CONSERVATION POTENTIAL ASSESSMENT

Project #1368

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Seattle City Light

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EXECUTIVE SUMMARY

Seattle City Light (City Light) has contracted with EnerNOC Utility Solutions (EnerNOC) to conduct a conservation potential assessment (CPA) to quantify the amount, the timing, and the cost of electric conservation resources available within the City Light service territory. The study's purpose is to establish cost-effective and achievable energy conservation targets for 2014–2015 to meet the legal requirements associated with Washington Administrative Code 194-371 (Initiative 937 or I-937), as well as to support City Light's Integrated Resource Plan (IRP). In accordance with I-937, this CPA is informed by and uses methodology consistent with the Northwest Power and Planning Council (NPCC) Sixth Power Plan. This study updates City Light's last CPA, which EnerNOC performed for the 2013-2014 biennium.

Report Organization

The report is organized as follows:

- Chapter 1 — Introduction
- Chapter 2 — Analysis Approach and Data Development
- Chapter 3 — Market Characterization and Market Profiles
- Chapter 4 — Baseline Projection
- Chapter 5 — Conservation Potential

Definitions

Before launching into the discussion of results, a few key terms are defined:

- **Technical potential** is defined as the theoretical upper limit of conservation potential. It assumes that customers adopt all feasible measures regardless of their cost. At the time of existing equipment failure, customers replace their equipment with the most efficient option available.
- **Economic potential** represents the adoption of all ***cost-effective*** conservation measures. In this analysis, cost-effectiveness is measured by the total resource cost (TRC) test as defined by the NPCC. This is a subset of technical potential.
- **Achievable potential** establishes a realistic target for the conservation savings that a utility can hope to achieve through its programs. It takes into account market maturity, customer preferences for energy-efficient technologies, and expected program participation, and is determined by applying a series of annual market adoption factors to the economic potential for each conservation measure. These factors represent the ramp rates at which technologies will penetrate the market. To develop these factors, the project team reviewed City Light's past conservation program achievements and program history over the last five years, as well as the NPCC ramp rates used in the Sixth Plan.
- **Baseline projection** is a reference end-use forecast developed specifically for this study. This estimates what would happen in the absence of any conservation programs. Consistent with the NPCC methodology, the baseline projection uses a frozen efficiency case in which the market purchase shares for efficient equipment do not change during the study period, unless equipment standards remove a technology option from the market. This methodology, removes from the baseline any effects of naturally occurring conservation or future conservation programs. Thus the CPA's resulting projections of potential compared to this baseline are gross, because naturally occurring conservation effects have been removed.

Overall Conservation Potential

Table ES-1 and Figure ES-1 summarizes the achievable potential across all sectors. **Based on the total achievable potential of 118.4 aMW in 2023, City Light is establishing a conservation target for the 2014–2015 biennium of 23.7 aMW**, which is 20% of the ten-year cumulative potential (118.4 aMW in 2023).

Table ES-1 Cumulative Achievable Potential by Sector (MWh)

	2014	2015	2018	2023	2028	2033
Achievable Cumulative Savings (MWh)						
Residential	28,500	59,974	127,865	249,900	398,666	548,450
Commercial	47,025	95,335	234,290	680,625	1,172,913	1,503,855
Industrial	14,509	22,765	37,031	69,591	90,627	106,463
Street Lighting	9,950	19,901	34,185	36,861	36,876	36,876
Total	**99,985**	**197,975**	**433,371**	**1,036,977**	**1,699,082**	**2,195,644**
Achievable Cumulative Savings (aMW)						
Residential	3.3	6.8	14.6	28.5	45.5	62.6
Commercial	5.4	10.9	26.7	77.7	133.9	171.7
Industrial	1.7	2.6	4.2	7.9	10.3	12.2
Street Lighting	1.1	2.3	3.9	4.2	4.2	4.24
Total	**11.4**	**22.6**	**49.5**	**118.4**	**194.0**	**250.6**

Figure ES-1 Cumulative Achievable Potential by Sector (MWh)

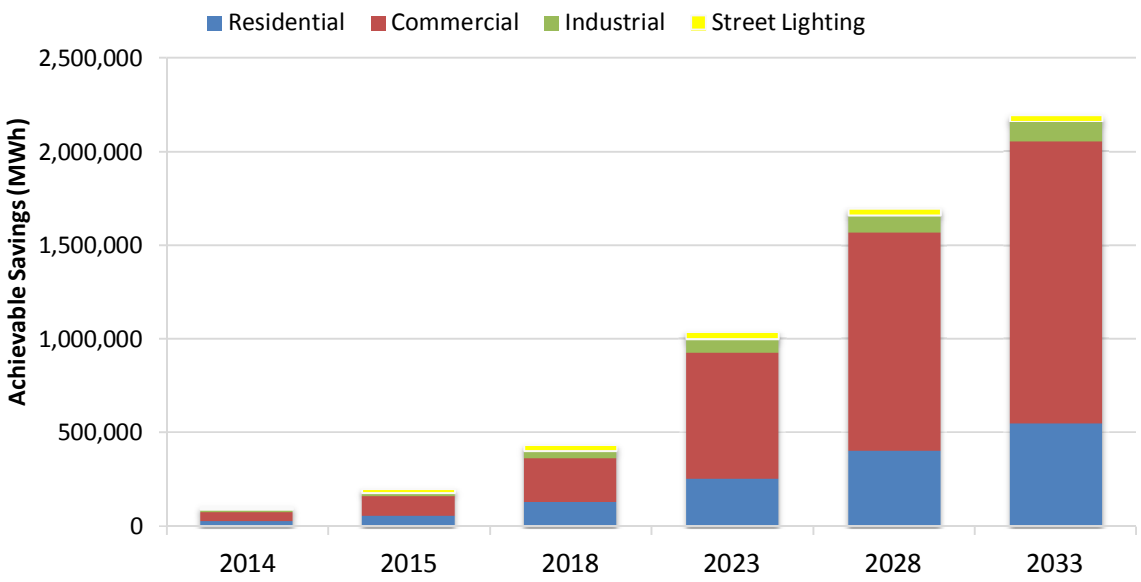


Table ES-2 presents the baseline projections of energy consumption, as well as the three levels of conservation potential for the residential, commercial, industrial, and street lighting sectors combined. As discussed in detail in Chapter 4, the baseline projection across all sectors increases over the 20-year time period. This is due largely to the growth in the commercial sector, which is tempered somewhat due to appliance and equipment standards, building codes, and a sluggish economy in the initial years. Key findings related to measure-level potentials are summarized as follows:

- **Achievable potential** across the four sectors is 197,975 MWh (22.6 aMW) in 2015 or 2.0% of the projected baseline. Cumulative achievable potential grows to 1,036,977 MWh or 118.4 aMW in 2023. This level of savings is consistent with other EnerNOC potential studies for utilities with mature conservation programs.
- **Economic potential**, which reflects the savings when all cost-effective measures are taken, is 57.5 aMW in 2015. Cumulative economic potential is 179.8 aMW in 2023.
- **Technical potential,** which reflects the adoption of all conservation measures regardless of cost-effectiveness, is a theoretical upper bound on savings. In 2013, technical potential is 74.9 aMW. In 2023, cumulative technical potential savings are 249.4 aMW.

Table ES-2 Summary of Achievable, Economic, and Technical Conservation Potential, All Sectors

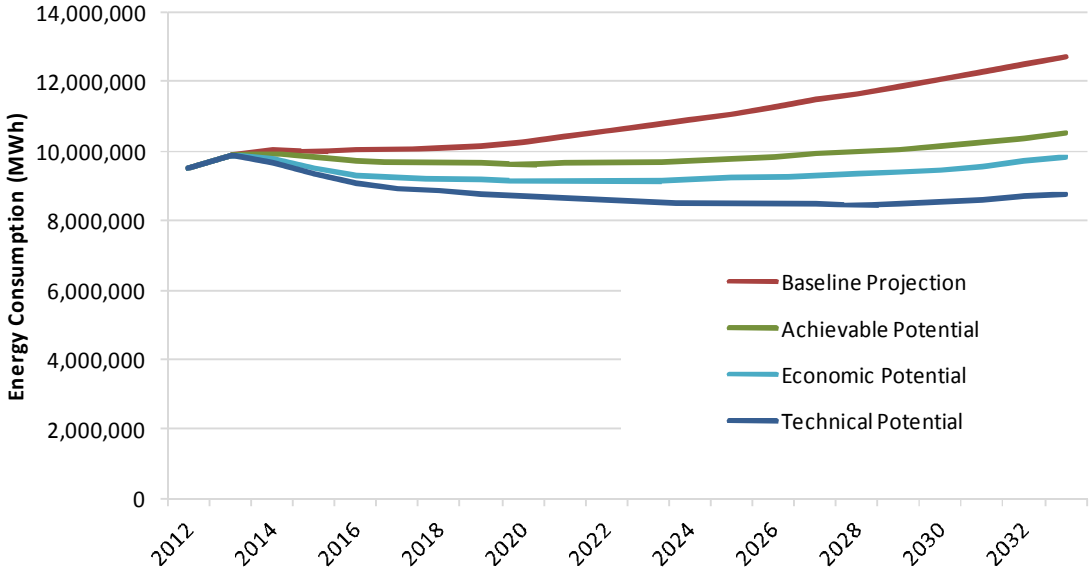
	2014	2015	2018	2023	2028	2033
Baseline Projection (MWh)	10,049,821	10,005,208	10,085,063	10,728,599	11,667,344	12,706,161
Cumulative Savings (MWh)						
Achievable Potential	99,985	197,975	433,371	1,036,977	1,699,082	2,195,644
Economic Potential	285,794	504,001	911,503	1,574,823	2,342,961	2,893,157
Technical Potential	376,456	656,464	1,243,763	2,185,003	3,209,910	3,938,790
Cumulative Savings (aMW)						
Achievable Potential	11.4	22.6	49.5	118.4	194.0	250.6
Economic Potential	32.6	57.5	104.1	179.8	267.5	330.3
Technical Potential	43.0	74.9	142.0	249.4	366.4	449.6

Per WAC 194-37-070 (6), the NPCC methodology yields a maximum penetration rate after 20 years of 85% for non-lost opportunity measures and 65% for lost opportunity measures achieved through a mix of utility programs and local, state and federal codes and standards. For 10-year potential, the penetration rates are 64% for non-lost opportunity measures and 23% for lost opportunity measures with a weighted average of 46% for both.1 The results of this CPA analysis show 10-year achievable potential for the residential, commercial, and industrial sectors combined that is 65% of the economic (cost-effective) potential, greater than the 46% weighted average cited in WAC 194-37-070. Note that the CPA projected achievable savings could be achieved either through utility programs or market transformation efforts (such as NEEA activities supported by City Light and other regional utilities) and excludes savings due to codes and standards, which are incorporated in the baseline projection. The CPA projection of achievable 20-year potential for lost and non-lost opportunities combined is 76% of economic potential.

Figure ES-2 displays the baseline and conservation potential projections.

[1] http://apps.leg.wa.gov/WAC/default.aspx?cite=194-37&full=true#194-37-070, 194-37-070, (6) (a) (xii).

Figure ES-2 Baseline and Conservation Potential Energy Projections (MWh)



Study Approach

To perform the conservation potential analysis, EnerNOC used a bottom-up analysis approach as follows:

1. Performed a market characterization to describe sector-level electricity use for the residential and non-residential (commercial and industrial) sectors for the base year, 2012. This step drew upon the market characterization from the 2011 CPA, but updated the characterization to incorporate new information from the NPCC, the Regional Technical Forum (RTF), the Northwest Energy Efficiency Alliance (NEEA) 2011 Residential Building Stock Assessment (RBSA), EnerNOC's own data, and the Energy Information Administration (EIA).
2. Developed a baseline electricity use projection by sector, segment, and end use for 2013 through 2033.
3. Identified and characterized conservation measures.
4. Estimated measure-level conservation potential for three cases: *Technical, Economic, and Achievable*.

We used EnerNOC's Load Management Analysis and Planning tool (LoadMAP™) version 3.0 to develop both the baseline projection and the estimates of conservation potential. EnerNOC developed LoadMAP in 2007 and has enhanced it over time, using it for the Electric Power Research Institute (EPRI) National Potential Study and numerous utility-specific potential studies.

The analysis approach and the data sources used are described in detail in Chapter 2.

Market Characterization

The market characterization provides an understanding of how City Light customers use energy by end use and technology. Total electricity use for the residential, non-residential, and outdoor lighting sectors for City Light in 2012, the study base year, was 9,494,297 MWh.[2] As shown in Table ES-3, the largest sector is non-residential, accounting for 66% of use, followed by residential, with 33% of sales. Street lighting represents only about 1% of sales.

[2] Based on EIA Form 861. Energy usage as measured "at-the-meter," i.e., does not include line losses.

Table ES-3 Customer Counts and Energy Sales by Sector, 2012

Sector / Rate Class	Number of meters (customers)	2012 Electricity sales (MWh)
Residential	362,524	3,146,951
Commercial	40,084	4,961,098
Industrial		1,294,369
Street Lighting	3,301	91,879
Total	**405,909**	**9,494,297**

To divide non-residential usage between the Commercial and Industrial sectors as shown in Table ES-3, the project team used a database developed by Data Marketing Incorporated (DMI). This database matched City Light's non-residential billing data with information from the King County Assessor to characterize City Light's customers by building or industry type. The resulting division between Commercial and Industrial differs slightly from that reported on City Light's EIA Form 861 because for the CPA, we assign facilities to the commercial or industrial sectors based on the facility's use and whether the primary end uses are lighting and HVAC, which is the case for commercial facilities, or whether the primary end uses are motors and process uses, which is the case for industrial facilities. Doing so enables us to model the efficiency measures that are most appropriate for the dominant end uses. See Chapter 4 for additional details.

Total residential electricity use in 2012 was 3,146,951 MWh, for an average use per home of 8,681 kWh/year. Figure ES-3 presents the shares of residential electrify use for each housing segment. The single family segment includes a very small percentage of mobile homes. Multiplex comprises 2–4 attached units or townhomes. Low-Rise Multifamily is defined as 5 or more units in buildings 6 or fewer stories in height, while High-Rise Multifamily consists of 5 or more units in buildings 7 or more stories in height. The single family segment consumed 60% of total residential sector electricity in 2012 as a result of having the largest number of customers and the highest intensity.

Figure ES-3 Residential Electricity Use by Customer Segment, 2012

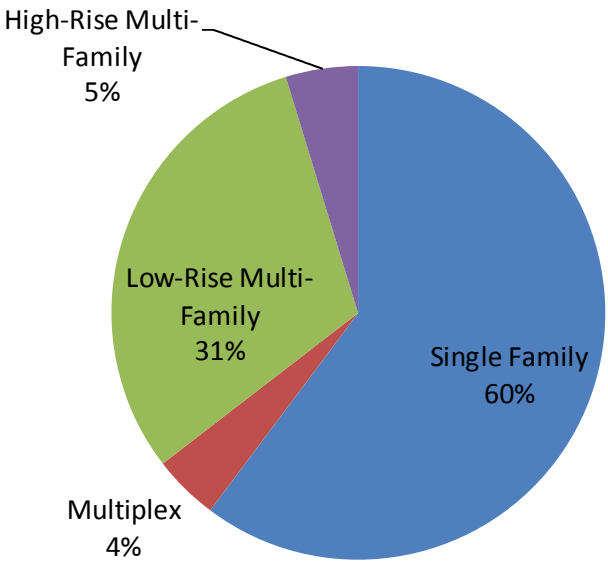


Figure ES-4 shows the breakdown of annual use per household by end use for each segment. Compared with the other housing types, single family homes allocate a smaller portion of their electricity use to space heating, due mainly to a higher saturation of gas heat in single family homes. Note that high-rise units use about 82% of the electricity that low-rise units do, despite the fact that they are slightly larger. We attribute this difference to three factors: high-rise buildings are generally newer and have better thermal shells as well as more efficient equipment overall, the high-rise units have a smaller ratio of exterior surfaces to total

unit space, and heating and cooling in high-rise buildings is more often provided by central building systems.

Due to Seattle's relatively mild climate, across all housing types, space conditioning accounts for only 23% of annual use. Appliances represent 28% of usage, water heating 17%, and interior lighting 13%. Electronics, which includes personal computers, TVs, set top boxes, home audio, etc., represent 11% of use, while the miscellaneous end use, which encompasses such devices as furnace fans, pool pumps, hot tubs, and other "plug" loads (hair dryers, power tools, coffee makers, etc.), consumes about 7%.

Figure ES-4 Residential Intensity by End Use and Segment (kWh/household, 2012)

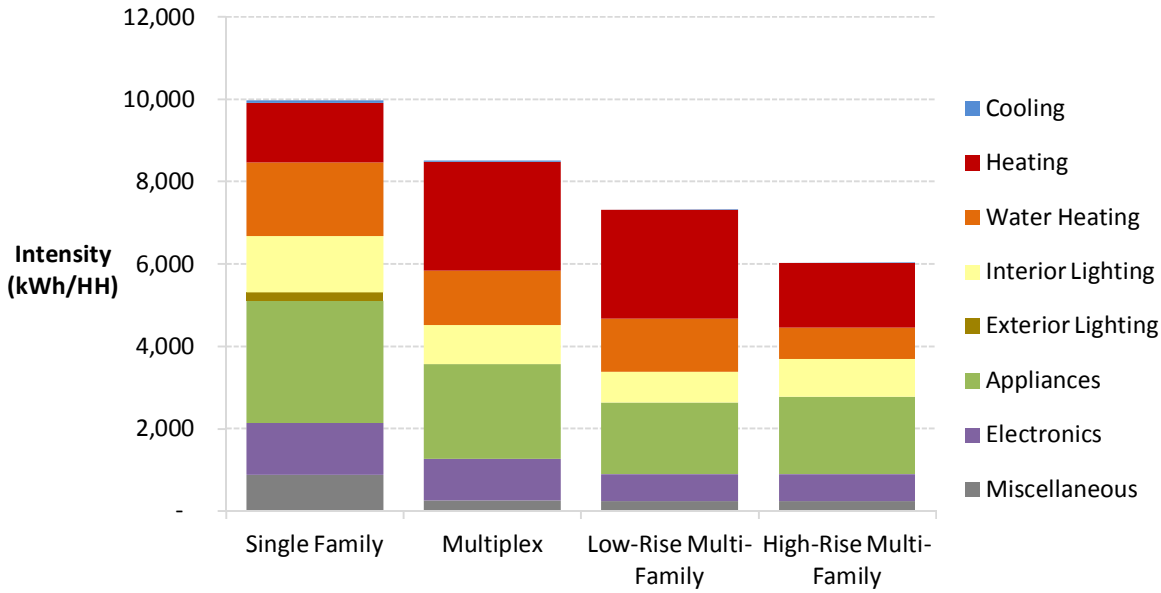


Figure ES-5 shows the percentage of the 2012 commercial sector energy use, 4,961,098 MWh, by each of the 16 segments analyzed for the CPA. The four largest segments are large office, college, data center, and retail, which together make up about 50% of sales in the commercial sector. The remaining segments individually constitute less than 6% of sales.

Figure ES-5 Share of Commercial Sector Electricity Use by Building Type, 2012

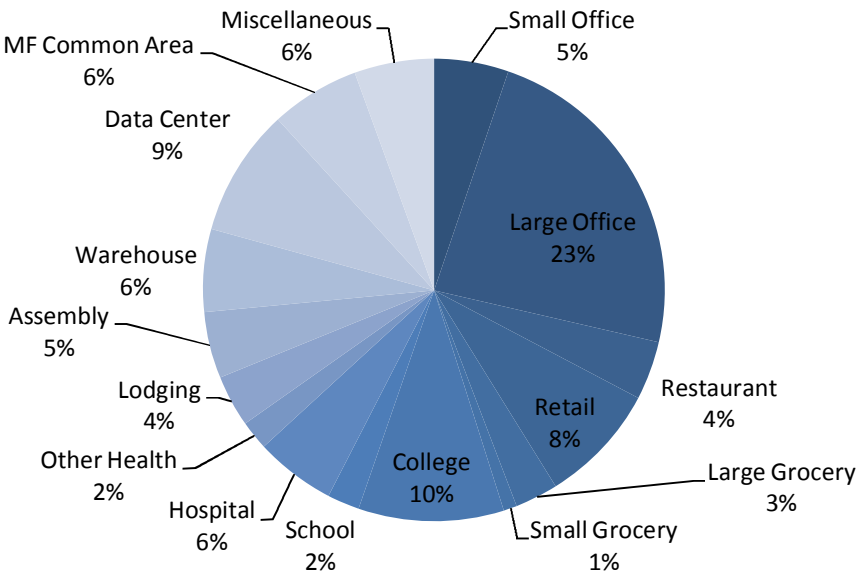
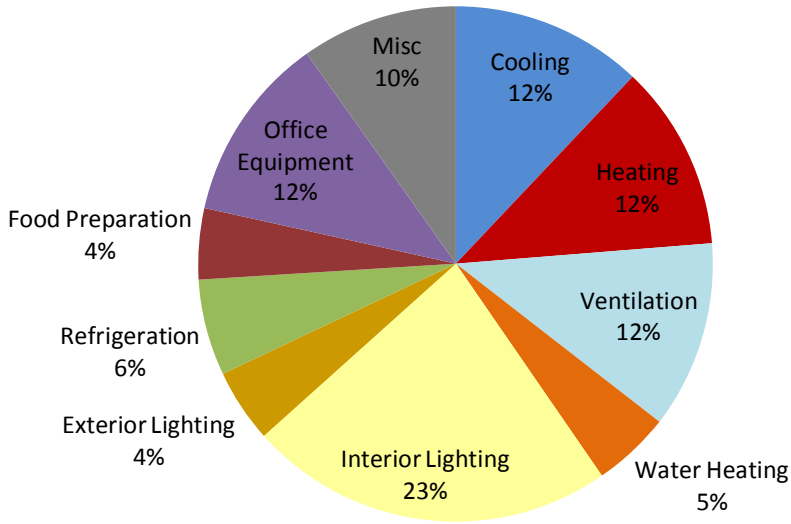


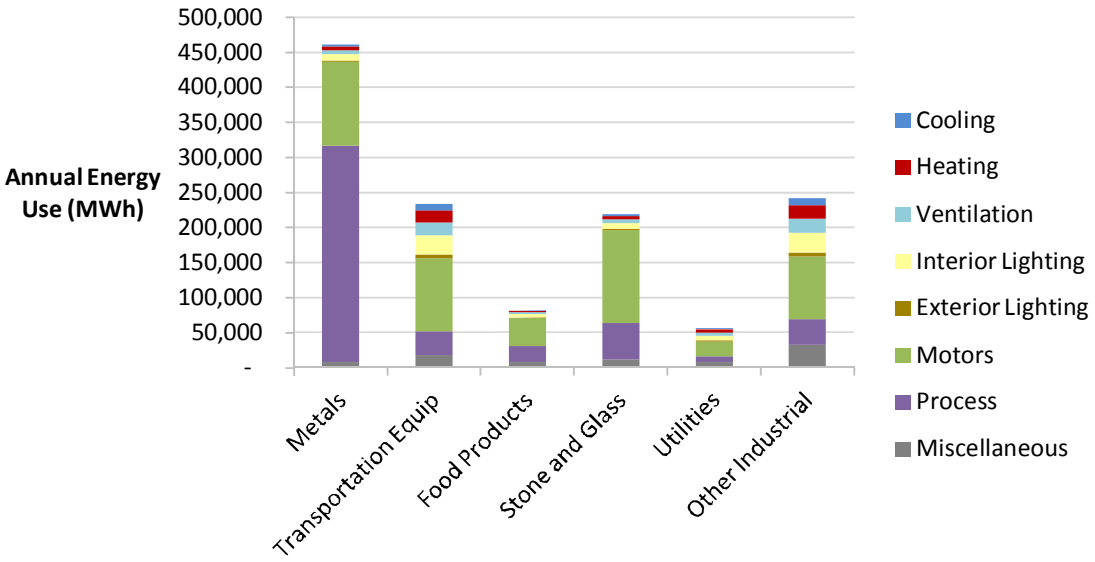
Figure ES-6 shows the breakdown of annual commercial electricity usage by end use for the commercial sector as a whole. Heating, ventilation, and cooling collectively account for 36% of energy use. Interior and exterior lighting combined represent 27% of consumption. Office equipment is significant as well, due to the large presence of data centers in the service territory. The relatively high consumption for the miscellaneous end use category, 10%, is due to the increasing use of various plug load equipment across all commercial building types. The remaining end uses — water heating, refrigeration, and food preparation — comprise 6% or less of total usage.

Figure ES-6 Commercial Electricity Consumption by End Use, 2012



The industrial sector used 1,294,369 MWh in 2012, representing about 13.6% of total City Light electricity sales. The five major industrial segments and their percentage of industrial use were identified as Metals (36%); Transportation Equipment (18%); Food Products (6%); Stone and Glass, including cement (17%); and Utilities including water and wastewater (4%). We combined the remaining industries into the Other Industrial category, which accounts for 19% of industrial use. Figure ES-7 shows each end use as a percentage of the segment's total use.

Figure ES-7 Industrial Electricity Use by End Use and Segment (MWh, 2012)



City Light reported street lighting usage of 91,879 MWh from its inventory of approximately 90,000 fixtures. The great majority of the street lighting fixtures, approximately 86%, are cobra head street lighting fixtures that traditionally use high-pressure sodium lamps. Beginning in 2010, City Light began replacing the cobra head street lighting fixtures with LED fixtures. Phase 1 of this project is expected to convert 40,763 fixtures by the end of 2013. Phase 2 of the project will begin in 2014.

Additional details of the Market Characterization appear in Chapter 3.

Baseline Projection

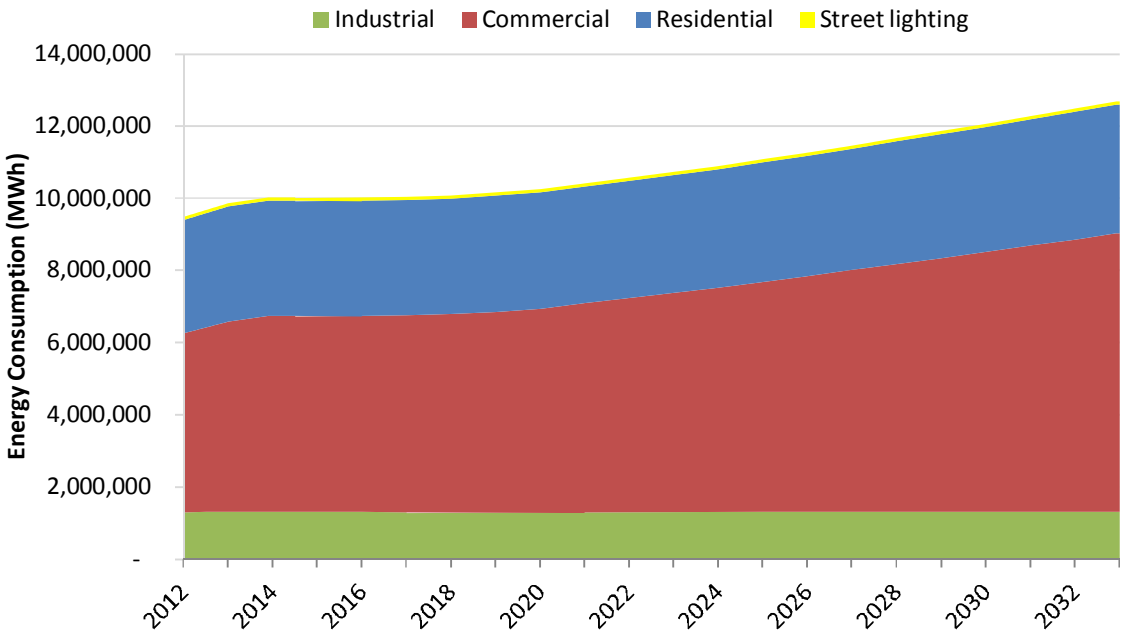
Prior to developing estimates of conservation potential, a baseline end-use projection was developed to quantify how electricity is used by end use in the base year and what the consumption is likely to be in the future in absence of new utility programs and naturally occurring conservation. The baseline projection serves as the metric against which conservation potentials are measured. The baseline projection we developed for City Light was within 5% of the City Light load forecasting group's forecast.

Table ES-4 and Figure ES-8 provide an overall summary of the baseline projection by sector and for City Light as a whole. Overall, the projection for the next 20 years grows steadily, with overall average annual growth of 1.4% per year, dominated by growth in the commercial sector.

Table ES-4 Baseline Projection Summary, All Sectors (MWh)

Sector	2012	2014	2015	2018	2023	2033	Avg. Growth Rate ('12-'33)
Residential	3,146,951	3,205,277	3,193,660	3,206,854	3,256,520	3,577,236	0.6%
Commercial	4,961,114	5,435,096	5,402,226	5,501,409	6,082,292	7,713,040	2.1%
Industrial	1,294,369	1,320,856	1,320,729	1,288,208	1,301,196	1,327,294	0.1%
Street Lighting	91,879	88,592	88,592	88,592	88,592	88,592	-0.2%
Total	9,494,313	10,049,821	10,005,208	10,085,063	10,728,599	12,706,161	1.4%

Figure ES-8 Baseline Projection Summary, All Sectors (MWh)



Additional details regarding the Baseline Projection by sector and end use appear in Chapter 4.

Conservation Potential

Conservation potential for all sectors combined appears above in Table ES-1 and Figure ES-1. Table ES-5 through Table ES-8 provide the various levels of potential for each of the individual sectors.

Table ES-5 Conservation Potential for the Residential Sector

	2014	2015	2018	2023	2028	2033
Baseline Projection (MWh)	3,205,277	3,193,660	3,206,854	3,256,520	3,395,213	3,577,236
Cumulative Savings (MWh)						
Achievable Potential	28,500	59,974	127,865	249,900	398,666	548,450
Economic Potential	130,668	247,102	415,827	504,274	662,997	833,258
Technical Potential	173,554	327,293	604,761	845,762	1,136,914	1,375,499
Cumulative Savings (aMW)						
Achievable Potential	3.3	6.8	14.6	28.5	45.5	62.6
Economic Potential	14.9	28.2	47.5	57.6	75.7	95.1
Technical Potential	19.8	37.4	69.0	96.5	129.8	157.0

Residential cumulative achievable potential by end use in 2015 is illustrated in Figure ES-9. Key insights are:

- **Interior lighting** provides the greatest achievable potential, with savings from both standard screw-in and specialty lighting.
- **Home electronics** offers the second largest achievable potential due primarily to televisions. Savings also come from efficient set-top boxes and digital video recorders.
- **Heating** savings are due mainly to the adoption of ductless heat pumps in single family and multiplex homes.
- **Interior lighting** provides the greatest achievable potential, with savings from both standard screw-in and specialty lighting. The study assumes that LED costs will continue to drop rapidly, and that they will be accepted by consumers.
- **Home electronics** offers the second largest achievable potential in the near term. A large portion of the savings is due to televisions. As noted above, the baseline for televisions was adjusted to more closely correspond to that used by NEEA for calculating savings. However, the market has transformed significantly, such that almost all TVs now sold are ENERGY STAR labeled. Savings also come from efficient set-top boxes and digital video recorders.
- **Heating** offers the third largest achievable potential, due mainly to the adoption of ductless heat pumps in single family and multiplex homes. Insulation measures are a small contributor to savings because City Light's long running programs have already achieved much of that potential.
- **Appliances** offer the next highest near-term savings. However, appliances' contribution to potential in future years diminishes as equipment standards move the market to efficient units.
- **Water Heating** achievable potential is limited in the near term because HPWH, which are the cost-effective option, still face significant market barriers. Therefore, most of the near-term water heating savings are due to low-flow showerheads and faucet aerators.
- **Behavioral measure,** assumed to be a comparative feedback program, provides savings across all end uses.

Figure ES-9 Residential Cumulative Achievable Potential by End Use in 2015

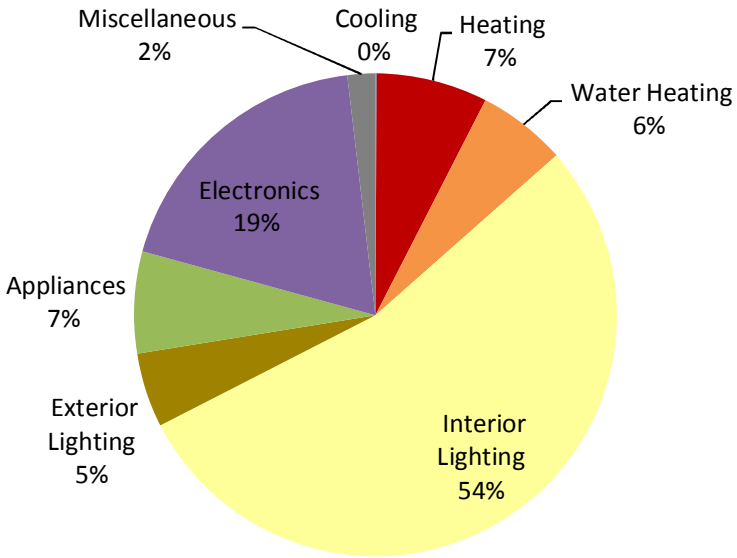


Table ES-6 Conservation Potential for the Commercial Sector

	2014	2015	2018	2023	2028	2033
Baseline Projection (MWh)	5,435,096	5,402,226	5,501,409	6,082,292	6,869,417	7,713,040
Cumulative Savings (MWh)						
Achievable Potential	47,025	95,335	234,290	680,625	1,172,913	1,503,855
Economic Potential	116,007	201,851	410,776	946,480	1,530,031	1,889,671
Technical Potential	157,533	265,915	541,388	1,186,159	1,878,483	2,346,823
Cumulative Savings (aMW)						
Achievable Potential	5.4	10.9	26.7	77.7	133.9	171.7
Economic Potential	13.2	23.0	46.9	108.0	174.7	215.7
Technical Potential	18.0	30.4	61.8	135.4	214.4	267.9

Figure ES-10 illustrates how the commercial cumulative achievable potential of 95,335 MWh in 2015 is distributed among the end uses. We note the following:

- Interior and exterior lighting combined represent nearly two-thirds of all potential, consistent with lighting's preponderance in technical and economic potential. Given that these are mature technologies, they have relatively high market acceptance.
- Ventilation provides 11% of achievable savings, while HVAC overall represents 16% of potential
- Office Equipment constitutes 13% of achievable potential, which reflects that efficient technologies in this area are both cost-effective and widely accepted in the market
- Water heating savings are modest at 2% of total achievable potential, despite significant technical and achievable potential. This reflects ongoing market barriers to widespread adoption of HPWH.

Figure ES-10 Commercial Cumulative Achievable Potential by End Use in 2015

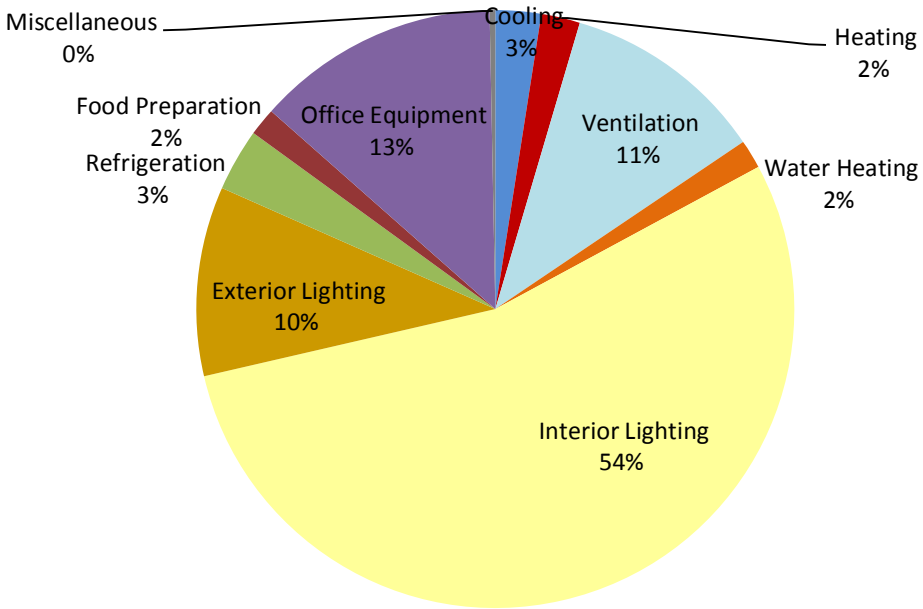


Table ES-7 Conservation Potential for the Industrial Sector

	2014	2015	2018	2023	2028	2033
Baseline Projection (MWh)	1,320,856	1,320,729	1,288,208	1,301,196	1,314,122	1,327,294
Cumulative Savings (MWh)						
Achievable Potential	14,509	22,765	37,031	69,591	90,627	106,463
Economic Potential	29,168	35,148	50,715	87,208	113,056	133,352
Technical Potential	34,913	42,346	61,822	114,501	155,932	177,887
Cumulative Savings (aMW)						
Achievable Potential	1.7	2.6	4.2	7.9	10.3	12.2
Economic Potential	3.3	4.0	5.8	10.0	12.9	15.2
Technical Potential	4.0	4.8	7.1	13.1	17.8	20.3

Figure ES-11 shows industrial cumulative achievable potential by end use in 2015. Motor end uses, which are 36% of achievable potential in 2015, also offer the greatest opportunity for energy savings across the all three levels of potential and all years. Because of motor standards, much of the cost-effective and achievable savings are not due to more efficient motors, but rather to controls and system optimization strategies. Process loads and lighting are the next greatest sources of savings, followed by ventilation.

Figure ES-11 Industrial Cumulative Achievable Potential by End Use in 2015

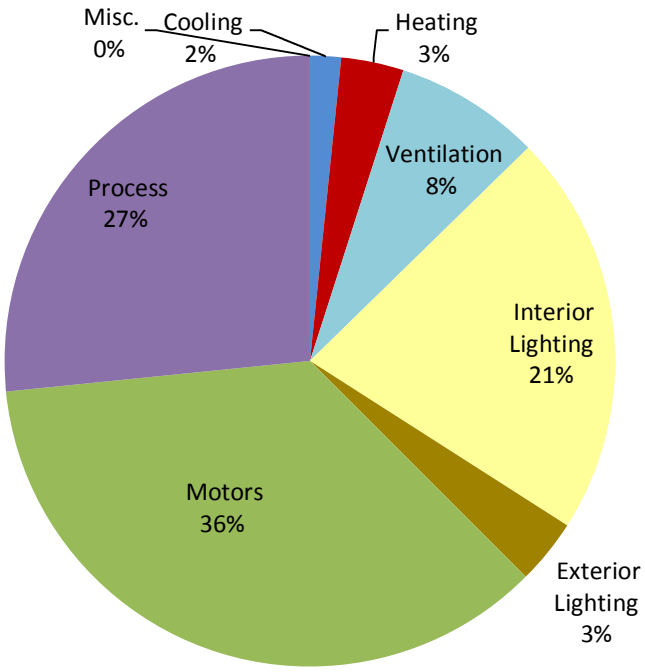


Table ES-8 Conservation Potential for the Street Lighting Sector

	2014	2015	2018	2023	2028	2033
Baseline Projection (MWh)	**88,592**	**88,592**	**88,592**	**88,592**	**88,592**	**88,592**
Cumulative Savings (MWh)						
Achievable Potential	9,950	19,901	34,185	36,861	36,876	36,876
Economic Potential	9,950	19,901	34,185	36,861	36,876	36,876
Technical Potential	10,455	20,910	35,793	38,581	38,581	38,581
Cumulative Savings (aMW)						
Achievable Potential	1.1	2.3	3.9	4.2	4.2	4.2
Economic Potential	1.1	2.3	3.9	4.2	4.2	4.2
Technical Potential	1.2	2.4	4.1	4.4	4.4	4.4

Additional details regarding potential by segment and the primary end uses and measures that contribute to potential appear in Chapter 5.

Avoided Cost Sensitivity Analysis

To assist City Light in evaluating variations in potential due to changes in avoided costs, EnerNOC also evaluated conservation potential, for the residential, commercial, and industrial sectors, based on an alternate stream of avoided costs. Street lighting measures were mainly cost-effective under the reference case, and thus were not modeled under the avoided costs alternative case.

- In the reference case, for which results are presented above, and referred to here as Market + CCT (combined cycle turbine), the avoided costs are based on market costs and assume that the marginal generation unit is a conventional combined cycle turbine. In addition, avoided costs include adders for

renewable energy credits, carbon dioxide offsets, transmission and distribution costs, and a 10% credit for the Regional Act Bonus, consistent with the Sixth Power Plan methodology. Note that City Light has sufficient capacity for the study period and thus did not provide an avoided cost of capacity.

- The second scenario, referred to here as the IRP Preferred Portfolio, assumed higher avoided energy costs starting in 2021 based on City Light's Integrated Resource Plan (IRP). City Light does not expect to acquire generation resources before roughly 2021. At this point, all new resources will be from a renewable source. As with the reference case, it also includes transmission and distribution costs and a 10% credit for the Regional Act Bonus. The changes in avoided costs affect economic potential directly and flow through to achievable potential. As avoided costs increase, the benefits of savings from conservation increase, causing the benefit-cost ratio to increase. If higher avoided costs result in measure B/C ratios rising to a value of 1.0 or above, then the measures are included in economic potential.

Figure ES-12 shows the two avoided costs streams used in the analyses. Table ES-9 compares the cumulative achievable and economic potential in 2023 under the two cases. Note that baseline and technical projections, which are independent of avoided costs, are the same in both cases. In 2023, achievable potential under the IRP Preferred Portfolio case is 1,077,688 MWh, or 104% of the 1,036,977 MWh reference case.

Figure ES-12 Avoided Costs of Energy Projections

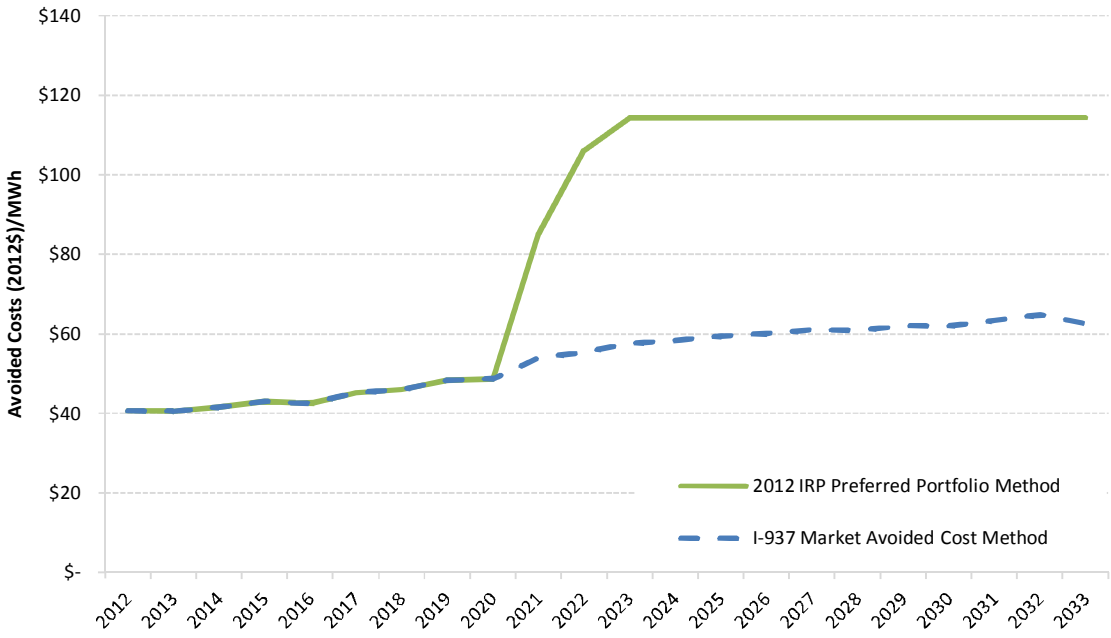


Table ES-9 Comparison of Potentials by Avoided Costs, 2023

Avoided Cost Case	Cumulative Achievable Potential	Change in Achievable Relative to I-937 Case	Cumulative Economic Potential	Change in Economic Relative to I-937 Case
I-937 Market Avoided Cost	1,036,977	n/a	1,574,823	n/a
2012 IRP Preferred Portfolio	1,077,688	104%	1,687,860	107%

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CHAPTER | 1

INTRODUCTION

Background

Seattle City Light (City Light or City Light) has contracted with EnerNOC Utility Solutions (EnerNOC) to conduct a conservation potential assessment (CPA) to quantify the amount, the timing, and the cost of electric conservation resources available within the City Light service territory. The study's purpose is to establish cost-effective and achievable energy conservation targets for 2014–2015 to meet the legal requirements associated with Washington Administrative Code 194-371 (Initiative 937 or I-937), as well as to support City Light's Integrated Resource Plan (IRP). In accordance with I-937, this CPA is informed by and uses methodology consistent with the Northwest Power and Planning Council (NPCC) Sixth Power Plan. This study updates City Light's last CPA, which EnerNOC performed for the 2013-2014 biennium.

Report Organization

The remainder of this report contains the following sections.

- Chapter 2 — Analysis Approach and Data Development
- Chapter 3 — Market Characterization and Market Profiles
- Chapter 4 — Baseline Projection
- Chapter 5 — Conservation Potential

Definition of Potential

In this study, we estimate the potential for conservation savings. The savings estimates represent gross savings developed into three levels of potential: technical potential, economic potential, and achievable potential. Technical and economic potential are both theoretical limits to conservation savings. Achievable potential embodies a set of assumptions about the decisions consumers make regarding the efficiency of the equipment they purchase, the maintenance activities they undertake, the controls they use for energy-consuming equipment, and the elements of building construction. The various levels are described below.

- **Technical potential** is defined as the theoretical upper limit of conservation potential. It assumes that customers adopt all feasible measures regardless of their cost. At the time of existing equipment failure, customers replace their equipment with the most efficient option available. In new construction, customers and developers also choose the most efficient equipment option. Technical potential also assumes the adoption of every other available measure, where applicable. For example, it includes installation of high-efficiency windows in all new construction opportunities and furnace maintenance in all existing buildings with furnace systems. These retrofit measures are phased in over a number of years, which is longer for higher-cost and complex measures.
- **Economic potential** represents the adoption of all ***cost-effective*** conservation measures. In this analysis, cost-effectiveness is measured by the total resource cost (TRC) test, which compares lifetime energy and capacity benefits to the incremental cost of the measure. If the benefits outweigh the costs (that is, if the TRC ratio is greater than 1.0), a given measure is included in the economic potential. Customers are then assumed to purchase the most cost-effective option applicable to them at any decision juncture.
- **Achievable potential** establishes a realistic target for the conservation savings that a utility can hope to achieve through its programs. It takes into account market maturity, customer preferences for energy-efficient technologies, and expected program participation, and is determined by applying a series of annual market adoption factors to the economic potential for each conservation measure. These factors represent the ramp rates at which technologies will penetrate the market. To develop these factors, the project team reviewed City Light's past conservation program achievements and

program history over the last five years, as well as the NPCC ramp rates used in the Sixth Plan. Details regarding the market adoption factors appear in Appendix E.

Abbreviations and Acronyms

Table 1-1 shows abbreviations or acronyms used in this report.

Table 1-1 Explanation of Abbreviations and Acronyms

Acronym	Explanation
ACS	American Community Survey
AEO	Annual Energy Outlook forecast developed annual by the Energy Information Administration of the DOE
B/C Ratio	Benefit to cost ratio
BEST	EnerNOC's Building Energy Simulation Tool
BPA	Bonneville Power Authority
C&I	Commercial and Industrial
CBECS	Commercial Building Energy Consumption Survey (prepared by EIA)
CBSA	NEAA Commercial Building Stock Assessment
CCT	Combined cycle turbine
CFL	Compact fluorescent lamp
CEUS	California Commercial End Use Survey
COMMEND	EPRI COMMercial END-use planning system
CPA	Conservation Potential Assessment
DEEM	EnerNOC's Database of Energy Efficiency Measures
DEER	State of California Database for Energy-Efficient Resources
DMI	Data Marketing Incorporated
DSM	Demand side management
EE	Energy efficiency
EER	Energy Efficiency Rating
EIA	Energy Information Administration
EISA	Energy Efficiency and Security Act of 2007
EPRI	Electric Power Research Institute
EUI	Energy-use index
EUL	Effective useful life
HH	Household
HID	High intensity discharge lamps
HPWH	Heat pump water heater
HVAC	Heating, ventilation, and air conditioning
I-937	Washington Initiative 937
IRP	Integrated Resource Plan

Acronym	Explanation
LED	Light emitting diode lamp
LoadMAP	EnerNOC's Load Management Analysis and PlanningTM tool
MECS	Manufacturing Energy Consumption Survey (prepared by EIA)
NEEA	Northwest Energy Efficiency Alliance
NPCC	Northwest Power and Conservation Council
RASS	California Residential Appliance Saturation Survey
RBSA	Residential Building Stock Assessment
RTF	Regional Technical Forum
REEPS	EPRI Residential End-use Energy Planning System
RBSA	NEAA Residential Building Stock Assessment
RCCS	City Light 2009 Residential Customer Characteristics Survey
RECS	Residential Energy Consumption Survey (prepared by EIA)
RTU	Roof top unit
SEEM	Simple Energy Enthalpy Model
SEER	Seasonal Energy Efficiency Rating
SCL	Seattle City Light
SIC	Standard Industrial Classification
Sq. ft.	Square feet
TRC	Total resource cost
UEC	Unit energy consumption
UES	Unit energy savings (as defined in RTF measure workbooks)

CHAPTER | 2

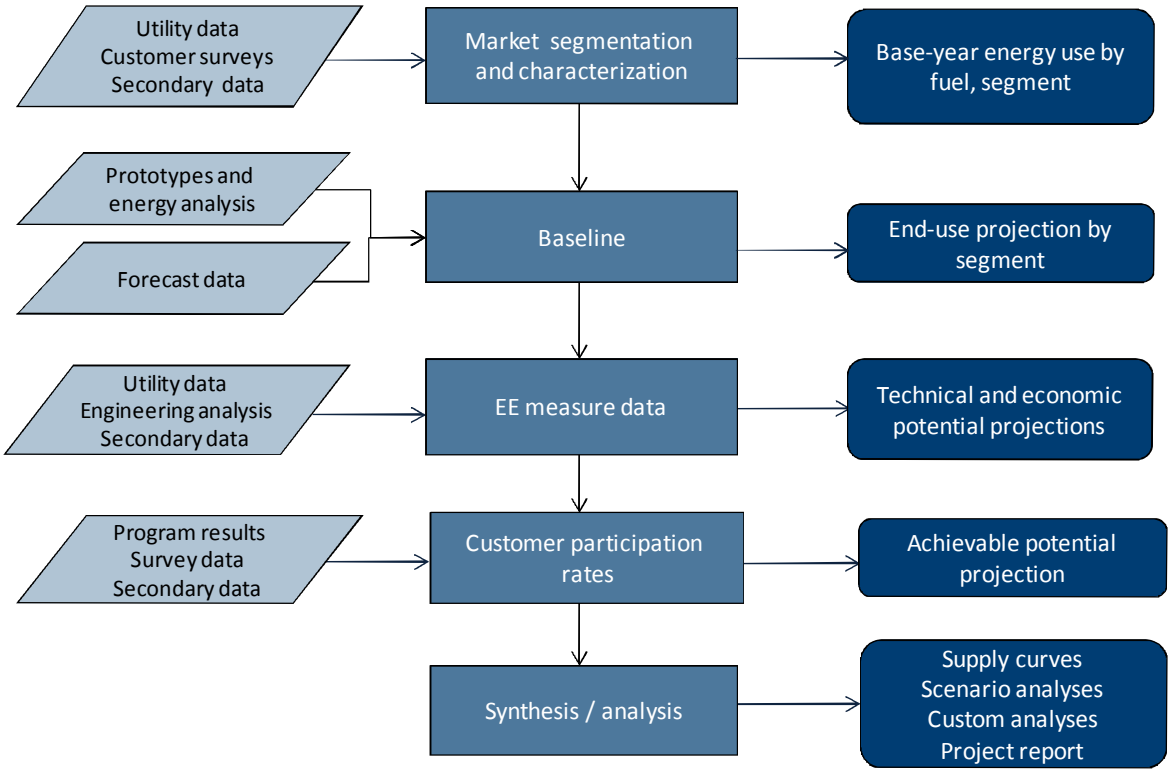
ANALYSIS APPROACH AND DATA DEVELOPMENT

This section describes the study analysis approach and the data sources EnerNOC used to develop the potential estimates.

Analysis Approach

EnerNOC employed a bottom-up analysis approach, as shown in Figure 2-1, to perform the conservation potential analysis.

Figure 2-1 Overview of Analysis Approach



The analysis involved the following steps.

1. Performed a market characterization to describe sector-level electricity use for the residential and non-residential (commercial and industrial) sectors for the base year, 2012. This step drew upon the market characterization from the 2011 CPA, but updated the characterization to incorporate new information from the NPCC, the Regional Technical Forum (RTF), the Northwest Energy Efficiency Alliance (NEEA) 2011 Residential Building Stock Assessment (RBSA), EnerNOC's own data, and the Energy Information Administration (EIA).
2. Developed a baseline electricity use projection by sector, segment, and end use for 2013 through 2033.
3. Identified and characterized conservation measures.
4. Estimated measure-level conservation potential for three cases: *Technical, Economic, and Achievable*.

The remainder of this chapter describes the analysis approach for these steps in further detail.

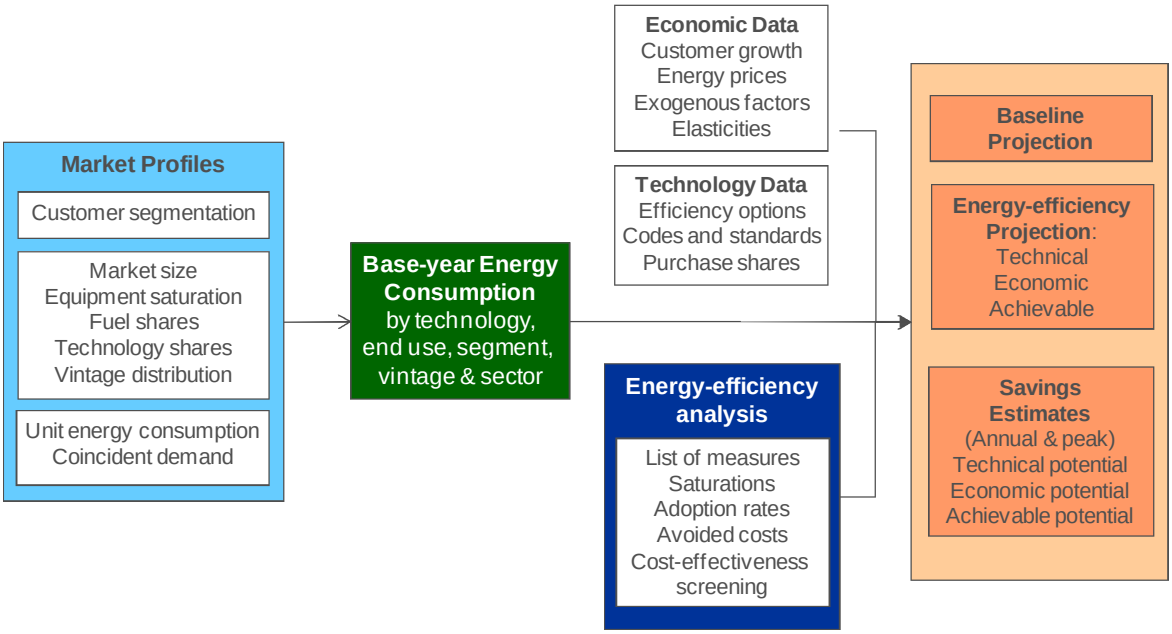
LoadMAP Model

We used EnerNOC's Load Management Analysis and Planning tool (LoadMAP™) version 3.0 to develop both the baseline projection and the estimates of conservation potential. EnerNOC developed LoadMAP in 2007 and has enhanced it over time, using it for the Electric Power Research Institute (EPRI) National Potential Study and numerous utility-specific potential studies. Built in Excel, the LoadMAP framework, illustrated in Figure 2-2, has the following key features.

- Embodies the basic principles of rigorous end-use models (such as EPRI's REEPS and COMMEND) but in a more simplified, accessible form.
- Includes stock-accounting algorithms that treat older, less efficient appliance/equipment stock separately from newer, more efficient equipment. Equipment is replaced according to the measure life and appliance vintage distributions defined by the user.
- Balances the competing needs of simplicity and robustness by incorporating important modeling details related to equipment saturations, efficiencies, vintage, and the like, where market data are available, and treats end uses separately to account for varying importance and availability of data resources.
- Isolates new construction from existing equipment and buildings and treats purchase decisions for new construction and existing buildings separately.
- Includes appliance and equipment models customized by end use. For example, the logic for lighting is distinct from refrigerators and freezers.

The LoadMAP model provides projections of baseline energy use by sector, segment, end use, and technology for existing and new buildings. It also provides projections of total energy use and conservation savings associated with the three levels of potential.

Figure 2-2 LoadMAP Analysis Framework



Market Characterization

To estimate the savings potential from conservation measures, it is necessary to understand how much energy customers use today and what equipment is consuming that energy. The project team began this characterization by segmenting City Light's energy footprint to quantify energy use by sector, segment, fuel, end-use application, and the current set of technologies used. The base year for this study is 2012, the most recent year for which City Light sales data were available.

Segmentation for Modeling Purposes

The market assessment first defined the market segments (building types, end uses and other dimensions) that are relevant in the City Light service territory. Table 2-1 presents this segmentation scheme.

Table 2-1 Overview of Segmentation Scheme for Potentials Modeling

Market Dimension	Segmentation Variable	Dimension Examples
1	Sector	Residential, commercial, industrial, street lighting
2	Building type	Residential (single family, multiplex, low-rise multifamily, high-rise multifamily) Commercial (small office, large office, restaurant, retail, etc.) Industrial (metals, transportation equipment, food products, stone and glass, utilities, other industrial)
3	Vintage	Existing and new construction
4	Fuel	Electricity
5	End uses	Cooling, space heating, lighting, water heat, motors, etc. (as appropriate by sector)
6	Appliances/end uses and technologies	Technologies such as lamp type, air conditioning equipment type, motors by application, etc.
7	Equipment efficiency levels for new purchases	Baseline and higher-efficiency options as appropriate for each technology

Following this scheme, we segmented the residential sector as described below, starting with customer segments by building type:

- Single family (including mobile homes)
- Multiplex (2–4 units)
- Low-Rise Multifamily (5 or more units in buildings 6 or fewer stories in height)
- High-Rise Multifamily (5 or more units in buildings 7 or more stories in height)

Mobile homes, which were a separate segment in the previous CPA but represent a small fraction of Seattle homes, are now included in the single family segment. The break between low-rise and high-rise multifamily corresponds to the number of stories used to separate building sizes in the RBSA.

In addition to segmentation by housing type, we identified the set of end uses and technologies that are appropriate for City Light's residential sector. These are shown in Table 2-2.

Table 2-2 Residential Electric End Uses and Technologies

End Use	Technology
Cooling	Central Air Conditioning (CAC)
Cooling	Room Air Conditioning (RAC)
Cooling/Space Heating	Air-Source Heat Pump
Heating	Electric Zonal Room Heat
Heating	Electric Furnace
Water Heating	Water Heater <= 55 Gal
Water Heating	Water Heater > 55 Gal
Interior Lighting	Screw-in Lamps
Interior Lighting	Linear Fluorescent Lamps
Interior Lighting	Specialty
Exterior Lighting	Screw-in Lamps
Appliances	Clothes Washer
Appliances	Clothes Dryer
Appliances	Dishwasher
Appliances	Refrigerator
Appliances	Freezer
Appliances	Second Refrigerator
Appliances	Stove
Appliances	Microwaves
Electronics	Personal Computers
Electronics	Monitor
Electronics	Laptops
Electronics	TVs
Electronics	Printer/Fax/Copier
Electronics	Set-top Boxes/DVR
Electronics	Devices and Gadgets
Miscellaneous	Pool Pump
Miscellaneous	Pool Heater
Miscellaneous	Hot Tub / Spa
Miscellaneous	Furnace Fan
Miscellaneous	Miscellaneous

The project team characterized non-residential energy as either commercial or industrial. For purposes of the CPA, we sought to distinguish between commercial facilities that are dominated by HVAC and lighting end uses, and industrial facilities, where the primary end uses are motors and process loads. This step facilitates modeling the efficiency measures that are most appropriate for the dominant end uses. As a result, some large energy users that City Light categorizes as commercial, such as the Port of Seattle and wastewater treatment facilities, are included in the industrial sector for purposes of the CPA. We also assigned to the industrial sector small industrial customers that may be considered commercial customers within City Light's records. Conversely, the project team assigned several facilities belonging to a large industrial customer, but which primarily contain office space, to the commercial sector for this analysis.

For the commercial sector, it is useful to think of the segments based on the unique characteristics of the type of building. This study used the building types listed below, which are largely consistent with those in the Sixth Plan.

- Small office
- Large office
- Restaurant
- Retail
- Large grocery
- Small grocery
- Warehouse
- School
- College
- Hospitals
- Other health
- Lodging
- Assembly
- Data centers
- Multifamily common area
- Miscellaneous

Table 2-3 lists the set of end uses and technologies for the commercial sector.

Table 2-3 Commercial Electric End Uses and Technologies

End Use	Technology
Cooling	Air-Cooled Chiller
Cooling	Water-Cooled Chiller
Cooling	Roof top AC
Cooling	Other Cooling
Cooling/Heating	Roof top Heat Pump
Heating	Electric Furnace
Heating	Electric Zonal Heat
Ventilation	Ventilation
Water Heating	Water Heater
Interior Lighting	Screw-in
Interior Lighting	High-Bay Fixtures
Interior Lighting	Linear Fluorescent
Exterior Lighting	Screw-in
Exterior Lighting	HID
Exterior Lighting	Linear Fluorescent
Refrigeration	Walk-in Refrigerator
Refrigeration	Reach-in Refrigerator
Refrigeration	Glass Door Display
Refrigeration	Open Display Case
Refrigeration	Icemaker
Refrigeration	Vending Machine
Food Preparation	Oven
Food Preparation	Fryer
Food Preparation	Dishwasher
Food Preparation	Hot Food Container
Office Equipment	Desktop Computer
Office Equipment	Laptop
Office Equipment	Server
Office Equipment	Monitor
Office Equipment	Printer/Copier/Fax
Office Equipment	POS Terminal
Miscellaneous	Non-HVAC Motors
Miscellaneous	Pool Pump
Miscellaneous	Pool Heater
Miscellaneous	Miscellaneous

Conservation potential studies typically segment the industrial sector by industry type. Because the industrial sector is complex, this study isolated the largest industries in terms of their energy use for analysis. The five major industrial segments we identified are Metals; Transportation Equipment; Food Products; Stone and Glass, including cement; and Utilities including water and wastewater. The remaining industries fall into the Other Industrial category.

In addition to segmentation by industry, we identified the set of end uses and technologies that are appropriate for City Light, as shown in Table 2-4.

Table 2-4 Industrial Electric End Uses and Technologies

End Use	Technology
Cooling	RTU
Cooling	Air-Cooled Chiller
Cooling	Water-Cooled Chiller
Cooling/Heating	Air-Source Heat Pump
Heating	Electric Resistance
Ventilation	Ventilation
Interior Lighting	Screw-in
Interior Lighting	High-Bay Fixtures
Interior Lighting	Linear Fluorescent
Exterior Lighting	Screw-in
Exterior Lighting	HID
Exterior Lighting	Linear Fluorescent
Motors	Pumps
Motors	Fans & Blowers
Motors	Compressed Air
Motors	Conveyors
Motors	Other Motors
Process	Process Heating
Process	Process Cooling
Process	Process Refrigeration
Process	Electrochemical Process
Process	Other Process
Miscellaneous	Miscellaneous

For the street lighting analysis, we did not divide the use into segments, but did allocate according to technology, based on City Light's data regarding its street lighting equipment inventory. The data identifies 93 categories based on fixture type (cobra head, low mount, flood, globe, wall mount, specific historic or architectural types, etc.) and wattage.

With the segmentation scheme defined, we then performed a high-level market characterization of electricity sales in the base year to allocate sales to each residential, commercial, and industrial customer segment. We used various data sources, as further described below and in Chapter 3, to identify the annual sales in each customer segment, as well as the number of customers for residential segments, the square footage for the commercial segments and employee count for the industrial segments. This information provided control totals (energy use and customers counts/square footage/employee totals) for calibrating the LoadMAP model to known data for the base-year.

Market Profiles

The project team next developed market profiles for each sector, customer segment, end use, and technology defined as described above. For each segment, we created two sets of market profiles. The *average* market profile represents existing vintage facilities in 2012. The new market profile characterizes new construction.

A market profile includes the following elements:

- **Market size** represents the number of customers in the segment. For the residential sector, it is the number of households. In the commercial sector, it is floor space measured in square feet. For the industrial sector, it is number of employees.
- **Saturations** define the fraction of homes, commercial square feet, or industrial employees with the various technologies. (e.g., homes with electric space heating).
- **UEC (unit energy consumption) or EUI (energy-use index)** describes the amount of energy that a specific technology consumed in 2012, in buildings that have the technology. UECs are expressed in kWh/household for the residential sector, while EUIs are expressed in kWh/square foot or kWh/employee for the commercial and industrial sectors respectively.

- **Intensity** for the residential sector represents the average energy use for the technology across all homes in 2012. We compute residential intensity as the product of the saturation and the UEC, with results expressed as kWh/household. For the commercial and industrial sector, intensity is the product of the saturation and the EUI, and represents the average use for the technology across all floor space or employees in 2012.
- **Usage** is the annual energy use by an end use technology in the segment. It is the product of the market size and intensity and is quantified in MWh. The market characterization results and the market profiles appear in Chapter 3.

Baseline Projection

The next step was to develop the baseline projection of annual electricity usage for 2013 through 2033 by sector, segment, and end use without new utility programs or naturally occurring efficiency. The end-use projection does include the relatively certain impacts of enacted codes and standards that will unfold over the study timeframe. All such mandates that were defined as of January 2012 are included in the baseline. The baseline projection is the foundation for the analysis of savings from future conservation efforts as well as the metric against which potential savings are measured.

Inputs to the baseline projection include:

- City Light historic sales data and conservation program achievements for 2007–2012
- Current economic growth projections (i.e., customer growth, income growth)
- Electricity price projections
- Trends in fuel shares and equipment saturations
- Existing and approved changes to building codes and equipment standards

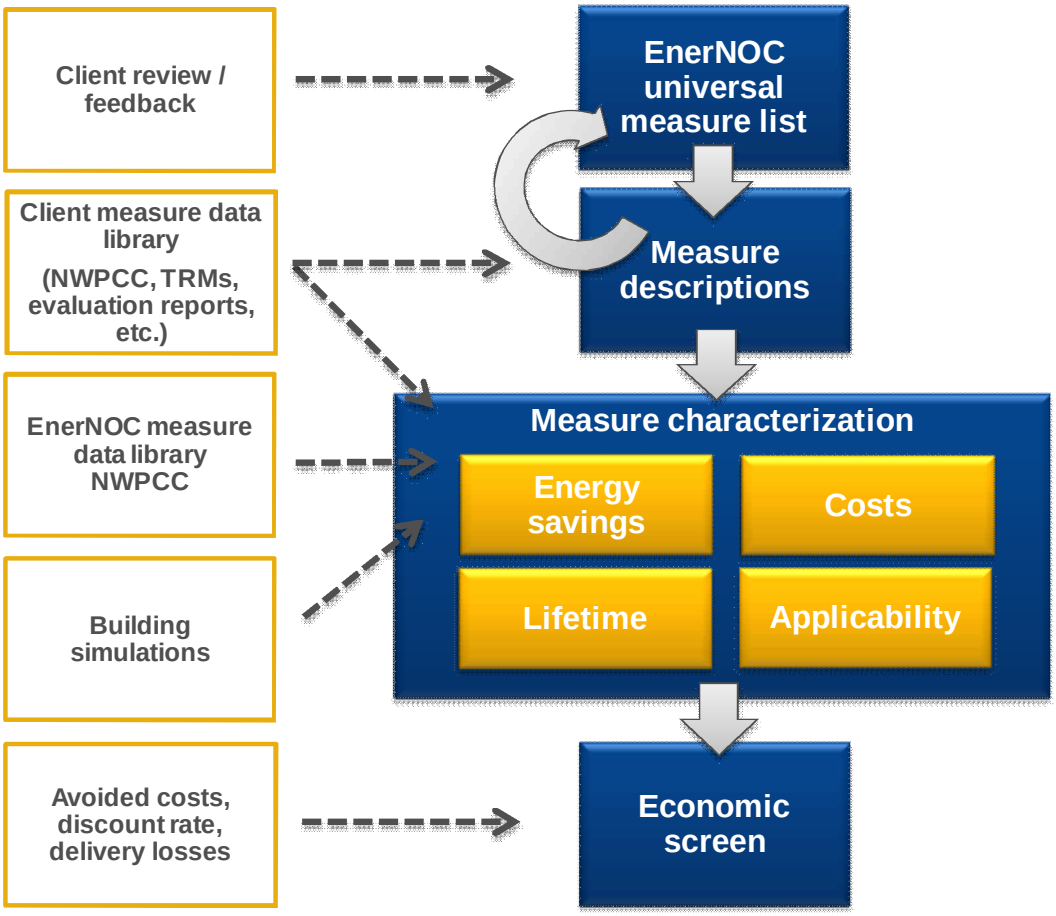
Conservation Measure Analysis

This section describes the framework used to assess the savings, costs, and other attributes of conservation measures. These characteristics form the basis for measure-level cost-effectiveness analyses as well as for determining measure-level savings. For all measures, EnerNOC assembled information on equipment performance, incremental costs, and equipment lifetimes. We used this information, along with City Light's avoided cost data, in the economic screen to determine cost-effective measures. Figure 2-3 outlines the framework for measure analysis.

The framework for assessing savings, costs, and other attributes of conservation measures involves identifying the list of conservation measures to include in the analysis, determining their applicability to each market sector and segment, fully characterizing each measure, and performing cost-effectiveness screening.

The first step of the conservation measure analysis was to identify the list of all relevant conservation measures that should be considered for the City Light potential assessment. EnerNOC prepared a preliminary list of measures that compared the list of measures included in City Light's previous CPA with those in the Sixth Plan, the RTF measure workbooks, and EnerNOC's own measure database in order to reconcile the various measure lists and provide the widest possible list of measures. This universal list of conservation measures covers all major types of end-use equipment, as well as devices and actions to reduce energy consumption. If considered today, some of these measures would not pass the economic screens initially, but may pass in future years as a result of lower projected equipment costs or higher avoided costs. After receiving feedback from City Light, we finalized the measures list. The final list included in the study, which reflects feedback and additions from City Light, is presented in Appendices B, C, and D for the residential, commercial, and industrial sectors respectively.

Figure 2-3 Approach for Measure Assessment



The selected measures are categorized into two types according to the LoadMAP taxonomy: equipment measures and non-equipment measures.

- **Equipment measures** are efficient energy-consuming pieces of equipment that save energy by providing the same service with a lower energy requirement than a standard unit. An example is an ENERGY STAR refrigerator that replaces a standard efficiency refrigerator. For equipment measures, many efficiency levels may be available for a given technology, ranging from the baseline unit (often determined by code or standard) up to the most efficient product commercially available. For instance, in the case of central air conditioners, this list begins with the current federal standard SEER 13 unit and spans a broad spectrum up to a maximum efficiency of a SEER 21 unit.
- **Non-equipment measures** save energy by reducing the need for delivered energy, but do not involve replacement or purchase of major end-use equipment (such as a refrigerator or air conditioner). An example would be a programmable thermostat that is pre-set to run heating and cooling systems only when people are home. Non-equipment measures can apply to more than one end use. For instance, addition of wall insulation will affect the energy use of both space heating and cooling. Non-equipment measures typically fall into one of the following categories:
  - Building shell (windows, insulation, roofing material)
  - Equipment controls (thermostat, energy management system)
  - Equipment maintenance (air conditioning and heat pump maintenance, changing setpoints)
  - Whole-building design (building orientation, passive solar lighting)
  - Lighting retrofits (included as a non-equipment measure because retrofits are performed prior to the equipment's normal end of life)

- Displacement measures (ceiling fan to reduce use of central air conditioners)
- Commissioning and retrocommissioning
- Behavioral programs

Table 2-5 summarizes the number of equipment and non-equipment measures evaluated for each segment within each sector.

Table 2-5 Number of Measures Evaluated

	Residential	Commercial	Industrial	Street Lighting	Total Number of Measures
Equipment Measures Evaluated	631	2,943	733	93	4,400
Non-Equipment Measures Evaluated	207	2,236	696	93	3,232
Total Measures Evaluated	838	5,179	1,429	186	7,632

Once we assembled the list of measures, the project team assessed their energy-saving characteristics. For each measure, we developed estimates of incremental cost, service life, and other performance factors, drawing upon data from the RTF measure workbooks, BPA data, and the Sixth Plan. Where measures were not characterized by the NPCC, the project team used data from EnerNOC's database of measure characteristics and simulation modeling. Following the measure characterization, we performed an economic screening of each measure, which serves as the basis for developing the economic potential.

Representative Measure Data Inputs

To provide an example of the measure data, Table 2-6 and Table 2-7 present examples of the detailed data inputs behind both equipment and non-equipment measures, respectively, for the case of air-source heat pumps in single-family homes. Table 2-7 displays the various efficiency levels available as equipment measures, as well as the corresponding useful life, energy usage, and cost estimates. The columns labeled On Market and Off Market reflect equipment availability due to codes and standards or the entry of new products to the market.

Table 2-6 Example Equipment Measures for Air-Source Heat Pump – Single Family Home

Efficiency Level	Useful Life	Equipment Cost	Energy Usage(kWh/yr)	On Market	Off Market
SEER 13, HSPF 7.7	15	1,002	4,176	2012	2014
SEER 14, HSPF 8.0	15	1,430	3,977	2012	n/a
SEER 15, HSPF 8.2	15	1,532	3,855	2012	n/a
SEER 16, HSPF 8.5	15	1,620	3,686	2012	n/a
SEER 18, HSPF 12.0	15	2,850	3,188	2012	n/a

Note: Energy usage includes both heating and cooling, where cooling is approximately 5% of total usage.

Table 2-7 lists some of the non-equipment measures applicable to heating in an existing single-family home. All measures are evaluated for cost-effectiveness based on the lifetime benefits relative to the cost of the measure. The total savings and costs are calculated for each year of the study and depend on the base year saturation of the measure, the applicability[3] of the measure, and the savings as a percentage of the relevant energy end uses.

[3] The applicability factors take into account whether the measure is applicable to a particular building type and whether it is feasible to install the measure. For instance, attic fans are not applicable to homes where there is insufficient space in the attic or there is no attic at all.

Table 2-7 Example Non-Equipment Measures – Single Family Home, Existing

End Use	Measure	Saturation in 2012[4]	Applicability	Lifetime (yrs)	Measure Installed Cost	Energy Savings (%)
Heating	Insulation – Ceiling	36%	94%	25	$694	8.1%
Heating	Insulation – Ducts inside	15%	90%	25	$726	3.5%
Heating	Insulation – Infiltration Control	24%	90%	25	$383	5.6%
Heating	Insulation – Wall Cavity	50%	90%	25	$5,724	3.4%
Heating	Ducting – Repair and Sealing	12%	90%	20	$831	11.3%
Heating	Doors - Storm and Thermal	38%	90%	25	$140	1.4%
Heating	Thermostat - Clock/Programmable	81%	95%	15	$118	10.5%
Heating	Central Heat Pump – Maintenance	41%	90%	2	$175	5.0%
Heating	Behavioral Measures	1%	90%	1	$10	1.0%

Screening Measures for Cost-Effectiveness

Only measures that are cost-effective are included in economic and achievable potential. Therefore, for each individual measure, LoadMAP performs an economic screen. This study uses the TRC test that compares the lifetime energy and peak demand benefits, as well as well as any non-energy benefits included in the RTF measure database, with the measure's incremental installed cost, including material and labor. The lifetime benefits are calculated by multiplying the annual energy and demand savings for each measure by all appropriate avoided costs for each year, and discounting the dollar savings to the present value equivalent. The analysis uses each measure's values for savings, costs, and lifetimes that were developed as part of the measure characterization process described above. The analysis also accounts for transmission and distribution losses, and for program administration costs.

The LoadMAP model performs this screening dynamically, taking into account changing savings and cost data over time. Thus, some measures pass the economic screen for some — but not all — of the years in the study period.

It is important to note the following about the economic screen:

- The economic evaluation of every measure in the screen is conducted relative to a baseline condition. For instance, in order to determine the kilowatt-hour (kWh) savings potential of a measure, kWh consumption with the measure applied must be compared to the kWh consumption of a baseline condition. For the City Light study, a weighted market baseline was used, consistent with NPCC methodology. For example, the energy use of an efficient LED would be compared against the weighted average energy usage of the prevailing market mix of incandescent, CFL, and LED lamps in a given year of the baseline case.
- The economic screening was conducted only for measures that are applicable to each building type and vintage; thus if a measure is deemed to be irrelevant to a particular building type and vintage, it is excluded from the respective economic screen.
- Non-energy benefits that are quantified by the RTF are accounted for in the LoadMAP model by means of an additional factor for measures that have these benefits, such as clothes washers that have water-related and/or detergent-related benefits.

[4] Note that saturation levels reflected for the base year change over time as more measures are adopted.

If the measure passes the screen with a benefit to cost (B/C) ratio greater than or equal to 1, based on the TRC test as defined by the NPCC, the measure is included in economic potential. Otherwise, it is screened out for that year. If multiple equipment measures have B/C ratios greater than or equal to 1.0, the most efficient technology is selected by the economic screen.

Conservation Potential

The approach we used for this study adheres to the approaches and conventions outlined in the National Action Plan for Energy-Efficiency (NAPEE) Guide for Conducting Potential Studies (November 2007).[5] The NAPEE Guide represents the most credible and comprehensive industry practice for specifying energy-efficiency potential. As described in Chapter 1, three types of potentials were developed as part of this effort: Technical potential, Economic potential, and Achievable potential.

- **Technical potential** is a theoretical construct that assumes the highest efficiency measures that are technically feasible to install are adopted by customers, regardless of cost or customer preferences. Thus, determining the technical potential is relatively straightforward. LoadMAP selects the most efficient equipment options for each technology at the time of equipment replacement. In addition, it installs all relevant non-equipment measures for each technology to calculate savings.

  For example, for an air-source heat pump, as shown in Table 2-6, the most efficient option is a SEER 18 system. The multiple non-equipment measures shown in Table 2-7 are then applied to the energy used by SEER 18 to further reduce heat pump energy use. LoadMAP applies the savings due to the non-equipment measures one-by-one to avoid double counting of savings. The measures are evaluated in order of their B/C ratio, with the measure with the highest B/C ratio applied first. Each time a measure is applied, the baseline energy use for the end use is reduced and the percentage savings for the next measure is applied to the revised (lower) usage.

- **Economic potential** results from the purchase of the most efficient cost-effective option available for a given equipment or non-equipment measure as determined in the cost-effectiveness screening process described above. As with technical potential, economic potential is a phased-in approach. Economic potential is still a hypothetical upper-boundary of savings potential as it represents only measures that are economic but does not yet consider customer acceptance and other factors.

- **Achievable potential** defines the range of savings that is very likely to occur. It accounts for customers' awareness of efficiency options, any barriers to customer adoption, limits to program design, and other factors that influence the rate at which conservation measures penetrate the market.

The calculation of technical and economic potential is straightforward as described above. To develop estimates for achievable potential, we specified market adoption rates for each measure and each year. For City Light, we began with the ramp rates specified in the Sixth Plan conservation workbooks. As appropriate, we adjusted these ramp rates to reflect Seattle-specific conditions and program history. For specific measures, we examined historic program results from 2007 through 2012. We then selected market acceptance rates so that the achievable potential for these measures in 2014 and 2015 aligned with the program history trends. For future years, we increased the potential factors to model increasing market acceptance and program improvements. For measures not currently included in City Light programs, we relied upon the Sixth Plan ramp rates and recent EnerNOC potential studies to create market adoption rates. The market adoption rates for each measure appear in Appendix D.

Results of all the potentials analysis are presented in Chapter 4.

Sensitivity Analysis

The reference case used avoided costs based on projected market costs of energy, assuming that the marginal generation unit is a conventional combined cycle turbine (CCT). In addition, avoided costs included adders for renewable energy credits, carbon dioxide offsets, transmission and distribution costs, and a 10% credit for the Regional Act bonus. Note that City Light has sufficient capacity for the study period and thus did not provide an avoided cost of capacity. To support the City Light Integrated Resource Plan

[5] National Action Plan for Energy Efficiency (2007). *National Action Plan for Energy Efficiency Vision for 2025: Developing a Framework for Change*. www.epa.gov/eeactionplan.

development, the EnerNOC team also developed a set of potential estimates based on a second stream of projected avoided costs, under a scenario corresponding to City Light's preferred resource portfolio.

Data Development

This section details the data sources EnerNOC used in this study, followed by a discussion of how we applied the data. In general, we adapted information to local conditions, for example, by using local sources for measure data and local weather for building simulations.

Data Sources

The data sources are organized into the following categories:

- City Light data
  - Data Marketing Incorporated (DMI) non-residential database
- NPCC and RTF data
- EnerNOC's databases and analysis tools
- Other secondary data and reports

Seattle City Light Data

Our highest priority data sources for this study were those that were specific to City Light.

- 2012 billing data — customer counts and electricity sales by sector (residential, commercial, industrial, outdoor lighting) from EIA Form 861
- Multifamily housing database based on King County Assessor data, representing 12,071 buildings and 174,158 multifamily housing units, and including information on number of stories, number of units in each building, and unit square footage
- Billing data for all non-residential customers including annual energy, Standard Industrial Classification (SIC) codes, and building type (where available)
- 2009 Residential Customer Characteristics Survey (RCCS) report, a residential saturation survey
- Energy forecast, at the sector level
- Forecasts of customer growth, persons per household, income, and business employment
- Price forecast
- Avoided energy costs forecast
- Discount rate
- Line loss factors
- Description of existing conservation programs and results from these programs
- Program administration expenses
- Inventory of street lighting fixtures from two City Light record keeping systems, including its Work and Asset Management System

Data Marketing, Incorporated

A unique aspect of this project was the work that DMI, EnerNOC's subcontractor, performed to characterize City Light's non-residential customers. DMI combined City Light's non-residential billing data with information from the King County Assessor to match assessor data on the building uses and square footage to City Light billing records. For purposes of the CPA, the primary objective was to improve how meter level energy use from billing records is allocated to specific commercial building or industrial segments. A second objective was to develop more accurate data on building square footage and energy intensity (kWh/sq.ft.) for each commercial building type segment. EnerNOC and City Light reviewed the DMI database, particularly the records for the 1,000 largest accounts, and adjusted the assignment of

records to segments as necessary to accurately reflect the facility's use. Beyond the CPA, City Light is using the resulting database to improve its understanding of its non-residential customers and their past participation in utility demand side management (DSM) programs, as well as to support future marketing activities.

Data resulting from DMI's work include:

- Energy use by building type or industry type
- Estimates of square footage by building type

Northwest Power and Conservation Council Data

- **NPCC Sixth Plan Conservation Supply Curve Workbooks, 2010.** To develop its Power Plan, the Council created workbooks with detailed information about measures, available at http://www.nwcouncil.org/energy/powerplan/6/supplycurves/default.htm .
- **RTF Unit Energy Savings Measure Workbooks:** The RTF maintains workbooks that characterize selected measures and provide data on unit energy savings (UES), measure cost, measure life, and non-energy benefits, available at http://www.nwcouncil.org/energy/rtf/measures/Default.asp.
- **RTF Standard Protocols:** The RTF also maintains standard workbooks containing useful information for characterizing more complex measures for which UES values have not been developed, such as commercial sector lighting.
- **Regional Technical Forum Residential Simple Energy Enthalpy Model (SEEM) modeling results:** http://rtf.nwcouncil.org/measures/support/Default.asp

EnerNOC Databases, Analysis Tools, and Reports

EnerNOC maintains several databases and modeling tools that we use for forecasting and potential studies.

- **EnerNOC Energy Market Profiles**: For more than 10 years, EnerNOC staff have maintained profiles of end-use consumption for the residential, commercial, and industrial sectors. These profiles include market size, fuel shares, unit consumption estimates, and annual energy use by fuel (electricity and natural gas), customer segment and end use for 10 regions in the U.S. The Energy Information Administration surveys — Residential Energy Consumption Survey (RECS), Commercial Building Energy Consumption Survey (CBECS), and Manufacturing Energy Consumption Survey (MECS) as well as state-level statistics and local customer research provide the foundation for these regional profiles.
- **Building Energy Simulation Tool (BEST)**. EnerNOC's BEST is a derivative of the DOE 2.2 building simulation model, used to estimate base-year UECs and EUIs, as well as measure savings for the HVAC-related measures.
- **EnerNOC's EnergyShape™:** This database of load shapes includes the following: Residential – electric load shapes for 10 regions, 3 housing types, 13 end uses; Commercial – electric load shapes for 9 regions, 54 building types, 10 end uses; Industrial – electric load shapes, whole facility only, 19 2-digit SIC codes, as well as various 3-digit and 4-digit SIC codes
- **EnerNOC's Database of Energy Efficiency Measures (DEEM):** EnerNOC maintains an extensive database of measure data for our studies. Our database draws upon reliable sources including the California Database for Energy Efficient Resources (DEER), the EIA Technology Forecast Updates – Residential and Commercial Building Technologies – Reference Case, RS Means cost data, and Grainger Catalog Cost data.
- **Recent studies**. EnerNOC has conducted numerous studies of conservation potential in the last five years. We checked our input assumptions and analysis results against the results from these other

studies, which include Idaho Power, and Avista. In addition, we used the information about impacts of building codes and appliance standards from a recent report for the Institute for Energy Efficiency.[6]

Other Secondary Data and Reports

Finally, EnerNOC used a variety of secondary data sources and reports for this study. The main sources are as follows:

- **Residential Building Stock Assessment, Single Family:** NEEA's 2011 Residential Building Stock Assessment (RBSA) provides results of a regional survey. City Light requested an oversample, resulting in 141 homes from City Light's service territory being included in the total sample of 1,404 homes. The single family survey also includes multiplex (2–4 units) homes. http://neea.org/docs/reports/residential-building-stock-assessment-single-family-characteristics-and-energy-use.pdf?sfvrsn=6
- **Residential Building Stock Assessment, Multifamily:** At the time of this project, the report on NEEA's 2011 RBSA multifamily homes survey had not yet been published. City Light had commissioned the RBSA contractor, Ecotope, to perform an oversample within City Light's service territory. Although the full report was not available, Ecotope provided summary tables, with results from the 111 buildings and 234 units in the City Light service territory. The report was published in September, 2013. http://neea.org/docs/default-source/reports/residential-building-stock-assessment--multi-family-characteristics-and-energy-use.pdf?sfvrsn=4
- **Commercial Building Stock Assessment:** NEEA's Commercial Building Stock Assessment (CBSA) provides data on regional commercial buildings. As of the most recent update in 2009, the database contains site-specific information for 2,061 buildings. http://neea.org/resource-center/regional-data-resources/commercial-building-stock-assessment
- **Bonneville Power Authority (BPA) Reference Deemed Measure List**, version 2.5, which was the most recent available when the study was performed.
- **American Community Survey:** The US Census American Community Survey (ACS) is an ongoing survey that provides data every year on household characteristics. http://www.census.gov/acs/www/
- **Residential Energy Consumption Survey (RECS).** http://www.eia.gov/consumption/residential/data/2009/
- **Annual Energy Outlook**. The Annual Energy Outlook (AEO), conducted each year by the EIA presents yearly projections and analysis of energy topics. For this study, we used data from the 2011 AEO.
- **California Statewide Surveys**. The Residential Appliance Saturation Survey (RASS) and the Commercial End Use Survey (CEUS) are comprehensive market research studies conducted by the California Energy Commission. These databases provide a wealth of information on appliance use in homes and businesses. RASS is based on information from almost 25,000 homes and CEUS is based on information from a stratified random sample of almost 3,000 businesses in California.
- **Database for Energy Efficient Resources (DEER).** The California Energy Commission and California Public Utilities Commission sponsor this database, which is designed to provide well-documented estimates of energy and peak demand savings values, measure costs, and effective useful life (EUL) for the state of California. We used the DEER database to cross check the measure savings we developed using BEST and DEEM.
- **Electric Power Research Institute — Assessment of Achievable Potential from Energy Efficiency and Demand Response Programs in the U.S.**, also known as the EPRI National Potential Study (2009). In 2009, EPRI hired EnerNOC to conduct an assessment of the national potential for energy efficiency, with estimates derived for the four DOE regions.

[6] "Assessment of Electricity Savings in the U.S. Achievable through New Appliance/Equipment Efficiency Standards and Building Efficiency Codes (2010 – 2025)." Global Energy Partners, LLC for the Institute for Electric Efficiency, May 2011. http://www.edisonfoundation.net/iee/reports/IEE_CodesandStandardsAssessment_2010-2025_UPDATE.pdf

- **EPRI End-Use Models (REEPS and COMMEND)**. These models provide the elasticities we apply to electricity prices, household income, home size and heating and cooling.
- **Other relevant sources.** These include reports from the Consortium for Energy Efficiency, the EPA, and the American Council for an Energy-Efficient Economy.

Data Application

We now discuss how the data sources described above were used for each step of the study.

Data Application for Residential Market Characterization

To construct the high-level market characterization of electricity use and number of households for each segment, we applied the following data sources:

- City Light billing data reported on EIA Form 861
- ACS census data on distribution of households for each housing type
- 2009 RCCS, RBSA, and RTF/SEEM data on average energy use per household
- King County Assessor data on multifamily housing buildings

Table 2-8 shows the sample sizes in the various survey data used for residential market characterization.

Table 2-8 Sample Size in Data Sources Used for Residential Market Characterization

Sample size	RCCS 2009	RBSA Single Family Oversample	RBSA Multifamily Oversample Buildings	RBSA Multifamily Oversample Units	Multifamily Assessor data
Single Family	1,753	140			
Multiplex	112	1			2,007
Low- Rise Multifamily	447		90	234	100,156
High-Rise Multifamily			21		18,861
Total	**2,312**	**141**	**111**	**234**	**121,024**

Data Application for Non-Residential Market Characterization

To construct the high-level market characterization of electricity use and intensity (energy use/square foot for commercial buildings and energy use/employee for industrial), EnerNOC applied the following data sources:

- City Light billing data reported on EIA Form 861
- DMI database incorporating City Light billing data and King County Assessor data

Data Application for Street Lighting Characterization

- City Light street lighting equipment inventory data
- City Light street lighting efficiency upgrades results to date

Data Application for Market Profiles

The specific data elements for the market profiles, together with the key data sources, are shown in Table 2-9. To develop the market profiles for each segment, we used the following approach:

1. Developed control totals for each segment. These include market size, segment-level annual electricity use, and annual intensity.
2. Used the Sixth Plan, RTF/SEEM data, NEEA reports including the recently released RBSA Single Family report, City Light's RCCS, BEST simulation results, and City Light program results data to provide information about market size for customer segments, appliance and equipment saturations,

appliance and equipment characteristics, UECs, EUIs, building characteristics, customer behavior, operating characteristics, and energy-efficiency actions already taken.

3. Incorporated secondary data sources to supplement and corroborate the data from items 1 and 2 above.
4. Compared and cross-checked with regional data obtained as part of the EPRI National Potential Study and with the Energy Market Profiles Database.
5. Ensured calibration to control totals for annual electricity sales in each sector and segment.
6. Worked with City Light staff to vet the data against their knowledge and experience.

The specific data elements for the market profiles, together with the key data sources, are shown in Table 2-9.

Table 2-9 Data Applied for the Market Profiles

Model Inputs	Description	Key Sources
Market size	Base-year residential dwellings, commercial floor space, and industrial employment	City Light billing data, King County Assessor multifamily data, DMI database, NEEA reports, NPCC Sixth Plan
Annual intensity	Residential: Annual energy use (kWh/household) Commercial: Annual energy use (kWh/ sq ft) Industrial: Annual energy use (kWh/employee)	City Light billing data, DMI analysis, Energy Market Profiles, NEEA reports, AEO, previous studies
Appliance/equipment saturations	Fraction of dwellings with an appliance/technology; Percentage of commercial floor space or industrial employment with equipment/technology	NEAA reports, RECS, Energy Market Profiles, and other secondary data
UEC/EUI for each end-use technology	UEC: Annual electricity use for a technology in dwellings that have the technology EUI: Annual electricity use per square foot/employee for a technology in floor space that has the technology	NEAA reports, RTF/SEEM data, RTF UES workbooks, RASS, CEUS, engineering analysis, BEST prototype simulations, engineering analysis
Appliance/equipment vintage distribution	Age distribution for each technology	NEEA reports, RASS, CEUS, secondary data (DEEM, EIA, EPRI, DEER, etc.)
Efficiency options for each technology	List of available efficiency options and annual energy use for each technology	Prototype simulations, engineering analysis, appliance/equipment standards, secondary data (DEEM, EIA, EPRI, DEER, etc.)

Data Application for Baseline Projection

Table 2-10 summarizes the LoadMAP model inputs requirements. These inputs are required for each segment within each sector, as well as for new construction and existing dwellings/buildings.

Table 2-10 Data Needs for the Baseline Projection and Potentials Estimation in LoadMAP

Model Inputs	Description	Key Sources
Customer growth forecasts	Forecasts of new construction in residential and C&I sectors	Data provided by City Light
Equipment purchase shares for baseline projection	For each equipment/technology, purchase shares for each efficiency level; specified separately for existing equipment replacement and new construction	Shipments data from AEO AEO 2012 regional forecast assumptions RTF data on current market baseline RBSA Appliance/efficiency standards analysis City Light program results
Electricity prices	Forecast of average energy and capacity avoided costs and retail prices	City Light projections
Utilization model parameters	Price elasticities, elasticities for other variables (income, weather)	EPRI's REEPS and COMMEND models AEO 2011 City Light's historical data for normal cooling & heating degree days.

We developed initial baseline purchase shares based on the Energy Information Agency's *Annual Energy Outlook* report (2011), which utilizes the National Energy Modeling System to produce a self-consistent supply and demand economic model. We adjusted the purchase shares in some cases where data was available from the RBSA, the RTF, or City Light conservation program results to reflect market transformation that has already occurred in the City Light service territory. For example, for compact fluorescent lighting (CFL), we matched the baseline purchase shares to the existing market saturation from the RBSA to reflect the assumption that for sockets already converted to CFLs, consumers will continue to purchase CFLs.

Beyond 2013, we assumed a frozen efficiency case in which the purchase shares for efficient equipment do not change during the study period, unless equipment standards remove a technology option from the market. Table 2-11 through Table 2-13 show the assumptions regarding upcoming equipment standards, based on known standards as of January 2013. This approach, which is consistent with the NPCC methodology, removes from the baseline any effects of naturally occurring conservation or effects of future DSM programs. Thus the CPA's resulting projections of potential compared to this baseline are gross, because naturally occurring conservation effects have been removed.

Table 2-11 Residential Electric Equipment Standards Applicable to City Light

Today's Efficiency or Standard Assumption | 1st Standard (relative to today's standard) | 2nd Standard (relative to today's standard)

End Use	Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Cooling	Central AC	SEER 13				SEER 14										
	Room AC	EER 9.8			EER 11.0											
Cooling/Heating	Heat Pump	SEER 13.0/HSPF 7.7				SEER 14.0/HSPF 8.0										
Water Heating	Water Heater (<=55 gallons)	EF 0.90				EF 0.95										
	Water Heater (>55 gallons)	EF 0.90				Heat Pump Water Heater										
Lighting	Screw-in/Pin Lamps	Incandescent			Advanced Incandescent - tier 1						Advanced Incandescent - tier 2					
	Linear Fluorescent	T8														
Appliances	Refrigerator/2nd Refrigerator	NAECA Standard			25% more efficient											
	Freezer	NAECA Standard			25% more efficient											
	Dishwasher	Conventional (355 kWh/yr)		14% more efficient (307 kWh/yr)												
	Clothes Washer	Conventional (MEF 1.26 for top loader)				MEF 1.72 for top loader			MEF 2.0 for top loader							
	Clothes Dryer	Conventional (EF 3.01)				5% more efficient (EF 3.17)										
	Range/Oven	Conventional														
	Microwave	Conventional														

Table 2-12 Commercial Electric Equipment Standards Applicable to City Light

Today's Efficiency or Standard Assumption | 1st Standard (relative to today's standard) | 2nd Standard (relative to today's standard)

End Use	Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Cooling	Chillers	2007 ASHRAE 90.1														
	Roof Top Units	EER 11.0/11.2														
	Packaged Terminal AC/HP	EER 9.8	EER 11.0													
Lighting	Screw-in/Pin Lamps	Incandescent			Advanced Incandescent - tier 1						Advanced Incandescent - tier 2					
	Linear Fluorescent	T12	T8													
	High Intensity Discharge	Metal Halide														
Refrigeration	Walk-in Refrigerator/Freezer	EISA 2007 Standard														
	Reach-in Refrigerator	EPACT 2005 Standard														
	Glass Door Display	EPACT 2005 Standard	42% more efficient													
	Open Display Case	EPACT 2005 Standard	18% more efficient													
	Vending Machines	EPACT 2005 Standard	33% more efficient													
	Icemaker	2010 Standard														
Miscellaneous	Non-HVAC Motors	62.3% Efficiency				70% Efficiency										
	Commercial Laundry	MEF 1.26		MEF 1.6												

Table 2-13 Industrial Electric Equipment Standards Applicable to City Light

Today's Efficiency or Standard Assumption
1st Standard (relative to today's standard)
2nd Standard (relative to today's standard)

End Use	Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Cooling	Chillers	2007 ASHRAE 90.1														
	Roof Top Units	EER 11.0/11.2														
	Packaged Terminal AC/HP	EER 9.8	EER 11.0													
Lighting	Screw-in/Pin Lamps	Incandescent			Advanced Incandescent - tier 1						Advanced Incandescent - tier 2					
	Linear Fluorescent	T12	T8													
	High Intensity Discharge	Metal Halide														
Machine Drive	Less than 5 HP	62.3% Efficiency				70% Efficiency										
	5-24 HP	EISA 2007 Standards														
	25-99 HP	EISA 2007 Standards														
	100-249 HP	EISA 2007 Standards														
	250-499 HP	EISA 2007 Standards														
	500 or more HP	EISA 2007 Standards														

Conservation Measure Data Application

Table 2-14 details the data sources used for measure characterization.

Table 2-14 Data Needs for the Measure Characteristics in LoadMAP

Model Inputs	Description	Key Sources
Energy Impacts	The annual reduction in consumption attributable to each specific measure. Savings were developed as a percentage of the energy end use that the measure affects.	City Light program results RTF workbooks NPCC workbooks BPA Reference Deemed Measure List NEEA reports BEST DEEM DEER Other secondary sources
Peak Demand Impacts	Savings during the peak demand periods are specified for each electric measure. These impacts relate to the energy savings and depend on the extent to which each measure is coincident with the system peak.	BEST EnergyShape
Costs	Equipment Measures: Includes the full cost of purchasing and installing the equipment on a per-household, per-square-foot, or per employee basis for the residential, commercial, and industrial sectors, respectively. Non-equipment measures: Existing buildings – full installed cost. New Construction - the costs may be either the full cost of the measure, or as appropriate, it may be the incremental cost of upgrading from a standard level to a higher efficiency level.	City Light program results RTF workbooks NPCC workbooks BPA Reference Deemed Measure List DEEM DEER RS Means Other secondary sources
Measure Lifetimes	Estimates derived from the technical data and secondary data sources that support the measure demand and energy savings analysis.	City Light program results RTF workbooks NPCC workbooks BPA Reference Deemed Measure List NEEA reports DEEM DEER Other secondary sources
Applicability	Estimate of the percentage of either dwellings in the residential sector or square feet/employment in the C&I sector where the measure is applicable and where it is technically feasible to implement.	DEEM DEER RTF workbooks NPCC workbooks Other secondary sources
On Market and Off Market Availability	Expressed as years for equipment measures to reflect when the equipment technology is available or no longer available in the market.	EnerNOC appliance standards and building codes analysis

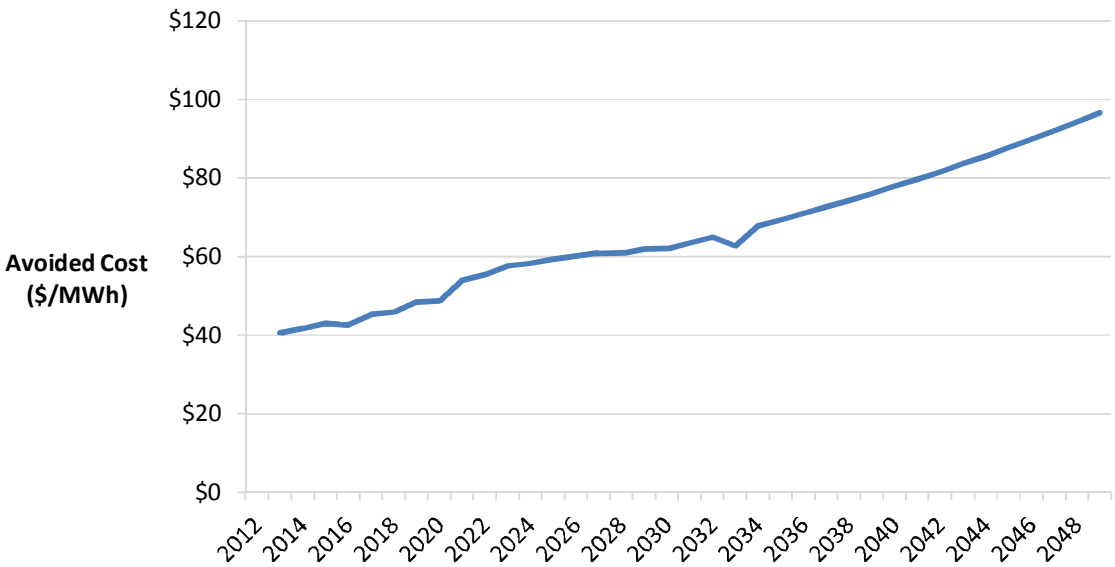
Data Application for Cost-effectiveness Screening

To perform the cost-effectiveness screening, EnerNOC applied the following information:

- Preliminary avoided cost of energy and capacity provided by City Light, as shown in Figure 2-4. In the reference case, the avoided costs are based on market costs and assume that the marginal generation unit is a conventional CCT. In addition, avoided costs include adders for renewable energy credits, carbon dioxide offsets, transmission and distribution costs, and a 10% credit for the Regional Act Bonus. Note that City Light has sufficient capacity for the study period and thus did not provide an avoided cost of capacity.
- Line losses of 9.1%, provided by City Light
- Discount rate of 3%, provided by City Light

- Program administration costs. Program administration costs are a significant portion of DSM program budgets, and can vary based on the particular market and delivery mechanism. For this study, we used values of 20% of incremental measure costs, consistent with the Sixth Plan.

Figure 2-4 Avoided Costs of Energy Projection.



Achievable Potential Estimation

To estimate potentials, two sets of parameters were required.

- **Diffusion rates for non-equipment measures.** The CPA approach assumes that equipment is replaced at the end of its useful life. But for non-equipment measures, a set of factors is required to model the gradual implementation over time. Rather than all non-equipment measures being installed in the first year of the projection (instantaneous potential), the LoadMAP model phases them in according to diffusion schedules that vary based on equipment cost and measure complexity, to emulate the diffusion rates of the stock turnover model for equipment measures. These diffusion rates are used within LoadMAP to generate the technical and economic potentials.
- **Market acceptance rates (MARs).** These factors are applied to Economic potential to estimate Achievable potential. We developed these factors by beginning with the NPCC ramp rates but then adjusting them to reflect City Light's DSM program history.

MARs are included in Appendix E.

Consistency with the Sixth Plan Methodology

The CPA approach is consistent with the Sixth Plan's methodology and fulfills the requirements of the utility analysis option as specified in WAC 194-37-070 subsection (6), (a)(i) through (xv).[7] This CPA, like the Sixth Plan, uses an end-use model, with a bottom-up approach that distinctly considers and accounts for the following:

- Building characteristics
- Fuel and equipment saturations
- Measure life
- Stock accounting

[7] http://apps.leg.wa.gov/WAC/default.aspx?cite=194-37&full=true

- Existing and new vintage
- Lost- and non-lost opportunities
- Measure saturation and applicability
- Measure savings, including contribution to peak
- Customer growth
- Economic trends

Like the Sixth Plan, the CPA uses a frozen efficiency approach that assumes equipment efficiency purchase decisions are fixed, with the exception of changes due to the phase in of new codes and standards. The CPA determines cost-effectiveness based on the Total Resource Cost test, as defined by the NPCC. It includes non-energy benefits, as well as the Regional Act 10% credit, which is added to the avoided costs.

In terms of conservation measures, this analysis comprises all major measures incorporated in the Sixth Plan, though the CPA mainly analyzes measures individually, whereas the Sixth Plan bundles measures in some cases. In addition to the Sixth Plan measures, the CPA also evaluated additional measures specific to City Light, such as measures for data centers. Measures analysis used data from the Sixth Plan and RTF workbooks, as well as other sources typically cited by the NPCC in its analyses.

The market acceptance rate factors that we used to develop achievable potential in the City Light CPA are based upon the Sixth Plan residential and commercial ramp rates. In general, the Sixth Plan ramp rates yield a maximum penetration rate after 20 years of 85% for non-lost opportunity measures and 65% for lost opportunity measures. However, in some cases, we adjusted these market acceptance factors, either up or down, to calibrate achievable potential results with recent City Light conservation program results.

CHAPTER | 3

MARKET CHARACTERIZATION AND MARKET PROFILES

The Seattle City Light Department is the tenth largest publicly owned utility in the United States in terms of retail energy sales. Its 131 square mile service area includes Seattle and several surrounding cities. City Light serves approximately 403,000 customers and has total operating revenues of approximately $800 million. Since 1977, the Conservation Resources Division has provided its customers conservation services. The results of these efforts have been significant: delivering a cost-effective energy resource for the utility; reducing residential, commercial, and industrial customers' bills; and avoiding greenhouse gas emissions and other environmental impacts of energy production.

Energy Use Summary

Total electricity use for the residential, non-residential, and outdoor lighting sectors for City Light in 2012, the study base year, was 9,494,297 MWh.[8] As shown in Table 3-1, the largest sector is non-residential, accounting for 66% of use, followed by residential, with 33% of sales. Street lighting represents only about 1% of sales. Later in this chapter, we describe how the non-residential sales were separated into two sectors, commercial and industrial.

Table 3-1 Customer Counts and Energy Sales by Sector, 2012

Sector / Rate Class	Number of meters (customers)	2012 Electricity sales (MWh)
Residential	362,524	3,146,951
Non-residential	40,084	6,255,467
Street Lighting	3,301	91,879
Total	**405,909**	**9,494,297**

Residential Sector Market Characterization

This section characterizes the residential market at a high level, and then provides a profile of how customers in each segment use electricity by end use. Total residential electricity use in 2012 was 3,146,951 MWh, for an average use per home of 8,681 kWh/year. Summary information for each segment is shown in Table 3-2 and Figure 3-1. The single-family segment consumed 60% of total residential sector electricity in 2012 as a result of having the largest number of customers and the highest intensity.

Note that the resulting use per household for all housing types is higher than the values from the data sources used to develop the segmentation. For example, the single-family RBSA Seattle oversample indicates a household intensity of 8,976 kWh/year, while the Assessor data suggested intensities of 7,695 kWh/yr, 5,842 kWh/yr, and 4,617 kWh/year respectively for multiplex, low-rise, and high-rise. It was necessary to increase the intensity for all housing types in order to match the total 2012 residential sector sales.

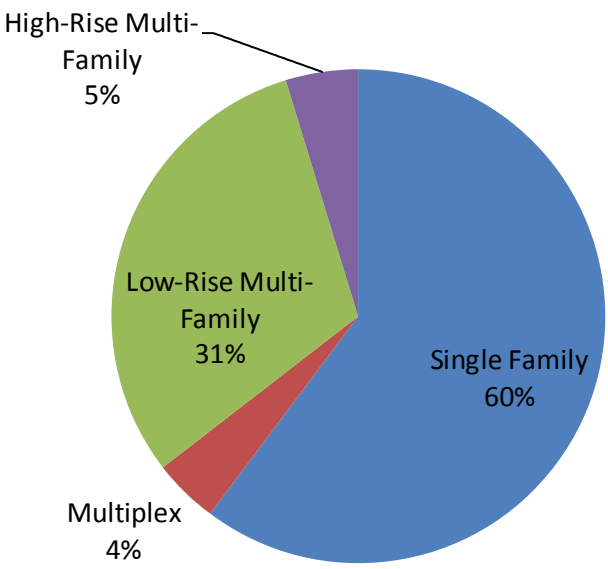
[8] Based on EIA Form 861. Energy usage as measured "at-the-meter," i.e., does not include line losses.

Table 3-2 Residential Sector Market Segmentation by Housing Type, 2012

Segment	Allocation of Customers	Electricity Sales (MWh)	% of Total Usage	Avg. Use/ Customer (kWh)
Single Family (including mobile homes)	190,032	1,895,657	60%	9,975
Multiplex (2–4 units)	15,852	135,050	4%	8,520
Low-Rise Multifamily (≥5 units, ≤6 stories)	131,817	966,343	31%	7,331
High-Rise Multifamily (≥5 units, ≥7 stories)	24,823	149,902	5%	6,039
Total, All segments	**362,524**	**3,146,951**	**100%**	**8,681**

Note: For the 2013 CPA, we combined the mobile home segment with single family.

Figure 3-1 Residential Electricity Use by Customer Segment, 2012



Residential Sector Energy Market Profiles

As we describe in Chapter 2, the market profiles provide the foundation upon which we develop the baseline projection. Table 3-3 presents the average existing home market profile for all residential segments, with intensity indicated on a per household (HH) basis. The existing-home profile represents all the housing stock in 2012. Market profiles for each of the residential segments appear in Appendix A.

Table 3-3 Average Residential Sector Market Profile

End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (MWh)
Cooling	Central AC	1.9%	267	5	1,792
Cooling	Room AC	7.0%	335	23	8,505
Cooling	Air-Source Heat Pump	2.0%	240	5	1,744
Space Heating	Electric Resistance	47.4%	3,148	1,494	541,525
Space Heating	Electric Furnace	4.4%	7,003	306	111,071
Space Heating	Air-Source Heat Pump	1.7%	4,148	71	25,873
Water Heating	Water Heater <= 55 Gal	65.8%	2,150	1,416	513,300
Water Heating	Water Heater > 55 Gal	3.0%	3,136	94	34,107
Interior Lighting	Screw-in	100.0%	828	828	300,237
Interior Lighting	Linear Fluorescent	100.0%	59	59	21,226
Interior Lighting	Specialty	100.0%	208	208	75,412
Exterior Lighting	Screw-in	100.0%	110	110	39,731
Appliances	Clothes Washer	74.4%	123	92	33,193
Appliances	Clothes Dryer	72.3%	675	488	176,862
Appliances	Dishwasher	74.8%	373	279	100,995
Appliances	Refrigerator	100.0%	777	777	281,742
Appliances	Freezer	22.7%	666	151	54,705
Appliances	Second Refrigerator	18.5%	961	178	64,628
Appliances	Stove	83.0%	417	346	125,500
Appliances	Microwave	84.8%	125	106	38,286
Electronics	Personal Computers	75.2%	273	206	74,525
Electronics	Monitor	78.2%	55	43	15,447
Electronics	Laptops	82.0%	117	96	34,797
Electronics	TVs	186.2%	154	286	103,664
Electronics	Printer/Fax/Copier	81.1%	42	34	12,305
Electronics	Set-top Boxes/DVR	243.3%	111	271	98,105
Electronics	Devices and Gadgets	100.0%	49	49	17,687
Miscellaneous	Pool Pump	0.7%	1,575	12	4,190
Miscellaneous	Pool Heater	0.2%	5,230	10	3,479
Miscellaneous	Hot Tub / Spa	6.7%	995	67	24,128
Miscellaneous	Furnace Fan	41.7%	222	93	33,580
Miscellaneous	Miscellaneous	100.0%	482	482	174,613
	Total			**8,681**	**3,146,951**

Table 3-4 and Figure 3-2 present the end-use shares of electricity use by housing type. Due to Seattle's relatively mild climate, across all housing types, space conditioning (air conditioning, furnaces, resistance heating, and heat pumps) accounts for only 23% of annual use. Appliances represent 28% of usage, water heating 17%, and interior lighting 13%. Electronics, which includes personal computers, TVs, set top boxes,

home audio, etc., represent 11% of use, while the miscellaneous end use, which encompasses such devices as furnace fans, pool pumps, hot tubs, and other "plug" loads (hair dryers, power tools, coffee makers, etc.), consumes about 7%. Compared with the other housing types, single family homes allocate a smaller portion of their electricity use to space heating, due mainly to a higher saturation of gas heat in single family homes.

Table 3-4 Residential Electricity Use by End Use and Segment (kWh/HH, 2012)

End Use	Single Family	Multiplex	Low-Rise Multifamily	High-Rise Multifamily	Total Residential
Cooling	47	43	15	13	33
Heating	1,463	2,630	2,654	1,570	1,954
Water Heating	1,781	1,333	1,281	764	1,510
Interior Lighting	1,372	941	748	912	1,095
Exterior Lighting	209	-	-	-	110
Appliances	2,964	2,317	1,738	1,886	2,416
Electronics	1,252	992	656	657	983
Miscellaneous	886	264	239	238	579
Total	**9,975**	**8,520**	**7,331**	**6,039**	**8,681**

Figure 3-2 Percentage of Residential Electricity Use by End Use and Segment (2012)

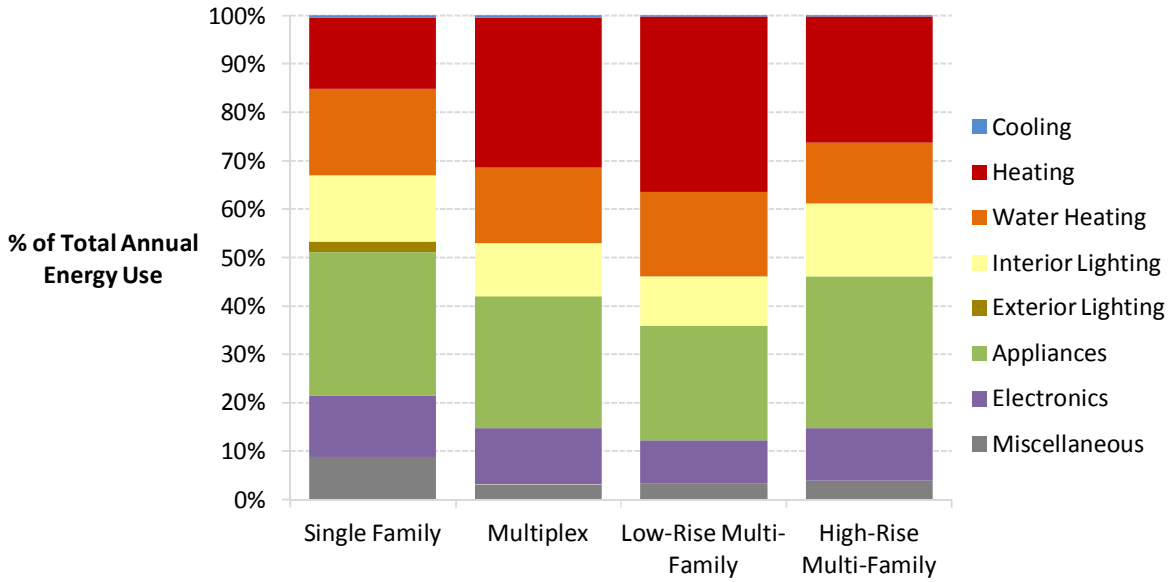
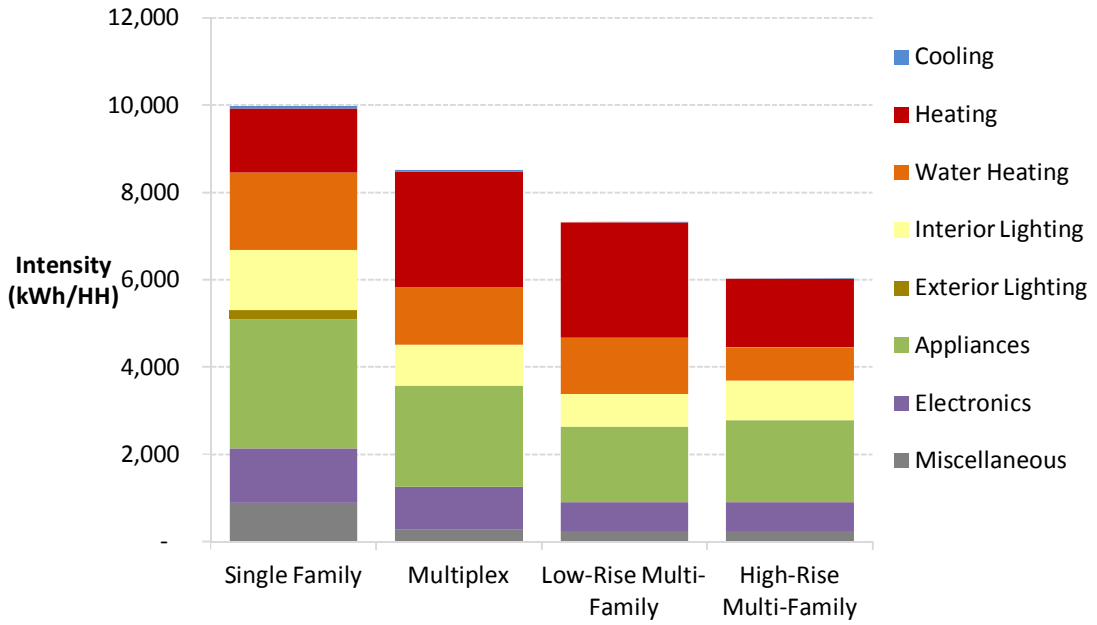


Figure 3-3 presents the end-use breakout in terms of intensity, kWh/household-year, by segment. Note that high-rise units use about 82% of the electricity that low-rise units do, despite the fact that they are slightly larger. We attribute this difference to three factors: high-rise buildings are generally newer and have better thermal shells as well as more efficient equipment overall, the high-rise units have a smaller ratio of exterior surfaces to total unit space, and heating and cooling in high-rise buildings is more often provided by central building systems.

Figure 3-3 Residential Intensity by End Use and Segment (kWh/household, 2012)



Distribution of Non-Residential Energy Use to Commercial and Industrial Sectors

As described in Chapter 2, EnerNOC's subcontractor DMI matched City Light's non-residential billing data with information from the King County Assessor to enable more accurately characterizing City Light's customers by building or industry type. EnerNOC and City Light reviewed the resulting database, focusing on the 1,000 largest accounts and comparing segment assignments with the previous CPA, to ensure that the largest customers were assigned to the correct segments. The DMI database was particularly helpful for segmenting the smaller customers, which did not merit individual inspection, and for distinguishing between small and large offices. Also, DMI's work helped the project team to identify commercial sector facilities that were not well characterized in the previous CPA, particularly facilities that are not buildings per se, such as parking garages/lots, parks, transit or rail facilities, and telecommunications towers or switching facilities, These facilities are now included in the Commercial sector, Miscellaneous segment. Port and shipping facilities are included within the Industrial sector, Other segment.

Table 3-5 compares the resulting allocation of energy usage between the commercial and industrial sector with the commercial and industrial usage reported in City Light's EIA Form 861. City Light's EIA Form 861 reported that 17% of non-residential sales are consumed by industrial customers, but the DMI database indicates that industrial accounts for roughly 21% of non-residential sales. This difference occurs because for the CPA, we assigned facilities to the commercial or industrial sectors mainly based on how the facility is used and whether the primary end uses are lighting and HVAC, which is the case for commercial facilities, or whether the primary end uses are motors and process uses, which is the case for industrial facilities. Doing so enables modeling the efficiency measures that are most appropriate for the dominant end uses. As a result, some large energy users that City Light considers commercial, such as the Port of Seattle and wastewater treatment facilities, are classified as industrial for purposes of the CPA. We also assigned some smaller industrial facilities, which City Light may classify as commercial, to the industrial sector for the CPA.

Table 3-5 Commercial and Industrial Energy Use, EIA Form 861 and CPA, 2012

Sector	Seattle City Light EIA Form 861 (MWh)	CPA Usage (MWh)
Commercial	5,173,899	4,961,098
Industrial	1,081,568	1,294,369
Non-Residential Total	**6,255,467**	**6,255,467**

Commercial Sector Market Characterization and Market Profiles

Based on the above, total electricity use in the commercial sector in 2012 was 4,961,098 MWh. The DMI database data was used to allocate this energy use to 15 building type segments described below, with the resulting shares shown in Figure 3-4.

- **Small office** (less than 50,000 square feet) — all types of offices (agriculture; finance, insurance, real estate; services; no classifiable establishments)
- **Large office** (greater than or equal to 50,000 square feet) — all types of offices as above, also includes large government facilities
- **Restaurant**
- **Retail**
- **Large grocery** — supermarkets
- **Small grocery** — convenience stores and mini-markets
- **College** — colleges, universities, and technical colleges
- **School** — primary and secondary schools
- **Hospital**
- **Other Health** — nursing homes and residential care facilities
- **Lodging** — motels, hotels, and resorts
- **Assembly** — meeting halls, churches, and libraries
- **Warehouse** — refrigerated and non-refrigerated warehouses
- **Data Center**
- **Multifamily Common Area**— the area within multifamily buildings that is not billed to the individual apartment units, which are covered in the residential sector
- **Miscellaneous** — all remaining building types such as fire stations, amusement parks, and parking garages; this segment also includes facilities that may have no building or only a small building on the premises, such as parking lots, railroad or transportation facilities, telecommunications towers, etc.

The building types selected for this analysis correspond to those used in the Sixth Plan, with a few exceptions that were made to simplify the analysis. Offices are broken out into small and large, whereas the Sixth Plan segments offices into small, medium, and large. Similarly, the Sixth Plan used multiple segments for retail, but the City Light CPA consolidates these into a single segment. One additional segment, data centers, was added due to the significant energy use of this building type in the City Light market.

These segments are the same as those used in the previous CPA, with the following exceptions:

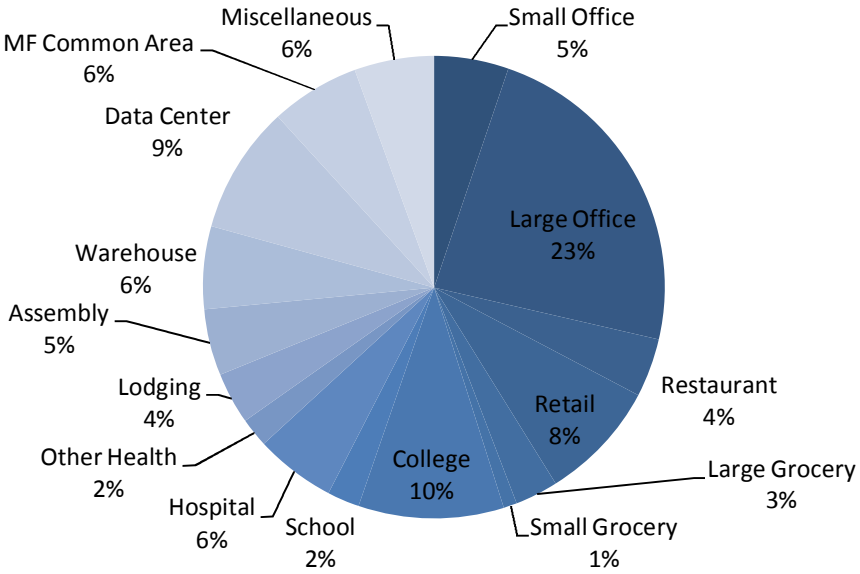
- **Multifamily Common Area** — This segment was added to cover the portion of multifamily building use that is billed on a commercial rate. It includes common area energy use, exterior lighting, parking garages, and may also include HVAC and domestic hot water if those are provided at the building level

rather than via equipment in individual units. In the previous CPA, this load was not treated separately, but was allocated to small offices, restaurant, and retail.

- **Warehouses** — In the previous CPA, refrigerated warehouses were including under the Industrial sector, Food segment. In the current CPA, this segment includes both refrigerated and unrefrigerated warehouses.
- **Other Health** — In the previous CPA, other health included both medical offices and residential care. In the current CPA, this segment now covers only residential care facilities. Medical offices are now included in either Large Office or Small Office segments, based on their size. This change is consistent with proposed NPCC changes regarding commercial building segments.

Figure 3-4 shows the relative energy use of each segment as a percentage of commercial sector energy sales. The four largest segments are large office, college, data center, and retail, which together make up about 50% of sales in the commercial sector. The remaining segments individually constitute less than 6% of sales. In the 2011 CPA, energy use associated with the Small Office segment was 10% of the total, but now it is only 5% of the total. As noted above, in the previous CPA, we distributed the energy use associated with multifamily and multi-use buildings among the Small Office, Restaurant, Retail, and Small Grocery segments. Now that Multifamily Common Area is treated as a separate segment, a significant part of the Small Office energy use has been moved to the new segment, where it can be more accurately modeled. The percentage of use associated with Restaurants, Retail, and Small Grocery has also decreased slightly.

Figure 3-4 Share of Commercial Sector Electricity Use by Building Type, 2012



The DMI database was also used to calculate segment level building intensities (annual kWh/sq. ft.) for the commercial building types. We compared the intensities from the DMI database with the intensities used in the previous CPA and other data sources (Sixth Plan workbooks, NEEA CBSA, and EnerNOC's Energy Market Profiles). While many of the resulting values were reasonable, several seemed unreasonably low, likely due to problems with the assignment of square footage in the assessor data. Therefore, for each building segment, the project team decided whether to use the intensity values from the DMI data or to override that value with the intensity used in the previous CPA. For Multifamily Common Area, we used the value from DMI, but adjusted it because for some buildings, the Assessor data included both the common area and the residential unit area.

Table 3-6 provides the results of this analysis. Finally, using the electricity use and selected intensity estimates, we infer floor space, which is the unit of analysis in LoadMAP for the commercial sector. Data centers have the highest intensity, followed by restaurants and groceries. The warehouse, school, assembly, and miscellaneous segments have the lowest intensities.

Table 3-6 Commercial Sector Market Characterization Results, 2012

Segment	Electricity Use (MWh)	Intensity (kWh/SqFt)	Floor Space (million SqFt)
Small Office[1]	260,243	16.5	15.8
Large Office	1,160,558	21.5	54.0
Restaurant[1]	203,061	40.2	5.1
Retail	418,029	13.1	32.0
Large Grocery[1]	149,763	47.3	3.2
Small Grocery	46,298	44.3	1.0
College	505,537	16.8	30.0
School[1]	112,791	8.1	13.9
Hospital	279,291	31.4	8.9
Other Health	100,236	10.3	9.7
Lodging	181,133	17.6	10.3
Assembly[1]	229,978	10.5	21.9
Warehouse	287,243	9.3	30.9
Data Center	444,152	175.5	2.5
MF Common Area[2]	309,955	19.0	16.3
Miscellaneous[1]	274,829	11.0	24.9
Total	**4,961,098**	**17.7**	**280.4**

1. *Intensity values for these segments are based on the 2011 CPA intensities. Intensities for other segments are based on the DMI database values.*
2. *MF Common Area intensity is based on the DMI database values, but adjusted to account for the inclusion of residential unit area as well as common area within the King County Assessor data.*

For each of the segments defined above, we developed Energy Market Profiles, as described in Chapter 2, that characterize energy use in terms of sector, customer segment, end use, and technology for the base year. Table 3-7 shows the average market profile for electricity for the commercial sector as a whole, representing a composite of all the building types. Market profiles for each building type are presented in Appendix A.

Table 3-7 Total Commercial Segment Market Profile, 2012

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/Sqft)	Usage (MWh)
Cooling	Air-Cooled Chiller	16.6%	2.34	0.39	108,872
Cooling	Water-Cooled Chiller	13.5%	4.18	0.56	157,883
Cooling	Roof top AC	26.8%	2.90	0.78	217,876
Cooling	Roof top Heat Pump	11.5%	2.65	0.30	85,259
Cooling	Other Cooling	3.3%	3.08	0.10	28,643
Heating	Roof top Heat Pump	11.5%	5.93	0.68	190,725
Heating	Electric Room Heat	1.9%	5.98	0.12	32,418
Heating	Electric Furnace	25.5%	4.96	1.26	354,207
Ventilation	Ventilation	100.0%	2.09	2.09	584,612
Water Heating	Water Heating	52.9%	1.64	0.86	242,308
Interior Lighting	Screw-in	100.0%	0.74	0.74	207,807
Interior Lighting	High-Bay Fixtures	100.0%	0.52	0.52	146,592
Interior Lighting	Linear Fluorescent	100.0%	2.81	2.81	787,509
Exterior Lighting	Screw-in	100.0%	0.19	0.19	54,086
Exterior Lighting	HID	100.0%	0.42	0.42	118,320
Exterior Lighting	Linear Fluorescent	100.0%	0.20	0.20	56,428
Refrigeration	Walk-in Refrigerator	6.8%	3.56	0.24	68,059
Refrigeration	Reach-in Refrigerator	11.9%	0.21	0.02	6,891
Refrigeration	Glass Door Display	42.1%	0.72	0.31	85,590
Refrigeration	Open Display Case	42.1%	0.60	0.25	70,596
Refrigeration	Icemaker	42.1%	0.29	0.12	34,011
Refrigeration	Vending Machine	42.1%	0.28	0.12	33,507
Food Preparation	Oven	17.4%	0.88	0.15	42,851
Food Preparation	Fryer	10.4%	0.90	0.09	26,318
Food Preparation	Dishwasher	27.5%	1.86	0.51	143,594
Food Preparation	Hot Food Container	12.3%	0.27	0.03	9,286
Office Equipment	Desktop Computer	92.6%	0.76	0.70	196,031
Office Equipment	Laptop	77.0%	0.16	0.12	34,821
Office Equipment	Server	77.8%	1.17	0.91	254,091
Office Equipment	Monitor	92.6%	0.21	0.19	54,644
Office Equipment	Printer/Copier/Fax	88.1%	0.14	0.12	33,490
Office Equipment	POS Terminal	48.6%	0.06	0.03	8,300
Miscellaneous	Non-HVAC Motors	68.3%	0.27	0.19	52,438
Miscellaneous	Pool Pump	20.5%	0.02	0.00	900
Miscellaneous	Pool Heater	4.0%	0.01	0.00	158
Miscellaneous	Miscellaneous	100.0%	1.54	1.54	431,980
Total				**17.69**	**4,961,098**

Figure 3-5 shows the breakdown of annual commercial electricity usage by end use for the commercial sector as a whole. Heating, ventilation, and cooling collectively account for 36% of energy use. Interior and exterior lighting combined represent 27% of consumption. Office equipment is significant as well, due to the large presence of data centers in the service territory. The relatively high consumption for the miscellaneous end use category, 10%, is due to the increasing use of various plug load equipment across all commercial building types. The remaining end uses — water heating, refrigeration, and food preparation — comprise 6% or less of total usage.

Figure 3-5 Commercial Electricity Consumption by End Use, 2012

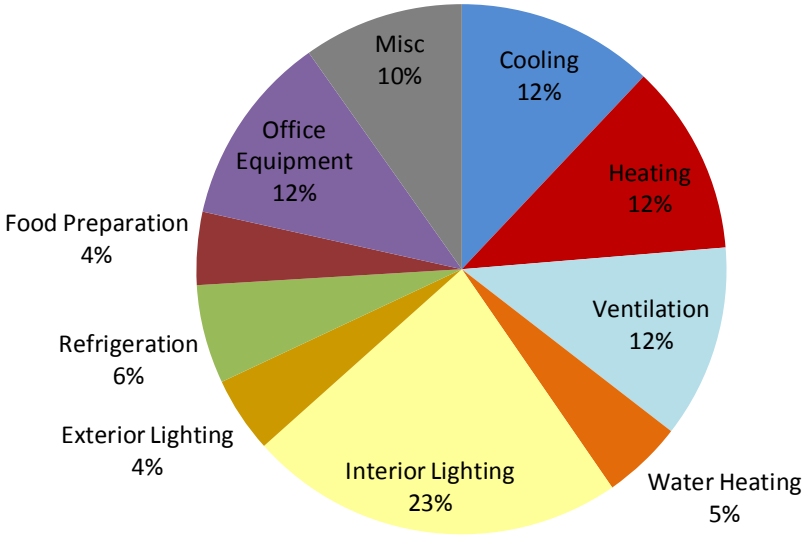


Figure 3-6 shows the electricity intensity by end use and building type in terms of kWh per square foot of building floor space. Data centers are the most energy intensive due to high server loads as well as significant cooling and ventilation requirements. The grocery sector is the next most energy intensive as a result of high refrigeration loads, followed by restaurants, due to high refrigeration and electric food preparation loads. Hospitals have relatively high miscellaneous end use consumption due to a wide range of diagnostic and treatment equipment. Within the Miscellaneous segment, many of the facilities are non-buildings, such as parks, transit facilities, and telecommunications systems. As a result, within the Miscellaneous segment, slightly more than 40% of use has been allocated to the miscellaneous end use.

Figure 3-6 Commercial Electricity Intensity by End Use and Segment (2012)

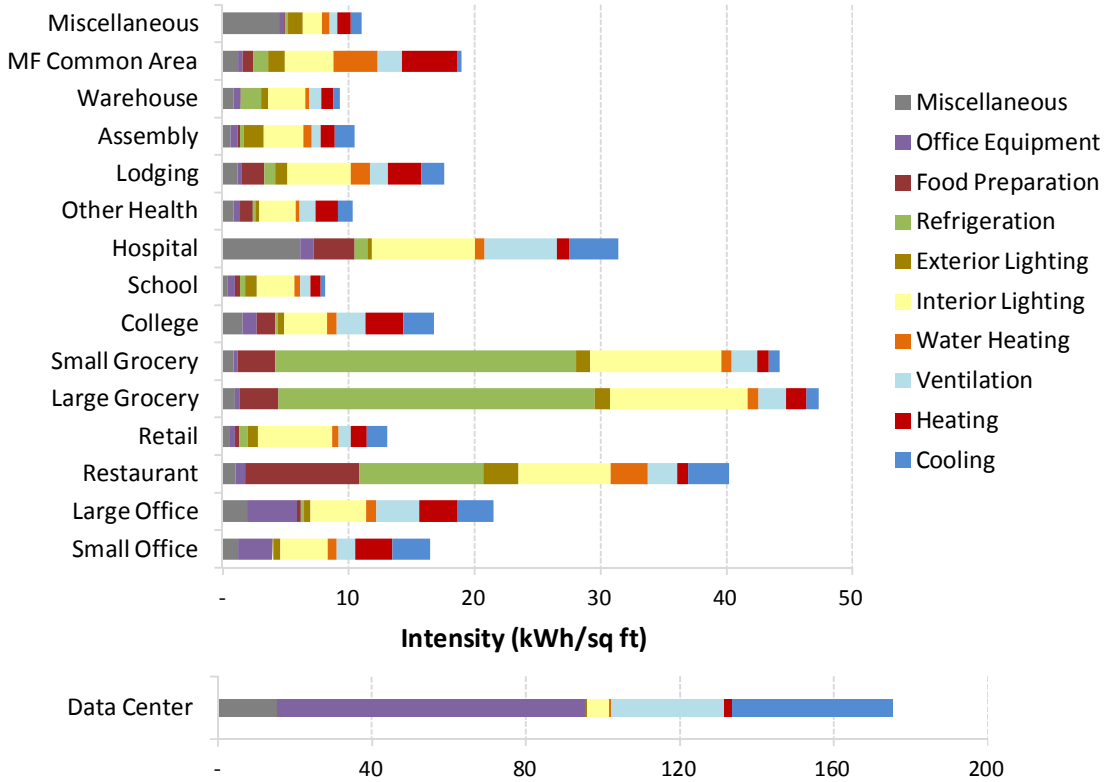


Figure 3-7 and Table 3-8 present 2012 electricity usage by end use and building type. As one might expect, offices account for the highest share of electricity use in City Light's commercial sector.

Figure 3-7 Commercial Electricity Usage by End Use and Segment (GWh, 2012)

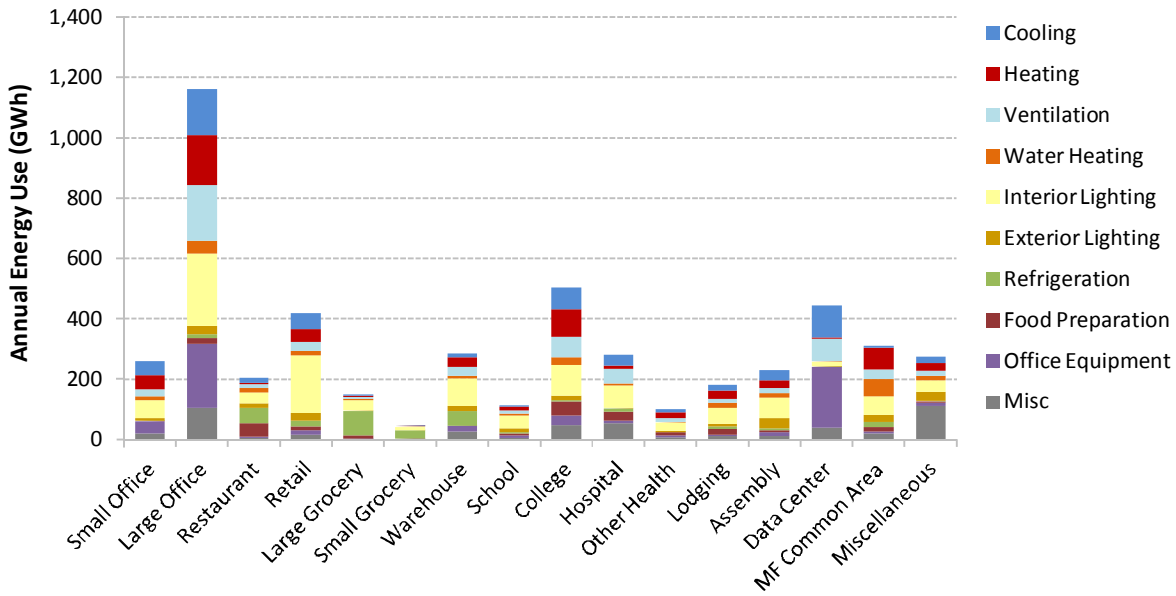


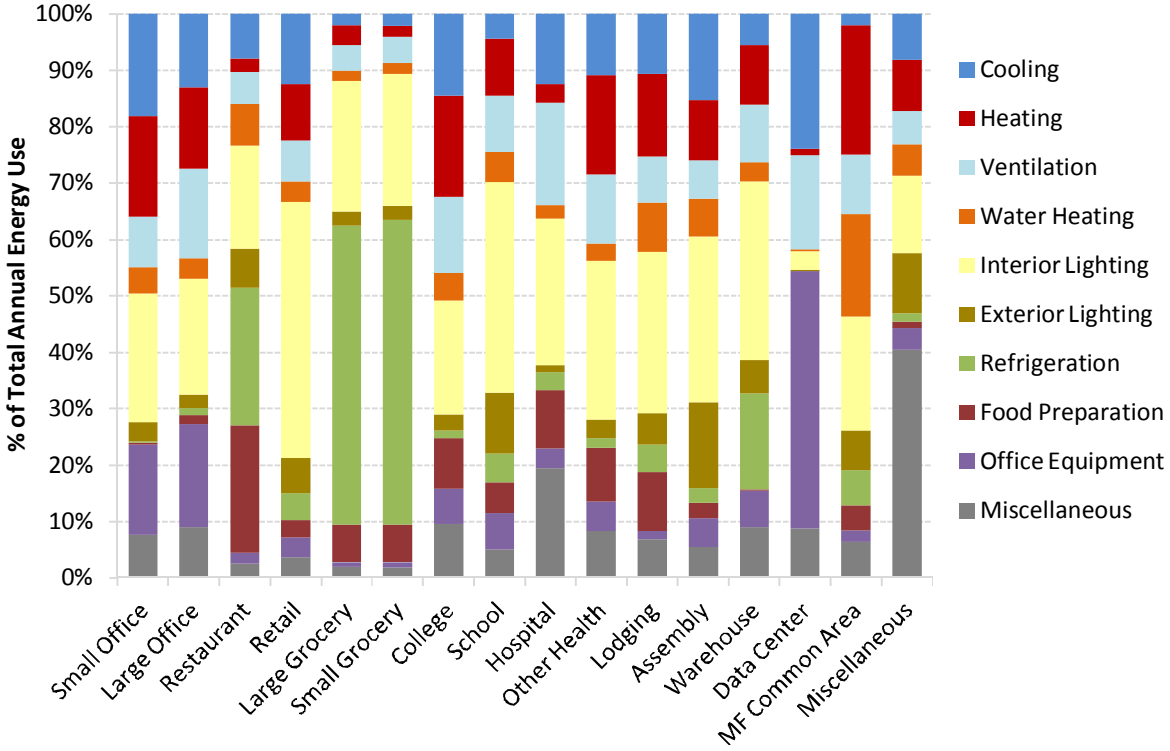
Table 3-8 Commercial Electricity Consumption by End Use and Segment (GWh, 2012)

End Use	Small Office	Large Office	Restau-rant	Retail	Large Grocery	Small Grocery	Ware-house	School
Cooling	47	151	16	52	3	1	16	5
Heating	46	167	5	41	5	1	31	11
Ventilation	24	185	12	30	7	2	29	11
Water Heating	12	42	15	15	3	1	10	6
Interior Lighting	59	239	37	190	35	11	91	42
Exterior Lighting	9	28	14	26	4	1	17	12
Refrigeration	1	14	50	20	80	25	49	6
Food Preparation	1	18	46	13	10	3	0	6
Office Equipment	42	213	4	15	1	0	19	7
Miscellaneous	20	104	5	15	3	1	26	6
Total	**260**	**1,161**	**203**	**418**	**150**	**46**	**287**	**113**

	College	Hospital	Other Health	Lodging	Assem-bly	Data Center	MF Common Area	Miscella-neous	TOTAL
Cooling	73	35	11	19	35	106	6	22	**599**
Heating	91	9	18	27	25	5	71	25	**577**
Ventilation	68	51	12	15	16	74	32	16	**585**
Water Heating	24	6	3	16	15	1	57	16	**242**
Interior Lighting	102	73	28	52	68	15	63	38	**1,142**
Exterior Lighting	15	3	3	10	35	1	22	29	**229**
Refrigeration	6	9	2	9	6	0	19	4	**299**
Food Preparation	45	29	10	19	6	0	14	3	**222**
Office Equipment	32	10	5	3	12	203	6	11	**581**
Miscellaneous	48	54	8	12	13	39	20	111	**485**
Total	**504**	**279**	**100**	**181**	**230**	**444**	**310**	**275**	**4,961**

Figure 3-8 shows each end use as a percentage of the segment's total use.

Figure 3-8 Commercial Electricity Usage by End Use and Segment (2012)

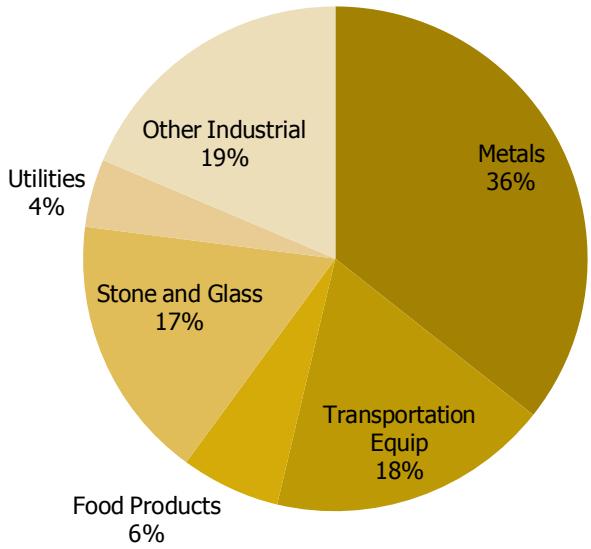


Industrial Sector Market Characterization and Market Profiles

The industrial sector used 1,294,369 MWh in 2012, as shown in Table 3-5, which represents about 13.6% of total City Light electricity sales. Figure 3-9 shows how the industrial sales break out by industry type. Using the DMI database, the study isolated the largest industries in terms of their energy use for analysis. The five major industrial segments thus identified are Metals; Transportation Equipment; Food Products; Stone and Glass, including cement; and Utilities including water and wastewater. The remaining industries were combined into the Other Industrial category. This classification was largely the same as used in the previous City Light CPA, with the segments described below, including any changes to their definitions.

- **Metals** — This segment includes not only City Light's single largest metal-industry customer, as was the case in the previous, but also other smaller customers involved in metals industries.
- **Transportation Equipment** — The previous CPA segment included an Aerospace segment. For 2013, Aerospace equipment manufacturing is included as well as other transportation equipment manufacturing. As a result, ship building activities previously included within Other Industrial have been moved to Transportation Equipment.
- **Food Production** — In the previous CPA, this segment included refrigerated warehouses. For 2013, refrigerated warehouses were being modeled within the Commercial sector, Warehouses segment.
- **Stone and Glass** — This segment primarily includes cement manufacturing and glass industries.
- **Utilities** — Water and wastewater processing are the primary industries in this segment.
- **Other industrial** — This segment comprises all remaining industrial customers.

Figure 3-9 Industrial Sector Electricity Use by Industry, 2012



Using intensity estimates for each industry type, we inferred the number of employees which is the unit of analysis in LoadMAP for the industrial sector. Table 3-9 provides 2012 sales by segment as well as the inferred number of employees for each segment.

Table 3-9 Industrial Market Segmentation by Industry Type, Base Year 2012

Industrial	Number of Employees	2012 Electricity Use (MWh)
Metals	2,766	461,409
Transportation Equip	12,539	233,474
Food Products	8,412	82,239
Stone and Glass	1,316	219,547
Utilities	873	56,590
Other Industrial	11,461	241,110
Total	**37,368**	**1,294,369**

For each of the segments defined above, we developed Energy Market Profiles that characterize electricity use in terms of sector, customer segment, end use, and technology for the base year. Table 3-10 shows the aggregate industrial market profile. The market profiles for each segment are shown in Appendix A.

Table 3-10 Total Industrial Sector Market Profile, 2012

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/Employee)	Usage (MWh)
Cooling	Air-Cooled Chiller	2.5%	2,984	75	2,788
Cooling	Water-Cooled Chiller	2.5%	3,738	93	3,492
Cooling	RTU	6.6%	4,234	280	10,471
Cooling	Air-Source Heat Pump	7.5%	3,523	266	9,935
Heating	Air-Source Heat Pump	7.5%	9,569	722	26,988
Heating	Electric Resistance	7.3%	10,048	735	27,484
Ventilation	Ventilation	100.0%	1,520	1,520	56,797
Interior Lighting	Screw-in	100.0%	217	217	8,095
Interior Lighting	High-Bay Fixtures	100.0%	711	711	26,558
Interior Lighting	Linear Fluorescent	100.0%	1,352	1,352	50,513
Exterior Lighting	Screw-in	100.0%	58	58	2,158
Exterior Lighting	HID	100.0%	345	345	12,891
Exterior Lighting	Linear Fluorescent	100.0%	23	23	864
Motors	Pumps	100.0%	1,389	1,389	51,918
Motors	Fans & Blowers	100.0%	2,200	2,200	82,221
Motors	Compressed Air	100.0%	1,315	1,315	49,152
Motors	Conveyors	100.0%	7,197	7,197	268,955
Motors	Other Motors	100.0%	1,475	1,475	55,132
Process	Process Heating	100.0%	4,855	4,855	181,408
Process	Process Cooling	100.0%	758	758	28,316
Process	Process Refrigeration	100.0%	758	758	28,316
Process	Electro-Chemical Processes	100.0%	5,899	5,899	220,425
Process	Other Process	100.0%	114	114	4,265
Miscellaneous	Miscellaneous	100.0%	2,281	2,281	85,228
	Total			**34,638**	**1,294,369**

Figure 3-10 shows the distribution of electricity energy consumption by end use for all industrial customers. Motors and Process are the largest overall end uses for the industrial sector, accounting for 39% and 36% of energy use respectively.[9] Lighting is the next highest, followed by miscellaneous, cooling, heating, and ventilation.

[9] Note that the motor sub-categories differ from the previous City Light CPA study, where they were specified in terms of horsepower size. In this study, they are specified in terms of function, to better ascribe relevant efficiency measures. The functions comprise a wide range of industrial equipment, such as air compressors, pumps, conveyor motors, and fans.

Figure 3-10 Industrial Electricity Use by End Use, 2012

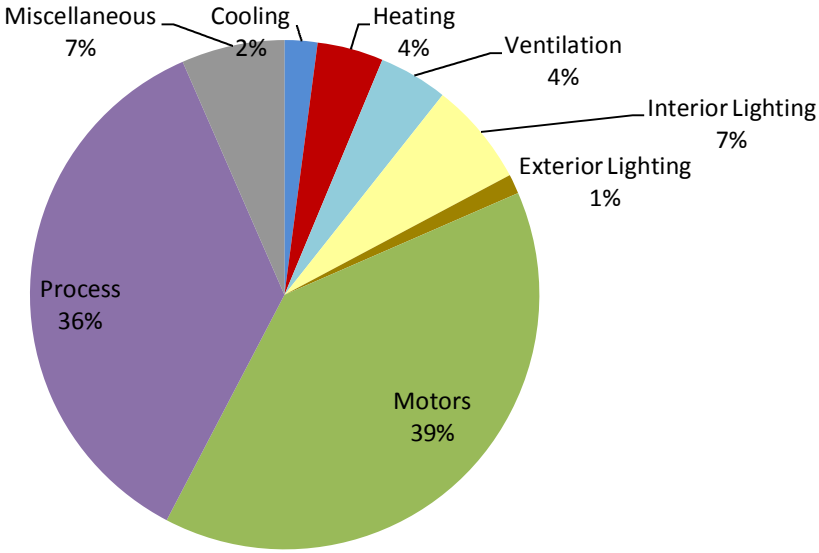


Figure 3-11 and Table 3-11 present the electricity consumption by end-use and industry type. Figure 3-12 shows each end use as a percentage of the segment's total use.

Figure 3-11 Industrial Electricity Use by End Use and Segment (MWh, 2012)

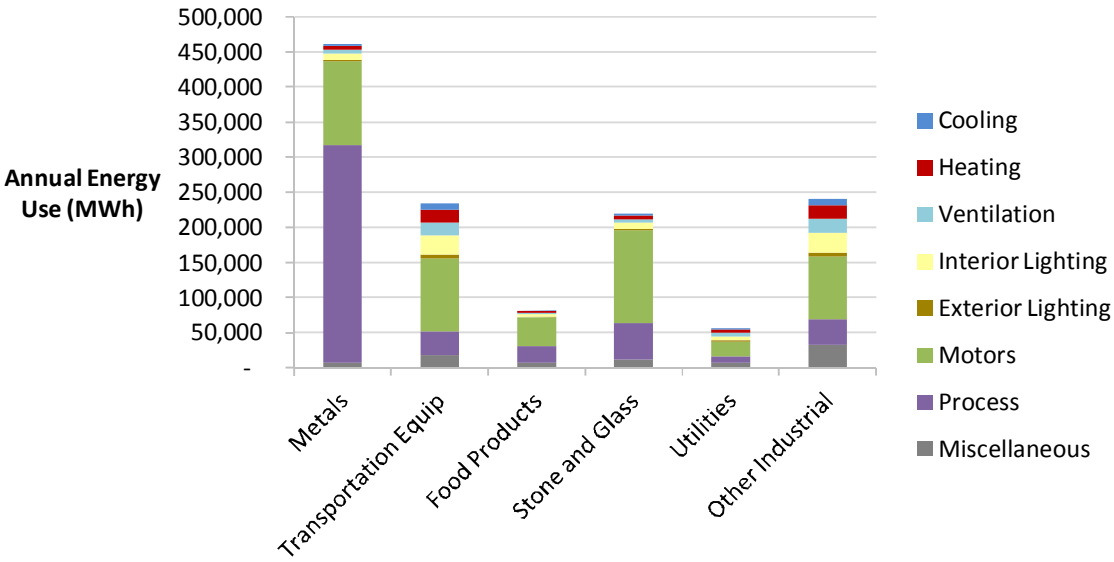
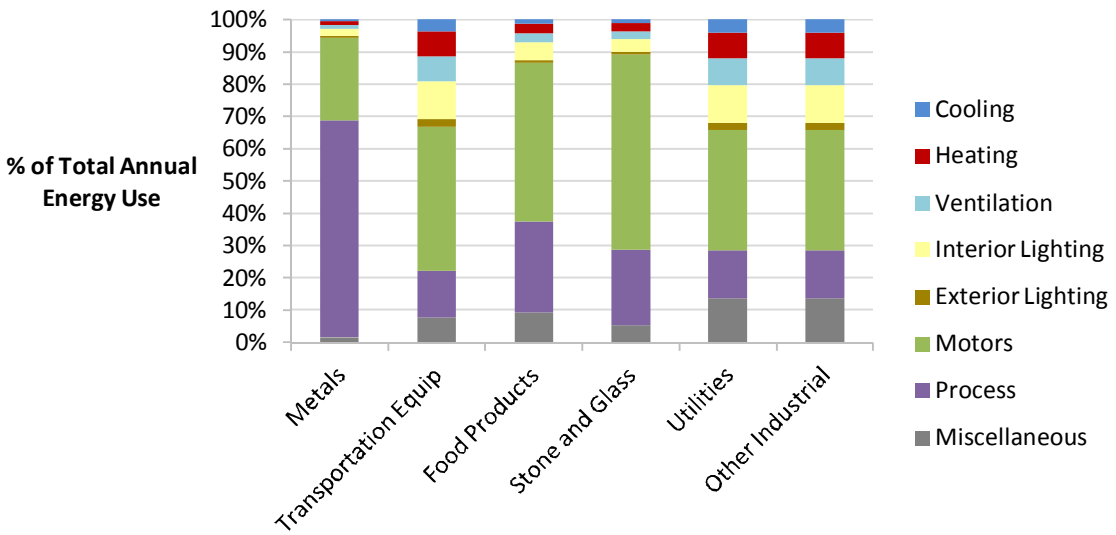


Table 3-11 Industrial Electricity Use by End Use and Segment (MWh, 2012)

End Use	Metals	Transportation Equip	Food Products	Stone and Glass	Utilities	Other Industrial	Total
Cooling	2,610	8,643	1,123	2,617	2,223	9,470	2,610
Heating	5,327	17,643	2,293	5,343	4,537	19,330	5,327
Ventilation	5,554	18,396	2,391	5,571	4,730	20,155	5,554
Interior Lighting	9,837	27,526	4,462	8,530	6,617	28,194	9,837
Exterior Lighting	1,838	5,143	834	1,594	1,236	5,268	1,838
Motors	119,085	103,995	40,352	132,575	21,170	90,199	119,085
Process	309,450	33,991	23,099	51,735	8,451	36,005	309,450
Miscellaneous	7,708	18,137	7,684	11,583	7,626	32,490	7,708
Total	**461,409**	**233,474**	**82,239**	**219,547**	**56,590**	**241,110**	**461,409**

Figure 3-12 Industrial Electricity Use by End Use and Segment, 2012



Street Lighting Characterization

City Light's 2012 EIA form 861 reports street lighting usage of 91,879 MWh. Per City Light, the 2012 count of street lighting fixtures is approximately 90,000, Seattle City Light's inventory of street lighting fixtures mainly consists of high-pressure sodium, metal halide, induction, and LED lamps. Characterization of this use is straightforward compared with the other sectors. City Light databases provide a breakdown of the street lighting inventory by fixture type, and also provide the lamp and fixture wattages for each type. The great majority of the street lighting fixtures, approximately 86%, are cobra head street lighting fixtures that traditionally use high-pressure sodium lamps. Beginning in 2010, City Light began replacing the cobra head street lighting fixtures with LED fixtures. Phase 1 of this project is expected to convert 40,763 fixtures by the end of 2013. Phase 2 of the project will begin in 2014.

Using the provided fixture counts and nominal fixture wattages, the total street lighting usage was calculated. To exactly match the street lighting usage of 91,879 MWh reported in the 2012 EIA form 861, we adjusted the timing of existing LED retrofits between 2012 and 2013. An assumption that 52% of Phase 1 retrofits occurred by 2012 provided a match to the targeted 2012 sales total.

CHAPTER | 4

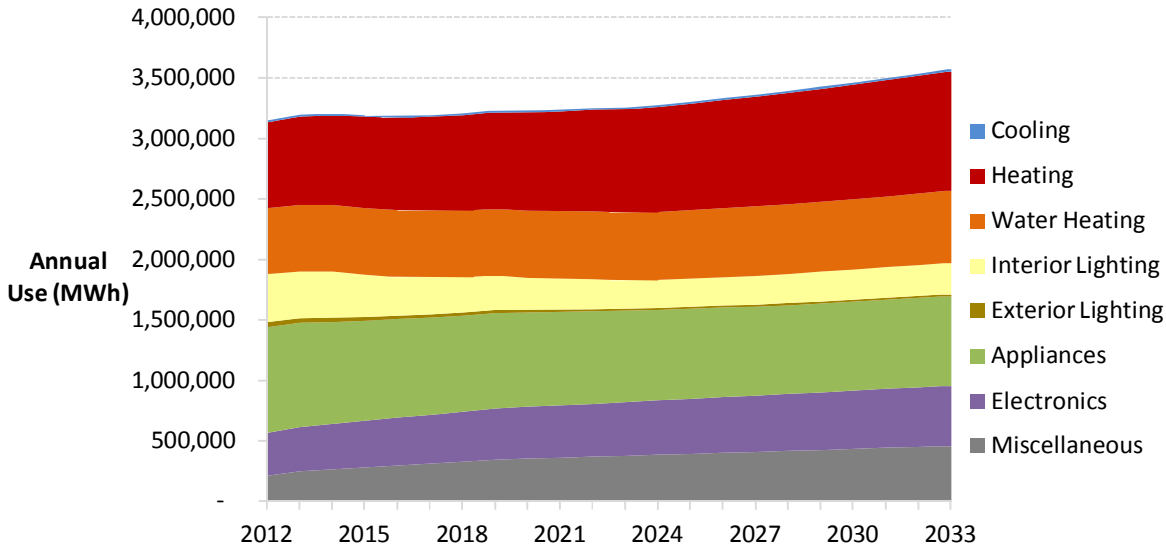
BASELINE PROJECTION

Prior to developing estimates of conservation potential, a baseline end-use projection was developed to quantify how electricity is used by end use in the base year and what the consumption is likely to be in the future in absence of new utility programs and naturally occurring conservation. The baseline projection serves as the metric against which conservation potentials are measured. The baseline projection we developed for City Light was within 5% of the City Light load forecasting group's forecast.

Residential Sector

The baseline projection incorporates assumptions about economic growth, electricity prices, and appliance/equipment standards and building codes already mandated, as described in Chapter 2. Figure 4-1 and Table 4-1 present the baseline projection at the end-use level for the residential sector as a whole. Table 4-2 shows the end-use projection at the technology level.

Figure 4-1 Residential Baseline Projection by End Use



Overall, residential use increases modestly, from 3,146,951 MWh in 2012 to 3,577,236 MWh in 2033, a 13.7% increase. Specific observations include:

- The primary reason for the modest initial growth in the baseline projection is the phase-in, beginning in 2012, of the federal Energy Independence and Security Act of 2007(EISA) lighting standards. However, because City Light has aggressively pursued lighting DSM programs over the past several years, this effect is less pronounced than would be the case otherwise. The standard causes a decline in interior lighting use by 34% and exterior lighting use by 58% over the 20-year projection period.
- Appliances energy use also decreases, due to mandated efficiency gains, particularly in refrigeration appliances.

- There is some growth in heating and cooling that reflects higher saturations of electric heating and cooling in new construction, mostly multifamily, as well as slightly larger homes and overall population growth.
- Water heating grows modestly as a result of higher electric saturations in new construction, mostly multifamily, though more efficient equipment offsets this trend.
- Growth in electricity use in electronics is substantial and reflects an increase in the saturation of electronics and the trend toward higher-powered computers, and additional devices such as electronic gaming. This increase is somewhat tempered by higher efficiency televisions.
- Growth in miscellaneous use is also substantial. This use includes various plug loads not elsewhere classified (e.g., hair dryers, power tools, coffee makers, etc.). This end use has grown consistently in the past and we incorporate future growth assumptions that are consistent with the Annual Energy Outlook.

Table 4-1 Residential Baseline Projection by End Use (MWh)

End Use	2012	2014	2015	2018	2023	2028	2033	% Change ('12-'33)	Avg. Growth Rate ('12-'33)
Cooling	12,041	13,491	13,657	14,373	15,657	16,911	18,075	**50%**	**1.9%**
Heating	708,477	742,497	755,188	787,323	853,901	921,776	987,812	**39%**	**1.6%**
Water Heating	547,407	550,314	551,792	551,937	561,616	575,007	594,405	**9%**	**0.4%**
Interior Lighting	396,876	381,617	348,877	292,762	232,458	242,939	260,534	**-34%**	**-2.0%**
Exterior Lighting	39,731	34,210	29,512	23,743	15,966	16,200	16,871	**-58%**	**-4.1%**
Appliances	875,910	843,679	829,806	794,549	755,921	733,716	742,389	**-15%**	**-0.8%**
Electronics	356,529	374,420	384,354	414,479	444,134	470,810	497,651	**40%**	**1.6%**
Miscellaneous	209,981	265,050	280,473	327,688	376,866	417,854	459,499	**119%**	**3.7%**
Total	**3,146,951**	**3,205,277**	**3,193,660**	**3,206,854**	**3,256,520**	**3,395,213**	**3,577,236**	**14%**	**0.6%**

Table 4-2 Residential Baseline Projection by End Use and Technology (MWh)

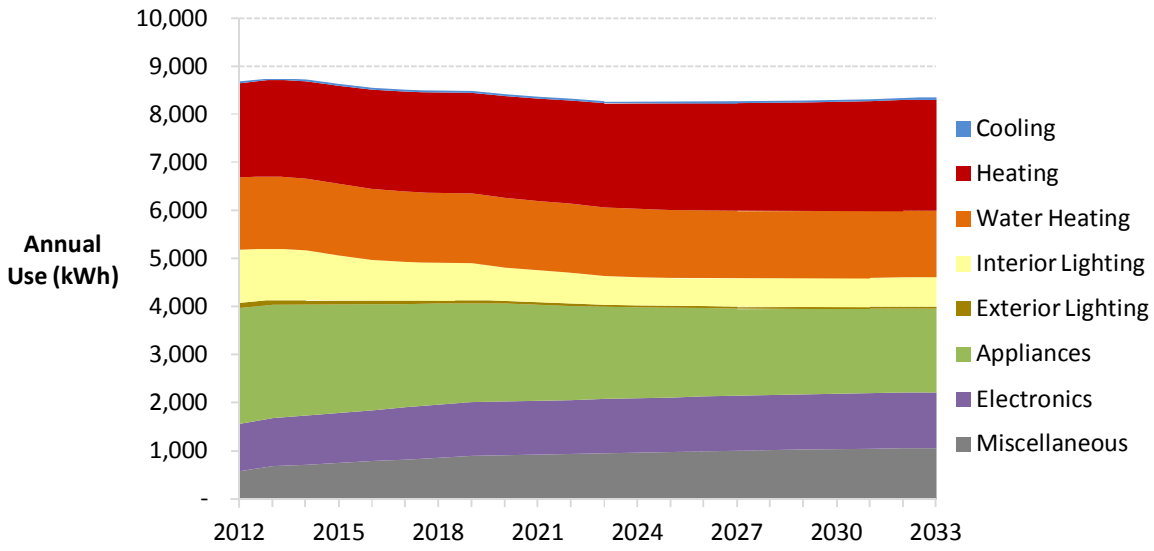
End Use	Technology	2012	2014	2015	2018	2023	2028	2033	% Change ('12-'33)	Avg. Growth Rate ('12-'33)
Cooling	Central AC	1,792	2,016	2,042	2,143	2,283	2,444	2,616	**46.0%**	**1.8%**
	Room AC	8,505	9,530	9,672	10,295	11,401	12,436	13,340	**56.8%**	**2.1%**
	Air-Source Heat Pump	1,744	1,945	1,942	1,935	1,973	2,031	2,119	**21.5%**	**0.9%**
Heating	Air-Source Heat Pump	25,873	26,270	26,273	26,239	26,842	27,707	28,826	**11.4%**	**0.5%**
	Electric Zonal Room Heat	583,618	613,442	624,870	654,242	714,977	777,213	838,179	**43.6%**	**1.7%**
	Electric Furnace	98,986	102,785	104,044	106,842	112,082	116,857	120,807	**22.0%**	**0.9%**
Water Heating	Water Heater <= 55 Gal	513,300	516,175	518,567	521,989	536,862	555,070	576,848	**12.4%**	**0.6%**
	Water Heater > 55 Gal	34,107	34,139	33,225	29,948	24,754	19,937	17,557	**-48.5%**	**-3.2%**
Interior Lighting	Screw-in	300,237	284,733	250,587	205,131	141,018	146,512	156,305	**-47.9%**	**-3.1%**
	Linear Fluorescent	21,226	21,943	22,367	23,298	25,202	27,234	29,214	**37.6%**	**1.5%**
	Specialty	75,412	74,941	75,924	64,333	66,239	69,194	75,014	**-0.5%**	**0.0%**
Exterior Lighting	Screw-in	39,731	34,210	29,512	23,743	15,966	16,200	16,871	**-57.5%**	**-4.1%**
Appliances	Clothes Washer	33,193	33,783	33,299	31,554	27,996	24,547	23,752	**-28.4%**	**-1.6%**
	Clothes Dryer	176,862	173,856	170,740	162,657	152,656	148,732	151,535	**-14.3%**	**-0.7%**
	Dishwasher	100,995	92,343	90,429	89,052	88,821	90,381	94,041	**-6.9%**	**-0.3%**
	Refrigerator	281,742	263,059	254,776	231,631	204,969	185,377	182,337	**-35.3%**	**-2.1%**
	Freezer	54,705	54,811	54,916	54,548	52,421	49,982	47,645	**-12.9%**	**-0.7%**
	Second Refrigerator	64,628	58,689	56,248	50,085	44,026	39,768	38,569	**-40.3%**	**-2.5%**
	Stove	125,500	127,256	128,562	131,544	138,495	145,745	152,747	**21.7%**	**0.9%**
	Microwave	38,286	39,882	40,838	43,478	46,537	49,184	51,762	**35.2%**	**1.4%**

Table 4-2 Residential Baseline Projection by End Use and Technology (MWh) (continued)

End Use	Technology	2012	2014	2015	2018	2023	2028	2033	% Change ('12-'33)	Avg. Growth Rate ('12-'33)
Electronics	Personal Computers	74,525	71,134	69,909	72,599	77,602	82,216	86,828	**16.5%**	**0.7%**
	Monitor	15,447	15,767	16,418	19,193	20,832	22,035	23,162	**49.9%**	**1.9%**
	Laptops	34,797	35,101	35,681	38,063	40,947	43,529	46,095	**32.5%**	**1.3%**
	TVs	103,664	105,192	106,647	111,246	116,551	122,293	128,340	**23.8%**	**1.0%**
	Printer/copier/fax	12,305	12,218	12,332	12,887	13,692	14,471	15,263	**24.0%**	**1.0%**
	Set-top Boxes/DVR	98,105	115,174	122,307	135,534	145,964	154,902	163,648	**66.8%**	**2.4%**
	Devices and Gadgets	17,687	19,834	21,059	24,958	28,546	31,363	34,315	**94.0%**	**3.2%**
Miscellaneous	Pool Pump	4,190	4,317	4,393	4,580	4,907	5,222	5,505	**31.4%**	**1.3%**
	Pool Heater	3,479	3,433	3,438	3,484	3,691	3,925	4,118	**18.4%**	**0.8%**
	Hot Tub / Spa	24,128	24,866	25,306	26,397	28,310	30,161	31,835	**31.9%**	**1.3%**
	Furnace Fan	33,580	34,431	34,957	36,234	38,535	40,767	42,689	**27.1%**	**1.1%**
	Miscellaneous	144,604	198,003	212,380	256,993	301,423	337,779	375,351	**159.6%**	**4.5%**
Grand Total		**3,146,951**	**3,205,277**	**3,193,660**	**3,206,854**	**3,256,520**	**3,395,213**	**3,577,236**	**13.7%**	**0.6%**

Figure 4-2 presents the projection of use per household. Most noticeable once again is that lighting use decreases significantly after 2012, as the EISA lighting standard comes into effect. Appliance use also decreases over the study period due to appliance standards. However, growth in miscellaneous end uses and electronics keeps energy use per household relatively flat.

Figure 4-2 Residential Baseline Electricity Use per Household by End Use



Commercial Sector

Electricity use in the commercial sector continues to grow during the study horizon, as new commercial construction increases overall square footage in the commercial sector. In addition, existing buildings are renovated to incorporate additional amenities, such as full-scale kitchens and work-out facilities. Consumption starts at 4,961,098 MWh in 2012 and increases to 7,713,040 MWh in 2033, an overall growth of 55%, or average annual growth of 2.1%.

Figure 4-3 and Table 4-3 present the baseline projection at the end-use level for the commercial sector as a whole. All end uses show growth over the study period, with the exception of cooling. Growth in lighting is less than in the other end uses, due to the EISA lighting standards. Table 4-4 presents the commercial sector projection by technology.

Specific observations include:

- Growth in the HVAC and water heating end uses is commensurate with projected growth in floor space and employment, the two principal drivers of commercial sector consumption. Air conditioning increases at a slightly greater rate as more buildings add air conditioning systems, while ventilation grows more slowly due to the trend toward VAV systems in new construction.
- Food preparation, though remaining a small percentage of total usage, grows at a higher rate than other end uses. This reflects the addition of kitchen facilities to commercial office buildings during new construction or renovation, as well as the expansion of food service offerings in other building types as well.
- Refrigeration drops substantially as new standards take effect that cover most types of commercial refrigeration equipment.
- Lighting energy grows at a lower rate than most end uses, driven by the EISA lighting standards. For linear fluorescent lighting, the effects of the EISA standards have largely already occurred prior to the

start of the study period, because City Light lighting programs have led to the replacement of most T-12 lighting systems with more efficient T-8s. As a result, linear fluorescent use grows by 24%. On the other hand, the baseline projection indicates that EISA's effects during 2012-2015 will be most evident for screw in lighting, causing energy use for this technology to remain nearly flat for interior lighting and to drop for exterior lighting.

- Energy use for computers, servers, printers, and other office equipment continues to grow, due to increased saturation of this category, even as the efficiency of individual units increases.
- Consumption by miscellaneous equipment, which includes a wide range of plug loads, also increases. This reflects the assumption that plug loads continue to increase in the commercial sector as we embrace new uses of electricity.

Figure 4-3 Commercial Baseline Electricity Projection by End Use

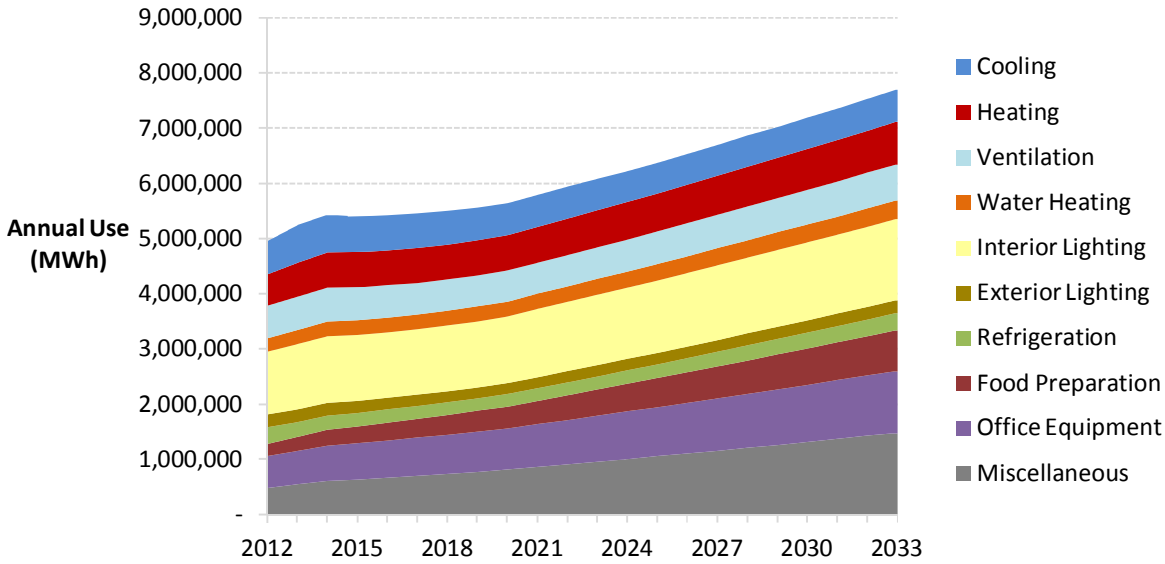


Table 4-3 Commercial Electricity Consumption by End Use (MWh)

End Use	2012	2014	2015	2018	2023	2028	2033	% Change ('12-'33)	Avg. Growth Rate ('12-'33)
Cooling	598,538	679,906	655,527	605,016	567,487	558,664	583,042	**-3%**	**-0.1%**
Heating	577,361	642,762	636,899	634,664	669,058	720,554	771,627	**34%**	**1.4%**
Ventilation	584,612	608,038	591,863	567,921	574,062	613,008	652,325	**12%**	**0.5%**
Water Heating	242,308	266,602	265,391	268,967	288,688	313,855	337,883	**39%**	**1.6%**
Interior Lighting	1,141,908	1,214,488	1,194,876	1,187,526	1,272,794	1,377,796	1,472,666	**29%**	**1.2%**
Exterior Lighting	228,834	227,547	217,518	202,538	205,697	220,122	233,942	**2%**	**0.1%**
Refrigeration	298,653	259,759	247,168	228,329	236,110	270,520	310,206	**4%**	**0.2%**
Food Preparation	222,049	282,960	299,257	356,226	475,295	605,775	739,950	**233%**	**5.7%**
Office Equipment	581,377	647,275	657,493	707,874	832,361	975,618	1,124,339	**93%**	**3.1%**
Miscellaneous	485,475	605,759	636,234	742,348	960,740	1,213,504	1,487,059	**206%**	**5.3%**
Total	**4,961,114**	**5,435,096**	**5,402,226**	**5,501,409**	**6,082,292**	**6,869,417**	**7,713,040**	**55%**	**2.1%**

Table 4-4 Commercial Baseline Electricity Projection by End Use and Technology (MWh)

End Use	Technology	2012	2014	2015	2018	2023	2028	2033	% Change ('12-'33)	Avg. Growth Rate ('12-'33)
Cooling	Air-Cooled Chiller	108,872	131,696	130,094	129,672	135,377	143,059	152,068	39.7%	1.6%
	Water-Cooled Chiller	157,883	173,455	165,275	152,419	143,214	139,114	142,428	-9.8%	-0.5%
	Roof top AC	217,876	244,555	234,562	208,265	180,722	168,833	179,501	-17.6%	-0.9%
	Air Source Heat Pump	85,264	94,846	90,421	79,198	70,323	66,468	64,384	-24.5%	-1.3%
	Other Cooling	28,643	35,353	35,175	35,462	37,851	41,191	44,661	55.9%	2.1%
Heating	Electric Furnace	354,207	397,980	395,616	398,529	424,604	459,924	493,227	39.2%	1.6%
	Air Source Heat Pump	190,736	199,174	191,971	175,261	162,392	156,636	152,793	-19.9%	-1.1%
	Electric Zonal Heat	32,418	45,608	49,312	60,874	82,062	103,994	125,608	287.5%	6.4%
Ventilation	Ventilation	584,612	608,038	591,863	567,921	574,062	613,008	652,325	11.6%	0.5%
Water Heating	Water Heater	242,308	266,602	265,391	268,967	288,688	313,855	337,883	39.4%	1.6%
Interior Lighting	Screw-in	207,807	171,648	152,958	129,275	139,702	150,179	158,305	-23.8%	-1.3%
	High-Bay Fixtures	146,592	152,891	148,822	137,902	135,302	151,281	154,496	5.4%	0.3%
	Linear Fluorescent	787,509	889,949	893,096	920,348	997,790	1,076,337	1,159,865	47.3%	1.8%
Exterior Lighting	Screw-in	54,086	47,961	44,666	40,044	44,171	48,267	51,640	-4.5%	-0.2%
	HID	118,320	117,053	110,610	100,023	96,300	101,687	106,841	-9.7%	-0.5%
	Linear Fluorescent	56,428	62,533	62,242	62,471	65,226	70,168	75,461	33.7%	1.4%
Refrigeration	Walk-in Refrigerator	68,059	66,842	64,195	62,424	71,501	87,419	105,299	54.7%	2.1%
	Reach-in Refrigerator	6,891	6,160	5,644	4,823	4,781	5,593	6,694	-2.8%	-0.1%
	Glass Door Display	85,590	48,543	44,724	37,902	35,115	39,215	44,034	-48.6%	-3.2%
	Open Display Case	70,596	69,139	65,837	61,334	63,606	70,935	79,278	12.3%	0.6%
	Icemaker	34,011	36,763	36,354	36,670	40,357	45,432	50,673	49.0%	1.9%
	Vending Machine	33,507	32,312	30,415	25,177	20,751	21,927	24,227	-27.7%	-1.5%

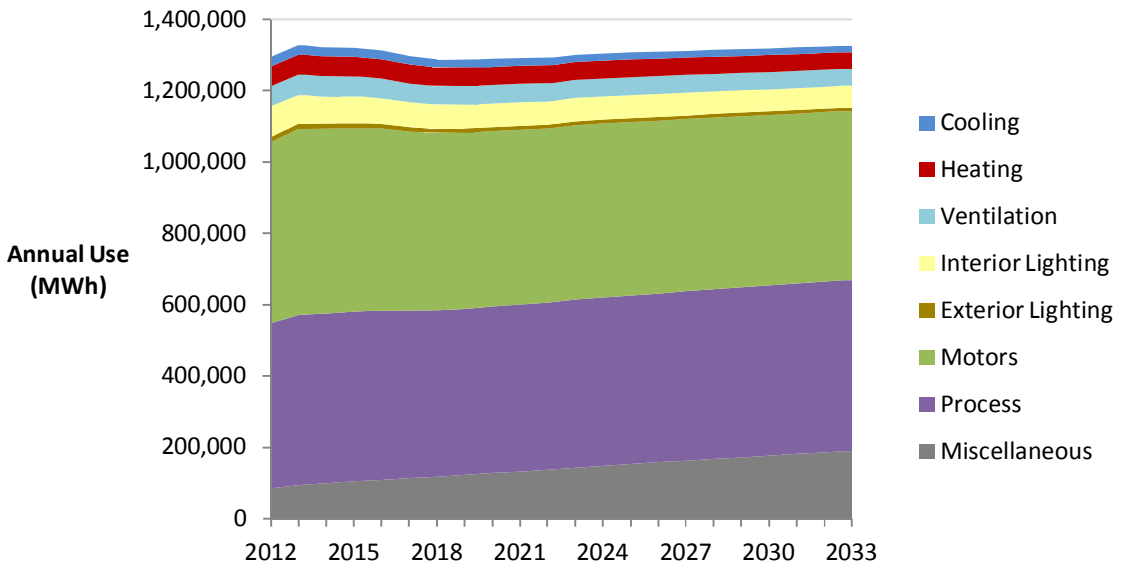
Table 4-4 Commercial Baseline Electricity Projection by End Use and Technology (MWh) (continued)

End Use	Technology	2012	2014	2015	2018	2023	2028	2033	% Change ('12-'33)	Avg. Growth Rate ('12-'33)
Food Preparation	Oven	42,851	67,980	78,017	109,408	168,903	227,208	286,999	569.8%	9.1%
	Fryer	26,318	30,385	30,767	32,627	37,263	42,489	47,685	81.2%	2.8%
	Dishwasher	143,594	174,791	180,552	203,456	255,701	318,919	384,049	167.5%	4.7%
	Hot Food Container	9,286	9,804	9,922	10,735	13,428	17,160	21,217	128.5%	3.9%
Office Equipment	Desktop Computer	196,031	213,177	211,911	217,570	241,906	271,002	300,687	53.4%	2.0%
	Laptop	34,821	38,070	38,061	39,492	43,964	49,316	54,791	57.3%	2.2%
	Server	254,091	292,727	304,398	342,730	423,375	514,527	609,951	140.1%	4.2%
	Monitor	54,644	57,089	56,632	58,531	65,073	72,898	80,879	48.0%	1.9%
	Printer/Copier/Fax	33,490	37,627	38,059	41,063	48,934	57,919	67,220	100.7%	3.3%
	POS Terminal	8,300	8,584	8,432	8,489	9,110	9,956	10,811	30.2%	1.3%
Miscellane-ous	Non-HVAC Motors	52,438	58,655	58,616	59,904	64,777	70,713	76,655	46.2%	1.8%
	Pool Pump	900	1,028	1,035	1,080	1,207	1,346	1,482	64.6%	2.4%
	Pool Heater	158	181	183	192	217	244	269	70.3%	2.5%
	Miscellaneous	431,980	545,895	576,399	681,171	894,538	1,141,201	1,408,653	226.1%	5.6%
Grand Total		**4,961,114**	**5,435,096**	**5,402,226**	**5,501,409**	**6,082,292**	**6,869,417**	**7,713,040**	**55.5%**	**2.1%**

Industrial Sector

The industrial sector as defined for the CPA (see Table makes up only 14% of City Light's total electricity usage. Figure 4-4 and Table 4-5 present the baseline projection at the end-use level for the industrial sector as a whole. Overall, industrial annual energy use increases modestly from 1,294.369 MWh in 2012 to 1,327,294 MWh in 2033, a 2.5% increase. Equipment standards for lighting and HVAC equipment cause these uses to decline and keep the baseline projection or less flat during the first years of the forecast. However, projected industrial growth, as well as increased use of industrial automation, which is included here in the miscellaneous category, cause the overall forecast to grow slightly. Table 4-6 shows the baseline projection at the technology level.

Figure 4-4 Industrial Baseline Electricity Projection by End Use



Street Lighting

As discussed in Chapter 3, City Light provided data on its existing 90,000 fixtures, including information on fixture type, lamp type, and lamp wattage. Reported street lighting use in 2012 was 91,879 MWh. EnerNOC's analysis projects that the remaining planned conversions of cobra head fixtures to LEDs will drop 2013 use to 88,592 kWh. For the 2014–2033 timeframe, it was assumed that no additional poles or luminaires will be added to the system. Therefore, in the baseline case, use remains constant at 88,592 kWh for the study period.

Baseline Projection Summary for All Sectors

Table 4-7 and Figure 4-5 provide an overall summary of the baseline projection by sector and for City Light as a whole. Overall, the projection for the next 20 years grows steadily, dominated by growth in the commercial sector, as discussed above.

Table 4-5 Industrial Electricity Consumption by End Use (MWh)

End Use	2012	2014	2015	2018	2023	2028	2033	% Change ('12-'33)	Avg. Growth Rate ('12-'33)
Cooling	26,686	26,313	25,754	23,574	20,989	19,230	18,274	**-32%**	**-1.8%**
Heating	54,472	55,097	54,561	51,869	49,872	48,102	46,516	**-15%**	**-0.8%**
Ventilation	56,797	56,694	55,828	52,533	50,578	48,956	47,381	**-17%**	**-0.9%**
Interior Lighting	85,166	76,566	74,965	67,833	65,619	63,311	61,449	**-28%**	**-1.6%**
Exterior Lighting	15,913	13,946	13,389	11,777	10,843	10,447	10,135	**-36%**	**-2.1%**
Motors	507,377	517,826	515,436	496,815	489,140	481,223	473,309	**-7%**	**-0.3%**
Process	462,731	475,478	476,478	466,274	471,012	475,448	479,884	**4%**	**0.2%**
Miscellaneous	85,228	98,937	104,318	117,533	143,144	167,405	190,347	**123%**	**3.8%**
Total	**1,294,369**	**1,320,856**	**1,320,729**	**1,288,208**	**1,301,196**	**1,314,122**	**1,327,294**	**2.5%**	**0.1%**

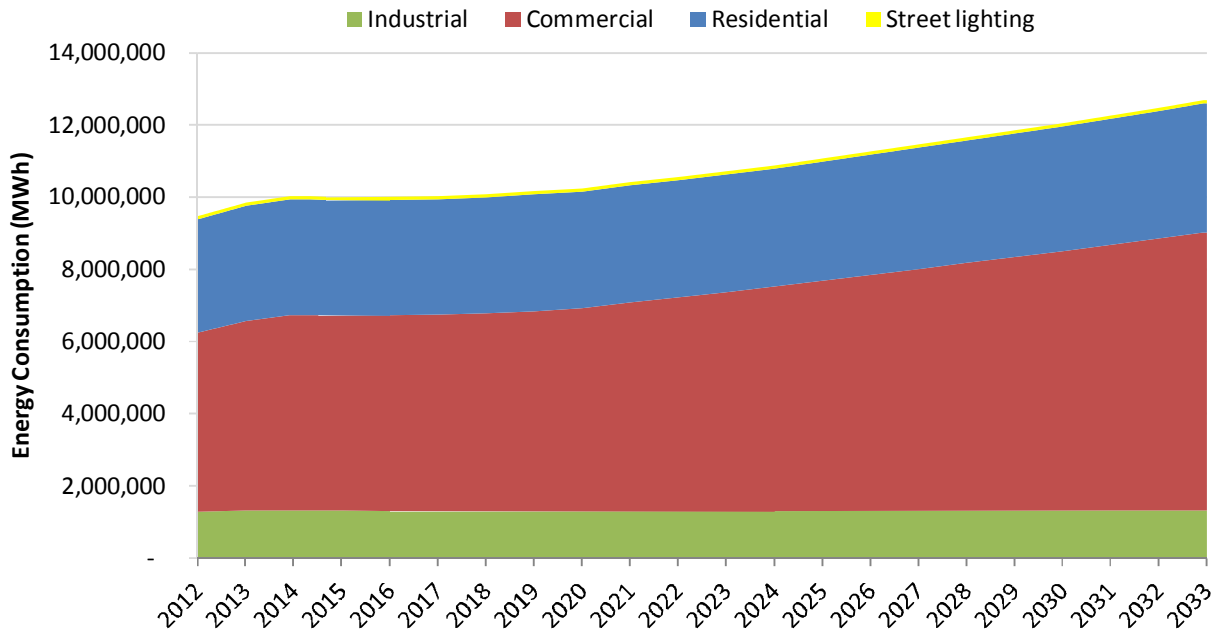
Table 4-6 Industrial Baseline Electricity Projection by End Use and Technology (MWh)

End Use	Technology	2012	2014	2015	2018	2023	2028	2033	% Change ('12-'33)	Avg. Growth Rate ('12-'33)
Cooling	Air-Cooled Chiller	2,788	2,822	2,795	2,653	2,531	2,406	2,308	**-17.2%**	**-0.9%**
	Water-Cooled Chiller	3,492	3,484	3,438	3,182	2,727	2,267	2,019	**-42.2%**	**-2.6%**
	Air Source Heat Pump	9,935	9,751	9,519	8,641	7,653	7,077	6,778	**-31.8%**	**-1.8%**
	RTU	10,471	10,256	10,002	9,098	8,077	7,481	7,168	**-31.5%**	**-1.8%**
Heating	Air Source Heat Pump	26,988	27,158	26,841	25,381	24,162	23,186	22,392	**-17.0%**	**-0.9%**
	Electric Resistance	27,484	27,939	27,720	26,488	25,709	24,916	24,123	**-12.2%**	**-0.6%**
Ventilation	Ventilation	56,797	56,694	55,828	52,533	50,578	48,956	47,381	**-16.6%**	**-0.9%**
Interior Lighting	Screw-in	8,095	5,889	5,640	4,613	4,621	4,635	4,599	**-43.2%**	**-2.7%**
	High-Bay Fixtures	26,558	20,207	19,462	16,137	16,201	15,488	14,994	**-43.5%**	**-2.7%**
	Linear Fluorescent	50,513	50,469	49,863	47,083	44,797	43,187	41,856	**-17.1%**	**-0.9%**
Exterior Lighting	Screw-in	2,158	1,159	1,059	844	845	848	841	**-61.0%**	**-4.5%**
	HID	12,891	11,917	11,469	10,122	9,228	8,859	8,578	**-33.5%**	**-1.9%**
	Linear Fluorescent	864	871	860	810	771	741	716	**-17.1%**	**-0.9%**
Motors	Pumps	51,918	53,106	52,996	51,561	51,420	51,276	51,132	**-1.5%**	**-0.1%**
	Fans & Blowers	82,221	83,963	83,631	80,818	79,850	78,852	77,856	**-5.3%**	**-0.3%**
	Compressed Air	49,152	50,322	50,253	48,863	48,774	48,667	48,561	**-1.2%**	**-0.1%**
	Conveyors	55,132	56,484	56,444	54,914	54,913	54,884	54,855	**-0.5%**	**0.0%**
	Other Motors	268,955	273,951	272,111	260,659	254,184	247,543	240,905	**-10.4%**	**-0.5%**
Process	Process Cooling	181,408	185,916	185,825	180,833	180,930	180,924	180,918	**-0.3%**	**0.0%**
	Process Heating	4,265	4,343	4,311	4,117	3,998	3,876	3,754	**-12.0%**	**-0.6%**
	Process Refrigeration	28,316	28,855	28,680	27,592	27,039	26,477	25,916	**-8.5%**	**-0.4%**
	Electrochemical Process	28,316	28,855	28,680	27,592	27,039	26,477	25,916	**-8.5%**	**-0.4%**
	Other Process	220,425	227,509	228,982	226,140	232,006	237,693	243,381	**10.4%**	**0.5%**
Miscellaneous	Miscellaneous	85,228	98,937	104,318	117,533	143,144	167,405	190,347	**123.3%**	**3.8%**
Grand Total		**1,081,568**	**1,294,369**	**1,320,856**	**1,320,729**	**1,288,208**	**1,301,196**	**1,314,122**	**1,327,294**	**2.5%**

Table 4-7 Baseline Projection Summary (MWh)

Sector	2012	2014	2015	2018	2023	2028	2033	% Change ('12-'33)	Avg. Growth Rate ('12-'33)
Residential	3,146,951	3,205,277	3,193,660	3,206,854	3,256,520	3,395,213	3,577,236	13.7%	0.6%
Commercial	4,961,114	5,435,096	5,402,226	5,501,409	6,082,292	6,869,417	7,713,040	55.5%	2.1%
Industrial	1,294,369	1,320,856	1,320,729	1,288,208	1,301,196	1,314,122	1,327,294	2.5%	0.1%
Street Lighting	91,879	88,592	88,592	88,592	88,592	88,592	88,592	-3.6%	-0.2%
Total	9,494,313	10,049,821	10,005,208	10,085,063	10,728,599	11,667,344	12,706,161	33.8%	1.4%

Figure 4-5 Baseline Projection Summary (MWh)



CHAPTER | 5

CONSERVATION POTENTIAL

This chapter presents the results of the potential analysis. First, we provide the overall potential, followed by results for each sector. Based on the total achievable potential of 118.4 aMW in 2023, City Light is establishing a conservation target for the 2014–2015 biennium of 23.7 aMW, which is 20% of the ten-year cumulative potential (118.4 aMW in 2023).

Overall Potential

Figure 5-1 and Table 5-1 summarize the achievable potential across all sectors. The commercial sector, which accounts for 59% of baseline use in 2023, is projected to provide approximately 66% of cumulative achievable potential in that same year.

Figure 5-1 Cumulative Achievable Potential by Sector (MWh)

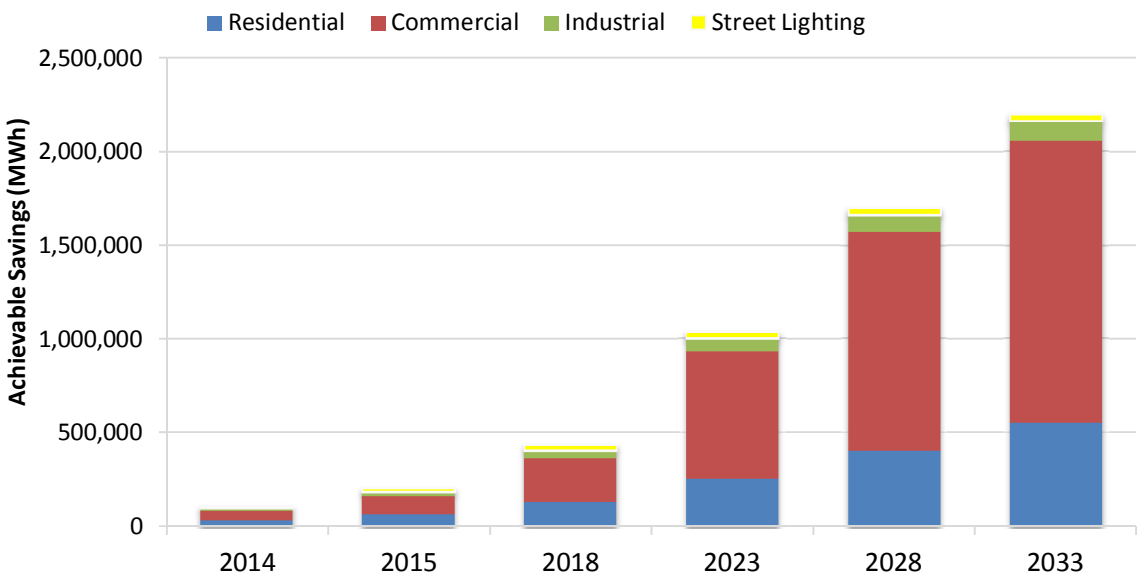


Table 5-1 Cumulative Achievable Potential by Sector (MWh)

	2014	2015	2018	2023	2028	2033
Achievable Cumulative Savings (MWh)						
Residential	28,500	59,974	127,865	249,900	398,666	548,450
Commercial	47,025	95,335	234,290	680,625	1,172,913	1,503,855
Industrial	14,509	22,765	37,031	69,591	90,627	106,463
Street Lighting	9,950	19,901	34,185	36,861	36,876	36,876
Total	**99,985**	**197,975**	**433,371**	**1,036,977**	**1,699,082**	**2,195,644**
Achievable Cumulative Savings (aMW)						
Residential	3.3	6.8	14.6	28.5	45.5	62.6
Commercial	5.4	10.9	26.7	77.7	133.9	171.7
Industrial	1.7	2.6	4.2	7.9	10.3	12.2
Street Lighting	1.1	2.3	3.9	4.2	4.2	4.24
Total	**11.4**	**22.6**	**49.5**	**118.4**	**194.0**	**250.6**

Table 5-2 presents the baseline projections of energy consumption, as well as the three levels of cumulative conservation potential for the residential, commercial, industrial, and street lighting sectors combined. As discussed in detail in Chapter 4, the baseline projection across all sectors increases over the 20-year time period. This is due largely to the growth in the commercial sector, which is tempered somewhat due to appliance and equipment standards, building codes, and a sluggish economy in the initial years. Key findings related to potentials are summarized below.

- **Achievable potential** across the four sectors is 197,975 MWh (22.6 aMW) in 2015 or 2.0% of the projected baseline. Cumulative achievable potential grows to 1,036,977 MWh or 118.4 aMW in 2023. This level of savings is consistent with other EnerNOC potential studies for utilities with mature conservation programs.
- **Economic potential**, which reflects the savings when all cost-effective measures are taken, is 57.5 aMW in 2015 or 5% of the projected baseline consumption. Cumulative economic potential is 179.8 aMW in 2023.
- **Technical potential,** which reflects the adoption of all conservation measures regardless of cost-effectiveness, is a theoretical upper bound on savings. In 2013, technical potential is 74.9 aMW or 6.6% of the baseline projection. In 2023, cumulative technical potential savings are 249.4 aMW.

Table 5-2 Summary of Achievable, Economic, and Technical Conservation Potential, All Sectors

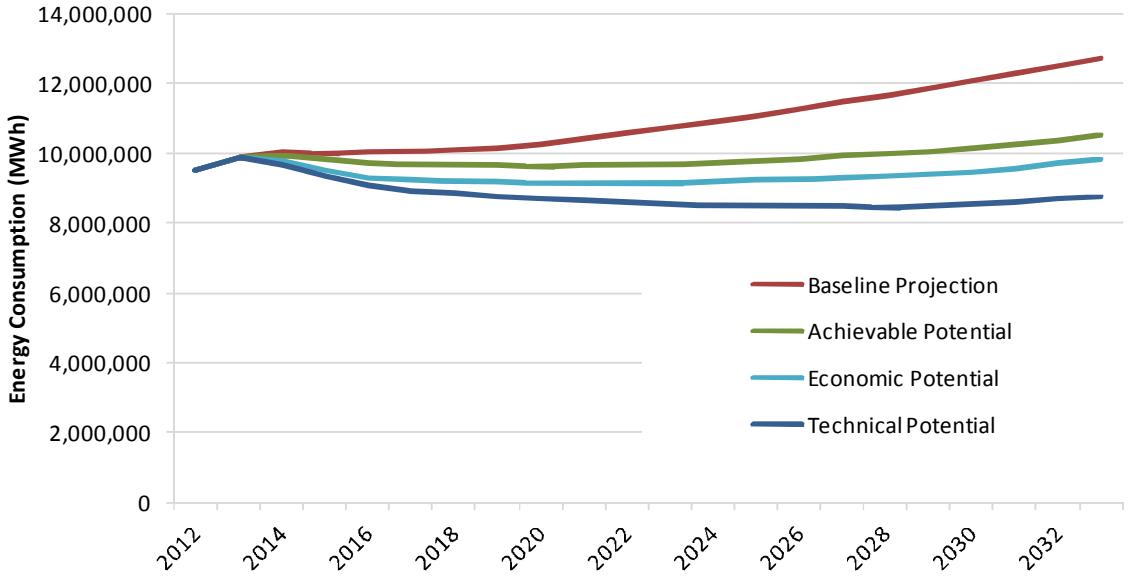
	2014	2015	2018	2023	2028	2033
Baseline Projection (MWh)	10,049,821	10,005,208	10,085,063	10,728,599	11,667,344	12,706,161
Cumulative Savings (MWh)						
Achievable Potential	99,985	197,975	433,371	1,036,977	1,699,082	2,195,644
Economic Potential	285,794	504,001	911,503	1,574,823	2,342,961	2,893,157
Technical Potential	376,456	656,464	1,243,763	2,185,003	3,209,910	3,938,790
Cumulative Savings (aMW)						
Achievable Potential	11.4	22.6	49.5	118.4	194.0	250.6
Economic Potential	32.6	57.5	104.1	179.8	267.5	330.3
Technical Potential	43.0	74.9	142.0	249.4	366.4	449.6

Per WAC 194-37-070 (6), the NPCC methodology yields a maximum penetration rate after 20 years of 85% for non-lost opportunity measures and 65% for lost opportunity measures achieved through a mix of utility programs and local, state and federal codes and standards. For 10-year potential, the penetration rates are 64% for non-lost opportunity measures and 23% for lost opportunity measures with a weighted average of 46% for both.[10] The results of this CPA analysis show 10-year achievable potential for the residential, commercial, and industrial sectors combined that is 65% of the economic (cost-effective) potential, greater than the 46% weighted average cited in WAC 194-37-070. Note that the CPA projection of achievable savings is attributed to utility programs and market transformation efforts (such as NEEA activities supported by City Light and other regional utilities) and excludes savings due to codes and standards, which are incorporated in the baseline projection. The CPA projection of achievable 20-year potential for lost and non-lost opportunities combined is 76%.

[10] http://apps.leg.wa.gov/WAC/default.aspx?cite=194-37&full=true#194-37-070, 194-37-070, (6) (a) (xii).

Figure 5-2 displays the baseline and conservation potential projections.

Figure 5-2 Baseline and Conservation Potential Energy Projections (MWh)



Residential Sector

Table 5-3 presents estimates for the three types of potential for the residential sector.

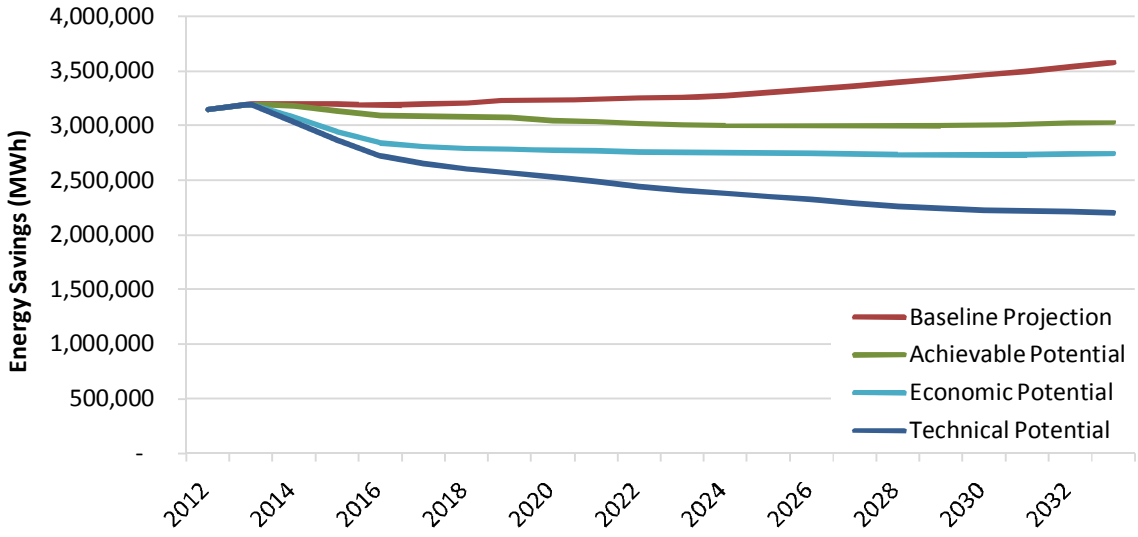
Table 5-3 Conservation Potential for the Residential Sector

	2014	2015	2018	2023	2028	2033
Baseline Projection (MWh)	3,205,277	3,193,660	3,206,854	3,256,520	3,395,213	3,577,236
Cumulative Savings (MWh)						
Achievable Potential	28,500	59,974	127,865	249,900	398,666	548,450
Economic Potential	130,668	247,102	415,827	504,274	662,997	833,258
Technical Potential	173,554	327,293	604,761	845,762	1,136,914	1,375,499
Cumulative Savings (aMW)						
Achievable Potential	3.3	6.8	14.6	28.5	45.5	62.6
Economic Potential	14.9	28.2	47.5	57.6	75.7	95.1
Technical Potential	19.8	37.4	69.0	96.5	129.8	157.0

- **Achievable potential** is 59,974 MWh (6.8 aMW) in 2015, equivalent to 1.9% of the baseline projection. By 2023, the cumulative achievable conservation savings are 249,900 MWh (29 aMW).
- **Economic potential**, which reflects the savings when all cost-effective measures are taken, is 247,102 MWh (28.2 aMW) in 2015, 7.7% of the baseline energy projection. By 2023, economic potential reaches 504,274 MWh. The relatively wide gap between achievable and economic potential reflects the fact that substantial savings are available from emerging technology measures such as ductless heat pumps and heat pump water heaters, which face substantial market barriers.
- **Technical potential**, which reflects the adoption of all energy conservation measures regardless of cost, is a theoretical upper bound on savings. In 2015, technical potential is 327,293 MWh (37.4 aMW), or 10.2% of the baseline energy projection. The 10-year technical potential is 845,762 MWh.

Figure 5-3 displays the projections under the three types of potential along with the baseline projection. In 2033, achievable potential, as indicated by the green line, offsets the growth projected in the baseline case.

Figure 5-3 Residential Baseline and Conservation Potential Projection



Residential Potential by End Use, Technology, and Measure Type

Table 5-4 provides estimates of savings for each end use and type of potential. Focusing first on technical and economic potential, there are significant savings that are both possible and economic in numerous end uses:

- **Heating** offers the highest technical potential, which would be achieved if all electric furnaces were replaced with SEER 16 heat pumps (either when furnaces fail or by installing a heat pump in lieu of a furnace during new construction) and all electric resistance heat was converted to ductless minisplit systems. Ductless minisplit conversions pass the economic screen as early as 2014 in existing construction in single family and multiplex housing.
- **Water Heating** offers the second-largest technical potential, which reflects the across the board-installation of heat pump water heaters and solar water heating. However, solar water heating is not found to be cost-effective.
- **Home electronics** offers the third-largest technical potential savings. Much of the savings come from TVs. Note that in order to calibrate with City Light's historical savings, which include NEEA's savings, we used a market baseline similar to that used in the Sixth Plan. However, the market has transformed significantly, such that almost all TVs now sold are ENERGY STAR labeled.
- **Interior lighting** is close behind electronics. For technical potential, LED lamps are the most efficient option, which drives the high level of technical potential. LEDs are cost-effective for standard screw-in lighting in most cases starting in 2014, which also leads to a high level of economic potential.
- **Appliances** offer relatively little potential, as compared to years past. Current equipment efficiency standards have moved the baseline unit to a relatively high efficiency level.

Table 5-4 Residential Cumulative Savings by End Use and Potential Type (MWh)

End Use	Potential Case	2014	2015	2018	2023	2028	2033
Cooling	Achievable	37	53	58	73	95	123
	Economic	105	107	116	139	175	221
	Technical	86	98	250	720	1,292	1,693
Heating	Achievable	2,373	4,458	11,912	34,982	64,737	99,092
	Economic	17,082	26,441	51,963	96,433	141,460	192,836
	Technical	40,840	71,573	156,257	285,030	404,654	531,209
Water Heating	Achievable	2,096	3,583	8,332	29,231	65,467	128,748
	Economic	16,779	26,318	58,338	119,386	179,458	244,172
	Technical	27,467	44,766	101,431	203,094	304,377	350,741
Interior Lighting	Achievable	13,581	32,359	61,444	84,901	122,415	152,188
	Economic	60,227	131,702	178,268	121,642	138,657	167,657
	Technical	62,400	135,655	187,875	140,390	162,307	190,155
Exterior Lighting	Achievable	1,191	2,996	5,214	6,614	9,612	10,963
	Economic	5,616	12,691	16,192	9,368	10,912	11,918
	Technical	5,893	12,891	16,354	9,725	11,530	12,901
Appliances	Achievable	2,949	4,092	5,645	9,210	13,448	18,820
	Economic	7,784	8,035	9,599	13,670	18,594	24,977
	Technical	9,728	12,177	19,703	34,012	50,685	65,113
Electronics	Achievable	5,560	11,327	33,749	82,723	119,859	134,264
	Economic	20,758	39,062	97,465	138,475	167,102	183,622
	Technical	23,963	45,731	115,217	160,103	184,221	203,365
Miscellaneous	Achievable	713	1,106	1,510	2,166	3,033	4,253
	Economic	2,318	2,746	3,885	5,160	6,640	7,855
	Technical	3,177	4,402	7,672	12,688	17,847	20,322
Total	**Achievable**	**28,500**	**59,974**	**127,865**	**249,900**	**398,666**	**548,450**
	Economic	**130,668**	**247,102**	**415,827**	**504,274**	**662,997**	**833,258**
	Technical	**173,554**	**327,293**	**604,761**	**845,762**	**1,136,914**	**1,375,499**

Moving from technical and economic potential to achievable potential, we focus on the residential cumulative achievable potential in 2015, as shown in Figure 5-4.

- **Interior lighting** provides the greatest achievable potential, with savings from both standard screw-in and specialty lighting. The study assumes that LED costs will continue to drop rapidly, and that they will be accepted by consumers.
- **Home electronics** offers the second largest achievable potential in the near term. A large portion of the savings is due to televisions. As noted above, the baseline for televisions was adjusted to more closely correspond to that used by NEEA for calculating savings. However, the market has transformed significantly, such that almost all TVs now sold are ENERGY STAR labeled. Savings also come from efficient set-top boxes and digital video recorders.
- **Heating** offers the third largest achievable potential, due mainly to the adoption of ductless heat pumps in single family and multiplex homes. Insulation measures are a small contributor to savings because City Light's long running programs have already achieved much of that potential.
- **Appliances** offer the next highest near-term savings. However, appliances' contribution to potential in future years diminishes as equipment standards move the market to efficient units. Clothes washers and freezers are the exceptions, although savings are modest.
- **Water Heating** achievable potential is limited in the near term because HPWH, which are the cost-effective option, still face significant market barriers. Therefore, most of the near-term water heating savings are due to low-flow showerheads and faucet aerators.
- **Behavioral measure,** assumed to be a comparative feedback program, provides savings across all end uses. See below for additional details regarding modeling assumptions used for this measure.

Figure 5-4 Residential Cumulative Achievable Potential by End Use in 2015

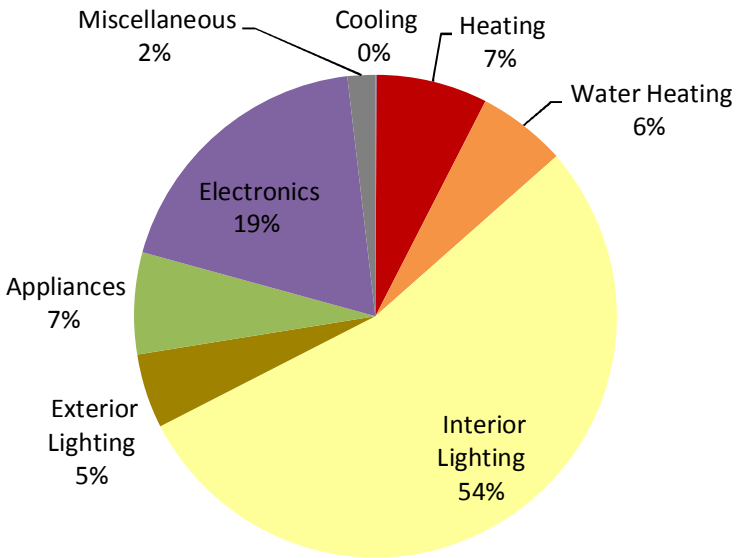


Table 5-5 presents the top twenty measures, which account for 99.9% of residential cumulative achievable potential in 2015. The top five measures alone represent 86% of potential, with lighting measures as three of those top five.

Table 5-5 Residential Top 20 Measures, Cumulative Achievable Potential in 2015

Rank	Measure	Savings (MWh)	% of Total Savings
1	Interior Lighting Screw-in	24,573	41%
2	Behavioral Measure	9,468	16%
3	Electronics TVs	7,722	13%
4	Interior Lighting Specialty	6,735	11%
5	Exterior Lighting Screw-in	2,869	5%
6	Heating Electric Zonal Room Heat	2,263	4%
7	Electronics Set-top Boxes/DVR	1,935	3%
8	Water Heater - Low-Flow Showerheads	1,023	2%
9	Appliances Clothes Washer	976	2%
10	Water Heater - Faucet Aerators	459	1%
11	Refrigerator - Decommissioning and Recycling	343	1%
12	Water Heating HPWH <= 55 Gal	319	0.5%
13	Electronics Laptops	302	0.5%
14	Thermostat - Clock/Programmable	239	0.4%
15	Insulation - Infiltration Control	213	0.4%
16	Electronics Monitor	105	0.2%
17	Miscellaneous Pool Heater	97	0.2%
18	Appliances Freezer	96	0.2%
19	Insulation - Ceiling	81	0.1%
20	Ducting - Repair and Sealing	71	0.1%
	Total	**59,890**	**99.9%**

The second largest conbributor to savings is a beheavioral measure, assumed to be a comparative feedback measure, in which householders receive a personalized home energy reports every month or two that compares the customer's usage with neighboring homes of similar size and location. Several evaluations of this program type provide savings estimates in the range of 1%–3%: We note however that many of the savings gained are related to the installation of tangible, efficient equipment or measures rather than pure behavioral changes, such as turning out lights or changing water heater temperature settings. The tangible measures are already covered in the CPA analysis framework and must be removed from savings estimates that include both tangible measures and behavioral ones to avoid double counting savings. One study estimates the tangible, non-behavioral component of these programs at 32% of the total savings[11] and it could possibly be higher. Therefore, the City Light analysis assumes 1.0% annual net savings per household for behavioral aspects alone. These savings are distributed across all of the end uses. Cost is assumed at $10 per year per household per year for the study.

With regard to measure life, the CPA uses a one-year measure life that coincides with ongoing reports during that year. Persistence of the program effect is assumed to decay if consumers stop receiving the reports. As a result, cumulative savings do not increase year-over-year, as is the case with many other

[11] California 2012 Potential Study. Table 2. "Forecast Behavioral Technical Potential (GWh)" http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/Energy+Efficiency+Goals+and+Potential+Studies.htm

measures. In fact, they decline slightly over time, because the total energy use per household also drops in the achievable potential case.

City Light is currently running a comparative information behavioral program. This study assumes that program participation will be increased from current levels of roughly 40,000 households to 70,000 households in 2014, 100,000 in 2015, and held at that level for each year thereafter.

Residential Potential by Market Segment

Single-family homes are slightly more than half of City Light's residential customers, but consumed 60% of the sector's energy use in 2012. Furthermore, potential as a percentage of baseline energy use is generally higher in single family homes, which have larger saturations of equipment beyond the basics of heating, water heating, and appliances. Thus, single-family homes account for the largest share of potential savings by segment, representing 72% of achievable potential in 2014. By the end of the study period, however, the share of residential potential in single family homes drops slightly to 65% as indicated in Table 5-6. This trend reflects that housing growth in the City Light service territory is expected to occur mainly in the multifamily housing types.

Table 5-6 Residential Cumulative Achievable Potential by Market Segment

	2014	2015	2018	2023	2028	2033
Achievable Savings (MWh)						
Single Family	21,059	43,157	88,244	170,457	273,177	357,448
Multiplex	1,459	2,941	6,610	15,085	26,087	36,964
Low-Rise Multifamily	4,940	11,445	27,386	51,595	77,518	122,616
High-Rise Multifamily	1,043	2,431	5,624	12,763	21,884	31,422
Total	**3,205,277**	**3,193,660**	**3,206,854**	**3,256,520**	**3,395,213**	**3,577,236**
Achievable - % of Savings						
Single Family	74%	72%	69%	68%	69%	65%
Multiplex	5%	5%	5%	6%	7%	7%
Low-Rise Multifamily	17%	19%	21%	21%	19%	22%
High-Rise Multifamily	4%	4%	4%	5%	5%	6%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Commercial Sector Potential

Table 5-7 presents the savings associated with each level of potential for the commercial sector. The baseline projection for the commercial sector grows steadily during the study period as the region emerges from the economic downturn. As a result, opportunities for energy-efficiency savings are significant for the commercial sector.

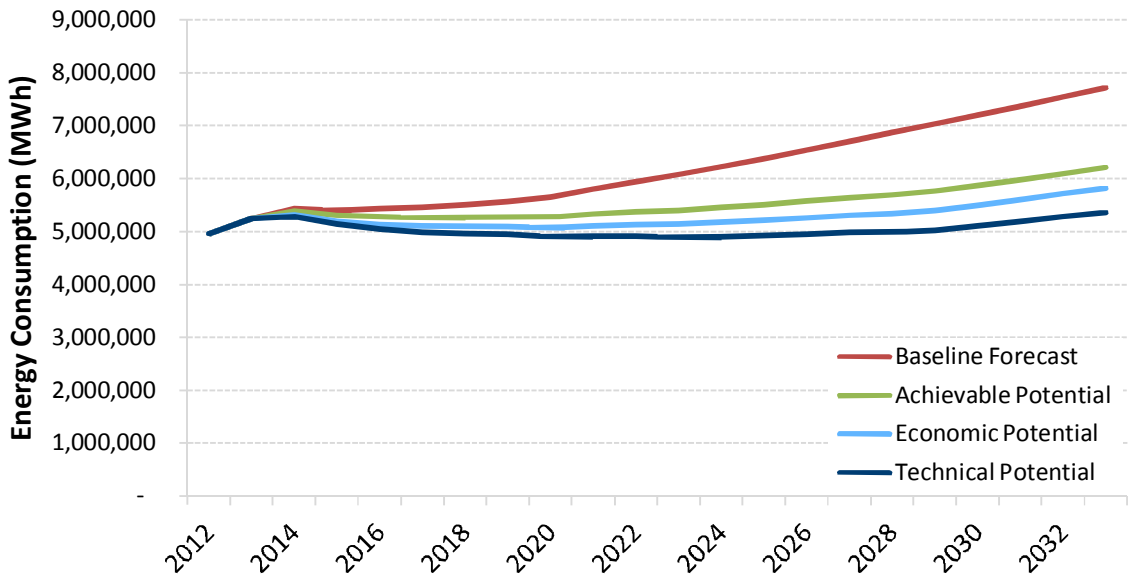
- **Achievable potential** projects 95,335 MWh (11 aMW) of energy savings in 2015, which corresponds to 1.8% of the baseline projection. In 2023, cumulative achievable potential reaches 680,625 MWh (78 aMW).
- **Economic potential**, which reflects the savings when all cost-effective measures are taken, is 946,480 MWh (108 aMW) in 2023.
- **Technical potential,** which reflects the adoption of all energy conservation measures regardless of cost, is a theoretical upper bound on savings. In 2023, technical potential energy savings are 1,186,159 MWh.

Table 5-7 Cumulative Conservation Potential for the Commercial Sector

	2014	2015	2018	2023	2028	2033
Baseline Projection (MWh)	5,435,096	5,402,226	5,501,409	6,082,292	6,869,417	7,713,040
Cumulative Savings (MWh)						
Achievable Potential	47,025	95,335	234,290	680,625	1,172,913	1,503,855
Economic Potential	116,007	201,851	410,776	946,480	1,530,031	1,889,671
Technical Potential	157,533	265,915	541,388	1,186,159	1,878,483	2,346,823
Cumulative Savings (aMW)						
Achievable Potential	5.4	10.9	26.7	77.7	133.9	171.7
Economic Potential	13.2	23.0	46.9	108.0	174.7	215.7
Technical Potential	18.0	30.4	61.8	135.4	214.4	267.9

Figure 5-5 shows the commercial sector baseline projection and the three potential level projections.

Figure 5-5 Commercial Energy Efficiency Potential Projection



Commercial Potential by End Use, Technology, and Measure Type

Table 5-8 presents the commercial sector savings by end use and potential type. The end uses with the highest technical and economic potential are:

- Interior lighting, the largest end use in the commercial sector, also has the highest technical potential. Because LEDs are found to be the cost-effective technology option for screw-in lighting, as are super T8s for linear fluorescent systems and T5s for high-bay fixtures, economic potential is highest for lighting as well, at 447,935 MWh in 2023.
- Ventilation provides the second highest technical potential savings due mainly to conversion of constant volume to variable volume systems, but also to control systems and operating strategies. Economic potential is about three-quarters of technical potential.
- Water heating is the next most promising end use for technical potential, which would include installation of heat pump water heaters in place of all existing electric water heating units as well as low-flow fixtures. Because these measures are cost-effective, economic potential for water heating is close on the heels of ventilation.

- Office equipment, including servers and measures to reduce energy use in data centers, has the fourth highest level of technical, about half of which is found to be cost-effective.

Table 5-8 Commercial Cumulative Potential by End Use and Potential Type (MWh)

End Use	Potential	2014	2015	2018	2023	2028	2033
Cooling	Achievable Potential	1,308	2,362	7,270	17,331	34,049	58,788
	Economic Potential	4,930	6,057	10,867	24,084	47,293	82,276
	Technical Potential	9,150	12,921	25,347	51,488	87,108	130,426
Heating	Achievable Potential	1,002	2,003	7,398	23,990	42,233	60,984
	Economic Potential	5,127	7,526	16,015	36,243	61,271	89,176
	Technical Potential	8,061	11,435	23,133	50,832	86,398	130,955
Ventilation	Achievable Potential	4,391	10,458	34,292	81,628	108,622	130,777
	Economic Potential	15,411	29,347	66,719	135,827	162,005	193,430
	Technical Potential	21,090	39,995	90,095	181,762	215,035	253,152
Water Heating	Achievable Potential	851	1,501	8,166	34,791	85,342	128,320
	Economic Potential	17,499	26,927	59,271	113,152	186,108	208,381
	Technical Potential	18,235	27,875	61,085	116,164	188,498	210,785
Interior Lighting	Achievable Potential	26,090	51,737	112,161	389,909	688,478	837,480
	Economic Potential	45,949	80,822	149,968	447,935	785,168	938,986
	Technical Potential	59,013	97,417	178,966	515,039	894,517	1,074,858
Exterior Lighting	Achievable Potential	4,686	9,760	22,079	59,910	96,602	119,635
	Economic Potential	7,880	15,518	30,212	64,242	104,887	128,133
	Technical Potential	9,077	16,890	32,211	73,427	119,978	148,160
Refrigeration	Achievable Potential	1,692	3,228	7,887	16,445	29,425	47,199
	Economic Potential	3,240	5,034	10,289	21,164	38,482	63,359
	Technical Potential	6,171	8,790	16,607	33,553	60,344	98,600
Food Preparation	Achievable Potential	880	1,995	6,255	18,662	40,679	63,659
	Economic Potential	4,575	9,003	21,903	45,378	72,537	99,697
	Technical Potential	6,058	10,969	25,926	56,935	99,786	152,410
Office Equipment	Achievable Potential	6,034	12,079	28,218	36,760	45,638	54,862
	Economic Potential	11,247	21,296	44,746	56,859	69,859	83,504
	Technical Potential	20,526	39,298	87,220	105,349	124,385	144,745
Miscellaneous	Achievable Potential	92	211	565	1,198	1,845	2,149
	Economic Potential	150	322	787	1,596	2,420	2,730
	Technical Potential	152	325	797	1,608	2,434	2,734
Total	**Achievable Potential**	**47,025**	**95,335**	**234,290**	**680,625**	**1,172,913**	**1,503,855**
	Economic Potential	**116,007**	**201,851**	**410,776**	**946,480**	**1,530,031**	**1,889,671**
	Technical Potential	**157,533**	**265,915**	**541,388**	**1,186,159**	**1,878,483**	**2,346,823**

Figure 5-6 illustrates how the commercial cumulative achievable potential of 95,335 MWh in 2015 is distributed among the end uses. We note the following:

- Interior and exterior lighting combined represent nearly two-thirds of all potential, consistent with lighting's preponderance in technical and economic potential. Given that these are mature technologies, they have relatively high market acceptance.
- Ventilation provides 11% of achievable savings, while HVAC overall represents 16% of potential
- Office Equipment constitutes 13% of achievable potential, which reflects that efficient technologies in this area are both cost-effective and widely accepted in the market
- Water heating savings are modest at 2% of total achievable potential, despite significant technical and achievable potential. This reflects ongoing market barriers to widespread adoption of HPWH.

Figure 5-6 Commercial Cumulative Achievable Potential by End Use in 2015

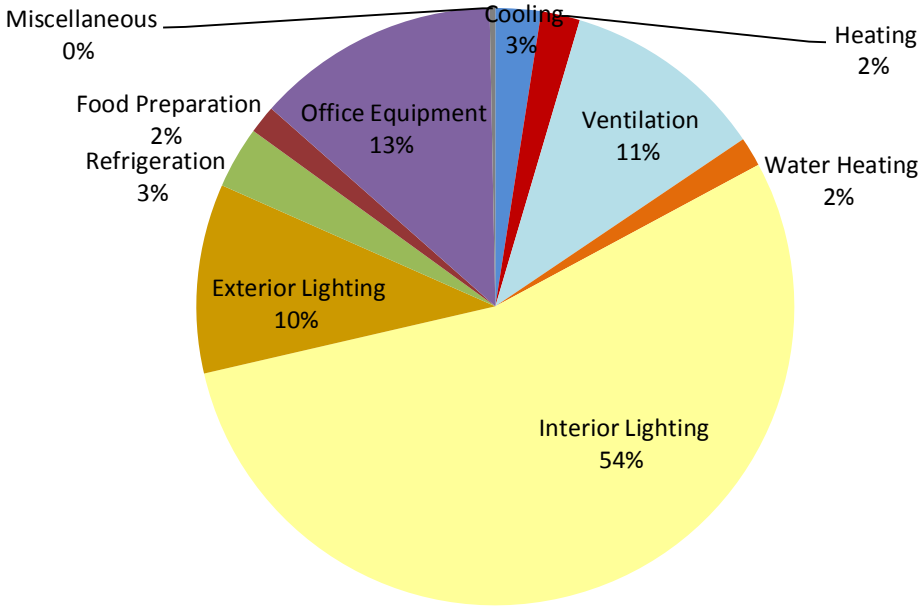


Table 5-9 presents the top twenty measures, which account for 94% of cumulative commercial sector achievable potential in 2015. Consistent with the discussion above, lighting measures dominate the list.

Table 5-9 Commercial Top 20 Measures, Cumulative Achievable Potential in 2015

Rank	Measure	Savings (MWh)	% of Total Savings
1	Interior Lighting Linear Fluorescent	23,945	25.1%
2	Interior Lighting Screw-in	14,913	15.6%
3	Office Equipment Server	10,121	10.6%
4	Variable Air Volume Ventilation	8,840	9.3%
5	Interior Lighting High-Bay Fixtures	7,650	8.0%
6	Exterior Lighting Screw-in	5,082	5.3%
7	Exterior Lighting HID	4,009	4.2%
8	Interior Lighting - Occupancy Sensors	2,818	3.0%
9	Refrigeration Walk-in Refrigerator	2,310	2.4%
10	Interior Lighting - Daylighting Controls	2,011	2.1%
11	Water Heating Heat Pump Water Heater	1,347	1.4%
12	Office Equipment Laptop	1,155	1.2%
13	Food Preparation Dishwasher	1,073	1.1%
14	Thermostat - Clock/Programmable	958	1.0%
15	Heating Electric Zonal Heat	721	0.8%
16	Ventilation - Variable Speed Control	688	0.7%
17	Office Equipment Printer/Copier/Fax	603	0.6%
18	Retrocommissioning	518	0.5%
19	Cooling Air-Cooled Chiller	510	0.5%
20	Office Equipment - Plug Load Occupancy Sensors	495	0.5%
	Total	**89,768**	**94%**

Industrial Sector Potential

Conservation potential was analyzed using conservation measures included in the Sixth Plan industrial measure analysis tool, as well as other relevant industrial measures. Where City Light was aware of the potential for heat recovery generation in industrial facilities, it was explicitly included in the study.

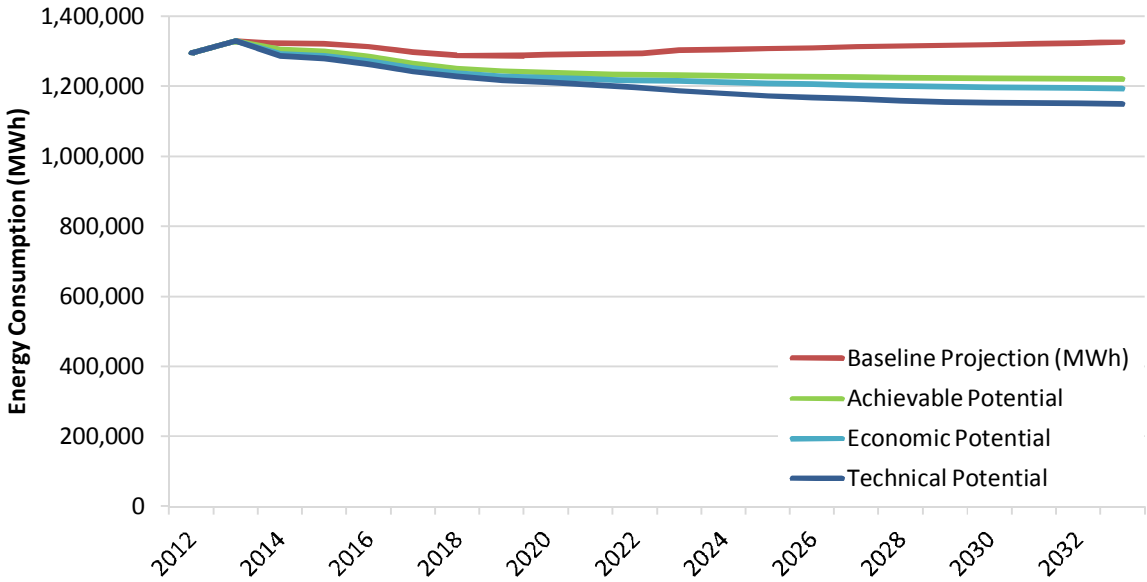
Table 5-10 presents the savings for the various levels of potential considered in this study. Figure 5-7 shows the baseline and the potential projections.

- **Achievable potential** is 22,765 MWh (2.6 aMW) in 2015, equal to 1.7% of the baseline projection. By 2023, the cumulative achievable conservation savings are 69,591 MWh (7.9 aMW).
- **Economic potential** which reflects the savings when all cost-effective measures are taken, is 35,148 MWh (4.0 aMW) in 2015 or 2.7% of the baseline energy projection. By 2023, economic potential reaches 87,208 MWh.
- **Technical potential** in 2015 is 42,346 MWh (4.8 aMW) or 3.2% of the baseline energy projection. The 10-year technical potential is 114,501 MWh,

Table 5-10 Cumulative Conservation Potential for the Industrial Sector

	2014	2015	2018	2023	2028	2033
Baseline Projection (MWh)	1,320,856	1,320,729	1,288,208	1,301,196	1,314,122	1,327,294
Cumulative Savings (MWh)						
Achievable Potential	14,509	22,765	37,031	69,591	90,627	106,463
Economic Potential	29,168	35,148	50,715	87,208	113,056	133,352
Technical Potential	34,913	42,346	61,822	114,501	155,932	177,887
Cumulative Savings (aMW)						
Achievable Potential	1.7	2.6	4.2	7.9	10.3	12.2
Economic Potential	3.3	4.0	5.8	10.0	12.9	15.2
Technical Potential	4.0	4.8	7.1	13.1	17.8	20.3

Figure 5-7 Industrial Baseline and Conservation Potential Energy Projections (MWh)



Industrial Potential by End Use

Table 5-11 presents the savings by end use and type of potential, while Figure 5-8 shows cumulative achievable potential by end use in 2015. Motor end uses, which are 36% of achievable potential in 2015, also offer the greatest opportunity for energy savings across the all three levels of potential and all years. Because of motor standards, much of the cost-effective and achievable savings are not due to more efficient motors, but rather to controls and system optimization strategies. Process loads and lighting are the next greatest sources of savings, followed by ventilation.

Table 5-11 Industrial Potential by End Use and Potential Type (MWh)

End Use	Potential	2014	2015	2018	2023	2028	2033
Cooling	Achievable Potential	300	374	557	890	1,346	1,858
	Economic Potential	596	658	853	1,329	1,953	2,626
	Technical Potential	959	1,109	1,581	2,646	3,827	4,687
Heating	Achievable Potential	578	754	1,256	2,204	3,092	3,849
	Economic Potential	1,282	1,443	1,974	3,295	4,581	5,682
	Technical Potential	1,896	2,127	2,888	4,584	6,413	8,051
Ventilation	Achievable Potential	860	1,754	4,236	7,657	7,888	7,772
	Economic Potential	1,240	2,347	5,226	9,231	9,349	9,228
	Technical Potential	1,868	3,560	7,957	14,063	14,230	14,030
Interior Lighting	Achievable Potential	3,485	4,867	6,842	12,996	14,546	15,699
	Economic Potential	5,410	7,027	9,209	16,237	17,896	19,780
	Technical Potential	6,335	8,025	10,451	29,002	41,995	44,499
Exterior Lighting	Achievable Potential	481	786	1,192	1,652	1,951	2,197
	Economic Potential	703	1,077	1,514	1,956	2,292	2,631
	Technical Potential	838	1,224	1,705	3,059	5,751	6,723
Motors	Achievable Potential	6,392	8,178	14,316	28,197	39,532	47,735
	Economic Potential	12,134	14,059	20,892	36,538	50,749	60,938
	Technical Potential	14,197	16,590	24,480	41,071	55,832	66,052
Process	Achievable Potential	2,413	6,053	8,632	15,995	22,272	27,354
	Economic Potential	7,805	8,537	11,047	18,621	26,236	32,467
	Technical Potential	8,820	9,710	12,760	20,077	27,884	33,844
Miscellaneous	Achievable Potential	-	-	-	-	-	-
	Economic Potential	-	-	-	-	-	-
	Technical Potential	-	-	-	-	-	-
Total	**Achievable Potential**	**14,509**	**22,765**	**37,031**	**69,591**	**90,627**	**106,463**
	Economic Potential	**29,168**	**35,148**	**50,715**	**87,208**	**113,056**	**133,352**
	Technical Potential	**34,913**	**42,346**	**61,822**	**114,501**	**155,932**	**177,887**

Figure 5-8 Industrial Cumulative Achievable Potential by End Use in 2015

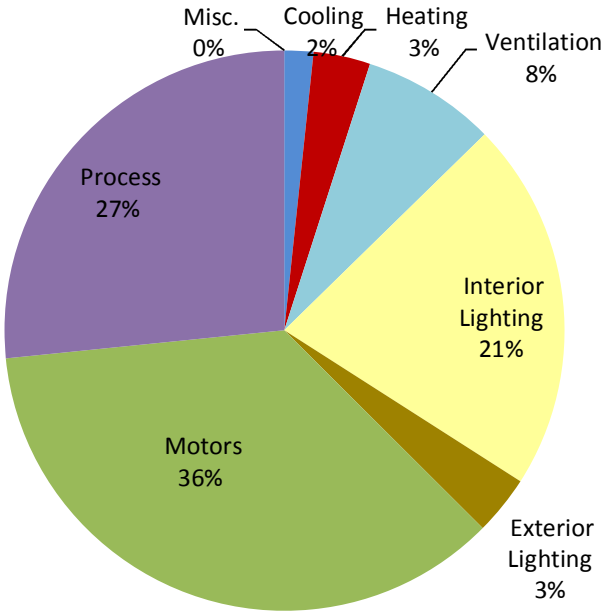


Table 5-12 presents the top twenty industrial measures, which account for 96% of cumulative commercial sector achievable potential in 2015. Consistent with the discussion above, motor-related measures including variable speed controls, compressed air optimization and upgrades are significant savers.

Table 5-12 Industrial Top 20 Measures, Cumulative Achievable Potential in 2015

Rank	Measure	Savings (MWh)	% of Total Savings
1	Motors - Variable Speed Controls	3,684	16.2%
2	Waste Heat Generation – Custom	2,984	13.1%
3	Process - Timers and Controls	2,047	9.0%
4	Compressed Air - Operations and Maintenance	1,864	8.2%
5	Variable Air Volume Ventilation	1,708	7.5%
6	Compressed Air - Equipment Upgrade	1,524	6.7%
7	Interior Lighting High-Bay Fixtures	1,370	6.0%
8	Interior Lighting Linear Fluorescent	1,138	5.0%
9	Transformer - High Efficiency	1,065	4.7%
10	Energy Management System	835	3.7%
11	Interior Lighting - Occupancy Sensors	651	2.9%
12	Interior Lighting - Time Clocks and Timers	601	2.6%
13	Exterior Lighting HID	561	2.5%
14	Interior Lighting Screw-in	417	1.8%
15	Motors - Rewind	352	1.5%
16	Thermostat - Clock/Programmable	271	1.2%
17	Refrigerated Storage Tuneup	228	1.0%
18	Refrigeration - Floating Head Pressure	207	0.9%
19	Heat Pump - Maintenance	200	0.9%
20	Refrigerated Storage Retrofit	194	0.9%
	Total	**21,902**	**96%**

Street Lighting Potential

Table 5-13 provides results of the street lighting analysis. The 10-year achievable savings in 2023 are 4.2 aMW, which is 36,861 MWh or 41.6% of the baseline street lighting forecast. Most equipment retrofits for LED lamps were found to be cost effective, but smart dimming controllers were only cost effective in select fixture types and situations. For the street lighting sector, economic and achievable potential are the same. City Light controls the implementation of lighting upgrades to the fixtures it owns and thus no market barriers exist to the implementation of these measures.

Table 5-13 Cumulative Conservation Potential for the Street Lighting Sector

	2014	2015	2018	2023	2028	2033
Baseline Projection (MWh)	**88,592**	**88,592**	**88,592**	**88,592**	**88,592**	**88,592**
Cumulative Savings (MWh)						
Achievable Potential	9,950	19,901	34,185	36,861	36,876	36,876
Economic Potential	9,950	19,901	34,185	36,861	36,876	36,876
Technical Potential	10,455	20,910	35,793	38,581	38,581	38,581
Cumulative Savings (aMW)						
Achievable Potential	1.1	2.3	3.9	4.2	4.2	4.2
Economic Potential	1.1	2.3	3.9	4.2	4.2	4.2
Technical Potential	1.2	2.4	4.1	4.4	4.4	4.4

Avoided Cost Sensitivity Analysis

To assist City Light in evaluating variations in potential due to changes in avoided costs, EnerNOC also evaluated conservation potential, for the residential, commercial, and industrial sectors, based on an alternate stream of avoided costs. Street lighting measures were mainly cost-effective under the reference case, and thus were not modeled under the avoided costs alternative case.

- In the reference case, for which results are presented above, and referred to here as Market + CCT, the avoided costs are based on market costs and assume that the marginal generation unit is a conventional combined cycle turbine. In addition, avoided costs include adders for renewable energy credits, carbon dioxide offsets, transmission and distribution costs, and a 10% credit for the Regional Act Bonus, consistent with the Sixth Power Plan methodology. Note that City Light has sufficient capacity for the study period and thus did not provide an avoided cost of capacity.
- The second scenario, referred to here as the IRP Preferred Portfolio, assumed higher avoided energy costs starting in 2021. City Light does not expect to acquire generation resources before roughly 2021. At this point, all new resources will be from a renewable source. As with the reference case, it also includes transmission and distribution costs and a 10% credit for the Regional Act Bonus. The changes in avoided costs affect economic potential directly and flow through to achievable potential. As avoided costs increase, the benefits of savings from conservation increase, causing the benefit-cost ratio to increase. If higher avoided costs result in measure B/C ratios rising to a value of 1.0 or above, then the measures are included in economic potential.

Figure 5-9 shows the two avoided costs streams used in the analyses. Table 5-14 compares the cumulative achievable and economic potential in 2023 under the two cases. The baseline and technical projections are not shown because by definition they are the same in both cases. In 2023, achievable potential under the IRP Preferred Portfolio case is 1,077,688 MWh, or 104% of the 1,036,977 MWh reference case.

Figure 5-9 Avoided Costs of Energy Projections

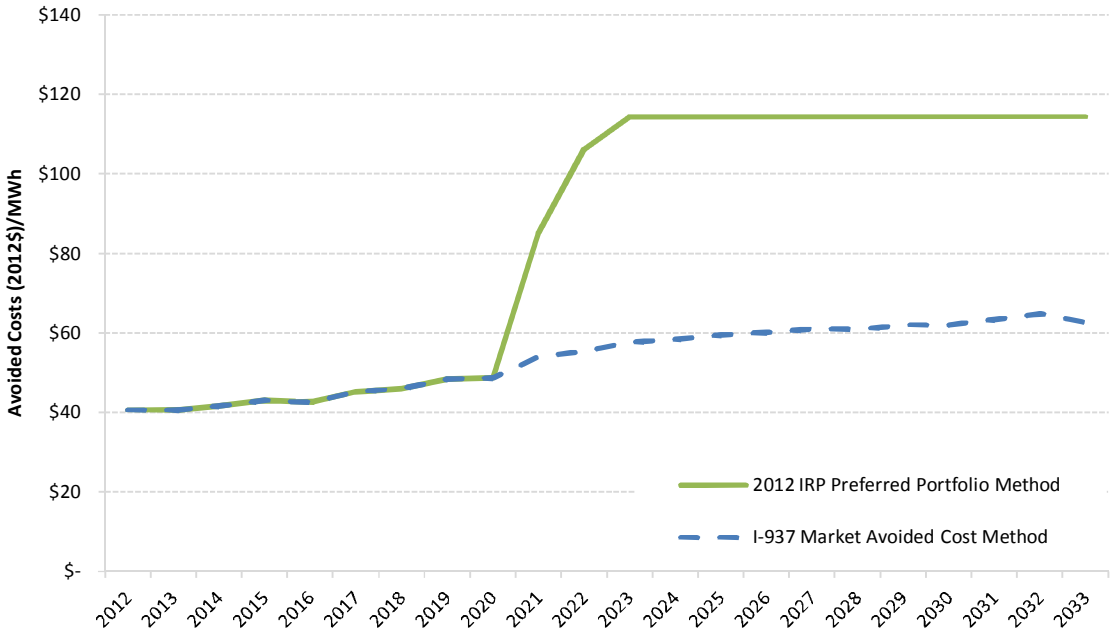


Table 5-14 Comparison of Potentials by Avoided Costs, 2023

Avoided Cost Case	Cumulative Achievable Potential	Change in Achievable Relative to I-937 Case	Cumulative Economic Potential	Change in Economic Relative to I-937 Case
I-937 Market Avoided Cost	1,036,977	n/a	1,574,823	n/a
2012 IRP Preferred Portfolio	1,077,688	104%	1,687,860	107%

About EnerNOC

EnerNOC's Utility Solutions Consulting team is part of EnerNOC's Utility Solutions, which provides a comprehensive suite of demand-side management (DSM) services to utilities and grid operators worldwide. Hundreds of utilities have leveraged our technology, our people, and our proven processes to make their energy efficiency (EE) and demand response (DR) initiatives a success. Utilities trust EnerNOC to work with them at every stage of the DSM program lifecycle – assessing market potential, designing effective programs, implementing those programs, and measuring program results.

EnerNOC's Utility Solutions deliver value to our utility clients through two separate practice areas – Implementation and Consulting.

- Our Implementation team leverages EnerNOC's deep "behind-the-meter expertise" and world-class technology platform to help utilities create and manage DR and EE programs that deliver reliable and cost-effective energy savings. We focus exclusively on the commercial and industrial (C&I) customer segments, with a track record of successful partnerships that spans more than a decade. Through a focus on high quality, measurable savings, EnerNOC has successfully delivered hundreds of thousands of MWh of energy efficiency for our utility clients, and we have thousands of MW of demand response capacity under management.
- The Consulting team provides expertise and analysis to support a broad range of utility DSM activities, including: potential assessments; end-use forecasts; integrated resource planning; EE, DR, and smart grid pilot and program design and administration; load research; technology assessments and demonstrations; evaluation, measurement and verification; and regulatory support.

The team has decades of combined experience in the utility DSM industry. The staff is comprised of professional electrical, mechanical, chemical, civil, industrial, and environmental engineers as well as economists, business planners, project managers, market researchers, load research professionals, and statisticians. Utilities view EnerNOC's experts as trusted advisors, and we work together collaboratively to make any DSM initiative a success.

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Appendices

Report Number 1368

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MARKET PROFILES

Market profiles describe electricity use by sector, segment, end use and technology in the base year of the study (2012). The market profiles are given for average buildings and new vintages.

As explained in Chapter 2, a market profile includes the following elements:

- **Market size** represents the number of customers in the segment. For the residential sector, it is number of households. In the commercial sector, it is floor space measured in square feet. For the industrial sector, it is number of employees.
- **Saturations** define the fraction of buildings with the specific technologies. (e.g., homes with electric space heating)
- **UEC (unit energy consumption) or EUI (energy-use index)** describes the amount of energy consumed in the base year by a specific technology in buildings that have the technology. We use UECs expressed in kWh/household for the residential sector, and EUIs expressed in kWh/square foot or kWh/employee for the commercial and industrial sectors respectively.
- **Intensity** for the residential sector represents the average energy use for the technology across all households in the base year. It is computed as the product of the saturation and the UEC and is defined as kWh/household for electricity. For the commercial and industrial sectors, intensity, computed as the product of the saturation and the EUI, represents the average use for the technology across all floor space or all employees in the base year.
- **Usage** is the annual energy use by a technology/end use in the segment. It is the product of the market size and intensity and is quantified in MWh for electricity.

This appendix presents the following market profiles:

- Residential market profiles by segment (Table A-1 through Table A-4)
- Commercial market profiles by building type (Table A-5 through Table A-20)
- Industrial market profiles by segment (Table A-21 through Table A-26)

Table A-1 Single Family Electric Market Profile, 2012

		Average Market Profile				New Units			
End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (MWh)	Saturation	UEC (kWh)	Intensity (kWh/HH)	Compared to Average
Cooling	Central AC	3.4%	270	9	1,741	5.1%	237	12	-12%
Cooling	Room AC	8.1%	377	31	5,828	8.1%	410	33	9%
Cooling	Air-Source Heat Pump	3.0%	255	8	1,435	3.0%	224	7	-12%
Heating	Electric Zonal Room Heat	11.6%	7,316	846	160,807	5.8%	6,585	381	-10%
Heating	Electric Furnace	7.5%	6,516	487	92,534	3.7%	5,864	219	-10%
Heating	Air-Source Heat Pump	3.0%	4,380	130	24,683	3.0%	3,740	111	-15%
Water Heating	Water Heater <= 55 Gal	49.0%	3,298	1,617	307,277	48.0%	3,197	1,536	-3%
Water Heating	Water Heater > 55 Gal	4.7%	3,516	164	31,211	4.6%	3,408	156	-3%
Interior Lighting	Screw-in	100.0%	1,032	1,032	196,055	100.0%	1,250	1,250	21%
Interior Lighting	Linear Fluorescent	100.0%	81	81	15,457	100.0%	90	90	11%
Interior Lighting	Specialty	100.0%	259	259	49,244	100.0%	275	275	6%
Exterior Lighting	Screw-in	100.0%	209	209	39,731	100.0%	223	223	7%
Appliances	Clothes Washer	93.1%	139	129	24,592	96.1%	130	125	-6%
Appliances	Clothes Dryer	88.1%	735	648	123,134	91.1%	625	569	-15%
Appliances	Dishwasher	79.5%	355	282	53,632	98.0%	215	210	-40%
Appliances	Refrigerator	100.0%	839	839	159,464	100.0%	543	543	-35%
Appliances	Freezer	40.9%	672	275	52,239	45.9%	524	241	-22%
Appliances	Second Refrigerator	31.8%	977	311	59,067	34.8%	633	220	-35%
Appliances	Stove	75.3%	488	368	69,897	75.3%	489	368	0%
Appliances	Microwave	87.9%	128	112	21,300	95.0%	128	121	0%
Electronics	Personal Computers	89.0%	289	257	48,799	106.8%	242	258	-16%
Electronics	Monitor	94.0%	57	54	10,257	112.8%	70	79	21%
Electronics	Laptops	90.0%	124	112	21,259	108.0%	117	126	-6%
Electronics	TVs	219.0%	182	398	75,710	262.8%	164	432	-10%
Electronics	Printer/Fax/Copier	98.0%	44	43	8,233	117.6%	39	46	-11%
Electronics	Set-top Boxes/DVR	287.0%	118	338	64,227	344.4%	133	458	13%
Electronics	Devices and Gadgets	100.0%	50	50	9,502	120.0%	50	60	0%
Miscellaneous	Pool Pump	1.4%	1,575	22	4,190	1.7%	1,575	26	0%
Miscellaneous	Pool Heater	0.4%	5,230	18	3,479	0.4%	4,550	19	-13%
Miscellaneous	Hot Tub / Spa	12.5%	998	125	23,695	15.0%	998	150	0%
Miscellaneous	Furnace Fan	75.3%	228	172	32,604	75.3%	226	170	-1%
Miscellaneous	Miscellaneous	100.0%	549	549	104,377	100.0%	640	640	17%
Total				9,975	1,895,657			9,156	-8.2%

Table A-2 Multiplex Electric Market Profile, 2012

		Average Market Profile				New Units			
End Use	**Technology**	**Saturation**	**UEC (kWh)**	**Intensity (kWh/HH)**	**Usage (MWh)**	**Saturation**	**UEC (kWh)**	**Intensity (kWh/HH)**	**Compared to Average**
Cooling	Central AC	1.6%	196	3	51	2.4%	171	4	-13%
Cooling	Room AC	13.9%	274	38	605	13.9%	246	34	-10%
Cooling	Air-Source Heat Pump	0.8%	185	2	24	0.8%	163	1	-12%
Heating	Electric Zonal Room Heat	45.8%	4,961	2,274	36,045	41.3%	4,465	1,842	-10%
Heating	Electric Furnace	7.5%	4,418	331	5,253	7.5%	3,976	298	-10%
Heating	Air-Source Heat Pump	0.8%	2,970	25	392	0.8%	2,535	21	-15%
Water Heating	Water Heater <= 55 Gal	59.6%	2,236	1,333	21,129	68.0%	2,173	1,477	-3%
Water Heating	Water Heater > 55 Gal	0.0%	2,384	-	-	0.0%	2,316	-	-3%
Interior Lighting	Screw-in	100.0%	707	707	11,214	100.0%	933	933	32%
Interior Lighting	Linear Fluorescent	100.0%	56	56	884	100.0%	71	71	27%
Interior Lighting	Specialty	100.0%	178	178	2,817	100.0%	224	224	26%
Exterior Lighting	Screw-in	100.0%	-	-	-	100.0%	-	-	0%
Appliances	Clothes Washer	74.8%	92	69	1,096	89.8%	87	78	-6%
Appliances	Clothes Dryer	74.0%	691	512	8,109	88.8%	588	522	-15%
Appliances	Dishwasher	69.3%	391	271	4,297	83.2%	236	197	-40%
Appliances	Refrigerator	100.0%	708	708	11,221	100.0%	458	458	-35%
Appliances	Freezer	16.4%	569	93	1,479	16.4%	444	73	-22%
Appliances	Second Refrigerator	21.9%	825	181	2,862	21.9%	534	117	-35%
Appliances	Stove	77.1%	506	390	6,185	77.1%	506	390	0%
Appliances	Microwave	78.0%	120	93	1,482	85.0%	120	102	0%
Electronics	Personal Computers	79.0%	247	195	3,088	94.8%	206	196	-16%
Electronics	Monitor	78.0%	49	38	607	93.6%	60	56	21%
Electronics	Laptops	95.0%	106	101	1,600	114.0%	100	114	-6%
Electronics	TVs	211.0%	147	311	4,925	253.2%	133	337	-10%
Electronics	Printer/Fax/Copier	86.0%	38	32	515	103.2%	34	35	-11%
Electronics	Set-top Boxes/DVR	266.0%	101	268	4,243	319.2%	114	363	13%
Electronics	Devices and Gadgets	100.0%	47	47	745	120.0%	47	56	0%
Miscellaneous	Pool Pump	0.0%	1,200	-	-	0.0%	1,200	-	0%
Miscellaneous	Pool Heater	0.0%	3,985	-	-	0.0%	3,467	-	-13%
Miscellaneous	Hot Tub / Spa	3.2%	855	27	434	3.8%	855	33	0%
Miscellaneous	Furnace Fan	37.5%	141	53	840	37.5%	140	53	-1%
Miscellaneous	Miscellaneous	100.0%	183	183	2,907	100.0%	431	431	135%
Total				8,520	135,050			8,515	-0.1%

Table A-3 Low-Rise Multifamily Electric Market Profile, 2012

		Average Market Profile				New Units			
End Use	**Technology**	**Saturation**	**UEC (kWh)**	**Intensity (kWh/HH)**	**Usage (MWh)**	**Saturation**	**UEC (kWh)**	**Intensity (kWh/HH)**	**Compared to Average**
Cooling	Central AC	0.0%	199	-	-	0.0%	159	-	-20%
Cooling	Room AC	4.8%	278	13	1,744	4.8%	243	12	-13%
Cooling	Air-Source Heat Pump	1.1%	188	2	285	1.1%	166	2	-12%
Heating	Electric Zonal Room Heat	92.8%	2,845	2,640	348,018	92.8%	2,512	2,331	-12%
Heating	Electric Furnace	0.3%	2,694	8	1,065	0.3%	2,378	7	-12%
Heating	Air-Source Heat Pump	0.3%	1,792	5	709	0.3%	1,530	5	-15%
Water Heating	Water Heater <= 55 Gal	91.0%	1,386	1,261	166,233	93.6%	1,347	1,261	-3%
Water Heating	Water Heater > 55 Gal	1.3%	1,477	20	2,603	1.4%	1,435	20	-3%
Interior Lighting	Screw-in	100.0%	575	575	75,734	100.0%	757	757	32%
Interior Lighting	Linear Fluorescent	100.0%	29	29	3,814	100.0%	37	37	27%
Interior Lighting	Specialty	100.0%	144	144	19,022	100.0%	182	182	26%
Exterior Lighting	Screw-in	100.0%	-	-	-	100.0%	-	-	0%
Appliances	Clothes Washer	50.7%	93	47	6,234	60.8%	87	53	-6%
Appliances	Clothes Dryer	52.2%	553	289	38,081	62.7%	471	295	-15%
Appliances	Dishwasher	67.5%	395	267	35,177	81.0%	239	193	-40%
Appliances	Refrigerator	100.0%	709	709	93,457	100.0%	459	459	-35%
Appliances	Freezer	0.2%	568	1	137	0.2%	443	1	-22%
Appliances	Second Refrigerator	1.2%	826	10	1,324	1.2%	535	7	-35%
Appliances	Stove	92.9%	340	315	41,586	92.9%	340	316	0%
Appliances	Microwave	81.7%	121	99	13,046	85.0%	121	103	0%
Electronics	Personal Computers	58.0%	249	145	19,051	69.6%	209	145	-16%
Electronics	Monitor	59.0%	50	29	3,857	70.8%	60	43	21%
Electronics	Laptops	71.0%	107	76	10,047	85.2%	101	86	-6%
Electronics	TVs	144.0%	102	147	19,380	172.8%	92	159	-10%
Electronics	Printer/Fax/Copier	60.0%	38	23	2,988	72.0%	34	24	-11%
Electronics	Set-top Boxes/DVR	188.0%	101	189	24,938	225.6%	114	256	13%
Electronics	Devices and Gadgets	100.0%	48	48	6,261	120.0%	48	57	0%
Miscellaneous	Pool Pump	0.0%	750	-	-	0.0%	750	-	0%
Miscellaneous	Pool Heater	0.0%	2,491	-	-	0.0%	2,167	-	-13%
Miscellaneous	Hot Tub / Spa	0.0%	855	-	-	0.0%	855	-	0%
Miscellaneous	Furnace Fan	1.7%	61	1	136	1.7%	60	1	-1%
Miscellaneous	Miscellaneous	100.0%	238	238	31,414	100.0%	416	416	75%
Total				7,331	966,343			7,227	-1.4%

Table A-4 High-Rise Multifamily Electric Market Profile, 2012

		Average Market Profile				New Units			
End Use	**Technology**	**Saturation**	**UEC (kWh)**	**Intensity (kWh/HH)**	**Usage (MWh)**	**Saturation**	**UEC (kWh)**	**Intensity (kWh/HH)**	**Compared to Average**
Cooling	Central AC	0.0%	159	-	-	0.0%	138	-	-13%
Cooling	Room AC	5.9%	223	13	328	5.9%	194	12	-13%
Cooling	Air-Source Heat Pump	0.0%	151	-	-	0.0%	132	-	-12%
Heating	Electric Zonal Room Heat	82.3%	1,897	1,561	38,748	82.3%	1,618	1,332	-15%
Heating	Electric Furnace	0.3%	1,796	5	134	0.3%	1,532	5	-15%
Heating	Air-Source Heat Pump	0.3%	1,195	4	89	0.3%	1,020	3	-15%
Water Heating	Water Heater <= 55 Gal	65.1%	1,155	752	18,662	71.5%	1,122	803	-3%
Water Heating	Water Heater > 55 Gal	1.0%	1,231	12	292	1.1%	1,196	13	-3%
Interior Lighting	Screw-in	100.0%	694	694	17,234	100.0%	915	915	32%
Interior Lighting	Linear Fluorescent	100.0%	43	43	1,072	100.0%	55	55	27%
Interior Lighting	Specialty	100.0%	174	174	4,329	100.0%	220	220	26%
Exterior Lighting	Screw-in	100.0%	-	-	-	100.0%	-	-	0%
Appliances	Clothes Washer	56.7%	90	51	1,271	65.2%	85	55	-6%
Appliances	Clothes Dryer	56.7%	536	304	7,538	65.2%	456	297	-15%
Appliances	Dishwasher	80.4%	395	318	7,889	92.5%	239	221	-40%
Appliances	Refrigerator	100.0%	709	709	17,599	100.0%	459	459	-35%
Appliances	Freezer	6.3%	543	34	850	6.3%	424	27	-22%
Appliances	Second Refrigerator	7.0%	791	55	1,374	7.0%	512	36	-35%
Appliances	Stove	92.9%	340	315	7,831	92.9%	340	316	0%
Appliances	Microwave	81.7%	121	99	2,457	85.0%	121	103	0%
Electronics	Personal Computers	58.0%	249	145	3,588	69.6%	209	145	-16%
Electronics	Monitor	59.0%	50	29	726	70.8%	60	43	21%
Electronics	Laptops	71.0%	107	76	1,892	85.2%	101	86	-6%
Electronics	TVs	144.0%	102	147	3,650	172.8%	92	159	-10%
Electronics	Printer/Fax/Copier	60.0%	38	23	569	72.0%	34	25	-11%
Electronics	Set-top Boxes/DVR	188.0%	101	189	4,696	225.6%	114	256	13%
Electronics	Devices and Gadgets	100.0%	48	48	1,179	120.0%	48	57	0%
Miscellaneous	Pool Pump	0.0%	750	-	-	0.0%	750	-	0%
Miscellaneous	Pool Heater	0.0%	2,491	-	-	0.0%	2,167	-	-13%
Miscellaneous	Hot Tub / Spa	0.0%	903	-	-	0.0%	903	-	0%
Miscellaneous	Furnace Fan	0.0%	61	-	-	0.0%	60	-	-1%
Miscellaneous	Miscellaneous	100.0%	238	238	5,907	100.0%	353	353	48%
Total				6,039	149,902			5,993	-0.8%

Table A-5 Small Office Electric Market Profile, 2012

		Average Market Profile				New Units			
End Use	Technology	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Usage (MWh)	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Compared to Average
Cooling	Air-Cooled Chiller	0.1%	3	0	73	0.2%	3	0	-5.2%
Cooling	Water-Cooled Chiller	0.0%	4	0	23	0.0%	2	0	-42.9%
Cooling	Roof top AC	37.9%	4	2	26,127	45.4%	3	1	-29.4%
Cooling	Other Cooling	12.5%	4	1	8,668	14.9%	4	1	-7.7%
Cooling	Air Source Heat Pump	20.4%	4	1	12,304	24.5%	3	1	-26.5%
Heating	Electric Furnace	16.7%	7	1	19,542	16.7%	6	1	-12.4%
Heating	Electric Zonal Heat	4.1%	6	0	3,906	24.5%	5	1	-12.4%
Heating	Air Source Heat Pump	20.4%	7	1	22,759	4.1%	6	0	-13.6%
Ventilation	Ventilation	100.0%	1	1	23,616	100.0%	1	1	-7.8%
Water Heating	Water Heater	68.0%	1	1	12,063	68.0%	1	1	-5.1%
Interior Lighting	Screw-in	100.0%	1	1	9,168	100.0%	1	1	-12.2%
Interior Lighting	High-Bay Fixtures	100.0%	1	1	8,110	100.0%	0	0	-23.5%
Interior Lighting	Linear Fluorescent	100.0%	3	3	41,874	100.0%	3	3	3.3%
Exterior Lighting	Screw-in	100.0%	0	0	3,101	100.0%	0	0	-18.4%
Exterior Lighting	HID	100.0%	0	0	4,328	100.0%	0	0	-44.1%
Exterior Lighting	Linear Fluorescent	100.0%	0	0	1,567	100.0%	0	0	3.3%
Refrigeration	Walk-in Refrigerator	1.4%	1	0	134	1.7%	0	0	-52.7%
Refrigeration	Reach-in Refrigerator	8.4%	0	0	210	10.1%	0	0	-56.1%
Refrigeration	Glass Door Display	5.1%	-	-	-	6.1%	-	-	0.0%
Refrigeration	Open Display Case	5.1%	-	-	-	6.1%	-	-	0.0%
Refrigeration	Icemaker	5.1%	0	0	146	6.1%	0	0	-12.1%
Refrigeration	Vending Machine	5.1%	0	0	113	6.1%	0	0	-40.2%
Food Preparation	Oven	3.9%	0	0	286	4.9%	0	0	-3.9%
Food Preparation	Fryer	2.5%	-	-	-	3.1%	-	-	0.0%
Food Preparation	Dishwasher	3.2%	1	0	512	4.0%	1	0	-15.9%
Food Preparation	Hot Food Container	2.5%	-	-	-	3.1%	-	-	0.0%
Office Equip.	Desktop Computer	97.9%	1	1	16,082	137.0%	1	1	-3.8%
Office Equip.	Laptop	93.0%	0	0	3,056	130.2%	0	0	-2.6%
Office Equip.	Server	97.9%	1	1	11,739	137.1%	1	1	-6.8%
Office Equip.	Monitor	99.8%	0	0	4,529	139.8%	0	0	-8.5%
Office Equip.	Printer/Copier/Fax	100.0%	0	0	5,822	135.0%	0	0	-7.9%
Office Equip.	POS Terminal	35.5%	0	0	593	39.0%	0	0	-16.9%
Miscellaneous	Non-HVAC Motors	22.0%	0	0	1,046	24.2%	0	0	0.4%
Miscellaneous	Pool Pump	0.0%	-	-	-	0.0%	-	-	0.0%
Miscellaneous	Pool Heater	0.0%	-	-	-	0.0%	-	-	0.0%
Miscellaneous	Miscellaneous	100.0%	1	1	18,746	100.0%	1	1	0.0%
Total				16	260,243			16	-1.2%

Table A-6 Large Office Electric Market Profile, 2012

		Average Market Profile				New Units			
End Use	Technology	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Usage (MWh)	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Compared to Average
Cooling	Air-Cooled Chiller	33.0%	2	1	38,572	37.4%	2	1	-5.1%
Cooling	Water-Cooled Chiller	23.0%	6	1	69,803	26.0%	3	1	-49.2%
Cooling	Roof top AC	14.7%	3	0	26,137	16.7%	2	0	-28.5%
Cooling	Other Cooling	0.2%	3	0	358	0.2%	3	0	-4.5%
Cooling	Air Source Heat Pump	10.5%	3	0	16,305	11.6%	2	0	-25.6%
Heating	Electric Furnace	46.3%	5	3	137,076	46.3%	5	2	-8.5%
Heating	Electric Zonal Heat	0.0%	5	-	-	11.6%	4	0	-8.5%
Heating	Air Source Heat Pump	10.5%	5	1	29,592	0.0%	5	-	-13.3%
Ventilation	Ventilation	100.0%	3	3	185,035	100.0%	3	3	-18.0%
Water Heating	Water Heater	68.0%	1	1	42,011	68.0%	1	1	-5.1%
Interior Lighting	Screw-in	100.0%	0	0	20,698	100.0%	0	0	5.3%
Interior Lighting	High-Bay Fixtures	100.0%	0	0	24,072	100.0%	0	0	-9.3%
Interior Lighting	Linear Fluorescent	100.0%	4	4	194,154	100.0%	4	4	4.3%
Exterior Lighting	Screw-in	100.0%	0	0	6,341	100.0%	0	0	-10.0%
Exterior Lighting	HID	100.0%	0	0	13,225	100.0%	0	0	-43.8%
Exterior Lighting	Linear Fluorescent	100.0%	0	0	8,636	100.0%	0	0	4.3%
Refrigeration	Walk-in Refrigerator	1.4%	0	0	258	1.7%	0	0	-52.7%
Refrigeration	Reach-in Refrigerator	8.4%	0	0	406	10.1%	0	0	-56.7%
Refrigeration	Glass Door Display	44.9%	0	0	3,652	53.9%	0	0	-59.9%
Refrigeration	Open Display Case	44.9%	0	0	3,012	53.9%	0	0	-36.3%
Refrigeration	Icemaker	44.9%	0	0	2,477	53.9%	0	0	-9.9%
Refrigeration	Vending Machine	44.9%	0	0	3,828	53.9%	0	0	-40.2%
Food Preparation	Oven	3.9%	2	0	5,088	4.7%	2	0	-3.9%
Food Preparation	Fryer	2.5%	2	0	2,590	3.0%	2	0	-0.6%
Food Preparation	Dishwasher	3.2%	5	0	9,123	3.8%	4	0	-15.9%
Food Preparation	Hot Food Container	2.5%	1	0	878	3.0%	0	0	-29.3%
Office Equip.	Desktop Computer	97.9%	2	2	123,976	137.0%	2	3	-3.8%
Office Equip.	Laptop	93.0%	0	0	23,554	130.2%	0	1	-2.6%
Office Equip.	Server	97.9%	0	0	15,082	137.1%	0	0	-6.8%
Office Equip.	Monitor	99.8%	1	1	34,911	139.8%	1	1	-8.5%
Office Equip.	Printer/Copier/Fax	100.0%	0	0	14,961	140.0%	0	0	-7.9%
Office Equip.	POS Terminal	35.5%	0	0	305	39.0%	0	0	-16.9%
Miscellaneous	Non-HVAC Motors	89.6%	1	0	25,252	107.5%	1	1	0.4%
Miscellaneous	Pool Pump	0.0%	-	-	-	0.0%	-	-	0.0%
Miscellaneous	Pool Heater	0.0%	-	-	-	0.0%	-	-	0.0%
Miscellaneous	Miscellaneous	100.0%	1	1	79,191	100.0%	1	1	0.0%
Total				21	1,160,558			21	-0.9%

Table A-7 Restaurant Electric Market Profile, 2012

		Average Market Profile				New Units			
End Use	Technology	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Usage (MWh)	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Compared to Average
Cooling	Air-Cooled Chiller	0.2%	4	0	42	0.3%	3	0	-9.4%
Cooling	Water-Cooled Chiller	0.0%	4	-	-	0.0%	2	-	-42.5%
Cooling	Roof top AC	49.4%	4	2	9,808	59.2%	3	2	-34.8%
Cooling	Other Cooling	16.3%	6	1	4,551	19.5%	5	1	-11.5%
Cooling	Air Source Heat Pump	10.2%	3	0	1,760	12.2%	2	0	-34.9%
Heating	Electric Furnace	6.0%	5	0	1,637	6.0%	5	0	-5.5%
Heating	Electric Zonal Heat	1.8%	3	0	299	12.2%	3	0	-5.5%
Heating	Air Source Heat Pump	10.2%	5	1	2,653	1.8%	4	0	-24.9%
Ventilation	Ventilation	100.0%	2	2	11,812	100.0%	2	2	-6.1%
Water Heating	Water Heater	35.2%	8	3	14,787	37.0%	8	3	-4.1%
Interior Lighting	Screw-in	100.0%	2	2	11,051	100.0%	2	2	-24.0%
Interior Lighting	High-Bay Fixtures	100.0%	1	1	6,668	100.0%	1	1	-40.7%
Interior Lighting	Linear Fluorescent	100.0%	4	4	19,492	100.0%	3	3	-10.4%
Exterior Lighting	Screw-in	100.0%	2	2	8,097	100.0%	1	1	-11.2%
Exterior Lighting	HID	100.0%	0	0	2,016	100.0%	0	0	-27.4%
Exterior Lighting	Linear Fluorescent	100.0%	1	1	3,709	100.0%	1	1	-10.4%
Refrigeration	Walk-in Refrigerator	24.4%	6	2	7,622	25.1%	3	1	-52.7%
Refrigeration	Reach-in Refrigerator	16.0%	2	0	1,317	16.4%	1	0	-56.5%
Refrigeration	Glass Door Display	97.3%	3	3	13,496	100.0%	1	1	-59.9%
Refrigeration	Open Display Case	97.3%	2	2	11,132	100.0%	1	1	-36.3%
Refrigeration	Icemaker	97.3%	2	2	9,155	100.0%	2	2	-12.1%
Refrigeration	Vending Machine	97.3%	1	1	7,074	100.0%	1	1	-40.2%
Food Preparation	Oven	10.1%	14	1	6,892	19.2%	14	3	5.7%
Food Preparation	Fryer	12.7%	11	1	6,895	24.2%	12	3	9.4%
Food Preparation	Dishwasher	40.7%	15	6	30,484	77.5%	13	10	-11.9%
Food Preparation	Hot Food Container	18.8%	2	0	1,725	35.8%	1	1	-22.2%
Office Equip.	Desktop Computer	75.9%	0	0	1,256	83.5%	0	0	-3.8%
Office Equip.	Laptop	55.3%	0	0	146	60.8%	0	0	-2.6%
Office Equip.	Server	54.6%	0	0	1,320	60.1%	0	0	-6.8%
Office Equip.	Monitor	74.8%	0	0	342	82.3%	0	0	-8.5%
Office Equip.	Printer/Copier/Fax	45.0%	0	0	211	49.5%	0	0	-7.9%
Office Equip.	POS Terminal	83.2%	0	0	560	99.8%	0	0	-16.9%
Miscellaneous	Non-HVAC Motors	20.0%	1	0	739	24.0%	1	0	0.4%
Miscellaneous	Pool Pump	0.0%	-	-	-	0.0%	-	-	0.0%
Miscellaneous	Pool Heater	0.0%	-	-	-	0.0%	-	-	0.0%
Miscellaneous	Miscellaneous	100.0%	1	1	4,312	100.0%	1	1	0.0%
Total				40	203,061			41	1.6%

Table A-8 Retail Electric Market Profile, 2012

		Average Market Profile				New Units			
End Use	Technology	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Usage (MWh)	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Compared to Average
Cooling	Air-Cooled Chiller	7.7%	2	0	4,041	10.0%	2	0	-7.7%
Cooling	Water-Cooled Chiller	1.9%	2	0	1,288	2.5%	1	0	-37.8%
Cooling	Roof top AC	43.8%	2	1	34,120	57.0%	2	1	-26.6%
Cooling	Other Cooling	2.3%	2	0	1,778	3.0%	2	0	-6.5%
Cooling	Air Source Heat Pump	16.3%	2	0	11,095	21.2%	2	0	-26.6%
Heating	Electric Furnace	11.1%	4	0	15,732	11.1%	4	0	-11.1%
Heating	Electric Zonal Heat	3.0%	4	0	3,620	21.2%	3	1	-11.1%
Heating	Air Source Heat Pump	16.3%	4	1	22,052	3.0%	4	0	-14.4%
Ventilation	Ventilation	100.0%	1	1	30,283	100.0%	1	1	-8.5%
Water Heating	Water Heater	63.0%	1	0	15,448	63.0%	1	0	-6.9%
Interior Lighting	Screw-in	100.0%	1	1	17,337	100.0%	0	0	-34.7%
Interior Lighting	High-Bay Fixtures	100.0%	1	1	21,454	100.0%	1	1	-19.2%
Interior Lighting	Linear Fluorescent	100.0%	5	5	151,281	100.0%	5	5	-4.2%
Exterior Lighting	Screw-in	100.0%	0	0	2,837	100.0%	0	0	-53.7%
Exterior Lighting	HID	100.0%	0	0	15,733	100.0%	0	0	-19.9%
Exterior Lighting	Linear Fluorescent	100.0%	0	0	7,194	100.0%	0	0	-4.2%
Refrigeration	Walk-in Refrigerator	0.0%	-	-	-	0.0%	-	-	0.0%
Refrigeration	Reach-in Refrigerator	29.4%	0	0	1,461	44.1%	0	0	-56.5%
Refrigeration	Glass Door Display	52.4%	0	0	4,381	78.6%	0	0	-59.9%
Refrigeration	Open Display Case	52.4%	0	0	3,614	78.6%	0	0	-36.3%
Refrigeration	Icemaker	52.4%	0	0	5,944	78.6%	0	0	-12.1%
Refrigeration	Vending Machine	52.4%	0	0	4,593	78.6%	0	0	-40.4%
Food Preparation	Oven	3.9%	1	0	1,584	5.8%	1	0	-3.9%
Food Preparation	Fryer	2.5%	1	0	806	3.7%	1	0	-0.6%
Food Preparation	Dishwasher	11.6%	3	0	10,325	17.4%	2	0	-15.9%
Food Preparation	Hot Food Container	0.0%	0	-	-	0.0%	0	-	-29.3%
Office Equip.	Desktop Computer	93.8%	0	0	4,664	103.2%	0	0	-3.8%
Office Equip.	Laptop	79.4%	0	0	789	87.3%	0	0	-2.6%
Office Equip.	Server	78.4%	0	0	5,689	94.1%	0	0	-6.8%
Office Equip.	Monitor	93.7%	0	0	1,286	103.0%	0	0	-8.5%
Office Equip.	Printer/Copier/Fax	85.4%	0	0	602	93.9%	0	0	-7.9%
Office Equip.	POS Terminal	81.9%	0	0	1,656	102.4%	0	0	-16.9%
Miscellaneous	Non-HVAC Motors	40.2%	0	0	1,934	48.2%	0	0	0.4%
Miscellaneous	Pool Pump	0.0%	-	-	-	0.0%	-	-	0.0%
Miscellaneous	Pool Heater	0.0%	-	-	-	0.0%	-	-	0.0%
Miscellaneous	Miscellaneous	100.0%	0	0	13,408	100.0%	0	0	0.0%
Total				13	418,029			12	-5.6%

Table A-9 Large Grocery Electric Market Profile, 2012

		Average Market Profile				New Units			
End Use	Technology	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Usage (MWh)	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Compared to Average
Cooling	Air-Cooled Chiller	2.2%	1	0	58	2.3%	1	0	-7.7%
Cooling	Water-Cooled Chiller	2.2%	1	0	74	2.3%	1	0	-37.8%
Cooling	Roof top AC	56.9%	1	1	2,248	59.8%	1	0	-34.0%
Cooling	Other Cooling	0.0%	1	-	-	0.0%	1	-	-11.4%
Cooling	Air Source Heat Pump	16.9%	1	0	583	16.9%	1	0	-40.9%
Heating	Electric Furnace	13.5%	6	1	2,408	13.5%	5	1	-11.1%
Heating	Electric Zonal Heat	0.0%	2	-	-	16.9%	2	0	-11.1%
Heating	Air Source Heat Pump	16.9%	5	1	2,866	0.0%	4	-	-18.4%
Ventilation	Ventilation	100.0%	2	2	6,836	100.0%	2	2	-16.0%
Water Heating	Water Heater	38.2%	2	1	2,742	38.2%	2	1	-4.1%
Interior Lighting	Screw-in	100.0%	1	1	3,994	100.0%	1	1	-43.0%
Interior Lighting	High-Bay Fixtures	100.0%	1	1	3,193	100.0%	1	1	-8.2%
Interior Lighting	Linear Fluorescent	100.0%	9	9	27,458	100.0%	9	9	2.0%
Exterior Lighting	Screw-in	100.0%	0	0	495	100.0%	0	0	-59.2%
Exterior Lighting	HID	100.0%	0	0	1,175	100.0%	0	0	-39.5%
Exterior Lighting	Linear Fluorescent	100.0%	1	1	2,078	100.0%	1	1	2.0%
Refrigeration	Walk-in Refrigerator	16.6%	10	2	5,138	16.8%	6	1	-33.8%
Refrigeration	Reach-in Refrigerator	6.6%	1	0	154	6.7%	0	0	-37.1%
Refrigeration	Glass Door Display	98.9%	12	12	38,858	100.0%	7	7	-43.9%
Refrigeration	Open Display Case	98.9%	10	10	32,051	100.0%	9	9	-10.8%
Refrigeration	Icemaker	98.9%	0	0	1,318	100.0%	1	1	23.0%
Refrigeration	Vending Machine	98.9%	1	1	2,037	100.0%	0	0	-39.0%
Food Preparation	Oven	28.3%	3	1	2,345	39.6%	3	1	-3.9%
Food Preparation	Fryer	28.3%	2	1	1,863	39.6%	2	1	-0.6%
Food Preparation	Dishwasher	22.4%	6	1	4,077	31.4%	5	2	-15.9%
Food Preparation	Hot Food Container	68.7%	1	0	1,533	96.2%	0	0	-29.3%
Office Equip.	Desktop Computer	95.5%	0	0	457	105.1%	0	0	-3.8%
Office Equip.	Laptop	66.4%	0	0	63	73.0%	0	0	-2.6%
Office Equip.	Server	66.3%	0	0	231	72.9%	0	0	-6.8%
Office Equip.	Monitor	94.1%	0	0	124	103.6%	0	0	-8.5%
Office Equip.	Printer/Copier/Fax	100.0%	0	0	68	110.0%	0	0	-7.9%
Office Equip.	POS Terminal	100.0%	0	0	243	110.0%	0	0	-16.9%
Miscellaneous	Non-HVAC Motors	34.6%	1	0	856	41.6%	1	0	0.4%
Miscellaneous	Pool Pump	0.0%	-	-	-	0.0%	-	-	0.0%
Miscellaneous	Pool Heater	0.0%	-	-	-	0.0%	-	-	0.0%
Miscellaneous	Miscellaneous	100.0%	1	1	2,139	100.0%	1	1	0.0%
Total				47	149,763			39	-17.4%

Table A-10 Small Grocery Electric Market Profile, 2012

		Average Market Profile				New Units			
End Use	Technology	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Usage (MWh)	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Compared to Average
Cooling	Air-Cooled Chiller	0.3%	1	0	2	0.3%	1	0	-7.7%
Cooling	Water-Cooled Chiller	0.0%	1	-	-	0.0%	1	-	-37.8%
Cooling	Roof top AC	55.7%	1	1	720	55.7%	1	0	-34.0%
Cooling	Other Cooling	18.3%	1	0	166	18.3%	1	0	-11.4%
Cooling	Air Source Heat Pump	5.2%	1	0	59	5.2%	1	0	-40.9%
Heating	Electric Furnace	10.0%	6	1	589	10.0%	5	1	-11.1%
Heating	Electric Zonal Heat	1.7%	2	0	41	5.2%	2	0	-11.1%
Heating	Air Source Heat Pump	5.2%	5	0	293	1.7%	4	0	-18.4%
Ventilation	Ventilation	100.0%	2	2	2,149	100.0%	2	2	-16.0%
Water Heating	Water Heater	38.2%	2	1	862	38.2%	2	1	-4.1%
Interior Lighting	Screw-in	100.0%	1	1	1,256	100.0%	1	1	-43.0%
Interior Lighting	High-Bay Fixtures	100.0%	1	1	1,004	100.0%	1	1	-8.2%
Interior Lighting	Linear Fluorescent	100.0%	8	8	8,632	100.0%	8	8	2.0%
Exterior Lighting	Screw-in	100.0%	0	0	155	100.0%	0	0	-59.2%
Exterior Lighting	HID	100.0%	0	0	369	100.0%	0	0	-39.5%
Exterior Lighting	Linear Fluorescent	100.0%	1	1	653	100.0%	1	1	2.0%
Refrigeration	Walk-in Refrigerator	16.6%	6	1	1,059	16.8%	4	1	-33.8%
Refrigeration	Reach-in Refrigerator	6.6%	2	0	111	6.7%	1	0	-37.1%
Refrigeration	Glass Door Display	98.9%	11	11	11,216	100.0%	6	6	-43.9%
Refrigeration	Open Display Case	98.9%	9	9	9,251	100.0%	8	8	-10.8%
Refrigeration	Icemaker	98.9%	2	2	1,902	100.0%	2	2	23.0%
Refrigeration	Vending Machine	98.9%	1	1	1,470	100.0%	1	1	-39.0%
Food Preparation	Oven	28.3%	2	1	737	39.6%	2	1	-3.9%
Food Preparation	Fryer	28.3%	2	1	586	39.6%	2	1	-0.6%
Food Preparation	Dishwasher	22.4%	5	1	1,282	31.4%	5	1	-15.9%
Food Preparation	Hot Food Container	68.7%	1	0	482	96.2%	0	0	-29.3%
Office Equip.	Desktop Computer	95.5%	0	0	135	105.1%	0	0	-3.8%
Office Equip.	Laptop	66.4%	0	0	15	73.0%	0	0	-2.6%
Office Equip.	Server	66.3%	0	0	137	72.9%	0	0	-6.8%
Office Equip.	Monitor	94.1%	0	0	37	103.6%	0	0	-8.5%
Office Equip.	Printer/Copier/Fax	100.0%	0	0	20	110.0%	0	0	-7.9%
Office Equip.	POS Terminal	100.0%	0	0	29	110.0%	0	0	-16.9%
Miscellaneous	Non-HVAC Motors	34.6%	1	0	304	41.6%	1	0	0.4%
Miscellaneous	Pool Pump	0.0%	-	-	-	0.0%	-	-	0.0%
Miscellaneous	Pool Heater	0.0%	-	-	-	0.0%	-	-	0.0%
Miscellaneous	Miscellaneous	100.0%	1	1	576	100.0%	1	1	0.0%
Total				44	46,298			38	-15.2%

Table A-11 College Electric Market Profile, 2012

		Average Market Profile				New Units			
End Use	**Technology**	**Saturation**	**UEC (kWh/sqft)**	**Intensity (kWh/sqft)**	**Usage (MWh)**	**Saturation**	**UEC (kWh/sqft)**	**Intensity (kWh/sqft)**	**Compared to Average**
Cooling	Air-Cooled Chiller	36.1%	4	1	40,851	40.9%	3	1	-11.5%
Cooling	Water-Cooled Chiller	9.0%	6	1	15,471	10.2%	3	0	-43.2%
Cooling	Roof top AC	21.3%	2	0	12,152	24.2%	1	0	-35.3%
Cooling	Other Cooling	0.0%	2	-	-	0.0%	2	-	-4.5%
Cooling	Air Source Heat Pump	8.6%	2	0	4,259	9.7%	1	0	-33.1%
Heating	Electric Furnace	8.5%	17	1	43,639	8.5%	16	1	-4.6%
Heating	Electric Zonal Heat	1.9%	9	0	5,406	9.7%	9	1	-4.6%
Heating	Air Source Heat Pump	8.6%	16	1	41,836	1.9%	12	0	-26.1%
Ventilation	Ventilation	100.0%	2	2	67,747	100.0%	2	2	-8.4%
Water Heating	Water Heater	26.3%	3	1	24,324	26.3%	3	1	-5.1%
Interior Lighting	Screw-in	100.0%	0	0	8,783	100.0%	0	0	-3.5%
Interior Lighting	High-Bay Fixtures	100.0%	1	1	17,159	100.0%	0	0	-28.3%
Interior Lighting	Linear Fluorescent	100.0%	3	3	76,236	100.0%	3	3	2.5%
Exterior Lighting	Screw-in	100.0%	0	0	54	100.0%	0	0	28.2%
Exterior Lighting	HID	100.0%	0	0	3,215	100.0%	0	0	-26.9%
Exterior Lighting	Linear Fluorescent	100.0%	0	0	11,324	100.0%	0	0	2.5%
Refrigeration	Walk-in Refrigerator	2.5%	0	0	258	3.5%	0	0	-52.7%
Refrigeration	Reach-in Refrigerator	13.2%	0	0	727	18.5%	0	0	-56.7%
Refrigeration	Glass Door Display	26.6%	0	0	1,230	37.2%	0	0	-59.9%
Refrigeration	Open Display Case	26.6%	0	0	1,015	37.2%	0	0	-36.3%
Refrigeration	Icemaker	26.6%	0	0	1,669	37.2%	0	0	-12.1%
Refrigeration	Vending Machine	26.6%	0	0	1,290	37.2%	0	0	-40.5%
Food Preparation	Oven	48.8%	1	0	9,863	68.3%	1	0	-3.9%
Food Preparation	Fryer	48.8%	1	0	7,835	68.3%	1	0	-0.6%
Food Preparation	Dishwasher	55.0%	1	1	24,417	77.0%	1	1	-15.9%
Food Preparation	Hot Food Container	54.2%	0	0	2,950	75.8%	0	0	-29.3%
Office Equip.	Desktop Computer	100.0%	1	1	17,025	140.0%	1	1	-3.8%
Office Equip.	Laptop	65.3%	0	0	2,222	91.4%	0	0	-2.6%
Office Equip.	Server	37.1%	0	0	3,075	52.0%	0	0	-6.8%
Office Equip.	Monitor	100.0%	0	0	4,700	140.0%	0	0	-8.5%
Office Equip.	Printer/Copier/Fax	100.0%	0	0	4,022	140.0%	0	0	-7.9%
Office Equip.	POS Terminal	32.9%	0	0	949	36.2%	0	0	-16.9%
Miscellaneous	Non-HVAC Motors	88.8%	0	0	2,278	106.6%	0	0	0.4%
Miscellaneous	Pool Pump	90.3%	0	0	119	108.4%	0	0	3.1%
Miscellaneous	Pool Heater	36.2%	0	0	91	43.4%	0	0	7.4%
Miscellaneous	Miscellaneous	100.0%	2	2	45,348	100.0%	2	2	0.0%
Total				17	503,537			16	-3.2%

Table A-12 School Electric Market Profile, 2012

		Average Market Profile				New Units			
End Use	Technology	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Usage (MWh)	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Compared to Average
Cooling	Air-Cooled Chiller	26.4%	1	0	2,603	27.7%	1	0	-14.6%
Cooling	Water-Cooled Chiller	6.6%	1	0	986	6.9%	1	0	-43.2%
Cooling	Roof top AC	18.2%	0	0	906	20.0%	0	0	-32.9%
Cooling	Other Cooling	0.0%	0	-	-	0.0%	0	-	-4.5%
Cooling	Air Source Heat Pump	11.2%	0	0	486	13.4%	0	0	-33.1%
Heating	Electric Furnace	3.2%	6	0	2,442	3.2%	5	0	-4.6%
Heating	Electric Zonal Heat	1.6%	3	0	683	13.4%	3	0	-4.6%
Heating	Air Source Heat Pump	11.2%	5	1	8,218	1.6%	4	0	-26.1%
Ventilation	Ventilation	100.0%	1	1	11,342	100.0%	1	1	-8.4%
Water Heating	Water Heater	38.1%	1	0	6,017	38.1%	1	0	-5.1%
Interior Lighting	Screw-in	100.0%	0	0	1,308	100.0%	0	0	-30.3%
Interior Lighting	High-Bay Fixtures	100.0%	0	0	5,801	100.0%	0	0	-23.0%
Interior Lighting	Linear Fluorescent	100.0%	3	3	35,005	100.0%	3	3	1.1%
Exterior Lighting	Screw-in	100.0%	0	0	47	100.0%	0	0	-29.4%
Exterior Lighting	HID	100.0%	0	0	1,836	100.0%	0	0	-21.3%
Exterior Lighting	Linear Fluorescent	100.0%	1	1	10,345	100.0%	1	1	1.1%
Refrigeration	Walk-in Refrigerator	19.7%	0	0	719	27.5%	0	0	-52.7%
Refrigeration	Reach-in Refrigerator	21.3%	0	0	411	29.8%	0	0	-56.7%
Refrigeration	Glass Door Display	65.7%	0	0	1,067	92.0%	0	0	-59.9%
Refrigeration	Open Display Case	65.7%	0	0	880	92.0%	0	0	-36.3%
Refrigeration	Icemaker	65.7%	0	0	1,448	92.0%	0	0	-12.1%
Refrigeration	Vending Machine	65.7%	0	0	1,119	92.0%	0	0	-40.5%
Food Preparation	Oven	16.6%	0	0	676	23.3%	0	0	-3.9%
Food Preparation	Fryer	1.5%	0	0	50	2.2%	0	0	-0.6%
Food Preparation	Dishwasher	57.0%	1	0	5,089	79.9%	1	0	-15.9%
Food Preparation	Hot Food Container	26.3%	0	0	288	36.8%	0	0	-29.3%
Office Equip.	Desktop Computer	98.3%	0	0	2,568	137.6%	0	0	-3.8%
Office Equip.	Laptop	96.1%	0	0	335	134.6%	0	0	-2.6%
Office Equip.	Server	96.2%	0	0	2,444	134.6%	0	0	-6.8%
Office Equip.	Monitor	100.0%	0	0	721	140.0%	0	0	-8.5%
Office Equip.	Printer/Copier/Fax	100.0%	0	0	1,234	140.0%	0	0	-7.9%
Office Equip.	POS Terminal	21.6%	0	0	76	21.6%	0	0	-16.9%
Miscellaneous	Non-HVAC Motors	43.7%	0	0	584	48.0%	0	0	0.4%
Miscellaneous	Pool Pump	8.1%	0	0	1	9.7%	0	0	3.1%
Miscellaneous	Pool Heater	0.0%	0	-	-	0.0%	0	-	7.4%
Miscellaneous	Miscellaneous	100.0%	0	0	5,055	100.0%	0	0	0.0%
Total				8	112,791			8	-3.4%

Table A-13 Hospital Electric Market Profile, 2012

		Average Market Profile				New Units			
End Use	Technology	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Usage (MWh)	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Compared to Average
Cooling	Air-Cooled Chiller	16.5%	2	0	2,266	16.5%	1	0	-13.5%
Cooling	Water-Cooled Chiller	66.2%	5	3	30,321	66.2%	3	2	-45.7%
Cooling	Roof top AC	10.9%	2	0	2,086	10.9%	1	0	-32.1%
Cooling	Other Cooling	0.4%	2	0	73	0.4%	2	0	-4.5%
Cooling	Air Source Heat Pump	1.0%	2	0	167	1.0%	1	0	-26.3%
Heating	Electric Furnace	3.6%	22	1	6,915	3.6%	19	1	-12.1%
Heating	Electric Zonal Heat	0.0%	11	-	-	1.0%	10	0	-12.1%
Heating	Air Source Heat Pump	1.0%	21	0	1,823	0.0%	13	-	-39.1%
Ventilation	Ventilation	100.0%	6	6	51,118	100.0%	5	5	-16.7%
Water Heating	Water Heater	12.6%	6	1	6,431	12.6%	6	1	-4.1%
Interior Lighting	Screw-in	100.0%	3	3	26,482	100.0%	3	3	-12.4%
Interior Lighting	High-Bay Fixtures	100.0%	1	1	5,441	100.0%	1	1	-18.1%
Interior Lighting	Linear Fluorescent	100.0%	5	5	40,893	100.0%	5	5	1.8%
Exterior Lighting	Screw-in	100.0%	0	0	1,875	100.0%	0	0	-59.5%
Exterior Lighting	HID	100.0%	0	0	700	100.0%	0	0	-35.3%
Exterior Lighting	Linear Fluorescent	100.0%	0	0	901	100.0%	0	0	1.8%
Refrigeration	Walk-in Refrigerator	7.7%	1	0	380	8.5%	0	0	-52.7%
Refrigeration	Reach-in Refrigerator	7.7%	0	0	100	8.5%	0	0	-61.1%
Refrigeration	Glass Door Display	90.4%	0	0	1,987	99.4%	0	0	-59.9%
Refrigeration	Open Display Case	90.4%	0	0	1,639	99.4%	0	0	-36.3%
Refrigeration	Icemaker	90.4%	0	0	2,696	99.4%	0	0	-12.1%
Refrigeration	Vending Machine	90.4%	0	0	2,083	99.4%	0	0	-56.4%
Food Preparation	Oven	17.0%	2	0	3,373	23.9%	2	1	-3.9%
Food Preparation	Fryer	17.1%	2	0	2,694	24.0%	2	0	-0.6%
Food Preparation	Dishwasher	50.8%	5	2	22,090	71.2%	4	3	-15.9%
Food Preparation	Hot Food Container	12.3%	1	0	656	17.2%	0	0	-29.3%
Office Equip.	Desktop Computer	98.0%	0	0	4,087	122.5%	0	1	-3.8%
Office Equip.	Laptop	73.4%	0	0	612	91.7%	0	0	-2.6%
Office Equip.	Server	90.0%	0	0	1,369	112.5%	0	0	-6.8%
Office Equip.	Monitor	99.4%	0	0	1,144	124.3%	0	0	-8.5%
Office Equip.	Printer/Copier/Fax	100.0%	0	0	1,477	125.0%	0	0	-7.9%
Office Equip.	POS Terminal	89.8%	0	0	952	98.8%	0	0	-16.9%
Miscellaneous	Non-HVAC Motors	74.1%	1	1	5,798	88.9%	1	1	0.4%
Miscellaneous	Pool Pump	0.0%	0	-	-	0.0%	0	-	3.1%
Miscellaneous	Pool Heater	0.0%	0	-	-	0.0%	0	-	7.4%
Miscellaneous	Miscellaneous	100.0%	5	5	48,664	100.0%	5	5	0.0%
Total				31	279,291			29	-8.8%

Table A-14 Other Health Electric Market Profile, 2012

		Average Market Profile				New Units			
End Use	Technology	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Usage (MWh)	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Compared to Average
Cooling	Air-Cooled Chiller	8.7%	1	0	807	8.7%	1	0	-13.5%
Cooling	Water-Cooled Chiller	5.8%	1	0	686	5.8%	1	0	-45.7%
Cooling	Roof top AC	66.1%	1	1	8,169	66.1%	1	1	-32.1%
Cooling	Other Cooling	3.4%	1	0	426	3.4%	1	0	-4.5%
Cooling	Air Source Heat Pump	7.3%	1	0	783	7.3%	1	0	-26.3%
Heating	Electric Furnace	28.5%	5	1	13,023	28.5%	4	1	-12.1%
Heating	Electric Zonal Heat	4.0%	4	0	1,470	7.3%	3	0	-12.1%
Heating	Air Source Heat Pump	7.3%	4	0	3,162	4.0%	3	0	-36.5%
Ventilation	Ventilation	100.0%	1	1	12,334	100.0%	1	1	-16.7%
Water Heating	Water Heater	36.6%	1	0	3,024	36.6%	1	0	-4.1%
Interior Lighting	Screw-in	100.0%	1	1	10,278	100.0%	1	1	-12.4%
Interior Lighting	High-Bay Fixtures	100.0%	0	0	2,112	100.0%	0	0	-18.1%
Interior Lighting	Linear Fluorescent	100.0%	2	2	15,871	100.0%	2	2	1.8%
Exterior Lighting	Screw-in	100.0%	0	0	1,754	100.0%	0	0	-59.5%
Exterior Lighting	HID	100.0%	0	0	655	100.0%	0	0	-35.3%
Exterior Lighting	Linear Fluorescent	100.0%	0	0	843	100.0%	0	0	1.8%
Refrigeration	Walk-in Refrigerator	1.4%	0	0	37	2.0%	0	0	-52.7%
Refrigeration	Reach-in Refrigerator	8.4%	0	0	58	11.8%	0	0	-61.1%
Refrigeration	Glass Door Display	43.8%	0	0	509	61.3%	0	0	-59.9%
Refrigeration	Open Display Case	43.8%	0	0	420	61.3%	0	0	-36.3%
Refrigeration	Icemaker	43.8%	0	0	345	61.3%	0	0	-12.1%
Refrigeration	Vending Machine	43.8%	0	0	267	61.3%	0	0	-56.4%
Food Preparation	Oven	3.9%	7	0	2,797	5.5%	7	0	-3.9%
Food Preparation	Fryer	2.5%	6	0	1,424	3.5%	6	0	-0.6%
Food Preparation	Dishwasher	3.2%	16	1	5,016	4.5%	14	1	-15.9%
Food Preparation	Hot Food Container	2.5%	2	0	483	3.5%	1	0	-29.3%
Office Equip.	Desktop Computer	97.9%	0	0	1,596	122.4%	0	0	-3.8%
Office Equip.	Laptop	93.0%	0	0	243	116.3%	0	0	-2.6%
Office Equip.	Server	97.9%	0	0	2,329	122.4%	0	0	-6.8%
Office Equip.	Monitor	99.8%	0	0	449	124.8%	0	0	-8.5%
Office Equip.	Printer/Copier/Fax	100.0%	0	0	462	125.0%	0	0	-7.9%
Office Equip.	POS Terminal	35.5%	0	0	118	39.0%	0	0	-16.9%
Miscellaneous	Non-HVAC Motors	22.0%	1	0	2,028	26.4%	1	0	0.4%
Miscellaneous	Pool Pump	0.0%	-	-	-	0.0%	-	-	0.0%
Miscellaneous	Pool Heater	0.0%	-	-	-	0.0%	-	-	0.0%
Miscellaneous	Miscellaneous	100.0%	1	1	6,261	100.0%	1	1	0.0%
Total				10	100,236			10	-7.4%

Table A-15 Lodging Electric Market Profile, 2012

		Average Market Profile				New Units			
End Use	Technology	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Usage (MWh)	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Compared to Average
Cooling	Air-Cooled Chiller	4.2%	1	0	314	5.1%	1	0	-10.8%
Cooling	Water-Cooled Chiller	17.0%	2	0	3,907	20.3%	1	0	-47.1%
Cooling	Roof top AC	7.7%	3	0	2,101	9.3%	2	0	-30.6%
Cooling	Other Cooling	26.3%	3	1	7,053	31.4%	2	1	-4.5%
Cooling	Air Source Heat Pump	24.7%	2	1	5,855	28.6%	2	0	-25.7%
Heating	Electric Furnace	31.5%	4	1	13,690	31.5%	4	1	-5.9%
Heating	Electric Zonal Heat	6.2%	4	0	2,719	28.6%	4	1	-5.9%
Heating	Air Source Heat Pump	24.7%	4	1	10,212	6.2%	4	0	-6.1%
Ventilation	Ventilation	100.0%	1	1	14,825	100.0%	1	1	-13.7%
Water Heating	Water Heater	31.5%	5	2	15,834	31.5%	5	1	-5.1%
Interior Lighting	Screw-in	100.0%	3	3	33,516	100.0%	3	3	-23.1%
Interior Lighting	High-Bay Fixtures	100.0%	0	0	2,074	100.0%	0	0	-22.9%
Interior Lighting	Linear Fluorescent	100.0%	2	2	16,187	100.0%	1	1	-12.1%
Exterior Lighting	Screw-in	100.0%	0	0	4,863	100.0%	0	0	-3.9%
Exterior Lighting	HID	100.0%	0	0	4,550	100.0%	0	0	-45.8%
Exterior Lighting	Linear Fluorescent	100.0%	0	0	514	100.0%	0	0	-12.1%
Refrigeration	Walk-in Refrigerator	13.3%	1	0	1,078	17.2%	0	0	-52.7%
Refrigeration	Reach-in Refrigerator	13.3%	0	0	285	17.2%	0	0	-57.7%
Refrigeration	Glass Door Display	58.9%	0	0	2,127	76.6%	0	0	-59.9%
Refrigeration	Open Display Case	58.9%	0	0	1,754	76.6%	0	0	-36.3%
Refrigeration	Icemaker	58.9%	0	0	1,443	76.6%	0	0	-12.1%
Refrigeration	Vending Machine	58.9%	0	0	2,230	76.6%	0	0	-40.8%
Food Preparation	Oven	42.6%	1	0	3,197	55.4%	1	0	-3.9%
Food Preparation	Fryer	13.1%	1	0	779	17.0%	1	0	-0.6%
Food Preparation	Dishwasher	90.8%	2	1	14,935	118.0%	1	2	-15.9%
Food Preparation	Hot Food Container	0.0%	0	-	-	0.0%	0	-	-29.3%
Office Equip.	Desktop Computer	93.0%	0	0	1,197	116.2%	0	0	-3.8%
Office Equip.	Laptop	78.2%	0	0	201	97.8%	0	0	-2.6%
Office Equip.	Server	84.0%	0	0	789	105.0%	0	0	-6.8%
Office Equip.	Monitor	91.4%	0	0	325	114.2%	0	0	-8.5%
Office Equip.	Printer/Copier/Fax	90.6%	0	0	165	113.2%	0	0	-7.9%
Office Equip.	POS Terminal	75.4%	0	0	99	82.9%	0	0	-16.9%
Miscellaneous	Non-HVAC Motors	91.3%	1	0	4,962	109.5%	1	1	0.4%
Miscellaneous	Pool Pump	51.1%	0	0	285	61.3%	0	0	3.1%
Miscellaneous	Pool Heater	3.6%	0	0	38	4.3%	0	0	7.4%
Miscellaneous	Miscellaneous	100.0%	1	1	7,032	100.0%	1	1	0.0%
Total				18	181,133			16	-8.1%

Table A-16 Assembly Electric Market Profile, 2012

		Average Market Profile				New Units			
End Use	Technology	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Usage (MWh)	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Compared to Average
Cooling	Air-Cooled Chiller	6.9%	1	0	2,180	7.8%	1	0	-6.5%
Cooling	Water-Cooled Chiller	4.6%	2	0	1,854	5.2%	1	0	-37.8%
Cooling	Roof top AC	52.4%	2	1	24,547	59.4%	2	1	-24.0%
Cooling	Other Cooling	2.7%	2	0	1,279	3.1%	2	0	-4.5%
Cooling	Air Source Heat Pump	12.7%	2	0	5,215	14.4%	1	0	-24.0%
Heating	Electric Furnace	10.0%	5	0	10,169	10.0%	5	0	-2.1%
Heating	Electric Zonal Heat	2.5%	4	0	2,156	14.4%	4	1	-2.1%
Heating	Air Source Heat Pump	12.7%	4	1	12,372	2.5%	3	0	-24.9%
Ventilation	Ventilation	100.0%	1	1	15,629	100.0%	1	1	-15.1%
Water Heating	Water Heater	51.3%	1	1	15,304	51.3%	1	1	-4.1%
Interior Lighting	Screw-in	100.0%	1	1	13,984	100.0%	0	0	-39.9%
Interior Lighting	High-Bay Fixtures	100.0%	1	1	10,989	100.0%	0	0	-24.4%
Interior Lighting	Linear Fluorescent	100.0%	2	2	42,741	100.0%	2	2	-2.0%
Exterior Lighting	Screw-in	100.0%	0	0	6,201	100.0%	0	0	-29.6%
Exterior Lighting	HID	100.0%	1	1	25,380	100.0%	1	1	-46.2%
Exterior Lighting	Linear Fluorescent	100.0%	0	0	3,472	100.0%	0	0	-2.0%
Refrigeration	Walk-in Refrigerator	15.4%	0	0	1,142	21.6%	0	0	-52.7%
Refrigeration	Reach-in Refrigerator	15.4%	0	0	603	21.6%	0	0	-56.7%
Refrigeration	Glass Door Display	30.2%	0	0	994	42.3%	0	0	-59.9%
Refrigeration	Open Display Case	30.2%	0	0	819	42.3%	0	0	-36.3%
Refrigeration	Icemaker	30.2%	0	0	1,348	42.3%	0	0	-12.1%
Refrigeration	Vending Machine	30.2%	0	0	1,042	42.3%	0	0	-40.2%
Food Preparation	Oven	34.0%	0	0	2,491	47.7%	0	0	-3.9%
Food Preparation	Fryer	2.5%	0	0	144	3.5%	0	0	-0.6%
Food Preparation	Dishwasher	20.7%	1	0	3,324	29.0%	1	0	-15.9%
Food Preparation	Hot Food Container	10.0%	0	0	197	14.0%	0	0	-29.3%
Office Equip.	Desktop Computer	72.3%	0	0	5,985	79.5%	0	0	-3.8%
Office Equip.	Laptop	56.9%	0	0	942	62.6%	0	0	-2.6%
Office Equip.	Server	43.6%	0	0	1,755	47.9%	0	0	-6.8%
Office Equip.	Monitor	68.3%	0	0	1,560	75.1%	0	0	-8.5%
Office Equip.	Printer/Copier/Fax	45.4%	0	0	888	49.9%	0	0	-7.9%
Office Equip.	POS Terminal	37.0%	0	0	519	44.4%	0	0	-16.9%
Miscellaneous	Non-HVAC Motors	59.9%	0	0	340	71.9%	0	0	0.4%
Miscellaneous	Pool Pump	80.4%	0	0	23	120.6%	0	0	3.1%
Miscellaneous	Pool Heater	0.0%	0	-	-	0.0%	0	-	7.4%
Miscellaneous	Miscellaneous	100.0%	1	1	12,393	100.0%	1	1	0.0%
Total				11	229,978			9	-13.0%

Table A-17 Warehouse Electric Market Profile, 2012

		Average Market Profile				New Units			
End Use	Technology	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Usage (MWh)	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Compared to Average
Cooling	Air-Cooled Chiller	0.0%	2	-	-	0.0%	2	-	-8.1%
Cooling	Water-Cooled Chiller	0.0%	2	-	-	0.0%	1	-	-41.5%
Cooling	Roof top AC	11.1%	3	0	8,589	11.1%	2	0	-31.2%
Cooling	Other Cooling	2.5%	3	0	1,975	2.5%	2	0	-6.1%
Cooling	Air Source Heat Pump	7.5%	2	0	5,094	7.5%	2	0	-31.2%
Heating	Electric Furnace	7.3%	6	0	14,092	7.3%	6	0	-4.7%
Heating	Electric Zonal Heat	1.7%	5	0	2,759	7.5%	5	0	-4.7%
Heating	Air Source Heat Pump	7.5%	6	0	13,838	1.7%	5	0	-19.7%
Ventilation	Ventilation	100.0%	1	1	29,123	100.0%	1	1	-11.2%
Water Heating	Water Heater	76.9%	0	0	9,806	76.9%	0	0	-6.0%
Interior Lighting	Screw-in	100.0%	0	0	8,655	100.0%	0	0	-31.1%
Interior Lighting	High-Bay Fixtures	100.0%	1	1	28,395	100.0%	1	1	-41.5%
Interior Lighting	Linear Fluorescent	100.0%	2	2	54,006	100.0%	2	2	-1.8%
Exterior Lighting	Screw-in	100.0%	0	0	2,308	100.0%	0	0	-52.7%
Exterior Lighting	HID	100.0%	0	0	13,782	100.0%	0	0	-46.2%
Exterior Lighting	Linear Fluorescent	100.0%	0	0	923	100.0%	0	0	-1.8%
Refrigeration	Walk-in Refrigerator	10.1%	16	2	48,979	12.1%	7	1	-52.7%
Refrigeration	Reach-in Refrigerator	0.0%	-	-	-	0.0%	-	-	0.0%
Refrigeration	Glass Door Display	0.0%	-	-	-	0.0%	-	-	0.0%
Refrigeration	Open Display Case	0.0%	-	-	-	0.0%	-	-	0.0%
Refrigeration	Icemaker	0.0%	-	-	-	0.0%	-	-	0.0%
Refrigeration	Vending Machine	0.0%	0	-	-	0.0%	0	-	-40.2%
Food Preparation	Oven	0.0%	0	-	-	0.0%	0	-	-3.9%
Food Preparation	Fryer	1.8%	0	0	9	2.0%	0	0	-0.6%
Food Preparation	Dishwasher	32.9%	0	0	445	39.5%	0	0	-15.9%
Food Preparation	Hot Food Container	0.0%	-	-	-	0.0%	-	-	0.0%
Office Equip.	Desktop Computer	79.0%	0	0	6,986	98.7%	0	0	-3.8%
Office Equip.	Laptop	36.8%	0	0	520	46.0%	0	0	-2.6%
Office Equip.	Server	64.9%	0	0	8,380	81.1%	0	0	-6.8%
Office Equip.	Monitor	74.6%	0	0	1,821	93.2%	0	0	-8.5%
Office Equip.	Printer/Copier/Fax	67.5%	0	0	847	84.4%	0	0	-7.9%
Office Equip.	POS Terminal	3.3%	0	0	59	3.6%	0	0	-16.9%
Miscellaneous	Non-HVAC Motors	49.9%	0	0	806	59.8%	0	0	0.4%
Miscellaneous	Pool Pump	0.0%	-	-	-	0.0%	-	-	0.0%
Miscellaneous	Pool Heater	0.0%	-	-	-	0.0%	-	-	0.0%
Miscellaneous	Miscellaneous	100.0%	1	1	25,046	100.0%	1	1	0.0%
Total				9	287,243			8	-18.0%

Table A-18 Data Center Electric Market Profile, 2012

		Average Market Profile				New Units			
End Use	Technology	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Usage (MWh)	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Compared to Average
Cooling	Air-Cooled Chiller	22.8%	28	6	15,936	21.3%	25	5	-9.9%
Cooling	Water-Cooled Chiller	15.6%	72	11	28,462	17.6%	41	7	-42.4%
Cooling	Roof top AC	45.2%	42	19	48,105	42.3%	30	13	-28.5%
Cooling	Other Cooling	0.6%	42	0	639	0.6%	40	0	-4.5%
Cooling	Air Source Heat Pump	13.8%	37	5	12,819	16.2%	26	4	-28.6%
Heating	Electric Furnace	43.0%	4	2	4,079	43.0%	3	1	-8.5%
Heating	Electric Zonal Heat	0.0%	3	-	-	16.2%	3	0	-8.5%
Heating	Air Source Heat Pump	13.8%	4	0	1,244	0.0%	3	-	-10.4%
Ventilation	Ventilation	100.0%	29	29	74,334	100.0%	24	24	-18.0%
Water Heating	Water Heater	68.0%	1	1	1,342	68.0%	1	1	-5.1%
Interior Lighting	Screw-in	100.0%	1	1	1,288	100.0%	1	1	5.3%
Interior Lighting	High-Bay Fixtures	100.0%	1	1	1,498	100.0%	1	1	-9.3%
Interior Lighting	Linear Fluorescent	100.0%	5	5	12,081	100.0%	5	5	4.3%
Exterior Lighting	Screw-in	100.0%	0	0	203	100.0%	0	0	-10.0%
Exterior Lighting	HID	100.0%	0	0	422	100.0%	0	0	-43.8%
Exterior Lighting	Linear Fluorescent	100.0%	0	0	276	100.0%	0	0	4.3%
Refrigeration	Walk-in Refrigerator	1.4%	0	0	7	1.5%	0	0	-52.7%
Refrigeration	Reach-in Refrigerator	8.4%	0	0	10	9.2%	0	0	-56.7%
Refrigeration	Glass Door Display	5.1%	0	0	11	5.6%	0	0	-59.9%
Refrigeration	Open Display Case	5.1%	0	0	9	5.6%	0	0	-36.3%
Refrigeration	Icemaker	5.1%	0	0	7	5.6%	0	0	-9.9%
Refrigeration	Vending Machine	5.1%	0	0	6	5.6%	0	0	-40.2%
Food Preparation	Oven	3.9%	0	0	14	4.3%	0	0	-3.9%
Food Preparation	Fryer	2.5%	0	0	7	2.7%	0	0	-0.6%
Food Preparation	Dishwasher	3.2%	0	0	25	3.5%	0	0	-15.9%
Food Preparation	Hot Food Container	2.5%	0	0	2	2.7%	0	0	-29.3%
Office Equip.	Desktop Computer	97.9%	1	1	2,708	137.0%	1	1	-3.8%
Office Equip.	Laptop	93.0%	0	0	515	130.2%	0	0	-2.6%
Office Equip.	Server	97.9%	80	78	197,665	137.1%	74	102	-6.8%
Office Equip.	Monitor	99.8%	0	0	763	139.8%	0	0	-8.5%
Office Equip.	Printer/Copier/Fax	100.0%	0	0	980	140.0%	0	0	-7.9%
Office Equip.	POS Terminal	35.5%	0	0	100	39.0%	0	0	-16.9%
Miscellaneous	Non-HVAC Motors	89.6%	1	0	1,155	107.5%	1	1	0.4%
Miscellaneous	Pool Pump	0.0%	-	-	-	0.0%	-	-	0.0%
Miscellaneous	Pool Heater	0.0%	-	-	-	0.0%	-	-	0.0%
Miscellaneous	Miscellaneous	100.0%	15	15	37,443	100.0%	15	15	0.0%
Total				175	444,152			183	4.1%

Table A-19 Multifamily Common Area Electric Market Profile, 2012

		Average Market Profile				New Units			
End Use	Technology	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Usage (MWh)	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Compared to Average
Cooling	Air-Cooled Chiller	1.4%	1	0	248	1.7%	1	0	-10.8%
Cooling	Water-Cooled Chiller	1.0%	3	0	531	1.2%	2	0	-47.1%
Cooling	Roof top AC	2.0%	4	0	1,282	2.4%	3	0	-30.6%
Cooling	Other Cooling	0.2%	4	0	127	0.2%	4	0	-4.5%
Cooling	Air Source Heat Pump	6.9%	3	0	3,862	8.0%	3	0	-25.7%
Heating	Electric Furnace	62.0%	6	4	58,034	62.0%	5	3	-5.9%
Heating	Electric Zonal Heat	7.7%	6	0	7,182	8.0%	5	0	-5.9%
Heating	Air Source Heat Pump	6.9%	5	0	6,147	7.7%	5	0	-11.1%
Ventilation	Ventilation	100.0%	2	2	32,395	100.0%	2	2	-13.7%
Water Heating	Water Heater	51.6%	7	3	56,676	51.6%	6	3	-5.1%
Interior Lighting	Screw-in	100.0%	2	2	32,225	100.0%	2	2	-23.1%
Interior Lighting	High-Bay Fixtures	100.0%	0	0	2,505	100.0%	0	0	-22.9%
Interior Lighting	Linear Fluorescent	100.0%	2	2	27,807	100.0%	1	1	-12.1%
Exterior Lighting	Screw-in	100.0%	1	1	10,628	100.0%	1	1	-3.9%
Exterior Lighting	HID	100.0%	1	1	9,942	100.0%	0	0	-45.8%
Exterior Lighting	Linear Fluorescent	100.0%	0	0	1,122	100.0%	0	0	-12.1%
Refrigeration	Walk-in Refrigerator	13.3%	-	-	-	17.2%	-	-	0.0%
Refrigeration	Reach-in Refrigerator	13.3%	0	0	708	17.2%	0	0	-57.7%
Refrigeration	Glass Door Display	58.9%	1	0	5,287	76.6%	0	0	-59.9%
Refrigeration	Open Display Case	58.9%	0	0	4,361	76.6%	0	0	-36.3%
Refrigeration	Icemaker	58.9%	0	0	3,586	76.6%	0	0	-12.1%
Refrigeration	Vending Machine	58.9%	1	0	5,542	76.6%	0	0	-40.8%
Food Preparation	Oven	42.6%	0	0	2,329	55.4%	0	0	-3.9%
Food Preparation	Fryer	13.1%	0	0	568	17.0%	0	0	-0.6%
Food Preparation	Dishwasher	90.8%	1	1	10,878	118.0%	1	1	-15.9%
Food Preparation	Hot Food Container	0.0%	0	-	-	0.0%	0	-	-29.3%
Office Equip.	Desktop Computer	93.0%	0	0	2,565	116.2%	0	0	-3.8%
Office Equip.	Laptop	78.2%	0	0	863	97.8%	0	0	-2.6%
Office Equip.	Server	84.0%	-	-	-	105.0%	-	-	0.0%
Office Equip.	Monitor	91.4%	0	0	696	114.2%	0	0	-8.5%
Office Equip.	Printer/Copier/Fax	90.6%	0	0	885	113.2%	0	0	-7.9%
Office Equip.	POS Terminal	75.4%	0	0	1,057	82.9%	0	0	-16.9%
Miscellaneous	Non-HVAC Motors	91.3%	0	0	1,460	109.5%	0	0	0.4%
Miscellaneous	Pool Pump	18.1%	0	0	74	21.7%	0	0	3.1%
Miscellaneous	Pool Heater	3.6%	0	0	28	4.3%	0	0	7.4%
Miscellaneous	Miscellaneous	100.0%	1	1	18,356	100.0%	1	1	0.0%
Total				19	309,955			17	-9.6%

Table A-20 Miscellaneous Commercial Electric Market Profile, 2012

		Average Market Profile				New Units			
End Use	Technology	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Usage (MWh)	Saturation	UEC (kWh/sqft)	Intensity (kWh/sqft)	Compared to Average
Cooling	Air-Cooled Chiller	3.0%	1	0	878	4.0%	1	0	-10.5%
Cooling	Water-Cooled Chiller	11.9%	2	0	4,479	16.2%	1	0	-39.2%
Cooling	Roof top AC	24.7%	2	0	10,781	33.6%	1	0	-24.0%
Cooling	Other Cooling	3.5%	2	0	1,550	4.8%	2	0	-6.1%
Cooling	Air Source Heat Pump	12.1%	2	0	4,612	16.4%	1	0	-24.0%
Heating	Electric Furnace	11.0%	4	0	11,138	11.0%	4	0	-2.1%
Heating	Electric Zonal Heat	2.6%	3	0	2,177	16.4%	3	1	-2.1%
Heating	Air Source Heat Pump	12.1%	4	0	11,659	2.6%	3	0	-24.9%
Ventilation	Ventilation	100.0%	1	1	16,034	100.0%	1	1	-15.1%
Water Heating	Water Heater	51.3%	1	1	15,636	51.3%	1	1	-4.1%
Interior Lighting	Screw-in	100.0%	0	0	7,784	100.0%	0	0	-39.2%
Interior Lighting	High-Bay Fixtures	100.0%	0	0	6,117	100.0%	0	0	-24.4%
Interior Lighting	Linear Fluorescent	100.0%	1	1	23,792	100.0%	1	1	-2.0%
Exterior Lighting	Screw-in	100.0%	0	0	5,129	100.0%	0	0	-28.8%
Exterior Lighting	HID	100.0%	1	1	20,991	100.0%	0	0	-46.2%
Exterior Lighting	Linear Fluorescent	100.0%	0	0	2,872	100.0%	0	0	-2.0%
Refrigeration	Walk-in Refrigerator	15.4%	0	0	1,247	21.6%	0	0	-52.7%
Refrigeration	Reach-in Refrigerator	15.4%	0	0	329	21.6%	0	0	-56.1%
Refrigeration	Glass Door Display	21.6%	0	0	776	30.2%	0	0	-59.9%
Refrigeration	Open Display Case	21.6%	0	0	640	30.2%	0	0	-36.3%
Refrigeration	Icemaker	21.6%	0	0	527	30.2%	0	0	-12.1%
Refrigeration	Vending Machine	21.6%	0	0	814	30.2%	0	0	-39.9%
Food Preparation	Oven	34.0%	0	0	1,180	47.7%	0	0	-3.9%
Food Preparation	Fryer	2.5%	0	0	68	3.5%	0	0	-0.6%
Food Preparation	Dishwasher	20.7%	0	0	1,575	29.0%	0	0	-15.9%
Food Preparation	Hot Food Container	10.0%	0	0	93	14.0%	0	0	-29.3%
Office Equip.	Desktop Computer	72.3%	0	0	4,745	90.4%	0	0	-3.8%
Office Equip.	Laptop	56.9%	0	0	747	71.2%	0	0	-2.6%
Office Equip.	Server	43.6%	0	0	2,087	54.5%	0	0	-6.8%
Office Equip.	Monitor	68.3%	0	0	1,237	85.3%	0	0	-8.5%
Office Equip.	Printer/Copier/Fax	45.4%	0	0	845	56.7%	0	0	-7.9%
Office Equip.	POS Terminal	37.0%	0	0	987	44.4%	0	0	-16.9%
Miscellaneous	Non-HVAC Motors	59.9%	0	0	2,896	71.9%	0	0	0.4%
Miscellaneous	Pool Pump	80.4%	0	0	398	92.9%	0	0	3.1%
Miscellaneous	Pool Heater	0.0%	0	-	-	0.0%	0	-	7.4%
Miscellaneous	Miscellaneous	100.0%	4	4	108,011	100.0%	4	4	0.0%
Total				11	274,829			10	-5.6%

Table A-21 Metals Electric Market Profile, 2012

		Average Market Profile				New Units			
End Use	Technology	Saturation	EUI (kWh/empl)	Intensity (kWh/empl)	Usage (MWh)	Saturation	EUI (kWh/empl)	Intensity (kWh/empl)	Compared to Average
Cooling	Air-Cooled Chiller	2.5%	3,942	99	273	2.5%	3,623	91	-8.1%
Cooling	Water-Cooled Chiller	2.5%	4,937	123	341	2.5%	2,886	72	-41.5%
Cooling	RTU	6.6%	5,592	370	1,024	6.6%	3,848	255	-31.2%
Cooling	Air-Source Heat Pump	7.5%	4,653	351	972	7.5%	3,199	241	-31.2%
Heating	Air-Source Heat Pump	7.5%	12,640	954	2,639	7.5%	10,146	766	-19.7%
Heating	Electric Resistance	7.3%	13,272	971	2,688	7.3%	12,648	926	-4.7%
Ventilation	Ventilation	100.0%	2,008	2,008	5,554	100.0%	1,783	1,783	-11.2%
Interior Lighting	Screw-in	100.0%	338	338	935	100.0%	233	233	-31.1%
Interior Lighting	High-Bay Fixtures	100.0%	1,109	1,109	3,068	100.0%	649	649	-41.5%
Interior Lighting	Linear Fluorescent	100.0%	2,109	2,109	5,835	100.0%	2,071	2,071	-1.8%
Exterior Lighting	Screw-in	100.0%	90	90	249	100.0%	43	43	-52.7%
Exterior Lighting	HID	100.0%	538	538	1,489	100.0%	383	383	-28.8%
Exterior Lighting	Linear Fluorescent	100.0%	36	36	100	100.0%	35	35	-1.8%
Motors	Pumps	100.0%	3,961	3,961	10,959	100.0%	3,960	3,960	0.0%
Motors	Fans & Blowers	100.0%	6,602	6,602	18,265	100.0%	6,600	6,600	0.0%
Motors	Compressed Air	100.0%	6,602	6,602	18,265	100.0%	6,601	6,601	0.0%
Motors	Conveyors	100.0%	16,637	16,637	46,027	100.0%	16,633	16,633	0.0%
Motors	Other Motors	100.0%	9,243	9,243	25,570	100.0%	9,241	9,241	0.0%
Process	Process Heating	100.0%	32,017	32,017	88,575	100.0%	32,017	32,017	0.0%
Process	Process Cooling	100.0%	618	618	1,710	100.0%	618	618	0.0%
Process	Process Refrigeration	100.0%	618	618	1,710	100.0%	618	618	0.0%
Process	Electrochemical Process	100.0%	78,263	78,263	216,513	100.0%	78,263	78,263	0.0%
Process	Other Process	100.0%	341	341	943	100.0%	341	341	0.0%
Miscellaneous	Miscellaneous	100.0%	2,786	2,786	7,708	100.0%	2,786	2,786	0.0%
Total				166,786	461,409			165,227	-0.9%

Table A-22 Transportation Equipment Electric Market Profile, 2012

		Average Market Profile				New Units			
End Use	Technology	Saturation	EUI (kWh/empl)	Intensity (kWh/empl)	Usage (MWh)	Saturation	EUI (kWh/empl)	Intensity (kWh/empl)	Compared to Average
Cooling	Air-Cooled Chiller	2.5%	2,880	72	903	2.5%	2,648	66	-8.1%
Cooling	Water-Cooled Chiller	2.5%	3,608	90	1,131	2.5%	2,109	53	-41.5%
Cooling	RTU	6.6%	4,087	270	3,391	6.6%	2,812	186	-31.2%
Cooling	Air-Source Heat Pump	7.5%	3,400	257	3,218	7.5%	2,338	176	-31.2%
Heating	Air-Source Heat Pump	7.5%	9,236	697	8,741	7.5%	7,414	560	-19.7%
Heating	Electric Resistance	7.3%	9,698	710	8,902	7.3%	9,242	677	-4.7%
Ventilation	Ventilation	100.0%	1,467	1,467	18,396	100.0%	1,303	1,303	-11.2%
Interior Lighting	Screw-in	100.0%	209	209	2,616	100.0%	144	144	-31.1%
Interior Lighting	High-Bay Fixtures	100.0%	685	685	8,584	100.0%	401	401	-41.5%
Interior Lighting	Linear Fluorescent	100.0%	1,302	1,302	16,326	100.0%	1,279	1,279	-1.8%
Exterior Lighting	Screw-in	100.0%	56	56	698	100.0%	26	26	-52.7%
Exterior Lighting	HID	100.0%	332	332	4,166	100.0%	237	237	-28.8%
Exterior Lighting	Linear Fluorescent	100.0%	22	22	279	100.0%	22	22	-1.8%
Motors	Pumps	100.0%	-	-	-	100.0%	-	-	0.0%
Motors	Fans & Blowers	100.0%	957	957	12,001	100.0%	957	957	0.0%
Motors	Compressed Air	100.0%	319	319	4,000	100.0%	319	319	0.0%
Motors	Conveyors	100.0%	6,539	6,539	81,992	100.0%	6,537	6,537	0.0%
Motors	Other Motors	100.0%	479	479	6,001	100.0%	478	478	0.0%
Process	Process Heating	100.0%	1,669	1,669	20,932	100.0%	1,669	1,669	0.0%
Process	Process Cooling	100.0%	384	384	4,810	100.0%	384	384	0.0%
Process	Process Refrigeration	100.0%	384	384	4,810	100.0%	384	384	0.0%
Process	Electrochemical Process	100.0%	141	141	1,765	100.0%	141	141	0.0%
Process	Other Process	100.0%	133	133	1,673	100.0%	133	133	0.0%
Miscellaneous	Miscellaneous	100.0%	1,446	1,446	18,137	100.0%	1,446	1,446	0.0%
Total				18,620	233,474			17,577	-5.6%

Table A-23 Food Products Electric Market Profile, 2012

		Average Market Profile				New Units			
End Use	Technology	Saturation	EUI (kWh/empl)	Intensity (kWh/empl)	Usage (MWh)	Saturation	EUI (kWh/empl)	Intensity (kWh/empl)	Compared to Average
Cooling	Air-Cooled Chiller	2.5%	558	14	117	2.5%	513	13	-8.1%
Cooling	Water-Cooled Chiller	2.5%	699	17	147	2.5%	409	10	-41.5%
Cooling	RTU	6.6%	792	52	441	6.6%	545	36	-31.2%
Cooling	Air-Source Heat Pump	7.5%	659	50	418	7.5%	453	34	-31.2%
Heating	Air-Source Heat Pump	7.5%	1,790	135	1,136	7.5%	1,437	108	-19.7%
Heating	Electric Resistance	7.3%	1,879	138	1,157	7.3%	1,791	131	-4.7%
Ventilation	Ventilation	100.0%	284	284	2,391	100.0%	252	252	-11.2%
Interior Lighting	Screw-in	100.0%	50	50	424	100.0%	35	35	-31.1%
Interior Lighting	High-Bay Fixtures	100.0%	165	165	1,391	100.0%	97	97	-41.5%
Interior Lighting	Linear Fluorescent	100.0%	315	315	2,646	100.0%	309	309	-1.8%
Exterior Lighting	Screw-in	100.0%	13	13	113	100.0%	6	6	-52.7%
Exterior Lighting	HID	100.0%	80	80	675	100.0%	57	57	-28.8%
Exterior Lighting	Linear Fluorescent	100.0%	5	5	45	100.0%	5	5	-1.8%
Motors	Pumps	100.0%	515	515	4,332	100.0%	515	515	0.0%
Motors	Fans & Blowers	100.0%	568	568	4,778	100.0%	568	568	0.0%
Motors	Compressed Air	100.0%	287	287	2,413	100.0%	287	287	0.0%
Motors	Conveyors	100.0%	880	880	7,404	100.0%	880	880	0.0%
Motors	Other Motors	100.0%	2,547	2,547	21,426	100.0%	2,546	2,546	0.0%
Process	Process Heating	100.0%	307	307	2,582	100.0%	307	307	0.0%
Process	Process Cooling	100.0%	1,205	1,205	10,139	100.0%	1,205	1,205	0.0%
Process	Process Refrigeration	100.0%	1,205	1,205	10,139	100.0%	1,205	1,205	0.0%
Process	Electrochemical Process	100.0%	11	11	93	100.0%	11	11	0.0%
Process	Other Process	100.0%	17	17	146	100.0%	17	17	0.0%
Miscellaneous	Miscellaneous	100.0%	913	913	7,684	100.0%	913	913	0.0%
Total				9,777	82,239			9,550	-2.3%

Table A-24 Stone and Glass Electric Market Profile, 2012

		Average Market Profile				New Units			
End Use	Technology	Saturation	EUI (kWh/empl)	Intensity (kWh/empl)	Usage (MWh)	Saturation	EUI (kWh/empl)	Intensity (kWh/empl)	Compared to Average
Cooling	Air-Cooled Chiller	2.5%	8,310	208	273	2.5%	7,639	191	-8.1%
Cooling	Water-Cooled Chiller	2.5%	10,408	260	342	2.5%	6,084	152	-41.5%
Cooling	RTU	6.6%	11,790	780	1,027	6.6%	8,113	537	-31.2%
Cooling	Air-Source Heat Pump	7.5%	9,810	740	974	7.5%	6,745	509	-31.2%
Heating	Air-Source Heat Pump	7.5%	26,647	2,011	2,647	7.5%	21,390	1,614	-19.7%
Heating	Electric Resistance	7.3%	27,979	2,048	2,696	7.3%	26,664	1,952	-4.7%
Ventilation	Ventilation	100.0%	4,232	4,232	5,571	100.0%	3,758	3,758	-11.2%
Interior Lighting	Screw-in	100.0%	616	616	811	100.0%	425	425	-31.1%
Interior Lighting	High-Bay Fixtures	100.0%	2,021	2,021	2,660	100.0%	1,183	1,183	-41.5%
Interior Lighting	Linear Fluorescent	100.0%	3,844	3,844	5,059	100.0%	3,775	3,775	-1.8%
Exterior Lighting	Screw-in	100.0%	164	164	216	100.0%	78	78	-52.7%
Exterior Lighting	HID	100.0%	981	981	1,291	100.0%	698	698	-28.8%
Exterior Lighting	Linear Fluorescent	100.0%	66	66	87	100.0%	65	65	-1.8%
Motors	Pumps	100.0%	11,743	11,743	15,456	100.0%	11,740	11,740	0.0%
Motors	Fans & Blowers	100.0%	16,526	16,526	21,751	100.0%	16,521	16,521	0.0%
Motors	Compressed Air	100.0%	2,975	2,975	3,915	100.0%	2,974	2,974	0.0%
Motors	Conveyors	100.0%	68,416	68,416	90,048	100.0%	68,399	68,399	0.0%
Motors	Other Motors	100.0%	1,068	1,068	1,405	100.0%	1,067	1,067	0.0%
Process	Process Heating	100.0%	32,100	32,100	42,249	100.0%	32,100	32,100	0.0%
Process	Process Cooling	100.0%	2,671	2,671	3,516	100.0%	2,671	2,671	0.0%
Process	Process Refrigeration	100.0%	2,671	2,671	3,516	100.0%	2,671	2,671	0.0%
Process	Electrochemical Process	100.0%	1,253	1,253	1,649	100.0%	1,253	1,253	0.0%
Process	Other Process	100.0%	612	612	805	100.0%	612	612	0.0%
Miscellaneous	Miscellaneous	100.0%	8,800	8,800	11,583	100.0%	8,800	8,800	0.0%
Total				166,807	219,547			163,746	-1.8%

Table A-25 Utilities Electric Market Profile, 2012

		Average Market Profile				New Units			
End Use	Technology	Saturation	EUI (kWh/empl)	Intensity (kWh/empl)	Usage (MWh)	Saturation	EUI (kWh/empl)	Intensity (kWh/empl)	Compared to Average
Cooling	Air-Cooled Chiller	2.5%	10,635	266	232	2.5%	9,776	244	-8.1%
Cooling	Water-Cooled Chiller	2.5%	13,320	333	291	2.5%	7,786	195	-41.5%
Cooling	RTU	6.6%	15,088	999	872	6.6%	10,383	687	-31.2%
Cooling	Air-Source Heat Pump	7.5%	12,554	948	827	7.5%	8,631	651	-31.2%
Heating	Air-Source Heat Pump	7.5%	34,102	2,574	2,248	7.5%	27,375	2,066	-19.7%
Heating	Electric Resistance	7.3%	35,807	2,621	2,289	7.3%	34,124	2,498	-4.7%
Ventilation	Ventilation	100.0%	5,417	5,417	4,730	100.0%	4,810	4,810	-11.2%
Interior Lighting	Screw-in	100.0%	720	720	629	100.0%	497	497	-31.1%
Interior Lighting	High-Bay Fixtures	100.0%	2,363	2,363	2,064	100.0%	1,383	1,383	-41.5%
Interior Lighting	Linear Fluorescent	100.0%	4,494	4,494	3,925	100.0%	4,414	4,414	-1.8%
Exterior Lighting	Screw-in	100.0%	192	192	168	100.0%	91	91	-52.7%
Exterior Lighting	HID	100.0%	1,147	1,147	1,002	100.0%	816	816	-28.8%
Exterior Lighting	Linear Fluorescent	100.0%	77	77	67	100.0%	75	75	-1.8%
Motors	Pumps	100.0%	4,608	4,608	4,025	100.0%	4,607	4,607	0.0%
Motors	Fans & Blowers	100.0%	5,534	5,534	4,833	100.0%	5,533	5,533	0.0%
Motors	Compressed Air	100.0%	4,475	4,475	3,908	100.0%	4,474	4,474	0.0%
Motors	Conveyors	100.0%	9,465	9,465	8,266	100.0%	9,462	9,462	0.0%
Motors	Other Motors	100.0%	159	159	139	100.0%	159	159	0.0%
Process	Process Heating	100.0%	5,892	5,892	5,146	100.0%	5,892	5,892	0.0%
Process	Process Cooling	100.0%	1,772	1,772	1,548	100.0%	1,772	1,772	0.0%
Process	Process Refrigeration	100.0%	1,772	1,772	1,548	100.0%	1,772	1,772	0.0%
Process	Electrochemical Process	100.0%	88	88	77	100.0%	88	88	0.0%
Process	Other Process	100.0%	152	152	133	100.0%	152	152	0.0%
Miscellaneous	Miscellaneous	100.0%	8,731	8,731	7,626	100.0%	8,731	8,731	0.0%
Total				64,797	56,590			61,070	-5.8%

Table A-26 Other Industrial Electric Market Profile, 2012

		Average Market Profile				New Units			
End Use	**Technology**	**Saturation**	**EUI (kWh/empl)**	**Intensity (kWh/empl)**	**Usage (MWh)**	**Saturation**	**EUI (kWh/empl)**	**Intensity (kWh/empl)**	**Compared to Average**
Cooling	Air-Cooled Chiller	2.5%	3,453	86	989	2.5%	3,174	79	-8.1%
Cooling	Water-Cooled Chiller	2.5%	4,324	108	1,239	2.5%	2,528	63	-41.5%
Cooling	RTU	6.6%	4,899	324	3,716	6.6%	3,371	223	-31.2%
Cooling	Air-Source Heat Pump	7.5%	4,076	308	3,526	7.5%	2,802	211	-31.2%
Heating	Air-Source Heat Pump	7.5%	11,072	836	9,577	7.5%	8,887	671	-19.7%
Heating	Electric Resistance	7.3%	11,625	851	9,753	7.3%	11,079	811	-4.7%
Ventilation	Ventilation	100.0%	1,759	1,759	20,155	100.0%	1,562	1,562	-11.2%
Interior Lighting	Screw-in	100.0%	234	234	2,680	100.0%	161	161	-31.1%
Interior Lighting	High-Bay Fixtures	100.0%	767	767	8,792	100.0%	449	449	-41.5%
Interior Lighting	Linear Fluorescent	100.0%	1,459	1,459	16,722	100.0%	1,433	1,433	-1.8%
Exterior Lighting	Screw-in	100.0%	62	62	715	100.0%	29	29	-52.7%
Exterior Lighting	HID	100.0%	372	372	4,267	100.0%	265	265	-28.8%
Exterior Lighting	Linear Fluorescent	100.0%	25	25	286	100.0%	25	25	-1.8%
Motors	Pumps	100.0%	1,496	1,496	17,147	100.0%	1,496	1,496	0.0%
Motors	Fans & Blowers	100.0%	1,797	1,797	20,592	100.0%	1,796	1,796	0.0%
Motors	Compressed Air	100.0%	1,453	1,453	16,651	100.0%	1,452	1,452	0.0%
Motors	Conveyors	100.0%	3,073	3,073	35,218	100.0%	3,072	3,072	0.0%
Motors	Other Motors	100.0%	52	52	591	100.0%	52	52	0.0%
Process	Process Heating	100.0%	1,913	1,913	21,923	100.0%	1,913	1,913	0.0%
Process	Process Cooling	100.0%	575	575	6,594	100.0%	575	575	0.0%
Process	Process Refrigeration	100.0%	575	575	6,594	100.0%	575	575	0.0%
Process	Electrochemical Process	100.0%	29	29	329	100.0%	29	29	0.0%
Process	Other Process	100.0%	49	49	565	100.0%	49	49	0.0%
Miscellaneous	Miscellaneous	100.0%	2,835	2,835	32,490	100.0%	2,835	2,835	0.0%
Total				21,037	241,110			19,827	-5.8%

RESIDENTIAL ENERGY EFFICIENCY EQUIPMENT AND MEASURE DATA

This appendix presents detailed information for all energy-efficiency measures (*equipment* and *non-equipment* measures per the LoadMAP taxonomy) that were evaluated as part of this study. Several sets of tables are provided.

Measure Descriptions

Table B-1 and Table B-2 provide brief descriptions for all equipment and non-equipment measures that were assessed for potential.

Equipment Measure Data

The attached file, *Appendix B Residential Equipment.xlsx,* lists the detailed unit-level data for the equipment measures for each of the housing type segments — Single Family, Multiplex, Low-Rise Multifamily, and High-Rise Multifamily, for existing and new construction, respectively. Savings are in annual kWh per household (kWh/HH), and incremental costs are in $/household (2012$/HH), unless noted otherwise. For the baseline technology in each case, these values are by definition equal to zero. The BC ratio shown in the tables are for the first year of the potential analysis (2014), although the B/C ratio is calculated within LoadMAP for each year of the forecast. The B/C ratio in the tables is 1.00 if the measure represents the baseline technology, and zero if the technology is not available in 2014. The final data item in these tables is the levelized cost of conserved energy, which is defined as the cost of the measure divided by the cumulative amount of energy savings accrued over the measure's lifetime (2012$/kWh). In the case that the efficient measure is less costly than the baseline, this value is shown as zero, rather than a negative value.

Non-Equipment Measure Data

The attached file, *Appendix B Residential Non-Equipment.xlsx*, list the detailed unit-level data for the non-equipment energy efficiency measures for each of the housing type segments and for existing and new construction, respectively. Because these measures can produce energy-use savings for multiple end-use loads (e.g., insulation affects heating and cooling energy use) savings are expressed as a net percentage of all the relevant, combined end-use loads. Base saturation indicates the percentage of homes in which the measure is already installed. Applicability is a factor that accounts for whether the measure is applicable to the building. Cost is expressed in 2012$/household. The detailed measure-level tables present the results of the benefit/cost (B/C) analysis for the first year of the analysis (2014) although the B/C ratio is calculated within LoadMAP for each year of the forecast. These tables also contain the levelized cost of conserved energy, which is defined as the cost of the measure divided by the cumulative amount of energy savings accrued over the measure's lifetime, given in terms of 2012$/kWh. In the case that the efficient measure is less costly than the baseline, this value is shown as zero, rather than a negative value.

Table B-1 Residential Energy Efficiency Equipment Measure Descriptions

End Use	Technology	Measure Description
Cooling	Central AC	Central air conditioners consist of a refrigeration system using a direct expansion cycle. Equipment includes a compressor, an air-cooled condenser (located outdoors), an expansion valve, and an evaporator coil. A supply fan near the evaporator coil distributes supply air through air ducts to the building. Cooling efficiencies vary based on materials used, equipment size, condenser type, and system configuration. CACs may be unitary (all components housed in a factory-built assembly) or split system (an outdoor condenser section and an indoor evaporator section connected by refrigerant lines and with the compressor either indoors or outdoors). Energy efficiency is rated according to the size of the unit using the Seasonal Energy Efficiency Rating (SEER). Ductless systems with Variable Refrigerant Flow further improve the operating efficiency.
Cooling	Room AC	Room air conditioners are designed to cool a single room or space. They incorporate a complete air-cooled refrigeration and air-handling system in an individual package. Room air conditioners come in several forms, including window, split-type, and packaged terminal units. Energy efficiency is rated according to the size of the unit using the Energy Efficiency Rating (EER).
Cooling/ Heating	Air-Source Heat Pump	A central heat pump consists of components similar to a CAC system, but is usually designed to function both as a heat pump and an air conditioner. It consists of a refrigeration system using a direct expansion (DX) cycle. Equipment includes a compressor, an air-cooled condenser (located outdoors), an expansion valve, and an evaporator coil (located in the supply air duct near the supply fan) and a reversing valve to change the DX cycle from cooling to heating when required. The cooling and heating efficiencies vary based on the materials used, equipment size, condenser type, and system configuration. Heat pumps may be unitary (all components housed in a factory-built assembly) or a split system (an outdoor condenser section and an indoor evaporator section connected by refrigerant lines, with either outdoors or indoors. A high-efficiency option for a ductless mini-split system is also analyzed.
Heating	Electric Zonal Room Heat	Resistive heating elements are used to convert electricity directly to heat. Conductive fins surrounding the element or another mechanism is used to deliver the heat directly to the surrounding room or area. These are typically either baseboard or wall-mounted units.
Heating	Electric Furnace	Furnaces heat air and distribute the heated air through the building using ducts. Efficiency improvements can include: exhaust fan controls, electronic ignition (no pilot light), compact size and lighter weight to reduce cycling losses, smaller-diameter flue pipe, and sealed combustion. Very high efficiency units, or condensing units, condense the water vapor produced in the combustion process and also use the heat from this condensation.
Water Heating	Water Heater	For electric hot water heating, the most common type is a storage heater, which incorporates an electric heating element, storage tank, outer jacket, insulation, and controls in a single unit. Efficient units are characterized by a high recovery or thermal efficiency and low standby losses (the ratio of heat lost per hour to the content of

End Use	Technology	Measure Description
		the stored water). A further efficiency gain is available through a heat pump water heater (HPWH), which uses a vapor-compression thermodynamic cycle similar to that found in an air-conditioner or refrigerator to extract heat from an available source (e.g., air) and reject that heat to a higher temperature sink, in this case, the water in the water heater. Electric instantaneous water heaters are available, but are excluded from this study due to potentially high instantaneous demand concerns.
Interior Lighting	Screw-in	Infrared halogen lamps are designed to be a replacement for standards incandescent lamps. Also referred to as advanced incandescent lamps, these products meet the Energy Independence and Security Act (EISA) lighting standards and are phased in as the baseline technology screw-in lamp technology to reflect the timeline over which the EISA lighting standards take effect. Compact fluorescent lamps are designed to be a replacement for standard incandescent lamps and use about 25% of the energy used by standard incandescent lamps to produce the same lumen output. They can use either electronic or magnetic ballasts. Integral compact fluorescent lamps have the ballast integrated into the base of the lamp and have a standard screw-in base that permits installation into existing incandescent fixtures. Light-emitting diode (LED) lighting has seen recent penetration in specific applications such as traffic lights and exit signs. With the potential for extremely high efficiency, LEDs show promise to provide general-use lighting for interior spaces. Current models commercially available have efficacies comparable to CFLs. However, theoretical efficiencies are significantly higher. LED models under development are expected to provide improved efficacies.
Interior Lighting	Linear Fluorescent	T8 fluorescent lamps are smaller in diameter than standard T12 lamps, resulting in greater light output per watt. T8 lamps also operate at a lower current and wattage, which increases the efficiency of the ballast but requires the lamps to be compatible with the ballast. Fluorescent lamp fixtures can include a reflector that increases the light output from the fixture, and thus make it possible to use a fewer number of lamps in each fixture. T5 lamps further increase efficiency by reducing the lamp diameter to 5/8”. Light-emitting diode (LED) lighting has seen recent penetration in specific applications such as traffic lights and exit signs. With the potential for extremely high efficiency, LEDs show promise to provide general-use lighting for interior spaces. Current models commercially available have efficacies comparable to CFLs. However, theoretical efficiencies are significantly higher. LED models under development are expected to provide improved efficacies.
Interior Lighting	Specialty Lighting	Bulbs that the DOE does not consider conventional and are not covered by federal efficiency standards. These include: appliance bulbs, heavy-duty bulbs, dimmable bulbs, three-way bulbs, G shape (globe) lamps, candelabra base, and others.
Exterior Lighting	Screw-in	Infrared halogen lamps are designed to be a replacement for standards incandescent lamps. Also referred to as advanced incandescent lamps, these products meet the Energy Independence and Security Act (EISA) lighting standards and are phased in as the

End Use	Technology	Measure Description
		baseline technology screw-in lamp technology to reflect the timeline over which the EISA lighting standards take effect. Compact fluorescent lamps are designed to be a replacement for standard incandescent lamps and use about 25% of the energy used by standard incandescent lamps to produce the same lumen output. They can use either electronic or magnetic ballasts. Integral compact fluorescent lamps have the ballast integrated into the base of the lamp and have a standard screw-in base that permits installation into existing incandescent fixtures. Light-emitting diode (LED) lighting has seen recent penetration in specific applications such as traffic lights and exit signs. With the potential for extremely high efficiency, LEDs show promise to provide general-use lighting for interior spaces. Current models commercially available have efficacies comparable to CFLs. However, theoretical efficiencies are significantly higher. LED models under development are expected to provide improved efficacies.
Appliances	Refrigerator	Energy-efficient refrigerators/freezers incorporate features such as improved cabinet insulation, more efficient compressors and evaporator fans, defrost controls, mullion heaters, oversized condenser coils, and improved door seals. Further efficiency increases can be obtained by reducing the volume of refrigerated space, or adding multiple compartments to reduce losses from opening doors.
Appliances	Second Refrigerator	Energy-efficient refrigerators/freezers incorporate features such as improved cabinet insulation, more efficient compressors and evaporator fans, defrost controls, mullion heaters, oversized condenser coils, and improved door seals. Further efficiency increases can be obtained by reducing the volume of refrigerated space, or adding multiple compartments to reduce losses from opening doors.
Appliances	Freezer	Energy-efficient refrigerators/freezers incorporate features such as improved cabinet insulation, more efficient compressors and evaporator fans, defrost controls, mullion heaters, oversized condenser coils, and improved door seals. Further efficiency increases can be obtained by reducing the volume of refrigerated space, or adding multiple compartments to reduce losses from opening doors.
Appliances	Clothes Washer	High efficiency clothes washers use superior designs that require less water. Sensors match the hot water needs to the size and soil level of the load, preventing energy waste. Further energy and water savings can be achieved through advanced technologies such as inverter-drive or combination washer-dryer units. MEF is the official energy efficiency metric used to compare relative efficiencies of different clothes washers. MEF considers the energy used to run the washer, heat the water, and run the dryer. The higher the MEF, the more efficient the clothes washer.
Appliances	Clothes Dryer	An energy-efficient clothes dryer has a moisture-sensing device to terminate the drying cycle rather than using a timer and an energy-efficient motor is used for spinning the dryer tub. Application of a heat pump cycle for extracting the moisture from clothes leads to additional energy savings.

End Use	Technology	Measure Description
Appliances	Dishwasher	High efficiency dishwashers save by using both improved technology for the primary wash cycle, and by using less hot water. Construction includes more effective washing action, energy-efficient motors, and other advanced technology such as sensors that determine the length of the wash cycle and the temperature of the water necessary to clean the dishes.
Appliances	Stove	These products have additional insulation in the oven compartment and tighter-fitting oven door gaskets and hinges to save energy. Conventional ovens must first heat up about 35 pounds of steel and a large amount of air before they heat up the food. Higher efficiency options include convection ovens, halogen burners, and induction burners.
Appliances	Microwave	Appliance that heats food with microwave radiation. No high efficiency option is modeled.
Electronics	Personal Computers	Improved power management can significantly reduce the annual energy consumption of PCs and monitors in both standby and normal operation. ENERGY STAR and Climate Savers labeled products provide increasing level of energy efficiency.
Electronics	Laptops	Improved power management can significantly reduce the annual energy consumption of PCs and monitors in both standby and normal operation. ENERGY STAR and Climate Savers labeled products provide increasing level of energy efficiency.
Electronics	TVs	In the average home, electronic products consumed significant energy, even when they are turn off, to maintain features like clocks, remote control, and channel/station memory. ENERGY STAR labeled consumer electronics can drastically reduce consumption during standby mode, in addition to saving energy through advanced power management during normal use.
Electronics	Printer/Fax/Copier	High efficiency electronics use efficient components and employ sleep/power save modes.
Electronics	Set-top Boxes/DVR	High efficiency electronics can use efficient components and employ sleep/powersave modes.
Miscellaneous	Pool Pump	High-efficiency motors and two-speed pumps provide improved energy efficiency for this load.
Miscellaneous	Pool Heater	Efficient pool heaters can make use of heat pump technology to achieve significantly higher coefficients of performance in the COP=5.0 range.
Miscellaneous	Hot Tub / Spa	High-efficiency motors and two-speed pumps provide improved energy efficiency for this load.
Miscellaneous	Furnace Fan	In homes heated by a furnace, there is still substantial energy use by the fan responsible for moving the hot air throughout the ductwork. Application of an Electronically Commutating Motor (ECM) ensures that motor speed matches the heating requirements of the system and saves energy when compared to a continuously operating standard motor.

Table B-2 Residential Energy Efficiency Non-Equipment Measure Descriptions

End Use	Measure	Description
HVAC (All)	Insulation - Ceiling	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation above ceilings can conserve energy by reducing the heat loss or gain into attics and/or through roofs. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose, loose-fill (blown) fiberglass, and rigid polystyrene.
Cooling	Insulation – Ducts Inside	Air distribution ducts can be insulated to reduce heating or cooling losses. Best results can be achieved by covering the entire surface area with insulation. Several types of ducts and duct insulation are available, including flexible duct, pre-insulated duct, duct board, duct wrap, tacked, or glued rigid insulation, and waterproof hard shell materials for exterior ducts. This analysis assumes that installing duct insulation can reduce the temperature drop/gain in ducts by 50%.
HVAC (All)	Insulation - Foundation	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation can conserve energy by reducing heat loss or gain from a building. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose, loose-fill (blown) fiberglass, and rigid polystyrene. Foundation insulation is modeled for new construction / major retrofits only.
HVAC (All)	Insulation - Infiltration Control	Lowering the air infiltration rate by caulking small leaks and weather-stripping around window frames, doorframes, power outlets, plumbing, and wall corners can provide significant energy savings. Weather-stripping doors and windows will create a tight seal and further reduce air infiltration.
HVAC (All)	Insulation - Wall Cavity	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation can conserve energy by reducing heat loss or gain from a building. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose, loose-fill (blown) fiberglass, and rigid polystyrene. Wall insulation is modeled for new construction / major retrofits only.
HVAC (All)	Insulation - Wall Sheathing	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation can conserve energy by reducing heat loss or gain from a building. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose, loose-fill (blown) fiberglass, and rigid polystyrene. Wall sheathing is modeled for new construction / major retrofits only.
Cooling	Ducting - Repair and Sealing	Leakage in unsealed ducts varies considerably because of the differences in fabricating machinery used, the methods for assembly, installation workmanship, and age of the ductwork. Air leaks from the system to the outdoors result in a direct loss proportional to the amount of leakage and the difference in enthalpy between the outdoor air and the conditioned air. To seal ducts, a wide variety of sealing methods and products exist. Each has a relatively short shelf life, and no documented research has identified the aging characteristics of sealant applications.
HVAC (All)	Windows - High Efficiency/ENERGY STAR	High-efficiency windows, such as those labeled under the ENERGY STAR Program, are designed to reduce energy use and increase occupant comfort. High-efficiency windows reduce the amount of heat transfer through the glazing surface. For example, some windows have a low-E coating, a thin film of metallic oxide coating on the glass surface that allows passage of short-wave solar energy through glass and prevents long-wave energy from escaping. Another example is double-pane glass that reduces conductive and convective heat transfer. Some double-pane windows are gas-filled (usually argon) to further increase the insulating properties of the window.

End Use	Measure	Description
HVAC (All)	Doors - Storm and Thermal	Like other components of the shell, doors are subject to several types of heat loss: conduction, infiltration, and radiant losses. Similar to a storm window, a storm door creates an insulating air space between the storm and primary doors. A tight fitting storm door can also help reduce air leakage or infiltration. Thermal doors have exceptional thermal insulation properties and also are provided with weather-stripping on the doorframe to reduce air leakage.
HVAC (All)	Thermostat - Clock/Programmable	A programmable thermostat can be added to most heating/cooling systems. They are typically used during winter to lower temperatures at night and in summer to increase temperatures during the afternoon. The energy savings from this type of thermostat are identical to those of a "setback" strategy with standard thermostats, but the convenience of a programmable thermostat makes it a much more attractive option. In this analysis, the baseline is assumed to have no thermostat setback.
Cooling / Heating	Central Heat Pump - Maintenance	A heat pump's filters, coils, and fins require regular cleaning and maintenance for the unit to function effectively and efficiently throughout its life. Neglecting necessary maintenance ensures a steady decline in performance while energy use steadily increases.
Water Heating	Water Heater - Drainwater Heat Recovery	Drainwater Heat Recovery is a system in which drain water is used to preheat cold water entering the water heater. While these systems themselves are relatively inexpensive, upgrading an existing system could be unreasonable because of demolition costs. Thus they are modeled for new vintage only.
Water Heating	Water Heater - Faucet Aerators	Water faucet aerators are threaded screens that attach to existing faucets. They reduce the volume of water coming out of faucets while introducing air into the water stream. This measure provides energy saving by reducing hot water use, as well as water conservation for both hot and cold water.
Water Heating	Water Heater - Low-Flow Showerheads	Similar to faucet aerators, low-flow showerheads reduce the consumption of hot water, which in turn decreases water heating energy use.
Water Heating	Water Heater - Pipe Insulation	Insulating hot water pipes decreases energy losses from piping that distributes hot water throughout the building. It also results in quicker delivery of hot water and may allow the lowering of the hot water set point, which saves energy. The most common insulation materials for this purpose are polyethylene and neoprene.
Water Heating	Water Heater - Timer	These measures use either a programmable thermostat or a timer to adjust the water heater setpoint at times of low usage, typically when a home is unoccupied.
Water Heating	Water Heater - Solar System	Solar water heating systems can be used in residential buildings that have an appropriate near-south-facing roof or nearby unshaded grounds for installing a collector. Although system types vary, in general these systems use a solar absorber surface within a solar collector or an actual storage tank. Either a heat-transfer fluid or the actual potable water flows through tubes attached to the absorber and transfers heat from it. (Systems with a separate heat-transfer-fluid loop include a heat exchanger that then heats the potable water.) The heated water is stored in a separate preheat tank or a conventional water heater tank. If additional heat is needed, it is provided by a conventional water-heating system.
Interior Lighting	Interior Lighting - Occupancy Sensors	Occupancy sensors turn lights off when a space is unoccupied. They are appropriate for areas with intermittent use, such as bathrooms or storage areas.
Exterior Lighting	Exterior Lighting - Photosensor Control	Photosensor controls turn exterior lighting on or off based on ambient lighting levels. Compared with manual operation, this can reduce the operation of exterior lighting during daylight hours.
Exterior Lighting	Exterior Lighting - Photovoltaic Installation	Solar photovoltaic generation may be used to power exterior lighting and thus eliminate all or part of the electrical energy use.
Exterior Lighting	Exterior Lighting - Timeclock	Lighting timers turn exterior lighting on or off based on a preset schedule. Compared with manual operation, this can reduce the operation of exterior

End Use	Measure	Description
	Installation	lighting during daylight hours.
Appliances	Refrigerator – Decommissioning and Recycling	Homeowners may have a second refrigerator or freezer that is not used to full capacity and that, because of its age, is extremely inefficient. This measure incents homeowners to recycle the second unit and thus also eliminates associated electricity use.
Appliances	Freezer - Decommissioning and Recycling	Homeowners may have a second refrigerator or freezer that is not used to full capacity and that, because of its age, is extremely inefficient. This measure incents homeowners to recycle the second unit and thus also eliminates associated electricity use.
Electronics	Electronics - Smart Power Strips	Representing a growing portion of home electricity consumption, plug-in electronics such as set-top boxes, DVD players, gaming systems, digital video recorders, and even battery chargers for mobile phones and laptop computers are often designed to supply a set voltage. When the units are not in use, this voltage could be dropped significantly (~1 W) and thereby generate a significant energy savings, assumed for this analysis to be between 4-5% on average. These savings are in excess of the measures already discussed for computers and televisions.
Miscellaneous	Pool Pump - Timer	A pool pump timer allows the pump to turn off automatically, eliminating the wasted energy associated with unnecessary pumping.
HVAC (All)	ENERGY STAR Home Design	ENERGY STAR home design uses an integrated approach to the design of new buildings to account for the interaction of building systems. Designs may specify the building orientation, building shell, proper sizing of equipment and systems, and controls strategies with the goal of optimizing building energy efficiency and comfort. Options that may be evaluated and incorporated include passive solar strategies, increased thermal mass, natural ventilation, energy recovery ventilation, daylighting strategies, and shading strategies; but with specific requirements that adhere to the ENERGY STAR standard and measurement system. This measure is modeled for new vintage only.
Miscellaneous	Behavioral Measures	The behavioral measure models the wide range of options for providing homeowners with ongoing information on their energy use, for example via a web portal. These tools are based on the premise that homeowners will reduce energy use if they better understand how they use energy and the associated costs. The level of assumed savings is based on isolated behavioral effects and excludes the technology effects of all other measures listed here.
HVAC (All)	Photovoltaic System	Adding a solar photovoltaic (PV) system to the home can meet a portion of the home's electric load and in some cases nearly all of the load, depending on the PV system size, orientation, solar resource, and other factors.

COMMERCIAL ENERGY EFFICIENCY EQUIPMENT AND MEASURE DATA

This appendix presents detailed information for all commercial energy-efficiency measures (*equipment* and *non-equipment* measures per the LoadMAP taxonomy) that were evaluated in this study.

Measure Descriptions

Table C-1 and Table C-2 provide brief narrative descriptions for all equipment and non-equipment measures that were assessed for potential.

Equipment Measure Data

The attached file, *Appendix C Commercial Equipment Tables.xlsx*, lists the detailed unit-level data (including economic screen results) for commercial equipment measures in existing and new buildings. Savings are in annual kWh per SQ FT, and incremental costs are in 2012$/SQ FT, unless noted otherwise. For the baseline technology in each case, these values are by definition equal to zero. The BC ratio shown in the tables are for the first year of the potential analysis (2014), although the B/C ratio is calculated within LoadMAP for each year of the forecast. The B/C ratio in the tables is 1.00 if the measure represents the baseline technology, and zero if the technology is not available in 2014. The final data item in these tables is the levelized cost of conserved energy, which is defined as the cost of the measure divided by the cumulative amount of energy savings accrued over the measure's lifetime (2012$/kWh). In the case that the efficient measure is less costly than the baseline, this value is shown as zero, rather than a negative value.

Non-Equipment Measure Data

The attached file, *Appendix C Commercial Non-Equipment Tables.xlsx*, lists the detailed unit-level data (including economic screen results) for commercial non-equipment measures in existing and new construction. Because these measures can produce energy-use savings for multiple end-use loads (e.g., insulation affects heating and cooling energy use) savings are expressed as a net percentage of all the relevant, combined end-use loads. Base saturation indicates the percentage of buildings in which the measure is already installed. Applicability is a factor that accounts for whether the measure is applicable to the building. Cost is expressed in 2012$/sq. ft. The detailed measure-level tables present the results of the benefit/cost (B/C) analysis for the first year of the analysis (2014) although the B/C ratio is calculated within LoadMAP for each year of the forecast. These tables also contain the levelized cost of conserved energy, which is defined as the cost of the measure divided by the cumulative amount of energy savings accrued over the measure's lifetime, given in terms of 2012$/kWh. In the case that the efficient measure is less costly than the baseline, this value is shown as zero, rather than a negative value.

Table C-1 Commercial Energy Efficiency Equipment Measure Descriptions

End Use	Technology	Measure Description
Cooling	Air-Cooled Chiller	A central chiller plant creates chilled water for distribution throughout the facility. Because of the wide variety of system types and sizes, savings and cost values for efficiency improvements represent an average over screw, reciprocating, and centrifugal technologies. Under this simplified approach, each central system is characterized by an aggregate efficiency value (inclusive of chiller, pumps, and motors), in kW/ton with a further efficiency upgrade through the application of variable refrigerant flow technology.
Cooling	Water-Cooled Chiller	A central chiller plant creates chilled water for distribution throughout the facility. Water source chillers include heat rejection via a condenser loop and cooling tower. Because of the wide variety of system types and sizes, savings and cost values for efficiency improvements represent an average over screw, reciprocating, and centrifugal technologies. Under this simplified approach, each central system is characterized by an aggregate efficiency value (inclusive of chiller, pumps, motors, and condenser loop equipment), in kW/ton with a further efficiency upgrade through the application of variable refrigerant flow technology.
Cooling	Roof Top AC	Packaged cooling systems, such as rooftop units (RTUs), are simple to install and maintain, and are commonly used in small and medium-sized commercial buildings. Applications range from a single supply system with air intake filters, supply fan, and cooling coil, or can become more complex with the addition of a return air duct, return air fan, and various controls to optimize performance. For packaged RTUs, varying Energy Efficiency Ratios (EER) are modeled, as well as a ductless mini-split system.
Cooling	Other Cooling	This measure includes efficiency upgrades to other small cooling systems in commercial buildings including room AC units, packaged terminal air conditioning (PTAC) units, and packaged terminal heat pumps (PTHP).
Cooling / Heating	Air-Source Heat Pump	For heat pumps, units with increasing EER and COP levels are evaluated, as well as a ductless mini-split system.
Heating	Electric Furnace	Resistive heating elements are used to convert electricity directly to heat. The heat is then delivered by a supply fan and duct system to the regions that require heating.
Heating	Electric Zonal Heat	Resistive heating elements are used to convert electricity directly to heat. Conductive fins surrounding the element or another mechanism is used to deliver the heat directly to the surrounding room or area. These are typically either baseboard or wall-mounted units.
Ventilation	Ventilation	A variable air volume ventilation system modulates the air flow rate as needed based on the interior conditions of the building to reduce fan load, improve dehumidification, and reduce energy usage.
Water Heating	Water Heater	Efficient electric water heaters are characterized by a high recovery or thermal efficiency (percentage of delivered electric energy which is transferred to the water) and low standby losses (the ratio of heat lost per hour to the content of the stored water). Included in the savings associated with high-efficiency electric water heaters are timers that allow temperature setpoints to change with hot water demand patterns. For example, the heating element could be shut off throughout the night, increasing the overall energy factor of the unit. In addition, tank and pipe insulation reduces standby losses and therefore reduces the demands on the water heater. This analysis considers conventional electric water heaters and heat pump water heaters.
Interior Lighting	Screw-in	This measure evaluates higher-efficiency alternatives for screw-in interior lamps including halogen, CFL, and LED.
Interior Lighting	High-Bay Fixtures	With the exception of screw-in lighting, commercial and industrial lighting efficiency changes typically require more than the simple purchase and installation of an alternative lamp Restrictions regarding ballasts, fixtures, and circuitry limit the potential for direct substitution of one lamp type for another. Also, during the build out for a leased office space, management could decide

End Use	Technology	Measure Description
		to replace all lamps, ballasts, and fixtures with different configurations. This type of decision-making is modeled on a stock turnover basis because of the time between opportunities for upgrades. For High-Bay fixtures, alternatives include mercury vapor, metal halides, T5 fluorescent high output, and high-pressure sodium.
Interior Lighting	Linear Fluorescent	With the exception of screw-in lighting, commercial and industrial lighting efficiency changes typically require more than the simple purchase and installation of an alternative lamp. Restrictions regarding ballasts, fixtures, and circuitry limit the potential for direct substitution of one lamp type for another. Also, during the build out for a leased office space, management could decide to replace all lamps, ballasts, and fixtures with different configurations. This type of decision-making is modeled on a stock turnover basis because of the time between opportunities for upgrades. For linear fluorescent fixtures, alternatives include T12, T8, Super T8, T5, and LED.
Exterior Lighting	Screw-in	This measure evaluates higher-efficiency alternatives for screw-in interior lamps including halogen, CFL, and LED.
Exterior Lighting	HID	Alternatives modeled include metal halides, T8 and T5 high output, high pressure sodium, and LEDs
Exterior Lighting	Linear Fluorescent	For linear fluorescent fixtures, alternatives include T12, T8, Super T8, T5, and LED.
Refrigeration	Walk-in Refrigerator	These refrigerators can be designed to perform at higher efficiency through a combination of compressor equipment upgrades, default temperature settings, and defrost patterns. Standard refrigeration compressors typically operate at approximately 65% efficiency. High-efficiency models are available that can improve compressor efficiency by 15%. Analysis assumes unit with: 140 square feet, Cooling capacity of 26,230 BTU/hr.
Refrigeration	Reach-in Refrigerator	A significant amount of energy in the commercial sector can be attributed to "reach-in" units. These stand-alone appliances can range from a residential-style refrigerator/freezer unit in an office kitchen or the breakroom of a retail store, to the larger reach-in units in foodservice applications. As in the case of residential units, these refrigerators can be designed to perform at higher efficiency through a combination of compressor equipment upgrades, default temperature settings, and defrost patterns. Analysis assumes unit with: 48 cubic feet, Cooling capacity of 3000 BTU/hr.
Refrigeration	Glass Door Display, Open Display Case	These refrigerators can be designed to perform at higher efficiency through a combination of compressor equipment upgrades, default temperature settings, and defrost patterns. Standard refrigeration compressors typically operate at approximately 65% efficiency. High-efficiency models are available that can improve compressor efficiency by 15%. Analysis assumes unit with: Cooling capacity of 20,000 BTU/hr
Refrigeration	Icemaker	By optimizing the timing of ice production and the type of output to the specific application, icemakers are assumed to deliver electricity savings.
Refrigeration	Vending Machine	High-efficiency vending machines incorporate more efficient compressors and lighting.
Food Preparation	Ovens, Fryers, Hot Food Containers, Dishwashers	This set of measures includes high-efficiency fryers, ovens, dishwashers, and hot food containers. Less common equipment, such as broilers and steamers, and assumed to be modeled with the other more common equipment types.
Office Equip.	Desktop Computer, Laptop, Monitors	ENERGY STAR labeled computers automatically power down to 15 watts or less when not in use and may actually last longer than conventional products because they spend a large portion of time in a low-power sleep mode. ENERGY STAR labeled computers also generate less heat than conventional models.
Office Equip.	Server	In addition to the "sleep" mode a reductions, servers have additional energy-saving opportunities through "virtualization" and other architecture solutions that involve optimal matching of computation tasks to hardware requirements

End Use	Technology	Measure Description
Office Equip.	Printer/Copier/Fax	ENERGY STAR labeled Office Equip. saves energy by powering down and "going to sleep" when not in use. ENERGY STAR labeled copiers are equipped with a feature that allows them to automatically turn off after a period of inactivity.
Office Equip.	POS Terminal	Point-of-sale terminals in retail and supermarket facilities are always on. Efficient models incorporate a high-efficiency power supply to reduce energy use.
Miscellaneous	Non-HVAC Motors	Includes motors for a variety of non-HVAC uses including vertical transportation. Premium efficiency motors can provide savings of 0.5% to 3% over standard motors. The savings results from the fact that energy efficient motors run cooler than their standard counterparts, resulting in an increase in the life of the motor insulation and bearing. In general, an efficient motor is a more reliable motor because there are fewer winding failures, longer periods between needed maintenance, and fewer forced outages. For example, using copper instead of aluminum in the windings, and increasing conductor cross-sectional area, lowers a motor's I2R losses.
Miscellaneous	Pool Pump	High-efficiency motors and two-speed pumps provide improved energy efficiency for this load.
Miscellaneous	Pool Heater	Efficient pool heaters can make use of heat pump technology to achieve significantly higher coefficients of performance in the COP=5.0 range.

Table C-2 Commercial Energy Efficiency Non-Equipment Measure Descriptions

End Use	Measure	Description
HVAC (All)	Insulation - Ceiling	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation can conserve energy by reducing the heat loss or gain of a building. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose; loose-fill (blown) fiberglass; and rigid polystyrene.
HVAC (All)	Insulation - Ducting	Air distribution ducts can be insulated to reduce heating or cooling losses. Best results can be achieved by covering the entire surface area with insulation. Insulation material inhibits the transfer of heat through the air-supply duct. Several types of ducts and duct insulation are available, including flexible duct, pre-insulated duct, duct board, duct wrap, tacked, or glued rigid insulation, and waterproof hard shell materials for exterior ducts.
HVAC (All)	Insulation – Foundation	Below Grade Insulation to R6
HVAC (All)	Insulation – Wall Cavity	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation can conserve energy by reducing the heat loss or gain of a building. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose; loose-fill (blown) fiberglass; and rigid polystyrene.
HVAC (All)	HVAC – Duct Repair and Sealing	Leakage in unsealed ducts varies considerably because of the differences in fabricating machinery used, the methods for assembly, installation workmanship, and age of the ductwork. Air leaks from the system to the outdoors result in a direct loss proportional to the amount of leakage and the difference in enthalpy between the outdoor air and the conditioned air. To seal ducts, a wide variety of sealing methods and products exist. Each has a relatively short shelf life, and no documented research has identified the aging characteristics of sealant applications.

End Use	Measure	Description
HVAC (All)	Doors - High Efficiency	Like other components of the shell, doors are subject to several types of heat loss: conduction, infiltration, and radiant losses. High efficiency doors have exceptional thermal insulation properties and tight-fitting, weather-stripping on the doorframe to reduce air leakage.
HVAC (All)	Windows - High Efficiency	High-efficiency windows, such as those labeled under the ENERGY STAR Program, are designed to reduce a building's energy bill while increasing comfort for the occupants at the same time. High-efficiency windows have reducing properties that reduce the amount of heat transfer through the glazing surface. For example, some windows have a low-E coating, which is a thin film of metallic oxide coating on the glass surface that allows passage of short-wave solar energy through glass and prevents long-wave energy from escaping. Another example is double-pane glass that reduces conductive and convective heat transfer. There are also double-pane glasses that are gas-filled (usually argon) to further increase the insulating properties of the window.
HVAC (All)	Roof - Reroofing	The color and material of a building structure surface will determine the amount of solar radiation absorbed by that surface and subsequently transferred into a building. This is called solar absorptance. By using a living roof or a roofing material with a light color (and a lower solar absorptance), the roof will absorb less solar radiation and consequently reduce the cooling load. Living roofs also reduce stormwater runoff.
Cooling	Chiller - Condenser Water Temperature Reset	Resetting the condenser water temperature to the lowest possible setting allows the cooling tower to generate cooler water whenever possible and decreases the temperature lift between the condenser and the evaporator. This will generally increase chiller part-load efficiency, though it may require increased tower fan energy use.
Cooling	Chiller - Economizer	Economizers allow outside air (when it is cool and dry enough) to be brought into the building space to meet cooling loads instead of using mechanically cooled interior air. A dual enthalpy economizer consists of indoor and outdoor temperature and humidity sensors, dampers, motors, and motor controls. Economizers are most applicable to temperate climates and savings will be smaller in extremely hot or humid areas.
Cooling	Chiller - VSD on Fans	Variable speed drives, which reduce chiller energy use under part load, are modeled for both air-cooled and water-cooled chillers.
Cooling	Chiller - Chilled Water Reset	Chilled water reset controls save energy by improving chiller performance through increasing the supply chilled water temperature, which allows increased suction pressure during low load periods. Raising the chilled water temperature also reduces chilled water piping losses. However, the primary savings from the chilled water reset measure results from chiller efficiency improvement. This is due partly to the smaller temperature difference between chilled water and ambient air, and partly due to the sensitivity of chiller performance to suction temperature.
Cooling	Chiller - Chilled Water Variable-Flow	Part-load efficiency of chilled water loops can be improved by varying the flow speed of the delivered water with the building demand for cooling.
Cooling	Chiller - High Efficiency Cooling Tower Fans	High-efficiency cooling fans utilize efficient components and variable frequency drives that improve fan performance by adjusting fan speed and rotation as conditions change.
Water Heating	Chiller – Chiller Heat Recovery	Capturing the waste heat from the cooling tower of a chiller by means of a heat exchanger in order to meet water heating loads.
Cooling	RTU - Maintenance	Regular cleaning and maintenance enables a roof top unit to function effectively and efficiently throughout its years of service. Neglecting necessary maintenance leads to a steady decline in performance while energy use increases. Maintenance can increase the efficiency of poorly performing equipment by as much as 10%.
Heating	Space Heating – Heat Recovery Ventilator	Heat recovery ventilation uses a counter-flow, air-to-air heat exchanger between inbound and outbound air to reduce space heating loads.

End Use	Measure	Description
Cooling / Heating	Heat Pump - Maintenance	Regular cleaning and maintenance enables a heat pump to function effectively and efficiently throughout its years of service. Neglecting necessary maintenance leads to a steady decline in performance while energy use increases. Maintenance can increase the efficiency of poorly performing equipment by as much as 10%.
Ventilation	Ventilation - ECM on VAV Boxes	ECM motors are well suited to the variable flow rates of VAV boxes. ECMs are a higher efficiency option for the air blowers and maintain efficiency better over a wide range of loads.
Ventilation	Ventilation - Variable Speed Control	Variable speed controls adjust ventilation fans for part-load conditions to reduce energy use.
Ventilation	Ventilation- CO2 Controlled	Carbon dioxide (CO2) levels indicate the level of occupancy in a space. This measure uses sensors to monitor CO2 levels and controls on the air handling system to adjust the amount of outside air accordingly. Ventilation rates are thereby controlled based on occupancy, rather than a fixed rate, thus saving HVAC energy use.
Ventilation	Fans - Energy-Efficient Motors	High-efficiency motors are essentially interchangeable with standard motors, but differences in construction make them more efficient. Energy-efficient motors achieve their improved efficiency by reducing the losses that occur in the conversion of electrical energy to mechanical energy. This analysis assumes that the efficiency of supply fans is increased by 5% due to installing energy-efficient motors.
Ventilation	Fans - Variable Speed Control	The part-load efficiency of ventilation fans can be improved substantially by varying the speed of the motor drive. There are two major types of variable speed controls: mechanical and electronic. An additional benefit of variable-speed controls is the ability to start and stop the motor gradually, thus extending the life of the motor and associated machinery. This analysis assumes that electronic variable speed controls are installed.
Water Heating	Water Heater - Faucet Aerators/Low Flow Nozzles	A faucet aerator or low flow nozzle spreads the stream from a faucet helping to reduce water usage. The amount of water passing through the aerator is measured in gallons per minute (GPM) and the lower the GPM the more water the aerator conserves.
Water Heating	Water Heater - High Efficiency Circulation Pump	A high efficiency circulation pump uses an electronically commutated motor (ECM) to improve motor efficiency over a larger range of partial loads. In addition, an ECM allows for improved low RPM performance with greater torque and smaller pump dimensions.
Water Heating	Water Heater - Solar System	Solar water heating systems can be used in residential buildings that have an appropriate near-south-facing roof or nearby unshaded grounds for installing a collector. Although system types vary, in general these systems use a solar absorber surface within a solar collector or an actual storage tank. Either a heat-transfer fluid or the actual potable water flows through tubes attached to the absorber and transfers heat from it. (Systems with a separate heat-transfer-fluid loop include a heat exchanger that then heats the potable water.) The heated water is stored in a separate preheat tank or a conventional water heater tank. If additional heat is needed, it is provided by a conventional water-heating system.
Water Heating	Water Heater - Install Timer	These measures use either a programmable thermostat or a timer to adjust the water heater setpoint at times of low usage, typically when a home is unoccupied.
Water Heating	Water Heater - Pipe Insulation	Insulating hot water pipes decreases the amount of energy lost during distribution of hot water throughout the building. Insulating pipes will result in quicker delivery of hot water and allows lowering the water heating set point. There are several different types of insulation, the most common being polyethylene and neoprene.
HVAC (All)	New Construction - Top Daylighting with Skylights	Addition of transparent windows/fixtures in the roof to allow daylight to enter and reduce the need for powered lighting. Applies to new construction only.

End Use	Measure	Description
Interior Lighting	Interior Lighting - Daylighting Controls	Daylighting controls use a photosensor to detect ambient light and adjust or turn off electric lights accordingly.
Interior Lighting	Interior Lighting - LED Exit Lighting	The lamps inside exit signs represent a significant energy end-use, since they usually operate 24 hours per day. Many old exit signs use incandescent lamps, which consume approximately 40 watts per sign. The incandescent lamps can be replaced with LED lamps that are specially designed for this specific purpose. In comparison, the LED lamps consume approximately 2-5 watts.
Interior Lighting	Interior Lighting - Occupancy Sensors	The installation of occupancy sensors allows lights to be turned off during periods when a space is unoccupied, virtually eliminating the wasted energy due to lights being left on. There are several types of occupancy sensors in the market.
Interior Lighting	Interior Lighting - Timeclocks and Timers	In many cases lighting remains on at night and during weekends. A simple timer can set a schedule for turning lights off to reduce operating hours.
Interior Lighting	Interior Lighting - Task Lighting	Individual work areas can use task lighting instead of brightly lighting the entire area. Significant energy savings can be realized by focusing light directly where it is needed and lowering the general lighting level. An example of task lighting is the common desk lamp. A 25W desk lamp can be installed in place of a typical lamp in a fixture.
Interior Lighting	Interior Fluorescent - Bi-Level Fixture	Bi-level fixtures have the ability to reduce light output to a lower level, given a control strategy that is based on a timer, occupancy sensor, motion sensor, or manual switch.
Interior Lighting	Interior Fluorescent - Photocell-Controlled Dimming Ballasts	Photocells, in concert with dimming ballasts, can detect when adequate daylighting is available and dim or turn off lights to reduce electricity consumption. Usually one photocell is used to control a group of fixtures, a zone, or a circuit.
Exterior Lighting	Exterior Lighting - Bi-Level Fixture	Bi-level fixtures have the ability to reduce light output to a lower level, given a control strategy that is based on a timer, occupancy sensor, motion sensor, or manual switch.
Exterior Lighting	Exterior Lighting - Daylighting Controls	Daylighting controls use a photosensor to detect ambient light and adjust or turn off electric lights accordingly.
Refrigeration	Refrigerator - Anti-Sweat Heater/ Auto Door Closer	Anti-sweat heaters are used in virtually all low-temperature display cases and many medium-temperature cases to control humidity and prevent the condensation of water vapor on the sides and doors and on the products contained in the cases. Typically, these heaters stay on all the time, even though they only need to be on about half the time. Anti-sweat heater controls can come in the form of humidity sensors or time clocks.
Refrigeration	Refrigerator - Decommissioning	Early retirement, removal, and recycling or older, little used refrigerators and freezers removes the energy use of these inefficient, aging units.
Refrigeration	Refrigerator - Demand Defrost	Units can be designed to perform at higher efficiency with a sensing and control system that runs defrost cycles based on demand/only when necessary.
Refrigeration	Refrigerator - Door Gasket Replacement	This measure involves replacing aging door gaskets that no longer adequately seal reach-in refrigerators or glass door display cases.
Refrigeration	Refrigerator - Evaporator Fan Controls	Evaporator fan motor controls allow for part load use or demand scheduling based on variable refrigeration load requirements, reducing energy consumption.
Refrigeration	Refrigeration- High Efficiency Evaporator Fan Motors	Electronically commutated motors (ECM) operate at variable speeds.
Refrigeration	Refrigerator - Floating Head Pressure	Floating head pressure control allows the pressure in the condenser to "float" with ambient temperatures. This method reduces refrigeration compression ratios, improves system efficiency and extends the compressor life. The greatest savings with a floating head pressure approach occurs when the ambient temperatures are low, such as in the winter season. Floating head pressure control is most practical for new installations. However, retrofits

End Use	Measure	Description
		installation can be completed with some existing refrigeration systems. Installing floating head pressure control increases the capacity of the compressor when temperatures are low, which may lead to short cycling.
Refrigeration	Refrigerator - Strip Curtain	Strip curtains at the entrances to large walk-in coolers or freezers, such as those used in supermarkets; reduce air transfer between the refrigerated space and the surrounding space.
Refrigeration	Refrigerator - High Efficiency Compressor	Standard compressors typically operate at approximately 65% efficiency. High-efficiency models are available that can improve compressor efficiency by 15%.
Refrigeration	Refrigerator - Variable Speed Compressor	The part-load efficiency of drive systems can be improved by varying the speed of the motor drive. An additional benefit of variable-speed controls is the ability to start and stop the motor and process gradually, thus extending the life of the motor and associated machinery.
Refrigeration	Refrigerator - eCube	The eCube consists of a solid, waxy food simulant that is fitted around a thermostat sensor that would otherwise measure air temperature. The refrigeration controls therefore attempt to regulate the temperature of food, which changes more slowly and gradually than air, thereby reducing the frequency of refrigeration cycles.
Refrigeration	Vending Machine - Controller	Cold beverage vending machines usually operate 24 hours a day regardless of whether the surrounding area is occupied or not. The result is that the vending machine consumes energy unnecessarily, because it will operate all night to keep the beverage cold even when there would be no customers until the next morning. A vending machine controller can reduce energy consumption without compromising the temperature of the vended product. The controller uses an infrared sensor to monitor the surrounding area's occupancy and will power down the vending machine when the area is unoccupied. It will also monitor the room's temperature and will re-power the machine at one to three hour intervals independent of occupancy to ensure that the product stays cold.
Refrigeration	Grocery- Display Case- LED Lighting	High-efficiency LED display case lighting not only reduces direct lighting energy use, but also reduce internal heat gains to the case from lights that must be removed by the refrigeration system.
Refrigeration	Grocery- Display Case Motion Sensors	Motion sensors reduce lighting load when area around display case is unoccupied to save energy on lighting.
Refrigeration	Grocery- ECM's for Display Cases	Replacement of shaded-pole evaporator fan motors with ECM motors in display cases allows for variable refrigeration loads to be handled. Reductions come from increased motor efficiency and the reduction of heating load.
Refrigeration	Grocery- Open Display Case- Night Covers	Night covers can be used on open refrigeration cases when a facility is closed or few customers are in the store.
Food Preparation	Cooking Exhaust Hoods with Sensor Control	Improved exhaust hoods involve installing variable-speed controls on commercial kitchen hoods. These controls provide ventilation based on actual cooking loads. When grills, broilers, stoves, fryers or other kitchen appliances are not being used, the controls automatically sense the reduced load and decrease the fan speed accordingly. This results in lower energy consumption because the system is only running as needed rather than at 100% capacity at all times.
Office Equip.	Office Equip. - Plug Load Occupancy Sensors	Occupancy sensors can control power strips and thus turn off energy used by plug loads, such as task lights, when an office is unoccupied.
Office Equip.	Electronics - Smart Power Strips	This measure relates to Controlled Power Strips (or Smart Strips) which are multi-plug power strips with the ability to automatically disconnect specific connected loads depending upon the power draw of a control load, also plugged into the strip. Power is disconnected from the switched (controlled) outlets when the control load power draw is reduced below a certain adjustable threshold, thus turning off the appliances plugged into the switched outlets. By disconnecting, the standby load of the controlled devices, the

End Use	Measure	Description
		overall load of a centralized group of equipment (i.e. entertainment centers and home office) can be reduced. Uncontrolled outlets are also provided that are not affected by the control device and so are always providing power to any device plugged into it.
Miscellaneous	Pool Pump - Timer	A pool pump timer allows the pump to turn off automatically, eliminating the wasted energy associated with unnecessary pumping.
Miscellaneous	Non-HVAC Motors - Variable Speed Control	The part-load efficiency of motors can be improved by varying the speed of the motor drive. There are two major types of variable speed controls: mechanical and electronic. An additional benefit of variable-speed controls is the ability to start and stop the motor gradually, thus extending the life of the motor and associated machinery. This analysis assumes that electronic variable speed controls are installed.
HVAC (All)	Energy Management System	An energy management system (EMS) allows managers/owners to monitor and control the major energy-consuming systems within a commercial building. At the minimum, the EMS can be used to monitor and record energy consumption of the different end-uses in a building, and can control operation schedules of the HVAC and lighting systems. The monitoring function helps building managers/owners to identify systems that are operating inefficiently so that actions can be taken to correct the problem. The EMS can also provide preventive maintenance scheduling that will reduce the cost of operations and maintenance in the long run. The control functionality of the EMS allows the building manager/owner to operate building systems from one central location. The operation schedules set via the EMS help to prevent building systems from operating during unwanted or unoccupied periods. This analysis assumes that this measure is limited to buildings with a central HVAC system.
HVAC (All)	Thermostat - Clock/Programmable	A programmable thermostat can be added to most heating/cooling systems. They are typically used during winter to lower temperatures at night and in summer to increase temperatures during the afternoon. There are two-setting models, and well as models that allow separate programming for each day of the week. The energy savings from this type of thermostat are identical to those of a "setback" strategy with standard thermostats, but the convenience of a programmable thermostat makes it a much more attractive option. In this analysis, the baseline is assumed to have no thermostat setback.
HVAC, Lighting	HVAC - Occupancy Sensors	Occupancy sensors turn off or adjust HVAC settings when a space is unoccupied.
HVAC, Lighting	Retrocommissioning	In existing buildings, the retrocommissioning process identifies low-cost or no cost measures, including controls adjustments, to improve building performance and reduce operating costs. Retrocommissioning addresses HVAC, lighting, DHW, and other major building systems.
HVAC (All)	Advanced New Construction Designs	Advanced new construction designs use an integrated approach to the design of new buildings to account for the interaction of building systems. Designs may specify the building orientation, building shell, proper sizing of equipment and systems, and controls strategies with the goal of optimizing building energy efficiency and comfort. Options that may be evaluated and incorporated include passive solar strategies, increased thermal mass, natural ventilation, energy recovery ventilation, daylighting strategies, and shading strategies. This measure is modeled for new vintage only.
HVAC (All)	Strategic Energy Management	Strategic Energy Management is a systematic approach to integrating energy management into an organization's business practices and creating lasting energy management processes that produce reliable energy savings.
HVAC	Pumps - High-Efficiency Motors	High-efficiency motors are essentially interchangeable with standard motors, but differences in construction make them more efficient. Energy-efficient motors achieve their improved efficiency by reducing the losses that occur in the conversion of electrical energy to mechanical energy. This analysis assumes that the efficiency of pumps is increased by 5% due to installing energy-efficient motors.

End Use	Measure	Description
HVAC, Miscellaneous	Pumps - Variable Speed Control	The part-load efficiency of chilled water / hot water loop pumps can be improved substantially by varying the speed of the motor drive according to the building demand for heating or cooling. This measure also reduces piping losses. However, pump speeds can generally only be reduced to a minimum specified rate, because chillers, boilers, and control valves may require a minimum flow rate to operate. Two major types of variable speed drives are mechanical and electronic. An additional benefit of variable-speed drives is the ability to start and stop the motor gradually, thus extending the life of the motor and associated machinery. This analysis assumes that electronic variable speed drives are installed.

INDUSTRIAL ENERGY EFFICIENCY EQUIPMENT AND MEASURE DATA

This appendix presents detailed information for all commercial energy-efficiency measures (*equipment* and *non-equipment* measures per the LoadMAP taxonomy) that were evaluated in this study.

Measure Descriptions

Table D-1 and Table D-2 provide brief narrative descriptions for all equipment and non-equipment measures that were assessed for potential.

Equipment Measure Data

The attached file, *Appendix D Industrial Equipment Tables.xlsx*, lists the detailed unit-level data (including economic screen results) for industrial equipment measures in existing and new facilities. Savings are in annual kWh per employee, and incremental costs are in 2012$/employee, unless noted otherwise. For the baseline technology in each case, these values are by definition equal to zero. The BC ratio shown in the tables are for the first year of the potential analysis (2014), although the B/C ratio is calculated within LoadMAP for each year of the forecast. The B/C ratio in the tables is 1.00 if the measure represents the baseline technology, and zero if the technology is not available in 2014. The final data item in these tables is the levelized cost of conserved energy, which is defined as the cost of the measure divided by the cumulative amount of energy savings accrued over the measure's lifetime (2012$/kWh). In the case that the efficient measure is less costly than the baseline, this value is shown as zero, rather than a negative value.

Equipment Measure Data

The attached file, *Appendix D Industrial Non-Equipment Tables.xlsx*, lists the detailed unit-level data (including economic screen results) for industrial non-equipment measures in existing and new construction. Savings are in annual kWh per employee, and incremental costs are in 2012$/employee, unless noted otherwise. For the baseline technology in each case, these values are by definition equal to zero. The BC ratio shown in the tables are for the first year of the potential analysis (2014), although the B/C ratio is calculated within LoadMAP for each year of the forecast. The B/C ratio in the tables is 1.00 if the measure represents the baseline technology, and zero if the technology is not available in 2014. The final data item in these tables is the levelized cost of conserved energy, which is defined as the cost of the measure divided by the cumulative amount of energy savings accrued over the measure's lifetime (2012$/kWh). In the case that the efficient measure is less costly than the baseline, this value is shown as zero, rather than a negative value.

Table D-1 Industrial Energy Efficiency Equipment Measure Descriptions

End Use	Technology	Measure Description
Cooling	Air-Cooled Chiller	A central chiller plant creates chilled water for distribution throughout the facility. Because of the wide variety of system types and sizes, savings and cost values for efficiency improvements represent an average over screw, reciprocating, and centrifugal technologies. Under this simplified approach, each central system is characterized by an aggregate efficiency value (inclusive of chiller, pumps, and motors), in kW/ton with a further efficiency upgrade through the application of variable refrigerant flow technology.
Cooling	Water-Cooled Chiller	A central chiller plant creates chilled water for distribution throughout the facility. Water source chillers include heat rejection via a condenser loop and cooling tower. Because of the wide variety of system types and sizes, savings and cost values for efficiency improvements represent an average over screw, reciprocating, and centrifugal technologies. Under this simplified approach, each central system is characterized by an aggregate efficiency value (inclusive of chiller, pumps, motors, and condenser loop equipment), in kW/ton with a further efficiency upgrade through the application of variable refrigerant flow technology.
Cooling	RTU	Rooftop units are simple to install and maintain, and are commonly used in small and medium-sized commercial buildings. Applications range from a single supply system with air intake filters, supply fan, and cooling coil, or can become more complex with the addition of a return air duct, return air fan, and various controls to optimize performance. For packaged RTUs, varying Energy Efficiency Ratios (EER) are modeled, as well as a ductless mini-split system.
Cooling / Heating	Air-Source Heat Pump	For heat pumps, units with increasing EER and COP levels are evaluated, as well as a ductless mini-split system.
Heating	Electric Resistance	Resistive heating elements are used to convert electricity directly to heat. Conductive fins surrounding the element or another mechanism is used to deliver the heat directly to the surrounding room or area. These are typically either baseboard or wall-mounted units.
Ventilation	Ventilation	A variable air volume ventilation system modulates the air flow rate as needed based on the interior conditions of the building to reduce fan load, improve dehumidification, and reduce energy usage.
Interior Lighting	Screw-in	This measure evaluates higher-efficiency alternatives for screw-in interior lamps including halogen, CFL, and LED.
Interior Lighting	High-Bay Fixtures	With the exception of screw-in lighting, commercial and industrial lighting efficiency changes require more than the simple purchase and installation of an alternative lamp. Restrictions regarding ballasts, fixtures, and circuitry limit the potential for direct substitution of one lamp type for another. During the build out for a leased office space, management could decide to replace all lamps, ballasts, and fixtures with different configurations. This type of decision-making is modeled on a stock turnover basis because of the time between opportunities for upgrades. For High-Bay fixtures, alternatives include mercury vapor, metal halides, T5 fluorescent high output, and high-pressure sodium.
Interior Lighting	Linear Fluorescent	With the exception of screw-in lighting, commercial and industrial lighting efficiency changes typically require more than the simple purchase and installation of an alternative lamp. Restrictions regarding ballasts, fixtures, and circuitry limit the potential for direct substitution of one lamp type for another. Also, during the build out for a leased office space, management could decide to replace all lamps, ballasts, and fixtures with different configurations. This type of decision-making is modeled on a stock turnover basis because of the time between opportunities for upgrades. For linear fluorescent fixtures, alternatives include T12, T8, Super T8, T5, and LED.
Exterior Lighting	Screw-in	This measure evaluates higher-efficiency alternatives for screw-in interior lamps including halogen, CFL, and LED.
Exterior Lighting	HID	Alternatives modeled include metal halides, T8 and T5 high output, high pressure sodium, and LEDs

End Use	Technology	Measure Description
Exterior Lighting	Linear Fluorescent	For linear fluorescent fixtures, alternatives include T12, T8, Super T8, T5, and LED.
Process	Process Electrochemical	Electrochemical processes deal with chemical reactions in solution driven by electricity applied at a cathode and anode.
Process	Other Process	This category is a "catch all" for the many unique process applications in the broader industrial sector.
Process	Process Cooling	Industrial process where cooling is applied
Process	Process Refrigeration	Industrial refrigeration process
Process	Process Heating	Industrial process where heating is applied
Motors	Pumps, Fans & Blowers, Compressed Air, Conveyors, Other Motors	Premium efficiency motors reduce the amount of lost energy going into heat rather than power. Since less heat is generated, less energy is needed to cool the motor with a fan. The initial cost of energy efficient motors is generally higher than for standard motors, however their life-cycle costs can make them far more economical because of savings they generate in operating expense. The fact that energy efficient motors run cooler than their standard counterparts also results in an increase in the life of the motor insulation and bearing. High efficiency units use copper instead of aluminum in the windings and increased conductor cross-sectional area to lower a motor's I2R losses.

Table D-2 Industrial Energy Efficiency Non-Equipment Measure Descriptions

End Use	Measure	Description
HVAC (All)	Insulation - Ceiling	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation can conserve energy by reducing the heat loss or gain of a building. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose; loose-fill (blown) fiberglass; and rigid polystyrene.
HVAC (All)	Insulation - Ducting	Air distribution ducts can be insulated to reduce heating or cooling losses. Best results can be achieved by covering the entire surface area with insulation. Insulation material inhibits the transfer of heat through the air-supply duct. Several types of ducts and duct insulation are available, including flexible duct, pre-insulated duct, duct board, duct wrap, tacked, or glued rigid insulation, and waterproof hard shell materials for exterior ducts.
HVAC (All)	Insulation - Wall Cavity	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation can conserve energy by reducing the heat loss or gain of a building. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose; loose-fill (blown) fiberglass; and rigid polystyrene.
HVAC (All)	HVAC - Duct Repair and Sealing	Leakage in unsealed ducts varies considerably because of the differences in fabricating machinery used, the methods for assembly, installation workmanship, and age of the ductwork. Air leaks from the system to the outdoors result in a direct loss proportional to the amount of leakage and the difference in enthalpy between the outdoor air and the conditioned air. To seal ducts, a wide variety of sealing methods and products exist. Each has a relatively short shelf life, and no documented research has identified the aging characteristics of sealant applications.
Cooling	Chiller - Condenser Water Temperature Reset	Resetting the condenser water temperature to the lowest possible setting allows the cooling tower to generate cooler water whenever possible and decreases the temperature lift between the condenser and the evaporator. This will generally increase chiller part-load efficiency, though it may require increased tower fan energy use.
Cooling	Chiller - Economizer	Economizers allow outside air (when it is cool and dry enough) to be brought into the building space to meet cooling loads instead of using mechanically cooled interior air. A dual enthalpy economizer consists of indoor and outdoor temperature and humidity sensors, dampers, motors, and motor controls. Economizers are most applicable to temperate climates and savings will be smaller in extremely hot or humid areas.
Cooling	Chiller - VSD on Fans	Variable speed drives, which reduce chiller energy use under part load, are modeled for both air-cooled and water-cooled chillers.
Cooling	Chiller - Chilled Water Reset	Chilled water reset controls save energy by improving chiller performance through increasing the supply chilled water temperature, which allows increased suction pressure during low load periods. Raising the chilled water temperature also reduces chilled water piping losses. However, the primary savings from the chilled water reset measure results from chiller efficiency improvement. This is due partly to the smaller temperature difference between chilled water and ambient air, and partly due to the sensitivity of chiller performance to suction temperature.
Cooling	Chiller - Chilled Water Variable-Flow System	The part-load efficiency of chilled water loops can be improved substantially by varying the flow speed of the delivered water with the building demand for cooling.
Cooling	Chiller - High Efficiency Cooling Tower Fans	High-efficiency cooling fans utilize efficient components and variable frequency drives that improve fan performance by adjusting fan speed and rotation as conditions change.
Cooling	Chiller - Condenser Water Temperature	Resetting the condenser water temperature to the lowest possible setting allows the cooling tower to generate cooler water whenever possible and

End Use	Measure	Description
	Reset	decreases the temperature lift between the condenser and the evaporator. This will generally increase chiller part-load efficiency, though it may require increased tower fan energy use.
Cooling	Chiller - Efficient Mechanical Layout	Improvements to layout and placement of chiller equipment, for example to enable unobstructed access to cooling tower airflow or minimize the length of refrigerant run between cooling tower and chiller head unit.
Cooling	Chiller - Maintenance	Filters, coils, and fins require regular cleaning and maintenance for the heat pump or roof top unit to function effectively and efficiently throughout its years of service. Neglecting necessary maintenance leads to a steady decline in performance while energy use increases.
Cooling	RTU - Maintenance	Regular cleaning and maintenance enables a roof top unit to function effectively and efficiently throughout its years of service. Neglecting necessary maintenance leads to a steady decline in performance while energy use increases. Maintenance can increase the efficiency of poorly performing equipment by as much as 10%.
Cooling / Heating	Heat Pump - Maintenance	Regular cleaning and maintenance enables a heat pump to function effectively and efficiently throughout its years of service. Neglecting necessary maintenance leads to a steady decline in performance while energy use increases. Maintenance can increase the efficiency of poorly performing equipment by as much as 10%.
HVAC, Lighting	Retrocommissioning – HVAC and Lighting	In existing buildings, the retrocommissioning process identifies low-cost or no cost measures, including controls adjustments, to improve building performance and reduce operating costs. Retrocommissioning addresses HVAC, lighting, DHW, and other major building systems.
HVAC	Destratification Fans (HVLS)	High volume low-speed (HVLS) ceiling fans are large (8-ft. to 20-ft. in diameter). They will effectively mix and circulate air within a given space to equalize temperature between ceiling and floor levels.
HVAC, Lighting	Energy Management System	An energy management system (EMS) allows managers/owners to monitor and control the major energy-consuming systems within a commercial building. At the minimum, the EMS can be used to monitor and record energy consumption of the different end-uses in a building, and can control operation schedules of the HVAC and lighting systems. The monitoring function helps building managers/owners to identify systems that are operating inefficiently so that actions can be taken to correct the problem. The EMS can also provide preventive maintenance scheduling that will reduce the cost of operations and maintenance in the long run. The control functionality of the EMS allows the building manager/owner to operate building systems from one central location. The operation schedules set via the EMS help to prevent building systems from operating during unwanted or unoccupied periods. This analysis assumes that this measure is limited to buildings with a central HVAC system.
HVAC	Thermostat - Clock/Programmable	A programmable thermostat can be added to most heating/cooling systems. They are typically used during winter to lower temperatures at night and in summer to increase temperatures during the afternoon. There are two-setting models, and well as models that allow separate programming for each day of the week. The energy savings from this type of thermostat are identical to those of a "setback" strategy with standard thermostats, but the convenience of a programmable thermostat makes it a much more attractive option. In this analysis, the baseline is assumed to have no thermostat setback.
Interior Lighting	LED Exit Lighting	The lamps inside exit signs represent a significant energy end-use, since they usually operate 24 hours per day. Many old exit signs use incandescent lamps, which consume approximately 40 watts per sign. The incandescent lamps can be replaced with LED lamps that are specially designed for this specific purpose. In comparison, the LED lamps consume approximately 2-5 watts.
Interior Lighting	Interior Lighting - Occupancy Sensors	The installation of occupancy sensors allows lights to be turned off during periods when a space is unoccupied, virtually eliminating the wasted energy due to lights being left on. There are several types of occupancy sensors in the

End Use	Measure	Description
		market.
Interior Lighting	Interior Lighting - Timeclocks and Timers	In many cases lighting remains on at night and during weekends. A simple timer can set a schedule for turning lights off to reduce operating hours.
Interior Lighting	Interior Screw-in - Task Lighting	Individual work areas can use task lighting instead of brightly lighting the entire area. Significant energy savings can be realized by focusing light directly where it is needed and lowering the general lighting level. An example of task lighting is the common desk lamp. A 25W desk lamp can be installed in place of a typical lamp in a fixture.
Interior Lighting	Interior Lighting - Skylights	Addition of transparent windows/fixtures in the roof to allow daylight to enter and reduce the need for powered lighting. Applies to new construction only.
Interior Lighting	Interior Fluorescent - Bi-Level Fixture	Bi-level fixtures have the ability to reduce light output to a lower level, given a control strategy that is based on a timer, occupancy sensor, motion sensor, or manual switch.
Exterior Lighting	Exterior Lighting - Daylighting Controls	Daylighting controls use a photosensor to detect ambient light and adjust or turn off electric lights accordingly.
Exterior Lighting	Exterior Lighting - Bi-Level Fixture	Bi-level fixtures have the ability to reduce light output to a lower level, given a control strategy that is based on a timer, occupancy sensor, motion sensor, or manual switch.
Process	Process - Conductivity Controls	Automated control of conductivity levels in a process solution, for example by variably injecting CO2 into a stream of rinse water, can maintain an optimal solution that increases process effectiveness, decreases impurities, reduces scaling or corrosion, and minimizes required rinse time.
Process	Process - Controls on Fume Hoods	Improved fume hoods involve installing sensors and variable-speed controls to provide ventilation based on actual demand. When the relevant equipment or process is not active, the controls automatically decrease the fan speed accordingly.
Process	Process - Timers and Controls	Significant energy savings can frequently be attained from processes by adding a timer or altering their control algorithms.
Process	Refrigeration - Floating Head Pressure	Floating head pressure control allows the pressure in the condenser to "float" with ambient temperatures. This method reduces refrigeration compression ratios, improves system efficiency and extends the compressor life. The greatest savings with a floating head pressure approach occurs when the ambient temperatures are low, such as in the winter season. Floating head pressure control is most practical for new installations. However, retrofits installation can be completed with some existing refrigeration systems. Installing floating head pressure control increases the capacity of the compressor when temperatures are low, which may lead to short cycling.
Process	Refrigerated Storage Tune-up	This measure includes maintaining refrigeration compressors, lubricating motors, maintaining/replacing seals, and optimizing setpoints / control strategies to reduce energy consumption.
Process	Refrigerated Storage Retrofit	This measure covers refrigerator compressor and other equipment replacement and/or Improved design of overall refrigeration system.
Motors	Compressed Air – Equipment Upgrade	This measure is the replacement of existing air compressor equipment with more efficient compressors and motors in order to improve energy efficiency. Basic energy efficiency on compressors, dryers, filters (all inside the compressor room).
Motors	Compressed Air – Operations and Maintenance	Comprehensive demand side management, repair obvious leaks, replacing failed nozzles, and lubricating the compressors. Some “ad hoc” pressure reduction when obviously too high low/no cost - based on CAC guidelines or equivalent. Would also include centralized controls, and system performance monitoring. These measures work in tandem to reduce energy usage by lowering system demand. Also includes Enhanced O&M Measures: systematic leak detection (ultrasonic) program, minimal pressure drop from compressor to end-use, and ongoing tracking of pressure.

End Use	Measure	Description
Pumps	Pumps – Equipment Upgrade	Equipment replacement and/or Improved design of flow, housing, control valves, impeller trimming, proper sizing, etc to increase productive output per energy input. Moreover, these improved systems could be assessed and managed in accordance with recognized standards such as ASME EA-2-2008.
Pumps	Pumps – Operations and Maintenance	This measure includes clearing traps, repairing impellers, and repairing broken seals or valves. Enhanced O&M with some predicative O&M, such as: coupling alignment, lubrication, seal maintenance, vibration analysis, motor condition, etc. based on a comprehensive demand side assessment. Energy management and assessment activities based on/equivalent to structured protocols from CAC. This reduces energy consumption by reducing losses incurred by moving fluids through the system. Significant energy savings can also be frequently attained from processes by adding a timer or altering their control algorithms.
Motors	Fans – Equipment Upgrade	Improved design of airflow, blades, housing, sizing, etc to increase productive output per energy input. Fans are widely used in industry for conveyance, drying and ventilation. For example, relatively inefficient centrifugal-radial fans, with efficiency as low as 22%, are commonly used in industry. These fans could be replaced with more efficient centrifugal backwardly inclined fans that increase overall fan efficiency by 20% to 30%. The savings potential for premium-efficiency fans is high, and the costs are relatively low. However, premium-efficiency fans are sometimes not chosen for industrial applications because of concerns about reliable operation in dirty environments.
Motors	Fans – Operations and Maintenance	This measure includes repairing holes in ducts, replacing clogged filters, maintaining belts and dampers, and lubricating the motors. This reduces energy consumption by improving fan efficiency and reducing system loss as gas moves through the ductwork. Significant energy savings can also be frequently attained from processes by adding a timer or altering their control algorithms.
Motors	Motors - Rewind	When a motor burns out or is in need of repair, the owner may elect to either replace the motor or have it rewound. A typical motor rewind costs less than a replacement motor, but at the cost of efficiency. An efficient rewind, however, attempts to improve the efficiency of the motor by reducing stator losses. If the manufacturer has left stator slots open, or not entirely filled, additional copper wire can be included to reduce resistance and increase efficiency.
Motors	Motors - Variable Speed Controls	The part-load efficiency of drive systems can be improved by varying the speed of the motor drive. An additional benefit of variable-speed controls is the ability to start and stop the motor and process gradually, thus extending the life of the motor and associated machinery.
Motors	Motors - Synchronous Belts	Synchronous belts offer higher efficiency compared with standard belts due to reduced slipping, as well as less maintenance and retensioning.
HVAC (All)	Transformer - High Efficiency	All electric power passes through one or more transformers on its way to service equipment, lighting, and other loads. Currently available materials and designs can considerably reduce both load and no-load losses. The new NEMA TP-1 standard is used as the reference definition for energy -efficient products. Tier-1 represents TP-1 dry-type transformers while Tier-2 reflects a switch to liquid immersed TP-1 products. More efficient transformers with attractive payback periods are estimated to save 40 to 50 percent of the energy lost by a "typical" transformer, which translates into a one to three percent reduction in electric bills for commercial and industrial customers.
Motors	Municipal Sewage - Optimize <1 MGD Design Capacity	Modeled using assumptions from the Sixth Plan Conservation Supply Curve file (PC-Wastewater-6P-D1.xls).
Motors	Municipal Sewage - Optimize >10 MGD Design Capacity	Modeled using assumptions from the Sixth Plan Conservation Supply Curve file (PC-Wastewater-6P-D1.xls).
Motors	Municipal Sewage - Optimize 1 to 10	Modeled using assumptions from the Sixth Plan Conservation Supply Curve file (PC-Wastewater-6P-D1.xls).

End Use	Measure	Description
	MGD Design Capacity	
Motors	Water Supply - Efficiency Improvements	Modeled using assumptions from the Sixth Plan Conservation Supply Curve file (PC-WaterSupply-6P-D3.xls).
HVAC (All)	Waste Heat Generation – Custom	Custom measure for waste heat recovery to generate electricity.
HVAC (All)	Strategic Energy Management	Strategic Energy Management is a systematic approach to integrating energy management into an organization's business practices and creating lasting energy management processes that produce reliable energy savings.

MARKET ADOPTION FACTORS

A set of market adoption factors are applied to Economic potential to estimate Achievable Potential. These estimate customer adoption of economic measures when delivered through efficiency programs under realistic market and customer preference conditions. They reflect expected program participation given barriers to customer acceptance and program implementation. These adoption rates generally increase over time, reflecting an increasing awareness and willingness to adopt energy-efficient measures. However, in some cases, where a new technology is introduced, the adoption rates drop to reflect that the new technology may not yet be accepted in the market. For mature measures, information channels are assumed to be established for marketing, educating consumers, and coordinating with trade allies and delivery partners. For evolving measures, this is not the case and thus the factors start at a lower level.

The market adoption rates for the City Light study were developed using the ramp rates from the Northwest Power & Conservation Council's Sixth Plan as a starting point. The ramp rates were then adjusted based on actual City Light program history. These adjustments mainly set the potential in the first years of the study to match with recent program achievements and thus show continuity of results.

Table E-1 and Table E-2 present the Achievable Potential market adoption factors for the residential sector, first for equipment measures and then for non-equipment measures. Table E-3 and Table E-4 provide potential factors for the commercial sector, while Table E-5 and Table E-6 show the industrial sector potential factors.

Table E-1 Residential Equipment Measures—Achievable Potential Market Adoption Factors

End Use	Fuel	Technology	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Cooling	Electric	Central AC	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Cooling	Electric	Room AC	13%	20%	27%	33%	40%	47%	53%	60%	65%	65%	65%	65%	65%
Cooling	Electric	Air-Source Heat Pump	13%	20%	27%	33%	40%	47%	53%	60%	65%	65%	65%	65%	65%
Heating	Electric	Electric Zonal Room Heat	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	65%
Heating	Electric	Electric Furnace	13%	20%	27%	33%	40%	47%	53%	60%	65%	65%	65%	65%	65%
Heating	Electric	Air-Source Heat Pump	13%	20%	27%	33%	40%	47%	53%	60%	65%	65%	65%	65%	65%
Water Heating	Electric	Water Heater <= 55 Gal	1%	2%	3%	5%	6%	13%	19%	26%	32%	39%	46%	52%	59%
Water Heating	Electric	Water Heater > 55 Gal	1%	2%	3%	5%	6%	13%	19%	26%	32%	39%	46%	52%	59%
Interior Lighting	Electric	Screw-in	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%
Interior Lighting	Electric	Linear Fluorescent	20%	30%	40%	50%	60%	70%	80%	85%	85%	85%	85%	85%	85%
Interior Lighting	Electric	Specialty	30%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%
Exterior Lighting	Electric	Screw-in	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%
Appliances	Electric	Clothes Washer	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Appliances	Electric	Clothes Dryer	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Appliances	Electric	Dishwasher	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Appliances	Electric	Refrigerator	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Appliances	Electric	Freezer	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Appliances	Electric	Second Refrigerator	20%	30%	40%	50%	60%	70%	80%	85%	85%	85%	85%	85%	85%
Appliances	Electric	Stove	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Appliances	Electric	Microwave	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Electronics	Electric	Personal Computers	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Electronics	Electric	Monitor	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Electronics	Electric	Laptops	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Electronics	Electric	TVs	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Electronics	Electric	Printer/Fax/Copier	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Electronics	Electric	Set-top Boxes/DVR	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%
Miscellaneous	Electric	Pool Pump	13%	20%	27%	33%	40%	47%	53%	60%	65%	65%	65%	65%	65%
Miscellaneous	Electric	Pool Heater	13%	20%	27%	33%	40%	47%	53%	60%	65%	65%	65%	65%	65%
Miscellaneous	Electric	Hot Tub / Spa	13%	20%	27%	33%	40%	47%	53%	60%	65%	65%	65%	65%	65%
Miscellaneous	Electric	Furnace Fan	13%	20%	27%	33%	40%	47%	53%	60%	65%	65%	65%	65%	65%

Table E-2 Residential Non-Equipment Measures— Achievable Potential Market Adoption Factors

Measures	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Insulation - Ceiling	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	65%
Insulation - Ducts Inside	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	65%
Insulation - Foundation	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	65%
Insulation - Infiltration Control	13%	20%	27%	33%	40%	47%	53%	60%	65%	65%	65%	65%	65%
Insulation - Wall Cavity	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	65%
Insulation - Wall Sheathing	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	65%
Ducting - Repair and Sealing	13%	20%	27%	33%	40%	47%	53%	60%	65%	65%	65%	65%	65%
Windows - High Efficiency/ENERGY STAR	13%	20%	27%	33%	40%	47%	53%	60%	65%	65%	65%	65%	65%
Doors - Storm and Thermal	13%	20%	27%	33%	40%	47%	53%	60%	65%	65%	65%	65%	65%
Thermostat - Clock/Programmable	20%	30%	40%	50%	60%	70%	80%	85%	85%	85%	85%	85%	85%
Central Heat Pump - Maintenance	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Water Heater - Drainwater Heat Recovery	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	65%
Water Heater - Faucet Aerators	40%	60%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Water Heater - Low-Flow Showerheads	40%	60%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Water Heater - Pipe Insulation	40%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Water Heater - Timer	40%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Water Heater - Solar System	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	65%
Interior Lighting - Occupancy Sensors	40%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Exterior Lighting - Photosensor Control	40%	60%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Exterior Lighting - Photovoltaic Installation	40%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Exterior Lighting - Timeclock Installation	40%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Refrigerator - Decommissioning and Recycling	40%	60%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Freezer - Decommissioning and Recycling	40%	60%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Electronics - Smart Power Strips	40%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Pool Pump - Timer	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
ENERGY STAR Home Design	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	65%
Behavioral Measure	45%	64%	64%	64%	64%	64%	64%	64%	64%	64%	64%	64%	64%
Photovoltaic System	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	65%

Table E-3 Commercial Equipment Measures — Achievable Potential Market Adoption Factors

End Use	Fuel	Technology	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Cooling	Electric	Air-Cooled Chiller	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Cooling	Electric	Water-Cooled Chiller	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Cooling	Electric	Roof top AC	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Cooling	Electric	Other Cooling	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Cooling	Electric	Air Source Heat Pump	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Heating	Electric	Electric Furnace	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Heating	Electric	Electric Zonal Heat	20%	27%	33%	40%	47%	53%	60%	65%	65%	65%	65%	65%	65%
Heating	Electric	Air Source Heat Pump	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Ventilation	Electric	Ventilation	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Water Heating	Electric	Water Heater	5%	6%	13%	19%	26%	32%	39%	46%	52%	59%	65%	65%	65%
Interior Lighting	Electric	Screw-in	60%	65%	70%	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%
Interior Lighting	Electric	High-Bay Fixtures	60%	65%	70%	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%
Interior Lighting	Electric	Linear Fluorescent	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Exterior Lighting	Electric	Screw-in	60%	65%	70%	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%
Exterior Lighting	Electric	HID	60%	65%	70%	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%
Exterior Lighting	Electric	Linear Fluorescent	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Refrigeration	Electric	Walk-in Refrigerator	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Refrigeration	Electric	Reach-in Refrigerator	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Refrigeration	Electric	Glass Door Display	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Refrigeration	Electric	Open Display Case	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Refrigeration	Electric	Icemaker	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Refrigeration	Electric	Vending Machine	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Food Preparation	Electric	Oven	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	65%	65%
Food Preparation	Electric	Fryer	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	65%	65%
Food Preparation	Electric	Dishwasher	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	65%	65%
Food Preparation	Electric	Hot Food Container	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	65%	65%
Office Equip.	Electric	Desktop Computer	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Office Equip.	Electric	Laptop	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Office Equip.	Electric	Server	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Office Equip.	Electric	Monitor	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%
Office Equip.	Electric	Printer/Copier/Fax	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Office Equip.	Electric	POS Terminal	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Miscellaneous	Electric	Non-HVAC Motors	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Miscellaneous	Electric	Pool Pump	20%	27%	33%	40%	47%	53%	60%	65%	65%	65%	65%	65%	65%
Miscellaneous	Electric	Pool Heater	20%	27%	33%	40%	47%	53%	60%	65%	65%	65%	65%	65%	65%

Table E-4 Commercial Non-Equipment Measures — Achievable Potential Market Adoption Factors

Measures	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Insulation - Ceiling	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	65%
Insulation - Ducting	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	65%
Insulation - Foundation	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	65%
Insulation - Wall Cavity	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	65%
HVAC - Duct Repair and Sealing	13%	20%	27%	33%	40%	47%	53%	60%	65%	65%	65%	65%	65%
Doors - High Efficiency	13%	20%	27%	33%	40%	47%	53%	60%	65%	65%	65%	65%	65%
Windows - High Efficiency	13%	20%	27%	33%	40%	47%	53%	60%	65%	65%	65%	65%	65%
Roof- Reroofing	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	65%
Air-Cooled Chiller - Economizer	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Air-Cooled Chiller - VSD on Fans	40%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Air-Cooled Chiller - Chilled Water Reset	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Air-Cooled Chiller - Variable Speed Chiller	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Air-Cooled Chiller - Chiller Heat Recovery	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Water-Cooled Chiller - Condenser Water Temperature Reset	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Water-Cooled Chiller - Economizer	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Water-Cooled Chiller - VSD on Fans	40%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Water-Cooled Chiller - Chilled Water Reset	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Water-Cooled Chiller - Variable Speed Chiller	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Water-Cooled Chiller - Chiller Heat Recovery	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
RTU - Maintenance	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Space Heating - Heat Recovery Ventilator	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	65%
Heat Pump - Maintenance	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Ventilation - ECM on VAV Boxes	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Ventilation - Variable Speed Control	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Water Heater - Faucet Aerators/Low Flow Nozzles	40%	60%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Water Heater - High Efficiency Circulation Pump	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Water Heater - Solar System	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	65%
Water Heater - Install Timer	40%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Water Heater - Pipe Insulation	40%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
New Construction - Top Daylighting with Skylights	13%	20%	27%	33%	40%	47%	53%	60%	65%	65%	65%	65%	65%
Interior Lighting - Daylighting Controls	40%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Interior Lighting - LED Exit Lighting	40%	60%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Interior Lighting - Occupancy Sensors	20%	30%	40%	50%	60%	70%	80%	85%	85%	85%	85%	85%	85%

Measures	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Interior Lighting - Timeclocks and Timers	20%	30%	40%	50%	60%	70%	80%	85%	85%	85%	85%	85%	85%
Interior Lighting - Task Lighting	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Interior Fluorescent - Bi-Level Fixture	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Interior Fluorescent - Photocell-Controlled Dimming Ballasts	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Exterior Lighting - Bi-Level Fixture	40%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Exterior Lighting - Daylighting Controls	40%	60%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Refrigeration - Anti-Sweat Heater	40%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Refrigeration - Decommissioning	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Refrigeration - Demand Defrost	40%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Refrigeration - Door Gasket Replacement	40%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Refrigeration - Evaporator Fan Controls	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Refrigeration - High Efficiency Evaporator Fan Motors	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Refrigeration - Floating Head Pressure	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Refrigeration - Strip Curtain	40%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Refrigeration - High Efficiency Compressor	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Refrigeration - Variable Speed Compressor	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Refrigeration - eCube	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Vending Machine - Controller	40%	60%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Office Equip. - Plug Load Occupancy Sensors	40%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Electronics - Smart Power Strips	40%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Pool Pump - Timer	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Ventilation - CO2 Controlled	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	65%
Non-HVAC Motors - Variable Speed Control	40%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Energy Management System	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Thermostat - Clock/Programmable	20%	30%	40%	50%	60%	70%	80%	85%	85%	85%	85%	85%	85%
HVAC - Occupancy Sensors	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Retrocommissioning	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Advanced New Construction Designs	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	65%
Cooking - Exhaust Hoods with Sensor Control	20%	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Fans - Energy-Efficient Motors	13%	20%	27%	33%	40%	47%	53%	60%	65%	65%	65%	65%	65%
Fans - Variable Speed Control	13%	20%	27%	33%	40%	47%	53%	60%	65%	65%	65%	65%	65%
Pumps - High-Efficiency Motors	13%	20%	27%	33%	40%	47%	53%	60%	65%	65%	65%	65%	65%
Pumps - Variable Speed Control	13%	20%	27%	33%	40%	47%	53%	60%	65%	65%	65%	65%	65%

Table E-5 Industrial Equipment Measures — Achievable Potential Market Adoption Factors

End Use	Fuel	Technology	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Cooling	Electric	Air-Cooled Chiller	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Cooling	Electric	Water-Cooled Chiller	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Cooling	Electric	RTU	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Cooling	Electric	Air-Source Heat Pump	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Heating	Electric	Air-Source Heat Pump	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Heating	Electric	Electric Resistance	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Ventilation	Electric	Ventilation	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Interior Lighting	Electric	Screw-in	60%	65%	70%	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%
Interior Lighting	Electric	High-Bay Fixtures	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Interior Lighting	Electric	Linear Fluorescent	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Exterior Lighting	Electric	Screw-in	60%	65%	70%	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%
Exterior Lighting	Electric	HID	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Exterior Lighting	Electric	Linear Fluorescent	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Motors	Electric	Pumps	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Motors	Electric	Fans & Blowers	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Motors	Electric	Compressed Air	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Motors	Electric	Conveyors	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Motors	Electric	Other Motors	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Process	Electric	Process Heating	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Process	Electric	Process Cooling	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Process	Electric	Process Refrigeration	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Process	Electric	Electrochemical Process	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Process	Electric	Other Process	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%

Table E-6 Industrial Non-Equipment Measures — Achievable Potential Market Adoption Factors

Measures	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Insulation - Ceiling	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	65%	65%
Insulation - Ducting	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	65%	65%
Insulation - Wall Cavity	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	65%	65%
HVAC - Duct Repair and Sealing	20%	27%	33%	40%	47%	53%	60%	65%	65%	65%	65%	65%	65%
Air-Cooled Chiller - Economizer	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Air-Cooled Chiller - Efficient Mechanical Layout	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Air-Cooled Chiller - Maintenance	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Air-Cooled Chiller - Chilled Water Reset	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Air-Cooled Chiller - Chilled Water Variable-Flow System	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Air-Cooled Chiller - Condenser Water Temperature Reset	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Air-Cooled Chiller - VSD on Fans	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Water-Cooled Chiller - Economizer	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Water-Cooled Chiller - Efficient Mechanical Layout	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Water-Cooled Chiller - Maintenance	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Water-Cooled Chiller - Chilled Water Reset	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Water-Cooled Chiller - Chilled Water Variable-Flow System	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Water-Cooled Chiller - Condenser Water Temperature Reset	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Water-Cooled Chiller - VSD on Fans	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
RTU - Maintenance	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Heat Pump - Maintenance	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Retrocommissioning - HVAC	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Destratification Fans (HVLS)	20%	27%	33%	40%	47%	53%	60%	65%	65%	65%	65%	65%	65%
Energy Management System	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Thermostat - Clock/Programmable	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Interior Lighting - Occupancy Sensors	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Interior Lighting - Skylights	20%	27%	33%	40%	47%	53%	60%	65%	65%	65%	65%	65%	65%
Interior Lighting - Time Clocks and Timers	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Interior Lighting - LED Exit Lighting	75%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Interior Lighting - Daylighting Controls	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Interior Screw-in - Task Lighting	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Interior Fluorescent - Bi-Level Fixture	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Retrocommissioning - Lighting	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Exterior Lighting - Bi-Level Fixture	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%

Measures	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Exterior Lighting - Daylighting Controls	60%	80%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Process - Conductivity Controls	50%	55%	60%	65%	70%	75%	80%	85%	85%	85%	85%	85%	85%
Process - Controls on Fume Hoods	50%	55%	60%	65%	70%	75%	80%	85%	85%	85%	85%	85%	85%
Process - Timers and Controls	50%	55%	60%	65%	70%	75%	80%	85%	85%	85%	85%	85%	85%
Refrigeration - Floating Head Pressure	50%	55%	60%	65%	70%	75%	80%	85%	85%	85%	85%	85%	85%
Refrigerated Storage Tune-up	50%	55%	60%	65%	70%	75%	80%	85%	85%	85%	85%	85%	85%
Refrigerated Storage Retrofit	50%	55%	60%	65%	70%	75%	80%	85%	85%	85%	85%	85%	85%
Compressed Air - Equipment Upgrade	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Compressed Air - Operations and Maintenance	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Pumps - Equipment Upgrade	50%	55%	60%	65%	70%	75%	80%	85%	85%	85%	85%	85%	85%
Pumps - Operations and Maintenance	50%	55%	60%	65%	70%	75%	80%	85%	85%	85%	85%	85%	85%
Fans - Equipment Upgrade	50%	55%	60%	65%	70%	75%	80%	85%	85%	85%	85%	85%	85%
Fans - Operations and Maintenance	50%	55%	60%	65%	70%	75%	80%	85%	85%	85%	85%	85%	85%
Motors - Rewind	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Motors - Variable Speed Controls	50%	55%	60%	65%	70%	75%	80%	85%	85%	85%	85%	85%	85%
Motors - Synchronous Belts	30%	40%	50%	60%	65%	65%	65%	65%	65%	65%	65%	65%	65%
Transformer - High Efficiency	50%	55%	60%	65%	70%	75%	80%	85%	85%	85%	85%	85%	85%
Municipal Sewage - Optimize <1 MGD Design Capacity	50%	55%	60%	65%	70%	75%	80%	85%	85%	85%	85%	85%	85%
Municipal Sewage - Optimize >10 MGD Design Capacity	50%	55%	60%	65%	70%	75%	80%	85%	85%	85%	85%	85%	85%
Municipal Sewage - Optimize 1 to 10 MGD Design Capacity	50%	55%	60%	65%	70%	75%	80%	85%	85%	85%	85%	85%	85%
Water Supply - Efficiency Improvements	20%	27%	33%	40%	47%	53%	60%	65%	65%	65%	65%	65%	65%
Waste Heat Generation – Custom	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Strategic Energy Management	20%	27%	33%	40%	47%	53%	60%	65%	65%	65%	65%	65%	65%

SAVINGS BY YEAR

This appendix provides potential savings results for all years. For all sectors combined, Table F-1 shows the cumulative savings, while Table F-2 shows incremental annual savings. Table F-3 through Table F-10 show cumulative and incremental savings by sector.

Table F-1 Cumulative Energy Savings, All Sectors

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Baseline Projection (MWh)	10,049,821	10,005,208	10,016,690	10,034,800	10,085,063	10,173,677	10,251,894	10,419,613	10,575,416	10,728,599
Cumulative Savings (MWh)										
Achievable Potential	99,985	197,975	299,749	365,639	433,371	519,252	643,556	776,185	901,905	1,036,977
Economic Potential	285,794	504,001	709,040	817,545	911,503	1,011,500	1,134,062	1,279,139	1,420,788	1,574,823
Technical Potential	376,456	656,464	924,678	1,092,893	1,243,763	1,390,808	1,566,579	1,768,628	1,964,826	2,185,003
Cumulative Savings (aMW)										
Achievable Potential	11.4	22.6	34.2	41.7	49.5	59.3	73.5	88.6	103.0	118.4
Economic Potential	32.6	57.5	80.9	93.3	104.1	115.5	129.5	146.0	162.2	179.8
Technical Potential	43.0	74.9	105.6	124.8	142.0	158.8	178.8	201.9	224.3	249.4

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Baseline Projection (MWh)	10,895,286	11,079,616	11,271,297	11,468,541	11,667,344	11,864,292	12,064,238	12,272,690	12,486,245	12,706,161
Cumulative Savings (MWh)										
Achievable Potential	1,160,380	1,296,003	1,428,538	1,559,389	1,699,082	1,822,986	1,915,330	2,008,908	2,097,287	2,195,644
Economic Potential	1,713,058	1,864,492	2,015,818	2,170,052	2,342,961	2,485,764	2,589,571	2,693,247	2,787,402	2,893,157
Technical Potential	2,380,062	2,581,016	2,782,479	2,985,611	3,209,910	3,393,862	3,530,590	3,668,670	3,794,973	3,938,790
Cumulative Savings (aMW)										
Achievable Potential	132.5	147.9	163.1	178.0	194.0	208.1	218.6	229.3	239.4	250.6
Economic Potential	195.6	212.8	230.1	247.7	267.5	283.8	295.6	307.4	318.2	330.3
Technical Potential	271.7	294.6	317.6	340.8	366.4	387.4	403.0	418.8	433.2	449.6

Table F-2 Incremental Energy Savings, All Sectors

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Incremental Annual Savings (MWh)										
Achievable Potential	99,985	97,990	101,774	65,891	67,732	85,881	124,305	132,629	125,721	135,072
Economic Potential	285,794	218,207	205,039	108,505	93,958	99,997	122,562	145,077	141,649	154,035
Technical Potential	376,456	280,008	268,214	168,215	150,870	147,045	175,771	202,049	196,198	220,178
Incremental Annual Savings (aMW)										
Achievable Potential	11.4	11.2	11.6	7.5	7.7	9.8	14.2	15.1	14.4	15.4
Economic Potential	32.6	24.9	23.4	12.4	10.7	11.4	14.0	16.6	16.2	17.6
Technical Potential	43.0	32.0	30.6	19.2	17.2	16.8	20.1	23.1	22.4	25.1

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Incremental Annual Savings (MWh)										
Achievable Potential	123,403	135,623	132,535	130,851	139,693	123,904	92,345	93,577	88,379	98,357
Economic Potential	138,234	151,435	151,325	154,234	172,910	142,802	103,807	103,677	94,155	105,755
Technical Potential	195,059	200,954	201,463	203,132	224,300	183,952	136,728	138,080	126,303	143,817
Incremental Annual Savings (aMW)										
Achievable Potential	14.1	15.5	15.1	14.9	15.9	14.1	10.5	10.7	10.1	11.2
Economic Potential	15.8	17.3	17.3	17.6	19.7	16.3	11.9	11.8	10.7	12.1
Technical Potential	22.3	22.9	23.0	23.2	25.6	21.0	15.6	15.8	14.4	16.4

Table F-3 Cumulative Electric Energy Savings, Residential

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Baseline Projection (MWh)	3,205,277	3,193,660	3,186,643	3,194,065	3,206,854	3,233,822	3,228,211	3,240,301	3,252,138	3,256,520
Cumulative Savings (MWh)										
Achievable Potential	28,500	59,974	91,537	109,214	127,865	159,967	180,214	206,161	231,907	249,900
Economic Potential	130,668	247,102	343,712	385,557	415,827	448,228	452,334	473,189	495,641	504,274
Technical Potential	173,554	327,293	462,537	541,112	604,761	666,119	701,524	754,938	808,184	845,762
Cumulative Savings (aMW)										
Achievable Potential	3.3	6.8	10.4	12.5	14.6	18.3	20.6	23.5	26.5	28.5
Economic Potential	14.9	28.2	39.2	44.0	47.5	51.2	51.6	54.0	56.6	57.6
Technical Potential	19.8	37.4	52.8	61.8	69.0	76.0	80.1	86.2	92.3	96.5

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Baseline Projection (MWh)	3,277,588	3,304,288	3,333,162	3,363,542	3,395,213	3,427,947	3,461,197	3,499,033	3,537,277	3,577,236
Cumulative Savings (MWh)										
Achievable Potential	275,361	306,822	338,052	369,108	398,666	429,150	458,743	488,622	515,951	548,450
Economic Potential	527,735	557,623	589,730	625,772	662,997	698,345	733,049	767,449	796,942	833,258
Technical Potential	897,805	954,053	1,011,955	1,072,960	1,136,914	1,187,445	1,233,801	1,281,206	1,321,841	1,375,499
Cumulative Savings (aMW)										
Achievable Potential	31.4	35.0	38.6	42.1	45.5	49.0	52.4	55.8	58.9	62.6
Economic Potential	60.2	63.7	67.3	71.4	75.7	79.7	83.7	87.6	91.0	95.1
Technical Potential	102.5	108.9	115.5	122.5	129.8	135.6	140.8	146.3	150.9	157.0

Table F-4 Incremental Energy Savings, Residential

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Incremental Annual Savings (MWh)										
Achievable Potential	28,500	31,474	31,563	17,677	18,651	32,102	20,247	25,946	25,746	17,993
Economic Potential	130,668	116,434	96,610	41,845	30,270	32,401	4,106	20,855	22,453	8,633
Technical Potential	173,554	153,739	135,244	78,575	63,648	61,359	35,405	53,414	53,245	37,579
Incremental Annual Savings (aMW)										
Achievable Potential	3.3	3.6	3.6	2.0	2.1	3.7	2.3	3.0	2.9	2.1
Economic Potential	14.9	3.6	3.6	2.0	2.1	3.7	2.3	3.0	2.9	2.1
Technical Potential	19.8	13.3	11.0	4.8	3.5	3.7	0.5	2.4	2.6	1.0

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Incremental Annual Savings (MWh)										
Achievable Potential	25,461	31,461	31,230	31,056	29,558	30,484	29,593	29,879	27,329	32,499
Economic Potential	23,461	29,889	32,107	36,042	37,226	35,348	34,703	34,400	29,493	36,316
Technical Potential	52,042	56,248	57,902	61,006	63,954	50,531	46,356	47,405	40,635	53,658
Incremental Annual Savings (aMW)										
Achievable Potential	2.9	3.6	3.6	3.5	3.4	3.5	3.4	3.4	3.1	3.7
Economic Potential	2.9	3.6	3.6	3.5	3.4	3.5	3.4	3.4	3.1	3.7
Technical Potential	2.7	3.4	3.7	4.1	4.2	4.0	4.0	3.9	3.4	4.1

Table F-5 Cumulative Energy Savings, Commercial

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Baseline Projection (MWh)	5,435,096	5,402,226	5,429,207	5,454,798	5,501,409	5,564,691	5,645,843	5,799,363	5,943,136	6,082,292
Cumulative Savings (MWh)										
Achievable Potential	47,025	95,335	154,291	194,388	234,290	278,777	375,966	476,377	571,767	680,625
Economic Potential	116,007	201,851	298,254	356,677	410,776	468,022	579,393	697,549	811,069	946,480
Technical Potential	157,533	265,915	385,185	465,106	541,388	616,062	747,890	888,186	1,023,320	1,186,159
Cumulative Savings (aMW)										
Achievable Potential	5.4	10.9	17.6	22.2	26.7	31.8	42.9	54.4	65.3	77.7
Economic Potential	13.2	23.0	34.0	40.7	46.9	53.4	66.1	79.6	92.6	108.0
Technical Potential	18.0	30.4	44.0	53.1	61.8	70.3	85.4	101.4	116.8	135.4

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Baseline Projection (MWh)	6,224,943	6,379,466	6,540,094	6,704,589	6,869,417	7,031,418	7,195,716	7,363,664	7,536,415	7,713,040
Cumulative Savings (MWh)										
Achievable Potential	773,623	872,775	970,253	1,066,282	1,172,913	1,262,996	1,322,567	1,383,035	1,441,251	1,503,855
Economic Potential	1,055,246	1,170,842	1,285,296	1,398,778	1,530,031	1,633,076	1,698,043	1,763,219	1,824,314	1,889,671
Technical Potential	1,317,958	1,453,302	1,589,200	1,724,736	1,878,483	2,005,567	2,091,644	2,178,253	2,260,479	2,346,823
Cumulative Savings (aMW)										
Achievable Potential	88.3	99.6	110.8	121.7	133.9	144.2	151.0	157.9	164.5	171.7
Economic Potential	120.5	133.7	146.7	159.7	174.7	186.4	193.8	201.3	208.3	215.7
Technical Potential	150.5	165.9	181.4	196.9	214.4	228.9	238.8	248.7	258.0	267.9

Table F-6 Incremental Energy Savings, Commercial

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Incremental Annual Savings (MWh)										
Achievable Potential	47,025	48,309	58,956	40,097	39,902	44,487	97,189	100,411	95,390	108,858
Economic Potential	116,007	85,844	96,403	58,423	54,099	57,246	111,370	118,156	113,520	135,412
Technical Potential	157,533	108,382	119,270	79,920	76,282	74,675	131,828	140,296	135,134	162,839
Incremental Annual Savings (aMW)										
Achievable Potential	5.4	5.5	6.7	4.6	4.6	5.1	11.1	11.5	10.9	12.4
Economic Potential	13.2	9.8	11.0	6.7	6.2	6.5	12.7	13.5	13.0	15.5
Technical Potential	18.0	12.4	13.6	9.1	8.7	8.5	15.0	16.0	15.4	18.6

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Incremental Annual Savings (MWh)										
Achievable Potential	92,999	99,152	97,478	96,029	106,632	90,083	59,571	60,468	58,216	62,603
Economic Potential	108,766	115,596	114,453	113,482	131,254	103,044	64,967	65,176	61,095	65,357
Technical Potential	131,799	135,344	135,898	135,535	153,748	127,084	86,076	86,610	82,225	86,344
Incremental Annual Savings (aMW)										
Achievable Potential	10.6	11.3	11.1	11.0	12.2	10.3	6.8	6.9	6.6	7.1
Economic Potential	12.4	13.2	13.1	13.0	15.0	11.8	7.4	7.4	7.0	7.5
Technical Potential	15.0	15.5	15.5	15.5	17.6	14.5	9.8	9.9	9.4	9.9

Table F-7 Cumulative Energy Savings, Industrial

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Baseline Projection (MWh)	1,320,856	1,320,729	1,312,248	1,297,345	1,288,208	1,286,572	1,289,248	1,291,358	1,291,549	1,301,196
Cumulative Savings (MWh)										
Achievable Potential	14,509	22,765	27,852	31,915	37,031	43,903	50,515	56,787	61,371	69,591
Economic Potential	29,168	35,148	41,005	45,189	50,715	58,646	65,474	71,541	77,217	87,208
Technical Potential	34,913	42,346	49,564	55,083	61,822	70,045	78,583	86,922	94,741	114,501
Cumulative Savings (aMW)										
Achievable Potential	1.7	2.6	3.2	3.6	4.2	5.0	5.8	6.5	7.0	7.9
Economic Potential	3.3	4.0	4.7	5.2	5.8	6.7	7.5	8.2	8.8	10.0
Technical Potential	4.0	4.8	5.7	6.3	7.1	8.0	9.0	9.9	10.8	13.1

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Baseline Projection (MWh)	1,304,163	1,307,271	1,309,448	1,311,817	1,314,122	1,316,335	1,318,733	1,321,401	1,323,961	1,327,294
Cumulative Savings (MWh)										
Achievable Potential	74,535	79,545	83,372	87,139	90,627	93,963	97,144	100,374	103,208	106,463
Economic Potential	93,216	99,166	103,931	108,641	113,056	117,467	121,603	125,703	129,269	133,352
Technical Potential	125,718	135,079	142,742	149,333	155,932	162,269	166,564	170,629	174,072	177,887
Cumulative Savings (aMW)										
Achievable Potential	8.5	9.1	9.5	9.9	10.3	10.7	11.1	11.5	11.8	12.2
Economic Potential	10.6	11.3	11.9	12.4	12.9	13.4	13.9	14.3	14.8	15.2
Technical Potential	14.4	15.4	16.3	17.0	17.8	18.5	19.0	19.5	19.9	20.3

Table F-8 Incremental Energy Savings, Industrial

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Incremental Annual Savings (MWh)										
Achievable Potential	14,509	8,256	5,087	4,063	5,116	6,872	6,612	6,271	4,584	8,221
Economic Potential	29,168	5,979	5,858	4,184	5,526	7,930	6,829	6,067	5,676	9,991
Technical Potential	34,913	7,433	7,218	5,519	6,739	8,223	8,539	8,339	7,819	19,760
Incremental Annual Savings (aMW)										
Achievable Potential	1.7	0.9	0.6	0.5	0.6	0.8	0.8	0.7	0.5	0.9
Economic Potential	1.7	0.9	0.6	0.5	0.6	0.8	0.8	0.7	0.5	0.9
Technical Potential	3.3	0.7	0.7	0.5	0.6	0.9	0.8	0.7	0.6	1.1

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Incremental Annual Savings (MWh)										
Achievable Potential	4,944	5,010	3,827	3,767	3,487	3,337	3,181	3,230	2,834	3,255
Economic Potential	6,008	5,950	4,765	4,710	4,415	4,411	4,136	4,100	3,566	4,082
Technical Potential	11,217	9,361	7,663	6,591	6,598	6,337	4,296	4,065	3,443	3,815
Incremental Annual Savings (aMW)										
Achievable Potential	0.6	0.6	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.4
Economic Potential	0.6	0.6	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.4
Technical Potential	0.7	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.5

Table F-9 Cumulative Energy Savings, Street Lighting

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Baseline Projection (MWh)	88,592	88,592	88,592	88,592	88,592	88,592	88,592	88,592	88,592	88,592
Cumulative Savings (MWh)										
Achievable Potential	9,950	19,901	26,069	30,123	34,185	36,604	36,861	36,861	36,861	36,861
Economic Potential	9,950	19,901	26,069	30,123	34,185	36,604	36,861	36,861	36,861	36,861
Technical Potential	10,455	20,910	27,392	31,592	35,793	38,581	38,581	38,581	38,581	38,581
Cumulative Savings (aMW)										
Achievable Potential	1.1	2.3	3.0	3.4	3.9	4.2	4.2	4.2	4.2	4.2
Economic Potential	1.1	2.3	3.0	3.4	3.9	4.2	4.2	4.2	4.2	4.2
Technical Potential	1.2	2.4	3.1	3.6	4.1	4.4	4.4	4.4	4.4	4.4

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Baseline Projection (MWh)	88,592	88,592	88,592	88,592	88,592	88,592	88,592	88,592	88,592	88,592
Cumulative Savings (MWh)										
Achievable Potential	36,861	36,861	36,861	36,861	36,876	36,876	36,876	36,876	36,876	36,876
Economic Potential	36,861	36,861	36,861	36,861	36,876	36,876	36,876	36,876	36,876	36,876
Technical Potential	38,581	38,581	38,581	38,581	38,581	38,581	38,581	38,581	38,581	38,581
Cumulative Savings (aMW)										
Achievable Potential	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
Economic Potential	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
Technical Potential	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4

Table F-10 Incremental Energy Savings, Street Lighting

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Incremental Annual Savings (MWh)										
Achievable Potential	9,950	9,950	6,169	4,053	4,063	2,419	257			
Economic Potential	9,950	9,950	6,169	4,053	4,063	2,419	257			
Technical Potential	10,455	10,455	6,482	4,200	4,200	2,789				
Incremental Annual Savings (aMW)										
Achievable Potential	1.1	1.1	0.7	0.5	0.5	0.3	0.03			
Economic Potential	1.1	1.1	0.7	0.5	0.5	0.3	0.03			
Technical Potential	1.2	1.2	0.7	0.5	0.5	0.3				

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EnerNOC Utility Solutions Consulting is part of EnerNOC Utility Solutions group, which provides a comprehensive suite of demand-side management (DSM) services to utilities and grid operators worldwide. Hundreds of utilities have leveraged our technology, our people, and our proven processes to make their energy efficiency (EE) and demand response (DR) initiatives a success. Utilities trust EnerNOC to work with them at every stage of the DSM program lifecycle – assessing market potential, designing effective programs, implementing those programs, and measuring program results.

EnerNOC Utility Solutions delivers value to our utility clients through two separate practice areas – Program Implementation and EnerNOC Utility Solutions Consulting.

- Our Program Implementation team leverages EnerNOC's deep "behind-the-meter expertise" and world-class technology platform to help utilities create and manage DR and EE programs that deliver reliable and cost-effective energy savings. We focus exclusively on the commercial and industrial (C&I) customer segments, with a track record of successful partnerships that spans more than a decade. Through a focus on high quality, measurable savings, EnerNOC has successfully delivered hundreds of thousands of MWh of energy efficiency for our utility clients, and we have thousands of MW of demand response capacity under management.
- The EnerNOC Utility Solutions Consulting team provides expertise and analysis to support a broad range of utility DSM activities, including: potential assessments; end-use forecasts; integrated resource planning; EE, DR, and smart grid pilot and program design and administration; load research; technology assessments and demonstrations; evaluation, measurement and verification; and regulatory support.

The EnerNOC Utility Solutions Consulting team has decades of combined experience in the utility DSM industry. The staff is comprised of professional electrical, mechanical, chemical, civil, industrial, and environmental engineers as well as economists, business planners, project managers, market researchers, load research professionals, and statisticians. Utilities view our experts as trusted advisors, and we work together collaboratively to make any DSM initiative a success.

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