS Michigan Potential Study (2013)

Meas ID	Savings Source	O&M	O&M Source	Incremental Cost	Cost Source
147	GDS 2013, assumes percent savings applied to total consumption for EIA 2013 analysis			$ 7	GDS Michigan Potential Study (2013)
148	GDS 2013, assumes percent savings applied to total consumption for EIA 2013 analysis			$ 7	GDS Michigan Potential Study (2013)
149	PNNL 2014			$ 78	PNNL 2014, assume the same as for gas and oil heat.
150	PNNL 2014			$ 78	PNNL 2014, only rec's RCx measures with 5 year payback or less. Assume average 4 year payback
151	PNNL 2014			$ 78	PNNL 2014, source only recommends RCx measures with 5 year payback or less. Assume average 4 year payback
152	SAG 2014			$ 48	SAG 2014
153	Department of Energy Notice of Data Availability, NYSERDA Power Management Research Report			$ 16	Department of Energy Notice of Data Availability (2013)
154	Department of Energy Notice of Data Availability, NYSERDA Power Management Research Report			$ 11	Department of Energy Notice of Data Availability (2013)
155	Engineering estimate			$ 61	SAG 2014, Commercial AC Tune-up
156	Engineering estimate			$ 61	SAG 2014, Commercial AC Tune-up
157	Engineering estimate			$ 448	SAG 2014
158	Engineering estimate			$ 40	SAG 2014
159	Engineering estimate			$ 417	SAG 2014
160	Engineering estimate			$ 480	SAG 2014
161	TecMarket Works 2010			$ (0)	Cost set to negligible negative value for analysis purposes assuming savings from reduced equipment costs compensate for HVAC design labor

Meas ID	Savings Source	O&M	O&M Source	Incremental Cost	Cost Source
162	TecMarket Works 2010			$ (0)	Cost set to negligible negative value for analysis purposes assuming savings from reduced equipment costs compensate for HVAC design labor
163	SAG 2014			$ 279	Navigant 2011, assume 900 kBtu/h boiler, according to assumptions regarding capacity per unit and number of units
164	SAG 2014			$ 211	Navigant 2011, study shows inc cost of $4.8 per kBtu for largest size boiler. Extrapolate to 3,300 kbtu implied by capacity * number of units
165	SAG 2014			$ 279	Navigant 2011, assume 900 kBtu/h boiler, according to assumptions regarding capacity per unit and number of units
166	SAG 2014			$ 211	Navigant 2011, study shows inc cost of $4.8 per kBtu for largest size boiler. Extrapolate to 3,300 kbtu implied by capacity * number of units

Meas ID	Savings Source	O&M	O&M Source	Incremental Cost	Cost Source
167	SAG 2014			$ 295	SAG 2014, in-unit furnace incremental cost is $1,438, but this cost probably assumes a much larger unit than the typical MF residence would require. Assume incremental costs consistent with the central furnace measure.
168	SAG 2014			$ 295	SAG 2011; this cost appears to be associated with a <=225,000 Btu/h unit. Incremental costs are not provided for larger units. Assume several central furnaces would be necessary to service a typical multifamily building
169	SAG 2014			$ 30	SAG 2011
170	SAG 2014			$ 30	SAG 2011
171	SAG 2014			$ 30	SAG 2011
172	Cadmus 2012			$ 352	Cadmus 2012
173	Cadmus 2012			$ 352	Cadmus 2012
174	Cadmus 2012b			$ 225	OEI 2014b
175	Cadmus 2012b			$ 225	OEI 2014b
176	Cadmus 2012b			$ 225	OEI 2014b
177	Cadmus 2012b			$ 225	OEI 2014b
178	Cadmus 2012b			$ 225	OEI 2014b
179	Cadmus 2012b			$ 225	OEI 2014b
180	SAG 2014			$ 97	SAG 2014
181	SAG 2014			$ 97	SAG 2014
182	TecMarket Works 2010, assume 2 inch steel pipe. Pipe feet per unit derived from NY Standard water heating pipe wrap data and MI total savings per unit data. See spreadsheet.			$ 5	GDS 2013

Meas ID	Is Early Retire-ment Retrofit	Early Retirement Baseline Shift	Early Retirement Adjusted Life	Avoided Replacement Cost	ARC Source	Measure Life (years)	Measure Life Source	Start Year	End Year	Use No Heating Fuel Share (TRUE, FALSE)	AC Saturation: Central Shared, Central In-Unit, Window, In-Unit, All, None, NA)
1	---		4			11	DOE 2009	2015	2034		NA
2	---		4			11	DOE 2009	2015	2034		NA
3	---		4			11	DOE 2009	2015	2034		NA
4	---		4			11	DOE 2009	2015	2034		NA
5	---		4			11	DOE 2009	2015	2034		NA
6	TRUE	50%	7	$ 156	RTF 2014	11	DOE 2009	2015	2034		NA
7	TRUE	50%	7	$ 156	RTF 2014	11	DOE 2009	2015	2034		NA
8	TRUE	53%	8	$ 156	RTF 2014	11	DOE 2009	2015	2034		NA
9	TRUE	53%	8	$ 156	RTF 2014	11	DOE 2009	2015	2034		NA
10	TRUE	53%	8	$ 156	RTF 2014	11	DOE 2009	2015	2034		NA
11	---		5			14	DOE 2012	2015	2034		NA
12	---		5			14	DOE 2012	2015	2034		NA
13	---		5			14	DOE 2012	2015	2034		NA
14	---		5			14	DOE 2012	2015	2034		NA
15	---		5			14	DOE 2012	2015	2034		NA
16	---		6			16	DOE 2011	2015	2034		NA
17	---		6			16	DOE 2011	2015	2034		NA
18	---		4			12	SAG 2014	2015	2034		NA
19	TRUE	34%	7	$ 394	SAG 2014	12	SAG 2014	2015	2034		NA
20	TRUE	15%	5	$ 394	SAG 2014	12	SAG 2014	2015	2034		NA
21	---		4			12	SAG 2014	2015	2034		NA
22	TRUE	51%	8	$ 394	SAG 2014	12	SAG 2014	2015	2034		NA
23	TRUE	26%	6	$ 394	SAG 2014	12	SAG 2014	2015	2034		NA
24	---		4			11	SAG 2014	2015	2034		NA
25	TRUE	47%	7	$ 200	OEI 2014	11	SAG 2014	2015	2034		NA
26	---		5			13	SAG 2014	2015	2034		NA
27	---		5			13	SAG 2014	2015	2034		NA
28	---		5			13	SAG 2014	2015	2034		NA
29	TRUE	30%	7	$ 350	OEI 2014, typical material cost of least expensive unit. Assume typical installation cost of $100	13	SAG 2014	2015	2034		NA
30	TRUE	30%	7	$ 350	OEI 2014, typical material cost of least expensive unit. Assume typical installation cost of $100	13	SAG 2014	2015	2034		NA
31	TRUE	30%	7	$ 350	OEI 2014, typical material cost of least expensive unit. Assume typical installation cost of $100	13	SAG 2014	2015	2034		NA
32	---		4			12	SAG 2014	2015	2034		NA

Meas ID	Is Early Retire-ment Retrofit	Early Retirement Baseline Shift	Early Retirement Adjusted Life	Avoided Replacement Cost	ARC Source	Measure Life (years)	Measure Life Source	Start Year	End Year	Use No Heating Fuel Share (TRUE, FALSE)	AC Saturation : Central Shared, Central In-Unit, Window, In-Unit, All, None, NA)
33	TRUE		4	$ 125	OEI 2014	12	SAG 2014	2015	2034		NA
34	---		5			15	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 15 years.	2015	2034		All
35	---		5			15	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 15 years.	2015	2019		All
36	---		5			15	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 15 years.	2015	2019		All
37	---		5			15	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 15 years.	2015	2019	TRUE	All
38	---		5			15	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 15 years.	2015	2019		None
39	---		5			15	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 15 years.	2015	2019		None

Meas ID	Is Early Retire-ment Retrofit	Early Retirement Baseline Shift	Early Retirement Adjusted Life	Avoided Replacement Cost	ARC Source	Measure Life (years)	Measure Life Source	Start Year	End Year	Use No Heating Fuel Share (TRUE, FALSE)	AC Saturation: Central Shared, Central In-Unit, Window, In-Unit, All, None, NA)
40	---		5			15	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 15 years.	2015	2019		None
41	---		5			15	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 15 years.	2015	2019	TRUE	None
42	---		7			20	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 20 years. Assumes technology lifetime will be closer to nominal values by 2020.	2020	2034		All
43	---		7			20	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 20 years. Assumes technology lifetime will be closer to nominal values by 2020.	2020	2034		All

Meas ID	Is Early Retire-ment Retrofit	Early Retirement Baseline Shift	Early Retirement Adjusted Life	Avoided Replacement Cost	ARC Source	Measure Life (years)	Measure Life Source	Start Year	End Year	Use No Heating Fuel Share (TRUE, FALSE)	AC Saturation : Central Shared, Central In-Unit, Window, In-Unit, All, None, NA)
44	---		7			20	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 20 years. Assumes technology lifetime will be closer to nominal values by 2020.	2020	2034		All
45	---		7			20	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 20 years. Assumes technology lifetime will be closer to nominal values by 2020.	2020	2034	TRUE	All
46	---		7			20	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 20 years. Assumes technology lifetime will be closer to nominal values by 2020.	2020	2034		None
47	---		7			20	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 20 years. Assumes technology lifetime will be closer to nominal values by 2020.	2020	2034		None

Meas ID	Is Early Retire-ment Retrofit	Early Retirement Baseline Shift	Early Retirement Adjusted Life	Avoided Replacement Cost	ARC Source	Measure Life (years)	Measure Life Source	Start Year	End Year	Use No Heating Fuel Share (TRUE, FALSE)	AC Saturation : Central Shared, Central In-Unit, Window, In-Unit, All, None, NA)
48	---		7			20	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 20 years. Assumes technology lifetime will be closer to nominal values by 2020.	2020	2034		None
49	---		7			20	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 20 years. Assumes technology lifetime will be closer to nominal values by 2020.	2020	2034	TRUE	None
50	---		2			7	SAG 2014	2015	2019		All
51	---		2			7	SAG 2014	2015	2019		All
52	---		2			7	SAG 2014	2015	2019		All
53	---		2			7	SAG 2014	2015	2019	TRUE	All
54	---		2			7	SAG 2014	2015	2019		None
55	---		2			7	SAG 2014	2015	2019		None
56	---		2			7	SAG 2014	2015	2019		None
57	---		2			7	SAG 2014	2015	2019	TRUE	None
58	---		2			7	SAG 2014	2020	2034		All
59	---		2			7	SAG 2014	2020	2034		All
60	---		2			7	SAG 2014	2020	2034		All
61	---		2			7	SAG 2014	2020	2034	TRUE	All
62	---		2			7	SAG 2014	2020	2034		None
63	---		2			7	SAG 2014	2020	2034		None
64	---		2			7	SAG 2014	2020	2034		None
65	---		2			7	SAG 2014	2020	2034	TRUE	None
66	---		5			15	SAG 2014	2015	2034		All
67	---		5			15	SAG 2014	2015	2034		All
68	---		5			15	SAG 2014	2015	2034		All
69	---		5			15	SAG 2014	2015	2034	TRUE	All
70	---		5			15	SAG 2014	2015	2034		None
71	---		5			15	SAG 2014	2015	2034		None
72	---		5			15	SAG 2014	2015	2034		None
73	---		5			15	SAG 2014	2015	2034	TRUE	None

Meas ID	Is Early Retire-ment Retrofit	Early Retirement Baseline Shift	Early Retirement Adjusted Life	Avoided Replacement Cost	ARC Source	Measure Life (years)	Measure Life Source	Start Year	End Year	Use No Heating Fuel Share (TRUE, FALSE)	AC Saturation : Central Shared, Central In-Unit, Window, In-Unit, All, None, NA)
74	---		1			4	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 15 years.	2015	2019		All
75	---		1			4	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 15 years.	2015	2019		All
76	---		1			4	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 15 years.	2015	2019		All
77	---		1			4	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 15 years.	2015	2019	TRUE	All
78	---		1			4	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 15 years.	2015	2019		None
79	---		1			4	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 15 years.	2015	2019		None

Meas ID	Is Early Retire-ment Retrofit	Early Retirement Baseline Shift	Early Retirement Adjusted Life	Avoided Replacement Cost	ARC Source	Measure Life (years)	Measure Life Source	Start Year	End Year	Use No Heating Fuel Share (TRUE, FALSE)	AC Saturation: Central Shared, Central In-Unit, Window, In-Unit, All, None, NA)
80	---		1			4	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 15 years.	2015	2019		None
81	---		1			4	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 15 years.	2015	2019	TRUE	None
82	---		1			4	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 15 years.	2020	2034		All
83	---		1			4	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 15 years.	2020	2034		All
84	---		1			4	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 15 years.	2020	2034		All
85	---		1			4	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 15 years.	2020	2034	TRUE	All

Meas ID	Is Early Retire-ment Retrofit	Early Retirement Baseline Shift	Early Retirement Adjusted Life	Avoided Replacement Cost	ARC Source	Measure Life (years)	Measure Life Source	Start Year	End Year	Use No Heating Fuel Share (TRUE, FALSE)	AC Saturation : Central Shared, Central In-Unit, Window, In-Unit, All, None, NA)
86	---		1			4	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 15 years.	2020	2034		None
87	---		1			4	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 15 years.	2020	2034		None
88	---		1			4	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 15 years.	2020	2034		None
89	---		1			4	Approximated based on typical lamp lifetime of 25,000 hours and typical application hours of use, capped at 15 years.	2020	2034	TRUE	None
90	---		6			16	SAG 2014	2015	2034		All
91	---		6			16	SAG 2014	2015	2034		All
92	---		6			16	SAG 2014	2015	2034		All
93	---		6			16	SAG 2014	2015	2034	TRUE	All
94	---		6			16	SAG 2014	2015	2034		None
95	---		6			16	SAG 2014	2015	2034		None
96	---		6			16	SAG 2014	2015	2034		None
97	---		6			16	SAG 2014	2015	2034	TRUE	None
98	---		6			16	SAG 2014	2015	2034		All
99	---		6			16	SAG 2014	2015	2034		All
100	---		6			16	SAG 2014	2015	2034		All
101	---		6			16	SAG 2014	2015	2034	TRUE	All
102	---		6			16	SAG 2014	2015	2034		None
103	---		6			16	SAG 2014	2015	2034		None
104	---		6			16	SAG 2014	2015	2034		None
105	---		6			16	SAG 2014	2015	2034	TRUE	None
106	---		3			9	SAG 2014	2015	2034		NA
107	---		5			15	SAG 2014	2015	2034		NA
108	---		4			10	GDS 2013	2015	2034		NA
109	---		4			10	GDS 2013	2015	2034		NA

Meas ID	Is Early Retire-ment Retrofit	Early Retirement Baseline Shift	Early Retirement Adjusted Life	Avoided Replacement Cost	ARC Source	Measure Life (years)	Measure Life Source	Start Year	End Year	Use No Heating Fuel Share (TRUE, FALSE)	AC Saturation: Central Shared, Central In-Unit, Window, In-Unit, All, None, NA)
110	---		4			10	GDS 2013	2015	2034		NA
111	---		4			10	GDS 2013	2015	2034		NA
112	---		4			10	GDS 2013	2015	2034		NA
113	---		4			10	GDS 2013	2015	2034		NA
114	---		4			10	GDS 2013	2015	2034		NA
115	---		4			10	GDS 2013	2015	2034		NA
116	---		4			10	GDS 2013	2015	2034		NA
117	---		4			10	ODC 2012	2015	2034		NA
118	---		2			6	GDS 2013	2015	2034		NA
119	---		2			6	GDS 2013	2015	2034		NA
120	---		2			6	GDS 2013	2015	2034		NA
121	---		2			7	GDS 2014b	2015	2034		NA
122	---		2			7	GDS 2014b	2015	2034		NA
123	---		2			7	GDS 2014b	2015	2034		NA
124	---		5			15	GDS 2013	2015	2034		NA
125	---		5			14	GDS 2014b	2015	2034		NA
126	---		5			15	GDS 2013	2015	2034		NA
127	---		5			13	GDS 2013	2015	2034		All
128	---		5			13	GDS 2013	2015	2034		All
129	---		5			13	GDS 2013	2015	2034		All
130	---		9			25	GDS 2014b	2015	2034		All
131	---		9			25	GDS 2014b	2015	2034		All
132	---		9			25	GDS 2014b	2015	2034		All
133	---		5			14	GDS 2014b	2015	2034		All
134	---		5			14	GDS 2014b	2015	2034		All
135	---		5			14	GDS 2014b	2015	2034		All
136	---		7			20	GDS 2013	2015	2034		All
137	---		7			20	GDS 2013	2015	2034		All
138	---		7			20	GDS 2013	2015	2034		All
139	---		7			20	GDS 2014b	2015	2034		All
140	---		7			20	GDS 2014b	2015	2034		All
141	---		7			20	GDS 2014b	2015	2034		All
142	---		4			10	GDS 2013	2015	2034		All
143	---		4			10	GDS 2013	2015	2034		All
144	---		7			20	GDS 2013	2015	2034		All
145	---		7			20	GDS 2013	2015	2034		All
146	---		0			1	GDS 2013	2015	2034		NA
147	---		0			1	GDS 2013	2015	2034		NA
148	---		0			1	GDS 2013	2015	2034		NA
149	---		2			7	GDS 2013	2015	2034		NA
150	---		2			7	GDS 2013	2015	2034		NA
151	---		2			7	GDS 2013	2015	2034		NA
152	---		4			10	NYSERDA Advanced Power Strip Research Report (2011)	2015	2034		NA
153	---		2			5	GDS 2013	2015	2034		NA
154	---		2			5	GDS 2013	2015	2034		NA
155	---		1			2	SAG 2014	2015	2034		Central Shared
156	---		1			2	SAG 2014	2015	2034		Central Shared

Meas ID	Is Early Retire-ment Retrofit	Early Retirement Baseline Shift	Early Retirement Adjusted Life	Avoided Replacement Cost	ARC Source	Measure Life (years)	Measure Life Source	Start Year	End Year	Use No Heating Fuel Share (TRUE, FALSE)	AC Saturation : Central Shared, Central In-Unit, Window, In-Unit, All, None, NA)
157	TRUE	24%	6	$ 408	SAG 2014; Estimated as the difference between the RET full cost and the REPL cost.	12	GDS 2007	2015	2034		Window
158	---		4			12	GDS 2007	2015	2034		Window
159	---		6			18	GDS 2007	2015	2034		Central In-Unit
160	---		6			18	GDS 2007	2015	2034		Central In-Unit
161	---		6			18	GDS 2007	2015	2034		Central Shared
162	---		6			18	GDS 2007	2015	2034		Central Shared
163	---		7			20	SAG 2014	2015	2034		NA
164	---		7			20	SAG 2014	2015	2034		NA
165	---		7			20	SAG 2014	2015	2034		NA
166	---		7			20	SAG 2014	2015	2034		NA
167	---		7			20	SAG 2014	2015	2034		NA
168	---		6			16.5	SAG 2014	2015	2034		NA
169	---		2			5	SAG 2014	2015	2034		NA
170	---		2			5	SAG 2014	2015	2034		NA
171	---		2			5	SAG 2014	2015	2034		NA
172	---		5			15	MA Potential Study	2015	2034		NA
173	---		5			15	MA Potential Study	2015	2034		NA
174	---		5			15	MA 2012; uses same assumption as programmable thermostat	2015	2034		None
175	---		5			15	MA 2012; uses same assumption as programmable thermostat	2015	2034		None
176	---		5			15	MA 2012; uses same assumption as programmable thermostat	2015	2034		None
177	---		5			15	MA 2012; uses same assumption as programmable thermostat	2015	2034		All
178	---		5			15	MA 2012; uses same assumption as programmable thermostat	2015	2034		All
179	---		5			15	MA 2012; uses same assumption as programmable thermostat	2015	2034		All
180	---		7			20	IL TRM	2015	2034		NA

Meas ID	Is Early Retire-ment Retrofit	Early Retirement Baseline Shift	Early Retirement Adjusted Life	Avoided Replacement Cost	ARC Source	Measure Life (years)	Measure Life Source	Start Year	End Year	Use No Heating Fuel Share (TRUE, FALSE)	AC Saturation : Central Shared, Central In-Unit, Window, In-Unit, All, None, NA)
181	---		7			20	IL TRM	2015	2034		NA
182	---		2			6	GDS 2013	2015	2034		NA

Meas ID	Applicability	Applicability Source	Not Complete	Not Complete Source	Interaction Factor	Achievable Penetration Profile
1	0.88	Energy Center of Wisconsin 2013, p.42	0.94	Energy Center of Wisconsin 2013, p.42	0.8	Appliances
2	0.88	Energy Center of Wisconsin 2013, p.42	0.94	Energy Center of Wisconsin 2013, p.42	0.8	Appliances
3	0.88	Energy Center of Wisconsin 2013, p.42	0.94	Energy Center of Wisconsin 2013, p.42	0.8	Appliances
4	0.88	Energy Center of Wisconsin 2013, p.42	0.94	Energy Center of Wisconsin 2013, p.42	0.8	Appliances
5	0.88	Energy Center of Wisconsin 2013, p.42	0.94	Energy Center of Wisconsin 2013, p.42	0.8	Appliances
6	0.88	Energy Center of Wisconsin 2013, p.42	0.94	Energy Center of Wisconsin 2013, p.42	0.8	Appliances
7	0.88	Energy Center of Wisconsin 2013, p.42	0.94	Energy Center of Wisconsin 2013, p.42	0.8	Appliances
8	0.88	Energy Center of Wisconsin 2013, p.42	0.94	Energy Center of Wisconsin 2013, p.42	0.8	Appliances
9	0.88	Energy Center of Wisconsin 2013, p.42	0.94	Energy Center of Wisconsin 2013, p.42	0.8	Appliances
10	0.88	Energy Center of Wisconsin 2013, p.42	0.94	Energy Center of Wisconsin 2013, p.42	0.8	Appliances
11	0.10	Energy Center of Wisconsin 2013, p.42	0.85	GDS 2014a, p.80; Energy Center of Wisconsin 2013, p.2; Cadmus 2011, p.43	0.8	Appliances
12	0.10	Energy Center of Wisconsin 2013, p.42	0.85	GDS 2014a, p.80; Energy Center of Wisconsin 2013, p.2; Cadmus 2011, p.43	0.8	Appliances
13	0.10	Energy Center of Wisconsin 2013, p.42	0.85	GDS 2014a, p.80; Energy Center of Wisconsin 2013, p.2; Cadmus 2011, p.43	0.8	Appliances
14	0.10	Energy Center of Wisconsin 2013, p.42	0.85	GDS 2014a, p.80; Energy Center of Wisconsin 2013, p.2; Cadmus 2011, p.43	0.8	Appliances
15	0.10	Energy Center of Wisconsin 2013, p.42	0.85	GDS 2014a, p.80; Energy Center of Wisconsin 2013, p.2; Cadmus 2011, p.43	0.8	Appliances
16	0.08	GDS 2014a, Cadmus 2011, Energy Center of Wisconsin 2013; Applicability varies significantly by source. Consistent with in-unit clothes washer measure, assume 10% of units have an in-unit clothes washer. Of those units, assume 90% have an in-unit dryer. Finally, assume 85% of in-unit dryers are electric-type.	0.86	Cadmus 2011; assumes ENERGY STAR clothes dryers are equally as prevalent ENERGY STAR clothes washers.	0.95	Appliances
17	0.01	GDS 2014a, Cadmus 2011, Energy Center of Wisconsin 2013; Applicability varies significantly by source. Consistent with in-unit clothes washer measure, assume 10% of units have an in-unit clothes washer. Of those units, assume 90% have an in-unit dryer. Finally, assume 15% of in-unit dryers are gas-type.	0.86	Cadmus 2011; assumes ENERGY STAR clothes dryers are equally as prevalent ENERGY STAR clothes washers.	0.95	Appliances
18	1.00	N/A, units per apartment based on 100% applicability	0.75	GDS 2014a, p.80	1	Appliances
19	0.30	Energy Center of Wisconsin 2013, estimated portion of existing refrigerators manufactured between 7/1/2001 and 2005.	0.75	GDS 2014a, p.80	1	Appliances
20	0.28	Energy Center of Wisconsin 2013, estimated portion of existing refrigerators manufactured prior to 7/1/2001.	0.75	GDS 2014a, p.80	1	Appliances
21	1.00	N/A, units per apartment based on 100% applicability	0.75	GDS 2014a, p.80	1	Appliances
22	0.30	Energy Center of Wisconsin 2013, estimated portion of existing refrigerators manufactured between 7/1/2001 and 2005.	0.75	GDS 2014a, p.80	1	Appliances

Meas ID	Applicability	Applicability Source	Not Complete	Not Complete Source	Interaction Factor	Achievable Penetration Profile
23	0.28	Energy Center of Wisconsin 2013, estimated portion of existing refrigerators manufactured prior to 7/1/2001.	0.75	GDS 2014a, p.80	1	Appliances
24	0.08	KEMA 2011, p.76; Cadmus 2012, p.29	0.88	GDS 2014a, p.80	1	Appliances
25	0.08	KEMA 2011, p.76; Cadmus 2012, p.29	0.88	GDS 2014a, p.80	1	Appliances
26	0.60	Energy Center of Wisconsin, p.43; KEMA 2011, p.76	0.69	GDS 2014a, p.80	0.8	Appliances
27	0.60	Energy Center of Wisconsin, p.43; KEMA 2011, p.76	0.69	GDS 2014a, p.80	0.8	Appliances
28	0.60	Energy Center of Wisconsin, p.43; KEMA 2011, p.76	0.69	GDS 2014a, p.80	0.8	Appliances
29	0.60	Energy Center of Wisconsin, p.43; KEMA 2011, p.76	0.69	GDS 2014a, p.80	0.8	Appliances
30	0.60	Energy Center of Wisconsin, p.43; KEMA 2011, p.76	0.69	GDS 2014a, p.80	0.8	Appliances
31	0.60	Energy Center of Wisconsin, p.43; KEMA 2011, p.76	0.69	GDS 2014a, p.80	0.8	Appliances
32	0.07	KEMA 2011, p.76; Cadmus 2012, p.29, GDS 2014a, p.77	0.59	GDS 2013	1	Appliances
33	0.07	KEMA 2011, p.76; Cadmus 2012, p.29, GDS 2014a, p.77	0.59	GDS 2013	1	Appliances
34	0.91	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	0.69	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	1	Lighting
35	0.91	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	0.69	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	1	Lighting
36	0.91	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	0.69	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	1	Lighting
37	0.91	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	0.69	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	1	Lighting
38	0.91	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	0.69	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	1	Lighting
39	0.91	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	0.69	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	1	Lighting
40	0.91	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	0.69	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	1	Lighting
41	0.91	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	0.69	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	1	Lighting
42	0.91	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	0.69	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	1	Lighting
43	0.91	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	0.69	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	1	Lighting
44	0.91	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	0.69	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	1	Lighting
45	0.91	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	0.69	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	1	Lighting
46	0.91	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	0.69	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	1	Lighting
47	0.91	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	0.69	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	1	Lighting
48	0.91	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	0.69	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	1	Lighting

Meas ID	Applicability	Applicability Source	Not Complete	Not Complete Source	Interaction Factor	Achievable Penetration Profile
49	0.91	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	0.69	KEMA 2011, Cadmus 2012, Cadmus 2011, Energy Center of Wisconsin 2013, GDS 2014a, Ecotope 2013	1	Lighting
50	0.09	GDS 2014a	0.99	GDS 2014a, p.55	1	Lighting
51	0.09	GDS 2014a	0.99	GDS 2014a, p.55	1	Lighting
52	0.09	GDS 2014a	0.99	GDS 2014a, p.55	1	Lighting
53	0.09	GDS 2014a	0.99	GDS 2014a, p.55	1	Lighting
54	0.09	GDS 2014a	0.99	GDS 2014a, p.55	1	Lighting
55	0.09	GDS 2014a	0.99	GDS 2014a, p.55	1	Lighting
56	0.09	GDS 2014a	0.99	GDS 2014a, p.55	1	Lighting
57	0.09	GDS 2014a	0.99	GDS 2014a, p.55	1	Lighting
58	0.09	GDS 2014a	0.99	GDS 2014a, p.55	1	Lighting
59	0.09	GDS 2014a	0.99	GDS 2014a, p.55	1	Lighting
60	0.09	GDS 2014a	0.99	GDS 2014a, p.55	1	Lighting
61	0.09	GDS 2014a	0.99	GDS 2014a, p.55	1	Lighting
62	0.09	GDS 2014a	0.99	GDS 2014a, p.55	1	Lighting
63	0.09	GDS 2014a	0.99	GDS 2014a, p.55	1	Lighting
64	0.09	GDS 2014a	0.99	GDS 2014a, p.55	1	Lighting
65	0.09	GDS 2014a	0.99	GDS 2014a, p.55	1	Lighting
66	0.34	Cadmus 2012, Energy Center of Wisconsin 2013, Ecotope 2013	0.90	OEI Assumption	1	Lighting
67	0.34	Cadmus 2012, Energy Center of Wisconsin 2013, Ecotope 2013	0.90	OEI Assumption	1	Lighting
68	0.34	Cadmus 2012, Energy Center of Wisconsin 2013, Ecotope 2013	0.90	OEI Assumption	1	Lighting
69	0.34	Cadmus 2012, Energy Center of Wisconsin 2013, Ecotope 2013	0.90	OEI Assumption	1	Lighting
70	0.34	Cadmus 2012, Energy Center of Wisconsin 2013, Ecotope 2013	0.90	OEI Assumption	1	Lighting
71	0.34	Cadmus 2012, Energy Center of Wisconsin 2013, Ecotope 2013	0.90	OEI Assumption	1	Lighting
72	0.34	Cadmus 2012, Energy Center of Wisconsin 2013, Ecotope 2013	0.90	OEI Assumption	1	Lighting
73	0.34	Cadmus 2012, Energy Center of Wisconsin 2013, Ecotope 2013	0.90	OEI Assumption	1	Lighting
74	0.65	Cadmus 2012, Energy Center of Wisconsin 2013, Ecotope 2013	0.99	OEI Assumption	1	Lighting
75	0.65	Cadmus 2012, Energy Center of Wisconsin 2013, Ecotope 2013	0.99	OEI Assumption	1	Lighting
76	0.65	Cadmus 2012, Energy Center of Wisconsin 2013, Ecotope 2013	0.99	OEI Assumption	1	Lighting
77	0.65	Cadmus 2012, Energy Center of Wisconsin 2013, Ecotope 2013	0.99	OEI Assumption	1	Lighting
78	0.65	Cadmus 2012, Energy Center of Wisconsin 2013, Ecotope 2013	0.99	OEI Assumption	1	Lighting
79	0.65	Cadmus 2012, Energy Center of Wisconsin 2013, Ecotope 2013	0.99	OEI Assumption	1	Lighting
80	0.65	Cadmus 2012, Energy Center of Wisconsin 2013, Ecotope 2013	0.99	OEI Assumption	1	Lighting
81	0.65	Cadmus 2012, Energy Center of Wisconsin 2013, Ecotope 2013	0.99	OEI Assumption	1	Lighting
82	0.65	Cadmus 2012, Energy Center of Wisconsin 2013, Ecotope 2013	0.99	OEI Assumption	1	Lighting
83	0.65	Cadmus 2012, Energy Center of Wisconsin 2013, Ecotope 2013	0.99	OEI Assumption	1	Lighting
84	0.65	Cadmus 2012, Energy Center of Wisconsin 2013, Ecotope 2013	0.99	OEI Assumption	1	Lighting
85	0.65	Cadmus 2012, Energy Center of Wisconsin 2013, Ecotope 2013	0.99	OEI Assumption	1	Lighting
86	0.65	Cadmus 2012, Energy Center of Wisconsin 2013, Ecotope 2013	0.99	OEI Assumption	1	Lighting
87	0.65	Cadmus 2012, Energy Center of Wisconsin 2013, Ecotope 2013	0.99	OEI Assumption	1	Lighting

Meas ID	Applicability	Applicability Source	Not Complete	Not Complete Source	Interaction Factor	Achievable Penetration Profile
88	0.65	Cadmus 2012, Energy Center of Wisconsin 2013, Ecotope 2013	0.99	OEI Assumption	1	Lighting
89	0.65	Cadmus 2012, Energy Center of Wisconsin 2013, Ecotope 2013	0.99	OEI Assumption	1	Lighting
90	1.00		0.07	Energy Center of Wisconsin 2013, p.143	1	Lighting
91	1.00		0.07	Energy Center of Wisconsin 2013, p.143	1	Lighting
92	1.00		0.07	Energy Center of Wisconsin 2013, p.143	1	Lighting
93	1.00		0.07	Energy Center of Wisconsin 2013, p.143	1	Lighting
94	1.00		0.07	Energy Center of Wisconsin 2013, p.143	1	Lighting
95	1.00		0.07	Energy Center of Wisconsin 2013, p.143	1	Lighting
96	1.00		0.07	Energy Center of Wisconsin 2013, p.143	1	Lighting
97	1.00		0.07	Energy Center of Wisconsin 2013, p.143	1	Lighting
98	1.00		0.07	Energy Center of Wisconsin 2013, p.143	1	Lighting
99	1.00		0.07	Energy Center of Wisconsin 2013, p.143	1	Lighting
100	1.00		0.07	Energy Center of Wisconsin 2013, p.143	1	Lighting
101	1.00		0.07	Energy Center of Wisconsin 2013, p.143	1	Lighting
102	1.00		0.07	Energy Center of Wisconsin 2013, p.143	1	Lighting
103	1.00		0.07	Energy Center of Wisconsin 2013, p.143	1	Lighting
104	1.00		0.07	Energy Center of Wisconsin 2013, p.143	1	Lighting
105	1.00		0.07	Energy Center of Wisconsin 2013, p.143	1	Lighting
106	0.50	OEI Assumption, Adjusted downward from 100% assuming not all multifamily buildings have illuminated parking areas.	0.90	OEI Assumption	1	Lighting
107	0.10	Energy Center of Wisconsin 2013	0.90	OEI Assumption	0.95	Lighting
108	1.00	N/A, units per apartment based on 100% applicability	0.79	Energy Center of Wisconsin 2013, p.143, KEMA 2011, p.74	0.8	Water Heating
109	1.00	N/A, units per apartment based on 100% applicability	0.79	Energy Center of Wisconsin 2013, p.143, KEMA 2011, p.74	0.8	Water Heating
110	1.00	N/A, units per apartment based on 100% applicability	0.79	Energy Center of Wisconsin 2013, p.143, KEMA 2011, p.74	0.8	Water Heating
111	1.00	N/A, units per apartment based on 100% applicability	0.74	Energy Center of Wisconsin 2013, p.143, KEMA 2011, p.74	0.8	Water Heating
112	1.00	N/A, units per apartment based on 100% applicability	0.74	Energy Center of Wisconsin 2013, p.143, KEMA 2011, p.74	0.8	Water Heating
113	1.00	N/A, units per apartment based on 100% applicability	0.74	Energy Center of Wisconsin 2013, p.143, KEMA 2011, p.74	0.8	Water Heating
114	1.00	N/A, units per apartment based on 100% applicability	0.74	Energy Center of Wisconsin 2013, p.143, KEMA 2011, p.74	0.8	Water Heating
115	1.00	N/A, units per apartment based on 100% applicability	0.74	Energy Center of Wisconsin 2013, p.143, KEMA 2011, p.74	0.8	Water Heating
116	1.00	N/A, units per apartment based on 100% applicability	0.74	Energy Center of Wisconsin 2013, p.143, KEMA 2011, p.74	0.8	Water Heating
117	0.39	EIA 2013 analysis, represents portion of total units with in-unit water heaters.	1.00	GDS 2014a	1	Water Heating
118	1.00		0.89	GDS 2014a, p.72	0.9	Water Heating
119	1.00		0.89	GDS 2014a, p.72	0.9	Water Heating
120	1.00		0.89	GDS 2014a, p.72	0.9	Water Heating
121	1.00		0.95	GDS 2014a, p.72	0.9	Water Heating

Meas ID	Applicability	Applicability Source	Not Complete	Not Complete Source	Interaction Factor	Achievable Penetration Profile
122	1.00		0.95	GDS 2014a, p.72	0.9	Water Heating
123	1.00		0.95	GDS 2014a, p.72	0.9	Water Heating
124	1.00		0.71	GDS 2013	1	Water Heating
125	1.00		0.71	GDS 2013	1	Water Heating
126	1.00		0.71	GDS 2013	1	Water Heating
127	1.00		0.77	GDS 2014a, p.39. Represents sum for "Poorly" and "Partially" sealed Multifamily. "Unable to Assess" apportioned.	0.6	Envelope
128	1.00		0.77	GDS 2014a, p.39. Represents sum for "Poorly" and "Partially" sealed Multifamily. "Unable to Assess" apportioned.	0.97	Envelope
129	1.00		0.77	GDS 2014a, p.39. Represents sum for "Poorly" and "Partially" sealed Multifamily. "Unable to Assess" apportioned.	0.97	Envelope
130	1.00		0.87	GDS 2014a, p.80	0.6	Envelope
131	1.00		0.87	GDS 2014a, p.80	0.97	Envelope
132	1.00		0.87	GDS 2014a, p.80	0.97	Envelope
133	0.13	EIA 2013 analysis; OEI Assumption, derated from 53% as this measure is only applicable to ducted heat pump systems	0.41	GDS 2014a, p.40. Represents sum for "Some observable leaks" and "Significant leaks" in Multifamily.	0.97	Envelope
134	0.53	EIA 2013 analysis	0.41	GDS 2014a, p.40. Represents sum for "Some observable leaks" and "Significant leaks" in Multifamily.	0.97	Envelope
135	0.53	EIA 2013 analysis	0.41	GDS 2014a, p.40. Represents sum for "Some observable leaks" and "Significant leaks" in Multifamily.	0.97	Envelope
136	0.05	GDS 2013; OEI Assumption, derated from 16% assuming basement wall insulation would affect a limited number of units.	0.29	GDS 2013	0.97	Envelope
137	0.05	GDS 2013; OEI Assumption, derated from 16% assuming basement wall insulation would affect a limited number of units.	0.29	GDS 2013	0.97	Envelope
138	0.05	GDS 2013; OEI Assumption, derated from 16% assuming basement wall insulation would affect a limited number of units.	0.29	GDS 2013	0.97	Envelope
139	1.00		0.98	GDS 2014a, p.80	0.95	Envelope
140	1.00		0.98	GDS 2014a, p.80	0.95	Envelope
141	1.00		0.98	GDS 2014a, p.80	0.95	Envelope
142	1.00		0.96	GDS 2014a, p.104	0.95	Envelope
143	1.00		0.96	GDS 2014a, p.104	0.95	Envelope
144	1.00		0.96	GDS 2014a, p.104	0.95	Envelope
145	1.00		0.96	GDS 2014a, p.104	0.95	Envelope
146	1.00		1.00	OEI Assumption	1	Behavior
147	1.00		1.00	OEI Assumption	1	Behavior
148	1.00		1.00	OEI Assumption	1	Behavior
149	1.00		1.00	Not complete included in savings	1	Central HVAC
150	1.00	Applicability included in savings	1.00	Not complete included in savings	1	Central HVAC
151	1.00	Applicability included in savings	1.00	Not complete included in savings	1	Central HVAC
152	1.00		0.98	GDS 2014a, LI figure p.86	1	Consumer Electronics
153	0.45	Cadmus 2012, p.35	0.37	GDS 2013	1	Consumer Electronics
154	0.19	Cadmus 2012, p.35 - figure derived using ratio in NYSERDA report	0.37	GDS 2013	1	Consumer Electronics
155	0.79	EIA 2013 analysis	0.90	OEI Assumption	1	Central HVAC
156	0.22	EIA 2013 analysis	0.90	OEI Assumption	1	Central HVAC
157	1.00	EIA 2013 analysis	0.90	OEI Assumption	1	In-unit HVAC
158	1.00	EIA 2013 analysis	0.90	OEI Assumption	1	In-unit HVAC
159	0.79	EIA 2013 analysis	0.95	OEI Assumption	0.97	In-unit HVAC
160	0.05	EIA 2013 analysis	0.90	OEI Assumption	1	In-unit HVAC
161	0.79	EIA 2013 analysis	0.85	OEI Assumption	0.95	Central HVAC

Meas ID	Applicability	Applicability Source	Not Complete	Not Complete Source	Interaction Factor	Achievable Penetration Profile
162	0.22	EIA 2013 analysis	0.85	OEI Assumption	0.95	Central HVAC
163	0.33	EIA 2013 analysis	0.95	OEI Assumption	1	Central HVAC
164	0.33	EIA 2013 analysis	0.95	OEI Assumption	1	Central HVAC
165	0.80	EIA 2013 Analysis	0.95	OEI Assumption	1	Central HVAC
166	0.80	EIA 2013 Analysis	0.95	OEI Assumption	1	Central HVAC
167	0.33		0.90	OEI Assumption	1	In-unit HVAC
168	0.13		0.90	OEI Assumption	1	Central HVAC
169	0.64		0.88	EIA 2013 Analysis	0.95	Programmable Thermostat
170	0.64		0.88	EIA 2013 Analysis	0.95	Programmable Thermostat
171	0.64		0.88	EIA 2013 Analysis	0.95	Programmable Thermostat
172	0.33		0.30	OEI Assumption	0.97	Central HVAC
173	0.80	EIA 2013 Analysis	0.30	OEI Assumption	0.97	Central HVAC
174	0.64		0.88	EIA 2013 Analysis	0.95	Programmable Thermostat
175	0.64		0.88	EIA 2013 Analysis	0.95	Programmable Thermostat
176	0.64		0.88	EIA 2013 Analysis	0.95	Programmable Thermostat
177	0.64		0.88	EIA 2013 Analysis	0.95	Programmable Thermostat
178	0.64		0.88	EIA 2013 Analysis	0.95	Programmable Thermostat
179	0.64		0.88	EIA 2013 Analysis	0.8	Programmable Thermostat
180	0.33		0.90	OEI Assumption	1	In-unit HVAC
181	0.33		0.90	OEI Assumption	1	In-unit HVAC
182	0.33		0.80	OEI Assumption	1	Central HVAC

APPENDIX F: LOCATION DEPENDENT PARAMETERS

The first table below indicates which location dependent parameter "category" is associated with each electric utility service territory. The following tables present the parameter values assumed for each category. Note that the climate factors are grouped and categorized by cooling degree days (i.e., the "Very High" category indicates very high cooling degree days).

TABLE F1. LOCATION DEPENDENT PARAMETER CATEGORIES BY UTILITY TERRITORY

State	Utility	Climate Factor	Lighting HOU	Measure Cost Factor	Electric Avoided Costs	Natural Gas Avoided Costs	Fuel Oil Avoided Cost
NY	New York State Electric & Gas Corp.	L	L	M	L	L	H
NY	Rochester Gas & Electric	L	L	M	L	L	H
NY	Orange and Rockland Utilities	L	L	H	L	H	H
NY	Niagara Mohawk	L	L	M	L	L	H
NY	Long Island Power Authority	L	L	H	L	H	H
NY	Con Edison of NY	M	H	H	H	H	H
NY	Central Hudson Gas & Electric Corp.	L	L	H	L	H	H
NY	Other	L	L	H	L	L	H
IL	Commonwealth Edison Company	L	L	H	L	H	N/A
IL	Ameren Services	M	L	H	L	H	N/A
IL	MidAmerican Energy Company	L	L	M	L	H	N/A
IL	Other	M	L	H	L	H	N/A
MD	Potomac Edison	M	L	M	H	H	N/A
MD	Potomac Electric Power Co.	M	L	M	H	H	N/A
MD	Baltimore Gas and Electric Company	M	L	M	H	H	N/A
MD	Delmarva Power	M	L	L	H	H	N/A
MD	Southern Maryland Electric Cooperative	M	L	M	H	H	N/A
MD	Other	M	L	M	H	H	N/A
MI	Consumers Energy	L	L	M	H	L	N/A
MI	DTE Energy Company	L	L	H	H	L	N/A
MI	Indiana Michigan Power	L	L	M	H	L	N/A
MI	Other Investor Owned Utilities (IOUs)	L	L	M	H	L	N/A
MI	Other	L	L	M	H	L	N/A
MO	Ameren Missouri	M	L	H	L	L	N/A
MO	Kansas City Power & Light	M	L	H	L	L	N/A
MO	Empire District	M	L	M	L	L	N/A
MO	City Utilities of Springfield	M	L	M	L	L	N/A
MO	Other	M	L	M	L	L	N/A
NC	Carolina Power & Light	H	L	L	L	L	N/A
NC	Virginia Electric and Power Company	H	L	L	L	L	N/A
NC	Duke Energy Carolinas, LLC	H	L	L	L	L	N/A
NC	EnergyUnited	H	L	L	L	L	N/A
NC	Other	H	L	L	L	L	N/A
PA	Duquesne Light	L	L	H	H	H	N/A
PA	PECO Energy Company	L	L	H	L	H	N/A
PA	Metropolitan Edison Company	L	L	M	L	H	N/A

State	Utility	Climate Factor	Lighting HOU	Measure Cost Factor	Electric Avoided Costs	Natural Gas Avoided Costs	Fuel Oil Avoided Cost
PA	Pennsylvania Electric Company	L	L	M	L	H	N/A
PA	PPL Electric Utilities	L	L	M	H	H	N/A
PA	Pennsylvania Power Co.	L	L	M	L	H	N/A
PA	West Penn Power Company	L	L	M	L	H	N/A
PA	Other	L	L	H	L	H	N/A
GA	Georgia Power	VH	L	L	L	L	N/A
GA	All Coops	VH	L	L	L	L	N/A
GA	All Munis/Public Power	VH	L	L	L	L	N/A
GA	Savannah Electric & Power Company	VH	L	L	L	L	N/A
GA	Other	VH	L	L	L	L	N/A
VA	Appalachian Power	M	L	L	L	L	N/A
VA	Dominion	M	L	M	L	L	N/A
VA	Kentucky Utilities Co. (Old Dominion/ PPL)	M	L	L	L	L	N/A
VA	NOVEC	M	L	M	L	L	N/A
VA	PEPCO Delmarva (VA only)	M	L	L	L	L	N/A
VA	Potomac Edison (VA only)	M	L	M	L	L	N/A
VA	Rappahannock Electric Cooperative	M	L	M	L	L	N/A
VA	All Munis/Public Power	M	L	M	L	L	N/A
VA	All Coops except NOVEC/ Rappahannock	M	L	M	L	L	N/A
VA	Other	M	L	M	L	L	N/A

TABLE F2. MEASURE COST FACTORS

Category	Cost Factor
Low	0.82
Medium	0.94
High	1.13

TABLE F3. CLIMATE FACTORS

Category	Full Load Hours Cooling, Room AC	Full Load Hours Cooling, Central AC	Full Lead Hours Heating, Heat Pumps	Full Load Hours Heating, Boilers/ Furnaces	Cooling Degree Days	Heating Degree Days
Low	603	187	2,647	1,012	514	6,915
Medium	1,038	322	2,137	723	1,143	4,983
High	1,289	400	1,853	400	1,349	3,715
Very High	1,706	529	1,461	279	1,924	2,587

TABLE F4. LIGHTING HOURS OF USE

Category	Lighting Hours of Use
Low	1,059
High	1,862

TABLE F5. SPACE HEATING FUEL SHARES BY BUILDING SIZE

	Buildings with 5-49 units			Buildings with 50 or more units		
State	**Electric**	**Natural Gas**	**Fuel Oil**	**Electric**	**Natural Gas**	**Fuel Oil**
Georgia	72%	27%	0%	81%	18%	0%
Illinois	30%	68%	0%	40%	56%	0%
Maryland	51%	47%	0%	58%	39%	0%
Michigan	27%	69%	0%	31%	64%	0%
Missouri	58%	39%	0%	73%	25%	0%
North Carolina	88%	11%	0%	90%	9%	0%
New York	21%	58%	17%	19%	44%	33%
Pennsylvania	48%	46%	0%	53%	41%	0%
Virginia	66%	32%	0%	69%	28%	0%

TABLE F6. WATER HEATING FUEL SHARES

State	Electric	Natural Gas	Fuel Oil
Georgia	60%	40%	-
Illinois	21%	65%	-
Maryland	51%	49%	-
Michigan	7%	88%	-
Missouri	76%	24%	-
North Carolina	86%	14%	-
New York	14%	64%	19%
Pennsylvania	39%	57%	-
Virginia	61%	39%	-

TABLE F7. COOLING EQUIPMENT SATURATIONS

State	No AC	Central In-Unit	Central Shared	Window / Wall
Georgia	0%	90%	7%	3%
Illinois	16%	36%	5%	43%
Maryland	13%	38%	26%	23%
Michigan	17%	24%	36%	23%
Missouri	2%	85%	5%	8%
North Carolina	0%	94%	2%	4%
New York	29%	7%	3%	61%
Pennsylvania	13%	45%	17%	26%
Virginia	5%	71%	6%	18%

APPENDIX G: AVOIDED COSTS

TABLE G1. AVOIDED ENERGY SUPPLY COSTS BY FUEL BY YEAR

	Electric				Natural Gas		Fuel Oil
	High/High Coincidence	High/Low Coincidence	Low/High Coincidence	Low/Low Coincidence	High	Low	High
Year	($/kWh)	($/kWh)	($/kWh)	($/kWh)	($/MMBtu)	($/MMBtu)	($/MMBtu)
2015	0.083	0.073	0.052	0.048	6.952	5.346	28.660
2016	0.083	0.074	0.053	0.049	7.160	5.400	29.139
2017	0.084	0.075	0.053	0.049	7.091	5.454	29.651
2018	0.085	0.075	0.054	0.050	7.162	5.508	29.790
2019	0.086	0.076	0.055	0.050	7.234	5.563	29.955
2020	0.087	0.077	0.055	0.051	7.306	5.619	30.148
2021	0.088	0.078	0.056	0.051	7.379	5.675	30.416
2022	0.088	0.078	0.056	0.052	7.453	5.732	30.622
2023	0.089	0.079	0.057	0.052	7.528	5.789	30.826
2024	0.090	0.080	0.057	0.053	7.603	5.847	31.047
2025	0.091	0.081	0.058	0.053	7.679	5.906	31.356
2026	0.092	0.082	0.058	0.054	7.756	5.965	31.500
2027	0.093	0.082	0.059	0.054	7.833	6.024	31.736
2028	0.094	0.083	0.060	0.055	7.912	6.084	31.962
2029	0.095	0.084	0.060	0.055	7.991	6.145	32.128
2030	0.096	0.085	0.061	0.056	8.071	6.207	32.409
2031	0.097	0.086	0.061	0.057	8.151	6.269	32.595
2032	0.098	0.087	0.062	0.057	8.233	6.332	32.777
2033	0.099	0.088	0.063	0.058	8.315	6.395	32.934
2034	0.100	0.088	0.063	0.058	8.398	6.459	33.057
2035	0.101	0.089	0.064	0.059	8.482	6.523	33.057
2036	0.102	0.090	0.065	0.059	8.567	6.589	33.057
2037	0.103	0.091	0.065	0.060	8.653	6.654	33.057
2038	0.104	0.092	0.066	0.061	8.739	6.721	33.057
2039	0.105	0.093	0.067	0.061	8.827	6.788	33.057
2040	0.106	0.094	0.067	0.062	8.915	6.856	33.057
2041	0.107	0.095	0.068	0.062	9.004	6.925	33.057
2042	0.108	0.096	0.069	0.063	9.094	6.994	33.057
2043	0.109	0.097	0.069	0.064	9.185	7.064	33.057
2044	0.110	0.098	0.070	0.064	9.277	7.135	33.057
2045	0.111	0.099	0.071	0.065	9.370	7.206	33.057
2046	0.111	0.099	0.071	0.065	9.370	7.206	33.057
2047	0.111	0.099	0.071	0.065	9.370	7.206	33.057
2048	0.111	0.099	0.071	0.065	9.370	7.206	33.057
2049	0.111	0.099	0.071	0.065	9.370	7.206	33.057
2050	0.111	0.099	0.071	0.065	9.370	7.206	33.057
2051	0.111	0.099	0.071	0.065	9.370	7.206	33.057
2052	0.111	0.099	0.071	0.065	9.370	7.206	33.057
2053	0.111	0.099	0.071	0.065	9.370	7.206	33.057
2054	0.111	0.099	0.071	0.065	9.370	7.206	33.057

	Electric				Natural Gas		Fuel Oil
	High/High Coincidence	High/Low Coincidence	Low/High Coincidence	Low/Low Coincidence	High	Low	High
Year	**($/kWh)**	**($/kWh)**	**($/kWh)**	**($/kWh)**	**($/MMBtu)**	**($/MMBtu)**	**($/MMBtu)**
2055	0.111	0.099	0.071	0.065	9.370	7.206	33.057
2056	0.111	0.099	0.071	0.065	9.370	7.206	33.057
2057	0.111	0.099	0.071	0.065	9.370	7.206	33.057
2058	0.111	0.099	0.071	0.065	9.370	7.206	33.057
2059	0.111	0.099	0.071	0.065	9.370	7.206	33.057
2060	0.111	0.099	0.071	0.065	9.370	7.206	33.057
2061	0.111	0.099	0.071	0.065	9.370	7.206	33.057
2062	0.111	0.099	0.071	0.065	9.370	7.206	33.057
2063	0.111	0.099	0.071	0.065	9.370	7.206	33.057
2064	0.111	0.099	0.071	0.065	9.370	7.206	33.057

APPENDIX H: NON-ENERGY BENEFITS FACTORS

The table below presents the non-energy benefits factors used in the sensitivity analyses. The factors are presented by fuel, avoided costs, and NEBs scenario. The particular factors used for a given utility service territory depend on the avoided costs "bin" assigned to that utility and sensitivity scenario analyzed.

TABLE H1. NON-ENERGY BENEFITS FACTORS

Fuel, Avoided Cost	NEBs Scenario	Avoided Costs Multiplier
Electric, Low/Low Coincidence	Low NEBs	2.28
Electric, Low/High Coincidence	Low NEBs	2.30
Electric, High/Low Coincidence	Low NEBs	1.84
Electric, High/High Coincidence	Low NEBs	1.83
Natural Gas, Low	Low NEBs	1.78
Natural Gas, High	Low NEBs	1.60
Fuel Oil, High	Low NEBs	1.60
Electric, Low/Low Coincidence	High NEBs	3.56
Electric, Low/High Coincidence	High NEBs	3.61
Electric, High/Low Coincidence	High NEBs	2.69
Electric, High/High Coincidence	High NEBs	2.66
Natural Gas, Low	High NEBs	2.56
Natural Gas, High	High NEBs	2.20
Fuel Oil, High	High NEBs	2.20

APPENDIX I: PENETRATION PROFILES

The table below presents the maximum achievable penetration rates used in the analysis. The rates are presented by end use or technology type. The rates are also differentiated by market. Note that the penetrations for replacement ("REPL") measures are typically much higher than those for the corresponding retrofit ("RET") measures as the replacement penetrations are applied only to the fraction of units where equipment needs to be replaced in a given year (i.e., the "turnover") whereas the retrofit penetrations are multiplied by the total unit counts.

TABLE I1. MAXIMUM ACHIEVABLE PENETRATION RATES

Profile	Market	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Water Heating	REPL	0.100	0.188	0.275	0.363	0.450	0.480	0.510	0.540	0.570	0.600
Water Heating	RET	0.002	0.004	0.005	0.009	0.012	0.018	0.026	0.033	0.040	0.046
Central HVAC	REPL	0.150	0.217	0.283	0.350	0.417	0.483	0.550	0.617	0.683	0.750
Central HVAC	RET	0.002	0.004	0.006	0.009	0.013	0.019	0.028	0.036	0.043	0.049
In-unit HVAC	REPL	0.100	0.167	0.233	0.300	0.367	0.433	0.500	0.567	0.633	0.700
In-unit HVAC	RET	0.002	0.004	0.005	0.009	0.012	0.018	0.026	0.033	0.040	0.046
Appliances	REPL	0.150	0.211	0.272	0.333	0.394	0.456	0.517	0.578	0.639	0.700
Appliances	RET	0.002	0.004	0.005	0.009	0.012	0.018	0.026	0.033	0.040	0.046
Envelope	REPL	0.330	0.373	0.415	0.458	0.500	0.540	0.580	0.620	0.660	0.700
Envelope	RET	0.002	0.004	0.005	0.009	0.012	0.018	0.026	0.033	0.040	0.046
Fuel Total	RET	0.002	0.004	0.006	0.009	0.013	0.019	0.028	0.036	0.043	0.049
Behavior	REPL	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Consumer Electronics	REPL	0.500	0.533	0.565	0.598	0.630	0.654	0.678	0.702	0.726	0.750
Lighting	REPL	0.500	0.533	0.565	0.598	0.630	0.654	0.678	0.702	0.726	0.750
Lighting	RET	0.002	0.004	0.006	0.009	0.013	0.019	0.028	0.036	0.043	0.049
Programmable Thermostat	RET	0.002	0.004	0.006	0.009	0.013	0.019	0.028	0.036	0.043	0.049

Profile	Market	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Water Heating	REPL	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600
Water Heating	RET	0.049	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
Central HVAC	REPL	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
Central HVAC	RET	0.053	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054
In-unit HVAC	REPL	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700
In-unit HVAC	RET	0.049	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
Appliances	REPL	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700
Appliances	RET	0.049	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
Envelope	REPL	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700	0.700
Envelope	RET	0.049	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
Fuel Total	RET	0.053	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054
Behavior	REPL	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Consumer Electronics	REPL	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
Lighting	REPL	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
Lighting	RET	0.053	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054
Programmable Thermostat	RET	0.053	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054

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