Seattle City Light

2020 Conservation Potential Assessment—Volume II

Project Lead/By: Jennifer Finnigan
Prepared by: Lakin Garth, Cadmus
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Washington Initiative 937 (I-937) Compliance Documentation

The Washington Administrative Code chapter 194-37-070 says CPAs must use methodologies consistent with the most recently published regional power plan and satisfy the 15 criteria. Table 1 lists these items and describes how City Light's 2020 CPA satisfies the criteria.

Following Table 1 the "Methodology Comparison" section discusses key parts of the Council's methodology for assessing conservation potential and explains how Cadmus' approach for City Light's 2020 CPA is consistent.

TABLE-1 WAC 194-37-070 DOCUMENTATION	
Northwest Power and Conservation Council Methodology	**Cadmus Methodology**
(a) Analyze a broad range of energy efficiency measures considered technically feasible;	Cadmus analyzed all of the most up-do-date, active measures from the Regional Technical Forum (RTF) and measures from the Northwest Power and Conservation Council's (Council) Seventh Power Plan. This study considered over 4,200 measure permutations.
(b) Perform a life-cycle cost analysis of measures or programs, including the incremental savings and incremental costs of measures and replacement measures where resources or measures have different measure lifetimes;	Cadmus performed life-cycle cost analysis in a manner consistent with the Council's PROCOST model. As a basis, the analysis used incremental costs, energy savings, and measure lives from the Seventh Power Plan and RTF workbooks.
(c) Set avoided costs equal to a forecast of regional market prices, which represents the cost of the next increment of available and reliable power supply available to the utility for the life of the energy efficiency measures to which it is compared;	City Light provided avoided-cost forecasts, consistent with City Light's IRP. Cadmus estimated potential for two avoided cost scenarios—one based on regional market prices; and the other based on City Light's preferred portfolio, selected by City Light's previous IRP. Conservation potential and targets were based on City Light's "IRP preferred" avoided costs.
(d) Calculate the value of the energy saved based on when it is saved. In performing this calculation, use time differentiated avoided costs to conduct the analysis that determines the financial value of energy saved through conservation;	Cadmus used measure load shapes to calculate time of day and year usage, and weighting of measure values was based upon peak and off-peak pricing, performed in a manner consistent with the Council's PROCOST model.
(e) Conduct a total resource cost analysis that assesses all costs and all benefits of conservation measures regardless of who pays the costs or receives the benefits. The NWPCC identifies conservation measures that pass the total resource cost test as economically achievable;	Cadmus conducted benefit-cost analysis according to the Council's methodology. The cost side considered capital costs, administrative costs, annual O&M costs and periodic replacement costs. The benefits side included energy, non-energy, operations and maintenance (O&M), and all other quantifiable benefits. The Total Resource Cost (TRC) benefit-cost ratio served to screen measures for cost-effectiveness (i.e., those greater than one were considered cost-effective).
(f) Identify conservation measures that pass the total resource cost test, by having a benefit/cost ratio of one or greater as economically achievable;	Cadmus considered measures achieving a BCR ratio (on a TRC basis) greater than or equal to one as achievable and cost-effective.
(g) Include the increase or decrease in annual or periodic operations and maintenance costs due to conservation measures;	Cadmus accounted for each measure's O&M costs in the total resource cost, according to the Council's assumptions.

TABLE-1 WAC 194-37-070 DOCUMENTATION	
(h) Include deferred capacity expansion benefits for transmission and distribution systems in its cost-effectiveness analysis;	Cost-benefit ratios and levelized costs incorporated City Light's avoided transmission and distribution cost forecasts.
(i) Include all non-power benefits that a resource or measure may provide that can be quantified and monetized;	Cadmus included quantifiable non-energy benefits for the appropriate measures. For example, non-energy benefits included water savings from clothes washers. The source of these benefits derived either the RTF or the Seventh Plan, depending upon the measure.
(j) Include an estimate of program administrative costs;	This study used a 20% residential and 23% commercial and industrial administrative cost (percent of incremental cost). Cadmus derived these cost adders from City Light's 2015 program expenditures.
(k) Discount future costs and benefits at a discount rate based on a weighted, after-tax, cost of capital for utilities and their customers for the measure lifetime;	Cadmus applied discount rates to each measure in the study, using the Council's methodology (with a 3% real discount rate used).
(l) Include estimates of the achievable conservation penetration rates for conservation measures;	Cadmus determined achievable potential estimates for each measure by applying the Council's 85% achievability factor and ramp rates, consistent with the Council's methodology.
(m) Include a ten percent bonus for conservation measures as defined in 16 U.S.C. § 839a of the Pacific Northwest Electric Power Planning and Conservation Act;	Cadmus applied the 10% bonus for conservation measures, as defined in 16 U.S.C. § 839a of the Pacific Northwest Electric Power Planning and Conservation Act to all measures in the study. This adder was included in avoided cost forecasts for cost-benefit analysis and in the calculation of levelized costs.
(n) Analyze the results of multiple scenarios. This includes testing scenarios that accelerate the rate of conservation acquisition in the earlier years; and	Cadmus considered two scenarios reflecting different avoided cost forecast, testing scenarios with accelerated ramp rates, increasing conservation in early years.
(o) Analyze the costs of estimated future environmental externalities in the multiple scenarios that estimate costs and risks.	The study considered two avoided cost scenarios to capture price uncertainty. Both forecasts included the value of avoided CO2 offsets, and the market price forecast included the value of avoided renewable energy credit purchases.

1.1. Methodology Comparison

To facilitate comparisons with the 7th Power Plan, the Council prepared an overview of the methodology used in developing the 7th Power Plan's conservation potential estimates. This appendix compares the methodology used in SCL's 2020 CPA to benchmarks established by the Council.

Italics denote descriptions of methodologies used in this study.

1.1.1. Technical Resource Potential Assessment

The assessment reviewed a wide array of energy efficiency technologies and practices, across all sectors and major end uses.

The study considered measures from a variety of sources, including the 7th Plan and RTF. Appendix D provides descriptions of all measures analyzed.

1.1.1.1 Methodology

- Technically feasibility savings = Number of applicable units * incremental savings/applicable units
- "Applicable" units accounted for:
    - Fuel saturations (e.g., electric vs. gas DHW).

      Whenever possible, fuel saturations were based on data specific to City Light's service territory. City Light's oversamples for the 2014 Commercial Building Stock Assessment (CBSA) and the 2017 Residential Building Stock Assessment (RBSA) served as the primary sources of this information.
    - Building characteristics (e.g., single-family vs. mobile homes, basement/non-basement).

      Data derived from NEEA's 2017 Residential Building Stock Assessment (RBSA), CBSA, and City Light's customer database.
    - System saturations (e.g., heat pump vs. zonal, central AC vs. window AC).

      Whenever possible, system saturations were based on data specific to City Light's service territory. City Light's oversamples for the 2014 Commercial Building Stock Assessment (CBSA) and the 2017 Residential Building Stock Assessment (RBSA) served as the primary sources of this information.
    - Current measure saturations.

      Current saturations were incorporated into the applicability, based on information from RBSA, CBSA, the 7th Plan, and RTF.
    - New and existing units.

      Existing and new units were calculated based on current and forecasted customers, respectively.
    - Measure life (stock turnover cycle).

Measure decay rates were applied to lost opportunity measures, based on measure life. Discretionary measures were assumed to be reinstalled at the end of their useful life.

- Measure substitutions (e.g., duct sealing of homes with forced-air resistance furnaces vs. conversion of homes to heat pumps with sealed ducts).

  The measure share applicability factor accounted for competition between measures to avoid double-counting.

- "Incremental" savings/applicable unit accounted for:
  - Expected kW and kWh savings, shaped by time-of-day, day of week, and month of year.

    Energy and demand savings were either based on deemed values or calculated as a percent reduction in baseline end-use consumption.

  - Savings over baseline efficiency. Baseline set by codes/standards or current practices.

    Baselines were set based on current codes, standards, or current practices. Standards passed but not yet implemented became the baseline at the time mandated in the new standard.

    Not always equivalent to savings over "current use" (e.g., new refrigerator savings measured as a "increment above current federal standards," not the refrigerator being replaced).

    Savings from equipment upgrades were calculated based on the market average efficiency level available at the time of burnout.

  - Climate: heating, cooling degree days, and solar availability.

    Savings were based on the typical climate in City Light's service territory.

  - Measure interactions (e.g., lighting and HVAC, duct sealing and heat pump performance, heat pump conversion, and weatherization savings).

    These interactive effects were treated as a reduction in measure savings (e.g., commercial lighting measures might save less due to increased heating requirements).

1.1.2. Economic Potential: Ranking Based on Resource Valuation

- The TRC served as the criterion for economic screening, and included all measure costs and benefits, regardless of the parties paying for or receiving them.
  - TRC B/C Ratio > = 1.0

    Benefit-cost analysis was conducted according to the Council's methodology. Capital cost, administrative cost, annual O&M cost and periodic replacement costs were all considered on the cost side. Energy, non-energy, O&M, and all other quantifiable benefits were included on the benefits side. The TRC benefit cost ratio was used to screen measures for cost-effectiveness (i.e., those greater than 1 are cost-effective).

- Levelized cost of conserved energy (CCE) < levelized avoided cost for the savings' load shape could substitute for TRC if adjusting "CCE" to account for "non-kWh" benefits, including deferred T&D, non-energy benefits, environmental benefits, and the Act's 10% conservation credit.

  Levelized costs, on a TRC basis, were calculated for each measure in comparison with the Integrated Resource Planning's (IRP) supply-side resources. The levelized cost calculation incorporated deferred T&D (for electric resources), non-energy benefits, secondary fuel benefits, and the Act's 10% conservation credit (for electric resources).

1.1.2.1 Methodology

- The energy and capacity value (i.e., benefit) of savings was based on the avoided cost of future wholesale market purchases (i.e., forward price curves).

  The study considered two avoided cost forecasts—one based on the avoided cost of future wholesale market purchases and a second based on the avoided cost of future market purchases and the construction of new renewable generation
- The energy and capacity values accounted for the savings shape (i.e., used time and seasonally differentiated avoided costs and measure savings).

  The analysis relied time differentiated avoided costs and savings to calculate the value of avoided energy and capacity
- Performing the valuation under a wide range of future market price scenarios during the IRP process accounted for uncertainties in future market prices.

  Two avoided cost scenarios were considered to account for price uncertainty
- Costs inputs (resource cost elements):

  All costs listed below were included in the per-unit measure costs, where appropriate.
  - Full incremental measure costs (material and labor).
  - Applicable ongoing O&M expenses (plus or minus).
  - Applicable periodic O&M expenses (plus or minus).
  - Utility administrative costs (e.g., program planning, marketing, delivery, ongoing administration, evaluation).
- Benefit inputs (resource value elements):

  All benefits listed below were assessed in calculating the levelized CCE and benefit-cost ratios, where appropriate.
  - Direct energy savings.
  - Direct capacity savings.
  - Avoided T&D losses.
  - Deferral value of transmission and distribution system expansion (if applicable).
  - Non-energy benefits (e.g., water savings).

- Environmental externalities.

- Discounted presented value inputs:
  - Rate = After-tax average cost of capital, weighted for project participants (real or nominal).

    The analysis used City Light's discount rate of 3.0%.
  - Term = Project life, generally equivalent to life of resources added during the planning period.

    Costs were levelized over each measure's expected useful life. Any reinstallation costs over the 21-year planning period were similarly levelized.
  - Money was discounted, not energy savings.

    The value of energy savings ($) is discounted

1.1.3. Achievable Potential

- Annual acquisition targets, established through the IRP process (i.e., portfolio modeling).

  Acquisition targets were established in accordance to WAC 194-37. The CPA determined conservation targets based on the pro-rata share of ten-year conservation potential and 2-year conservation potential. This level of conservation was included in City Light's IRP modeling.
- Conservation competed against all other resource options in portfolio analysis. Conservation resource supply curves separated into the following:
  - Discretionary (non-lost opportunity).

    Defined as retrofit opportunities in existing facilities.
  - Lost-opportunity.

    Including equipment replacements in existing facilities and all new construction measures.
  - Annual achievable potential, constrained by historic "ramp rates" for discretionary and lost-opportunity resources:

    The maximum ramp-up/ramp-down rate for discretionary was 3x the prior year for discretionary, with an upper limit of 85% over the 21-year planning period.

    Analysis assumed 85% of discretionary resources could be acquired within at least a 20-year timeframe.

    A lost-opportunity used a 15% ramp rate in the first year, growing to 85% by the 12th year.

    Lost opportunity ramp rates varied by measure and were based on City Light's program history.

    Achievable potentials could vary by the type of measure, customer sector, and program design (e.g., measures subject to federal standards could have 100% "achievable" potential).

While the analysis removed savings from known standards, it did not attempt to predict which savings would be acquired from future codes or standards.

- Revised technical, economic, and achievable potential were based on changes in market conditions (e.g., revised codes or standards), program accomplishments, evaluations, and experience.

  Changes taking effect after the finalization of the 2018 CPA are reflected in the 2020 CPA.
- All programs should incorporate Measurement and Verification (M&V) plans that, at a minimum, track administrative and measure costs and savings.
- The International Performance Measurement and Verification Protocols (IPMVP) should be used as a guide.

Baseline Data

Appendix B includes summaries of baseline forecasts for the residential, commercial, and industrial sectors. Cadmus calibrated these forecasts to City Light's load forecasts, though individual sector forecasts may differ from City Light's due to adjustments for future equipment standards. This appendix also includes detailed baseline inputs for the residential and commercial sectors, such as end-use saturations, fuel shares, and unit energy consumption (UEC) or end-use energy-use intensities (EUIs). UECs, applying to the residential sector, are expressed in kWh per unit. EUIs, applying to the commercial sector, are expressed in kWh per square foot.

B.1. Residential Baseline Data

Figure B-1. Residential Baseline Forecast by Segment

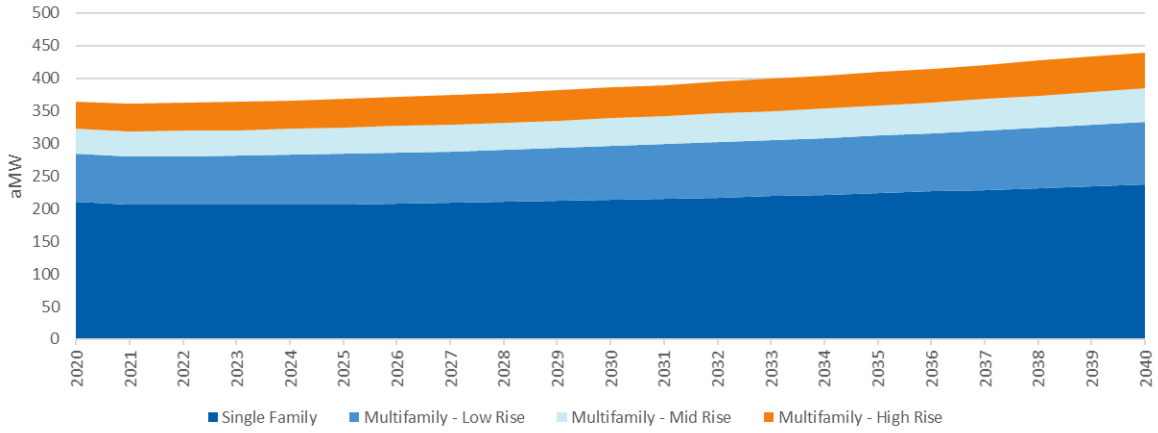


Figure B-2. Residential Baseline Forecast by End Use

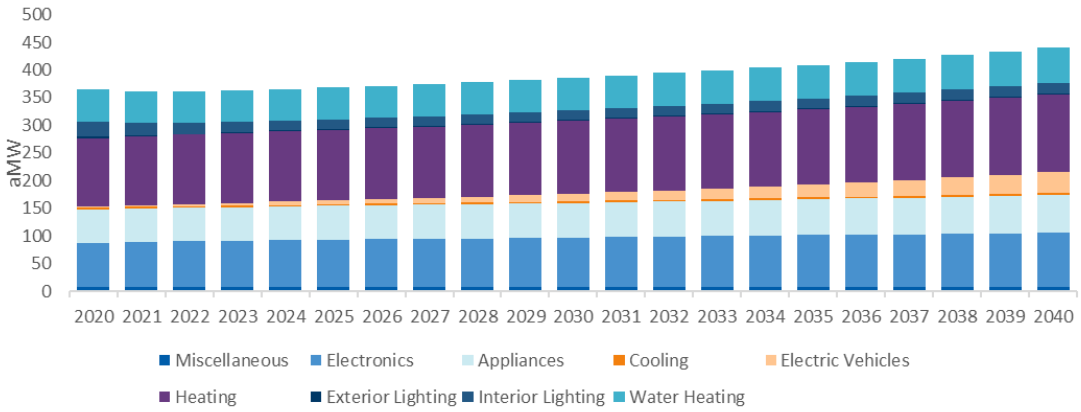


TABLE B-1. RESIDENTIAL SATURATION FUEL SHARES AND UECS					
Segment	**End Use**	**Saturation**	**Fuel Share**	**Weighted Average UEC Existing (kWh/Unit)**	**Weighted Average UEC New (kWh/Unit)**
Multifamily - High Rise	Air Purifier	0.0	100%	233.50	224.46
Multifamily - High Rise	Computer - Desktop	0.4	100%	65.01	65.01
Multifamily - High Rise	Computer - Laptop	0.4	100%	18.91	18.91
Multifamily - High Rise	Cooking Oven	1.0	93%	73.42	73.42
Multifamily - High Rise	Cooking Range	1.0	93%	49.95	49.95
Multifamily - High Rise	Cool Central	0.0	100%	41.81	12.22
Multifamily - High Rise	Cool Room	0.2	100%	13.43	12.97
Multifamily - High Rise	Copier	0.0	100%	225.54	224.51
Multifamily - High Rise	Dryer	0.4	100%	185.31	139.32
Multifamily - High Rise	DVD Player	1.2	100%	10.19	10.19
Multifamily - High Rise	Electric Vehicles	0.0	100%	1895.44	1895.44
Multifamily - High Rise	Freezer	0.0	100%	97.62	87.47
Multifamily - High Rise	Heat Central	0.0	0%	7269.04	3531.37
Multifamily - High Rise	Heat Pump	0.0	100%	562.97	248.40
Multifamily - High Rise	Heat Room	0.8	97%	957.93	957.93
Multifamily - High Rise	Home Audio System	0.5	100%	50.64	50.64
Multifamily - High Rise	Lighting Exterior Standard	0.1	100%	8.16	2.83
Multifamily - High Rise	Lighting Interior Linear Fluorescent	1.6	100%	4.93	4.93
Multifamily - High Rise	Lighting Interior Specialty	6.5	100%	7.54	7.54
Multifamily - High Rise	Lighting Interior Standard	9.2	100%	3.40	1.50
Multifamily - High Rise	Microwave	0.7	100%	40.61	40.61
Multifamily - High Rise	Monitor	0.3	100%	30.44	30.44
Multifamily - High Rise	Multifunction Device	0.9	100%	79.06	77.75

TABLE B-1. RESIDENTIAL SATURATION FUEL SHARES AND UECS					
Multifamily - High Rise	Other	1.0	100%	0.00	0.00
Multifamily - High Rise	Plug Load Other	1.0	100%	302.63	302.63
Multifamily - High Rise	Printer	0.3	100%	57.79	57.79
Multifamily - High Rise	Refrigerator	1.0	100%	80.78	79.01
Multifamily - High Rise	Set Top Box	0.3	100%	73.35	73.35
Multifamily - High Rise	Television	0.7	100%	102.79	102.79
Multifamily - High Rise	Television - Big Screen	0.4	100%	219.99	219.99
Multifamily - High Rise	Ventilation and Circulation	0.0	100%	248.40	155.90
Multifamily - High Rise	Waste Water	1.0	100%	82.55	82.55
Multifamily - High Rise	Water Heat GT 55 Gal	0.0	100%	187.83	92.05
Multifamily - High Rise	Water Heat LE 55 Gal	0.3	100%	173.82	169.82
Multifamily - Low Rise	Air Purifier	0.0	100%	233.50	224.46
Multifamily - Low Rise	Computer - Desktop	0.2	100%	65.01	65.01
Multifamily - Low Rise	Computer - Laptop	0.6	100%	18.91	18.91
Multifamily - Low Rise	Cooking Oven	1.0	89%	73.42	73.42
Multifamily - Low Rise	Cooking Range	1.0	89%	49.95	49.95
Multifamily - Low Rise	Cool Central	0.0	100%	50.06	14.63
Multifamily - Low Rise	Cool Room	0.2	100%	13.43	12.97
Multifamily - Low Rise	Copier	0.0	100%	225.54	224.51
Multifamily - Low Rise	Dryer	0.1	100%	173.81	139.32
Multifamily - Low Rise	DVD Player	1.2	100%	10.19	10.19
Multifamily - Low Rise	Electric Vehicles	0.0	100%	1895.44	1895.44
Multifamily - Low Rise	Freezer	0.1	100%	97.62	87.47
Multifamily - Low Rise	Heat Central	0.0	0%	8703.25	4228.13
Multifamily - Low Rise	Heat Pump	0.0	100%	674.05	297.41
Multifamily - Low Rise	Heat Room	0.9	100%	1123.31	1123.31
Multifamily - Low Rise	Home Audio System	0.5	100%	50.04	50.04

TABLE B-1. RESIDENTIAL SATURATION FUEL SHARES AND UECS					
Multifamily - Low Rise	Lighting Exterior Standard	0.0	100%	8.16	2.83
Multifamily - Low Rise	Lighting Interior Linear Fluorescent	1.6	100%	4.93	4.93
Multifamily - Low Rise	Lighting Interior Specialty	3.5	100%	7.54	7.54
Multifamily - Low Rise	Lighting Interior Standard	12.5	100%	3.40	1.50
Multifamily - Low Rise	Microwave	0.7	100%	40.61	40.61
Multifamily - Low Rise	Monitor	0.4	100%	30.44	30.44
Multifamily - Low Rise	Multifunction Device	0.9	100%	79.06	77.75
Multifamily - Low Rise	Other	1.0	100%	0.00	0.00
Multifamily - Low Rise	Plug Load Other	1.0	100%	302.63	302.63
Multifamily - Low Rise	Printer	0.3	100%	57.79	57.79
Multifamily - Low Rise	Refrigerator	1.0	100%	80.06	78.65
Multifamily - Low Rise	Set Top Box	0.8	100%	62.84	62.84
Multifamily - Low Rise	Television	1.0	100%	92.11	92.11
Multifamily - Low Rise	Television - Big Screen	0.4	100%	200.31	200.31
Multifamily - Low Rise	Ventilation and Circulation	0.0	100%	248.40	155.90
Multifamily - Low Rise	Waste Water	1.0	100%	101.80	101.80
Multifamily - Low Rise	Water Heat GT 55 Gal	0.0	0%	231.64	113.52
Multifamily - Low Rise	Water Heat LE 55 Gal	0.6	100%	214.36	209.42
Multifamily - Mid Rise	Air Purifier	0.0	100%	233.50	224.46
Multifamily - Mid Rise	Computer - Desktop	0.4	100%	65.01	65.01
Multifamily - Mid Rise	Computer - Laptop	0.4	100%	18.91	18.91
Multifamily - Mid Rise	Cooking Oven	1.0	93%	73.42	73.42
Multifamily - Mid Rise	Cooking Range	1.0	93%	49.95	49.95
Multifamily - Mid Rise	Cool Central	0.0	100%	41.81	12.22

TABLE B-1. RESIDENTIAL SATURATION FUEL SHARES AND UECS					
Multifamily - Mid Rise	Cool Room	0.2	100%	13.43	12.97
Multifamily - Mid Rise	Copier	0.0	100%	225.54	224.51
Multifamily - Mid Rise	Dryer	0.4	100%	185.31	139.32
Multifamily - Mid Rise	DVD Player	1.2	100%	10.19	10.19
Multifamily - Mid Rise	Electric Vehicles	0.0	100%	1895.44	1895.44
Multifamily - Mid Rise	Freezer	0.0	100%	97.62	87.47
Multifamily - Mid Rise	Heat Central	0.0	0%	7269.04	3531.37
Multifamily - Mid Rise	Heat Pump	0.0	100%	562.97	248.40
Multifamily - Mid Rise	Heat Room	0.8	97%	934.30	934.30
Multifamily - Mid Rise	Home Audio System	0.5	100%	50.64	50.64
Multifamily - Mid Rise	Lighting Exterior Standard	0.1	100%	8.16	2.83
Multifamily - Mid Rise	Lighting Interior Linear Fluorescent	1.6	100%	4.93	4.93
Multifamily - Mid Rise	Lighting Interior Specialty	6.5	100%	7.54	7.54
Multifamily - Mid Rise	Lighting Interior Standard	9.2	100%	3.40	1.50
Multifamily - Mid Rise	Microwave	0.7	100%	40.61	40.61
Multifamily - Mid Rise	Monitor	0.3	100%	30.44	30.44
Multifamily - Mid Rise	Multifunction Device	0.9	100%	79.06	77.75
Multifamily - Mid Rise	Other	1.0	100%	0.00	0.00
Multifamily - Mid Rise	Plug Load Other	1.0	100%	302.63	302.63
Multifamily - Mid Rise	Printer	0.3	100%	57.79	57.79
Multifamily - Mid Rise	Refrigerator	1.0	100%	80.78	79.01
Multifamily - Mid Rise	Set Top Box	0.3	100%	73.35	73.35
Multifamily - Mid Rise	Television	0.7	100%	102.79	102.79
Multifamily - Mid Rise	Television - Big Screen	0.4	100%	219.99	219.99
Multifamily - Mid Rise	Ventilation and Circulation	0.0	100%	248.40	155.90
Multifamily - Mid Rise	Waste Water	1.0	100%	82.55	82.55

TABLE B-1. RESIDENTIAL SATURATION FUEL SHARES AND UECS					
Multifamily - Mid Rise	Water Heat GT 55 Gal	0.0	100%	187.83	92.05
Multifamily - Mid Rise	Water Heat LE 55 Gal	0.3	100%	173.82	169.82
Single Family	Air Purifier	0.0	100%	233.50	224.46
Single Family	Computer - Desktop	0.8	100%	69.69	69.69
Single Family	Computer - Laptop	0.7	100%	19.74	19.74
Single Family	Cooking Oven	1.1	81%	73.90	73.90
Single Family	Cooking Range	1.1	76%	49.95	49.95
Single Family	Cool Central	0.1	100%	105.81	30.92
Single Family	Cool Room	0.1	100%	13.43	12.97
Single Family	Copier	0.0	100%	225.54	224.51
Single Family	Dryer	1.0	86%	185.90	139.32
Single Family	DVD Player	1.6	100%	10.19	10.19
Single Family	Electric Vehicles	0.0	100%	1895.44	1895.44
Single Family	Freezer	0.3	100%	97.62	87.47
Single Family	Heat Central	0.6	2%	9198.06	4468.51
Single Family	Heat Pump	0.0	100%	1214.18	532.97
Single Family	Heat Room	0.3	70%	1431.75	1431.75
Single Family	Home Audio System	0.9	100%	51.70	51.70
Single Family	Lighting Exterior Standard	4.7	100%	8.16	2.83
Single Family	Lighting Interior Linear Fluorescent	4.4	100%	4.93	4.93
Single Family	Lighting Interior Specialty	24.2	100%	7.54	7.54
Single Family	Lighting Interior Standard	24.2	100%	3.40	1.50
Single Family	Microwave	0.8	100%	40.61	40.61
Single Family	Monitor	0.7	100%	31.01	31.01
Single Family	Multifunction Device	1.2	100%	79.06	77.75

TABLE B-1. RESIDENTIAL SATURATION FUEL SHARES AND UECS					
Single Family	Other	1.0	100%	0.00	0.00
Single Family	Plug Load Other	1.0	100%	720.38	720.38
Single Family	Pool Pump	0.0	100%	266.54	266.54
Single Family	Printer	0.7	100%	57.79	57.79
Single Family	Refrigerator	1.4	100%	80.48	78.77
Single Family	Set Top Box	0.9	100%	85.70	85.70
Single Family	Television	1.2	100%	113.53	113.53
Single Family	Television - Big Screen	0.6	100%	238.23	238.23
Single Family	Ventilation and Circulation	0.6	100%	248.40	155.90
Single Family	Waste Water	1.0	100%	153.00	153.00
Single Family	Water Heat GT 55 Gal	0.2	88%	348.14	170.61
Single Family	Water Heat LE 55 Gal	0.8	64%	322.17	314.74

B.2. Commercial Baseline Data

Figure B-3. Commercial Baseline Forecast by Sector

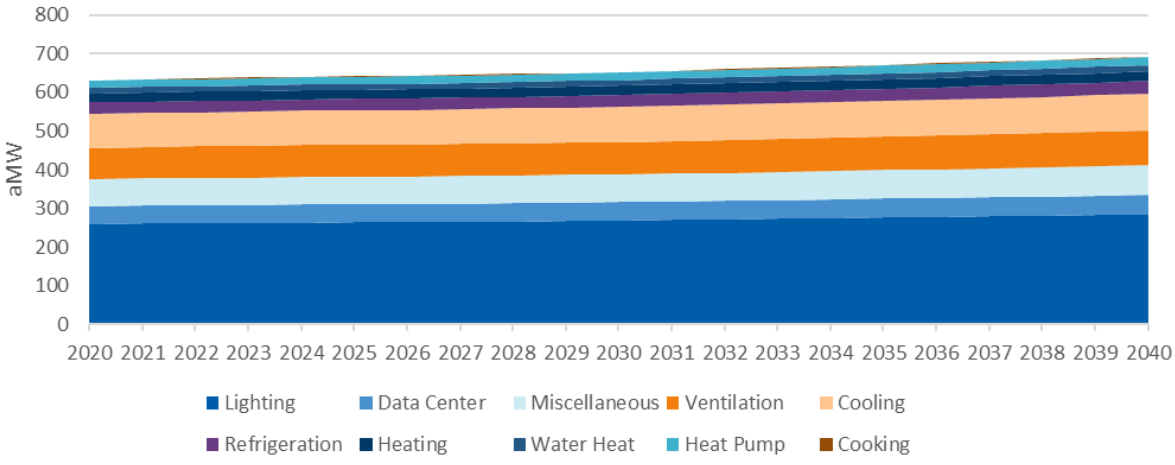


Figure B-4. Commercial Baseline Forecast by End Use

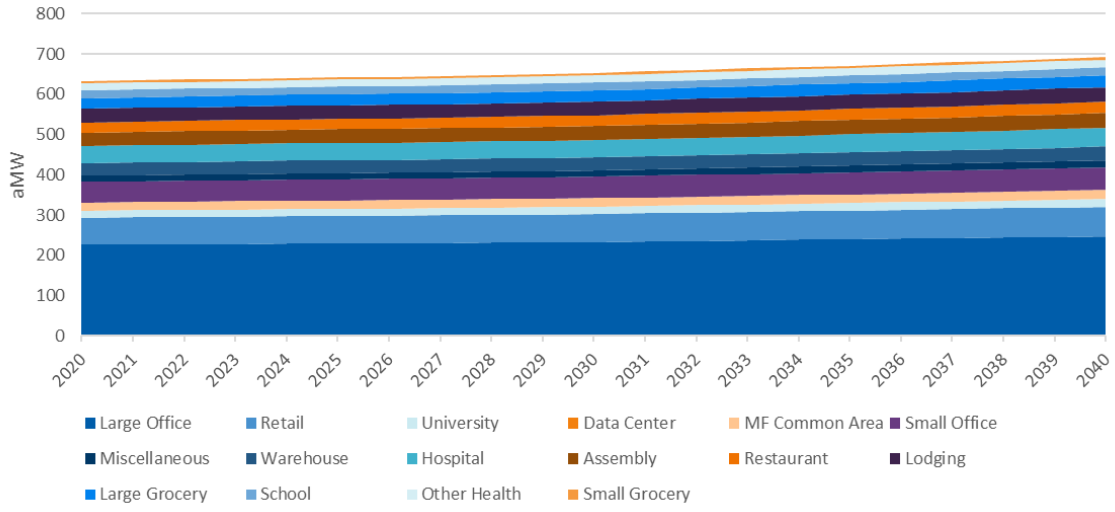


TABLE B-2. COMMERCIAL SATURATION FUEL SHARES AND UECS					
Segment	**End Use**	**Saturation**	**Fuel Share**	**Weighted Average UEC Existing (kWh/Unit)**	**Weighted Average UEC New (kWh/Unit)**
Assembly	Compressed Air	3%	100%	0.71	0.71
Assembly	Cooking	0%	0%	0.00	0.00
Assembly	Cool Central	41%	100%	3.32	3.32
Assembly	Data Center	100%	100%	0.44	0.44
Assembly	Exterior Lighting	100%	100%	1.12	1.12
Assembly	Heat Central	75%	13%	2.37	2.37
Assembly	Heat Pump	22%	100%	2.73	2.73
Assembly	Interior Lighting	100%	100%	3.56	3.56
Assembly	Other	100%	100%	0.00	0.00
Assembly	Plug Load Other	100%	100%	1.30	1.30
Assembly	Refrigeration	100%	100%	0.17	0.17
Assembly	Ventilation	97%	100%	1.93	1.93
Assembly	Waste Water	100%	100%	0.12	0.12
Assembly	Water Heat GT 55 Gal	35%	63%	0.35	0.35
Assembly	Water Heat LE 55 Gal	65%	85%	0.32	0.32
Hospital	Compressed Air	0%	100%	0.00	0.00
Hospital	Cooking	100%	13%	0.65	0.65
Hospital	Cool Central	65%	100%	4.56	4.56
Hospital	Data Center	100%	100%	1.75	1.75
Hospital	Exterior Lighting	100%	100%	0.70	0.70
Hospital	Heat Central	76%	34%	1.52	1.52
Hospital	Heat Pump	23%	100%	4.36	4.36
Hospital	Interior Lighting	100%	100%	7.26	7.26
Hospital	Other	100%	100%	0.00	0.00
Hospital	Plug Load Other	100%	100%	5.05	5.05
Hospital	Refrigeration	100%	100%	0.59	0.59

TABLE B-2. COMMERCIAL SATURATION FUEL SHARES AND UECS					
Segment	**End Use**	**Saturation**	**Fuel Share**	**Weighted Average UEC Existing (kWh/Unit)**	**Weighted Average UEC New (kWh/Unit)**
Hospital	Ventilation	99%	100%	6.46	6.46
Hospital	Waste Water	100%	100%	0.26	0.26
Hospital	Water Heat GT 55 Gal	79%	4%	1.70	1.70
Hospital	Water Heat LE 55 Gal	21%	67%	1.59	1.59
Large Off	Compressed Air	0%	100%	0.00	0.00
Large Off	Cooking	0%	0%	0.00	0.00
Large Off	Cool Central	87%	100%	3.86	3.86
Large Off	Data Center	100%	100%	1.75	1.75
Large Off	Exterior Lighting	100%	100%	0.54	0.54
Large Off	Heat Central	85%	31%	3.39	3.39
Large Off	Heat Pump	14%	100%	3.16	3.16
Large Off	Interior Lighting	100%	100%	4.81	4.81
Large Off	Other	100%	100%	0.00	0.00
Large Off	Plug Load Other	100%	100%	1.47	1.47
Large Off	Refrigeration	100%	100%	0.09	0.09
Large Off	Ventilation	98%	100%	1.62	1.62
Large Off	Waste Water	100%	100%	0.21	0.21
Large Off	Water Heat GT 55 Gal	41%	53%	0.50	0.50
Large Off	Water Heat LE 55 Gal	59%	100%	0.47	0.47
Large Ret	Compressed Air	48%	100%	0.15	0.15
Large Ret	Cooking	0%	0%	0.00	0.00
Large Ret	Cool Central	97%	100%	1.94	1.94
Large Ret	Data Center	100%	100%	0.44	0.44
Large Ret	Exterior Lighting	100%	100%	1.14	1.14
Large Ret	Heat Central	98%	6%	2.07	2.07

TABLE B-2. COMMERCIAL SATURATION FUEL SHARES AND UECS					
Segment	**End Use**	**Saturation**	**Fuel Share**	**Weighted Average UEC Existing (kWh/Unit)**	**Weighted Average UEC New (kWh/Unit)**
Large Ret	Heat Pump	0%	100%	2.98	2.98
Large Ret	Interior Lighting	100%	100%	7.53	7.53
Large Ret	Other	100%	100%	0.00	0.00
Large Ret	Plug Load Other	100%	100%	0.83	0.83
Large Ret	Refrigeration	100%	100%	0.08	0.08
Large Ret	Ventilation	98%	100%	2.79	2.79
Large Ret	Waste Water	100%	100%	0.13	0.13
Large Ret	Water Heat GT 55 Gal	43%	11%	0.30	0.30
Large Ret	Water Heat LE 55 Gal	57%	50%	0.28	0.28
Lodging	Compressed Air	0%	100%	0.00	0.00
Lodging	Cooking	100%	11%	0.53	0.53
Lodging	Cool Central	50%	100%	2.71	2.71
Lodging	Data Center	100%	100%	0.44	0.44
Lodging	Exterior Lighting	100%	100%	0.54	0.54
Lodging	Heat Central	63%	46%	3.25	3.25
Lodging	Heat Pump	35%	100%	3.08	3.08
Lodging	Interior Lighting	100%	100%	5.65	5.65
Lodging	Other	100%	100%	0.00	0.00
Lodging	Plug Load Other	100%	100%	0.92	0.92
Lodging	Refrigeration	100%	100%	0.22	0.22
Lodging	Ventilation	98%	100%	2.63	2.63
Lodging	Waste Water	100%	100%	0.32	0.32
Lodging	Water Heat GT 55 Gal	87%	12%	1.41	1.41
Lodging	Water Heat LE 55 Gal	13%	100%	1.32	1.32
Medium Off	Compressed Air	0%	100%	0.00	0.00

TABLE B-2. COMMERCIAL SATURATION FUEL SHARES AND UECS					
Segment	**End Use**	**Saturation**	**Fuel Share**	**Weighted Average UEC Existing (kWh/Unit)**	**Weighted Average UEC New (kWh/Unit)**
Medium Off	Cooking	0%	0%	0.00	0.00
Medium Off	Cool Central	87%	100%	4.08	4.08
Medium Off	Data Center	100%	100%	1.75	1.75
Medium Off	Exterior Lighting	100%	100%	0.57	0.57
Medium Off	Heat Central	85%	31%	3.57	3.57
Medium Off	Heat Pump	14%	100%	3.34	3.34
Medium Off	Interior Lighting	100%	100%	5.07	5.07
Medium Off	Other	100%	100%	0.00	0.00
Medium Off	Plug Load Other	100%	100%	1.55	1.55
Medium Off	Refrigeration	100%	100%	0.10	0.10
Medium Off	Ventilation	98%	100%	1.70	1.70
Medium Off	Waste Water	100%	100%	0.21	0.21
Medium Off	Water Heat GT 55 Gal	41%	53%	0.52	0.52
Medium Off	Water Heat LE 55 Gal	59%	100%	0.49	0.49
Medium Ret	Compressed Air	48%	100%	0.15	0.15
Medium Ret	Cooking	0%	0%	0.00	0.00
Medium Ret	Cool Central	97%	100%	1.67	1.67
Medium Ret	Data Center	100%	100%	0.44	0.44
Medium Ret	Exterior Lighting	100%	100%	0.98	0.98
Medium Ret	Heat Central	98%	6%	1.79	1.79
Medium Ret	Heat Pump	0%	100%	2.57	2.57
Medium Ret	Interior Lighting	100%	100%	6.50	6.50
Medium Ret	Other	100%	100%	0.00	0.00
Medium Ret	Plug Load Other	100%	100%	0.72	0.72
Medium Ret	Refrigeration	100%	100%	0.07	0.07
Medium Ret	Ventilation	98%	100%	2.41	2.41

TABLE B-2. COMMERCIAL SATURATION FUEL SHARES AND UECS					
Segment	**End Use**	**Saturation**	**Fuel Share**	**Weighted Average UEC Existing (kWh/Unit)**	**Weighted Average UEC New (kWh/Unit)**
Medium Ret	Waste Water	100%	100%	0.13	0.13
Medium Ret	Water Heat GT 55 Gal	43%	11%	0.26	0.26
Medium Ret	Water Heat LE 55 Gal	57%	50%	0.24	0.24
MiniMart	Compressed Air	29%	100%	2.62	2.62
MiniMart	Cooking	100%	9%	1.98	1.98
MiniMart	Cool Central	71%	100%	1.27	1.27
MiniMart	Data Center	100%	100%	0.44	0.44
MiniMart	Exterior Lighting	100%	100%	0.78	0.78
MiniMart	Heat Central	74%	45%	1.59	1.59
MiniMart	Heat Pump	13%	100%	3.39	3.39
MiniMart	Interior Lighting	100%	100%	6.86	6.86
MiniMart	Other	100%	100%	0.00	0.00
MiniMart	Plug Load Other	100%	100%	0.91	0.91
MiniMart	Refrigeration	100%	100%	15.11	15.11
MiniMart	Ventilation	87%	100%	1.59	1.59
MiniMart	Waste Water	100%	100%	0.09	0.09
MiniMart	Water Heat GT 55 Gal	1%	33%	0.23	0.23
MiniMart	Water Heat LE 55 Gal	99%	71%	0.21	0.21
Multi Family Common Area	Compressed Air	100%	100%	0.00	0.00
Multi Family Common Area	Cooking	100%	100%	0.00	0.00
Multi Family Common Area	Cool Central	100%	100%	0.00	0.00
Multi Family Common Area	Data Center	100%	100%	0.00	0.00
Multi Family Common	Exterior Lighting	100%	100%	0.00	0.00

TABLE B-2. COMMERCIAL SATURATION FUEL SHARES AND UECS					
Segment	**End Use**	**Saturation**	**Fuel Share**	**Weighted Average UEC Existing (kWh/Unit)**	**Weighted Average UEC New (kWh/Unit)**
Area					
Multi Family Common Area	Heat Central	100%	100%	0.00	0.00
Multi Family Common Area	Heat Pump	100%	100%	0.00	0.00
Multi Family Common Area	Interior Lighting	100%	100%	2.75	2.75
Multi Family Common Area	Other	100%	100%	0.00	0.00
Multi Family Common Area	Plug Load Other	100%	100%	0.00	0.00
Multi Family Common Area	Refrigeration	100%	100%	0.00	0.00
Multi Family Common Area	Ventilation	100%	100%	0.00	0.00
Multi Family Common Area	Waste Water	100%	100%	0.00	0.00
Multi Family Common Area	Water Heat GT 55 Gal	100%	100%	0.00	0.00
Multi Family Common Area	Water Heat LE 55 Gal	100%	100%	0.00	0.00
Other	Compressed Air	23%	100%	0.29	0.29
Other	Cooking	0%	0%	0.00	0.00
Other	Cool Central	70%	100%	1.59	1.59
Other	Data Center	100%	100%	0.18	0.18
Other	Exterior Lighting	100%	100%	0.53	0.53
Other	Heat Central	87%	21%	1.13	1.13
Other	Heat Pump	10%	100%	1.30	1.30
Other	Interior Lighting	100%	100%	1.70	1.70
Other	Other	100%	100%	0.00	0.00
Other	Plug Load Other	100%	100%	0.62	0.62
Other	Refrigeration	100%	100%	0.08	0.08

TABLE B-2. COMMERCIAL SATURATION FUEL SHARES AND UECS					
Segment	**End Use**	**Saturation**	**Fuel Share**	**Weighted Average UEC Existing (kWh/Unit)**	**Weighted Average UEC New (kWh/Unit)**
Other	Ventilation	97%	100%	0.92	0.92
Other	Waste Water	100%	100%	0.11	0.11
Other	Water Heat GT 55 Gal	49%	16%	0.16	0.16
Other	Water Heat LE 55 Gal	51%	72%	0.15	0.15
Residential Care	Compressed Air	0%	100%	0.00	0.00
Residential Care	Cooking	0%	0%	0.00	0.00
Residential Care	Cool Central	65%	100%	2.01	2.01
Residential Care	Data Center	100%	100%	0.44	0.44
Residential Care	Exterior Lighting	100%	100%	0.31	0.31
Residential Care	Heat Central	76%	34%	0.67	0.67
Residential Care	Heat Pump	23%	100%	1.92	1.92
Residential Care	Interior Lighting	100%	100%	3.21	3.21
Residential Care	Other	100%	100%	0.00	0.00
Residential Care	Plug Load Other	100%	100%	2.23	2.23
Residential Care	Refrigeration	100%	100%	0.26	0.26
Residential Care	Ventilation	99%	100%	2.85	2.85
Residential Care	Waste Water	100%	100%	0.26	0.26
Residential Care	Water Heat GT 55 Gal	79%	4%	0.75	0.75
Residential Care	Water Heat LE 55 Gal	21%	67%	0.70	0.70
Restaurant	Compressed Air	0%	100%	0.00	0.00
Restaurant	Cooking	100%	11%	7.08	7.08
Restaurant	Cool Central	73%	100%	3.09	3.09
Restaurant	Data Center	100%	100%	0.44	0.44
Restaurant	Exterior Lighting	100%	100%	1.77	1.77
Restaurant	Heat Central	88%	9%	1.02	1.02

TABLE B-2. COMMERCIAL SATURATION FUEL SHARES AND UECS					
Segment	**End Use**	**Saturation**	**Fuel Share**	**Weighted Average UEC Existing (kWh/Unit)**	**Weighted Average UEC New (kWh/Unit)**
Restaurant	Heat Pump	7%	100%	3.66	3.66
Restaurant	Interior Lighting	100%	100%	6.44	6.44
Restaurant	Other	100%	100%	0.00	0.00
Restaurant	Plug Load Other	100%	100%	1.21	1.21
Restaurant	Refrigeration	100%	100%	4.01	4.01
Restaurant	Ventilation	96%	100%	2.68	2.68
Restaurant	Waste Water	100%	100%	1.92	1.92
Restaurant	Water Heat GT 55 Gal	53%	26%	6.65	6.65
Restaurant	Water Heat LE 55 Gal	47%	43%	6.24	6.24
School K-12	Compressed Air	0%	100%	0.00	0.00
School K-12	Cooking	100%	14%	0.17	0.17
School K-12	Cool Central	53%	100%	0.54	0.54
School K-12	Data Center	100%	100%	0.88	0.88
School K-12	Exterior Lighting	100%	100%	0.57	0.57
School K-12	Heat Central	85%	3%	4.29	4.29
School K-12	Heat Pump	14%	100%	2.04	2.04
School K-12	Interior Lighting	100%	100%	2.58	2.58
School K-12	Other	100%	100%	0.00	0.00
School K-12	Plug Load Other	100%	100%	0.62	0.62
School K-12	Refrigeration	100%	100%	0.37	0.37
School K-12	Ventilation	100%	100%	1.00	1.00
School K-12	Waste Water	100%	100%	0.25	0.25
School K-12	Water Heat GT 55 Gal	63%	21%	1.14	1.14
School K-12	Water Heat LE 55 Gal	37%	35%	1.07	1.07
Small Off	Compressed Air	0%	100%	0.00	0.00

TABLE B-2. COMMERCIAL SATURATION FUEL SHARES AND UECS					
Segment	**End Use**	**Saturation**	**Fuel Share**	**Weighted Average UEC Existing (kWh/Unit)**	**Weighted Average UEC New (kWh/Unit)**
Small Off	Cooking	0%	0%	0.00	0.00
Small Off	Cool Central	65%	100%	3.35	3.35
Small Off	Data Center	100%	100%	1.75	1.75
Small Off	Exterior Lighting	100%	100%	0.47	0.47
Small Off	Heat Central	67%	51%	2.93	2.93
Small Off	Heat Pump	29%	100%	2.74	2.74
Small Off	Interior Lighting	100%	100%	4.17	4.17
Small Off	Other	100%	100%	0.00	0.00
Small Off	Plug Load Other	100%	100%	1.27	1.27
Small Off	Refrigeration	100%	100%	0.08	0.08
Small Off	Ventilation	96%	100%	1.40	1.40
Small Off	Waste Water	100%	100%	0.21	0.21
Small Off	Water Heat GT 55 Gal	20%	83%	0.43	0.43
Small Off	Water Heat LE 55 Gal	80%	93%	0.40	0.40
Small Ret	Compressed Air	23%	100%	0.52	0.52
Small Ret	Cooking	0%	0%	0.00	0.00
Small Ret	Cool Central	54%	100%	2.05	2.05
Small Ret	Data Center	100%	100%	0.44	0.44
Small Ret	Exterior Lighting	100%	100%	1.20	1.20
Small Ret	Heat Central	79%	18%	2.19	2.19
Small Ret	Heat Pump	15%	100%	3.15	3.15
Small Ret	Interior Lighting	100%	100%	7.96	7.96
Small Ret	Other	100%	100%	0.00	0.00
Small Ret	Plug Load Other	100%	100%	0.88	0.88
Small Ret	Refrigeration	100%	100%	0.08	0.08
Small Ret	Ventilation	94%	100%	2.95	2.95

TABLE B-2. COMMERCIAL SATURATION FUEL SHARES AND UECS					
Segment	**End Use**	**Saturation**	**Fuel Share**	**Weighted Average UEC Existing (kWh/Unit)**	**Weighted Average UEC New (kWh/Unit)**
Small Ret	Waste Water	100%	100%	0.06	0.06
Small Ret	Water Heat GT 55 Gal	4%	100%	0.31	0.31
Small Ret	Water Heat LE 55 Gal	96%	73%	0.29	0.29
Supermarket	Compressed Air	7%	100%	0.06	0.06
Supermarket	Cooking	100%	15%	2.55	2.55
Supermarket	Cool Central	81%	100%	1.64	1.64
Supermarket	Data Center	100%	100%	0.44	0.44
Supermarket	Exterior Lighting	100%	100%	1.00	1.00
Supermarket	Heat Central	92%	10%	2.04	2.04
Supermarket	Heat Pump	0%	100%	4.36	4.36
Supermarket	Interior Lighting	100%	100%	8.81	8.81
Supermarket	Other	100%	100%	0.00	0.00
Supermarket	Plug Load Other	100%	100%	1.17	1.17
Supermarket	Refrigeration	100%	100%	19.42	19.42
Supermarket	Ventilation	92%	100%	2.04	2.04
Supermarket	Waste Water	100%	100%	0.06	0.06
Supermarket	Water Heat GT 55 Gal	40%	27%	0.29	0.29
Supermarket	Water Heat LE 55 Gal	60%	54%	0.27	0.27
University	Compressed Air	0%	100%	0.00	0.00
University	Cooking	100%	14%	0.77	0.77
University	Cool Central	53%	100%	1.30	1.30
University	Data Center	100%	100%	0.88	0.88
University	Exterior Lighting	100%	100%	1.39	1.39
University	Heat Central	85%	3%	10.36	10.36
University	Heat Pump	14%	100%	4.92	4.92

TABLE B-2. COMMERCIAL SATURATION FUEL SHARES AND UECS					
Segment	**End Use**	**Saturation**	**Fuel Share**	**Weighted Average UEC Existing (kWh/Unit)**	**Weighted Average UEC New (kWh/Unit)**
University	Interior Lighting	100%	100%	6.20	6.20
University	Other	100%	100%	0.00	0.00
University	Plug Load Other	100%	100%	1.50	1.50
University	Refrigeration	100%	100%	0.90	0.90
University	Ventilation	100%	100%	2.42	2.42
University	Waste Water	100%	100%	0.26	0.26
University	Water Heat GT 55 Gal	63%	21%	2.76	2.76
University	Water Heat LE 55 Gal	37%	35%	2.59	2.59
Warehouse	Compressed Air	21%	100%	1.52	1.52
Warehouse	Cooking	0%	0%	0.00	0.00
Warehouse	Cool Central	37%	100%	0.52	0.52
Warehouse	Data Center	100%	100%	0.44	0.44
Warehouse	Exterior Lighting	100%	100%	0.39	0.39
Warehouse	Heat Central	82%	3%	1.56	1.56
Warehouse	Heat Pump	0%	100%	1.00	1.00
Warehouse	Interior Lighting	100%	100%	4.03	4.03
Warehouse	Other	100%	100%	0.00	0.00
Warehouse	Plug Load Other	100%	100%	0.61	0.61
Warehouse	Refrigeration	100%	100%	0.04	0.04
Warehouse	Ventilation	83%	100%	0.80	0.80
Warehouse	Waste Water	100%	100%	0.19	0.19
Warehouse	Water Heat GT 55 Gal	11%	55%	0.27	0.27
Warehouse	Water Heat LE 55 Gal	89%	80%	0.26	0.26
Xlarge Ret	Compressed Air	48%	100%	0.15	0.15
Xlarge Ret	Cooking	0%	0%	0.00	0.00

TABLE B-2. COMMERCIAL SATURATION FUEL SHARES AND UECS					
Segment	**End Use**	**Saturation**	**Fuel Share**	**Weighted Average UEC Existing (kWh/Unit)**	**Weighted Average UEC New (kWh/Unit)**
Xlarge Ret	Cool Central	97%	100%	1.57	1.57
Xlarge Ret	Data Center	100%	100%	0.44	0.44
Xlarge Ret	Exterior Lighting	100%	100%	0.93	0.93
Xlarge Ret	Heat Central	98%	6%	1.68	1.68
Xlarge Ret	Heat Pump	0%	100%	2.42	2.42
Xlarge Ret	Interior Lighting	100%	100%	6.11	6.11
Xlarge Ret	Other	100%	100%	0.00	0.00
Xlarge Ret	Plug Load Other	100%	100%	0.68	0.68
Xlarge Ret	Refrigeration	100%	100%	0.06	0.06
Xlarge Ret	Ventilation	98%	100%	2.26	2.26
Xlarge Ret	Waste Water	100%	100%	0.13	0.13
Xlarge Ret	Water Heat GT 55 Gal	43%	11%	0.24	0.24
Xlarge Ret	Water Heat LE 55 Gal	57%	50%	0.23	0.23

B.3. Industrial Baseline Data

Figure B-5. Industrial Baseline Forecast by Industry

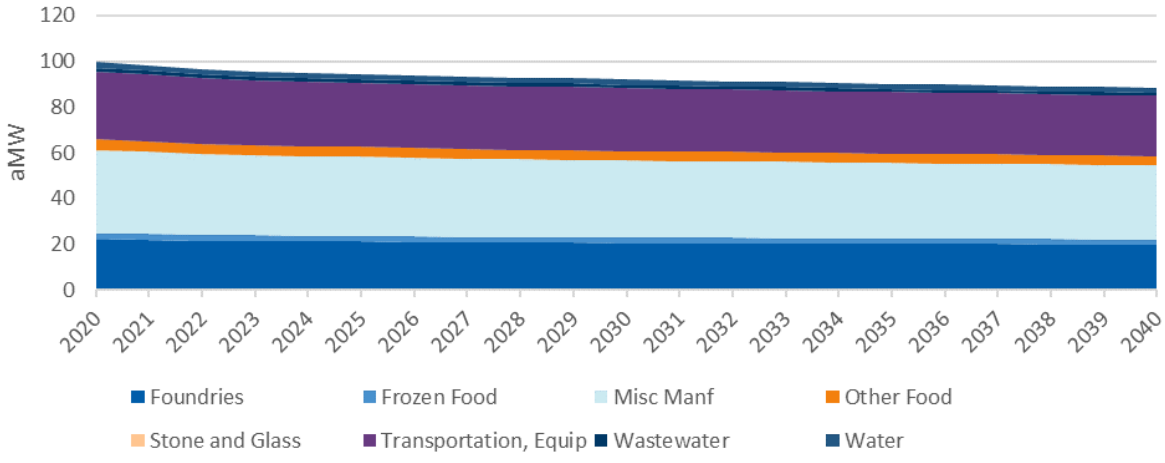
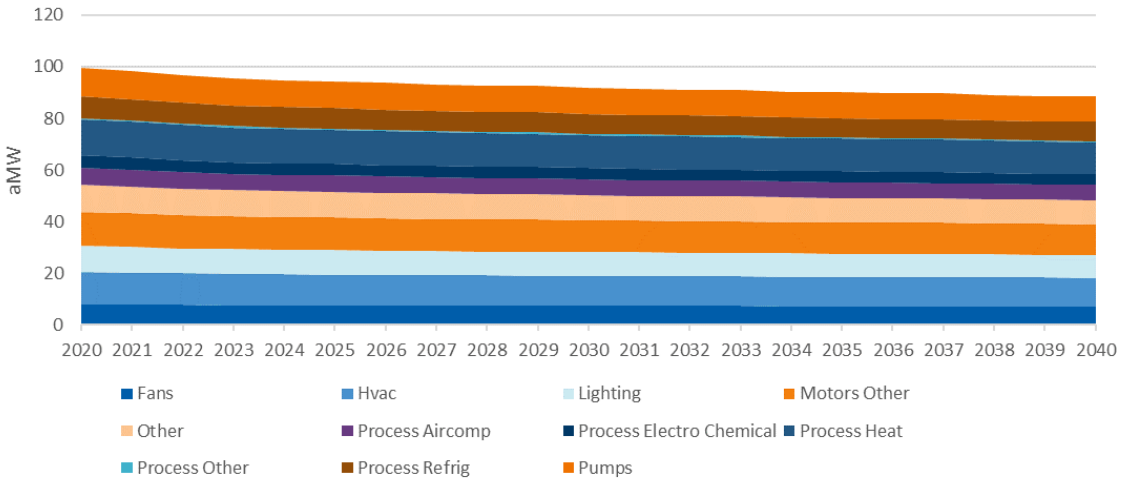


Figure B-6. Industrial Baseline Forecast by End Use



Measure Descriptions

This section presents a brief description of each measure used in the energy efficiency potential.

C.1. Residential Electric Retrofit Measure Descriptions

C.1.1. Heating and Cooling

Controlled Optimization Program. This measure represents a suite of behavioral measures, including the following:

- Water heater setback thermostat
- Lighting hours-of-use reduction
- HVAC usage reduction

Based on the 7th Plan workbook "res-cop-7p_v2".

Measure Name	Measure Efficiency
Controlled Optimization Program—Lighting	Controlled Optimization Program—Lighting
Controlled Optimization Program—HVAC	Controlled Optimization Program—HVAC
Controlled Optimization Program—Water Heat	Controlled Optimization Program—Water Heat

Controls Commissioning and Sizing. The installation of a heat pump with the proper sizing and commissioning of control setpoint temperatures can save energy through enhanced performance. Correctly sized HVAC systems operate for longer periods of time (instead of cycling on and off frequently), resulting in optimum equipment operating efficiencies and better control. Based on the 7th Plan workbook "res-ccs-7p_v4".

Measure Name	Measure Efficiency
SF CC&S + HZ1	Heating Savings
SF CC&S + HZ1	Cooling Savings

Duct Sealing. Duct sealing cost-effectively saves energy, improves air and thermal distribution (comfort and ventilation), and reduces cross contamination between different zones in a building (such as smoking vs. non-smoking, bio-aerosols, and localized indoor air pollutants). Based on the 7th Plan workbook "res-duct_seal-7p_v4".

Measure Name	Measure Efficiency
SF Performance-based Duct Sealing—Heat Pump + HZ1	SF Performance-based Duct Sealing—Heat Pump + HZ1
New SF Performance-based Duct Sealing—Heat Pump + HZ1	New SF Performance-based Duct Sealing—Heat Pump + HZ1

Heat Pump—Single-Family. This measure represents a suite of measures, including the following:

- Converting an electric furnace to a heat pump
- Converting an electric furnace and a central air conditioner to a heat pump
- Replace an existing heat pump with a more efficient, variable-capacity heat pump
- Replace zonal heating and cooling with a ductless heat pump

Based on the 7th Plan workbook "res-sf_hp-7p_v5".

Measure Name	Measure Efficiency
Existing Single-Family Home HVAC Conversion—Convert FAF w/CAC to Heat Pump—House with "Good Insulation" + HZ1	Heating Savings
Existing Single-Family Home HVAC Conversion—Convert FAF w/o CAC to Heat Pump—House with "Good Insulation" + HZ1CZ1	Heating Savings
Existing Single-Family Home HVAC Conversion—Convert FAF w/CAC to Heat Pump—House with "Good Insulation" + HZ1	Cooling Savings
Existing Single-Family Home HVAC Conversion—Convert FAF w/o CAC to Heat Pump—House with "Good Insulation" + HZ1CZ1	Cooling Savings

Heat Recovery Ventilation (HRV). This measure mechanically ventilates homes in cold climates. During the winter, it transfers heat from exhausted air to outside air entering the home, with between 50% and 80% of the heat normally lost in exhausted air returned to the house. Air-to-air heat exchangers can be installed as part of a central heating and cooling system or in walls or windows. Wall- and window-mounted units, resembling air conditioners, ventilate one room or area. Based on the 7th Plan workbook "res-hrv-7p_v1".

Measure Name	Measure Efficiency
SF RNC HRV ACH3 HZ1CZ1	Heating Savings
SF RNC HRV ACH3 HZ1CZ1	Cooling Savings

Weatherization—Multifamily. This measure represents a suite of measures, including the following:

- Attic insulation R-value improvement
- Floor insulation R-value improvement
- Wall insulation R-value improvement
- Window U-value improvement

Based on the 7th Plan workbook "res-mf_wx-7p_v7".

Measure Name	Measure Efficiency
WALL R0—R11_Electric Zonal	WALL R0—R11
FLOOR R0—R19_Electric Zonal	FLOOR R0—R19
FLOOR R0—R30_Electric Zonal	FLOOR R0—R30
ATTIC R0—R19_Electric Zonal	ATTIC R0—R19
ATTIC R0—R38_Electric Zonal	ATTIC R0—R38
ATTIC R0—R49_Electric Zonal	ATTIC R0—R49
ATTIC R19—R30_Electric Zonal	ATTIC R19—R30
ATTIC R19—R38_Electric Zonal	ATTIC R19—R38
ATTIC R19—R49_Electric Zonal	ATTIC R19—R49
WINDOW CL22 Prime Window Replacement of Single-Pane Base_Electric Zonal	WINDOW CL22 Prime Window Replacement of Single-Pane Base
WINDOW CL22 Prime Window Replacement of Double-Pane Base_Electric Zonal	WINDOW CL22 Prime Window Replacement of Double-Pane Base
WINDOW CL30 Prime Window Replacement of Single-Pane Base_Electric Zonal	WINDOW CL30 Prime Window Replacement of Single-Pane Base
WINDOW CL30 Prime Window Replacement of Double-Pane Base_Electric Zonal	WINDOW CL30 Prime Window Replacement of Double-Pane Base
WALL R0—R11_Electric FAF	WALL R0—R11
FLOOR R0—R19_Electric FAF	FLOOR R0—R19
FLOOR R0—R30_Electric FAF	FLOOR R0—R30
ATTIC R0—R19_Electric FAF	ATTIC R0—R19
ATTIC R0—R38_Electric FAF	ATTIC R0—R38
ATTIC R0—R49_Electric FAF	ATTIC R0—R49
ATTIC R19—R30_Electric FAF	ATTIC R19—R30
ATTIC R19—R38_Electric FAF	ATTIC R19—R38
ATTIC R19—R49_Electric FAF	ATTIC R19—R49
WINDOW CL22 Prime Window Replacement of Single-Pane Base_Electric FAF	WINDOW CL22 Prime Window Replacement of Single-Pane Base
WINDOW CL22 Prime Window Replacement of Double-Pane Base_Electric FAF	WINDOW CL22 Prime Window Replacement of Double-Pane Base
WINDOW CL30 Prime Window Replacement of Single-Pane Base_Electric FAF	WINDOW CL30 Prime Window Replacement of Single-Pane Base
WINDOW CL30 Prime Window Replacement of Double-Pane Base_Electric FAF	WINDOW CL30 Prime Window Replacement of Double-Pane Base
WALL R0—R11_Heat Pump	WALL R0—R11
FLOOR R0—R19_Heat Pump	FLOOR R0—R19
FLOOR R0—R30_Heat Pump	FLOOR R0—R30

Measure Name	Measure Efficiency
ATTIC R0—R19_Heat Pump	ATTIC R0—R19
ATTIC R0—R38_Heat Pump	ATTIC R0—R38
ATTIC R0—R49_Heat Pump	ATTIC R0—R49
ATTIC R19—R30_Heat Pump	ATTIC R19—R30
ATTIC R19—R38_Heat Pump	ATTIC R19—R38
ATTIC R19—R49_Heat Pump	ATTIC R19—R49
WINDOW CL22 Prime Window Replacement of Single-Pane Base_Heat Pump	WINDOW CL22 Prime Window Replacement of Single-Pane Base
WINDOW CL22 Prime Window Replacement of Double-Pane Base_Heat Pump	WINDOW CL22 Prime Window Replacement of Double-Pane Base
WINDOW CL30 Prime Window Replacement of Single-Pane Base_Heat Pump	WINDOW CL30 Prime Window Replacement of Single-Pane Base
WINDOW CL30 Prime Window Replacement of Double-Pane Base_Heat Pump	WINDOW CL30 Prime Window Replacement of Double-Pane Base

Weatherization — Single-Family. This measure represents a suite of measures including the following:

- Attic insulation R-value improvement
- Floor insulation R-value improvement
- Wall insulation R-value improvement
- Window U-value improvement
- Infiltration reduction

Based on the 7th Plan workbook "res-sf_wx-7p_v7".

Measure Name	Measure Efficiency
ATTIC R0—R38_Electric FAF	ATTIC R0—R38
ATTIC R0—R49_Electric FAF	ATTIC R0—R49
ATTIC R11—R38_Electric FAF	ATTIC R11—R38
ATTIC R11—R49_Electric FAF	ATTIC R11—R49
ATTIC R19—R38_Electric FAF	ATTIC R19—R38
ATTIC R19—R49_Electric FAF	ATTIC R19—R49
WALL R0—R11_Electric FAF	WALL R0—R11
FLOOR R0—R19_Electric FAF	FLOOR R0—R19
FLOOR R0—R25_Electric FAF	FLOOR R0—R25
FLOOR R0—R30_Electric FAF	FLOOR R0—R30
WINDOW CL30 Prime Window Replacement of Single-Pane Base_Electric FAF	WINDOW CL30 Prime Window Replacement of Single-Pane Base
WINDOW CL30 Prime Window Replacement of Double-Pane Base_Electric FAF	WINDOW CL30 Prime Window Replacement of Double-Pane Base
WINDOW CL22 Prime Window Replacement of Single-Pane Base_Electric FAF	WINDOW CL22 Prime Window Replacement of Single-Pane Base
WINDOW CL22 Prime Window Replacement of Double-Pane Base_Electric FAF	WINDOW CL22 Prime Window Replacement of Double-Pane Base
CFM50 Infiltration Reduction_Electric FAF	CFM50 Infiltration Reduction
ATTIC R0—R38_Electric Zonal	ATTIC R0—R38
ATTIC R0—R49_Electric Zonal	ATTIC R0—R49
ATTIC R11—R38_Electric Zonal	ATTIC R11—R38
ATTIC R11—R49_Electric Zonal	ATTIC R11—R49
ATTIC R19—R38_Electric Zonal	ATTIC R19—R38
ATTIC R19—R49_Electric Zonal	ATTIC R19—R49
WALL R0—R11_Electric Zonal	WALL R0—R11
FLOOR R0—R19_Electric Zonal	FLOOR R0—R19
FLOOR R0—R25_Electric Zonal	FLOOR R0—R25
FLOOR R0—R30_Electric Zonal	FLOOR R0—R30
WINDOW CL30 Prime Window Replacement of Single-Pane Base_Electric Zonal	WINDOW CL30 Prime Window Replacement of Single-Pane Base
WINDOW CL30 Prime Window Replacement of Double-Pane Base_Electric Zonal	WINDOW CL30 Prime Window Replacement of Double-Pane Base
WINDOW CL22 Prime Window Replacement of Single-Pane Base_Electric Zonal	WINDOW CL22 Prime Window Replacement of Single-Pane Base
WINDOW CL22 Prime Window Replacement of Double-Pane Base_Electric Zonal	WINDOW CL22 Prime Window Replacement of Double-Pane Base

Measure Name	Measure Efficiency
CFM50 Infiltration Reduction_Electric Zonal	CFM50 Infiltration Reduction
ATTIC R0—R38_Heat Pump	ATTIC R0—R38_Heat Pump
ATTIC R0—R49_Heat Pump	ATTIC R0—R49_Heat Pump
ATTIC R11—R38_Heat Pump	ATTIC R11—R38_Heat Pump
ATTIC R11—R49_Heat Pump	ATTIC R11—R49_Heat Pump
ATTIC R19—R38_Heat Pump	ATTIC R19—R38_Heat Pump
ATTIC R19—R49_Heat Pump	ATTIC R19—R49_Heat Pump
WALL R0—R11_Heat Pump	WALL R0—R11_Heat Pump
FLOOR R0—R19_Heat Pump	FLOOR R0—R19_Heat Pump
FLOOR R0—R25_Heat Pump	FLOOR R0—R25_Heat Pump
FLOOR R0—R30_Heat Pump	FLOOR R0—R30_Heat Pump
WINDOW CL30 Prime Window Replacement of Single-Pane Base_Heat Pump	WINDOW CL30 Prime Window Replacement of Single-Pane Base_Heat Pump
WINDOW CL30 Prime Window Replacement of Double-Pane Base_Heat Pump	WINDOW CL30 Prime Window Replacement of Double-Pane Base_Heat Pump
WINDOW CL22 Prime Window Replacement of Single-Pane Base_Heat Pump	WINDOW CL22 Prime Window Replacement of Single-Pane Base_Heat Pump
WINDOW CL22 Prime Window Replacement of Double-Pane Base_Heat Pump	WINDOW CL22 Prime Window Replacement of Double-Pane Base_Heat Pump
CFM50 Infiltration Reduction_Heat Pump	CFM50 Infiltration Reduction_Heat Pump
ATTIC R0—R38_DHP	ATTIC R0—R38
ATTIC R0—R49_DHP	ATTIC R0—R49
ATTIC R11—R38_DHP	ATTIC R11—R38
ATTIC R11—R49_DHP	ATTIC R11—R49
ATTIC R19—R38_DHP	ATTIC R19—R38
ATTIC R19—R49_DHP	ATTIC R19—R49
WALL R0—R11_DHP	WALL R0—R11
FLOOR R0—R19_DHP	FLOOR R0—R19
FLOOR R0—R25_DHP	FLOOR R0—R25
FLOOR R0—R30_DHP	FLOOR R0—R30
WINDOW CL30 Prime Window Replacement of Single-Pane Base_DHP	WINDOW CL30 Prime Window Replacement of Single-Pane Base
WINDOW CL30 Prime Window Replacement of Double-Pane Base_DHP	WINDOW CL30 Prime Window Replacement of Double-Pane Base
WINDOW CL22 Prime Window Replacement of Single-Pane Base_DHP	WINDOW CL22 Prime Window Replacement of Single-Pane Base

Measure Name	Measure Efficiency
WINDOW CL22 Prime Window Replacement of Double-Pane Base_DHP	WINDOW CL22 Prime Window Replacement of Double-Pane Base
CFM50 Infiltration Reduction_DHP	CFM50 Infiltration Reduction

Wi-Fi Thermostat. Thermostats connected to the Internet can be controlled from any location with an Internet connection and follow occupants' schedules for heating and cooling, decreasing run times for heating and cooling. Based on the 7th Plan workbook "res-wifitstat-7p_v3".

Measure Name	Measure Efficiency
Single-Family WIFI Enabled Thermostat HZ1	WIFI HZ1

C.1.2. Water Heat

Clothes Washer. High-efficiency clothes washer that meet CEE efficiency level tiers[1] use less energy and water than regular washers. Cadmus compared three efficiency levels in units of the corresponding Integrated Modified Energy Factor (IMEF) —for this measure. The baseline IMEF represents the average IMEF of non-ENERGY STAR and ENERGY STAR-qualified models below the CEE efficiency tiers. Based on the 7th Plan workbook "res-clotheswasher-7p_v4".

[1] http://library.cee1.org/sites/default/files/library/12282/CEE_ResidentialClothesWasherSpec_07Mar2015.pdf

Measure Name	Measure Efficiency
Single-Family CEE Tier 1 Clothes Washer—Any DHW, Any Dryer—54% ENERGY STAR Baseline	Washer Savings
Single-Family CEE Tier 2 Clothes Washer—Any DHW, Any Dryer—54% ENERGY STAR Baseline	Washer Savings
Single-Family CEE Tier 3 Clothes Washer—Any DHW, Any Dryer—54% ENERGY STAR Baseline	Washer Savings
Single-Family CEE Tier 1 Clothes Washer—Any DHW, Any Dryer—54% ENERGY STAR Baseline	Dryer Savings
Single-Family CEE Tier 2 Clothes Washer—Any DHW, Any Dryer—54% ENERGY STAR Baseline	Dryer Savings
Single-Family CEE Tier 3 Clothes Washer—Any DHW, Any Dryer—54% ENERGY STAR Baseline	Dryer Savings
Single-Family CEE Tier 1 Clothes Washer—Any DHW, Any Dryer—54% ENERGY STAR Baseline	Waste Water Energy
Single-Family CEE Tier 2 Clothes Washer—Any DHW, Any Dryer—54% ENERGY STAR Baseline	Waste Water Energy
Single-Family CEE Tier 3 Clothes Washer—Any DHW, Any Dryer—54% ENERGY STAR Baseline	Waste Water Energy
Multifamily—Low-Rise CEE Tier 1 Clothes Washer—Any DHW, Any Dryer—4% ENERGY STAR Baseline	Washer Savings
Multifamily—Low-Rise CEE Tier 2 Clothes Washer—Any DHW, Any Dryer—54% ENERGY STAR Baseline	Washer Savings
Multifamily—Low-Rise CEE Tier 3 Clothes Washer—Any DHW, Any Dryer—54% ENERGY STAR Baseline	Washer Savings
Multifamily—Low-Rise CEE Tier 1 Clothes Washer—Any DHW, Any Dryer—54% ENERGY STAR Baseline	Dryer Savings
Multifamily—Low-Rise CEE Tier 2 Clothes Washer—Any DHW, Any Dryer—54% ENERGY STAR Baseline	Dryer Savings
Multifamily—Low-Rise CEE Tier 3 Clothes Washer—Any DHW, Any Dryer—54% ENERGY STAR Baseline	Dryer Savings
Multifamily—Low-Rise CEE Tier 1 Clothes Washer—Any DHW, Any Dryer—54% ENERGY STAR Baseline	Waste Water Energy
Multifamily—Low-Rise CEE Tier 2 Clothes Washer—Any DHW, Any Dryer—54% ENERGY STAR Baseline	Waste Water Energy
Multifamily—Low-Rise CEE Tier 3 Clothes Washer—Any DHW, Any Dryer—54% ENERGY STAR Baseline	Waste Water Energy
Multifamily—High-Rise CEE Tier 1 Clothes Washer—Any DHW, Any Dryer—54% ENERGY STAR Baseline	Washer Savings
Multifamily—High-Rise CEE Tier 2 Clothes Washer—Any DHW, Any Dryer—54% ENERGY STAR Baseline	Washer Savings

Measure Name	Measure Efficiency
Multifamily—High-Rise CEE Tier 3 Clothes Washer—Any DHW, Any Dryer—54% ENERGY STAR Baseline	Washer Savings
Multifamily—High-Rise CEE Tier 1 Clothes Washer—Any DHW, Any Dryer—54% ENERGY STAR Baseline	Dryer Savings
Multifamily—High-Rise CEE Tier 2 Clothes Washer—Any DHW, Any Dryer—54% ENERGY STAR Baseline	Dryer Savings
Multifamily—High-Rise CEE Tier 3 Clothes Washer—Any DHW, Any Dryer—54% ENERGY STAR Baseline	Dryer Savings
Multifamily—High-Rise CEE Tier 1 Clothes Washer—Any DHW, Any Dryer—54% ENERGY STAR Baseline	Waste Water Energy
Multifamily—High-Rise CEE Tier 2 Clothes Washer—Any DHW, Any Dryer—54% ENERGY STAR Baseline	Waste Water Energy
Multifamily—High-Rise CEE Tier 3 Clothes Washer—Any DHW, Any Dryer—54% ENERGY STAR Baseline	Waste Water Energy

Dishwasher. This dishwasher uses advanced technology to clean dishes using less water and energy. The efficient model uses less than 295 kWh/year (including standby consumption). The baseline model consumes 307 kWh/year. Based on the 7th Plan workbook "res-dishwasher-7p_v4".

Measure Name	Measure Efficiency
Single-Family ENERGY STAR Dishwasher—Any DHW	All Except Waste Water Energy
Single-Family ENERGY STAR Dishwasher—Any DHW	Waste Water Energy
Multifamily—Low-Rise ENERGY STAR Dishwasher—Any DHW	All Except Waste Water Energy
Multifamily—Low-Rise ENERGY STAR Dishwasher—Any DHW	Waste Water Energy
Multifamily—High-Rise ENERGY STAR Dishwasher—Any DHW	All Except Waste Water Energy
Multifamily—High-Rise ENERGY STAR Dishwasher—Any DHW	Waste Water Energy

Drain Water Heat Recovery. Also called gravity film heat exchanges, this device recovers heat energy from domestic drain water, and then uses this to pre-heat cold water entering the hot water tank. This minimizes the temperature difference between the heating setpoint and the temperature of water entering the system. Based on the 7th Plan workbook "res-gfx-7p_v3".

Measure Name	Measure Efficiency
Single-Family GFHX DHW & Shower Preheat, Electric Resistance	GFHX DHW & Shower Preheat, Electric Resistance
Single-Family GFHX DHW & Shower Preheat, Heat Pump	GFHX DHW & Shower Preheat, Heat Pump
Single-Family GFHX DHW Preheat, Electric Resistance	GFHX DHW Preheat, Electric Resistance
Single-Family GFHX DHW Preheat, Heat Pump	GFHX DHW Preheat, Heat Pump

Measure Name	Measure Efficiency
Multifamily GFHX DHW & Shower Preheat, Electric Resistance	GFHX DHW & Shower Preheat, Electric Resistance
Multifamily GFHX DHW & Shower Preheat, Heat Pump	GFHX DHW & Shower Preheat, Heat Pump
Multifamily GFHX DHW Preheat, Electric Resistance	GFHX DHW Preheat, Electric Resistance
Multifamily GFHX DHW Preheat, Heat Pump	GFHX DHW Preheat, Heat Pump

Faucet Aerators, Bathroom. By mixing water and air, faucet aerators reduce water amounts flowing through faucets. The faucet aerator creates a fine water spray, using a screen inserted in the faucet head. Based on the 7th Plan workbook "res-aerator-7p_v5".

Measure Name	Measure Efficiency
Single-Family Bathroom Aerator 1.0 GPM AnyWH	Aerator 2.48 to 1.0 GPM
Single-Family Bathroom Aerator 1.0 GPM AnyWH	Aerator 2.48 to 1.0 GPM
Multifamily—Low-Rise Bathroom Aerator 1.0 GPM AnyWH	Aerator 2.48 to 1.0 GPM
Multifamily—High-Rise Bathroom Aerator 1.0 GPM AnyWH	Aerator 2.48 to 1.0 GPM
Single-Family Bathroom Aerator 1.0 GPM HPWH	Aerator 2.48 to 1.0 GPM

Low-Flow Showerheads. Low-flow showerheads mix water and air to reduce the amount of water flowing through a showerhead. The showerhead creates a fine water spray through an screen inserted in the showerhead. Based on the 7th Plan workbook "res-showerhead-7p_v5".

Measure Name	Measure Efficiency
SF Showerhead Replace_2_00gpm_Any Shower_ AnyWH	SF Showerhead Replace_2_00gpm_Any Shower_ AnyWH
SF Showerhead Replace_1_75gpm_Any Shower_ AnyWH	SF Showerhead Replace_1_75gpm_Any Shower_ AnyWH
SF Showerhead Replace_1_50gpm_Any Shower_ AnyWH	SF Showerhead Replace_1_50gpm_Any Shower_ AnyWH
SF Showerhead Replace_1_50GPM_any shower_HPWH	SF Showerhead Replace_1_50GPM_any shower_HPWH
MF Showerhead Replace_2_00gpm_Any Shower_ AnyWH	MF Showerhead Replace_2_00gpm_Any Shower_ AnyWH
MF Showerhead Replace_1_75gpm_Any Shower_ AnyWH	MF Showerhead Replace_1_75gpm_Any Shower_ AnyWH
MF Showerhead Replace_1_50gpm_Any Shower_ AnyWH	MF Showerhead Replace_1_50gpm_Any Shower_ AnyWH

C.1.3. Appliances

Fridge and Freezer Decommissioning. This refers to environmentally friendly disposal of unneeded or inefficient appliances (e.g., refrigerators, standalone freezers). Based on the RTF workbook "ResFridgeFreezeDecommissioning_v4_4".

Measure Name	Measure Efficiency
Refrigerator Decommissioning and Recycling	Refrigerator Decommissioning and Recycling
Freezer Decommissioning and Recycling	Freezer Decommissioning and Recycling

C.1.4. Plug Load

Advanced Power Strip. Advanced power strips turn off power to all devices plugged into the strip (e.g., computers, desk lights, entertainment equipment), based on occupancy within the area, reduced load below a certain wattage threshold, or lack of infrared activity within a set timeframe. Based on the 7th Plan workbook "res-powerstrips-7p_v6".

Measure Name	Measure Efficiency
Load-sensing advanced power strip	Load-sensing advanced power strip
Occupancy-sensing advanced power strip	Occupancy-sensing advanced power strip
Infrared-sensing advanced power strip	Infrared-sensing advanced power strip

C.1.5. Other (Pool)

Advanced Power Strip. Advanced power strips turn off power to all devices plugged into the strip (e.g., computers, desk lights, entertainment equipment), based on occupancy within the area, reduced load below a certain wattage threshold, or lack of infrared activity within a set timeframe. Based on the 7th Plan workbook "res-powerstrips-7p_v6".

Measure Name	Measure Efficiency
Load-sensing advanced power strip	Load-sensing advanced power strip
Occupancy-sensing advanced power strip	Occupancy-sensing advanced power strip
Infrared-sensing advanced power strip	Infrared-sensing advanced power strip

C.2. Residential Electric Equipment Measure Descriptions

C.2.1. Heating and Cooling

Air or Ground Source Heat Pump (ASHP or GSHP). Electric heat pumps move heat to or from the air or the ground to cool and heat a home. Based on the 7th Plan workbooks "res-sf_hp-7p_v5" and "res-gshp-7p_v2".

Measure Name	Measure Efficiency	Baseline Efficiency
Existing Single-Family Home HVAC Upgrade + HZ1	Existing Single-Family Home HVAC Upgrade + HZ1	Market Average Heat Pump
New SF HVAC Upgrade—Heat Pump Upgrade to 9.0 HSPF/14 SEER	New SF HVAC Upgrade — Heat Pump Upgrade to 9.0 HSPF/14 SEER	Market Average Heat Pump
Existing Single-Family Home HVAC Upgrade—Central Heat Pump Upgrade to Variable Capacity Central Heat Pump + HZ1CZ1	Existing Single-Family Home HVAC Upgrade—Central Heat Pump Upgrade to Variable Capacity Central Heat Pump + HZ1CZ1	Market Average Heat Pump
New SF HVAC Upgrade—Central Heat Pump Upgrade to Variable Capacity Central Heat Pump	New SF HVAC Upgrade—Central Heat Pump Upgrade to Variable Capacity Central Heat Pump	Market Average Heat Pump
GSHP Upgrade from ASHP—With Desuperheater—Existing House less than 4,000 square feet	GSHP Upgrade from ASHP—With Desuperheater—Existing House less than 4,000 square feet	Market Average Heat Pump
GSHP Upgrade from ASHP—With Desuperheater—New House less than 4,000 square feet	GSHP Upgrade from ASHP—With Desuperheater—New House less than 4,000 square feet	Market Average Heat Pump

Central Air Conditioner. This measure consists of two different air conditioner technology/efficiency levels. The baseline size is the same as the measure size.

Measure Name	Measure Efficiency	Baseline Efficiency
Central Air Conditioner—ENERGY STAR	ENERGY STAR Central Air Conditioner SEER/EER 14.5/12 (Split System)	Market Average Central Air Conditioner SEER/EER 13/11.2 (Split System)
Central Air Conditioner—CEE Tier 3	CEE Tier 3 Central Air Conditioner SEER/EER 16/13 (Split System)	Market Average Central Air Conditioner SEER/EER 13/11.2 (Split System)

Conversion Baseboard Heating to Ductless Heat Pump (DHP). DHPs move heat to or from the air to cool and heat a home without the need for costly ductwork. This method of heating has a HSPF value of 9.5, consuming less energy than baseboard heating that has a HSPF value of 3.412. Based on the 7th Plan workbook "res-sf_hp-7p_v5".

Measure Name	Measure Efficiency	Baseline Efficiency
Zonal to DHP No Screen + HZ1CZ1	Heating Savings	Market Average Zonal Heating
New SF Zonal to DHP	Heating Savings	Market Average Zonal Heating

Conversion Forced Air Furnace to DHP. DHPs move heat to or from the air to cool and heat a home without the need for costly ductwork. This heating method has a HSPF value of 9.5, consuming less energy than a forced air furnace with a HSPF value of 3.412. Based on the 7th Plan workbook "res-faf_to_dhp-7p_v2".

Measure Name	Measure Efficiency	Baseline Efficiency
Install DHP in House with Existing FAF—Single-Family Home + HZ1	Install DHP in House with Existing FAF—Single-Family Home—HZ1	Standard Electric Furnace HSPF = 3.412

Room AC Conversion to DHP. DHPs use less energy than room ACs while producing less noise and requiring no costly ductwork. Based on the 7th Plan workbook "res-sf_hp-7p_v5".

Measure Name	Measure Efficiency	Baseline Efficiency
New SF Zonal to DHP	Cooling Savings	Room AC—Market Average (8,000–13,999 Btuh)

Motor—ECM. Electronically commutated motors (ECMs) consume less power than standard motors used in ventilation and circulation systems.

Measure Name	Measure Efficiency	Baseline Efficiency
Motor—ECM	ECM Motor	Standard Motor

C.2.2. Lighting

Lighting Exterior. This measure represents improvements to exterior lighting technologies by replacing existing lamps with more efficient lighting technologies: CFLs and LEDs. Based on the 7th Plan workbooks "res-lighting-7p_v5" and "res-lighting_ppa-7p_v5".

Measure Name	Measure Efficiency	Baseline Efficiency
Incandescent—2020 EISA* Backstop Provisions	Incandescent—2020 EISA Backstop Provisions	Market Average Lighting Exterior Standard
CFL	CFL	Market Average Lighting Exterior Standard
LED—Exterior	LED—Exterior	CFL

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- **CFLs—Exterior.** Standard CFLs use 5% less energy than typical exterior (market average) bulbs.
- **General Service Lamp—2020 EISA Backstop Provisions.** EISA contains a backstop provision that requires a minimum efficacy of 45 lumens-per-watt lighting technologies, beginning in 2020.
- **LEDs—Exterior.** Standard LEDs use 21% less energy than CFL bulbs.

Lighting Interior Linear Fluorescent. Represents improvements to interior lighting with linear fluorescent technologies that replace existing T12 f-foot and 8-foot fixtures with the more efficient, high-performance T8 (T8HP) 4-foot fixtures. Based on the RTF workbook "ResLightingHPT8Lamps_v1_3".

Measure Name	Measure Efficiency	Baseline Efficiency
Linear Fluorescent—T8HP	T8HP Linear Fluorescent	Market Average Linear Fluorescent

Lighting Interior Specialty. Represents improvements to interior lighting technologies not impacted by EISA by replacing existing lamps with more efficient lighting technologies: CFLs and LEDs. Based on the 7th Plan workbook "res-lighting-7p_v5".

Measure Name	Measure Efficiency	Baseline Efficiency
CFL—Specialty	CFL—Specialty	Incandescent—Specialty
LED—Specialty	LED—Specialty	Incandescent—Specialty

- **CFLs—Specialty.** Specialty (or EISA exempt) bulbs include three-way, candelabra, some globes, and some reflectors. CFLs use up to 77% less energy and have a longer life than incandescent specialty light bulb.

- **LEDs—Specialty.** Specialty LEDs are solid-state devices that convert electricity to light, use 84% less energy, and have a long life.

Lighting Interior Standard. Represents improvements to interior lighting technologies impacted by EISA by replacing existing lamps with more efficient lighting technologies: CFLs and LEDs. Based on the 7th Plan workbooks "res-lighting-7p_v5" and "res-lighting_ppa-7p_v5".

Measure Name	Measure Efficiency	Baseline Efficiency
EISA 2020 Backstop	EISA 2020 Backstop Interior General-Purpose Bulb	Market Average Lighting Interior Standard
CFL	CFL	Market Average Lighting Interior Standard
LED Interior General Purpose Bulb	LED Interior General-Purpose Bulb	CFL

- **CFLs—Standard.** Standard CFLs use 14% less energy than the typical interior (market average) bulbs.
- **General Service Lamp—2020 EISA Backstop Provisions.** EISA contains a backstop provision requiring a minimum efficacy of 45 lumens per watt lighting technologies, beginning in 2020.
- **LEDs—Standard.** Standard LEDs use 25% less energy than the CFL bulbs.

C.2.3. Water Heat

Water Heater, Heat Pump and Solar. This measure represents two end uses: Water Heat LE 55 Gal (less than 55 gallons) and Water Heat GT 55 Gal (greater than 55 gallons). A high-efficiency heat pump water heater measure moves heat from a warm reservoir (such as air) into the hot water system, reducing the heat amount needed from electric resistance heating. Solar Water Heaters use thermal energy to heat water without use of electricity, gas, or heating oil. Based on the 7th Plan workbooks "res-hpwh-7p_v3p" and "res-swh-7p_v1p".

End Use	Measure Efficiency	Baseline Efficiency
Water Heat LE 55 Gal	Single-Family Tier1_buffered	Market Standard Storage Water Heater
Water Heat LE 55 Gal	Single-Family Tier1_indor2	Market Standard Storage Water Heater
Water Heat LE 55 Gal	Single-Family Tier2_buffered	Market Standard Storage Water Heater
Water Heat LE 55 Gal	Single-Family Tier2_indor2	Market Standard Storage Water Heater
Water Heat LE 55 Gal	SHW Solar Zone 1	Market Standard Storage Water Heater
Water Heat GT 55 Gal	SHW Solar Zone 1	Market Standard Water Heater

C.2.4. Appliances

Cooking Oven, High Efficiency. A high-efficiency cooking oven uses fans to circulate heat evenly throughout the oven (convection heat), operating at lower temperatures and achieving cooking times

quicker than a standard oven. The baseline is a standard oven. Based on the 7th Plan workbook "res-oven-7p_v3".

Measure Name	Measure Efficiency	Baseline Efficiency
Efficient Oven	Efficient Oven	Federal Standard 2012 Cooking Oven

Dryer, High Efficiency. A high-efficiency dryer incorporates features (such as moisture sensors) that minimize energy usage while retaining performance. A heat pump dryer moves heat from a warm reservoir (such as air) into the dryer, reducing the amount of heat needed from electric resistance heating. Based on the 7th Plan workbook "res-clothesdryer-7p_v2".

Measure Name	Measure Efficiency	Baseline Efficiency
Heat Pump Dryer	Heat Pump Dryer	Market Average Dryer

Freezer, ENERGY STAR. ENERGY STAR-qualified freezers use less energy than standard models due to improvements in insulation and compressors. Based on the 7th Plan workbook "res-refrigfreezer-7p_v3p".

Measure Name	Measure Efficiency	Baseline Efficiency
Std Size Freezer—ENERGY STAR	Std Size Freezer—ENERGY STAR	Market Average Freezer

Microwave, High-Efficiency. High-efficiency microwaves use more efficient power supplies, fans, magnetron, and reflective surfaces that provide energy savings compared to conventional microwaves. Based on the 7th Plan workbook "res-microwave-7p_v3".

Measure Name	Measure Efficiency	Baseline Efficiency
Microwave Top Tier	TSL4 Efficiency	Market Average Microwave

Refrigerator, ***High-Efficiency.*** CEE-qualified refrigerators use less energy than standard models due to improvements in insulation and compressors. Based on the 7th Plan workbook "res-refrigfreezer-7p_v4".

Measure Name	Measure Efficiency	Baseline Efficiency
Std Size Refrig and Refrig-Freezer—CEE Tier 1	Std Size Refrig and Refrig-Freezer—CEE Tier 1	Market Average Refrigerator
Std Size Refrig and Refrig-Freezer—CEE Tier 2	Std Size Refrig and Refrig-Freezer—CEE Tier 2	Market Average Refrigerator
Std Size Refrig and Refrig-Freezer—CEE Tier 3	Std Size Refrig and Refrig-Freezer—CEE Tier 3	Market Average Refrigerator

C.2.5. Plug Load

Air Purifier, ENERGY STAR. **ENERGY STAR certified room air purifiers** are 40% more energy-efficient than standard models.[2]

Measure Name	Measure Efficiency	Baseline Efficiency
Air Purifier—ENERGY STAR	ENERGY STAR Air Purifier	Standard Air Purifier

Computer, ENERGY STAR. ENERGY STAR computers consume less than 2 watts in sleep- and off- modes, and operate more efficiently than conventional units in idle mode, resulting in 40% energy savings. Based on the 7th Plan workbook "res-computers-7p_v4".

Measure Name	Measure Efficiency	Baseline Efficiency
ENERGY STAR Desktops	ENERGY STAR Desktop	Standard Desktop Computer
ENERGY STAR Laptops	ENERGY STAR Notebook	Standard Laptop Computer

DVD, ENERGY STAR. ENERGY STAR-qualified DVD products that meet new requirements use up to 50% less energy than standard models.[3] ENERGY STAR DVD players use as little as one-fourth of the energy of standard models in the off mode. The baseline for this measure is a standard DVD player.

Measure Name	Measure Efficiency	Baseline Efficiency
DVD—ENERGY STAR	ENERGY STAR DVD Player	Standard DVD Player

Home Audio System, ENERGY STAR. ENERGY STAR home audio systems can achieve 20% energy savings over standard home audio systems.

Measure Name	Measure Efficiency	Baseline Efficiency
Home Audio System—ENERGY STAR	ENERGY STAR Home Audio System	Standard Home Audio System

2 https://www.energystar.gov/products/certified-products/detail/air-purifiers-cleaners

3 https://www.energystar.gov/products/certified-products/detail/audiovideo

Monitor, ENERGY STAR. ENERGY STAR monitors feature: (1) on mode, where the maximum allowed power varies based on the computer monitor's resolution; (2) sleep mode, where computer monitors must consume 2 watts or less; and (3) off mode, where computer monitors must consume 1 watt or less. The baseline equipment does not include these features.[4] Based on the 7th Plan workbook "res-computers-7p_v4".

Measure Name	Measure Efficiency	Baseline Efficiency
ENERGY STAR Monitors	ENERGY STAR LCD Display	Standard Monitor

Multifunction Device (All-in-One). ENERGY STAR models meeting the most recent ENERGY STAR requirements are more energy efficient and feature efficient designs that help the equipment run cooler and last longer.

Measure Name	Measure Efficiency	Baseline Efficiency
Multifunction Device (All-in-one)—ENERGY STAR	ENERGY STAR Multifunction Device (All-in-one)	Standard Multifunction Device (All-in-one)

Office Copier, ENERGY STAR. ENERGY STAR copy machines operate more efficiently and use less energy than standard office copy machines.

Measure Name	Measure Efficiency	Baseline Efficiency
Office Copier—ENERGY STAR	ENERGY STAR Office Copier	Standard Office Copier

Office Printer, ENERGY STAR. Printers earning the ENERGY STAR rating operate at least 30% more efficiently than conventional models.[5] The baseline measure is a standard printer.

Measure Name	Measure Efficiency	Baseline Efficiency
Office Printer—ENERGY STAR	ENERGY STAR Office Printer	Standard Office Printer

Set Top Box, ENERGY STAR. Set top boxes earning the ENERGY STAR rating operate at least 35% more efficiently than conventional models.[6] The baseline measure is a standard set top box.

Measure Name	Measure Efficiency	Baseline Efficiency
Set Top Box—ENERGY STAR	ENERGY STAR Set Top Box	Standard Set Top Box

4 https://www.energystar.gov/products/certified-products/detail/displays
5 https://www.energystar.gov/products/certified-products/detail/imaging-equipment
6 https://www.energystar.gov/products/certified-products/detail/set-top-boxes-cable-boxes

TV, ENERGY STAR. ENERGY STAR-qualified TVs use roughly 25% less energy than standard units.[7] ENERGY STAR models are required to consume no more than 1 watt while in sleep mode. The baseline is a standard television, which generally consumes more than 3 watts when turned off.

Measure Name	Measure Efficiency	Baseline Efficiency
TV LCD—ENERGY STAR	ENERGY STAR LED-LCD TV (0-40in.)	Standard LCD TV (0-40in.)
TV LCD—ENERGY STAR	ENERGY STAR LED-LCD TV (40+in.)	Standard LCD TV (40+in.)

C.2.6. Other (Pool)

Pool Pumps, VSD. This measure enables a pool pump motor to operate at variable speeds as opposed to running constantly at full power. This measure's baseline is a standard two-speed motor

Measure Name	Measure Efficiency	Baseline Efficiency
Pool Pump—VSD	VSD Pool Pump	Two-Speed Pool Pump

C.3. Commercial Electric Measure Description

C.3.1. HVAC (and Envelope)

Advanced Rooftop Controller. Advanced controllers for rooftop units with single-zone, ducted systems. Retrofitting existing packaged rooftop units with advanced control strategies not ordinarily used for packaged units. Savings come primarily from fan energy savings through using advanced controls with a variable-speed drive. Applied only to systems with constant speed fans. Based on the 7th Plan workbook "com-rooftopcontroller-7p_v6".

Commercial Energy Management. Energy management measures for commercial buildings, excluding single-zone ducted systems. A suite of measures, most of which focus on making HVAC systems work better through control changes. Based on the 7th Plan workbook "com-em-7p_v5".

DCV Hood and DCV Hood w/ MUA. Utilizing sensors and two-speed or variable speed fans, hood controls reduce exhaust (and makeup) airflow when appliances do not run at capacity (or have been turned off). The baseline for this measure is a unit without hood controls. Based on the 7th Plan workbook "com-dcv-kitchenvent-7p_v3".

DCV Parking Garage. Where the ventilation system automatically adjusts air flow when CO_2 rises above a specified level. CO_2 controls maintain a minimum ventilation rate at all times to control non-occupant contaminants (e.g., off-gassing from furniture, equipment, building components). This measure's baseline is an existing ventilation system that runs constantly. Based on the 7th Plan workbook "com-dcv-garage-7p_v3".

[7] https://www.energystar.gov/products/certified-products/detail/televisions

Demand Controlled Ventilation (DCV). Evaluates retrofit DCV and Dedicated Outdoor Air Supply (DOAS). Both DVC and the DOAS measures reduce the amount of ventilation air required to be conditioned and the amount of distribution fan energy used to move cooling or heating to occupants. The single-zone DOAS measures uses a fleet strategy, which involves designating some HVAC fleet units as ventilation units, while letting other units cycle on call for heating, cooling, or additional, required ventilation. The designated units can be standalone HRV units or rooftop units with added HRV/ERVs, where only a small fraction of units operate, or standard rooftops with one-half of units operating to provide ventilation. Based on the 7th Plan workbook "com-dcv-7p_v5".

Ductless Heat Pumps (DHP). DHPs move heat to or from the air, cooling and heating buildings without costly ductwork. This measure provides savings compared to electric resistance heating. Based on the 7th Plan workbook "com-dhp-7p_v2".

ECM VAV. High-efficiency, electronically commutated, permanent magnet (ECM or ECPM) motors with built-in variable speed controls for VAV fans. Based on the 7th Plan workbook "com-ecm-vav-7p_v4".

Economizer. An air-side economizer mixes return air with outside air to cool indoor spaces, saving energy as less air must be cooled. This measure reflects optimizing economizers, coil cleaning, and adjusting refrigerant charges. Based on the 7th Plan workbook "com-economizer-7p_v2".

Motors Rewind. This measure follows the Green Motors Practices Group™ recommendations for best practices in maintaining original efficiencies, commonly called a Green Rewind.[8] A failed motor can be rewound to a lower efficiency, rewound to maintain the original efficiency, or replaced. Based on the 7th Plan workbook "com-motorsrewind-7p_v3".

VRF. A variable refrigerant flow (VRF) system is an energy-efficient heating and cooling system using inverter-driven compressor technology without ducting. Baseline technology is assumed to be a typical VAV rooftop HVAC system. Based on the 7th Plan workbook "com-vrf-7p_v6".

WEPT. Web-enabled programmable thermostats (WEPT) control setpoint temperatures automatically, ensuring HVAC system do not run during low-occupancy hours. Based on the 7th Plan workbook "com-wept-7p_v2".

Windows—Secondary Glazing Systems. A permanent window unit is installed on the inside of an existing primary window. Based on the 7th Plan workbook "com-windowsgs-7p_v5".

C.3.2. Lighting

Bi-Level Stairway Lighting. This measure allows an occupancy sensor to reduce light loads in an unoccupied stairwell by 50% for a set period of time. The baseline is continuous operation at full power. Based on the 7th Plan workbook "com-bi-level-stairwell-7p_v4".

Exterior Lighting Improvements. Measures going from existing technology to LED technology. Based on the 7th Plan workbook "com-exteriorlighting-7p_v14".

8 http://www.bpa.gov/energy/n/industrial/Green_motors/

Measure Group
Exterior Lighting: Façade—LED
Exterior Lighting: Parking Lot—LED
Exterior Lighting: Walkway—LED

Interior Lighting Improvements. The measures go from existing technology to LED technology, or other high-performance lighting, fixtures, or redesign elements. Based on the 7th Plan workbook "com-lightinginterior-7p_v41".

Measure Group
CFL—Other
LED—Display or Track
LED—High-Bay
LED—Linear Fluorescent
LED—Recessed Can
LED—Other
Linear Fluorescent—High-Bay
Linear Fluorescent RDX—Linear Fluorescent
Metal Halide—Display or Track

LEC Exit Sign. Light Emitting Capacitor (LEC) exit signs consume less than one watt, resulting in energy savings over traditional exit signs. The assumed baseline is a LED exit sign. Based on the 7th Plan workbook "com-exitsign-7p_v3".

LED Case Lighting. LEDs are highly efficient bulbs that can be used for refrigeration case lights, resulting in energy savings over standard fluorescent case lights. Based on the 7th Plan workbook "com-grocery-7p_v7".

LED Motion Sensors on Display Case. Savings result from direct reductions in lighting runtimes, and reduced cooling loads from addition of display case motion sensors. Based on the 7th Plan workbook "com-grocery-7p_v7".

LED Parking Garage Lighting. Replacing inefficient metal halide lamps with LED fixtures and bi-level occupancy controls, reducing energy use of covered parking garages. Based on the 7th Plan workbook "com-parkinggaragelighting-7p_v7".

Lighting Controls. This represents two measures: 1) Embedded unitary controls for occupancy, daylight harvest, and personal dimming; and 2) Integrated controls where a control module is addressable remotely and can log conditions data. Based on the 7th Plan workbook "com-interiorlightingcontrols-7p_v10".

Market Average HP Low-Power T8 Shift. Shifting a mix of T8 Fluorescent lamps from 32W to 28W and 25W. Based on the 7th Plan workbook "com-hplowpowergsfl-7p_v8".

TLED Over Ballast on SP32WT8. Replacing a two-lamp, four-foot T8 fixture with 21W LED linear tubes (TLED). Based on the 7th Plan workbook "com-hplowpowergsfl-7p_v8".

C.3.3. Water Heat

Efficient Water Tanks. High-efficiency water heaters operate more efficiently than standard electric water heaters due to reduced standby losses. Based on the 7th Plan workbook "com-whtanks-7p_v6"

Pre-Rinse Spray Valve. Low-flow spray valves mix water and air to reduce water amounts flowing through spray heads, creating a fine water spray through an inserted screen in the spray head. Based on the 7th Plan workbook "com-prerinsespray-7p_v3".

Showerheads. Low-flow showerheads mix water and air to reduce amounts of water flowing through the showerhead, which creates a fine water spray using an inserted screen in the showerhead. The assumed efficiency of the installed showerhead is 1.5 GPM. Based on the 7th Plan workbook "com-showerhead-7p_v5".

C.3.4. Refrigeration

Anti-Sweat Heater Controls. This measure enables users to turn refrigeration display case, anti-sweat heaters off when the ambient relative humidity become low enough to prevent sweating. Without controls, heaters generally run continuously. Based on the 7th Plan workbook "com-grocery-7p_v7".

ECM Controllers on Walk-In Evaporator Motors. A walk-in fan is a component of refrigeration systems. ECMs typically have small horsepower motors (less than 1 HP), factory programmed to run at certain speeds. ECMs operate from a single-phase power source, with an electronic controller in or on the motor. The baseline measure is a standard efficiency motor. Based on the 7th Plan workbook "com-grocery-7p_v7".

Floating Head Pressure Control. This measure adds controls to floating head pressure temperatures down during periods of low load. The base case is a standard multiplex system with a fixed condensing setpoint. Based on the 7th Plan workbook "com-grocery-7p_v7".

Freezer Decommissioning and Recycling. This refers to environmentally friendly disposal of unneeded appliances, such as standalone freezers. Based on the RTF workbook "ComRefrigeratorFreezerDecommissioning_v2_4".

Refrigerator Decommissioning and Recycling. This refers to environmentally friendly disposal of unneeded appliances, such as secondary refrigerators. Based on the RTF workbook "ComRefrigeratorFreezerDecommissioning_v2_4".

Replace Shaded Pole with ECM in Walk-in Cooler. A walk-in fan is a component of refrigeration systems. ECMs typically have small horsepower motors (less than 1 HP), factory programmed to run at certain speeds. ECMs operate from a single-phase power source, with an electronic controller in or on the

motor. The baseline measure is a standard efficiency motor. Based on the 7th Plan workbook "com-grocery-7p_v7".

Strip Curtains: Walk-In Coolers/ Freezers. This measure reduces infiltration of warm air into the refrigerated space by improving the barrier between refrigerated and ambient air. Based on the 7th Plan workbook "com-grocery-7p_v7".

C.3.5. Cooking

Combi Oven. This measure uses dry heat and steam, injected into the oven when required by cooking food. ENERGY STAR combination ovens use less energy than standard combination ovens. Equipment sizes are based on ENERGY STAR v2.0 eligibility criteria for ≥ 6 pan and ≤ 20 pan. Based on the 7th Plan workbook "com-cooking-7p_v5".

Convection Oven (Wt Average). This measure meets specification requirements of 70% cooking energy efficiency and an idle energy rate of 1.6 kW. Standard electric convection ovens have a 65% cooking energy efficiency and an idle energy rate of 2 kW. Equipment sizes are based on ENERGY STAR v2.0 eligibility criteria. Based on the 7th Plan workbook "com-cooking-7p_v5".

Fryers. ENERGY STAR fryers operate 80% more efficiently, resulting in energy savings when compared to non-ENERGY STAR commercial fryers with a baseline efficiency of 75%. Equipment sizes based on ENERGY STAR v2.0 eligibility criteria. Based on the 7th Plan workbook "com-cooking-7p_v5".

Hot Food Holding Cabinet (Wt Average Size). Installation of a new electric HFHC meeting ENERGY STAR v2.0 requirements. The baseline measure is a conventional holding cabinet. Based on the 7th Plan workbook "com-cooking-7p_v5".

Steamer (Wt Average Size). This measure operates at a cooking efficiency of 68%, with idle energy rates that vary depending upon pan sizes. The baseline efficiency is a standard commercial steam cooker with 26% efficiency. Based on the 7th Plan workbook "com-cooking-7p_v5".

C.3.6. Data Center

Data Center Improvements. A total of 22 efficiency measures, divided into three tiers: Best Practice; Commercial Technology; and Cutting Edge. Based on CBSA's 2014 data on data centers embedded in commercial buildings. Based on the 7th Plan workbook "com-datacenters-7p_v6".

Measure Type	Measure Name
Best Practice	Decommissioning of unused servers
Best Practice	Energy-efficient data storage management
Best Practice	Server power management
Best Practice	Server virtualization/consolidation
Commercial Technology	Air-side economizer
Commercial Technology	Efficient network topology
Commercial Technology	Energy-efficient lighting
Commercial Technology	Energy-efficient power supplies (UPS)
Commercial Technology	Energy-efficient servers
Commercial Technology	Energy-efficient transformers
Commercial Technology	Hot or cold aisle configuration
Commercial Technology	Hot or cold aisle configuration, plus containment (e.g., strip curtains or rigid enclosures)
Commercial Technology	In-row cooling
Commercial Technology	Install misters, foggers, or ultrasonic humidifiers
Commercial Technology	Massive array of idle disks (MAID)
Commercial Technology	Premium efficiency motors
Commercial Technology	Variable-speed drives on pumps/fans
Commercial Technology	Water-side economizer
Cutting Edge	Direct current (as opposed to AC) to the racks
Cutting Edge	Direct liquid cooling of chips
Cutting Edge	Efficient network topology
Cutting Edge	Solid-state storage

C.3.7. Other

Compressed Air Upgrade. A suite of energy-efficient air compressor measures including the following:

- Demand reduction
- VFD controls
- Equipment upgrades

Based on the 7th Plan workbook "com-compressedair-7p_v4".

ENERGY STAR Desktop. ENERGY STAR computers consume less than 2 watts in "sleep" and "off" modes, operating more efficiently than conventional units in "idle" modes, resulting in 42% energy savings. Based on the 7th Plan workbook "com-computers-7p_v3".

ENERGY STAR Display. ENERGY STAR monitors feature the following: (1) an "on" mode, where the maximum allowed power varies, based on the computer monitor's resolution; (2) a "sleep" mode, where computer monitor models must consume 2 watts or less; and (3) an "off" mode, where computer monitor models must consume 1 watt or less. The baseline equipment does not include these features. Based on the 7th Plan workbook "com-computers-7p_v3".

ENERGY STAR Laptop. ENERGY STAR computers consume less than 2 watts in "sleep" and "off" modes, and operate more efficiently than conventional units in "idle" modes, resulting in 42% energy savings. Based on the 7th Plan workbook "com-computers-7p_v3".

Indoor Agriculture. A suite of energy-efficient indoor agriculture measures, including the following:

- **LED Fixture.** Replacing existing metal halide or high-pressure sodium grow lights with LED fixtures results in energy savings due to reduced wattage of LED fixtures. Additionally, LED fixtures produce less heat than metal halide or high-pressure sodium fixtures, resulting in a reduced HVAC cooling load.
- **Premium Air Conditioning Equipment.** Represents installing a 12.0 EER air conditioning system, resulting in energy savings over a federal standard air conditioner. The baseline equipment efficiency is 11.2 EER.
- **High-Efficiency Ventilation System.** Increasing the CFM per watt of the ventilation system saves energy by providing the same amount of ventilation, but at a decreased wattage. Represents savings from replacing room ventilation systems and lighting ventilation systems.
- **Mini-Split Heat Pump.** Represents installing a 12.0 EER and 3.6 COP mini-split heat pump, resulting in energy savings over a federal standard heat pump. The baseline equipment efficiency is 11.2 EER and 3.2 COP.

Premium Fume Hood—NR. A package of high-performance technologies that minimizes energy consumption of laboratory fume hoods. The package would include high-efficiency variable-speed fans and heat recovery to recover some energy in the conditioned air drawn from the laboratory space around the hood. Automatic sash positioning also could be implemented, with an occupancy sensor automatically closing the sash when occupants are not detected and the fume hood is not in use. Based on the 7th Plan workbook "com-fumehood-7p_v2".

Smart Plug Power Strips—Retro. In commercial office spaces, installation of a power strip that turns office equipment off outside of regular office hours, resulting in energy savings. A master outlet controls other outlets, turned off based on the master outlet's load sensor reading. Does not include computer or monitor savings. Occupancy-sensing power strips are also included. Based on the 7th Plan workbook "com-powerstrips-7p_v5".

Water Cooler Timer. This represents two measures: upgrading from a market average cooler to an ENERGY STAR 2.0 cooler; and a timer on the ENERGY STAR 2.0 cooler. The timer turns the cooler off during unoccupied periods. Based on the 7th Plan workbook "com-watercooler-7p_v6".

C.4. Industrial Electric Measure Descriptions

Air Compressor Improvements. These measures improve an overall compressed air system by improved system designs, leak repairs, usage practices, more efficient dryer and storage systems, and compressor upgrades.

Measure Name
Air Compressor Demand Reduction
Air Compressor Equipment1
Air Compressor Equipment2
Air Compressor Optimization

Clean Room Improvements. These measures save energy through improved clean room equipment and practices. Savings can be attributed to optimization of chiller operating parameters, upgrading to more efficient equipment, and improving filter replacement strategies.

Measure Name
Clean Room: Change Filter Strategy
Clean Room: Chiller Optimize
Clean Room: Clean Room HVAC

Efficiency Centrifugal Fan. This measure achieves energy savings through an improved fan design.

Measure Name
Efficient Centrifugal Fan

Fan System Optimization. This measure involves overall optimization of fan systems with improved system designs, enhanced flow designs, better maintenance practices, and adjustments to system parameters.

Measure Name
Fan System Optimization

Food Manufacturing (Cooling and Storage, Refrigerator Storage Tune-up). These measures maintain and enhance cooling equipment for each facility type. Tune-ups may include refrigerant charges, equipment cleaning, general maintenance, and improved practices.

Measure Name
Food: Cooling and Storage
Food: Refrig Storage Tune Up

General Process Improvements. This measure includes upgrading/replacing equipment and using optimum size/capacity equipment.

Measure Name
Metal: New Arc Furnace

High-Efficiency Fans. This measure involves upgrading motors to higher-efficiency units. As NEMA Premium motors are becoming the baseline code requirement in 2010, this measure is based on super-premium motors with efficiency levels at least one efficiency band above NEMA premium.

Measure Name
Fan Equipment Upgrade

LED Street Light Conversions. LED street lights can replace standard high-pressure sodium (HPS) street lights, with similar lumens achieved with less wattage.

Measure Name
LED HPS Replacement—135 W LED
LED HPS Replacement—270 W LED

Lighting Improvements. Changes to overall illumination levels, use of natural lighting, or technology improvements to more efficient bulbs or ballasts can decrease overall lighting energy consumption. These measures include upgrades from T12 to T8 systems, T8 to high-performance T8 systems, HID to fluorescent conversions, standard HID to high-efficiency HID systems, and occupancy and day lighting controls.

Measure Name
Efficient Lighting 1 Shift
Efficient Lighting 2 Shift
Efficient Lighting 3 Shift
High-Bay Lighting 1 Shift
High-Bay Lighting 2 Shift
High-Bay Lighting 3 Shift
Lighting Controls

Motor Rewind. This measure follows the Green Motors Practices Group™ best practices recommendations to maintain original efficiency, commonly called a Green Rewind.[9] A failed motor can be rewound to a lower efficiency, rewound to maintain the original efficiency, or replaced.

Measure Name
Motors: Rewind 20-50 HP
Motors: Rewind 51-100 HP
Motors: Rewind 101-200 HP
Motors: Rewind 201-500 HP
Motors: Rewind 501-5000 HP

Municipal Water Supply. Municipal water supply savings, primarily achieved from reduced pumping energy. Measures include more-efficient pumps/drives, water end-use efficiency improvements, leak reduction, water treatment, and compressed air improvements. Based on the 7th Plan workbook "com-watersupply-7p_v5p".

Measure Name
Municipal Water Supply—Retro

Optimize Municipal Sewage. Measures defined based the size of the treatment plant: <1 MGD, 1 to 10 MGD, and >10 MGD (MGD = Million Gallons per Day). Baseline consumption is defined for each of these three categories in Million kWh/MGD. Electricity saved per flow rate (Million kWh/MGD flow) is based on case studies. Based on the 7th Plan workbook "com-wastewater-7p_v5p".

Measure Name
Optimize Municipal Sewage; <1 MGD Design Capacity
Optimize Municipal Sewage; >10 MGD Design Capacity
Optimize Municipal Sewage; 1 to 10 MGD Design Capacity

Pump Equipment Upgrade. This measure achieves energy savings through improved pump design and sizing.

Measure Name
Pump Equipment Upgrade

9 http://www.bpa.gov/energy/n/industrial/Green_motors/

Pump Improvements (Pump Energy Management, Pump System Optimization). This measure optimizes overall pump systems with improved system designs, enhanced flow designs, better maintenance practices, and adjustments to system parameters.

Measure Name
Pump Energy Management
Pump System Optimization

Synchronous Belts. This measure contains mating, corresponding grooves in a drive sprocket, preventing slip and reducing energy losses.

Measure Name
Synchronous Belts

Transformers. Energy-efficient transformers provide improved power quality while minimizing losses.

Measure Name
Transformers—Retrofit
Transformers—New

Whole Plant Improvements. These measures include synergistic savings of plantwide energy management and improvements across multiple systems (e.g., compressed air, pumping, fan systems).

Measure Name
Energy Project Management
Fan Energy Management
Integrated Plant Energy Management
Plant Energy Management

Detailed Energy Efficiency Potential

D.1. Detailed Energy Efficiency Potential

Appendix D summarizes total cumulative achievable economic potential in 2040 (21-year cumulative) for the IRP avoided cost scenario by segment, sector, and end use. Note: for end uses for which the share of total potential is less than 1% is expressed as "0%" in the pie charts.

D.2. Energy Efficiency Potential Summary

Figure D-1. Achievable Economic Potential: Residential by Segment

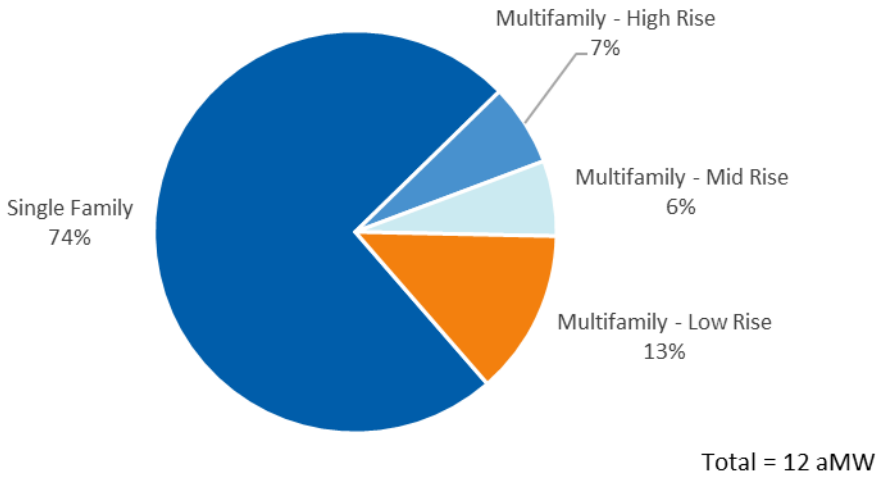


Figure D-2. Achievable Economic Potential: Commercial by Segment

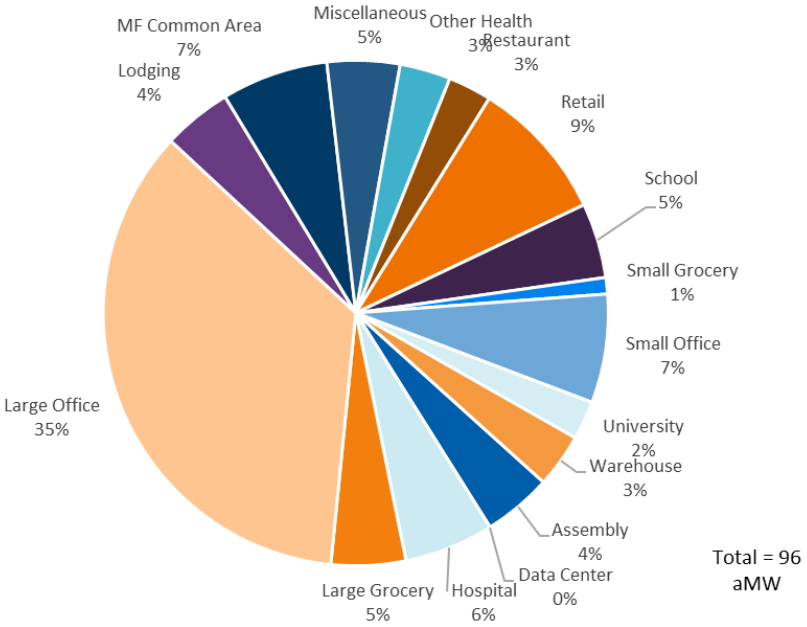


Figure D-3. Achievable Economic Potential: Industrial by Segment

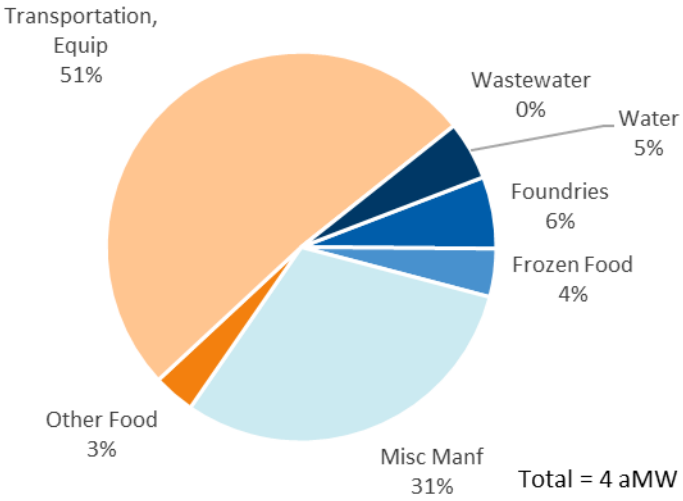


Figure D-4. Achievable Economic Potential: Residential by End Use

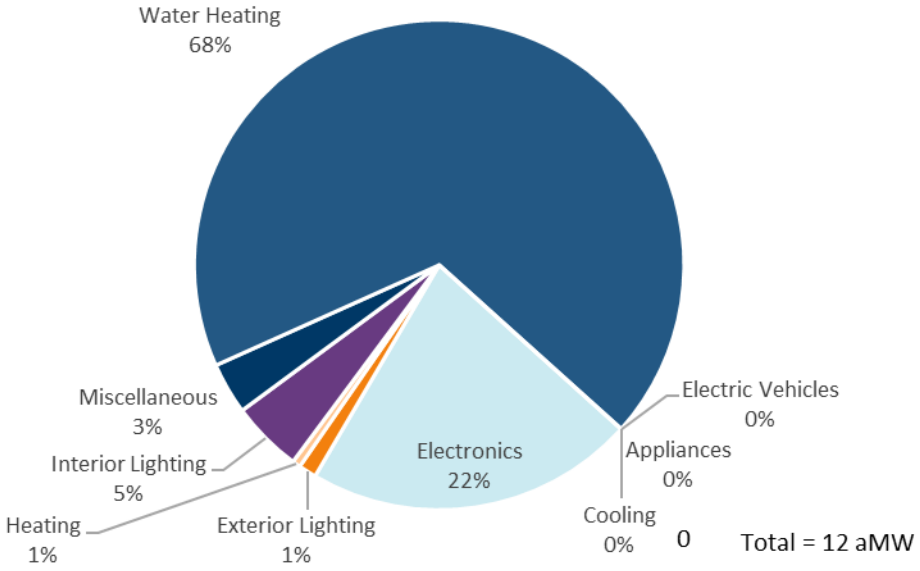


Figure D-5. Achievable Economic Potential: Commercial by End Use

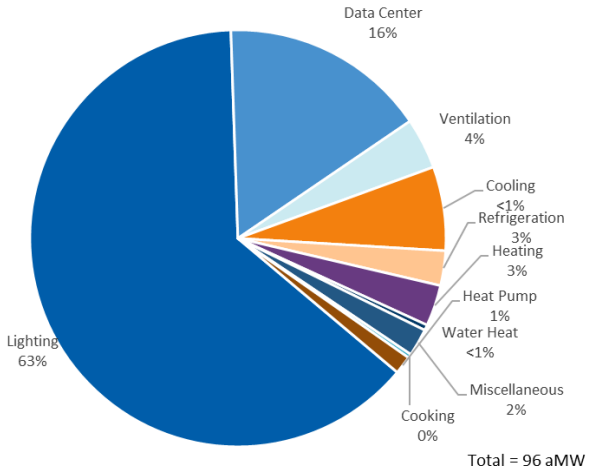
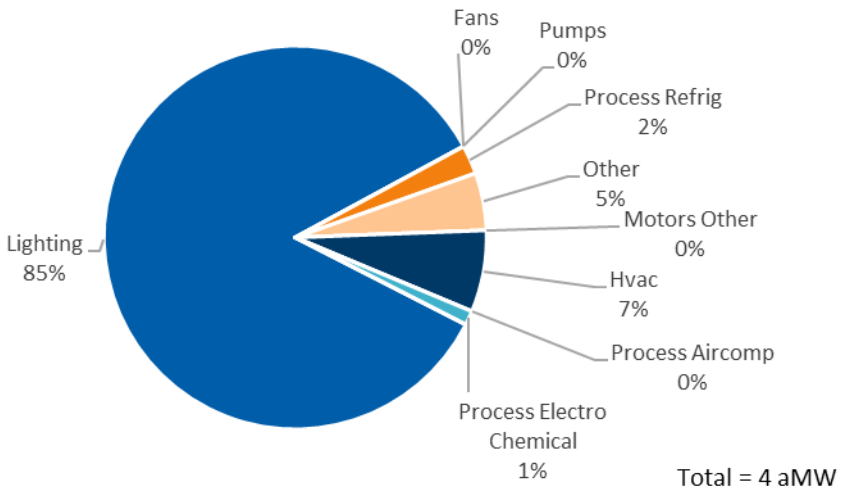


Figure D-6. Achievable Economic Potential: Industrial by End Use



D.3. Residential Segments by End Use

Figure D-7. Achievable Economic Potential: Residential Single Family by End Use

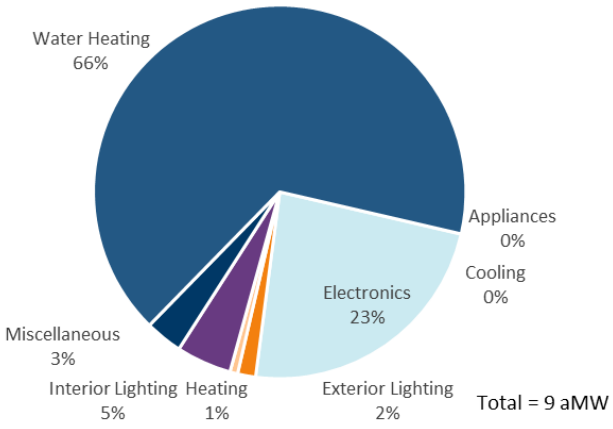


Figure D-8. Achievable Economic Potential: Residential Multifamily – Mid Rise by End Use

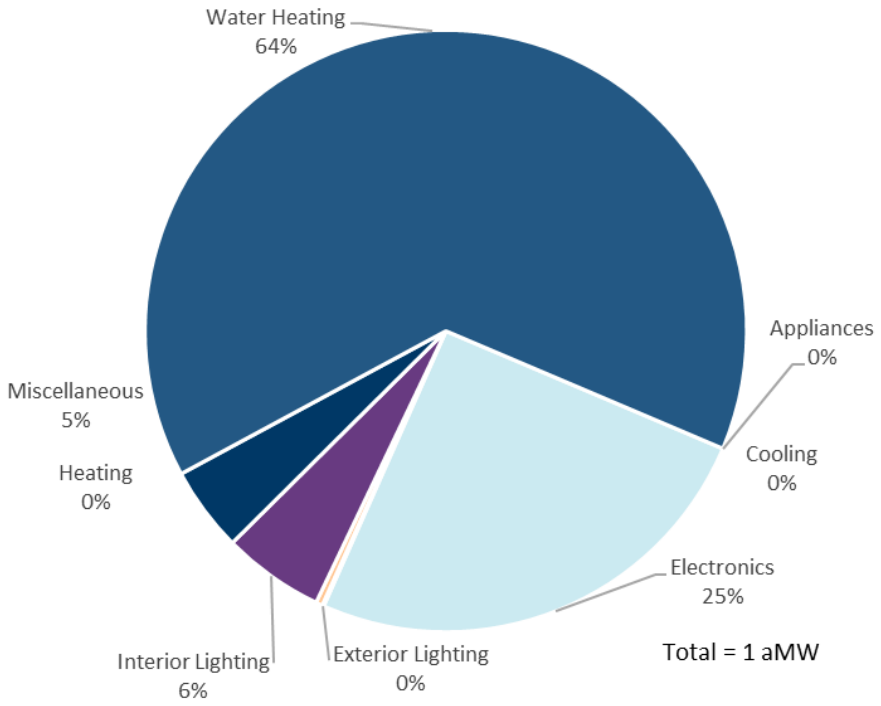


Figure D-9. Achievable Economic Potential: Residential Multifamily – Low Rise by End Use

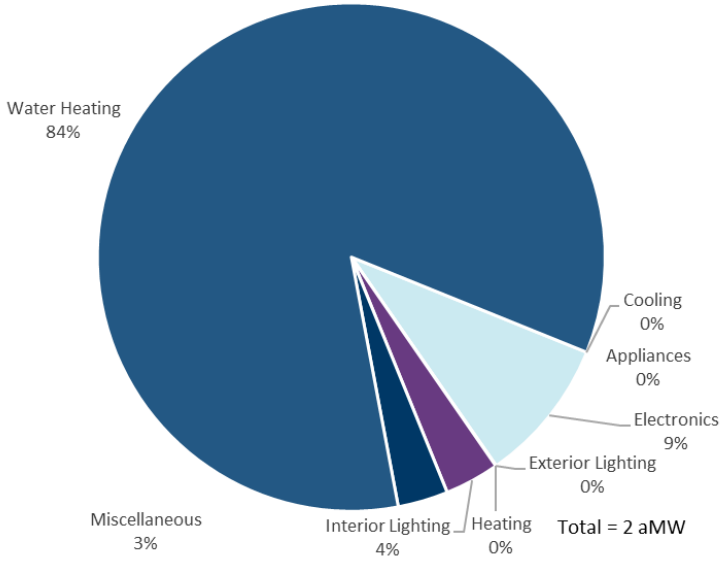
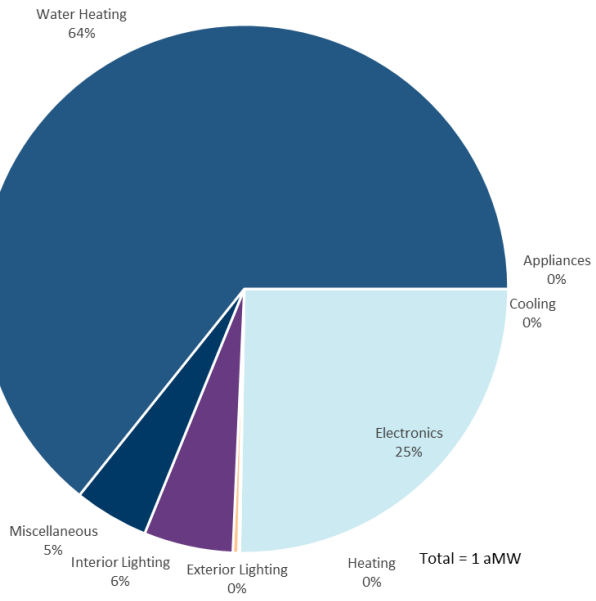


Figure D-10. Achievable Economic Potential: Residential Multifamily – High Rise by End Use



D.4. Commercial Segments by End Use

Figure D-11. Achievable Economic Potential: Commercial Assembly by End Use

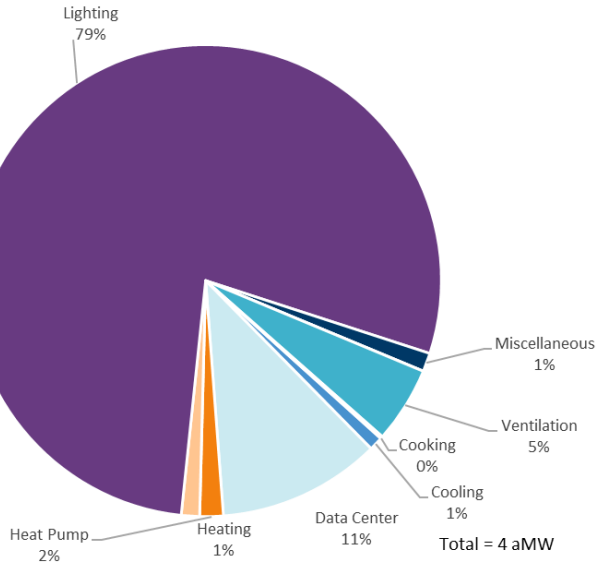


Figure D-12. Achievable Economic Potential: Commercial Hospital by End Use

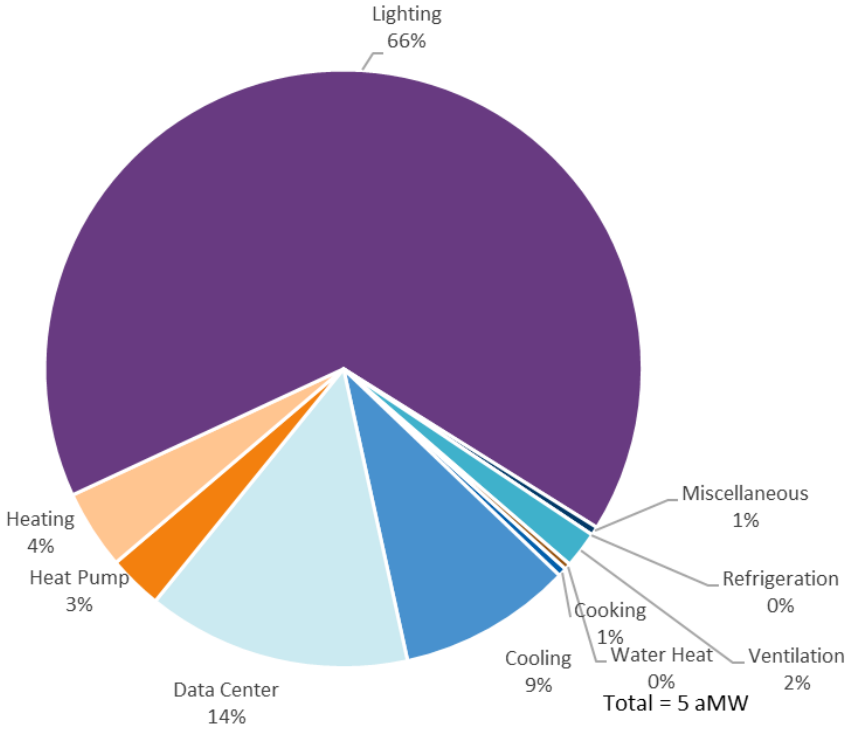


Figure D-13. Achievable Economic Potential: Commercial Large Grocery by End Use

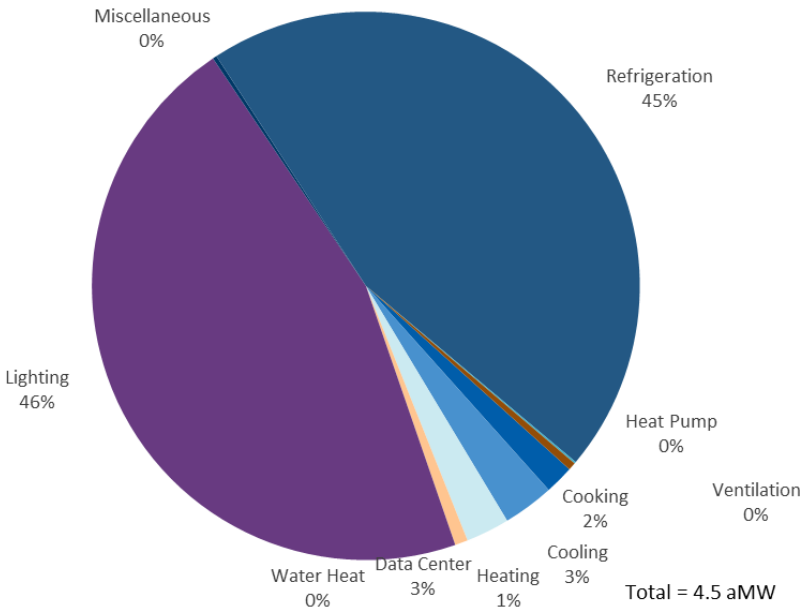


Figure D-14. Achievable Economic Potential: Commercial Large Office by End Use

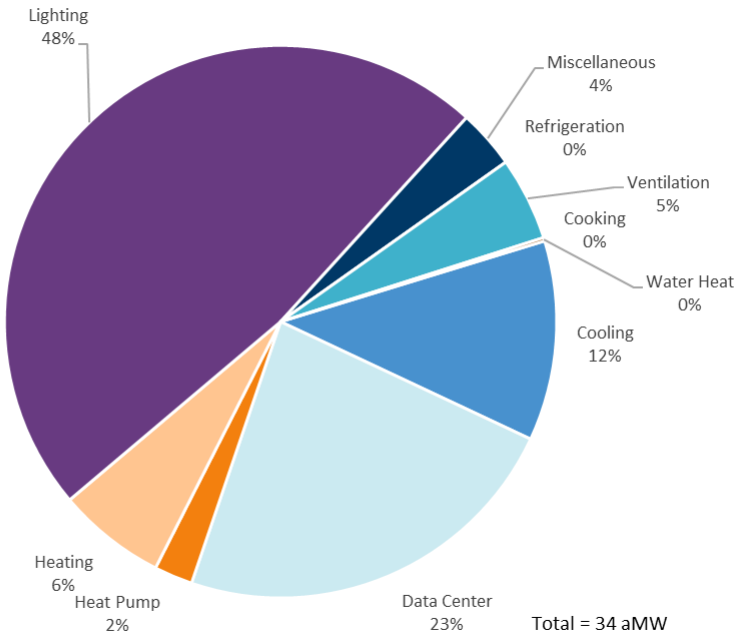


Figure D-15. Achievable Economic Potential: Commercial Lodging by End Use

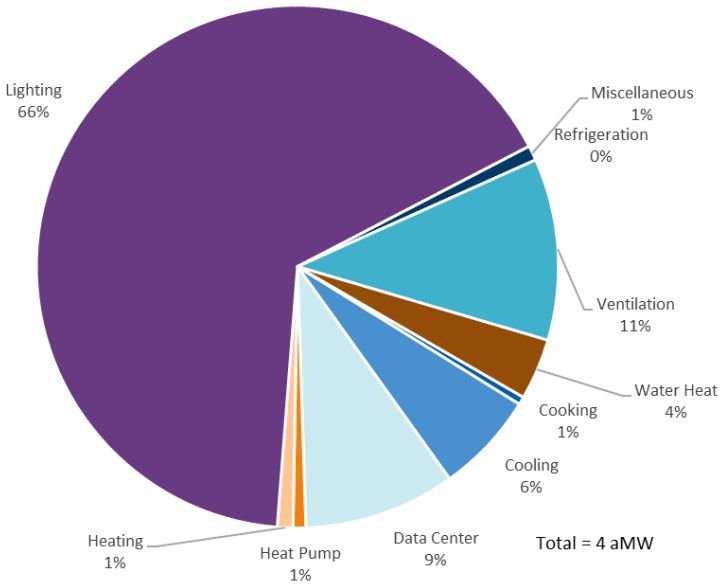


Figure D-16. Achievable Economic Potential: Commercial MF Common Area by End Use

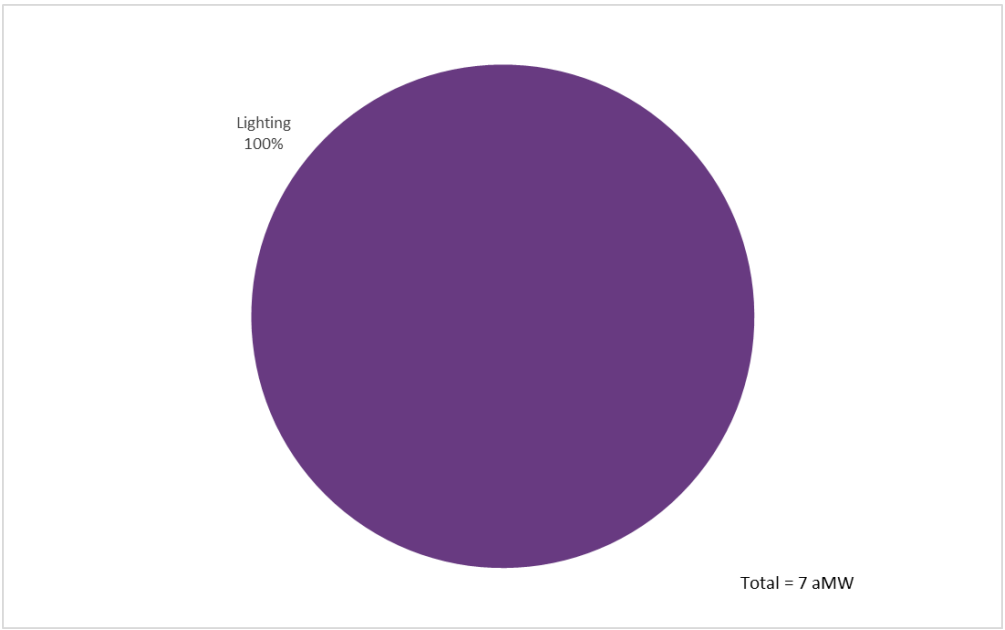


Figure D-17. Achievable Economic Potential: Commercial Miscellaneous by End Use

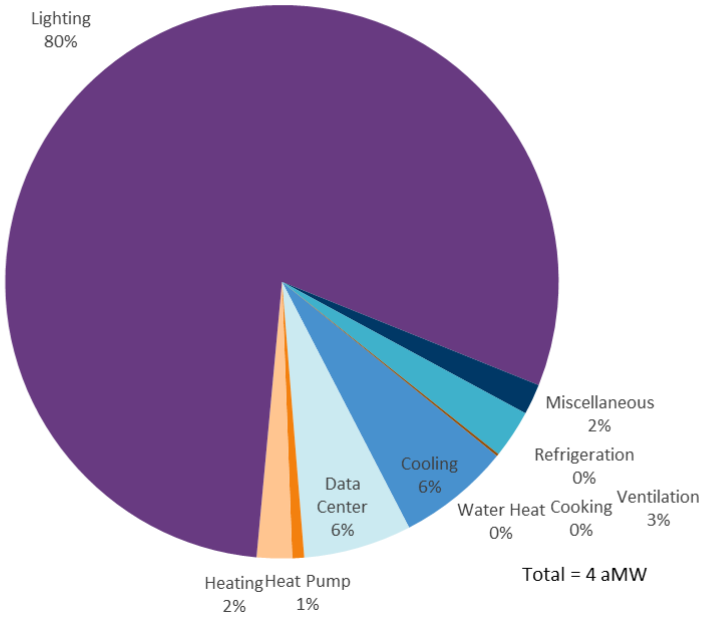


Figure D-18. Achievable Economic Potential: Commercial Other Health by End Use

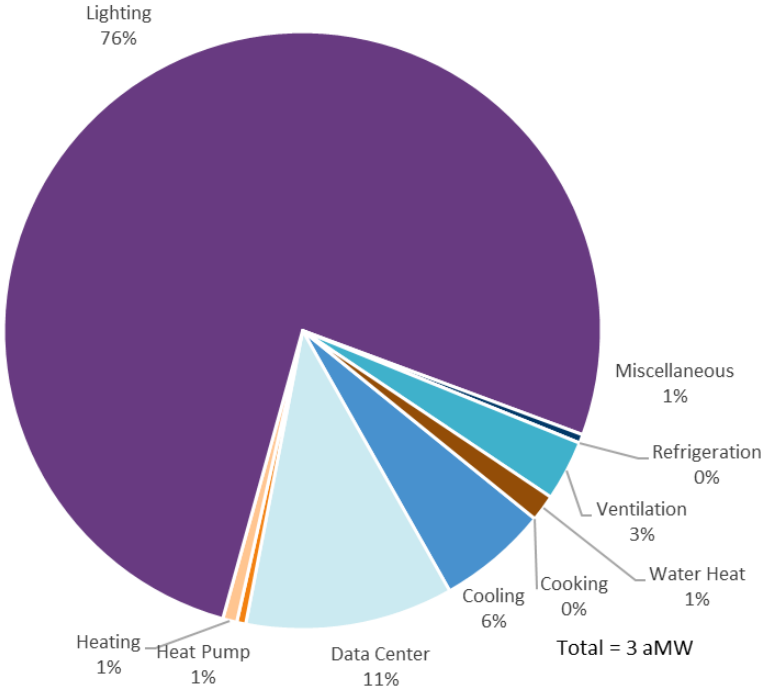


Figure D-19. Achievable Economic Potential: Commercial Restaurant by End Use

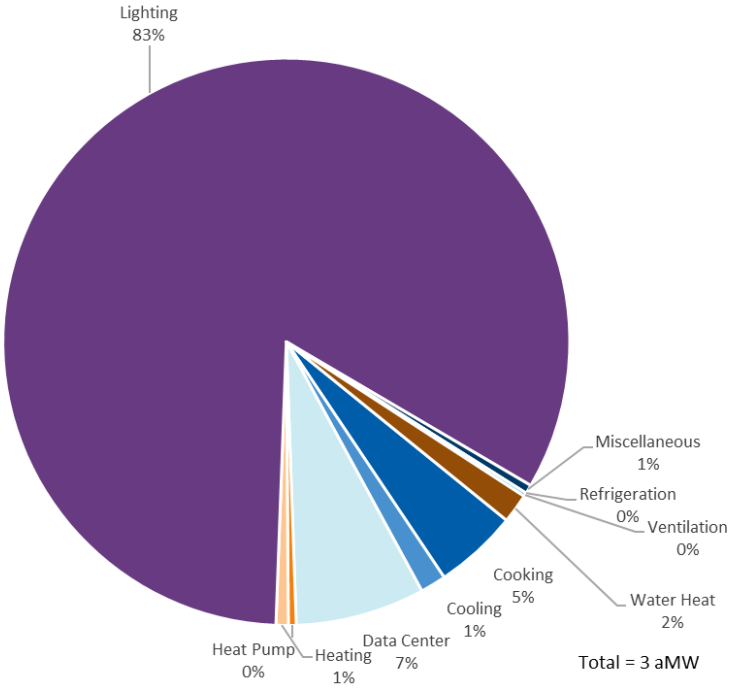


Figure D-20. Achievable Economic Potential: Commercial Retail by End Use

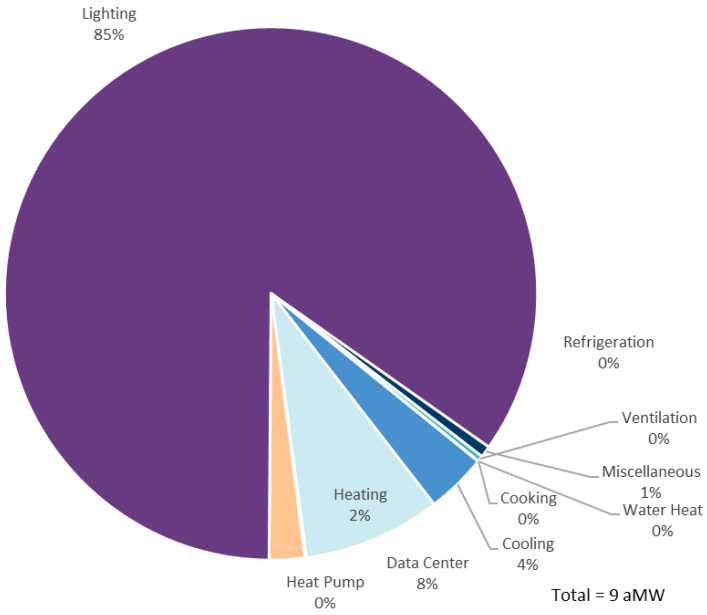


Figure D-21. Achievable Economic Potential: Commercial School by End Use

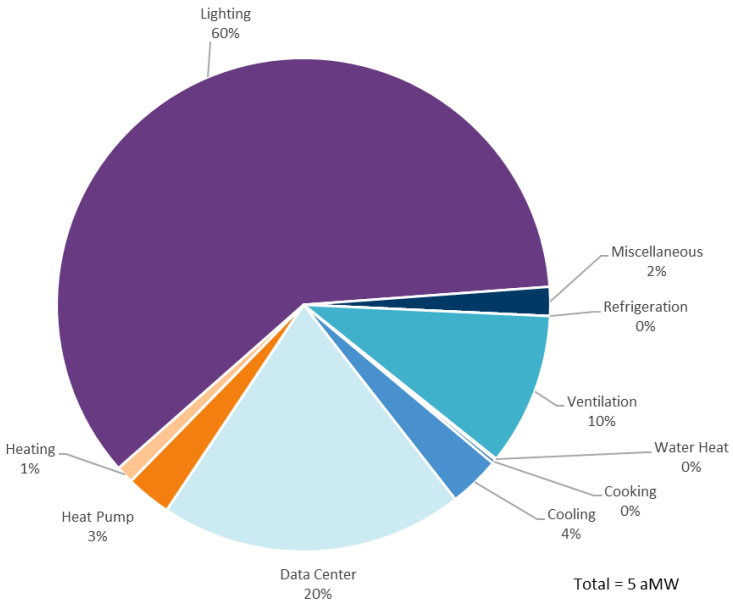


Figure D-22. Achievable Economic Potential: Commercial Small Grocery by End Use

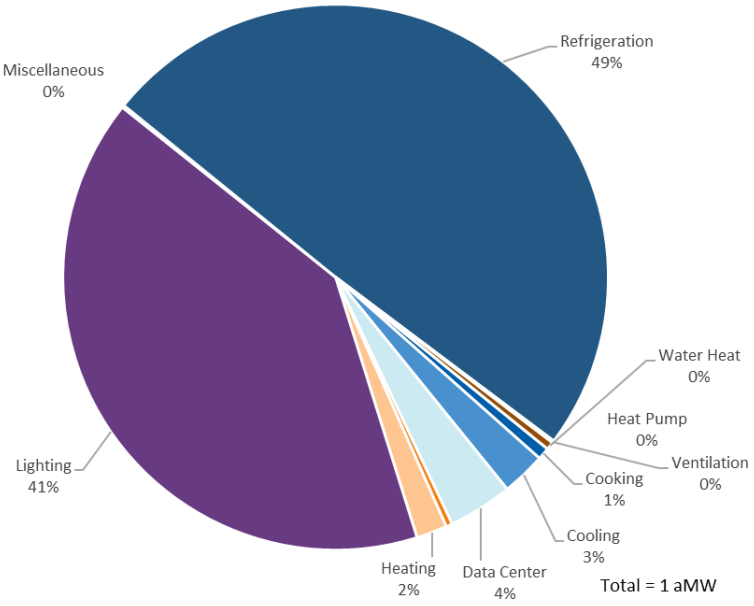


Figure D-23. Achievable Economic Potential: Commercial Small Office by End Use

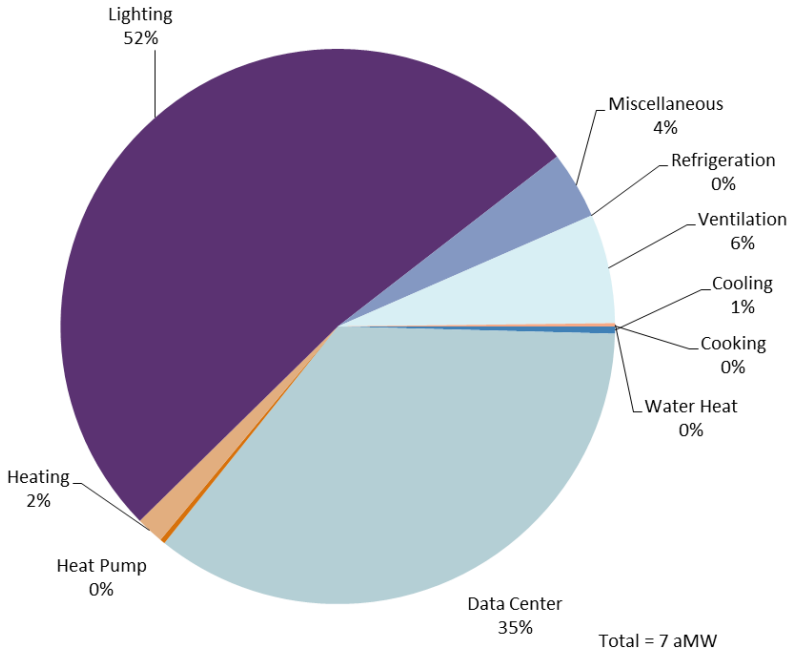


Figure D-24. Achievable Economic Potential: Commercial University by End Use

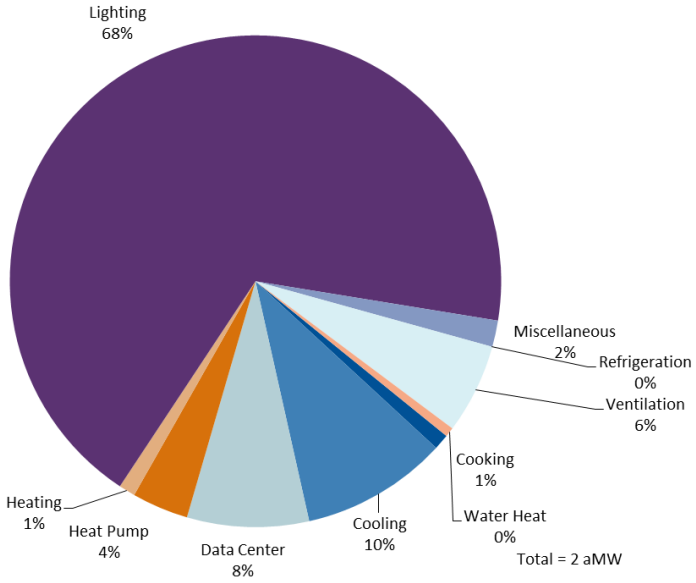
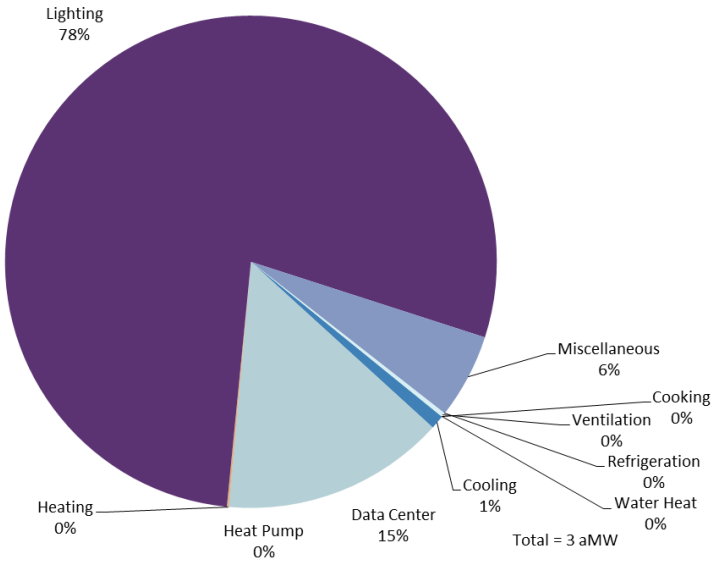


Figure D-25. Achievable Economic Potential: Commercial Warehouse by End Use



D.5. Industrial Segments by End Use

Figure D-26. Achievable Economic Potential: Industrial – Other Food by End Use

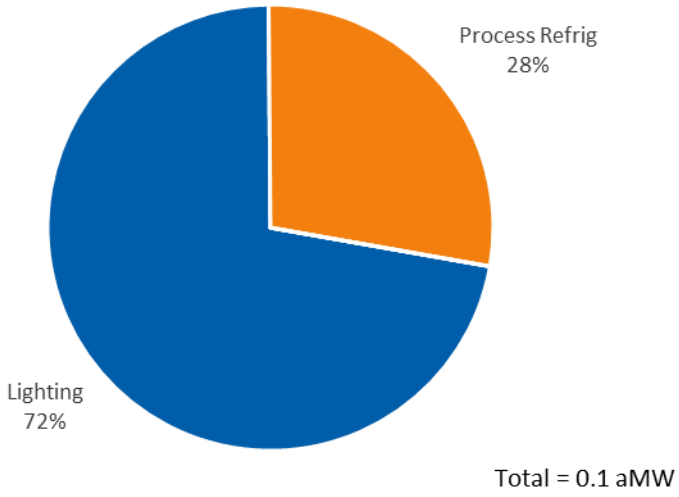


Figure D-27. Achievable Economic Potential: Industrial – Misc. Manufacturing by End Use

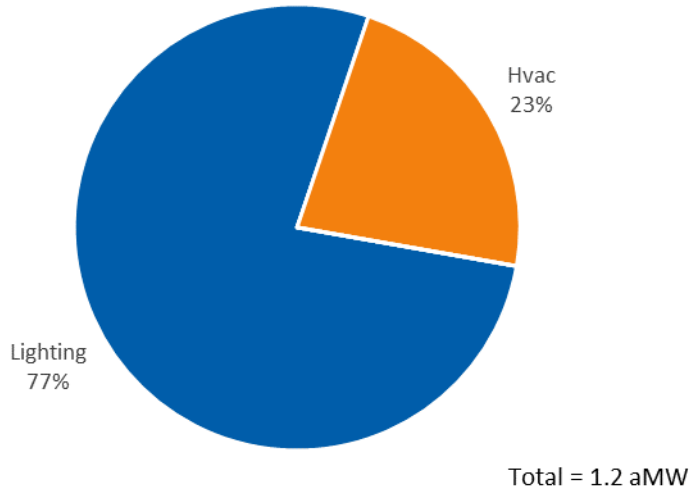


Figure D-28. Achievable Economic Potential: Industrial – Foundries by End Use

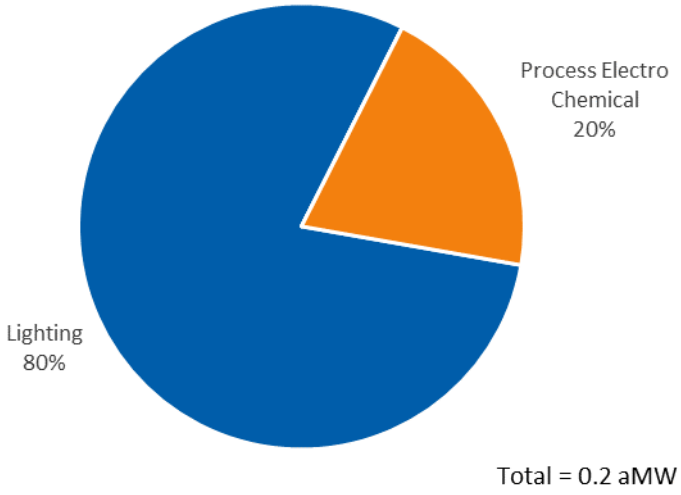


Figure D-29. Achievable Economic Potential: Industrial – Transportation, Equip by End Use

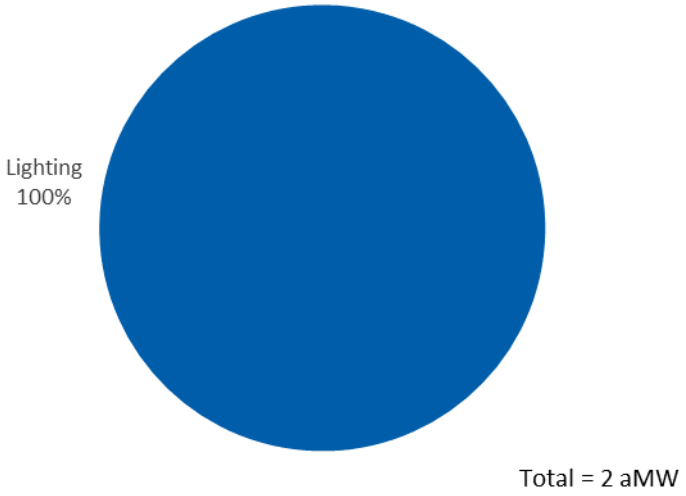


Figure D-30. Achievable Economic Potential: Industrial – Wastewater by End Use

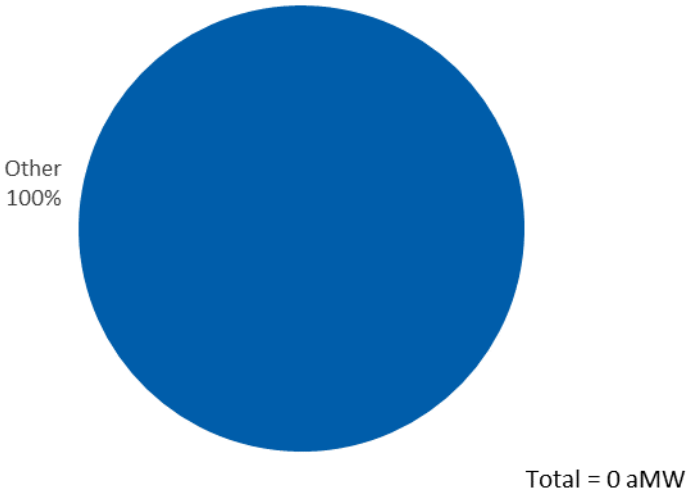


Figure D-31. Achievable Economic Potential: Industrial – Water by End Use

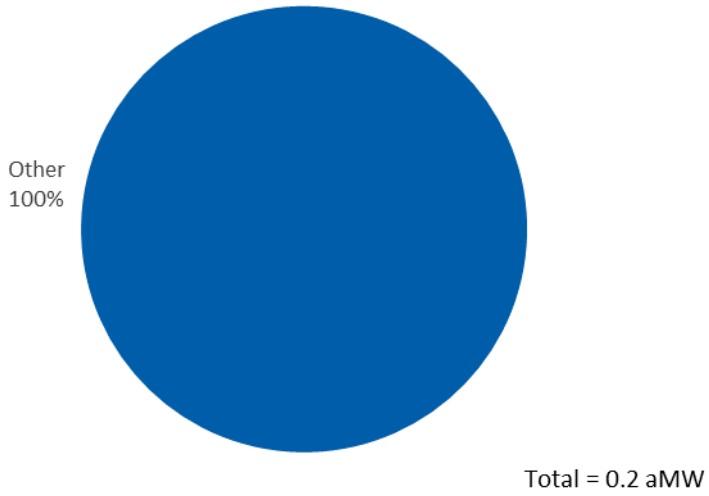
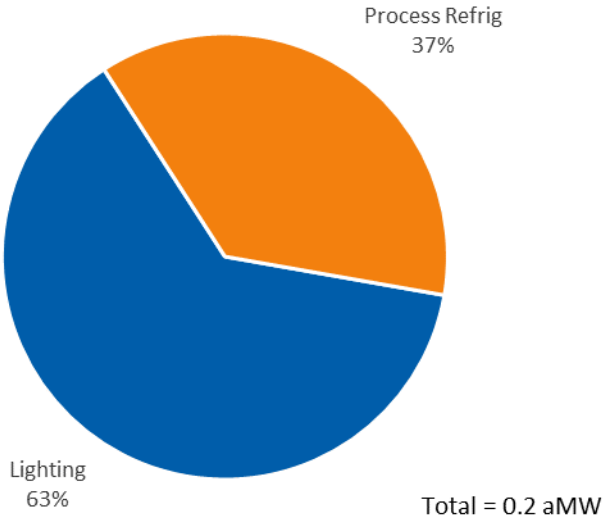


Figure D-32. Achievable Economic Potential: Industrial – Frozen Food by End Use



Measure Details

E.1. Measure Details

Appendix E includes detailed measure costs, savings, and applicability factors for all measure permutations considered in this study. This appendix includes three separate tables for each sector: residential, commercial, and industrial.

- **Segment**
- **End Use**
- **Construction Vintage:** New or Existing
- **Measure Name**
- **Measure Description**
- **Baseline Description**
- **Unit Description**: Units of savings and costs (e.g., per square foot, per unit, per industry).
- **Savings per Unit**: Per-unit standalone savings for the energy efficiency measure.
- **Measure Life**: Expected useful lifetime of a given measure (years).
- **Incremental Cost ($)**: Incremental cost to install an energy efficiency measure (including capital costs, labor, and annual operations and maintenance); industrial costs expressed in thousands of dollars.
- **Levelized Cost**: The total resource cost (TRC), levelized cost of conserved energy, discounted over the 20-year study horizon.
- **TRC Benefit-Cost (B/C) Ratio**: The ratio of net present value TRC benefits to net present value TRC costs.
- **Technical Potential**: Cumulative, 20-year, technically feasible, energy efficiency potential, expressed in MWh.
- **Economic Potential**: Cumulative, 20-year, energy efficiency potential for cost-effective measures, expressed in MWh. Note: due to interactions, economic potential may exceed technical potential for some measures.
- **Achievable Economic Potential**: IRP scenario cumulative, 20-year, achievable potential, expressed in MWh.

Appendix E is included as an attachment to this volume of the report.