EAST KENTUCKY POWER COOPERATIVE

Energy Efficiency & Demand Response Potential

FINAL REPORT

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prepared by

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1 Executive Summary

1.1 BACKGROUND

This energy efficiency and demand response potential study for the East Kentucky Power Cooperative (EKPC) provides a roadmap and identifies the energy efficiency and demand response measures having the greatest potential savings and the measures that are the most cost-effective. In addition to technical and economic potential estimates, the development of achievable potential estimates for a range of feasible energy efficiency measures is useful for program planning and modification purposes. Unlike achievable potential estimates, technical and economic potential estimates do not include customer acceptance considerations for energy efficiency measures, which are often among the most important factors when estimating the likely customer response to new programs.

All energy efficiency results were developed using customized residential, commercial and industrial sector-level energy efficiency potential assessment Excel models and Company-specific cost effectiveness criteria including the most recent EKPC avoided energy and capacity cost projections for electricity. Demand response results were calculated in a separate model.

The results of this study provide detailed information on measures that are cost-effective and have potential kWh and kW savings. The data referenced in this report were the best available at the time this analysis was developed. As building and appliance codes and energy efficiency standards change, and as energy prices fluctuate, additional opportunities for energy efficiency may occur while current practices may become outdated. Actual energy and demand savings will depend upon the level and degree of voluntary member system participation in DSM programs.

1.2 STUDY SCOPE

This study examines the potential to reduce electric consumption and peak demand through the implementation of DSM technologies and practices in residential, commercial, and industrial facilities. The study assessed energy efficiency potential and demand response throughout EKPC Members' service territories over fifteen years, from 2019 through 2033.

The scope of this study distinguishes three types of energy efficiency potential: (1) technical, (2) economic, and (3) achievable.

- ***Technical Potential*** is the theoretical maximum amount of energy use that could be displaced by efficiency, disregarding all non-engineering constraints such as cost-effectiveness and the willingness of end users to adopt the efficiency measures. Technical potential is constrained only by factors such as technical feasibility and applicability of measures.
- ***Economic Potential*** refers to the subset of the technical potential that is economically cost-effective as compared to conventional supply-side energy resources. Economic potential follows the same adoption rates as technical potential. Like technical potential, the economic scenario ignores market barriers to ensuring actual implementation of efficiency. Finally, economic potential only considers the costs of efficiency measures themselves, ignoring any programmatic costs (e.g., marketing, analysis, administration) that would be necessary to capture them.[1]
- ***Achievable Potential*** is the amount of energy use that efficiency can realistically be expected to displace, assuming the most aggressive program scenario possible (e.g., providing end users with payments for the entire incremental cost of more efficient equipment). Achievable potential considers real-world barriers to encouraging end users to adopt efficiency measures, the non-measure costs of delivering programs (for administration, marketing, tracking systems, and

[1] National Action Plan for Energy Efficiency, "Guide for Conducting Energy Efficiency Potential Studies" (November 2007), page 2-4.

monitoring and evaluation), and the capability of programs and administrators to boost program activity over time.[2] The study assessed two types of achievable potential: maximum (MAP) and realistic (RAP). See section 2.4.4 for a description.

1.3 ENERGY EFFICIENCY POTENTIAL

Figure 1-1 provides the 15-yr technical, economic, and achievable potential across all sectors in the EKPC service territory. The realistic achievable potential is approximately 9% of forecasted sales for both the commercial and industrial sectors and 12% for the residential sector.

FIGURE 1-1 ELECTRIC EFFICIENCY POTENTIAL SAVINGS SUMMARY – BY 2033

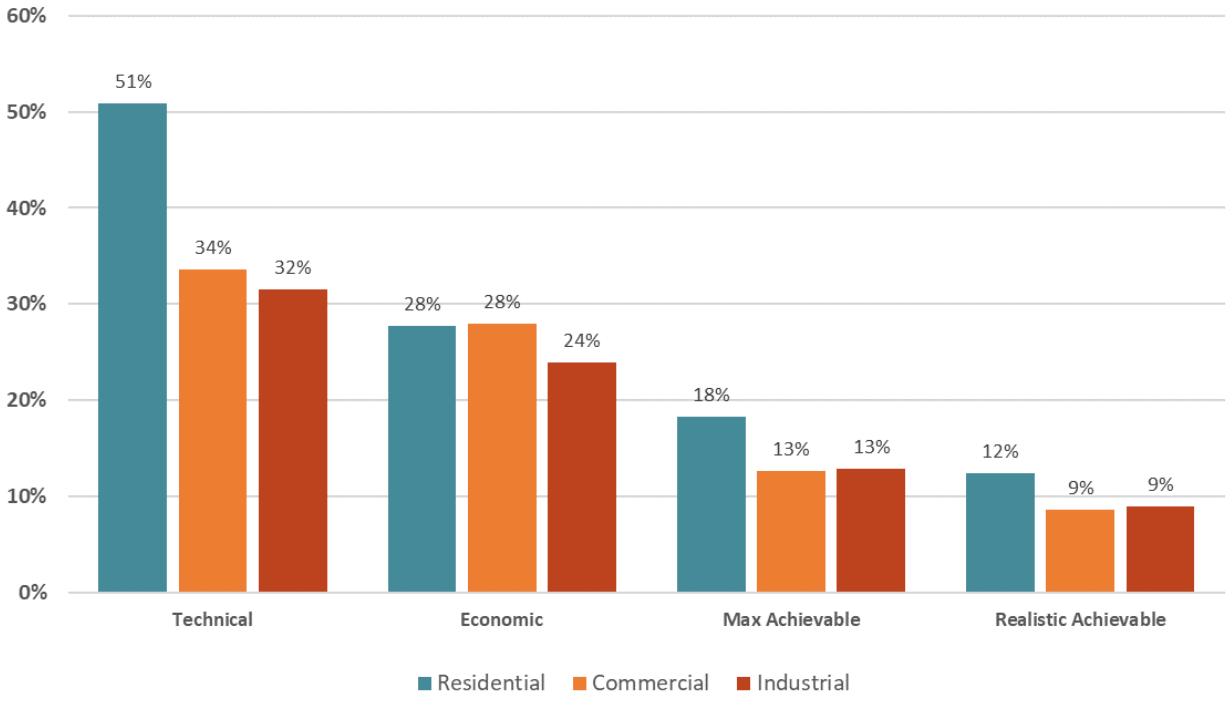


Table 1-1 provides the 15-yr energy potential in total MWh as well as the percent savings of the forecasted sales. The overall EKPC realistic achievable potential is approximately 1.6 million MWh, or nearly 11% of the total forecasted sales.

TABLE 1-1 SECTOR-LEVEL CUMULATIVE ANNUAL ENERGY EFFICIENCY SAVINGS – BY 2033

Sector	Technical	Economic	MAP	RAP
Cumulative Annual Savings %				
Residential	50.8%	27.7%	18.3%	12.4%
Commercial	33.6%	28.0%	12.6%	8.6%
Industrial	31.5%	23.9%	12.9%	8.9%
Total	42.3%	26.6%	15.7%	10.8%
Cumulative Annual MWh				
Residential	4,101,328	2,235,491	1,474,578	1,000,348
Commercial	833,818	693,952	313,605	214,307
Industrial	1,386,909	1,051,536	566,253	392,850
Total	6,322,055	3,980,979	2,354,436	1,607,505

[2] National Action Plan for Energy Efficiency, "Guide for Conducting Energy Efficiency Potential Studies" (Nov. 2007), page 2-4.

Table 1-2 shows the net present value benefits, costs and benefit-cost ratios for the MAP and RAP scenarios examined in this study. The overall TRC ratio in the RAP scenario is 2.4 and yields more than $ $600 million in NPV net benefits.

TABLE 1-2 ACHIEVABLE POTENTIAL COST-EFFECTIVENESS ($ IN MILLIONS)

Potential	NPV Benefits	NPV Costs	TRC Test Ratio
Maximum Achievable	$1,547	$712	2.2
Realistic Achievable	$1,056	$446	2.4

1.4 DEMAND RESPONSE POTENTIAL

The demand response assessment included a switch scenario and a thermostat scenario (see Section 2.5 for details). Table 1-3 shows the technical, economic, and achievable (MAP and RAP) cumulative annual potential for years 5, 10 and 15 of the study in the switch scenario. Table 1-4 shows results for each level of potential in the thermostat scenario.

Achievable potential includes a participation rate to estimate the realistic number of customers that are expected to participate in each cost-effective demand response program option. These values are at the customer meter. The maximum achievable potential (MAP) assumes the maximum participation that would happen in the real-world, while the realistically achievable potential (RAP) discounts MAP by considering barriers to program implementation that could limit the amount of savings achieved.

TABLE 1-3 SUMMARY OF TECHNICAL, ECONOMIC, AND ACHIEVABLE POTENTIAL – SWITCH SCENARIO

Potential Level (MW)	5-Year Savings (2023)	10-Year Savings (2028)	15-Year Savings (2033)
Technical	1265	1275	1282
Economic	1126	1131	1134
MAP	358	409	455
RAP	130	172	214

TABLE 1-4 SUMMARY OF TECHNICAL, ECONOMIC, AND ACHIEVABLE POTENTIAL – THERMOSTAT SCENARIO

Potential Level (MW)	5-Year Savings (2023)	10-Year Savings (2028)	15-Year Savings (2033)
Technical	962	987	1012
Economic	822	843	865
MAP	357	408	453
RAP	118	149	180

1.5 REPORT ORGANIZATION

The body of the report is divided into six subsequent chapters:

- ***Chapter 2: Methodology*** describes the approaches taken to each sector for the energy efficiency assessment and the demand response assessment.
- ***Chapter 3: Market Characterization*** provides the sales forecasts by sector and breakdown of sales by market segment.
- ***Chapter 4: Residential Energy Efficiency Potential*** provides the residential sector energy efficiency potential results. In addition to technical, economic, and achievable potential results, there are results for several other budget scenarios.
- ***Chapter 5: Commercial Energy Efficiency Potential*** provides the commercial sector energy efficiency potential results.

- ***Chapter 6: Industrial Energy Efficiency Potential*** provides the industrial sector energy efficiency potential results.
- ***Chapter 7: Demand Response Analysis*** provides the demand response results.
- ***Appendices:*** The appendices provide additional sector level detail and global assumptions.

2 Methodology

This section describes the overall methodology that was utilized by GDS to develop the energy efficiency potential study for EKPC. The main objective of this energy efficiency potential study is to quantify the technical, economic and achievable potential for electric energy efficiency savings in EKPC member service territories. This report provides estimates of the potential kWh and kW electric savings for each level (technical, economic and achievable potential) of energy efficiency potential. This document describes the general steps and methods that were used at each stage of the analytical process necessary to produce the various estimates of energy efficiency potential. GDS did not examine delivery approaches for energy efficiency programs as this task was not included in the scope of work for this study.

Energy efficiency potential studies involve several analytical steps to produce estimates of each type of energy efficiency potential: technical, economic, and achievable. This study utilizes benefit/cost screening tools for the residential and non-residential sectors to assess the cost effectiveness of energy efficiency measures. These cost effectiveness screening tools are Excel-based models that integrate technology-specific impacts and costs, customer characteristics, utility avoided cost forecasts and more. Excel was used as the modeling platform to provide transparency to the estimation process and allow for simple customization based on EKPC's unique characteristics and the availability of specific model input data. The major analytical steps and an overview of the potential savings are summarized below, and specific changes in methodology from one sector to another have been noted throughout this section

2.1 OVERVIEW OF APPROACH

For the residential sector, GDS took a bottom-up approach to the modeling, whereby measure-level estimates of costs, savings, and useful lives were used as the basis for developing the technical, economic, and achievable potential estimates. The measure data was used to build-up the technical potential, by applying the data to each relevant market segment. The measure data allowed for benefit-cost screening to assess economic potential, which was in turn used as the basis for achievable potential, which took into consideration incentives and estimates of annual adoption rates.

For the commercial and industrial sectors, GDS took a bottom-up modeling approach to first estimate measure-level savings and costs as well as cost-effectiveness, and then applied cost-effective measure savings to all applicable shares of energy load. Disaggregated forecast data served as the foundation for the development of the energy efficiency potential estimates. The creation of the disaggregation involved two steps. First, GDS looked at actual customer groupings based on NAICS code and then calibrated our top down load allocation based these codes to determine whether the customer was captured in the load forecast. Second, GDS determined the appropriate industry for industrial customers and the building type for commercial customers.

2.2 MARKET CHARACTERIZATION

The initial step in the analysis was to gather a clear understanding of the current market segments in the EKPC service area. The GDS team coordinated with EKPC to gather utility sales and customer data and existing market research to define appropriate market sectors and market segments. This information served as the basis for completing a forecast disaggregation and market characterization of both the residential and nonresidential sectors.

2.2.1 Forecast Disaggregation

In the residential sector, GDS calibrated its building energy modeling simulations with EKPC's electric sales forecasts.[3] This process began with the construction of building energy models, using the BEopt™ (Building Energy Optimization)[4] software, which were specified in accordance with the most currently available data describing the residential building stock in the EKPC service area. Models were constructed for both single-family and manufactured homes, as well as various types of heating and cooling equipment. Key characteristics defining these models include conditioned square footage, typical building envelope conditions such as insulation levels and representative appliance and HVAC efficiency levels. The simulations yielded estimated energy consumption for each building prototype, including estimates of each key end use. These end use estimates were then multiplied by the estimated proportion of customers that applied to each end use, to calculate an estimated service territory total consumption for each end use. For example, simulated heat pump electric heating consumption was multiplied by the proportion of homes that rely on heat pumps for their electric heating needs, to calculate the total heat pump electric heating load in the EKPC service territory.

In the commercial and industrial sectors, disaggregated forecast data provides the foundation for the development of energy efficiency potential estimates. GDS disaggregated the commercial sector sales into building type using data provided by EKPC with regional energy use estimates from the US Energy Information Administration (EIA) 2012 Commercial Building Energy Consumption Survey (CBECS) data for the East South-Central Census region. For the industrial sector, the baseline electric forecasts were disaggregated by industry type using detailed sales by customer for all customers over 1,000 kW demand, and a sample of customers under 1,000 kW demand. Table 2-1 provides the segmentation by segment.

TABLE 2-1 NON-RESIDENTIAL SEGMENTS

COMMERCIAL		INDUSTRIAL	
☑ Food Sales	☑ Public Order & Safety	☑ Food	☑ Non-metallic Mineral
☑ Food Service	☑ Religious Worship	☑ Textile Mill Products	☑ Fabricated Metals
☑ Education	☑ Service	☑ Wood	☑ Transportation Equipment
☑ Health Care	☑ Warehouse & Storage	☑ Printing	☑ Miscellaneous
☑ Lodging	☑ Other	☑ Petroleum	
☑ Retail	☑ Vacant	☑ Chemicals	
☑ Office		☑ Plastics & Rubber	
☑ Public Assembly		☑ Primary Metals	

GDS further disaggregated sales for each of the segments into end uses. For commercial segments, GDS again primarily used EIA 2012 Commercial Building Energy Consumption Survey (CBECS) data for the East South-Central Census region. This information was used to determine energy use intensities, expressed in kWh per square foot, for each end use within each segment.[5] For the industrial sector, the analysis relied on the EIA's Manufacturing Energy Consumption survey to disaggregate industry-specific estimates of electric consumption into end uses.[6]

[3] East Kentucky Power Cooperative. 2016 Load Forecast. Prepared by Load Forecasting Department. December 2016.
[4] BEopt can be used to analyze both new construction and existing home retrofits, as well as single-family detached and multi-family buildings, through evaluation of single building designs, parametric sweeps, and cost-based optimizations.
[5] U.S. Energy Information Agency. *Commercial Buildings Energy Consumption Survey (CBECS)*. May 20, 2016. https://www.eia.gov/consumption/commercial/..
[6] U.S. EIA. *Manufacturing Energy Consumption Survey (MECS) 2010.* March 2013. https://www.eia.gov/consumption/manufacturing/data/2010/.

Table 2-2 and lists the electric end-uses considered in the forecast disaggregation and subsequent potential assessment.

TABLE 2-2 ELECTRIC END USES

RESIDENTIAL	COMMERCIAL	
☑ Lighting	☑ Interior Lighting	☑ Facility Lighting
☑ HVAC Equipment	☑ Exterior Lighting	☑ Facility HVAC
☑ HVAC Shell	☑ Space Cooling – Chillers	☑ Conventional Boiler Use
☑ Refrigerator/ Freezer	☑ Space Cooling – Unitary/Split	☑ Process Heating
☑ Clothes Washer/Dryer	☑ Space Heating	☑ Process Cooling and Refrigeration
☑ Dishwasher	☑ Ventilation	☑ Machine Drive
☑ Electronics	☑ Motors	☑ Electro-Chemical Processes
☑ Hot Water	☑ Water Heating	☑ Other Process Use
☑ Pool/Spa	☑ Cooking	☑ Other Facility Support
☑ Cross-Cutting/ Behavior	☑ Refrigeration	☑ Onsite Transportation
	☑ Office Equipment	☑ Other Non-Process Use
	☑ Compressed Air	
	☑ Pools	

2.3 MEASURE CHARACTERIZATION

2.3.1 Measure Lists

The energy efficiency measures included in this study cover energy efficiency measures currently included in EKPC's energy efficiency programs, as well as additional measures suggested by the GDS Team based on existing knowledge and current databases of electric end-use technologies and energy efficiency measures. The study scope includes measures and practices that are currently commercially available as well as emerging technologies. The commercially available measures are of the most immediate interest to EKPC. However, a small number of well documented emerging technologies were considered for each sector. Emerging technology research was focused on measures that are commercially available but may not be widely accepted at the current time. These measure lists were then reviewed, discussed and updated as necessary. A complete listing of the energy efficiency measures included in this study is provided in the Appendices of this report.

In addition, this study includes measures that could be relatively easily substituted for, or applied to, existing technologies on a retrofit or replace-on-burnout basis. Replace-on-burnout applies to equipment replacements that are made normally in the market when a piece of equipment is at the end of its useful life. A retrofit measure is eligible to be replaced at any time in the life of the equipment or building. Replace-on-burnout measures are generally characterized by incremental measure costs and savings (e.g. the costs and savings of a high-efficiency versus standard efficiency air conditioner); whereas retrofit measures are generally characterized by full costs and savings (e.g. the full costs and savings associated with adding ceiling insulation into an existing attic). For new construction, energy efficiency measures can be implemented when each new home or building is constructed, thus the rate of availability is a direct function of the rate of new construction.

In total, GDS analyzed 372 measure types for EKPC. Many measures required multiple permutations for different applications, such as different building types, efficiency levels, and replacement options. GDS developed a total of 3,651 measure permutations for this study Table 2-3 provides a breakdown of the sector-level number of measures and permutations.

TABLE 2-3 NUMBER OF MEASURES EVALUATED

	# of Measures	Total # of Measure Permutations
Residential	120	351
Commercial	138	1,932
Industrial	114	1,368
Total	372	3,651

2.3.2 Assumptions and Source

A significant amount of data is needed to estimate the kWh and kW savings potential for individual energy efficiency and demand response measures or programs across the entire existing residential and non-residential sectors for EKPC. GDS used Kentucky specific data wherever it was available and up-to-date. Considerable effort was expended to identify, review, and document all available data sources.[7]

This review has allowed the development of reasonable and supportable assumptions regarding: measure lives; measure installed incremental or full costs (as appropriate); and electric savings and saturations for each energy efficiency measure included in the final list of measures in this study.

Costs and savings for new construction and replace on burnout measures are calculated as the incremental difference between the code minimum equipment and the energy efficiency measure. This approach is utilized because the consumer must select an efficiency level that is at least the code minimum equipment. The incremental cost is calculated as the difference between the cost of high efficiency and standard (code compliant) equipment. However, for retrofit measures, the measure cost is considered the "full" cost of the measure, as the baseline scenario assumes the consumer would do nothing. In general, the savings for retrofit measures are calculated as the difference between the energy use of the removed equipment and the energy use of the new high efficiency equipment (until the removed equipment would have reached the end of its useful life).

Measure Savings: GDS utilized several sources including the 2015 Indiana (IN) TRM to inform calculations supporting estimates of annual measure savings as a percentage of base equipment usage. Other sources used include:

- Mid-Atlantic TRM, Illinois TRM, Maine TRM, Minnesota TRM and other existing deemed savings databases
- Building energy simulation software (BEopt) and engineering analyses
- Secondary sources such as the American Council for an Energy-Efficient Economy (ACEEE), Department of Energy (DOE), Energy Information Administration (EIA), ENERGY STAR©, and other technical potential studies

Measure Costs: Measure costs represent either incremental or full costs. These costs typically include the incremental cost of measure installation, when appropriate based on the measure definition. For purposes of this study, nominal measure costs held constant over time. One exception is an assumed decrease in costs for light emitting diode (LED) bulbs over the study horizon. LED bulb consumer costs have been declining rapidly over the last several years and future cost projections indicate a continued decrease in bulb costs.[8] GDS' treatment of LED bulb costs and market penetration are discussed in greater detail in Section 2.3.5, "Review of LED Lighting Assumptions."

[7] The appendices and supporting databases to this report provide the data sources used by GDS to obtain up-to-date data on energy efficiency measure costs, savings, useful lives, and saturations.
[8] LED Incremental Cost Study Overall Final Report. The Cadmus Group. February 2016

GDS obtained measure cost estimates from a variety of sources, starting with the IN TRM. Other sources leveraged include:

- Mid-Atlantic TRM, Illinois TRM, Maine TRM, Minnesota TRM and other existing deemed savings databases
- Secondary sources such as the ACEEE, ENERGY STAR, National Renewable Energy Lab (NREL),), California Database for Energy Efficient Resources (DEER) database, Northeast Energy Efficiency Partnership (NEEP) Incremental Cost Study, and other technical potential studies

Measure Life: Measure life represents the number of years that energy using equipment is expected to operate. GDS obtained measure life estimates from the 2015 IN VT TRM, and used the following other data sources:

- TRMs in other states
- Manufacturer data
- Savings calculators and life-cycle cost analyses
- The California DEER database
- Other consultant research or technical reports

Building/Equipment Saturation Data: To assess the amount of electric energy efficiency savings still available, estimates of the current saturation of baseline equipment and energy efficiency measures, or for the non-residential sector, the amount of energy use that is associated with a specific end-use (such as HVAC) and percent of that energy use that is associated with energy efficient equipment are necessary. Up-to-date measure saturation data were primarily obtained from the following recent studies:

- 2016 EKPC Member System End-Use Survey
- 2015 EIA Residential Energy Consumption Survey (RECS)
- Energy Stat Unit Shipment Data
- 2014 EIA Manufacturing Energy Consumption Survey (MECS)
- 2012 EIA Commercial Building Energy Consumption Survey (CBECS)

2.3.3 Remaining Factor

The remaining factor is the proportion of a given market segment that is not yet efficient and can still be converted to an efficient alternative. If is by definition, the inverse of the saturation of an energy efficient measure, prior to any adjustments. For this study we made two key adjustments to recognize that the energy efficient saturation does not necessarily always fully represent the state of market transformation. In other words, while a percentage of installed measures may already be efficient, this does not preclude customers from backsliding, or reverting to standard technologies, or otherwise less efficient alternatives in the future, based on considerations like measure cost and availability and customer preferences (e.g. historically, some customers have disliked CFL light quality, and have reverted to incandescent and halogen bulbs after the CFLs burn out).

For measures categorized as market opportunity (i.e. replace-on-burnout), we assumed that 50% of the instances in which an efficient measure is already installed, the burnout or failure of those measures would be eligible for inclusion in the estimate of future savings potential. Essentially this adjustment implies that we are assuming that 50% of the market is transformed, and no future savings potential exists, whereas the remaining 50% of the market is not transformed and could backslide without the intervention of an EKPC program and an incentive. Similarly, for retrofit measures, we assumed that only 10% of the instances in which an efficient measure is already installed, the burnout or failure of those measures would be eligible for inclusion in the estimate of future savings potential. This recognizes the more proactive nature of retrofit measures, as the implementation of these measures are more likely to be elective in nature, compared to market opportunity measures, which are more likely to be needs-based.

We recognize the uncertainty in these assumptions, but we believe these are appropriate assumptions, as they recognize a key component of the nature of customer decision making.

2.3.4 Treatment of Codes and Standards

Although this analysis does not attempt to predict how energy codes and standards will change over time, the analysis does account for the impacts of several known improvements to federal codes and standards. Although not exhaustive, key adjustments include[9]:

- The baseline efficiency for air source heat pumps (ASHP) is anticipated to improve to 14 SEER/8.2 HSPF[10] in 2015. As the existing stock of ASHPs was estimated to turn over and allowing for a sell-through period, the baseline efficiency was assumed to be the new federal standard, beginning in FY18.
- In 2015, the DOE makes amended standards effective for residential water heaters that required updated energy factors (EF) depending on the type of water heater and the rated storage volume. For electric storage water heaters with a volume greater than 55 gallons, the standards effectively require heat pumps for electric storage products. For storage tank water heaters with a volume of 55 gallons or less, the new standard (EF=0.948) becomes essentially the equivalent of today's efficient storage tank water heaters. [11]
- In March 2015, the DOE amended the standards for residential clothes washers. The new standards will require the Integrated Modified Energy Factor (MEF) (ft^3/kWh/cycle) to meet certain thresholds based on the machine configurations. The ENERGY STAR specifications for residential clothes washers will also be amended to increase the efficiency of units that can earn the ENERGY STAR label. Version 7.0 of the ENERGY STAR specification is scheduled to go into effect in March 2015. These amended federal and ENERGY STAR standards have been factored into the study.
- In line with the phase-in of 2005 EPAct regulations, the baseline efficiency for general service linear fluorescent lamps was moved from the T12 light bulb to a T8 light bulb effective June 1, 2016.

2.3.5 Review of LED Lighting Assumptions

Recognizing that there remains significant uncertainty regarding the future potential of residential screw-in lighting, GDS reviewed the latest lighting-specific program designs and consulted with industry peers to develop critical assumptions regarding the future assumed baselines for LED screw base omnidirectional, specialty/decorative, and reflector/directional lamps over the study timeframe.

- *EISA Impacts:* LED screw base omnidirectional and decorative lamps are impacted by the EISA 2007 regulation backstop provision, which requires all non-exempt lamps to be 45 lumens/watt, beginning in 2020. Based on this current legislation, the federal baseline in 2020 will be roughly equivalent to a CFL bulb. However, in January 2017, the Department of Energy expanded the scope of the standard to include directional and specialty bulb but stated that they may delay enforcement based on ongoing dialog with industry stakeholders. Although there is uncertainty surrounding EISA and the backstop provision, this study assumes the backstop provision for standard (A-lamp) screw-in bulbs will take effect beginning in 2020. The analysis assumes the expanded definition of general service lamps to include specialty and reflector sockets will impact those sockets beginning in 2021.

- *LED Bulb Costs:* Based on EIA Technology Forecast Report, LED bulb costs were assumed to decrease over the analysis period. LED bulb costs ranged between $3 (standard) and $8.60 (reflector) in 2020,

[9] Key adjustments for LED screw-in lighting are addressed separately later in this section.
[10] SEER: Seasonal Energy Efficiency Ratio; HSPF: Heating Seasonal Performance Factor.
[11] Ultimately, GDS did not incorporate the requirements for large capacity water heaters into the analysis due to recent legislation that allows grid-enabled water heaters to remain at lower efficiency levels.

decreasing to $2-$3 by 2038. Incentives were modeled as a % of incremental cost, resulting in decreasing incentives over the analysis timeframe as well.

- *LED Lighting Efficacy:* Using the same EIA Technical Forecast Report, LED efficacy was also assumed to improve over the analysis timeframe. By 2040, the LED wattage of a bulb equivalent to a 60W incandescent will improve from 8W (today's typical LED) down to 4W.

2.3.6 Net to Gross (NTG)

All estimates of technical, economic, and achievable potential, as well as measure level cost-effectiveness screening were conducted in terms of gross savings to reflect the absence of program design considerations in these phases of the analysis.

2.4 ENERGY EFFICIENCY POTENTIAL

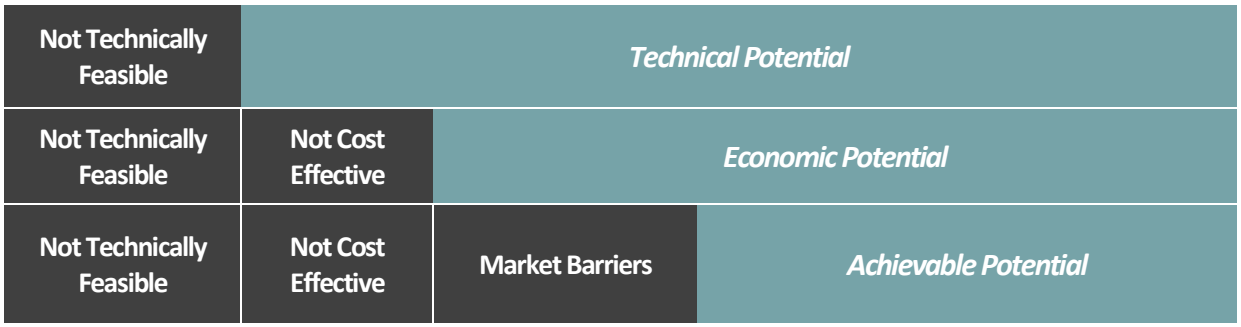
This section reviews the types of potential analyzed in this report, as well as some key methodological considerations in the development of technical, economic, and achievable potential.

2.4.1 Types of Potential

Potential studies often distinguish between several types of energy efficiency potential: technical, economic, achievable, and program. However, because there are often important definitional issues between studies, it is important to understand the definition and scope of each potential estimate as it applies to this analysis.

The first two types of potential, technical and economic, provide a theoretical upper bound for energy savings from energy efficiency measures. Still, even the best-designed portfolio of programs is unlikely to capture 100% of the technical or economic potential. Therefore, achievable potential attempts to estimate what savings may realistically be achieved through market interventions, when it can be captured, and how much it would cost to do so. Figure 2-1 illustrates the types of energy efficiency potential considered in this analysis. Program potential, including specific delivery mechanisms and funding levels was not specifically analyzed as part of this study.[12]

FIGURE 2-1 ILLUSTRATION OF TYPES OF POTENTIAL



2.4.2 Technical Potential

Technical potential is the theoretical maximum amount of energy use that could be displaced by efficiency, disregarding all non-engineering constraints such as cost-effectiveness and the willingness of end users to adopt the efficiency measures. Technical potential is only constrained by factors such as technical feasibility and applicability of measures. Under technical potential, GDS assumed that 100% of

[12] GDS did analyze several funding scenarios in the residential sector. The results of these scenarios are presented in section 4.2.6. While these scenarios can be used by EKPC as guidance for program planning, these scenarios are scaled from the Realistic Achievable Potential results. Actual EKPC may adopt alternative delivery mechanisms or include additional program considerations that would could result in different savings projections.

new construction and market opportunity measures are adopted as those opportunities become available (e.g., as new buildings are constructed they immediately adopt efficiency measures, or as existing measures reach the end of their useful life). For retrofit measures, implementation was assumed to be resource constrained and that it was not possible to install all retrofit measures all at once. Rather, retrofit opportunities were assumed to be replaced incrementally until 100% of stock were converted to the efficient measure over a period of no more than 15 years.

2.4.2.1 Competing Measures and Interactive Effects Adjustments

GDS prevents double-counting of savings, and accounts for competing measures and interactive savings effects, through three primary adjustment factors:

- *Baseline Saturation Adjustment:* Competing measure shares may be factored into the baseline saturation estimates. For example, nearly all homes can receive insulation, but the analysis has created multiple measure permutations to account for varying impacts of different heating/cooling combinations and have applied baseline saturations to reflect proportions of households with each heating/cooling combination

- *Applicability Factor Adjustment:* Grouped measures into measure groups, where total applicability across measures is set to 100%(*). For example, homes cannot receive a programmable thermostat and smart thermostat. Generally, the models assign the measure with the most savings the largest applicability, with competing measures picking up any remaining share.

- *Interactive Savings Adjustment:* As savings are introduced from select measures, the per-unit savings from other measures need to be adjusted (downward) to avoid over-counting. The analysis typically prioritizes market opportunity equipment measures (versus retrofit measures that can be installed at any time). For example, the savings from a smart thermostat are adjusted down to reflect the efficiency gains of installing an efficient air source heat pump. *The analysis also prioritizes efficiency measures relative to conservation (behavioral) measures.

2.4.3 Economic Potential

Economic potential refers to the subset of the technical potential that is economically cost-effective (based on screening with the TRC test utilized for this study) as compared to conventional supply-side energy resources. The TRC measures the net benefits of the energy efficiency program for the region. Costs included in the TRC are costs to purchase and install the energy efficiency measure and overhead costs of running the energy efficiency program, regardless of who pays these costs. The benefits included are the avoided costs of electric energy as well as fuel avoided costs, water avoided costs, and other non-energy benefits (e.g. avoided bulb purchases).

GDS has calculated the benefit/cost ratios for this study according to the cost effectiveness test definitions provided in the November 2008 National Action Plan for Energy Efficiency (NAPEE) guide titled "Understanding Cost Effectiveness of Energy Efficiency Programs". Both technical and economic potential are theoretical numbers that assume immediate implementation of energy efficiency measures, with no regard for the gradual "ramping up" process of real-life programs. In addition, they ignore market barriers to ensuring actual implementation of energy efficiency. *Finally, they typically only consider the costs of efficiency measures themselves, ignoring any programmatic costs (e.g., marketing, analysis, administration, program evaluation, etc.) that would be necessary to capture them.*

All measures that were not found to be cost-effective based on the results of the measure-level cost effectiveness screening were excluded from the economic and achievable potential. Then allocation factors were re-adjusted and applied to the remaining measures that were cost effective.

2.4.3.1 Avoided Costs

Avoided energy supply costs are used to assess the value of energy savings. Avoided cost values for electric energy, electric capacity, avoided T&D, and avoided natural gas were provided directly from EKPC as part of an initial data request. Electric energy is based on an annual system marginal cost. Natural gas and water avoided costs (considered in the Total Resource Cost Test) were based on the Henry Hub forward price curve and the 2016 water and sewer rates for Kentucky-American Water Company, respectively. For years outside of the avoided cost forecast timeframe, future year avoided costs are escalated by the rate of inflation (2.2%).

2.4.3.2 Measure Costs and Incentive Levels

As noted earlier, all measure costs, except for screw-in LED lighting, were held constant in nominal dollars. GDS reviewed the deemed measure cost assumptions included in the Illinois TRM from 2012 (v1) through 2018 (v7). Where a direct comparison of cost was applicable, GDS found no change in measure cost across 80% of residential and nonresidential measures. In a similar search of the Michigan Energy Measure Database (MEMD) from 2011 to 2018, GDS again found that most of incremental measure costs in 2018 were either the same or higher than the recorded incremental measure cost in 2011.

As measure costs were held constant in nominal dollars, incentives were also held constant over the analysis timeframe. GDS relied on EKPC's latest DSM Annual Report and filings to map current measure offerings to their historical incentive levels. For study measures that did not map directly to a current offering, GDS applied "typical" incentive levels to the new measures. In the residential sector, lighting incentive levels were assumed to represent 50% of the measure cost. Remaining residential incentive levels generally ranged from 35%-50%. Direct Install measures received incentives equal to 100% of the measure cost. In the nonresidential sector, incentives were set at 14% of measure cost for lighting ns 50% for all non-lighting measures. As in the residential sector, these incentive levels were based on current incentive levels offered by EKPC.

In the maximum achievable potential (MAP) scenario, all incentives for all sectors were set to 100% of the incremental measure cost.

2.4.4 Achievable Potential

Achievable potential is the amount of energy that can realistically be saved given various market barriers. Achievable potential considers real-world barriers to encouraging end users to adopt efficiency measures; the non-measure costs of delivering programs (for administration, marketing, analysis, and EM&V); and the capability of programs and administrators to boost program activity over time. Barriers include financial, customer awareness and willingness to participate in programs, technical constraints, and other barriers the "program intervention" is modeled to overcome. Additional considerations include political and/or regulatory constraints. The potential study evaluated two achievable potential scenarios:

- ***Maximum Achievable Potential*** estimates achievable potential on paying incentives equal to 100% of measure incremental costs and aggressive adoption rates.
- ***Realistic Achievable Potential*** estimates achievable potential on EKPC paying incentive levels (as a percent of incremental measure costs) closely calibrated to historical levels but is not constrained by any previously determined EKPC spending levels.

2.4.4.1 Market Adoption Rates

GDS assessed achievable potential on a measure-by-measure basis. In addition to accounting for the natural replacement cycle of equipment in the achievable potential scenario, GDS estimated measure specific maximum adoption rates that reflect the presence of possible market barriers and associated difficulties in achieving the 100% market adoption assumed in the technical and economic scenarios.

The initial step in the market penetration methodology was to assess the long-term market adoption potential for energy efficiency technologies. Due to the wide variety of measures across multiple end-uses, GDS employed varied measure and end-use-specific ultimate adoption rates versus a singular universal market adoption curve. These long-term market adoption estimates were based on publicly available DSM research including market adoption rate surveys. These surveys include questions to residential homeowners and nonresidential facility managers regarding their perceived willingness to purchase and install energy efficient technologies across various end uses and incentive levels.

GDS utilized likelihood and willingness-to-participate data to estimate the long-term (20-year) market adoption potential for both the maximum and realistic achievable scenarios. Table 2-4 presents the long-term market adoption rates at varied incentive levels used for both the residential and nonresidential sectors. When incentives are assumed to represent 100% of the measure cost (maximum achievable), the long-term market adoption ranged by sector and end-use from 41% to 90%. For the realistic achievable potential scenario, the incentive levels also varied by measure resulting in measure-specific market adoption rates. Table 2-4 provides the long-term adoption rates by incentive level.

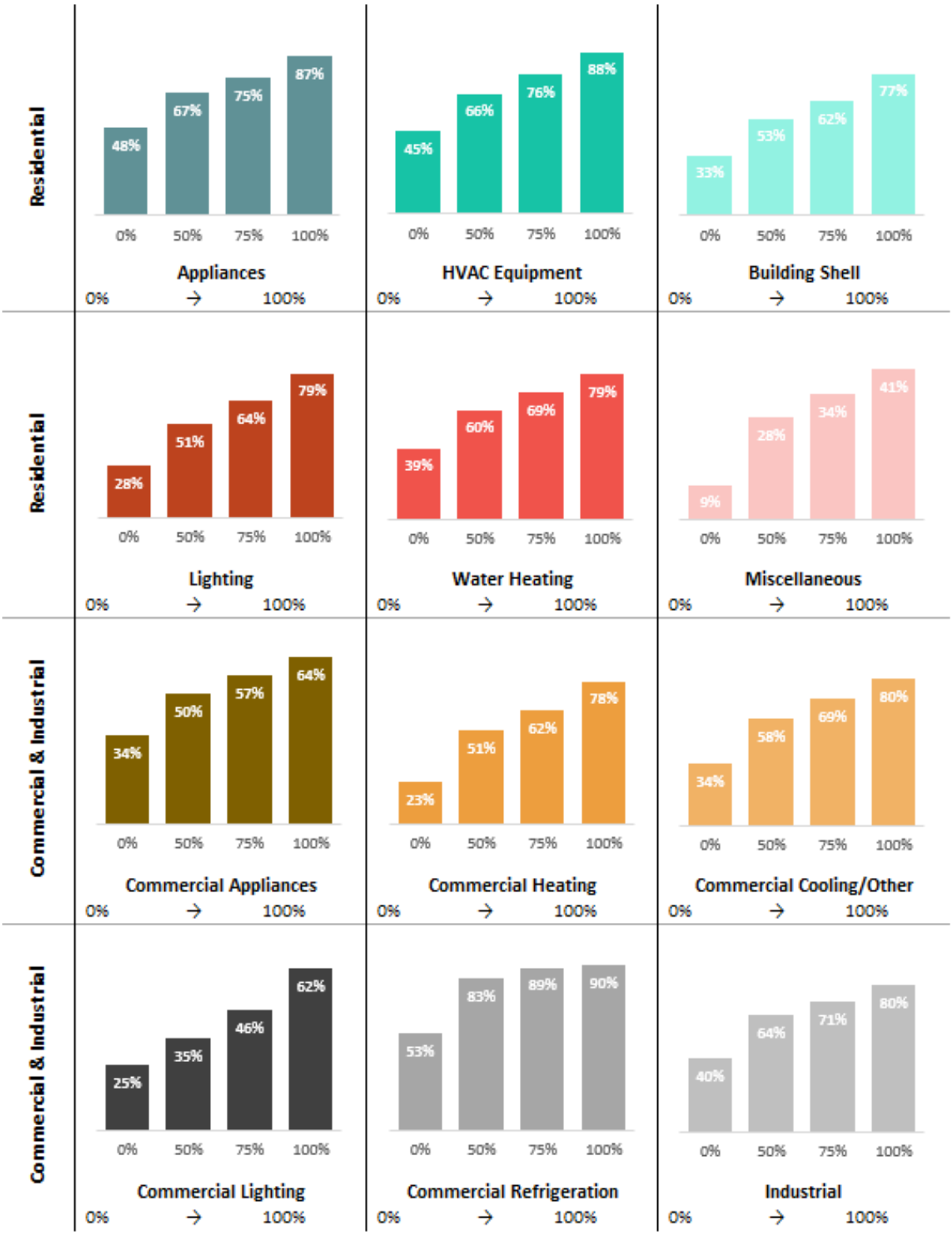
Once the long-term market adoption rate was determined, GDS estimated initial year adoption rates by reviewing the current saturation levels of efficient technologies and (if necessary) calibrating the estimates of 2019 annual potential to recent historical levels achieved by EKPC's DSM portfolio. This calibration effort ensures that the forecasted achievable potential in 2019 is realistic and attainable. GDS then assumed an annual ramp rate from the initial year market adoption rate to the various long-term market adoption rates for each specific end-use.

One caveat to this approach is that the ultimate long-term adoption rate is generally a simple function of incentive levels and payback. There are many other possible elements that may influence a customer's willingness to purchase an energy efficiency measure. For example, increased marketing and education programs can have a critical impact on the success of energy efficiency programs. Additionally, other perceived measure benefits, such as increased comfort or safety as well as reduced maintenance costs could also factor into a customer's decision to purchase and install energy efficiency measures. Although these additional elements are not explicitly accounted for under this incentive/payback analysis, the estimated adoption rates and penetration curves provide a concise method for estimating achievable savings potential over a specified timeframe.

2.4.4.2 Funding Scenarios (Residential Sector Only)

Once achievable potential scenarios were developed, GDS also developed several funding scenarios that mapped select cost-effective energy efficient measures into likely programs and scaled the achievable potential savings and costs into the selected funding scenarios. GDS calculated the residential potential results for four funding scenarios: $750,000, $1.5 million, $3 million, and $6 million. Currently, EKPC does not plan to operate energy efficiency programs in the nonresidential sector; as a result, no funding scenarios were run in the commercial and industrial sectors.

TABLE 2-4 LONG-TERM MARKET ADOPTION RATES AT DISCRETE INCENTIVE LEVELS (*BASED ON WILLINGNESS-TO-PARTICIPATE SURVEY RESULTS*)



2.5 DEMAND RESPONSE POTENTIAL

2.5.1 Demand Response Program Options

Table 2-5 provides a brief description of the demand response program options considered and identifies the eligible customer segment for each demand response program that was considered in this study.

TABLE 2-5 DEMAND RESPONSE PROGRAM OPTIONS AND ELIGIBLE MARKETS

DR Program Option	Program Description	Eligible Markets
DLC AC (Switch)	The compressor of the air conditioner is remotely shut off (cycled) by the system operator for periods that may range from ½ to 15 minutes during every 30-minute period (i.e., 25%-50% duty cycle) 7	Residential and Small Non-Residential Customers
DLC AC (Thermostat)	The system operator can remotely raise the AC's thermostat set point during peak load conditions, lowering AC load.	Residential and Small Non-Residential Customers
DLC Pool Pumps	The swimming pool pump is remotely shut off by the system operator for periods normally ranging from 2 to 4 hours.	Residential Customers
DLC Water Heaters	The water heater is remotely shut off by the system operator for periods normally ranging from 2 to 8 hours.	Residential and Small Non-Residential Customers
DLC Agricultural Irrigation	The irrigation pump is remotely shut off by the system operator for periods normally ranging from 2 to 4 hours.	Farms
Interruptible Rate	A discounted rate is offered to the customer for agreeing to interrupt or curtail load during peak period. The interruption is mandatory. No buy-through options are available.	Large Non-Residential Customers
Large C&I Behavioral	Participants are required to be available to curtail their load any non-holiday weekday during peak hours. Each event typically lasts 4 hours in duration.	Large Non-Residential Customers
Demand Buyback	A year-round, flexible, Internet-based bidding program that offers business customers credits for voluntarily reducing power when an event is called.	Large Non-Residential Customers
Critical Peak Pricing with Enabling Technology	A retail rate in which an extra-high price for electricity is provided during a limited number of critical periods (e.g. 100 hours) of the year. Market-based prices are typically provided on a day-ahead basis, or an hour-ahead basis. Includes enabling technology that connects technologies within building. Only for customers with AC.	Residential and Non-Residential Customers

DR Program Option	Program Description	Eligible Markets
Critical Peak Pricing without Enabling Technology	A retail rate in which an extra-high price for electricity is provided during a limited number of critical periods (e.g. 100 hours) of the year. Market-based prices are typically provided on a day-ahead basis, or an hour-ahead basis.	Residential and Non-Residential Customers
PEV Charging	Special rate service for electric vehicles that charge off-peak	Residential and Non-Residential Customers

Double-counting savings from demand response programs that affect the same end uses is a common issue that must be addressed when calculating the demand response savings potential. For example, a direct load control program of air conditioning and a rate program both assume load reduction of the customers' air conditioners. For this reason, it is typically assumed that customers cannot participate in multiple programs that affect the same end uses. As EKPC and its owner-member cooperatives have offered a Direct Load Control program since 2008, it was assumed that participation in this offering be prioritized before rate-based DR options. The order of the rest of the programs is based on savings where programs with higher savings per customer are prioritized.

2.5.2 Demand Response Potential Assessment Approach Overview

The analysis of DR, where possible, closely followed the approach outlined for energy efficiency. The framework for assessing the cost-effectiveness of demand response programs is based *on A Framework for Evaluating the Cost-Effectiveness of Demand Response, prepared for the National Forum on the National Action Plan (NAPA) on Demand Response*.[13] Additionally, GDS reviewed the May 2017 National Standard Practice Manual published by the National Efficiency Screening Project.[14] GDS utilized this guide to define avoided ancillary services and energy and/or capacity price suppression benefits.

The demand response analysis was conducted using the GDS DR Model. The GDS Demand Response Model determines the estimated savings for each demand response program by performing a review of all benefits and cost associated with each program. GDS developed the model such that the value of future programs could be determined and to help facilitate demand response program planning strategies. The model contains approximately 50 required inputs for each program including: expected life, CP kW load reductions, proposed rebate levels, program related expenses such as vendor service fees, marketing and evaluation cost and on-going O&M expenses. This model and future program planning features can be used to standardize the cost-effectiveness screening process between EKPC departments interested in the deployment of demand response resources.

The Total Cost Resource Cost (TRC) test was used to determine the cost-effectiveness of each demand response program. Benefits are based on avoided demand, energy (including load shifting), wholesale cost reductions and T&D costs. Costs include incremental program equipment costs (such as control switches or smart thermostats), fixed program capital costs (such as the cost of a central controller), program administrative, marketing, and evaluation costs. Incremental equipment program costs are included for both new and replacement units (such as control switches) to account for units that are replaced at the end of their useful life.

[13] Study was prepared by Synapse Energy Economics and the Regulatory Assistance Project, February 2013.
[14] National Standard Practice Manual for Assessing Cost-Effectiveness of Energy Efficiency Resources, May 18, 2017, Prepared by The National Efficiency Screening Project

The demand response analysis includes estimates of technical, economic, and achievable potential. Achievable potential is broken into maximum and realistic achievable potential in this study:

MAP represents an estimate of the maximum cost-effective demand response potential that can be achieved over the 20-year study period. For this study, this is defined as customer participation in demand response program options that reflect a "best practices" estimate of what could eventually be achieved. MAP assumes no barriers to effective delivery of programs.

RAP represents an estimate of the amount of demand response potential that can be realistically achieved over the 20-year study period. For this study, this is defined as achieving customer participation in demand response program options that reflect a realistic estimate of what could eventually be achieved assuming typical or "average" industry experience. RAP is a discounted MAP, by considering program barriers that limit participation, therefore reducing savings that could be achieved.

Last, the analysis evaluated DR potential under two possible conditions: 1) a ***switch scenario*** that assumes all cost-effective DR programs will be implemented by EKPC, and load switches will be used to control central air conditioning; and 2) a ***smart thermostat scenario*** that also assumes that all cost-effective DR programs will be implemented, but in this scenario controllable smart thermostats will be used to control central air conditioning. In both scenarios, no spending caps are placed on achievable potential.

2.5.3 Avoided Costs

Avoided costs for demand response were consistent with those utilized in the energy efficiency potential analysis and were provided by EKPC. The primary benefit of demand responses is avoided generation capacity, resulting from a reduction in the need for new peaking generation capacity. Demand response can also produce energy related benefits. If the demand response option is considered "load shifting", such as direct load control of electric water heating, the consumption of energy is shifted from the control period to the period immediately following the period of control. For this study, GDS assumed that the energy is shifted with no loss of energy. If the program is not considered to be "load shifting" the measure is turned off during peak control hours, and the energy is saved altogether. Demand response programs can also potentially delay the construction of new transmission and distribution lines and facilities, which is reflected in avoided T&D costs.

2.5.4 Demand Response Program Assumptions

This section briefly discusses the general assumptions and sources used to complete the demand response potential analysis. Appendix F provides additional detail by program and sector related to load reduction, program costs, and projected participation.

Load Reduction: Demand reductions were based on load reductions found in East Kentucky's existing demand response programs, and various secondary data sources including the FERC and other industry reports, including demand response potential studies. DLC and thermostat-based DR options were typically calculated based on a per-unit kW demand reduction whereas rate-based DR options were typically assumed to reduce a percentage of the total facility peak load.

Useful Life: The useful life of a smart thermostat is assumed to be 15 years . Load control switches have a useful life of 15 years . This life was used for all direct load control measures in this study.

Program Costs: One-time program development costs included in the first year of the analysis for new programs. No program development costs are assumed for programs that already exist. It was assumed that there would be a cost of $50 per new participant for marketing for residential and small C&I programs. Large C&I programs require a higher marketing costs due to more time spent to acquire a

participant, including potential site visits. Marketing costs are assumed to be 33.3% higher for MAP. All program costs were escalated each year by the general rate of inflation assumed for this study.

Saturation: The number of control units per participant was assumed to be 1 for all direct load control programs using switches (such as water heaters and air conditioning switches), because load control switches can control up to two units. However, for controllable thermostats, some participants have more than one thermostat. The average number of residential thermostats per single family home was assumed to be 1.72 thermostats

2.5.5 DR Program Adoption Levels

Long-term program adoption levels (or "steady state" participation) represents the enrollment rate once the fully achievable participation has been reached. GDS reviewed industry data and program adoption levels from several utility DR programs. The main sources of participant rates are several studies completed by the Brattle Group. Additional detail about participation rates and sources are shown in Appendix F. As noted earlier in this section, for direct load control programs, interruptible rate, behavioral, and demand bidding DR programs, maximum achievable potential participation rates rely on industry best adoption rates and realistic achievable potential participation rates are based on industry average adoption levels. For critical peak pricing and PEV charging, the MAP steady-state participation rates assumed programs were opt-out based and RAP participation assumed opt-in status.

Customer participation in new demand response programs is assumed to reach the steady state take rate over a five-year period. The path to steady state customer participation follows an "S-shaped" curve, in which participation growth accelerates over the first half of the five-year period, and then slows over the second half of the period (see Figure 2-2). Existing programs have already gone through this ramp-up period, so they were escalated linearly to the final participation rate.

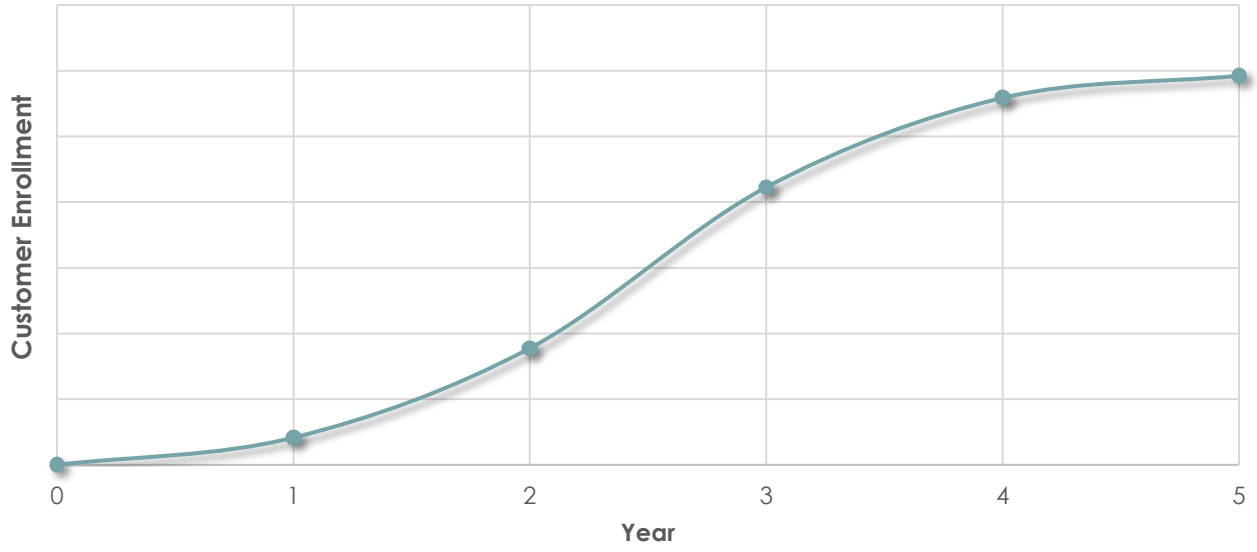


FIGURE 2-2 ILLUSTRATION OF S-SHAPED MARKET ADOPTION CURVE

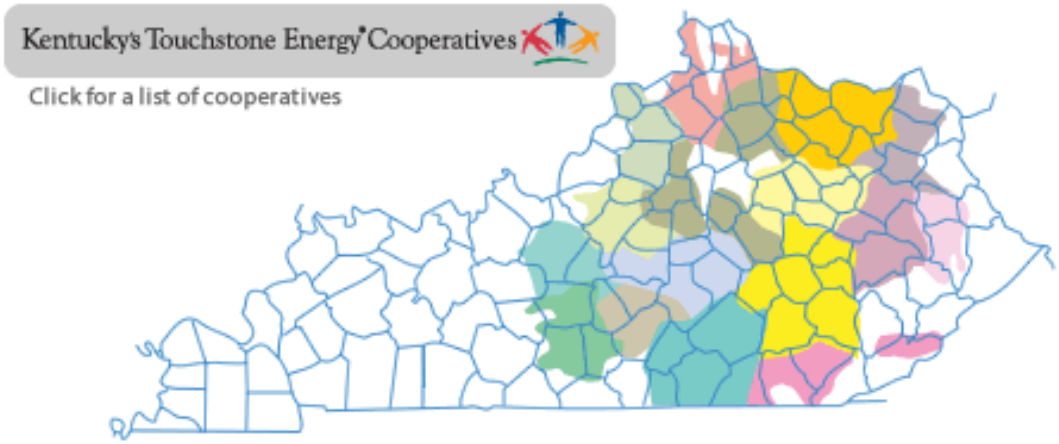
3 Market Characterization

This chapter provides up-to-date historical and forecast information on electricity consumption, consumption by market segment and by energy end use in EKPC's member service territories. This chapter also provides an overview of the number of households and housing units in EKPC's service area. Developing this information is a fundamental part of any energy efficiency potential study. It is necessary to understand how energy is consumed in a state or region before one can assess the energy efficiency savings potential that remains to be tapped.

3.1 EKPC MEMBER SERVICE TERRITORIES

EKPC member service territories are located in an area from central Kentucky to eastern Kentucky. Figure 3-1 shows a map of the 16 cooperatives in EKPC's service area. Note that the size of service areas varies.

FIGURE 3-1 MAP OF THE 16 COOPERATIVES IN THE EKPC SERVICE AREA



3.2 SECTOR-LEVEL FORECASTS AND MARKET SEGMENTATIONS

Table 3-1 provides the sales by sector across the 2019-2033 timeframe. Sales are forecasted to gradually increase in each of the three major sales categories: residential, small commercial, and large commercial. Total sales are forecasted to be nearly 15 million MWh by 2033.

TABLE 3-1 15-YR SALES FORECAST BY SECTOR

Year	Residential Sales (MWh)	Small Comm. Sales (MWh)	Large Comm. Sales (MWh)	Other	Total Retail Sales (MWh)
2019	7,078,677	2,064,437	3,619,935	50,081	12,813,131
2020	7,133,148	2,086,506	3,708,426	50,510	12,978,589
2021	7,155,553	2,098,818	3,775,624	50,940	13,080,935
2022	7,217,794	2,117,881	3,828,426	51,357	13,215,458
2023	7,286,842	2,139,806	3,882,149	51,765	13,360,562
2024	7,392,857	2,167,353	3,940,308	52,163	13,552,681
2025	7,453,978	2,188,120	3,990,232	52,554	13,684,884
2026	7,533,318	2,216,091	4,048,992	52,954	13,851,356
2027	7,613,196	2,242,410	4,099,771	53,349	14,008,726
2028	7,717,310	2,272,256	4,159,107	53,745	14,202,418
2029	7,763,173	2,294,131	4,212,911	54,123	14,324,337
2030	7,821,563	2,313,139	4,266,265	54,479	14,455,446
2031	7,897,604	2,333,454	4,326,871	54,815	14,612,744

Year	Residential Sales (MWh)	Small Comm. Sales (MWh)	Large Comm. Sales (MWh)	Other	Total Retail Sales (MWh)
2032	8,007,592	2,360,013	4,388,273	55,150	14,811,028
2033	8,068,609	2,378,642	4,450,138	55,488	14,952,877

Figure 3-2 provides the distribution of end use consumption by building type in the commercial sector. Water heating, ventilation, and lighting are among the leading end uses throughout the various building types.

FIGURE 3-2 COMMERCIAL SECTOR ENERGY END USE BREAKDOWN BY BUILDING TYPE

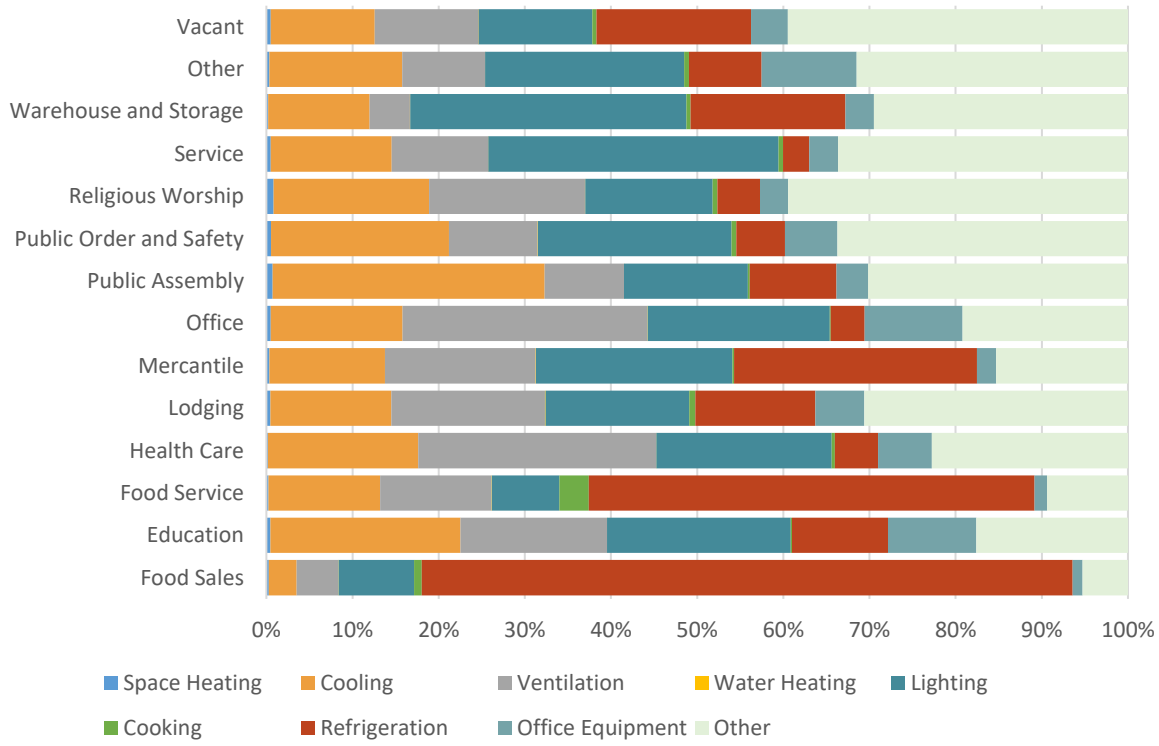


Figure 3-3 provides the distribution of sales by business type in the commercial sector.

FIGURE 3-3 COMMERCIAL SALES BY BUILDING TYPE

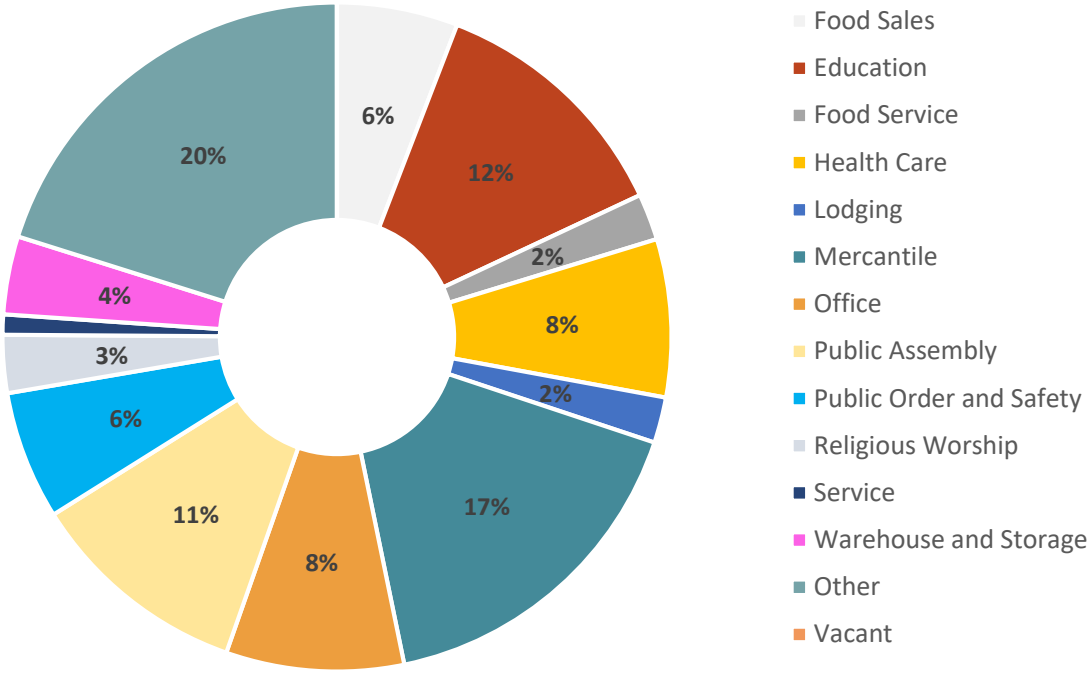


Figure 3-4 provides a breakdown of sales by industrial market segment.

FIGURE 3-4 INDUSTRIAL SALES MARKET SEGMENTATION

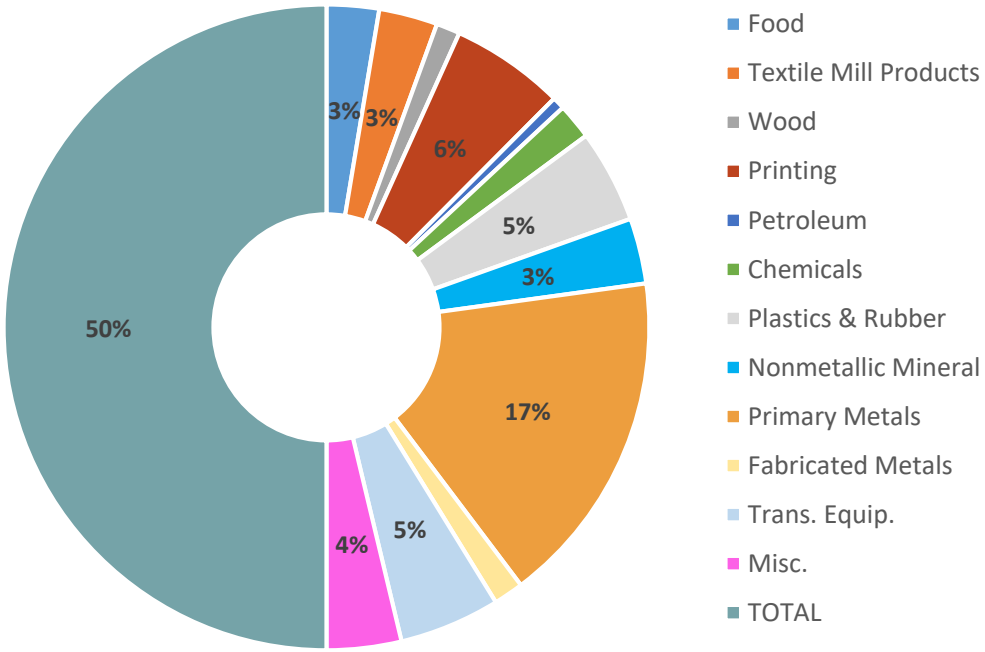
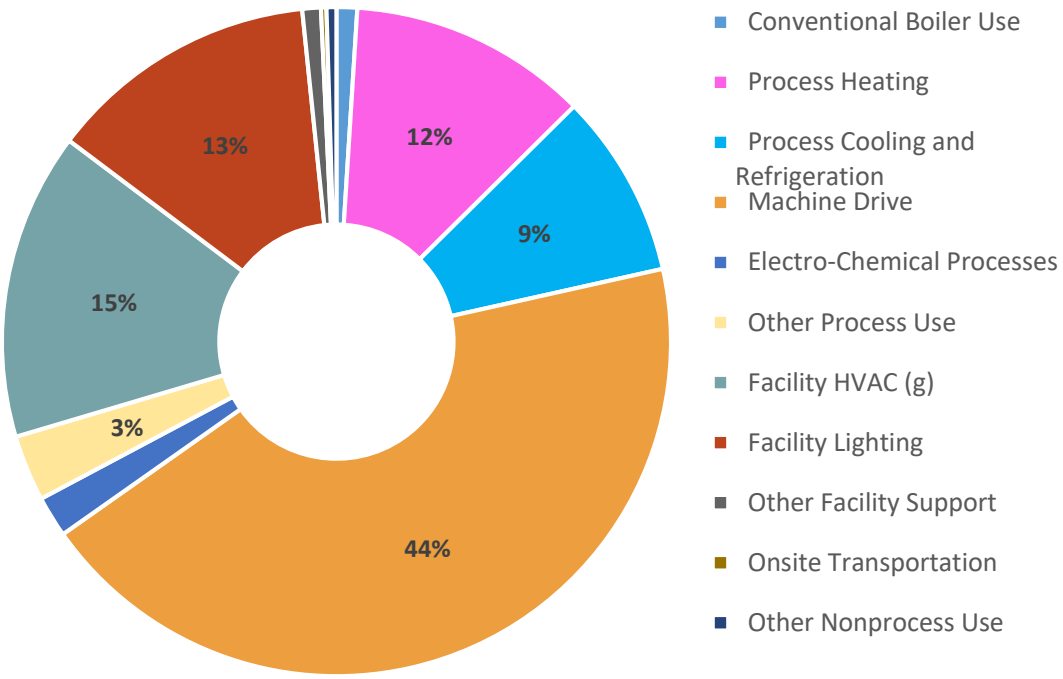


Figure 3-5 provides an industrial sector end use level breakdown.

FIGURE 3-5 INDUSTRIAL SECTOR ENERGY END USE BREAKDOWN



4 Residential Energy Efficiency Potential

This chapter provides the potential results for technical, economic, and achievable potential for the residential sector. The chapter breakdowns of the potential by end use and market segment. The results are provided on a five, ten and fifteen-year basis. Budget and benefit-cost data are provided for the achievable potential scenarios.

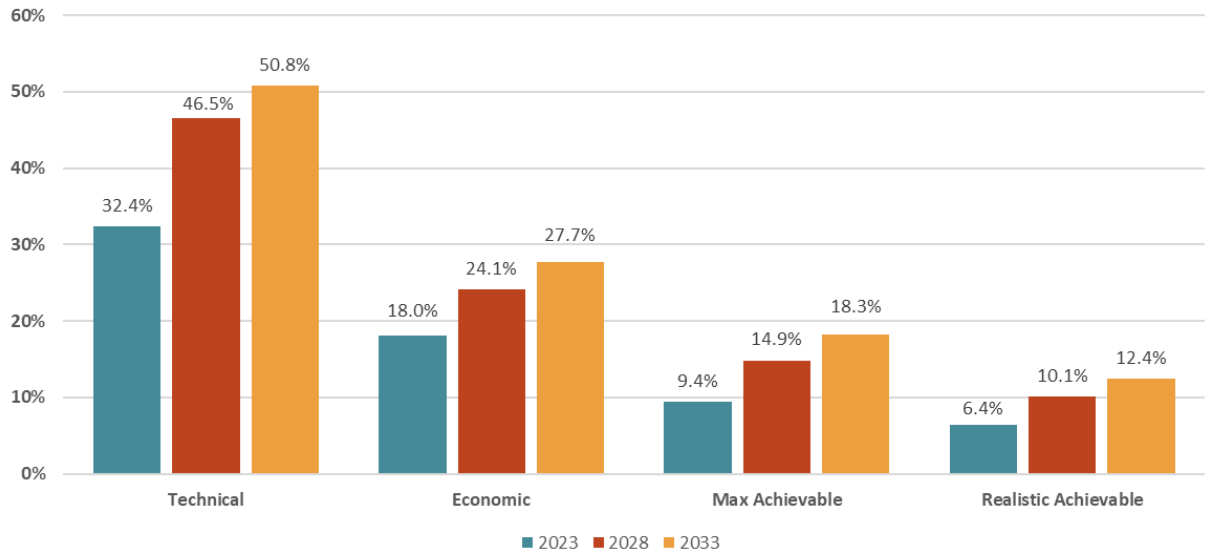
4.1 MEASURES EXAMINED

There were 351 total electric energy efficiency measures included in the analysis. The list of measures was developed based on a review of the Illinois TRM, the current EKPC program offerings, and the 2014 residential potential study measure list. Measure data includes incremental costs, electric energy and demand savings, natural gas savings, and measure life. See Appendix B for residential measure list and assumptions details.

4.2 RESULTS

Figure 4-1 provides the technical, economic, and achievable results for the 5-yr, 10-yr, and 15-yr timeframes. The 5-yr technical potential is 32.4% of forecasted sales, and the economic potential is 18.0% of forecasted sales, indicating that about half of the technical potential is cost-effective. The 3-yr realistic achievable potential is 6.4%. Achievable potential grows to 12.4% over a fifteen-year timeframe.

FIGURE 4-1 RESIDENTIAL ELECTRIC ENERGY (MWH) CUMULATIVE ANNUAL POTENTIAL (AS A % OF RESIDENTIAL SALES)



4.2.1 Technical Potential

Table 4-1 provides 5-, 10-, and 15-yr estimates of cumulative annual technical potential for energy and summer peak demand. The energy savings are provided by end use, and the overall peak demand savings are also provided. HVAC Shell, HVAC Equipment and Water Heating are the leading end uses.

TABLE 4-1 RESIDENTIAL SECTOR TECHNICAL POTENTIAL SAVINGS

End Use	2023	2028	2033
Cumulative Annual MWh			
Appliances	71,567	124,520	145,019
Behavioral	150,194	122,072	115,108
Bundles	2,087	1,728	2,612
Clothes Washer/ Dryer	42,761	85,370	119,884
Dishwasher	3,394	6,776	7,679
Electronics	247,964	318,242	330,787
HVAC Shell	883,068	1,249,403	1,312,698
HVAC Equipment	353,659	641,146	934,857
Lighting	120,997	142,295	135,204
New Construction	66,177	129,902	187,754
Pool/Spa	8,746	17,491	17,507
Water Heating	408,976	753,376	792,219
Total	2,359,591	3,592,320	4,101,328
% of Forecasted Sales	32.4%	46.5%	50.8%
Cumulative Annual MW			
Total	393	624	684
% of Forecasted Demand	19.1%	29.2%	31.4%

4.2.2 Economic Potential

Table 4-2 provides 5-, 10-, and 15-yr estimates of cumulative annual economic potential for energy and summer peak demand. The energy savings are provided by end use, and the overall peak demand savings are also provided. HVAC Shell, HVAC Equipment and Water Heating are the leading end uses.

TABLE 4-2 RESIDENTIAL SECTOR ECONOMIC POTENTIAL SAVINGS

End Use	2023	2028	2033
Cumulative Annual MWh			
Appliances	46,264	74,022	74,022
Behavioral	125,540	118,765	115,362
Bundles	0	0	0
Clothes Washer/ Dryer	31,010	61,905	86,943
Dishwasher	0	0	0
Electronics	136,804	171,233	179,332
HVAC Shell	435,050	534,520	600,651
HVAC Equipment	260,125	466,025	677,926
Lighting	120,993	142,286	135,194
New Construction	51,568	101,224	146,305
Pool/Spa	8,746	17,491	17,507
Water Heating	97,502	173,509	202,250
Total	1,313,601	1,860,979	2,235,491
% of Forecasted Sales	18.0%	24.1%	27.7%
Cumulative Annual MW			
Total	179	243	273
% of Forecasted Demand	8.7%	11.4%	12.6%

4.2.3 Achievable Potential

Figure 4-2 provides a graphical representation of the 5-, 10-, and 15-yr cumulative annual achievable potential results by end use. HVAC Shell, HVAC Equipment and Electronics are the leading end uses.

FIGURE 4-2 RESIDENTIAL ELECTRIC ENERGY (CUMULATIVE ANNUAL GWH) MAXIMUM ACHIEVABLE POTENTIAL BY END-USE

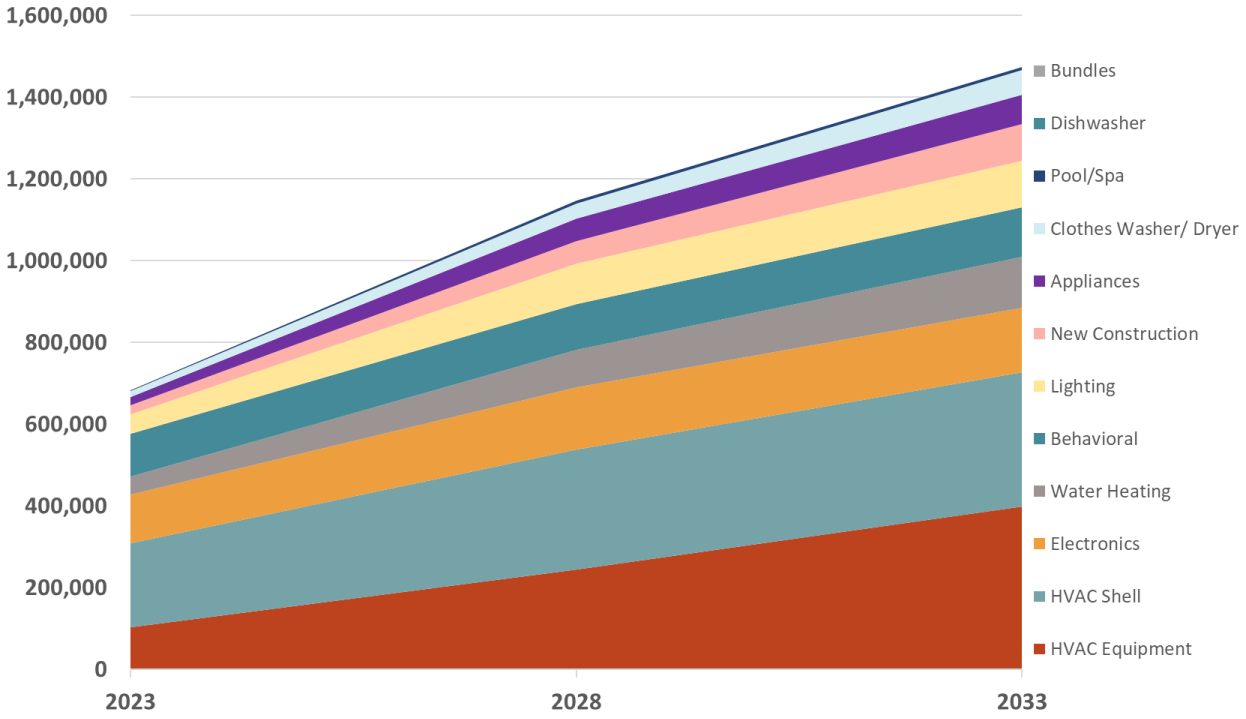


Table 4-3 provides 5-, 10-, and 15-yr cumulative annual maximum achievable potential estimates. The maximum achievable potential rises from 9.4% in 2023, to 14.9% in 2028, and 18.3% in 2033.

TABLE 4-3 RESIDENTIAL ELECTRIC ENERGY (CUMULATIVE ANNUAL MWH) MAXIMUM ACHIEVABLE POTENTIAL BY END-USE

End Use	2023	2028	2033
Cumulative Annual MWh			
Appliances	20,093	54,528	71,589
Behavioral	104,087	111,302	120,753
Bundles	0	0	0
Clothes Washer/ Dryer	14,022	37,230	62,005
Dishwasher	0	0	0
Electronics	120,037	151,123	158,273
HVAC Shell	205,206	293,865	327,975
HVAC Equipment	102,407	244,631	398,293
Lighting	48,900	100,806	114,266
New Construction	21,580	54,486	88,678
Pool/Spa	3,356	6,942	7,177
Water Heating	43,949	92,171	125,569
Total	683,638	1,147,083	1,474,578
% of Forecasted Sales	9.4%	14.9%	18.3%
Cumulative Annual MW			
Total	94	151	178

End Use	2023	2028	2033
% of Forecasted Demand	4.6%	7.1%	8.2%

Figure 4-3 provides a graphical representation of the 5-, 10-, and 15-yr cumulative annual achievable potential results by end use. HVAC Shell, HVAC Equipment and Electronics are the leading end uses.

FIGURE 4-3 RESIDENTIAL ELECTRIC ENERGY (CUMULATIVE ANNUAL GWH) REALISTIC ACHIEVABLE POTENTIAL BY END-USE

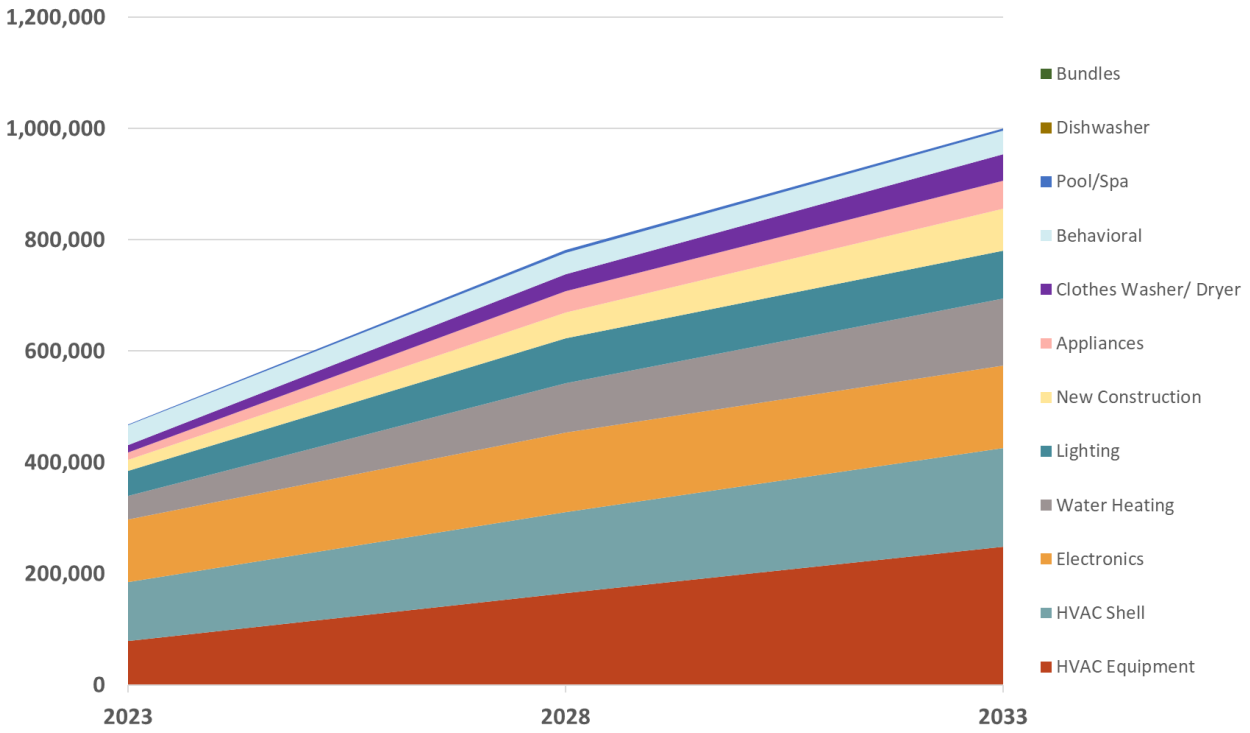


Table 4-4 provides 5-, 10-, and 15-yr cumulative annual realistic achievable potential estimates. The realistic achievable potential rises from 6.4% in 2023, to 10.1% in 2028, and 12.4% in 2033.

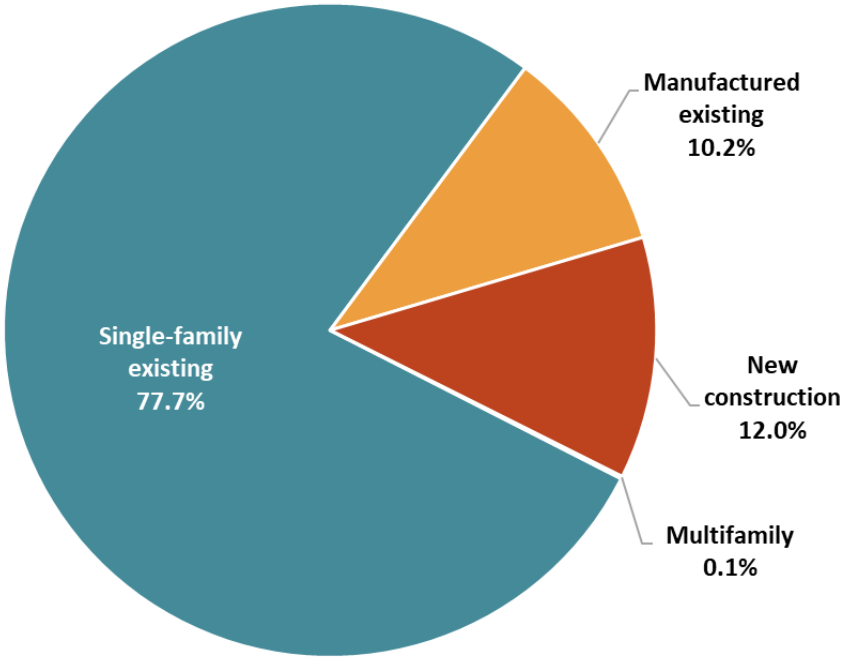
TABLE 4-4 RESIDENTIAL ELECTRIC ENERGY (CUMULATIVE ANNUAL MWH) REALISTIC ACHIEVABLE POTENTIAL BY END-USE

End Use	2023	2028	2033
Cumulative Annual MWh			
Appliances	14,255	38,685	50,789
Behavioral	35,097	38,338	42,196
Bundles	0	0	0
Clothes Washer/ Dryer	12,776	30,404	47,305
Dishwasher	0	0	0
Electronics	112,851	142,103	148,798
HVAC Shell	105,142	145,514	176,882
HVAC Equipment	78,952	165,179	248,261
Lighting	45,728	80,837	85,714
New Construction	18,738	46,620	75,144
Pool/Spa	2,425	4,849	4,853
Water Heating	42,555	88,951	120,405
Total	468,518	781,480	1,000,348
% of Forecasted Sales	6.4%	10.1%	12.4%

End Use	2023	2028	2033
Cumulative Annual MW			
Total	67	107	126
% of Forecasted Demand	3.2%	5.0%	5.8%

Figure 4-4 illustrates a market segmentation of the achievable potential in the residential sector by 2033. The leading market segment is single-family existing homes at 78% of total savings. Manufactured homes account for 10% of savings. New construction accounts for 12% of savings.

FIGURE 4-4 2033 RESIDENTIAL ELECTRIC ENERGY (CUMULATIVE ANNUAL) ACHIEVABLE POTENTIAL BY MARKET SEGMENT



4.2.4 Measure Level Detail

Table 4-5 below presents the measure-level technical, economic, and achievable MWh savings. Measures with significant remaining potential either possess significant per unit savings opportunities or are applicable to a large number homes in the EKPC territory. Measures with zero economic and achievable potential were not found to be cost effective.

TABLE 4-5 RESIDENTIAL TECHNICAL, ECONOMIC, ACHIEVABLE SAVINGS POTENTIAL (MWH), BY MEASURE (2033)

Measure Name	Technical	Economic	Max	Realistic
Heat Pump	496,084	361,978	211,653	125,361
ENERGY STAR TV	120,222	120,222	106,088	106,088
Duct Sealing	190,774	207,532	121,090	88,846
Touchstone Energy Home	187,754	146,305	88,678	75,144
Air Sealing	230,056	136,184	82,044	67,679
ENERGY STAR Clothes Washer	86,943	86,943	62,005	47,305
Standard LEDs	70,529	70,529	60,739	45,796
ENERGY STAR Printer	59,110	59,110	52,185	42,710
Water Heater Pipe Wrap	28,707	57,211	38,244	37,379
Thermostatic Restriction Valve	28,015	55,832	37,840	37,295
Specialty/Reflector LEDs	59,161	59,161	49,040	37,229

Measure Name	Technical	Economic	Max	Realistic
Dual Fuel Heat Pump	135,672	100,288	58,640	33,962
Refrigerator Recycling	49,324	49,324	47,703	33,843
Low Flow Showerhead	33,503	66,586	35,820	32,976
Programmable Thermostat	0	67,026	32,803	32,803
Home Energy Report	50,726	85,549	91,458	31,959
Ductless Mini-Split AC/HP	140,563	93,214	54,503	26,443
Ceiling Insulation	315,125	173,382	124,842	20,357
Freezer Recycling	24,698	24,698	23,886	16,946
Smart Thermostat	108,303	23,606	16,531	14,347
Low Flow Faucet Aerators	11,375	22,621	13,664	12,755
Home Energy Display Monitor	64,383	29,814	29,295	10,237
Room AC Recycling	11,398	11,398	9,003	9,003
Efficient Furnace Fan	20,417	20,417	15,160	6,342
Pool Pump	17,507	17,507	7,177	4,853
All Other Measures	1,560,981	89,057	4,486	2,689
Total	**4,101,328**	**2,235,491**	**1,474,578**	**1,000,348**
% of Forecasted Sales	**50.8%**	**27.7%**	**18.3%**	**12.4%**

*For some measures, the economic and achievable potential may exceed technical potential. This is due primarily to an adjustment to the applicability factors among measures in the same measure group that compete to save the same kWh (e.g. not all smart thermostats are cost-effective, which requires shifting some of the applicability factors to programmable thermostats, which are excluded from technical potential in favor of higher saving smart thermostats).

4.2.5 Benefits and Costs – Achievable Scenarios

Figure 4-5 shows the annual budgets for both achievable potential scenarios. The incentive and admin budgets are listed separately. The RAP budget fluctuates between $18 million and $26 million across the 15-year timeframe.

FIGURE 4-5 RESIDENTIAL SECTOR ANNUAL BUDGETS – MAX AND REALISTIC ACHIEVABLE POTENTIAL (15-YR)

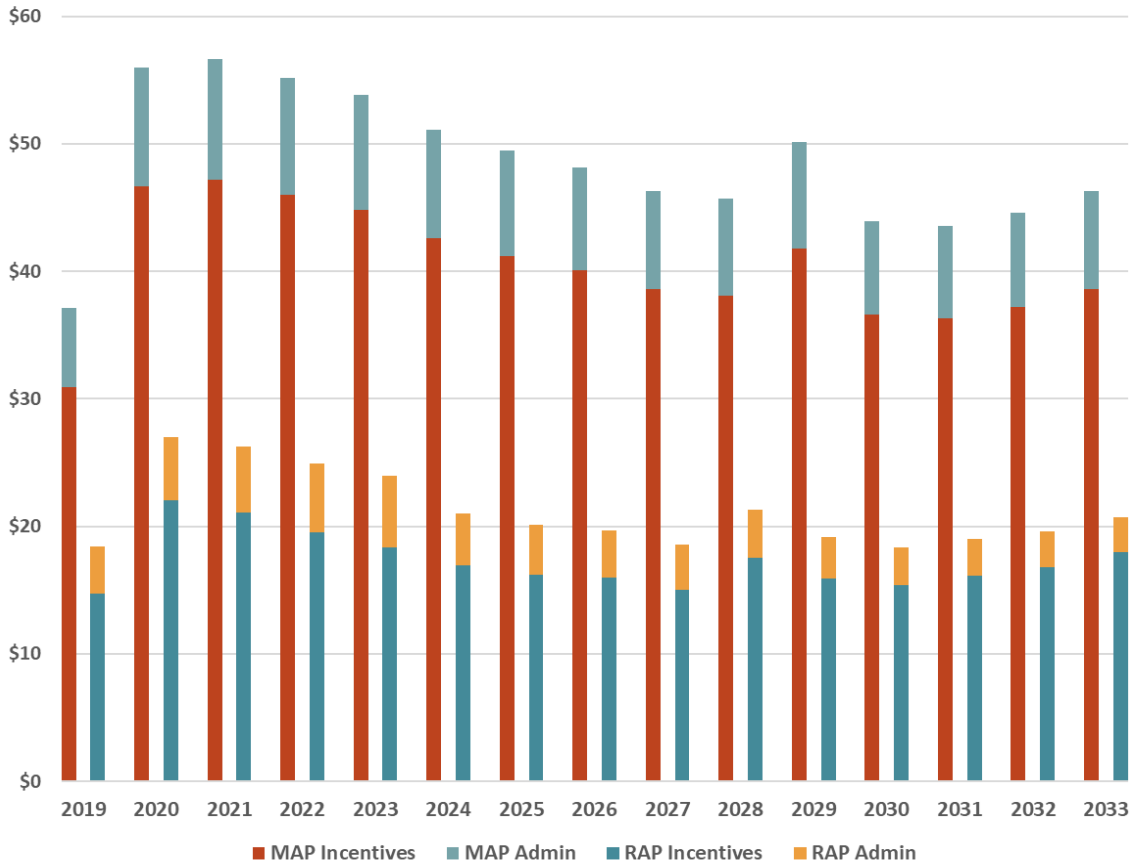


FIGURE 4-5 RESIDENTIAL SECTOR ANNUAL BUDGETS – MAX AND REALISTIC ACHIEVABLE POTENTIAL (15-YR)

Table 4-6 provides the net present value (NPV) benefits and costs across the 2019-2033 timeframe for both achievable potential scenarios. The TRC ratio ranges between 2.0 and 2.2 across the two scenarios. NPV benefits exceed $1.1 billion in the MAP scenario.

TABLE 4-6 RESIDENTIAL NPV BENEFITS AND COSTS (15-YR, $ IN MILLIONS) – MAX AND REALISTIC ACHIEVABLE POTENTIAL

Scenario	NPV Benefits	NPV Costs	TRC Ratio
Max Achievable	$1,151	$574	2.0
Realistic Achievable	$824	$372	2.2

4.2.6 Additional Scenario Analysis

GDS calculated the residential potential results for four additional funding scenarios: $750,000, $1.5 million, $3 million, and $6 million. Table 4-7 below provides the end-use level and total potential energy savings across the 15-yr timeframe of the study for each of these scenarios. HVAC Equipment is the leading end-use in all scenarios. The savings percentages relative to forecasted sales range from 0.3% to 2.7%.

TABLE 4-7 RESIDENTIAL SCENARIO POTENTIAL – BY END USE THROUGH 2033

End Use	$750k	$1.5M	$3.0M	$6.0M
Cumulative Annual MWh				
Appliances	0	0	0	0
Behavioral	724	1,328	1,690	3,984

End Use	$750k	$1.5M	$3.0M	$6.0M
Cumulative Annual MWh				
Bundles	0	0	0	0
Clothes Washer/ Dryer	0	0	0	0
Dishwasher	0	0	0	0
Electronics	0	0	0	0
HVAC Shell	0	2,148	6,284	14,265
HVAC Equipment	20,090	36,318	80,318	165,017
Lighting	1,114	1,150	1,185	1,433
New Construction	2,599	6,232	14,211	30,569
Pool/Spa	0	0	0	0
Water Heating	0	0	0	0
Total	24,528	47,175	103,688	215,269
% of Forecasted Sales	**0.3%**	**0.6%**	**1.3%**	**2.7%**

Table 4-8 provides the net present value (NPV) benefits and costs across the 2019-2033 timeframe for the additional scenarios. The TRC ratio equals 1.6 for each scenario.

TABLE 4-8 RESIDENTIAL NPV BENEFITS AND COSTS (15-YR, $ IN MILLIONS) – ADDITIONAL SCENARIOS

Scenario	NPV Benefits	NPV Costs	TRC Ratio
$750k	$13.7	$8.6	1.6
$1.5M	$27.3	$16.9	1.6
$3.0M	$60.5	$37.2	1.6
$6.0M	$126.2	$77.5	1.6

5 Commercial Energy Efficiency Potential

This chapter provides the potential results for technical, economic, and achievable potential for the commercial sector. The chapter breakdowns of the potential by end use and market segment. The results are provided on a five, ten and fifteen-year basis. Budget and benefit-cost data are provided for the achievable potential scenarios.

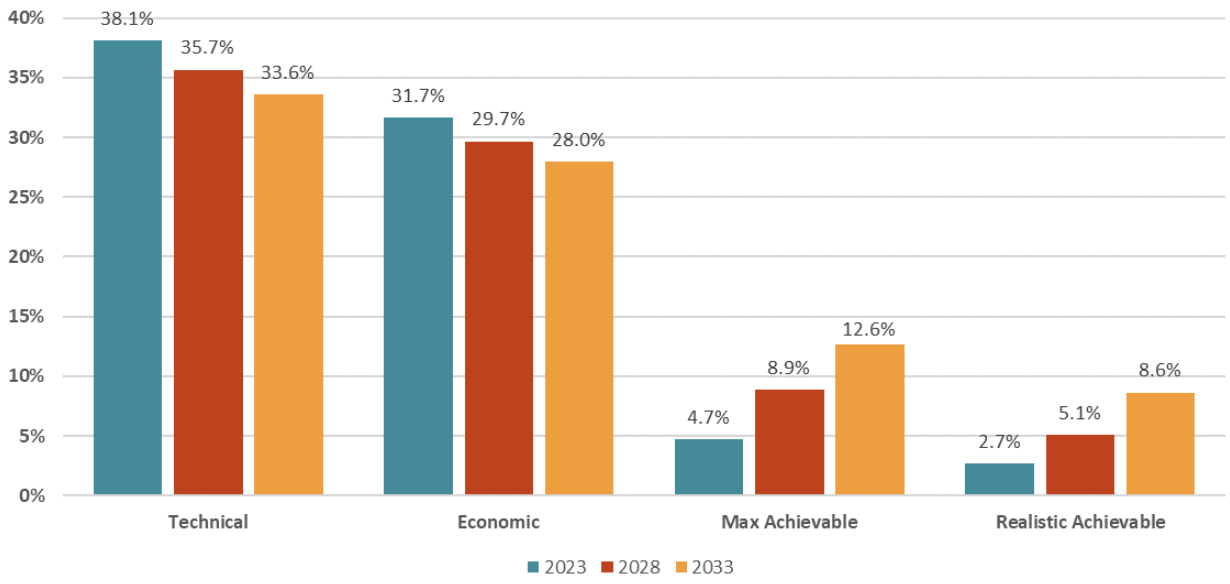
5.1 MEASURES EXAMINED

There were 138 total electric energy efficiency measures included in the analysis. The list of measures was developed based on a review of the Illinois TRM, the current EKPC program offerings, and the 2014 residential potential study measure list. Measure data includes incremental costs, electric energy and demand savings, natural gas savings, and measure life. See Appendix C for commercial measure list and assumptions details.

5.2 RESULTS

Figure 5-1 provides the technical, economic, and achievable results for the 5-yr, 10-yr, and 15-yr timeframes. The 5-yr technical potential is 38.1% of forecasted sales, and the economic potential is 31.7% of forecasted sales, indicating that most technical potential is cost-effective. The 3-yr realistic achievable potential is 2.7%. Achievable potential grows to 8.6% over a fifteen-year timeframe.

FIGURE 5-1 COMMERCIAL ELECTRIC ENERGY (MWH) CUMULATIVE ANNUAL POTENTIAL (AS A % OF COMMERCIAL SALES)



5.2.1 Technical Potential

Table 5-1 provides 5-, 10-, and 15-yr estimates of cumulative annual technical potential for energy and summer peak demand. The energy savings are provided by end use, and the overall peak demand savings are also provided. Refrigeration, Ventilation, and Interior Lighting are the leading end uses.

TABLE 5-1 COMMERCIAL SECTOR TECHNICAL POTENTIAL SAVINGS

End Use	2023	2028	2033
Cumulative Annual MWh			
Interior Lighting	181,311	181,311	181,311
Exterior Lighting	23,850	23,850	23,850
Space Cooling - Chillers	56,647	56,647	56,647
Space Cooling - Unitary / Split	107,369	107,369	107,369
Space Heating	5,039	5,039	5,039
Ventilation	110,241	110,241	110,241
Motors	14,532	14,532	14,532
Water Heating	274	274	274
Cooking	2,606	2,606	2,606
Refrigeration	219,564	219,564	219,564
Office Equipment	29,780	29,780	29,780
Compressed Air	60,211	60,211	60,211
Pools	22,395	22,395	22,395
Total	833,818	833,818	833,818
% of Forecasted Sales	38.1%	35.7%	33.6%
Cumulative Annual MW			
Total	81	81	81
% of Forecasted Demand	18.1%	16.9%	15.9%

5.2.2 Economic Potential

Table 5-2 provides 5-, 10-, and 15-yr estimates of cumulative annual economic potential for energy and summer peak demand. The energy savings are provided by end use, and the overall peak demand savings are also provided. Refrigeration, Ventilation, and Interior Lighting are the leading end uses.

TABLE 5-2 COMMERCIAL SECTOR ECONOMIC POTENTIAL SAVINGS

End Use	2023	2028	2033
Cumulative Annual MWh			
Interior Lighting	161,617	161,617	161,617
Exterior Lighting	23,850	23,850	23,850
Space Cooling - Chillers	43,231	43,231	43,231
Space Cooling - Unitary / Split	69,398	69,398	69,398
Space Heating	5,783	5,783	5,783
Ventilation	91,642	91,642	91,642
Motors	14,532	14,532	14,532
Water Heating	273	273	273
Cooking	2,000	2,000	2,000
Refrigeration	191,470	191,470	191,470
Office Equipment	21,185	21,185	21,185
Compressed Air	59,735	59,735	59,735
Pools	9,237	9,237	9,237
Total	693,952	693,952	693,952
% of Forecasted Sales	31.7%	29.7%	28.0%
Cumulative Annual MW			

End Use	2023	2028	2033
Total	67	67	67
% of Forecasted Demand	15.0%	14.0%	13.2%

5.2.3 Achievable Potential

Figure 5-2 provides a graphical representation of the 5-, 10-, and 15-yr cumulative annual achievable potential results by end use. Refrigeration, Lighting and Ventilation are the leading end uses.

FIGURE 5-2 COMMERCIAL ELECTRIC ENERGY (CUMULATIVE ANNUAL GWH) MAXIMUM ACHIEVABLE POTENTIAL BY END-USE

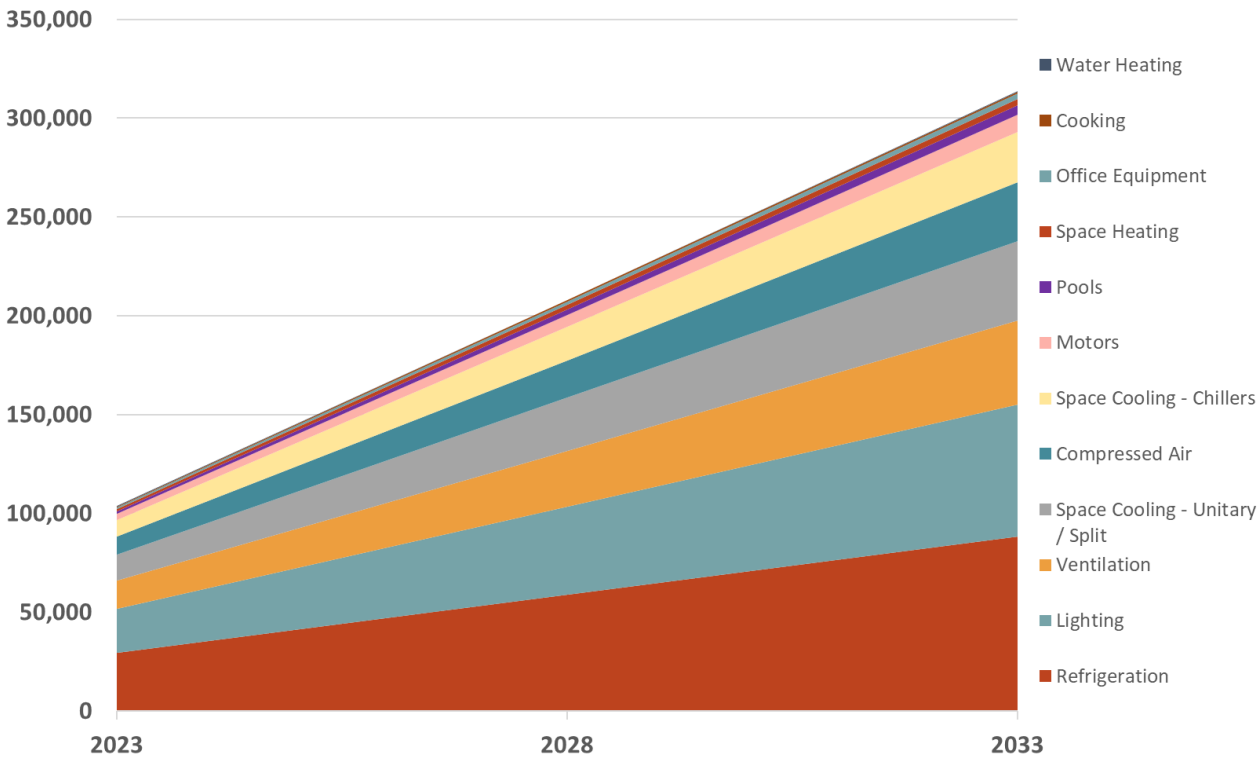


Table 5-3 provides 5-, 10-, and 15-yr cumulative annual maximum achievable potential estimates. The maximum achievable potential rises from 4.7% in 2023, to 8.9% in 2028, and 12.6% in 2033.

TABLE 5-3 COMMERCIAL ELECTRIC ENERGY (CUMULATIVE ANNUAL MWH) MAXIMUM ACHIEVABLE POTENTIAL BY END-USE

End Use	2023	2028	2033
Cumulative Annual MWh			
Lighting	22,270	44,540	66,810
Space Cooling - Chillers	8,493	16,987	25,480
Space Cooling - Unitary / Split	13,421	26,843	40,264
Space Heating	1,115	2,230	3,344
Ventilation	14,178	28,357	42,535
Motors	2,896	5,792	8,688
Water Heating	54	107	161
Cooking	386	771	1,157
Refrigeration	29,363	58,725	88,088
Office Equipment	871	1,741	2,612
Compressed Air	8,989	18,958	29,906

End Use	2023	2028	2033
Pools	1,520	3,040	4,560
Total	103,556	208,091	313,605
% of Forecasted Sales	4.7%	8.9%	12.6%
Cumulative Annual MW			
Total	14	**28**	42
% of Forecasted Demand	3.2%	5.9%	8.4%

Figure 5-3 provides a graphical representation of the 5-, 10-, and 15-yr cumulative annual achievable potential results by end use. Refrigeration, Ventilation and Space Cooling – Unitary/Split are the leading end uses.

FIGURE 5-3 COMMERCIAL ELECTRIC ENERGY (CUMULATIVE ANNUAL GWH) REALISTIC ACHIEVABLE POTENTIAL BY END-USE

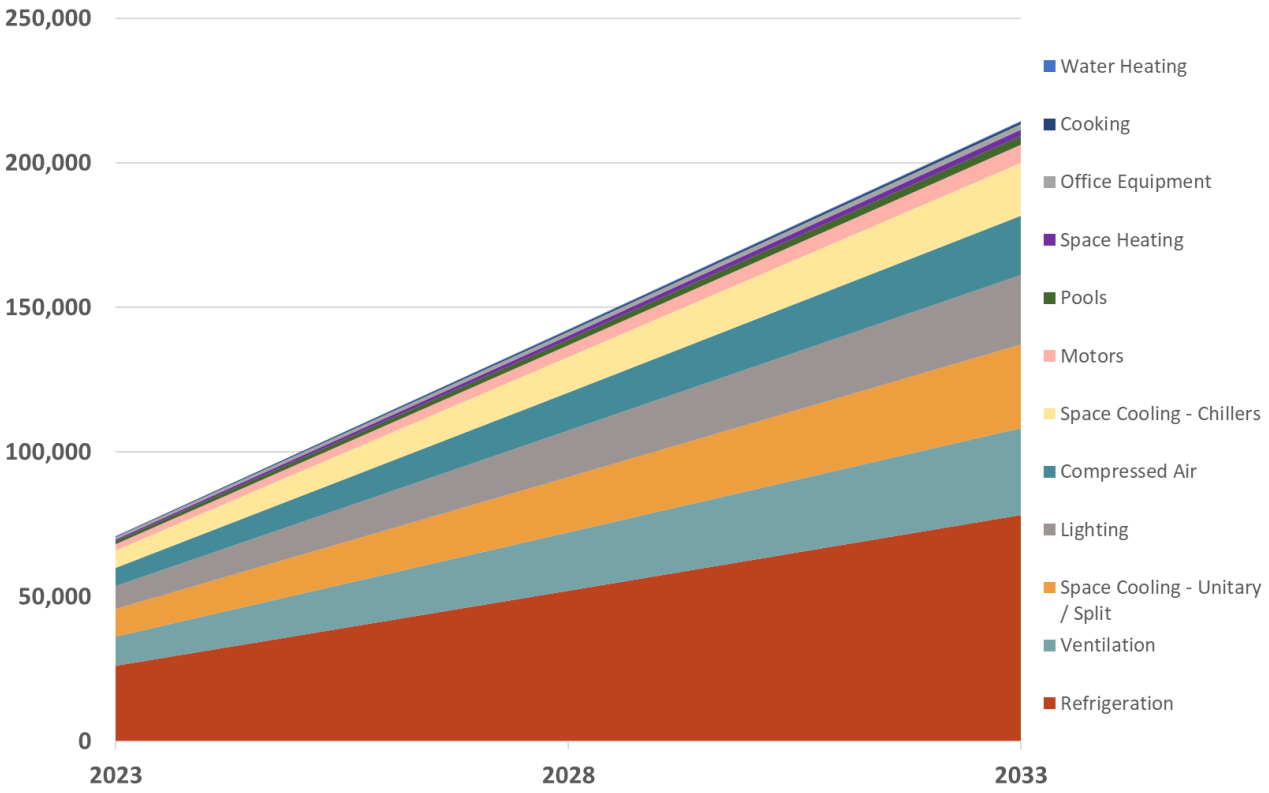


Table 5-3 provides 5-, 10-, and 15-yr cumulative annual realistic achievable potential estimates. The maximum achievable potential rises from 2.7% in 2023, to 5.1% in 2028, and 8.6% in 2033.

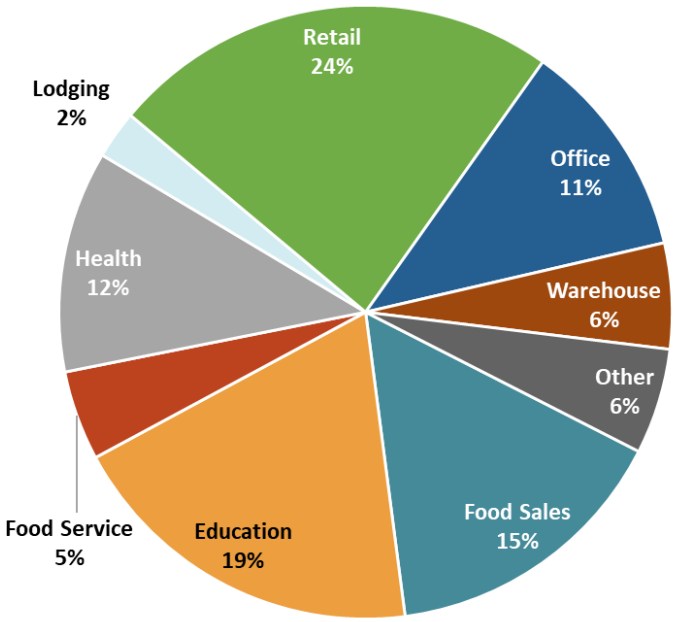
TABLE 5-4 COMMERCIAL ELECTRIC ENERGY (CUMULATIVE ANNUAL MWH) REALISTIC ACHIEVABLE POTENTIAL BY END-USE

End Use	2023	2028	2033
Cumulative Annual MWh			
Lighting	7,981	15,961	23,942
Space Cooling - Chillers	6,115	12,229	18,344
Space Cooling - Unitary / Split	9,602	19,205	28,807
Space Heating	733	1,466	2,199
Ventilation	10,055	20,109	30,164
Motors	2,096	4,193	6,289

End Use	2023	2028	2033
Water Heating	37	74	111
Cooking	265	529	794
Refrigeration	26,061	52,123	78,184
Office Equipment	680	1,359	2,039
Compressed Air	6,210	13,060	20,552
Pools	961	1,922	2,883
Total	70,795	142,230	214,307
% of Forecasted Sales	3.2%	6.1%	8.6%
Cumulative Annual MW			
Total	9	18	28
% of Forecasted Demand	2.0%	3.8%	5.4%

Figure 5-4 illustrates a market segmentation of the achievable potential in the commercial sector by 2033. The leading market segment is retail (24%), followed by education (19%), food service (11%), food sales (15%), and health care (12%).

FIGURE 5-4 2033 COMMERCIAL ELECTRIC ENERGY (CUMULATIVE ANNUAL) ACHIEVABLE POTENTIAL BY MARKET SEGMENT



5.2.4 Measure Level Detail

Table 5-5 below presents the measure-level technical, economic, and achievable MWh savings. Measures with significant remaining potential either possess significant per unit savings opportunities or are applicable to a large number of homes in the EKPC territory. Measures with zero economic and achievable potential were not found to be cost effective.

TABLE 5-5 COMMERCIAL TECHNICAL, ECONOMIC, ACHIEVABLE SAVINGS POTENTIAL (MWH), BY MEASURE (2033)

Measure Name	Technical	Economic	Max	Realistic
Evaporator Fan Motor Control for freezers and coolers	37,574	37,574	19,516	17,531
Electronically-Commutated Permanent Magnet Motors	25,221	33,628	19,962	15,441
Efficient Air Compressors	35,359	35,359	20,914	15,110
Zero Energy Doors for freezers and coolers	6,861	24,426	16,312	15,015
Water-Side Economizer - 200 Tons	33,430	33,430	19,774	14,286
Anti-sweat heater controls on freezers	21,171	21,171	12,096	10,976
LED Linear Replacement Lamps	37,330	52,811	24,346	10,911
Brushless DC Motors (ECM) for freezers and coolers	14,116	14,116	9,427	8,677
Anti-sweat heater controls, on refrigerators	13,248	13,248	7,569	6,868
VFD Supply and Return Fans, 11 to 50 HP	14,935	19,914	8,127	5,457
VFD Supply and Return Fans, <3 to 10 HP	14,935	19,914	8,127	5,457
Split AC (11.4 IEER to 15 IEER), 8.3 ton	6,731	10,096	5,972	4,314
VFD on Chilled Water Pump, 20 HP	9,497	9,497	5,617	4,058
Compressed Air Leak Survey and Repair	12,912	12,912	6,104	3,988
DX Packaged System (CEE Tier 2), 10 ton	5,284	7,925	4,688	3,387
Split AC (11.4 IEER to 14 IEER), 8.3 ton	5,208	7,812	4,621	3,338
Vending Miser, Cold Beverage	7,723	7,723	3,725	3,318
DX Packaged System (CEE Tier 2), > 20 ton	5,099	7,648	4,524	3,268
VFD Retrofit on Pool Circulation Pump	9,237	9,237	4,511	2,847
DX Packaged System (CEE Tier 2), < 20 ton	4,314	6,472	3,828	2,766
Programable Thermostats - Cooling	7,788	7,788	4,029	2,751
High Bay 8 lamp HPT8 vs (Metal Halide 400W)	11,026	11,026	5,083	2,278
Solid Door Refrigerator, 50+ cu ft, Energy Star	10,344	10,344	2,802	2,260
Split AC (11.4 IEER to 13 IEER), 8.3 ton	3,452	5,177	3,062	2,212
Solid Door Freezer, 50+ cu ft, Energy Star	9,991	9,991	2,706	2,183
All Other Measures	471,030	264,711	86,163	45,608
Total	**833,818**	**693,952**	**313,605**	**214,307**
% of Forecasted Sales	**33.6%**	**28.0%**	**12.6%**	**8.6%**

*For some measures, the economic and achievable potential may exceed technical potential. This is due primarily to an adjustment to the applicability factors among measures in the same measure group that compete to save the same kWh (e.g. Zero Energy Doors for freezers and coolers have greater economic and achievable potential than technical potential).

5.2.5 Benefits and Costs – Achievable Scenarios

Figure 5-5 shows the annual budgets for both achievable potential scenarios. The incentive and admin budgets are listed separately. The RAP budget fluctuates between $1.9 million and $2.8 million across the 15-year timeframe.

FIGURE 5-5 COMMERCIAL SECTOR ANNUAL BUDGETS – MAX AND REALISTIC ACHIEVABLE POTENTIAL (15-YR)

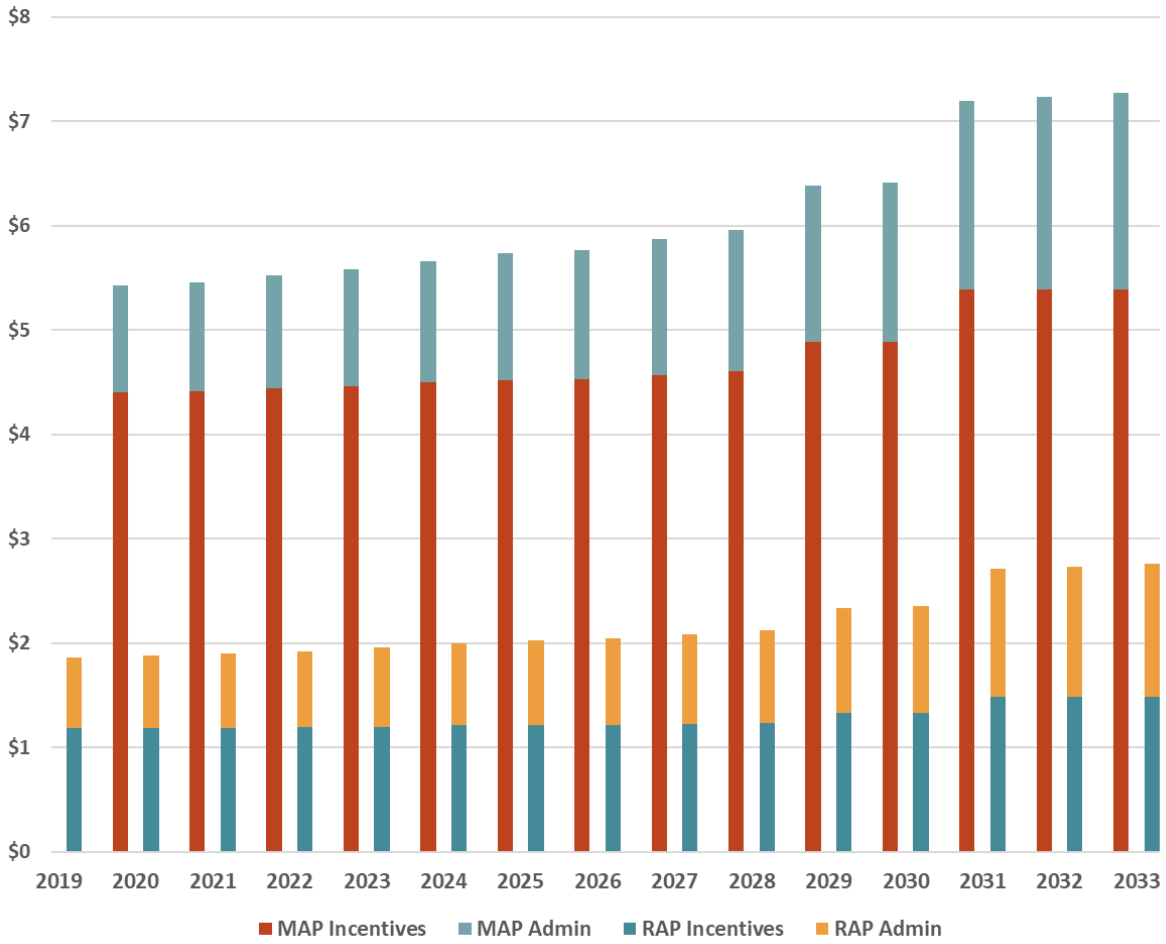


Table 5-6 provides the net present value (NPV) benefits and costs across the 2019-2033 timeframe for both achievable potential scenarios. The TRC ratio is 2.2 in both scenarios. NPV benefits exceed $45 million in the RAP scenario.

TABLE 5-6 COMMERCIAL NPV BENEFITS AND COSTS (15-YR) – MAX AND REALISTIC ACHIEVABLE POTENTIAL

Scenario	NPV Benefits	NPV Costs	TRC Ratio
Max Achievable	$129.2	$57.4	2.2
Realistic Achievable	$46.5	$20.7	2.2

6 Industrial Energy Efficiency Potential

This chapter provides the potential results for technical, economic, and achievable potential for the industrial sector. The chapter breakdowns of the potential by end use and market segment. The results are provided on a five, ten and fifteen-year basis. Budget and benefit-cost data are provided for the achievable potential scenarios.

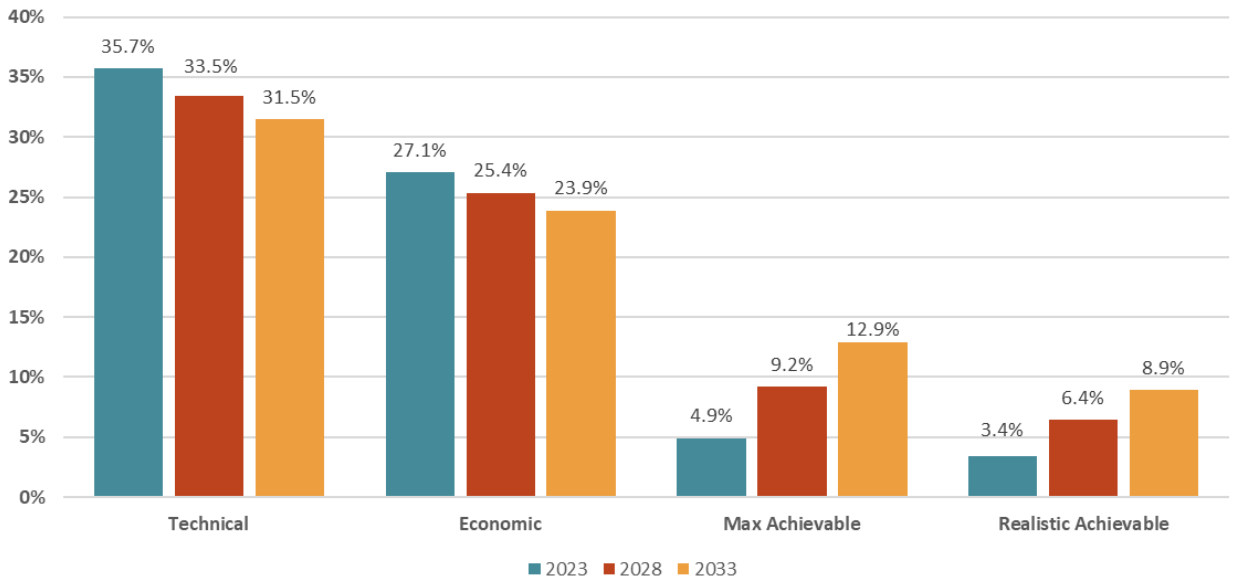
6.1 MEASURES EXAMINED

There were 114 total electric energy efficiency measures included in the analysis. The list of measures was developed based on a review of the Illinois TRM, the current EKPC program offerings, and the 2014 residential potential study measure list. Measure data includes incremental costs, electric energy and demand savings, natural gas savings, and measure life. See Appendix D for industrial measure list and assumptions details.

6.2 RESULTS

Figure 6-1 provides the technical, economic, and achievable results for the 5-yr, 10-yr, and 15-yr timeframes. The 5-yr technical potential is 35.7% of forecasted sales, and the economic potential is 27.1% of forecasted sales, indicating that most technical potential is cost-effective. The 3-yr realistic achievable potential is 3.4%. Achievable potential grows to 8.9% over a fifteen-year timeframe.

FIGURE 6-1 INDUSTRIAL ELECTRIC ENERGY (MWH) CUMULATIVE ANNUAL POTENTIAL (AS A % OF INDUSTRIAL SALES)



6.2.1 Technical Potential

Table 6-1 provides 5-, 10-, and 15-yr estimates of cumulative annual technical potential for energy and summer peak demand. The energy savings are provided by end use, and the overall peak demand savings are also provided. Machine drive, lighting, and space cooling are the leading end uses. These three end uses account for 80% of the technical potential.

TABLE 6-1 INDUSTRIAL SECTOR TECHNICAL POTENTIAL SAVINGS

End Use	2023	2028	2033
Cumulative Annual MWh			
Machine Drive	507,289	507,289	507,289
Lighting	359,670	359,670	359,670
Space Cooling	244,626	244,626	244,626
Ventilation	76,114	76,114	76,114
Process Heating and Cooling	117,816	117,816	117,816
Space Heating	63,120	63,120	63,120
Other	5,307	5,307	5,307
Agriculture	11,357	11,357	11,357
Water Heating	637	637	637
Computers & Office Equipment	972	972	972
Total	1,386,909	1,386,909	1,386,909
% of Forecasted Sales	35.7%	33.5%	31.5%
Cumulative Annual MW			
Total	236	236	236
% of Forecasted Demand	29.8%	28.3%	27.1%

6.2.2 Economic Potential

Table 6-2 provides 5-, 10-, and 15-yr estimates of cumulative annual economic potential for energy and summer peak demand. The energy savings are provided by end use, and the overall peak demand savings are also provided. Machine drive, lighting, and process heating and cooling are the leading end uses. These three end uses account for 85% of the economic potential.

TABLE 6-2 INDUSTRIAL SECTOR ECONOMIC POTENTIAL SAVINGS

End Use	2023	2028	2033
Cumulative Annual MWh			
Machine Drive	507,289	507,289	507,289
Lighting	271,044	271,044	271,044
Space Cooling	44,654	44,654	44,654
Ventilation	67,060	67,060	67,060
Process Heating and Cooling	117,815	117,815	117,815
Space Heating	28,097	28,097	28,097
Other	3,962	3,962	3,962
Agriculture	10,341	10,341	10,341
Water Heating	482	482	482
Computers & Office Equipment	792	792	792
Total	1,051,536	1,051,536	1,051,536
% of Forecasted Sales	27%	25%	24%
Cumulative Annual MW			
Total	179	179	179
% of Forecasted Demand	22.6%	21.5%	20.6%

6.2.3 Achievable Potential

Figure 6-2 provides a graphical representation of the 5-, 10-, and 15-yr cumulative annual maximum achievable potential results by end use. Machine drive, lighting, and process heating and cooling are the leading end uses. These three end uses account for 85% of the maximum achievable potential.

FIGURE 6-2 INDUSTRIAL ELECTRIC ENERGY (CUMULATIVE ANNUAL GWH) MAXIMUM ACHIEVABLE POTENTIAL BY END-USE

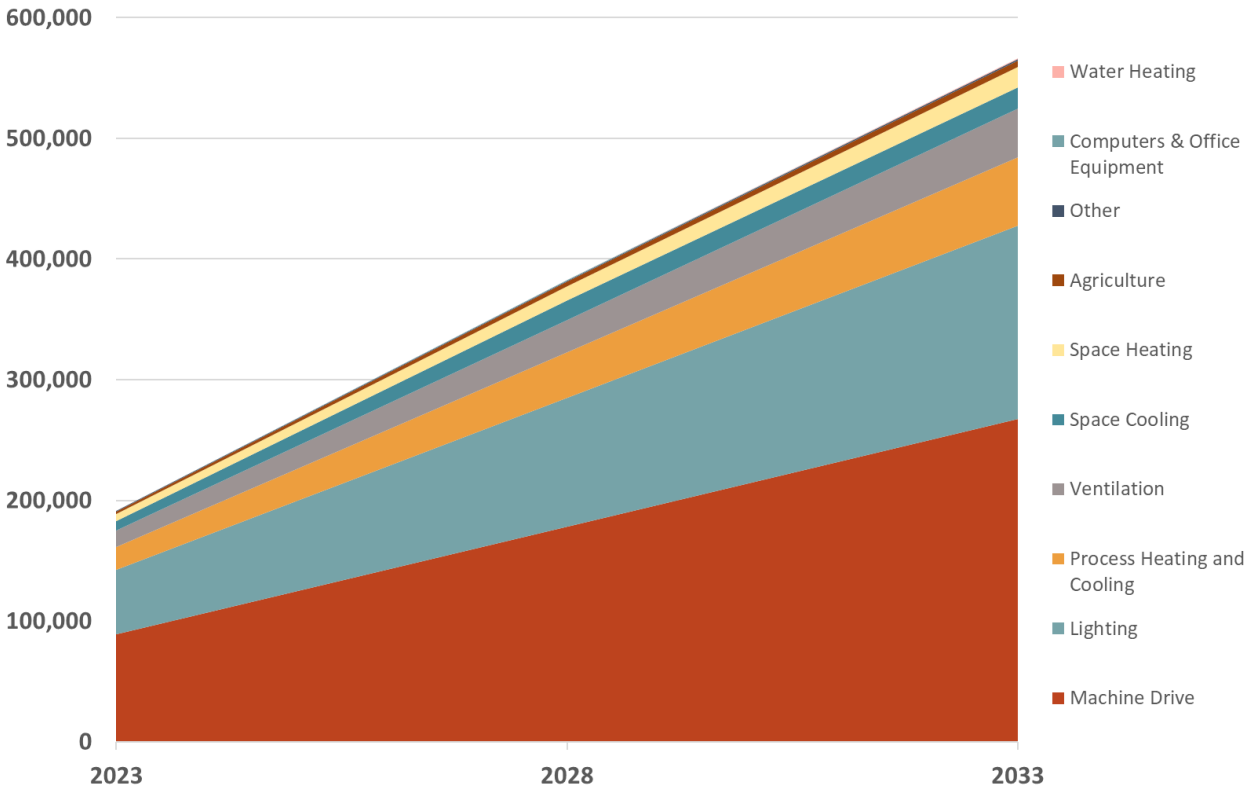


Table 6-3 provides 5-, 10-, and 15-yr cumulative annual maximum achievable potential estimates. The maximum achievable potential rises from 4.0% in 2023, to 7.7% in 2028, and 11.1% in 2033.

TABLE 6-3 INDUSTRIAL ELECTRIC ENERGY (CUMULATIVE ANNUAL MWH) MAXIMUM ACHIEVABLE POTENTIAL BY END-USE

End Use	2023	2028	2033
Cumulative Annual MWh			
Machine Drive	89,116	178,232	267,347
Lighting	53,383	106,765	160,148
Space Cooling	8,167	16,314	18,185
Ventilation	13,350	26,699	40,049
Process Heating and Cooling	18,946	37,891	56,837
Space Heating	5,907	11,814	16,409
Other	385	770	1,156
Agriculture	1,822	3,644	5,465
Water Heating	79	159	238
Computers & Office Equipment	140	279	419
Total	191,294	382,567	566,253
% of Forecasted Sales	4.9%	9.2%	12.9%
Cumulative Annual MW			

End Use	2023	2028	2033
Total	32	64	96
% of Forecasted Demand	4.0%	7.7%	11.1%

Figure 6-3 provides a graphical representation of the 5-, 10-, and 15-yr cumulative annual realistic achievable potential results by end use. Machine drive, lighting, and ventilation are the leading end uses. These three end uses account for 85% of the realistic achievable potential.

FIGURE 6-3 INDUSTRIAL ELECTRIC ENERGY (CUMULATIVE ANNUAL GWH) REALISTIC ACHIEVABLE POTENTIAL BY END-USE

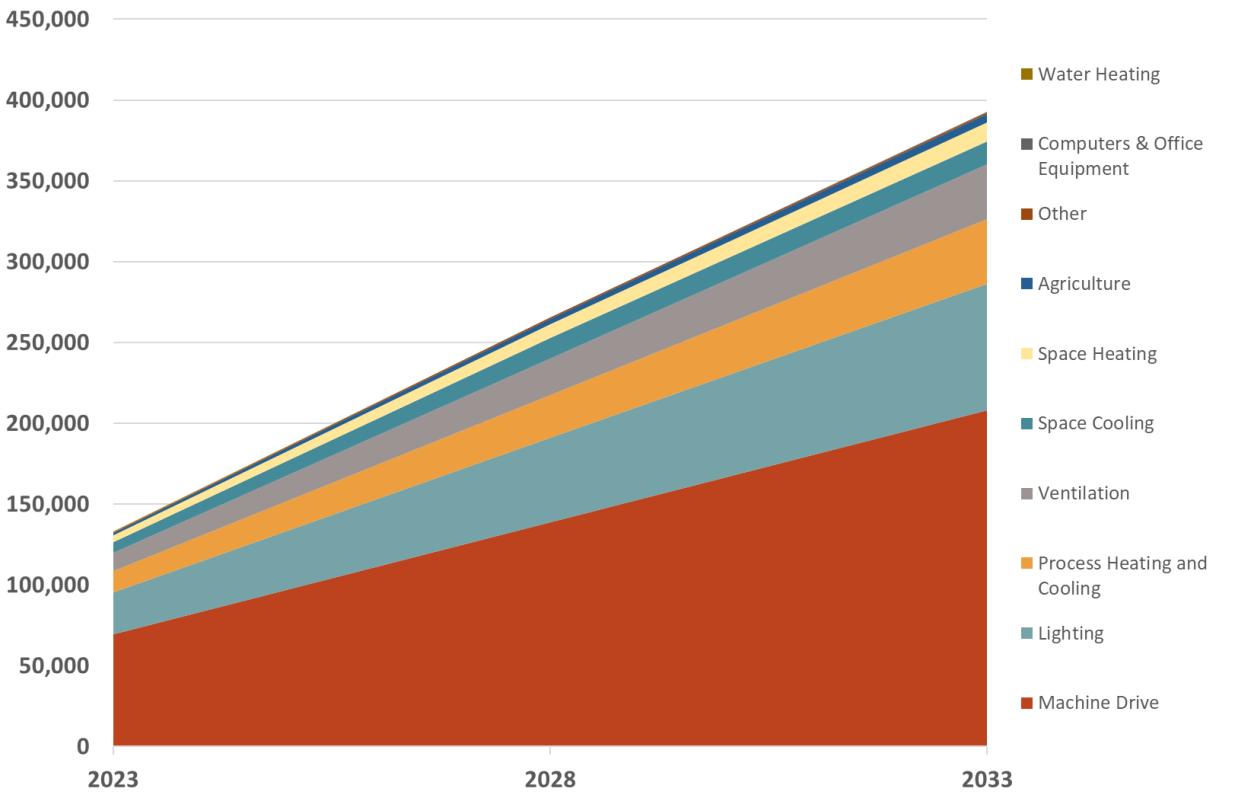


Table 6-4 provides 5-, 10-, and 15-yr cumulative annual realistic achievable potential estimates. The realistic achievable potential rises from 2.8% in 2023, to 6.4% in 2028, and 7.6% in 2033.

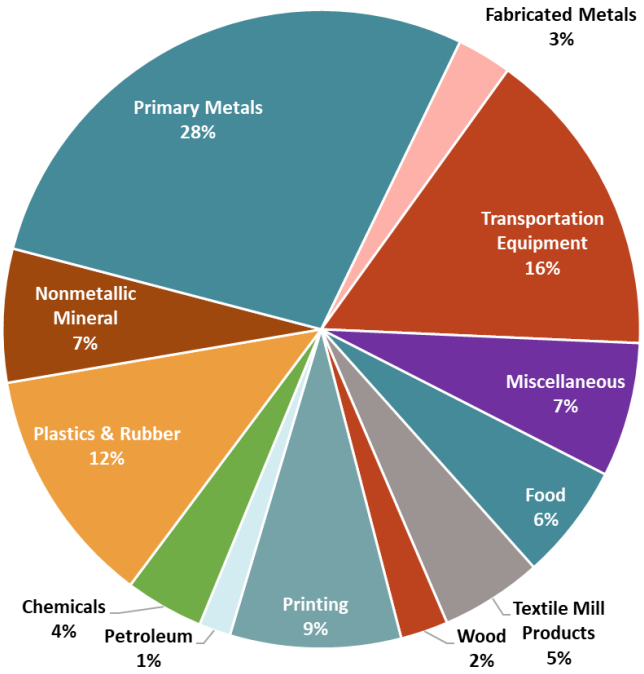
TABLE 6-4 INDUSTRIAL ELECTRIC ENERGY (CUMULATIVE ANNUAL MWH) REALISTIC ACHIEVABLE POTENTIAL BY END-USE

End Use	2023	2028	2033
Cumulative Annual MWh			
Machine Drive	69,258	138,517	207,775
Lighting	26,162	52,324	78,487
Space Cooling	6,324	12,631	14,164
Ventilation	11,315	22,629	33,944
Process Heating and Cooling	13,312	26,623	39,935
Space Heating	4,312	8,624	12,069
Other	350	700	1,050
Agriculture	1,657	3,314	4,970
Water Heating	64	128	193

End Use	2023	2028	2033
Computers & Office Equipment	88	175	263
Total	132,841	265,666	392,850
% of Forecasted Sales	3.4%	6.4%	8.9%
Cumulative Annual MW			
Total	22	44	66
% of Forecasted Demand	2.8%	5.3%	7.6%

Figure 6-4 illustrates a market segmentation of the realistic achievable potential in the industrial sector by 2033. The leading market segment is primary metals (28%), followed by transportation equipment (16%), and plastics and rubber (12%).

FIGURE 6-4 2033 INDUSTRIAL ELECTRIC ENERGY (CUMULATIVE ANNUAL) ACHIEVABLE POTENTIAL BY MARKET SEGMENT



6.2.4 Measure Level Detail

Table 6-5 below presents the measure-level technical, economic, and achievable MWh savings. Measures with significant remaining potential either possess significant per unit savings opportunities or are applicable to a large number homes in the EKPC territory. Measures with zero economic and achievable potential were not found to be cost effective.

TABLE 6-5 INDUSTRIAL TECHNICAL, ECONOMIC, ACHIEVABLE SAVINGS POTENTIAL (MWH), BY MEASURE (2033)

Measure Name	Technical	Economic	Max	Realistic
Motor System Optimization (Including ASD)	151,038	151,038	115,417	89,977
High Efficiency Pumps and Pump VFDs	90,980	90,980	68,284	52,353
Compressed Air Measures (Nozzles, Tank, Drains, Blower, Filters)	62,286	62,286	42,296	36,947
VFD for Process Fans	38,655	38,655	29,539	23,029
Sensors & Controls	47,257	47,257	31,697	21,958
Pump System Efficiency Improvements	41,733	41,733	28,752	20,179

Measure Name	Technical	Economic	Max	Realistic
High bay 4 lamp HPT8 vs (Metal halide 250 W)	52,698	52,698	40,994	18,114
Improved Refrigeration	38,080	38,080	25,441	17,411
VFD Supply and Return Fans	21,523	21,523	16,664	13,811
Occupancy Sensors and Central Lighting Control	29,959	29,959	24,597	13,701
LED Linear Replacement Lamps	38,676	38,676	29,752	12,416
Switching Controls for Multilevel Lighting (Non-HID)	21,390	21,390	17,722	10,203
EMS for Manufacturing HVAC Fan	15,784	15,784	12,220	10,128
Compressed Air Audits and Leak Repair	14,452	14,452	9,799	8,567
Advanced Efficient Motors	13,959	13,959	9,762	6,867
Fan System Improvements	6,775	6,775	4,455	3,130
High performance T5 (replacing T8)	16,964	16,964	11,971	2,944
Industrial Motor Management	5,965	5,965	3,916	2,824
Evaporator Fan Motor Controls Ag	4,422	4,422	656	2,737
Energy Information System	5,252	5,252	3,589	2,445
Compressed Air Outdoor Air Intake	3,867	3,867	2,621	2,292
Lamp & Ballast Retrofit (HPT8 Replacing Standard T8)	13,026	13,026	9,192	2,261
Compressed Air Pressure Flow Controller	3,633	3,633	2,467	2,150
Retrocommissioning	3,042	3,042	2,382	1,869
Injection Molding Machine - efficient (plastics)	3,231	3,231	1,869	1,818
All Other Measures	642,261	306,888	20,199	12,719
Total	**1,386,909**	**1,051,536**	**566,253**	**392,850**
% of Forecasted Sales	**31.5%**	**23.9%**	**12.9%**	**8.9%**

*For some measures, the economic and achievable potential may exceed technical potential. This is due primarily to an adjustment to the applicability factors among measures in the same measure group that compete to save the same kWh.

6.2.5 Benefits and Costs – Achievable Scenarios

Figure 6-5 shows the annual budgets for both achievable potential scenarios. The incentive and admin budgets are listed separately. The RAP budget rises from $2.9 million in 2019 to $4.2 million in 2033.

FIGURE 6-5 INDUSTRIAL SECTOR ANNUAL BUDGETS ($ MILLIONS) – MAX AND REALISTIC ACHIEVABLE POTENTIAL (15-YR)

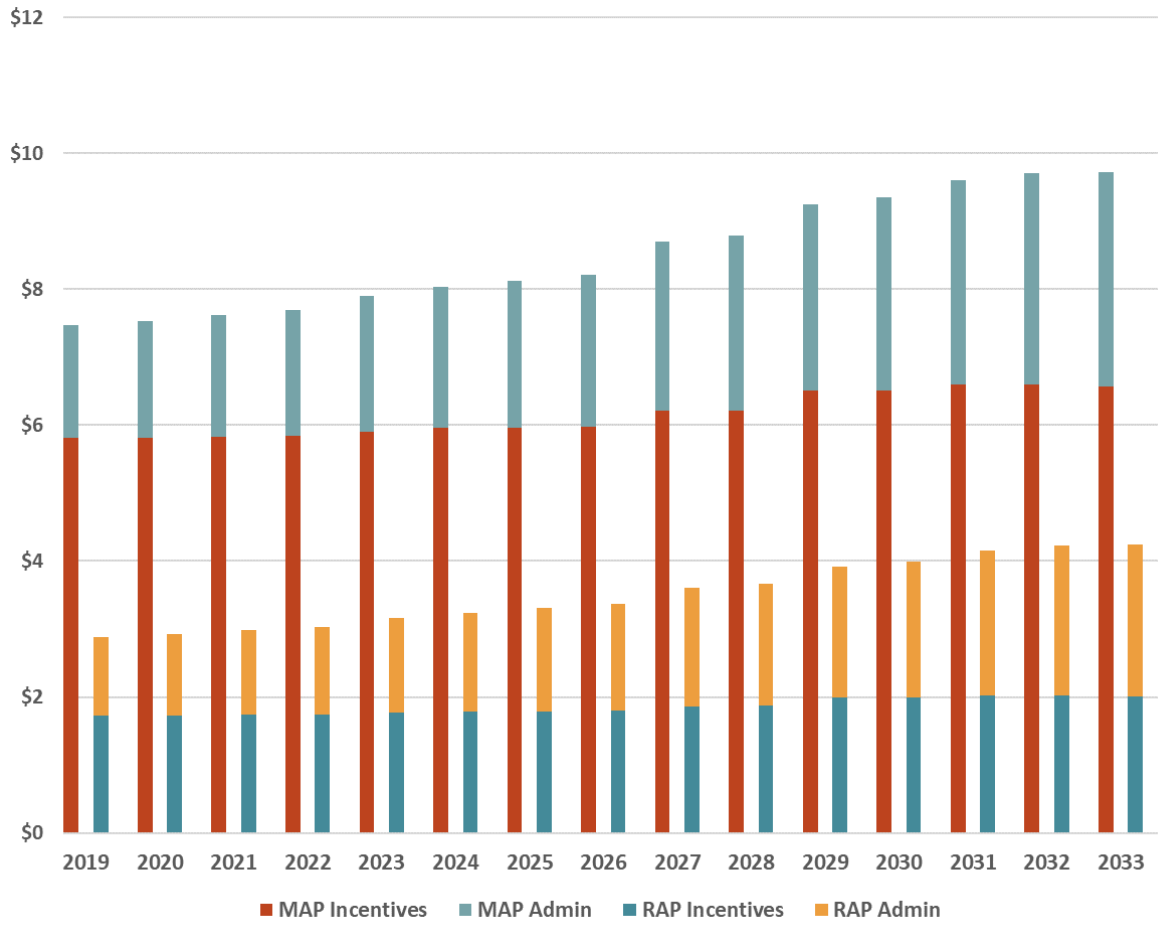


Table 6-6 provides the net present value (NPV) benefits and costs across the 2019-2033 timeframe for both achievable potential scenarios. The TRC ratio exceeds 3.0 in both scenarios. NPV benefits exceed $180 million in the RAP scenario.

TABLE 6-6 INDUSTRIAL NPV BENEFITS AND COSTS (15-YR) – MAX AND REALISTIC ACHIEVABLE POTENTIAL

Scenario	NPV Benefits	NPV Costs	TRC Ratio
Max Achievable	$266	$81	3.3
Realistic Achievable	$185	$54	3.5

7 Demand Response Analysis

7.1 TOTAL DEMAND RESPONSE POTENTIAL

Table 7-1 and Table 7-2 show the MAP and RAP residential net present values of the total benefits, costs, and savings, along with the TRC ratio for each program for the length of the study. The study period is 2019 to 2038. Two scenarios were looked at for the demand response study: control of air conditioners by load control switches or smart thermostats. Therefore, the programs lower in the hierarchy that are affected by the DLC AC programs are affected differently depending on which option is selected.

TABLE 7-1 MAP NPV BENEFITS, COSTS, AND TRC RATIOS FOR EACH DEMAND RESPONSE PROGRAM

	Program	NPV Benefits	NPV Costs	TRC Ratio
Residential	DLC AC (Thermostat)	$21,081,013	$17,741,946	1.19
	DLC AC (Switch)	$106,755,835	$58,860,975	1.81
	DLC Swimming Pool Pumps	$11,973,360	$5,923,242	2.02
	DLC Water Heating	$46,684,625	$71,128,160	0.66
	Critical Peak Pricing with Enabling Tech (Switch Scenario)	$213,850,280	$11,549,673	18.52
	Critical Peak Pricing with Enabling Tech (Thermostat Scenario)	$282,128,763	$13,086,453	21.56
	Critical Peak Pricing without Enabling Tech (Switch Scenario)	$39,716,779	$5,182,629	7.66
	Critical Peak Pricing without Enabling Tech (Thermostat Scenario)	$41,974,704	$5,519,620	7.60
Non-Residential	DLC AC (Thermostat)	$6,626,535	$2,277,924	2.91
	DLC AC (Switch)	$5,612,310	$2,406,594	2.33
	DLC Water Heating	$3,592,755	$1,694,337	2.12
	DLC Agricultural Irrigation	$11,972,545	$424,982	28.17
	Interruptible Rate	$252,238,015	$18,409,681	13.70
	Large C&I Behavioral	$1,205,665	$307,891	3.92
	Demand Buyback	$12,661	$209,594	0.06
	Critical Peak Pricing with Enabling Tech (Switch Scenario)	$46,280,645	$919,429	50.34
	Critical Peak Pricing with Enabling Tech (Thermostat Scenario)	$43,600,839	$899,118	48.49
	Critical Peak Pricing without Enabling Tech (Switch Scenario)	$3,913,583	$490,426	7.98
	Critical Peak Pricing without Enabling Tech (Thermostat Scenario)	$3,764,066	$485,887	7.75
Residential & Non-Residential	PEV Charging	$27,297,597	$3,767,785	7.24

TABLE 7-2 RAP NPV BENEFITS, COSTS, AND TRC RATIOS FOR EACH DEMAND RESPONSE PROGRAM

	Program	NPV Benefits	NPV Costs	TRC Ratio
Residential	DLC AC (Thermostat)	$14,639,592	$12,081,430	1.21
	DLC AC (Switch)	$73,702,593	$36,532,895	2.02
	DLC Swimming Pool Pumps	$5,986,680	$2,978,129	2.01
	DLC Water Heating	$29,840,941	$44,168,725	0.68
	Critical Peak Pricing with Enabling Tech (Switch Scenario)	$59,521,437	$2,359,648	25.22
	Critical Peak Pricing with Enabling Tech (Thermostat Scenario)	$69,958,942	$2,565,635	27.27
	Critical Peak Pricing without Enabling Tech (Switch Scenario)	$20,035,223	$2,056,281	9.74
	Critical Peak Pricing without Enabling Tech (Thermostat Scenario)	$22,415,144	$2,208,960	10.15
Non-Residential	DLC AC (Thermostat)	$2,790,120	$997,719	2.80
	DLC AC (Switch)	$1,202,638	$590,940	2.04
	DLC Water Heating	$1,569,941	$791,738	1.98
	DLC Agricultural Irrigation	$5,986,272	$349,866	17.11
	Interruptible Rate	$232,693,895	$17,229,759	13.51
	Large C&I Behavioral	$183,006	$218,574	0.84
	Demand Buyback	$1,876	$204,204	0.01
	Critical Peak Pricing with Enabling Tech (Switch Scenario)	$15,151,632	$352,660	42.96
	Critical Peak Pricing with Enabling Tech (Thermostat Scenario)	$14,374,876	$341,056	42.15
	Critical Peak Pricing without Enabling Tech (Switch Scenario)	$2,472,786	$323,581	7.64
	Critical Peak Pricing without Enabling Tech (Thermostat Scenario)	$2,364,058	$315,203	7.50
Residential & Non-Residential	PEV Charging	$16,569,037	$2,268,482	7.30

Table 7-3 shows the technical, economic, and achievable (MAP and RAP) cumulative annual potential for years 5, 10 and 15 of the study in the switch scenario. Table 7-4 shows results for each level of potential in the thermostat scenario.

Achievable potential includes a participation rate to estimate the realistic number of customers that are expected to participate in each cost-effective demand response program option. These values are at the customer meter. The maximum achievable potential (MAP) assumes the maximum participation that would happen in the real-world, while the realistically achievable potential (RAP) discounts MAP by considering barriers to program implementation that could limit the amount of savings achieved.

TABLE 7-3 SUMMARY OF TECHNICAL, ECONOMIC, AND ACHIEVABLE POTENTIAL – SWITCH SCENARIO

Potential Level (MW)	5-Year Savings (2023)	10-Year Savings (2028)	15-Year Savings (2033)
Technical	1639	1668	1697
Economic	1302	1320	1340

Potential Level (MW)	5-Year Savings (2023)	10-Year Savings (2028)	15-Year Savings (2033)
MAP	514	563	608
RAP	286	326	367

TABLE 7-4 SUMMARY OF TECHNICAL, ECONOMIC, AND ACHIEVABLE POTENTIAL – THERMOSTAT SCENARIO

Potential Level (MW)	5-Year Savings (2023)	10-Year Savings (2028)	15-Year Savings (2033)
Technical	1336	1381	1428
Economic	999	1032	1070
MAP	499	552	601
RAP	260	294	328

Table 7-5 and Table 7-6 show the achievable potential savings for years 5, 10, and 15, by program. Only those programs that were found to be cost-effective are included.

TABLE 7-5 MAP SAVINGS BY PROGRAM

Sector	Program	5-Year Savings (2023)	10-Year Savings (2028)	15-Year Savings (2033)
Residential	DLC AC (Thermostat)	7	15	22
	DLC AC (Switch)	47	75	104
	DLC Swimming Pool Pumps	4	8	13
	Critical Peak Pricing with Enabling Tech (Switch Scenario)	208	187	159
	Critical Peak Pricing with Enabling Tech (Thermostat Scenario)	232	236	234
	Critical Peak Pricing without Enabling Tech (Switch Scenario)	32	31	31
	Critical Peak Pricing without Enabling Tech (Thermostat Scenario)	33	33	33
	Total (Switch Scenario)	**290**	**302**	**307**
	Total (Thermostat Scenario)	**276**	**292**	**303**
Non-Residential	DLC AC (Thermostat)	2	5	7
	DLC AC (Switch)	2	4	6
	DLC Water Heating	2	4	6
	DLC Agricultural Irrigation	9	10	10
	Interruptible Rate	160	182	207
	Large C&I Behavioral	1	1	1
	Critical Peak Pricing with Enabling Tech (Switch Scenario)	39	39	38
	Critical Peak Pricing with Enabling Tech (Thermostat Scenario)	38	37	35
	Critical Peak Pricing without Enabling Tech (Switch Scenario)	3	3	3
	Critical Peak Pricing without Enabling Tech (Thermostat Scenario)	3	3	3

Sector	Program	5-Year Savings (2023)	10-Year Savings (2028)	15-Year Savings (2033)
	Total (Switch Scenario)	**216**	**242**	**270**
	Total (Thermostat Scenario)	**215**	**241**	**268**
Residential & Non-Residential	PEV Charging	8	19	31
	Total (Switch Scenario)	**514**	**563**	**608**
	Total (Thermostat Scenario)	**499**	**552**	**601**

TABLE 7-6 RAP SAVINGS BY PROGRAM

Sector	Program	5-Year Savings (2023)	10-Year Savings (2028)	15-Year Savings (2033)
Residential	DLC AC (Thermostat)	5	10	16
	DLC AC (Switch)	36	52	69
	DLC Swimming Pool Pumps	2	4	6
	Critical Peak Pricing with Enabling Tech (Switch Scenario)	53	51	47
	Critical Peak Pricing with Enabling Tech (Thermostat Scenario)	57	58	59
	Critical Peak Pricing without Enabling Tech (Switch Scenario)	17	17	16
	Critical Peak Pricing without Enabling Tech (Thermostat Scenario)	18	19	19
	Total (Switch Scenario)	**108**	**124**	**139**
	Total (Thermostat Scenario)	**81**	**91**	**99**
Non-Residential	DLC AC (Thermostat)	1	2	3
	DLC AC (Switch)	0.4	1	1
	DLC Water Heating	1	2	2
	DLC Agricultural Irrigation	5	5	5
	Interruptible Rate	154	169	186
	Critical Peak Pricing with Enabling Tech (Switch Scenario)	12	13	13
	Critical Peak Pricing with Enabling Tech (Thermostat Scenario)	12	12	12
	Critical Peak Pricing without Enabling Tech (Switch Scenario)	2	2	2
	Critical Peak Pricing without Enabling Tech (Thermostat Scenario)	2	2	2
	Total (Switch Scenario)	**173**	**191**	**209**
	Total (Thermostat Scenario)	**174**	**191**	**210**
Residential & Non-Residential	PEV Charging	5	11	19
	Total (Switch Scenario)	**286**	**326**	**367**
	Total (Thermostat Scenario)	**260**	**294**	**328**

7.2 GENERAL COSTS OF DEMAND RESPONSE

Table 7-7 and Table 7-8 show the MAP and RAP costs (for only cost-effective programs) that would be required to achieve the cumulative annual potential. The current and future hardware and software cost of a Demand Response Management System and the cost of non-equipment incentives are included in these budgets.

TABLE 7-7 SUMMARY OF MAP BUDGET REQUIREMENTS

	Switch Scenario	Thermostat Scenario
2019	$11,577,488	$5,974,266
2020	$10,649,843	$8,415,078
2021	$15,686,683	$10,578,371
2022	$9,126,679	$7,140,993
2023	$7,349,132	$5,089,765
2024	$6,227,937	$3,683,322
2025	$6,545,527	$3,587,650
2026	$8,530,128	$4,857,444
2027	$8,981,131	$5,043,883
2028	$9,402,147	$5,244,157
2029	$9,897,483	$5,526,024
2030	$10,230,411	$5,635,407
2031	$10,675,598	$5,846,811
2032	$11,113,477	$6,050,629
2033	$11,565,921	$6,265,800
2034	$12,053,034	$6,505,834
2035	$12,563,952	$6,756,135
2036	$13,050,886	$6,993,825
2037	$13,042,639	$6,958,922
2038	$13,457,635	$7,145,240

TABLE 7-8 SUMMARY OF RAP BUDGET REQUIREMENTS

	Switch Scenario	Thermostat Scenario
2019	$5,663,381	$1,946,374
2020	$3,689,931	$1,976,973
2021	$6,503,304	$2,878,173
2022	$6,907,886	$3,258,160
2023	$5,020,881	$3,313,347
2024	$7,802,517	$4,240,144
2025	$5,270,757	$3,749,655
2026	$4,759,784	$3,104,987
2027	$4,445,760	$2,670,289
2028	$4,603,787	$2,693,286
2029	$5,490,716	$3,495,214

	Switch Scenario	Thermostat Scenario
2030	$5,768,070	$3,604,207
2031	$6,006,049	$3,725,768
2032	$6,321,288	$3,931,328
2033	$6,469,903	$3,964,447
2034	$6,721,184	$4,094,545
2035	$6,967,172	$4,219,490
2036	$7,221,974	$4,351,582
2037	$7,496,296	$4,498,507
2038	$7,784,099	$4,651,922

APPENDIX A. List of Key Data Sources

This appendix provides a list of key data sources used in the development of the measure assumptions (to be updated).

1. BEOpt: Building Energy Optimization software
2. EIA - Technology Forecast Updates – Residential and Commercial Building Technologies – Reference Case
3. Energy Efficiency Emerging Technologies
4. Illinois TRM (Version 7.0)
5. Indiana TRM (Version 2.2) ***Hyperlink unavailable - embedded document provided below***

2018 MPS RFP
(Appendix I) Indiana

6. Michigan Energy Measures Database (MEMD)
7. Mid-Atlantic Technical Reference Manual V7, Dated May 2017
8. National Residential Efficiency Measures Database

APPENDIX B. Residential Measure Detail

EKPC DSM **Measure Assumptions**

Measure #	End-Use	Measure Name	Home Type	Income Type	Replacement Type	Base Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer NCP kW	Per Unit Winter NCP kW	Per unit NG Saving	Per Unit Water Savings	RC EUL	EE EUL	Initial Measure Cost	TRC Ratio
1001	Appliances	Energy Star Compliant Top-Mount Refrigerator	SF	All	MO	441.7	10%	44.3	0.007	0.007	0.00	0	17.0	17.0	$30	0.85
1002	Appliances	CEE Tier 2 Compliant Top-Mount Refrigerator	SF	All	MO	441.7	25%	110.5	0.017	0.017	0.00	0	17.0	17.0	$140	0.45
1003	Appliances	Energy Star Compliant Side-by-Side Refrigerator	SF	All	MO	517.1	10%	51.7	0.008	0.008	0.00	0	17.0	17.0	$30	0.99
1004	Appliances	CEE Tier 2 Compliant Side-by-Side Refrigerator	SF	All	MO	517.1	25%	129.3	0.020	0.020	0.00	0	17.0	17.0	$140	0.53
1005	Appliances	Energy Star Compliant Chest Freezer	SF	All	MO	311.4	10%	31.2	0.005	0.005	0.00	0	11.0	11.0	$35	0.25
1006	Appliances	Energy Star Compliant Upright Freezer (Manual Def.)	SF	All	MO	349.2	10%	35.0	0.006	0.006	0.00	0	11.0	11.0	$35	0.28
1007	Appliances	Second Refrigerator Turn In	SF	All	Recycle	1,036.0	100%	1,036.0	0.152	0.152	0.00	0	8.0	8.0	$131	2.31
1008	Appliances	Second Freezer Turn In	SF	All	Recycle	942.0	100%	942.0	0.138	0.138	0.00	0	8.0	8.0	$131	2.07
1009	Appliances	Energy Star Compliant Top-Mount Refrigerator	MH	All	MO	441.7	10%	44.3	0.007	0.007	0.00	0	17.0	17.0	$30	0.85
1010	Appliances	CEE Tier 2 Compliant Top-Mount Refrigerator	MH	All	MO	441.7	25%	110.5	0.017	0.017	0.00	0	17.0	17.0	$140	0.45
1011	Appliances	Energy Star Compliant Side-by-Side Refrigerator	MH	All	MO	517.1	10%	51.7	0.008	0.008	0.00	0	17.0	17.0	$30	0.99
1012	Appliances	CEE Tier 2 Compliant Side-by-Side Refrigerator	MH	All	MO	517.1	25%	129.3	0.020	0.020	0.00	0	17.0	17.0	$140	0.53
1013	Appliances	Energy Star Compliant Chest Freezer	MH	All	MO	311.4	10%	31.2	0.005	0.005	0.00	0	11.0	11.0	$35	0.25
1014	Appliances	Energy Star Compliant Upright Freezer (Manual Def.)	MH	All	MO	349.2	10%	35.0	0.006	0.006	0.00	0	11.0	11.0	$35	0.28
1015	Appliances	Second Refrigerator Turn In	MH	All	Recycle	1,036.0	100%	1,036.0	0.152	0.152	0.00	0	8.0	8.0	$131	2.31
1016	Appliances	Second Freezer Turn In	MH	All	Recycle	942.0	100%	942.0	0.138	0.138	0.00	0	8.0	8.0	$131	2.07
1017	Appliances	Energy Star Compliant Top-Mount Refrigerator	SF	All	NC	441.7	10%	44.3	0.007	0.007	0.00	0	17.0	17.0	$30	0.85
1018	Appliances	CEE Tier 2 Compliant Top-Mount Refrigerator	SF	All	NC	441.7	25%	110.5	0.017	0.017	0.00	0	17.0	17.0	$140	0.45
1019	Appliances	Energy Star Compliant Side-by-Side Refrigerator	SF	All	NC	517.1	10%	51.7	0.008	0.008	0.00	0	17.0	17.0	$30	0.99
1020	Appliances	CEE Tier 2 Compliant Side-by-Side Refrigerator	SF	All	NC	517.1	25%	129.3	0.020	0.020	0.00	0	17.0	17.0	$140	0.53
1021	Appliances	Energy Star Compliant Chest Freezer	SF	All	NC	311.4	10%	31.2	0.005	0.005	0.00	0	11.0	11.0	$35	0.25
1022	Appliances	Energy Star Compliant Upright Freezer (Manual Def.)	SF	All	NC	349.2	10%	35.0	0.006	0.006	0.00	0	11.0	11.0	$35	0.28
1023	Appliances	Energy Star Compliant Top-Mount Refrigerator	MH	All	NC	441.7	10%	44.3	0.007	0.007	0.00	0	17.0	17.0	$30	0.85
1024	Appliances	CEE Tier 2 Compliant Top-Mount Refrigerator	MH	All	NC	441.7	25%	110.5	0.017	0.017	0.00	0	17.0	17.0	$140	0.45
1025	Appliances	Energy Star Compliant Side-by-Side Refrigerator	MH	All	NC	517.1	10%	51.7	0.008	0.008	0.00	0	17.0	17.0	$30	0.99
1026	Appliances	CEE Tier 2 Compliant Side-by-Side Refrigerator	MH	All	NC	517.1	25%	129.3	0.020	0.020	0.00	0	17.0	17.0	$140	0.53
1027	Appliances	Energy Star Compliant Chest Freezer	MH	All	NC	311.4	10%	31.2	0.005	0.005	0.00	0	11.0	11.0	$35	0.25
1028	Appliances	Energy Star Compliant Upright Freezer (Manual Def.)	MH	All	NC	349.2	10%	35.0	0.006	0.006	0.00	0	11.0	11.0	$35	0.28
2001	Behavioral	Pre-Paid Energy Display Monitor - Gas/CAC	SF	All	Opt-In	13,949.3	11%	1,534.4	0.523	0.070	6.73	0	1.0	1.0	$100	0.82
2002	Behavioral	Home Energy Reports - Gas/CAC	SF	All	Opt-Out	13,949.3	2%	279.0	0.095	0.013	1.22	0	1.0	1.0	$7	2.20
2003	Behavioral	Pre-Paid Energy Display Monitor - ASHP	SF	All	Opt-In	17,770.4	11%	1,954.7	0.369	0.772	0.00	0	1.0	1.0	$100	0.76
2004	Behavioral	Home Energy Reports - ASHP	SF	All	Opt-Out	17,770.4	2%	355.4	0.067	0.140	0.00	0	1.0	1.0	$7	2.03
2005	Behavioral	Pre-Paid Energy Display Monitor - Elec Furn/CAC	SF	All	Opt-In	24,655.7	11%	2,712.1	0.384	1.265	0.00	0	1.0	1.0	$100	1.03
2006	Behavioral	Home Energy Reports - Elec Furn/CAC	SF	All	Opt-Out	24,655.7	2%	493.1	0.070	0.230	0.00	0	1.0	1.0	$7	2.78
2007	Behavioral	Pre-Paid Energy Display Monitor - Gas/CAC	MH	All	Opt-In	11,217.1	11%	1,233.9	0.367	0.056	5.20	0	1.0	1.0	$100	0.64
2008	Behavioral	Home Energy Reports - Gas/CAC	MH	All	Opt-Out	11,217.1	2%	224.3	0.067	0.010	0.95	0	1.0	1.0	$7	1.73
2009	Behavioral	Pre-Paid Energy Display Monitor - ASHP	MH	All	Opt-In	15,080.5	11%	1,658.9	0.344	0.602	0.00	0	1.0	1.0	$100	0.65
2010	Behavioral	Home Energy Reports - ASHP	MH	All	Opt-Out	15,080.5	2%	301.6	0.063	0.109	0.00	0	1.0	1.0	$7	1.74
2011	Behavioral	Pre-Paid Energy Display Monitor - Elec Furn/CAC	MH	All	Opt-In	20,487.9	11%	2,253.7	0.351	1.048	0.00	0	1.0	1.0	$100	0.87
2012	Behavioral	Home Energy Reports - Elec Furn/CAC	MH	All	Opt-Out	20,487.9	2%	409.8	0.064	0.191	0.00	0	1.0	1.0	$7	2.33
2013	Behavioral	Pre-Paid Energy Display Monitor - Gas/CAC	SF	All	NC	12,067.5	11%	1,327.4	0.269	0.053	4.52	0	1.0	1.0	$100	0.63
2014	Behavioral	Home Energy Reports - Gas/CAC	SF	All	NC	12,067.5	2%	241.4	0.049	0.010	0.82	0	1.0	1.0	$7	1.69
2015	Behavioral	Pre-Paid Energy Display Monitor - ASHP	SF	All	NC	14,766.1	11%	1,624.3	0.236	0.483	0.00	0	1.0	1.0	$100	0.61
2016	Behavioral	Home Energy Reports - ASHP	SF	All	NC	14,766.1	2%	295.3	0.043	0.088	0.00	0	1.0	1.0	$7	1.64
2017	Behavioral	Pre-Paid Energy Display Monitor - Gas/CAC	MH	All	NC	9,870.7	11%	1,085.8	0.243	0.046	4.43	0	1.0	1.0	$100	0.54
2018	Behavioral	Home Energy Reports - Gas/CAC	MH	All	NC	9,870.7	2%	197.4	0.044	0.008	0.81	0	1.0	1.0	$7	1.45
2019	Behavioral	Pre-Paid Energy Display Monitor - ASHP	MH	All	NC	12,747.2	11%	1,402.2	0.225	0.441	0.00	0	1.0	1.0	$100	0.53
2020	Behavioral	Home Energy Reports - ASHP	MH	All	NC	12,747.2	2%	254.9	0.041	0.080	0.00	0	1.0	1.0	$7	1.42
3001	Bundles	Multi-Family Homes Efficiency Kit	MF	All	Retrofit	9,460.0	4%	347.0	0.061	0.056	0.00	0	7.0	7.0	$1,000	0.10
3002	Bundles	Multi-Family Homes Efficiency Kit	MF	All	NC	9,460.0	4%	347.0	0.061	0.056	0.00	0	7.0	7.0	$1,000	0.10
4001	Clothes Washer/ Dryer	Energy Star Clothes Washer (w/ Elec. WH & Elec. Dryer)	SF	All	MO	613.1	27%	162.7	0.552	0.552	0.00	2,024	14.0	14.0	$65	4.27
4002	Clothes Washer/ Dryer	Energy Star Most Efficient Clothes Washer (w/ Elec. WH & E	SF	All	MO	613.1	39%	242.1	0.821	0.821	0.00	2,760	14.0	14.0	$210	2.12
4003	Clothes Washer/ Dryer	Energy Star Clothes Washer (w/ NG WH & Elec. Dryer)	SF	All	MO	421.8	18%	77.0	0.261	0.261	0.37	2,024	14.0	14.0	$65	3.87
4004	Clothes Washer/ Dryer	Energy Star Most Efficient Clothes Washer (w/ NG WH & Ele	SF	All	MO	421.8	21%	88.2	0.299	0.299	0.66	2,760	14.0	14.0	$210	1.87

EKPC DSM **Measure Assumptions**

Measure #	End-Use	Measure Name	Home Type	Income Type	Replacement Type	Base Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer NCP kW	Per Unit Winter NCP kW	Per unit NG Saving	Per Unit Water Savings	RC EUL	EE EUL	Initial Measure Cost	TRC Ratio
4005	Clothes Washer/ Dryer	ENERGY STAR Clothes Dryer	SF	All	MO	768.9	21%	160.0	0.565	0.565	0.00	0	14.0	14.0	$152	0.50
4006	Clothes Washer/ Dryer	Energy Star Clothes Washer (w/ Elec. WH & Elec. Dryer)	MH	All	MO	613.1	27%	162.7	0.552	0.552	0.00	2,024	14.0	14.0	$65	4.27
4007	Clothes Washer/ Dryer	Energy Star Most Efficient Clothes Washer (w/ Elec. WH & E	MH	All	MO	613.1	39%	242.1	0.821	0.821	0.00	2,760	14.0	14.0	$210	2.12
4008	Clothes Washer/ Dryer	Energy Star Clothes Washer (w/ NG WH & Elec. Dryer)	MH	All	MO	421.8	18%	77.0	0.261	0.261	0.37	2,024	14.0	14.0	$65	3.87
4009	Clothes Washer/ Dryer	Energy Star Most Efficient Clothes Washer (w/ NG WH & Ele	MH	All	MO	421.8	21%	88.2	0.299	0.299	0.66	2,760	14.0	14.0	$210	1.87
4010	Clothes Washer/ Dryer	ENERGY STAR Clothes Dryer	MH	All	MO	768.9	21%	160.0	0.565	0.565	0.00	0	14.0	14.0	$152	0.50
4011	Clothes Washer/ Dryer	Energy Star Clothes Washer (w/ Elec. WH & Elec. Dryer)	SF	All	NC	613.1	27%	162.7	0.552	0.552	0.00	2,024	14.0	14.0	$65	4.27
4012	Clothes Washer/ Dryer	Energy Star Most Efficient Clothes Washer (w/ Elec. WH & E	SF	All	NC	613.1	39%	242.1	0.821	0.821	0.00	2,760	14.0	14.0	$210	2.12
4013	Clothes Washer/ Dryer	Energy Star Clothes Washer (w/ NG WH & Elec. Dryer)	SF	All	NC	421.8	18%	77.0	0.261	0.261	0.37	2,024	14.0	14.0	$65	3.87
4014	Clothes Washer/ Dryer	Energy Star Most Efficient Clothes Washer (w/ NG WH & Ele	SF	All	NC	421.8	21%	88.2	0.299	0.299	0.66	2,760	14.0	14.0	$210	1.87
4015	Clothes Washer/ Dryer	ENERGY STAR Clothes Dryer	SF	All	NC	768.9	21%	160.0	0.565	0.565	0.00	0	14.0	14.0	$152	0.50
4016	Clothes Washer/ Dryer	Energy Star Clothes Washer (w/ Elec. WH & Elec. Dryer)	MH	All	NC	613.1	27%	162.7	0.552	0.552	0.00	2,024	14.0	14.0	$65	4.27
4017	Clothes Washer/ Dryer	Energy Star Most Efficient Clothes Washer (w/ Elec. WH & E	MH	All	NC	613.1	39%	242.1	0.821	0.821	0.00	2,760	14.0	14.0	$210	2.12
4018	Clothes Washer/ Dryer	Energy Star Clothes Washer (w/ NG WH & Elec. Dryer)	MH	All	NC	421.8	18%	77.0	0.261	0.261	0.37	2,024	14.0	14.0	$65	3.87
4019	Clothes Washer/ Dryer	Energy Star Most Efficient Clothes Washer (w/ NG WH & Ele	MH	All	NC	421.8	21%	88.2	0.299	0.299	0.66	2,760	14.0	14.0	$210	1.87
4020	Clothes Washer/ Dryer	ENERGY STAR Clothes Dryer	MH	All	NC	768.9	21%	160.0	0.565	0.565	0.00	0	14.0	14.0	$152	0.50
5001	Dishwasher	Energy Star Dishwasher (Electric Water Heating)	SF	All	MO	307.0	12%	37.0	0.147	0.147	0.00	252	11.0	11.0	$50	0.87
5002	Dishwasher	Energy Star Dishwasher (Non-Electric WH)	SF	All	MO	135.1	12%	16.3	0.065	0.065	0.09	252	11.0	11.0	$50	0.72
5003	Dishwasher	Energy Star Dishwasher (Electric Water Heating)	MH	All	MO	307.0	12%	37.0	0.147	0.147	0.00	252	11.0	11.0	$50	0.87
5004	Dishwasher	Energy Star Dishwasher (Non-Electric WH)	MH	All	MO	135.1	12%	16.3	0.065	0.065	0.09	252	11.0	11.0	$50	0.72
5005	Dishwasher	Energy Star Dishwasher (Electric Water Heating)	SF	All	NC	307.0	12%	37.0	0.147	0.147	0.00	252	11.0	11.0	$50	0.87
5006	Dishwasher	Energy Star Dishwasher (Non-Electric WH)	SF	All	NC	135.1	12%	16.3	0.065	0.065	0.09	252	11.0	11.0	$50	0.72
5007	Dishwasher	Energy Star Dishwasher (Electric Water Heating)	MH	All	NC	307.0	12%	37.0	0.147	0.147	0.00	252	11.0	11.0	$50	0.87
5008	Dishwasher	Energy Star Dishwasher (Non-Electric WH)	MH	All	NC	135.1	12%	16.3	0.065	0.065	0.09	252	11.0	11.0	$50	0.72
6001	Electronics	Efficient Televisions	SF	All	MO	246.0	64%	158.1	0.234	0.234	0.00	0	6.0	6.0	$10	2.04
6002	Electronics	Energy Star Desktop Computer	SF	All	MO	238.5	32%	76.6	0.023	0.023	0.00	0	4.0	4.0	$20	0.55
6003	Electronics	Energy Star Computer Monitor	*SF*	All	MO	56.8	25%	14.2	0.001	0.001	0.00	0	5.0	5.0	$3	0.81
6004	Electronics	Energy Star Laptop Computer	*SF*	All	MO	30.7	25%	7.7	0.001	0.001	0.00	0	4.0	4.0	$3	0.37
6005	Electronics	Smart Strip Power Strip - Tier 1	SF	All	MO	173.6	13%	23.0	0.003	0.003	-0.04	0	4.0	4.0	$21	0.15
6006	Electronics	Smart Strip Power Strip - Tier 2	SF	All	MO	432.0	55%	238.0	0.054	0.054	0.00	0	7.0	7.0	$80	0.78
6007	Electronics	Office Multifunction Device	SF	All	MO	573.6	46%	263.3	0.030	0.030	0.00	0	6.0	6.0	$30	1.56
6008	Electronics	Efficient Televisions	MH	All	MO	246.0	64%	158.1	0.234	0.234	0.00	0	6.0	6.0	$10	2.04
6009	Electronics	Energy Star Desktop Computer	MH	All	MO	238.5	32%	76.6	0.023	0.023	0.00	0	4.0	4.0	$20	0.55
6010	Electronics	Energy Star Computer Monitor	MH	All	MO	56.8	25%	14.2	0.001	0.001	0.00	0	5.0	5.0	$3	0.81
6011	Electronics	Energy Star Laptop Computer	MH	All	MO	30.7	25%	7.7	0.001	0.001	0.00	0	4.0	4.0	$3	0.37
6012	Electronics	Smart Strip Power Strip - Tier 1	MH	All	MO	173.6	13%	23.0	0.003	0.003	-0.04	0	4.0	4.0	$21	0.15
6013	Electronics	Smart Strip Power Strip - Tier 2	MH	All	MO	432.0	55%	238.0	0.054	0.054	0.00	0	7.0	7.0	$80	0.78
6014	Electronics	Office Multifunction Device	MH	All	MO	573.6	46%	263.3	0.030	0.030	0.00	0	6.0	6.0	$30	1.56
6015	Electronics	Efficient Televisions	SF	All	NC	246.0	64%	158.1	0.234	0.234	0.00	0	6.0	6.0	$10	2.04
6016	Electronics	Energy Star Desktop Computer	SF	All	NC	238.5	32%	76.6	0.023	0.023	0.00	0	4.0	4.0	$20	0.55
6017	Electronics	Energy Star Computer Monitor	SF	All	NC	56.8	25%	14.2	0.001	0.001	0.00	0	5.0	5.0	$3	0.81
6018	Electronics	Energy Star Laptop Computer	SF	All	NC	30.7	25%	7.7	0.001	0.001	0.00	0	4.0	4.0	$3	0.37
6019	Electronics	Smart Strip Power Strip - Tier 1	SF	All	NC	173.6	13%	23.0	0.003	0.003	-0.04	0	4.0	4.0	$21	0.15
6020	Electronics	Smart Strip Power Strip - Tier 2	SF	All	NC	432.0	55%	238.0	0.054	0.054	0.00	0	7.0	7.0	$80	0.78
6021	Electronics	Office Multifunction Device	*SF*	All	NC	573.6	46%	263.3	0.030	0.030	0.00	0	6.0	6.0	$30	1.56
6022	Electronics	Efficient Televisions	*MH*	All	NC	246.0	64%	158.1	0.234	0.234	0.00	0	6.0	6.0	$10	2.04
6023	Electronics	Energy Star Desktop Computer	MH	All	NC	238.5	32%	76.6	0.023	0.023	0.00	0	4.0	4.0	$20	0.55
6024	Electronics	Energy Star Computer Monitor	MH	All	NC	56.8	25%	14.2	0.001	0.001	0.00	0	5.0	5.0	$3	0.81
6025	Electronics	Energy Star Laptop Computer	MH	All	NC	30.7	25%	7.7	0.001	0.001	0.00	0	4.0	4.0	$3	0.37
6026	Electronics	Smart Strip Power Strip - Tier 1	MH	All	NC	173.6	13%	23.0	0.003	0.003	-0.04	0	4.0	4.0	$21	0.15
6027	Electronics	Smart Strip Power Strip - Tier 2	MH	All	NC	432.0	55%	238.0	0.054	0.054	0.00	0	7.0	7.0	$80	0.78
6028	Electronics	Office Multifunction Device	MH	All	NC	573.6	46%	263.3	0.030	0.030	0.00	0	6.0	6.0	$30	1.56
7001	HVAC Shell	Insulation - Ceiling (R-0 to R-38) - (Elec AC & Gas Heat)	SF	All	Retrofit	6,658.7	40%	2,633.5	3.930	0.407	41.80	0	25.0	25.0	$2,340	2.74
7002	HVAC Shell	Insulation - Ceiling (R-11 to R-49) - (Elec AC & Gas Heat)	SF	All	Retrofit	4,333.7	8%	354.9	0.772	0.083	10.38	0	25.0	25.0	$2,145	0.59

EKPC DSM **Measure Assumptions**

Measure #	End-Use	Measure Name	Home Type	Income Type	Replacement Type	Base Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer NCP kW	Per Unit Winter NCP kW	Per unit NG Saving	Per Unit Water Savings	RC EUL	EE EUL	Initial Measure Cost	TRC Ratio
7003	HVAC Shell	Insulation - Ceiling (R-19 to R-49) - (Elec AC & Gas Heat)	SF	All	Retrofit	4,206.1	5%	227.3	0.455	0.046	6.18	0	25.0	25.0	$1,794	0.43
7004	HVAC Shell	Insulation - Floor (R-0 to R-19) - (Elec AC & Gas Heat)	SF	All	Retrofit	4,015.3	-9%	-364.8	-0.206	0.098	9.18	0	25.0	25.0	$1,268	0.28
7005	HVAC Shell	Insulation - Floor (R-11 to R-30) - (Elec AC & Gas Heat)	SF	All	Retrofit	4,296.4	-3%	-145.9	-0.096	0.029	2.84	0	25.0	25.0	$1,268	0.10
7006	HVAC Shell	Wall Insulation - (Elec AC & Gas Heat)	SF	All	Retrofit	4,862.3	14%	666.0	1.039	0.172	16.82	0	25.0	25.0	$1,920	1.02
7007	HVAC Shell	Basement Wall Insulation - (Elec AC & Gas Heat)	SF	All	Retrofit	4,206.1	3%	130.7	-0.098	0.105	9.61	0	25.0	25.0	$1,360	0.34
7008	HVAC Shell	Energy Star Windows - (Elec AC & Gas Heat)	SF	All	Retrofit	4,206.1	6%	246.8	0.367	0.036	3.18	0	25.0	25.0	$5,624	0.10
7009	HVAC Shell	Air Sealing (Tier 1) - (Elec AC & Gas Heat)	SF	All	Retrofit	4,625.4	5%	246.7	0.340	0.177	15.86	0	15.0	15.0	$605	1.23
7010	HVAC Shell	Air Sealing (Tier 2) - (Elec AC & Gas Heat)	SF	All	Retrofit	4,327.3	8%	359.9	0.476	0.130	12.34	0	15.0	15.0	$605	1.21
7011	HVAC Shell	Duct Sealing - (Elec AC & Gas Heat)	SF	All	Retrofit	4,253.6	10%	425.4	0.300	0.050	6.28	0	20.0	20.0	$330	1.90
7012	HVAC Shell	Cool Roof - (Elec AC & Gas Heat)	SF	All	Retrofit	4,206.1	41%	1,726.6	2.550	-0.043	-3.02	0	25.0	25.0	$2,925	0.83
7013	HVAC Shell	Insulation - Ceiling (R-0 to R-38) - (Elec HP)	SF	All	Retrofit	13,962.0	47%	6,561.3	3.007	5.354	0.00	0	25.0	25.0	$2,340	2.56
7014	HVAC Shell	Insulation - Ceiling (R-11 to R-49) - (Elec HP)	SF	All	Retrofit	8,836.2	18%	1,585.6	0.721	1.260	0.00	0	25.0	25.0	$2,145	0.67
7015	HVAC Shell	Insulation - Ceiling (R-19 to R-49) - (Elec HP)	SF	All	Retrofit	8,027.3	10%	776.7	0.376	0.559	0.00	0	25.0	25.0	$1,794	0.40
7016	HVAC Shell	Insulation - Floor (R-0 to R-19) - (Elec HP)	SF	All	Retrofit	8,448.0	8%	667.6	-0.148	1.377	0.00	0	25.0	25.0	$1,268	0.24
7017	HVAC Shell	Insulation - Floor (R-11 to R-30) - (Elec HP)	SF	All	Retrofit	7,890.2	2%	184.0	-0.064	0.421	0.00	0	25.0	25.0	$1,268	0.05
7018	HVAC Shell	Wall Insulation - (Elec HP)	SF	All	Retrofit	10,518.3	24%	2,555.8	0.864	2.663	0.00	0	25.0	25.0	$1,920	1.10
7019	HVAC Shell	Basement Wall Insulation - (Elec HP)	SF	All	Retrofit	8,027.3	4%	297.4	-0.137	0.648	0.00	0	25.0	25.0	$1,360	0.06
7020	HVAC Shell	Energy Star Windows - (Elec HP)	SF	All	Retrofit	8,027.3	6%	515.0	0.305	0.486	0.00	0	25.0	25.0	$5,624	0.09
7021	HVAC Shell	Air Sealing (Tier 1) - (Elec HP)	SF	All	Retrofit	9,766.5	12%	1,159.3	0.224	1.420	0.00	0	15.0	15.0	$605	0.90
7022	HVAC Shell	Air Sealing (Tier 2) - (Elec HP)	SF	All	Retrofit	8,414.2	9%	774.3	0.201	0.910	0.00	0	15.0	15.0	$605	0.63
7023	HVAC Shell	Duct Sealing - (Elec HP)	SF	All	Retrofit	8,347.3	10%	834.7	0.300	0.970	0.00	0	20.0	20.0	$330	1.77
7024	HVAC Shell	Cool Roof - (Elec HP)	SF	All	Retrofit	8,027.3	21%	1,653.3	1.237	0.926	0.00	0	25.0	25.0	$2,925	0.59
7025	HVAC Shell	Insulation - Ceiling (R-0 to R-38) - (Elec Furnace / AC)	SF	All	Retrofit	25,990.7	48%	12,401.6	3.285	9.041	0.00	0	25.0	25.0	$2,340	4.12
7026	HVAC Shell	Insulation - Ceiling (R-11 to R-49) - (Elec Furnace / AC)	SF	All	Retrofit	16,373.7	19%	3,102.0	0.710	2.120	0.00	0	25.0	25.0	$2,145	1.08
7027	HVAC Shell	Insulation - Ceiling (R-19 to R-49) - (Elec Furnace / AC)	SF	All	Retrofit	14,912.6	11%	1,640.9	0.377	1.012	0.00	0	25.0	25.0	$1,794	0.68
7028	HVAC Shell	Insulation - Floor (R-0 to R-19) - (Elec Furnace / AC)	SF	All	Retrofit	14,912.6	5%	772.6	-0.081	0.933	0.00	0	25.0	25.0	$1,268	0.32
7029	HVAC Shell	Insulation - Floor (R-11 to R-30) - (Elec Furnace / AC)	SF	All	Retrofit	14,490.4	4%	592.4	-0.069	0.738	0.00	0	25.0	25.0	$1,268	0.24
7030	HVAC Shell	Wall Insulation - (Elec Furnace / AC)	SF	All	Retrofit	19,681.6	25%	4,909.0	0.886	4.181	0.00	0	25.0	25.0	$1,920	1.84
7031	HVAC Shell	Basement Wall Insulation - (Elec Furnace / AC)	SF	All	Retrofit	14,912.6	8%	1,157.3	-0.173	1.707	0.00	0	25.0	25.0	$1,360	0.42
7032	HVAC Shell	Energy Star Windows - (Elec Furnace / AC)	SF	All	Retrofit	14,912.6	6%	961.5	0.308	0.851	0.00	0	25.0	25.0	$5,624	0.14
7033	HVAC Shell	Air Sealing (Tier 1) - (Elec Furnace / AC)	SF	All	Retrofit	18,873.6	14%	2,636.1	0.240	2.407	0.00	0	15.0	15.0	$605	1.84
7034	HVAC Shell	Air Sealing (Tier 2) - (Elec Furnace / AC)	SF	All	Retrofit	15,795.5	11%	1,759.5	0.201	1.595	0.00	0	15.0	15.0	$605	1.25
7035	HVAC Shell	Duct Sealing - (Elec Furnace / AC)	SF	All	Retrofit	15,277.2	10%	1,527.7	0.300	0.970	0.00	0	20.0	20.0	$330	2.75
7036	HVAC Shell	Cool Roof - (Elec AC & Gas Heat)	SF	All	Retrofit	14,912.6	4%	606.4	1.305	-0.465	0.00	0	25.0	25.0	$2,925	0.39
7037	HVAC Shell	Insulation - Ceiling (R-0 to R-38) - (Elec AC & Gas Heat)	MH	All	Retrofit	3,029.8	1%	45.4	0.365	0.205	23.84	0	25.0	25.0	$1,613	0.91
7038	HVAC Shell	Energy Star Windows - (Elec AC & Gas Heat)	MH	All	Retrofit	3,047.8	21%	628.8	0.894	0.052	4.40	0	25.0	25.0	$3,507	0.33
7039	HVAC Shell	Air Sealing (Tier 1) - (Elec AC & Gas Heat)	MH	All	Retrofit	3,343.7	6%	197.0	0.243	0.115	10.31	0	15.0	15.0	$417	1.02
7040	HVAC Shell	Air Sealing (Tier 2) - (Elec AC & Gas Heat)	MH	All	Retrofit	3,211.4	6%	200.2	0.261	0.088	8.82	0	15.0	15.0	$417	0.94
7041	HVAC Shell	Duct Sealing - (Elec AC & Gas Heat)	MH	All	Retrofit	3,131.2	10%	313.1	0.300	0.050	4.91	0	20.0	20.0	$296	1.78
7042	HVAC Shell	Insulation - Ceiling (R-0 to R-38) - (Elec HP)	MH	All	Retrofit	9,747.6	33%	3,181.8	0.883	3.266	0.00	0	25.0	25.0	$1,613	1.56
7043	HVAC Shell	Energy Star Windows - (Elec HP)	MH	All	Retrofit	6,911.3	16%	1,080.2	0.890	0.676	0.00	0	25.0	25.0	$3,507	0.35
7044	HVAC Shell	Air Sealing (Tier 1) - (Elec HP)	MH	All	Retrofit	8,039.0	10%	784.3	0.176	0.851	0.00	0	15.0	15.0	$417	0.76
7045	HVAC Shell	Air Sealing (Tier 2) - (Elec HP)	MH	All	Retrofit	7,480.9	9%	681.4	0.189	0.732	0.00	0	15.0	15.0	$417	0.69
7046	HVAC Shell	Duct Sealing - (Elec HP)	MH	All	Retrofit	7,225.3	10%	722.5	0.300	0.970	0.00	0	20.0	20.0	$296	1.81
7047	HVAC Shell	Insulation - Ceiling (R-0 to R-38) - (Elec Furnace / AC)	MH	All	Retrofit	17,588.2	34%	6,021.5	0.433	5.374	0.00	0	25.0	25.0	$1,613	2.40
7048	HVAC Shell	Energy Star Windows - (Elec Furnace / AC)	MH	All	Retrofit	12,318.6	14%	1,679.7	0.889	1.218	0.00	0	25.0	25.0	$3,507	0.45
7049	HVAC Shell	Air Sealing (Tier 1) - (Elec Furnace / AC)	MH	All	Retrofit	14,818.2	12%	1,748.2	0.185	1.575	0.00	0	15.0	15.0	$417	1.50
7050	HVAC Shell	Air Sealing (Tier 2) - (Elec Furnace / AC)	MH	All	Retrofit	13,574.2	11%	1,519.9	0.198	1.343	0.00	0	15.0	15.0	$417	1.33
7051	HVAC Shell	Duct Sealing - (Elec Furnace / AC)	MH	All	Retrofit	12,786.1	10%	1,278.6	0.300	0.970	0.00	0	20.0	20.0	$296	2.70
8001	HVAC Equipment	HVAC Tune-Up (Central AC) (from 10seer to 11 seer)	SF	All	Retrofit	3,753.6	5%	187.7	0.238	0.000	0.00	0	5.0	5.0	$64	0.93
8002	HVAC Equipment	High Efficiency Central AC - 16 SEER from 14 seer	SF	All	MO	2,181.5	14%	312.4	0.436	0.000	0.00	0	18.0	18.0	$533	0.70
8003	HVAC Equipment	High Efficiency Central AC - 17 SEER from 14 seer	SF	All	MO	2,181.5	20%	436.3	0.423	0.000	0.00	0	18.0	18.0	$829	0.50
8004	HVAC Equipment	Ductless mini-split AC replacing central AC (gas)	SF	All	MO	2,181.5	34%	735.8	0.863	0.000	0.00	0	18.0	18.0	$3,913	0.20
8005	HVAC Equipment	HVAC Tune-Up (Heat Pump) (from 10 seer to 11 seer)	SF	All	Retrofit	8,027.3	5%	401.4	0.238	0.351	0.00	0	5.0	5.0	$128	0.73

EKPC DSM **Measure Assumptions**

Measure #	End-Use	Measure Name	Home Type	Income Type	Replacement Type	Base Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer NCP kW	Per Unit Winter NCP kW	Per unit NG Saving	Per Unit Water Savings	RC EUL	EE EUL	Initial Measure Cost	TRC Ratio
8006	HVAC Equipment	High Efficiency Heat Pump (HP Upgrade) - 16 SEER/9.0 HSPF	SF	All	MO	6,455.6	9%	597.0	0.509	0.237	0.00	0	18.0	18.0	$1,097	0.47
8007	HVAC Equipment	High Efficiency Heat Pump (HP Upgrade) - 17 SEER/9.5 HSPF	SF	All	MO	6,455.6	12%	743.3	0.628	0.325	0.00	0	18.0	18.0	$1,645	0.39
8008	HVAC Equipment	Ground Source Heat Pump (HP Upgrade) 18.2 eer from 14 s	SF	All	MO	6,455.6	21%	1,331.5	0.421	1.274	0.00	0	25.0	25.0	$18,391	0.06
8009	HVAC Equipment	Dual Fuel Heat Pump Upgrade (Replacing New ASHP)	SF	All	MO	6,455.6	36%	2,304.5	0.509	2.678	-22.87	0	18.0	18.0	$1,097	0.66
8010	HVAC Equipment	Ductless mini-split HP (replacing ASHP)	SF	All	MO	6,455.6	24%	1,545.4	0.507	0.628	0.00	0	18.0	18.0	$3,125	0.30
8011	HVAC Equipment	Heat Pump (Replacing Electric Furnace and 14 seer AC) - 16	SF	All	MO	14,181.9	59%	8,323.3	0.613	12.605	0.00	0	18.0	18.0	$3,470	1.14
8012	HVAC Equipment	Dual Fuel Heat Pump (Replacing Electric Furnace)	SF	All	MO	14,912.6	72%	10,761.5	1.567	11.655	-22.87	0	18.0	18.0	$4,197	1.10
8013	HVAC Equipment	Ductless mini-split HP (replacing electric furnace)	SF	All	MO	14,912.6	67%	10,002.3	1.445	7.348	0.00	0	18.0	18.0	$4,768	1.09
8014	HVAC Equipment	Efficient Room A/C (11 EER to 11.5 EER)	SF	All	MO	489.9	10%	49.0	0.110	0.000	0.00	0	9.0	9.0	$114	0.25
8015	HVAC Equipment	Ductless mini-split AC seer 16 (from 11eer RAC)	SF	All	MO	489.9	22%	108.5	0.244	0.000	0.00	0	18.0	18.0	$3,307	0.04
8016	HVAC Equipment	Room Air Conditioner Recycling	SF	All	Recycle	693.5	100%	693.5	1.558	0.000	0.00	0	4.0	4.0	$49	1.34
8017	HVAC Equipment	Programmable Thermostat - Gas/AC	SF	All	Retrofit	4,206.1	4%	151.4	0.000	0.000	2.20	0	15.0	15.0	$35	3.44
8018	HVAC Equipment	Programmable Thermostat - ASHP	SF	All	Retrofit	8,027.3	4%	289.0	0.000	0.000	0.00	0	15.0	15.0	$35	2.92
8019	HVAC Equipment	Programmable Thermostat - Elec Furnace/AC	SF	All	Retrofit	14,912.6	4%	536.9	0.000	0.000	0.00	0	15.0	15.0	$35	5.42
8020	HVAC Equipment	Smart Thermostat - Gas Heat / AC	SF	All	Retrofit	4,206.1	5%	227.1	0.000	0.000	3.30	0	15.0	15.0	$250	0.72
8021	HVAC Equipment	Smart Thermostat - ASHP	SF	All	Retrofit	8,027.3	5%	433.5	0.000	0.000	0.00	0	15.0	15.0	$250	0.61
8022	HVAC Equipment	Smart Thermostat - Elec Furnace/AC	SF	All	Retrofit	14,912.6	5%	805.3	0.000	0.000	0.00	0	15.0	15.0	$250	1.14
8023	HVAC Equipment	ECM Furnace Fan	SF	All	Retrofit	5,304.8	8%	408.1	0.187	0.000	0.00	0	20.0	20.0	$97	3.52
8024	HVAC Equipment	HVAC Tune-Up (Central AC) (from 10seer to 11 seer)	MH	All	Retrofit	2,697.3	5%	134.9	0.167	0.000	0.00	0	5.0	5.0	$64	0.67
8025	HVAC Equipment	High Efficiency Central AC - 16 SEER from 14 seer	MH	All	MO	1,957.6	12%	226.7	0.281	0.000	0.00	0	18.0	18.0	$533	0.46
8026	HVAC Equipment	High Efficiency Central AC - 17 SEER from 14 seer	MH	All	MO	1,957.6	18%	361.4	0.483	0.000	0.00	0	18.0	18.0	$829	0.51
8027	HVAC Equipment	Ductless mini-split AC replacing central AC (gas)	MH	All	MO	2,302.8	40%	910.5	0.650	0.000	0.00	0	18.0	18.0	$3,913	0.19
8028	HVAC Equipment	HVAC Tune-Up (Heat Pump) (from 10 seer to 11 seer)	MH	All	Retrofit	6,911.3	5%	345.6	0.167	0.273	0.00	0	5.0	5.0	$128	0.59
8029	HVAC Equipment	High Efficiency Heat Pump (HP Upgrade) - 16 SEER/9.0 HSPF	MH	All	MO	5,541.2	9%	510.0	0.442	0.153	0.00	0	18.0	18.0	$1,097	0.41
8030	HVAC Equipment	High Efficiency Heat Pump (HP Upgrade) - 17 SEER/9.5 HSPF	MH	All	MO	5,541.2	12%	638.9	0.554	0.223	0.00	0	18.0	18.0	$1,645	0.34
8031	HVAC Equipment	Dual Fuel Heat Pump Upgrade (Replacing New ASHP)	MH	All	MO	5,541.2	26%	1,432.5	0.340	1.898	-17.16	0	18.0	18.0	$1,097	0.47
8032	HVAC Equipment	Ductless mini-split HP (replacing ASHP)	MH	All	MO	5,541.2	21%	1,151.3	0.438	0.362	0.00	0	18.0	18.0	$3,125	0.24
8033	HVAC Equipment	Heat Pump (Replacing Electric Furnace and 14 seer AC) - 16	MH	All	MO	11,457.4	56%	6,426.2	0.485	9.549	0.00	0	18.0	18.0	$3,470	0.89
8034	HVAC Equipment	Dual Fuel Heat Pump (Replacing Electric Furnace)	MH	All	MO	12,318.6	67%	8,210.0	1.324	9.372	-17.16	0	18.0	18.0	$4,197	0.89
8035	HVAC Equipment	Ductless mini-split HP (replacing electric furnace)	MH	All	MO	12,318.6	64%	7,928.8	1.316	5.438	0.00	0	18.0	18.0	$4,768	0.88
8036	HVAC Equipment	Efficient Room A/C (11 EER to 11.5 EER)	MH	All	MO	489.9	10%	49.0	0.110	0.000	0.00	0	9.0	9.0	$114	0.25
8037	HVAC Equipment	Ductless mini-split AC seer 16 (from 11eer RAC)	MH	All	MO	489.9	22%	108.5	0.244	0.000	0.00	0	18.0	18.0	$2,480	0.05
8038	HVAC Equipment	Room Air Conditioner Recycling	MH	All	Recycle	693.5	100%	693.5	1.558	0.000	0.00	0	4.0	4.0	$49	1.34
8039	HVAC Equipment	Programmable Thermostat - Gas/AC	MH	All	Retrofit	3,047.8	4%	109.7	0.000	0.000	1.70	0	15.0	15.0	$35	2.59
8040	HVAC Equipment	Programmable Thermostat - ASHP	MH	All	Retrofit	6,911.3	4%	248.8	0.000	0.000	0.00	0	15.0	15.0	$35	2.51
8041	HVAC Equipment	Programmable Thermostat - Elec Furnace/AC	MH	All	Retrofit	12,318.6	4%	443.5	0.000	0.000	0.00	0	15.0	15.0	$35	4.48
8042	HVAC Equipment	Smart Thermostat - Gas Heat / AC	MH	All	Retrofit	3,047.8	5%	164.6	0.000	0.000	2.55	0	15.0	15.0	$250	0.54
8043	HVAC Equipment	Smart Thermostat - ASHP	MH	All	Retrofit	6,911.3	5%	373.2	0.000	0.000	0.00	0	15.0	15.0	$250	0.53
8044	HVAC Equipment	Smart Thermostat - Elec Furnace/AC	MH	All	Retrofit	12,318.6	5%	665.2	0.000	0.000	0.00	0	15.0	15.0	$250	0.94
8045	HVAC Equipment	ECM Furnace Fan	MH	All	Retrofit	5,304.8	8%	408.1	0.187	0.000	0.00	0	20.0	20.0	$97	3.52
8046	HVAC Equipment	High Efficiency Central AC - 16 SEER from 14 seer	SF	All	NC	2,225.9	11%	242.8	0.246	0.000	0.00	0	18.0	18.0	$533	0.44
8047	HVAC Equipment	High Efficiency Central AC - 17 SEER from 14 seer	SF	All	NC	2,225.9	18%	389.9	0.414	0.000	0.00	0	18.0	18.0	$829	0.48
8048	HVAC Equipment	Ductless mini-split AC replacing central AC (gas)	SF	All	NC	2,534.4	40%	1,004.1	0.692	0.000	0.00	0	18.0	18.0	$3,913	0.21
8049	HVAC Equipment	High Efficiency Heat Pump (HP Upgrade) - 16 SEER/9.0 HSPF	SF	All	NC	5,233.8	6%	307.2	0.285	-0.062	0.00	0	18.0	18.0	$1,097	0.25
8050	HVAC Equipment	High Efficiency Heat Pump (HP Upgrade) - 17 SEER/9.5 HSPF	SF	All	NC	5,233.8	9%	449.5	0.400	0.005	0.00	0	18.0	18.0	$1,645	0.24
8051	HVAC Equipment	Ground Source Heat Pump (HP Upgrade) 18.2 eer from 14 s	SF	All	NC	5,233.8	21%	1,121.1	0.355	1.062	0.00	0	25.0	25.0	$18,391	0.05
8052	HVAC Equipment	Dual Fuel Heat Pump Upgrade (Replacing New ASHP)	SF	All	NC	5,233.8	32%	1,683.9	0.285	2.237	-15.71	0	18.0	18.0	$1,097	0.54
8053	HVAC Equipment	Ductless mini-split HP (replacing ASHP)	SF	All	NC	5,233.8	23%	1,220.6	0.402	0.471	0.00	0	18.0	18.0	$3,125	0.24
8054	HVAC Equipment	Efficient Room A/C (11 EER to 11.5 EER)	SF	All	NC	489.9	10%	49.0	0.110	0.000	0.00	0	9.0	9.0	$114	0.25
8055	HVAC Equipment	Ductless mini-split AC seer 16 (from 11eer RAC)	SF	All	NC	489.9	22%	108.5	0.244	0.000	0.00	0	18.0	18.0	$3,307	0.04
8056	HVAC Equipment	Programmable Thermostat - Gas/AC	SF	All	NC	2,534.4	4%	91.2	0.000	0.000	1.48	0	15.0	15.0	$35	2.21
8057	HVAC Equipment	Programmable Thermostat - ASHP	SF	All	NC	5,233.8	4%	188.4	0.000	0.000	0.00	0	15.0	15.0	$35	1.90
8058	HVAC Equipment	Smart Thermostat - Gas Heat / AC	SF	All	NC	2,534.4	5%	136.9	0.000	0.000	2.22	0	15.0	15.0	$250	0.46
8059	HVAC Equipment	Smart Thermostat - ASHP	SF	All	NC	5,233.8	5%	282.6	0.000	0.000	0.00	0	15.0	15.0	$250	0.40

EKPC DSM **Measure Assumptions**

Measure #	End-Use	Measure Name	Home Type	Income Type	Replacement Type	Base Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer NCP kW	Per Unit Winter NCP kW	Per unit NG Saving	Per Unit Water Savings	RC EUL	EE EUL	Initial Measure Cost	TRC Ratio
8060	HVAC Equipment	ECM Furnace Fan	SF	All	NC	4,866.5	7%	361.4	0.160	0.000	0.00	0	20.0	20.0	$97	3.07
8061	HVAC Equipment	High Efficiency Central AC - 16 SEER from 14 seer	MH	All	NC	1,791.3	13%	225.4	0.260	0.000	0.00	0	18.0	18.0	$533	0.44
8062	HVAC Equipment	High Efficiency Central AC - 17 SEER from 14 seer	MH	All	NC	1,791.3	19%	348.0	0.414	0.000	0.00	0	18.0	18.0	$829	0.45
8063	HVAC Equipment	Ductless mini-split AC replacing central AC (gas)	MH	All	NC	1,791.3	29%	522.3	0.564	0.000	0.00	0	18.0	18.0	$3,913	0.13
8064	HVAC Equipment	High Efficiency Heat Pump (HP Upgrade) - 16 SEER/9.0 HSPF	MH	All	NC	4,970.5	8%	422.5	0.372	0.053	0.00	0	18.0	18.0	$1,097	0.33
8065	HVAC Equipment	High Efficiency Heat Pump (HP Upgrade) - 17 SEER/9.5 HSPF	MH	All	NC	4,970.5	11%	537.0	0.467	0.113	0.00	0	18.0	18.0	$1,645	0.28
8066	HVAC Equipment	Dual Fuel Heat Pump Upgrade (Replacing New ASHP)	MH	All	NC	4,970.5	34%	1,695.7	0.372	1.969	-14.17	0	18.0	18.0	$1,097	0.58
8067	HVAC Equipment	Ductless mini-split HP (replacing ASHP)	MH	All	NC	4,970.5	21%	1,022.8	0.361	0.333	0.00	0	18.0	18.0	$3,125	0.20
8068	HVAC Equipment	Efficient Room A/C (11 EER to 11.5 EER)	MH	All	NC	489.9	10%	49.0	0.110	0.000	0.00	0	9.0	9.0	$114	0.25
8069	HVAC Equipment	Ductless mini-split AC seer 16 (from 11eer RAC)	MH	All	NC	489.9	22%	108.5	0.244	0.000	0.00	0	18.0	18.0	$2,480	0.05
8070	HVAC Equipment	Programmable Thermostat - Gas/AC	MH	All	NC	2,093.6	4%	75.4	0.000	0.000	1.45	0	15.0	15.0	$35	2.03
8071	HVAC Equipment	Programmable Thermostat - ASHP	MH	All	NC	2,093.6	4%	75.4	0.000	0.000	0.00	0	15.0	15.0	$35	0.76
8072	HVAC Equipment	Smart Thermostat - Gas Heat / AC	MH	All	NC	2,093.6	5%	113.1	0.000	0.000	2.17	0	15.0	15.0	$250	0.43
8073	HVAC Equipment	Smart Thermostat - ASHP	MH	All	NC	4,970.5	5%	268.4	0.000	0.000	0.00	0	15.0	15.0	$250	0.38
8074	HVAC Equipment	ECM Furnace Fan	MH	All	NC	4,866.5	7%	361.4	0.160	0.000	0.00	0	20.0	20.0	$97	3.07
9001	Lighting	Standard CFL (Replacing EISA Bulb)	SF	All	MO	36.5	67%	24.6	0.031	0.031	-0.04	0	5.0	5.0	$0	9.38
9002	Lighting	Specialty CFL (Replacing Specialty Incandescent)	SF	All	MO	67.2	77%	51.5	0.049	0.049	-0.11	0	5.0	5.0	$1	4.39
9003	Lighting	Standard LED (Replacing EISA Bulb)	SF	All	MO	36.5	85%	30.9	0.038	0.038	-0.05	0	5.0	15.0	$2	5.36
9004	Lighting	Specialty LED (Replacing Specialty Incandescent)	SF	All	MO	67.2	89%	59.8	0.056	0.056	-0.13	0	5.0	15.0	$4	3.89
9005	Lighting	Standard CFL (Replacing CFL)	SF	All	MO	36.5	67%	24.6	0.031	0.031	-0.04	0	5.0	5.0	$0	9.38
9006	Lighting	Specialty CFL (Replacing Specialty CFL)	SF	All	MO	67.2	77%	51.5	0.049	0.049	-0.11	0	5.0	5.0	$1	4.39
9007	Lighting	Standard LED (Replacing CFL)	SF	All	MO	36.5	85%	30.9	0.038	0.038	-0.05	0	5.0	15.0	$2	5.36
9008	Lighting	Specialty LED (Replacing Specialty CFL)	SF	All	MO	67.2	89%	59.8	0.056	0.056	-0.13	0	5.0	15.0	$4	3.89
9009	Lighting	Reflector CFL (Replacing EISA Bulb)	SF	All	MO	72.8	77%	56.0	0.053	0.053	-0.12	0	5.0	5.0	$2	3.74
9010	Lighting	Reflector LED (Replacing EISA Bulb)	SF	All	MO	72.8	87%	63.4	0.060	0.060	-0.14	0	5.0	15.0	$7	3.47
9011	Lighting	Reflector CFL (Replacing CFL)	SF	All	MO	72.8	77%	56.0	0.053	0.053	-0.12	0	5.0	5.0	$2	3.74
9012	Lighting	Reflector LED (Replacing CFL Bulb)	SF	All	MO	72.8	87%	63.4	0.060	0.060	-0.14	0	5.0	15.0	$7	3.47
9013	Lighting	T8 Replacing T12 Linear Fluorescent Bulb	SF	All	Retrofit	70.1	29%	20.6	0.025	0.025	0.00	0	8.0	8.0	$60	0.10
9014	Lighting	Residential Occupancy Sensors	SF	All	Retrofit	486.2	30%	145.9	0.093	0.093	0.00	0	10.0	10.0	$30	1.53
9015	Lighting	LED Nightlights	SF	All	Retrofit	14.6	93%	13.6	0.005	0.005	0.00	0	16.0	16.0	$3	1.80
9016	Lighting	Standard CFL (Replacing EISA Bulb)	SF	All	NC	36.5	67%	24.6	0.031	0.031	-0.04	0	5.0	5.0	$0	9.38
9017	Lighting	Specialty CFL (Replacing Specialty Incandescent)	SF	All	NC	67.2	77%	51.5	0.049	0.049	-0.11	0	5.0	5.0	$1	4.39
9018	Lighting	Standard LED (Replacing EISA Bulb)	SF	All	NC	36.5	85%	30.9	0.038	0.038	-0.05	0	5.0	15.0	$2	5.36
9019	Lighting	Specialty LED (Replacing Specialty Incandescent)	SF	All	NC	67.2	89%	59.8	0.056	0.056	-0.13	0	5.0	15.0	$4	3.89
9020	Lighting	Standard CFL (Replacing CFL)	SF	All	NC	36.5	67%	24.6	0.031	0.031	-0.04	0	5.0	5.0	$0	9.38
9021	Lighting	Specialty CFL (Replacing Specialty CFL)	SF	All	NC	67.2	77%	51.5	0.049	0.049	-0.11	0	5.0	5.0	$1	4.39
9022	Lighting	Standard LED (Replacing CFL)	SF	All	NC	36.5	85%	30.9	0.038	0.038	-0.05	0	5.0	15.0	$2	5.36
9023	Lighting	Specialty LED (Replacing Specialty CFL)	SF	All	NC	67.2	89%	59.8	0.056	0.056	-0.13	0	5.0	15.0	$4	3.89
9024	Lighting	Reflector CFL (Replacing EISA Bulb)	SF	All	NC	72.8	77%	56.0	0.053	0.053	-0.12	0	5.0	5.0	$2	3.74
9025	Lighting	Reflector LED (Replacing EISA Bulb)	SF	All	NC	72.8	87%	63.4	0.060	0.060	-0.14	0	5.0	15.0	$7	3.47
9026	Lighting	Reflector CFL (Replacing CFL)	SF	All	NC	72.8	77%	56.0	0.053	0.053	-0.12	0	5.0	5.0	$2	3.74
9027	Lighting	Reflector LED (Replacing CFL Bulb)	SF	All	NC	72.8	87%	63.4	0.060	0.060	-0.14	0	5.0	15.0	$7	3.47
9028	Lighting	Residential Occupancy Sensors	SF	All	NC	486.2	30%	145.9	0.093	0.093	0.00	0	10.0	10.0	$30	1.53
9029	Lighting	Standard CFL (Replacing EISA Bulb)	MF	All	MO	36.5	67%	24.6	0.031	0.031	-0.04	0	5.0	5.0	$0	9.38
9030	Lighting	Specialty CFL (Replacing Specialty Incandescent)	MF	All	MO	67.2	77%	51.5	0.049	0.049	-0.11	0	5.0	5.0	$1	4.39
9031	Lighting	Standard LED (Replacing EISA Bulb)	MF	All	MO	36.5	85%	30.9	0.038	0.038	-0.05	0	5.0	15.0	$2	5.36
9032	Lighting	Specialty LED (Replacing Specialty Incandescent)	MF	All	MO	67.2	89%	59.8	0.056	0.056	-0.13	0	5.0	15.0	$4	3.89
9033	Lighting	Standard CFL (Replacing CFL)	MF	All	MO	36.5	67%	24.6	0.031	0.031	-0.04	0	5.0	5.0	$0	9.38
9034	Lighting	Specialty CFL (Replacing Specialty CFL)	MF	All	MO	67.2	77%	51.5	0.049	0.049	-0.11	0	5.0	5.0	$1	4.39
9035	Lighting	Standard LED (Replacing CFL)	MF	All	MO	36.5	85%	30.9	0.038	0.038	-0.05	0	5.0	15.0	$2	5.36
9036	Lighting	Specialty LED (Replacing Specialty CFL)	MF	All	MO	67.2	89%	59.8	0.056	0.056	-0.13	0	5.0	15.0	$4	3.89
9037	Lighting	Reflector CFL (Replacing EISA Bulb)	MF	All	MO	72.8	77%	56.0	0.053	0.053	-0.12	0	5.0	5.0	$2	3.74
9038	Lighting	Reflector LED (Replacing EISA Bulb)	MF	All	MO	72.8	87%	63.4	0.060	0.060	-0.14	0	5.0	15.0	$7	3.47
9039	Lighting	Reflector CFL (Replacing CFL)	MF	All	MO	72.8	77%	56.0	0.053	0.053	-0.12	0	5.0	5.0	$2	3.74

EKPC DSM — **Measure Assumptions**

Measure #	End-Use	Measure Name	Home Type	Income Type	Replacement Type	Base Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer NCP kW	Per Unit Winter NCP kW	Per unit NG Saving	Per Unit Water Savings	RC EUL	EE EUL	Initial Measure Cost	TRC Ratio
9040	Lighting	Reflector LED (Replacing CFL Bulb)	MF	All	MO	72.8	87%	63.4	0.060	0.060	-0.14	0	5.0	15.0	$7	3.47
9041	Lighting	T8 Replacing T12 Linear Fluorescent Bulb	MF	All	Retrofit	70.1	29%	20.6	0.025	0.025	0.00	0	8.0	8.0	$60	0.10
9042	Lighting	Residential Occupancy Sensors	MF	All	Retrofit	486.2	30%	145.9	0.093	0.093	0.00	0	10.0	10.0	$30	1.53
9043	Lighting	LED Nightlights	MF	All	Retrofit	14.6	93%	13.6	0.005	0.005	0.00	0	16.0	16.0	$3	1.80
9044	Lighting	Standard CFL (Replacing EISA Bulb)	MF	All	NC	36.5	67%	24.6	0.031	0.031	-0.04	0	5.0	5.0	$0	9.38
9045	Lighting	Specialty CFL (Replacing Specialty Incandescent)	MF	All	NC	67.2	77%	51.5	0.049	0.049	-0.11	0	5.0	5.0	$1	4.39
9046	Lighting	Standard LED (Replacing EISA Bulb)	MF	All	NC	36.5	85%	30.9	0.038	0.038	-0.05	0	5.0	15.0	$2	5.36
9047	Lighting	Specialty LED (Replacing Specialty Incandescent)	MF	All	NC	67.2	89%	59.8	0.056	0.056	-0.13	0	5.0	15.0	$4	3.89
9048	Lighting	Standard CFL (Replacing CFL)	MF	All	NC	36.5	67%	24.6	0.031	0.031	-0.04	0	5.0	5.0	$0	9.38
9049	Lighting	Specialty CFL (Replacing Specialty CFL)	MF	All	NC	67.2	77%	51.5	0.049	0.049	-0.11	0	5.0	5.0	$1	4.39
9050	Lighting	Standard LED (Replacing CFL)	MF	All	NC	36.5	85%	30.9	0.038	0.038	-0.05	0	5.0	15.0	$2	5.36
9051	Lighting	Specialty LED (Replacing Specialty CFL)	MF	All	NC	67.2	89%	59.8	0.056	0.056	-0.13	0	5.0	15.0	$4	3.89
9052	Lighting	Reflector CFL (Replacing EISA Bulb)	MF	All	NC	72.8	77%	56.0	0.053	0.053	-0.12	0	2.0	5.0	$2	3.74
9053	Lighting	Reflector LED (Replacing EISA Bulb)	MF	All	NC	72.8	87%	63.4	0.060	0.060	-0.14	0	2.0	15.0	$7	3.47
9054	Lighting	Reflector CFL (Replacing CFL)	MF	All	NC	72.8	77%	56.0	0.053	0.053	-0.12	0	5.0	5.0	$2	3.74
9055	Lighting	Reflector LED (Replacing CFL Bulb)	MF	All	NC	72.8	87%	63.4	0.060	0.060	-0.14	0	5.0	15.0	$7	3.47
9056	Lighting	Residential Occupancy Sensors	MF	All	NC	486.2	30%	145.9	0.093	0.093	0.00	0	10.0	10.0	$30	1.53
10001	New Construction	New Construction - 15% more efficient (w/AC only)	SF	All	NC	12,067.5	15%	1,810.1	0.367	0.072	6.17	0	20.0	20.0	$990	1.01
10002	New Construction	New Construction - 15% more efficient (w/Elec. HP)	SF	All	NC	14,766.1	15%	2,214.9	0.321	0.659	0.00	0	20.0	20.0	$761	0.97
10003	New Construction	New Construction - 30% more efficient (w/AC only)	SF	All	NC	12,067.5	30%	3,620.3	0.733	0.144	12.34	0	20.0	20.0	$1,980	1.28
10004	New Construction	New Construction - 30% more efficient (w/Elec. HP)	SF	All	NC	14,766.1	30%	4,429.8	0.643	1.318	0.00	0	20.0	20.0	$1,522	1.59
10005	New Construction	New Construction - 15% more efficient (w/AC only)	MH	All	NC	9,870.7	15%	1,480.6	0.331	0.062	6.04	0	20.0	20.0	$990	0.87
10006	New Construction	New Construction - 15% more efficient (w/Elec. HP)	MH	All	NC	12,747.2	15%	1,912.1	0.307	0.601	0.00	0	20.0	20.0	$761	0.84
10007	New Construction	New Construction - 30% more efficient (w/AC only)	MH	All	NC	9,870.7	30%	2,961.2	0.663	0.124	12.08	0	20.0	20.0	$1,980	1.10
10008	New Construction	New Construction - 30% more efficient (w/Elec. HP)	MH	All	NC	12,747.2	30%	3,824.2	0.614	1.202	0.00	0	20.0	20.0	$1,522	1.39
11001	Pool/Spa	Two Speed Pool Pumps	SF	All	MO	1,363.5	32%	436.3	1.341	1.341	0.00	0	10.0	10.0	$235	3.29
11002	Pool/Spa	Variable Speed Pool Pumps	SF	All	MO	1,363.5	86%	1,172.6	2.068	2.068	0.00	0	10.0	10.0	$549	2.39
11003	Pool/Spa	Premium Efficiency Pool Pump Motor	SF	All	MO	1,363.5	30%	404.3	0.674	0.674	0.00	0	10.0	10.0	$50	8.64
11004	Pool/Spa	Two Speed Pool Pumps	MH	All	NC	1,363.5	32%	436.3	1.341	1.341	0.00	0	10.0	10.0	$235	3.29
11005	Pool/Spa	Variable Speed Pool Pumps	MH	All	NC	1,363.5	86%	1,172.6	2.068	2.068	0.00	0	10.0	10.0	$549	2.39
11006	Pool/Spa	Premium Efficiency Pool Pump Motor	MH	All	NC	1,363.5	30%	404.3	0.674	0.674	0.00	0	10.0	10.0	$50	8.64
11007	Pool/Spa	Two Speed Pool Pumps	SF	All	MO	1,363.5	32%	436.3	1.341	1.341	0.00	0	10.0	10.0	$235	3.29
11008	Pool/Spa	Variable Speed Pool Pumps	SF	All	MO	1,363.5	86%	1,172.6	2.068	2.068	0.00	0	10.0	10.0	$549	2.39
11009	Pool/Spa	Premium Efficiency Pool Pump Motor	SF	All	MO	1,363.5	30%	404.3	0.674	0.674	0.00	0	10.0	10.0	$50	8.64
11010	Pool/Spa	Two Speed Pool Pumps	MH	All	NC	1,363.5	32%	436.3	1.341	1.341	0.00	0	10.0	10.0	$235	3.29
11011	Pool/Spa	Variable Speed Pool Pumps	MH	All	NC	1,363.5	86%	1,172.6	2.068	2.068	0.00	0	10.0	10.0	$549	2.39
11012	Pool/Spa	Premium Efficiency Pool Pump Motor	MH	All	NC	1,363.5	30%	404.3	0.674	0.674	0.00	0	10.0	10.0	$50	8.64
12001	Water Heating	Low Flow Faucet Aerators	SF	All	Retrofit	3,460.0	1%	29.7	0.012	0.012	0.00	469	10.0	10.0	$2	26.62
12002	Water Heating	Low Flow Showerhead	SF	All	Retrofit	3,460.0	5%	168.4	0.067	0.067	0.00	1,641	10.0	10.0	$19	11.02
12003	Water Heating	Thermostatic Restriction Valve	SF	All	Retrofit	3,460.0	2%	80.1	0.032	0.032	0.00	859	10.0	10.0	$50	2.17
12004	Water Heating	Water Heater Blanket	SF	All	Retrofit	3,460.0	2%	79.0	0.009	0.009	0.00	0	5.0	5.0	$35	0.42
12005	Water Heating	Water Heater Pipe Wrap	SF	All	Retrofit	3,460.0	4%	134.0	0.015	0.015	0.00	0	15.0	15.0	$45	1.40
12006	Water Heating	Heat Pump Water Heater (resistance heat)	SF	All	MO	3,460.0	14%	499.0	0.197	0.197	0.00	0	10.0	10.0	$700	0.21
12007	Water Heating	Heat Pump Water Heater (ASHP heat)	SF	All	MO	3,460.0	37%	1,297.0	0.512	0.512	0.00	0	10.0	10.0	$700	0.54
12008	Water Heating	Heat Pump Water Heater (non-electric heat)	SF	All	MO	3,460.0	60%	2,076.0	0.820	0.820	-7.38	0	10.0	10.0	$700	0.71
12009	Water Heating	CO2 Heat Pump Water Heater	SF	All	MO	3,460.0	66%	2,283.6	0.902	0.902	0.00	0	10.0	10.0	$3,800	0.18
12010	Water Heating	Solar Water Heating	SF	All	MO	3,460.0	64%	2,207.0	1.833	1.833	0.00	0	10.0	20.0	$9,506	0.14
12011	Water Heating	Drain Water Heat Recovery	SF	All	Retrofit	3,460.0	6%	208.0	0.033	0.033	0.00	0	20.0	20.0	$1,022	0.10
12012	Water Heating	Low Flow Faucet Aerators	MH	All	Retrofit	3,460.0	1%	29.7	0.012	0.012	0.00	469	10.0	10.0	$2	26.62
12013	Water Heating	Low Flow Showerhead	MH	All	Retrofit	3,460.0	5%	168.4	0.067	0.067	0.00	1,641	10.0	10.0	$19	11.02
12014	Water Heating	Thermostatic Restriction Valve	MH	All	Retrofit	3,460.0	2%	80.1	0.032	0.032	0.00	859	10.0	10.0	$50	2.17
12015	Water Heating	Water Heater Blanket	MH	All	Retrofit	3,460.0	2%	79.0	0.009	0.009	0.00	0	5.0	5.0	$35	0.42
12016	Water Heating	Water Heater Pipe Wrap	MH	All	Retrofit	3,460.0	4%	134.0	0.015	0.015	0.00	0	15.0	15.0	$45	1.40
12017	Water Heating	Heat Pump Water Heater (resistance heat)	MH	All	MO	3,460.0	14%	499.0	0.197	0.197	0.00	0	10.0	10.0	$700	0.21

EKPC DSM **Measure Assumptions**

Measure #	End-Use	Measure Name	Home Type	Income Type	Replacement Type	Base Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer NCP kW	Per Unit Winter NCP kW	Per unit NG Saving	Per Unit Water Savings	RC EUL	EE EUL	Initial Measure Cost	TRC Ratio
12018	Water Heating	Heat Pump Water Heater (ASHP heat)	MH	All	MO	3,460.0	37%	1,297.0	0.512	0.512	0.00	0	10.0	10.0	$700	0.54
12019	Water Heating	Heat Pump Water Heater (non-electric heat)	MH	All	MO	3,460.0	60%	2,076.0	0.820	0.820	-7.38	0	10.0	10.0	$700	0.71
12020	Water Heating	CO2 Heat Pump Water Heater	MH	All	MO	3,460.0	66%	2,283.6	0.902	0.902	0.00	0	10.0	10.0	$3,800	0.18
12021	Water Heating	Solar Water Heating	MH	All	MO	3,460.0	64%	2,207.0	1.833	1.833	0.00	0	10.0	20.0	$9,506	0.14
12022	Water Heating	Drain Water Heat Recovery	MH	All	Retrofit	3,460.0	6%	208.0	0.033	0.033	0.00	0	20.0	20.0	$1,022	0.10
12023	Water Heating	Low Flow Faucet Aerators	SF	All	NC	3,460.0	1%	29.7	0.012	0.012	0.00	469	10.0	10.0	$2	26.62
12024	Water Heating	Low Flow Showerhead	SF	All	NC	3,460.0	5%	168.4	0.067	0.067	0.00	1,641	10.0	10.0	$19	11.02
12025	Water Heating	Thermostatic Restriction Valve	SF	All	NC	3,460.0	2%	80.1	0.032	0.032	0.00	859	10.0	10.0	$50	2.17
12026	Water Heating	Water Heater Blanket	SF	All	NC	3,460.0	2%	79.0	0.009	0.009	0.00	0	5.0	5.0	$35	0.42
12027	Water Heating	Water Heater Pipe Wrap	SF	All	NC	3,460.0	4%	134.0	0.015	0.015	0.00	0	15.0	15.0	$45	1.40
12028	Water Heating	Heat Pump Water Heater (resistance heat)	SF	All	NC	3,460.0	14%	499.0	0.197	0.197	0.00	0	10.0	10.0	$700	0.21
12029	Water Heating	Heat Pump Water Heater (ASHP heat)	SF	All	NC	3,460.0	37%	1,297.0	0.512	0.512	0.00	0	10.0	10.0	$700	0.54
12030	Water Heating	Heat Pump Water Heater (non-electric heat)	SF	All	NC	3,460.0	60%	2,076.0	0.820	0.820	-7.38	0	10.0	10.0	$700	0.71
12031	Water Heating	CO2 Heat Pump Water Heater	SF	All	NC	3,460.0	66%	2,283.6	0.902	0.902	0.00	0	10.0	10.0	$3,800	0.18
12032	Water Heating	Solar Water Heating	SF	All	NC	3,460.0	64%	2,207.0	1.833	1.833	0.00	0	10.0	20.0	$9,506	0.14
12033	Water Heating	Drain Water Heat Recovery	SF	All	NC	3,460.0	6%	208.0	0.033	0.033	0.00	0	20.0	20.0	$1,022	0.10
12034	Water Heating	Low Flow Faucet Aerators	MH	All	NC	3,460.0	1%	29.7	0.012	0.012	0.00	469	10.0	10.0	$2	26.62
12035	Water Heating	Low Flow Showerhead	MH	All	NC	3,460.0	5%	168.4	0.067	0.067	0.00	1,641	10.0	10.0	$19	11.02
12036	Water Heating	Thermostatic Restriction Valve	MH	All	NC	3,460.0	2%	80.1	0.032	0.032	0.00	859	10.0	10.0	$50	2.17
12037	Water Heating	Water Heater Blanket	MH	All	NC	3,460.0	2%	79.0	0.009	0.009	0.00	0	5.0	5.0	$35	0.42
12038	Water Heating	Water Heater Pipe Wrap	MH	All	NC	3,460.0	4%	134.0	0.015	0.015	0.00	0	15.0	15.0	$45	1.40
12039	Water Heating	Heat Pump Water Heater (resistance heat)	MH	All	NC	3,460.0	14%	499.0	0.197	0.197	0.00	0	10.0	10.0	$700	0.21
12040	Water Heating	Heat Pump Water Heater (ASHP heat)	MH	All	NC	3,460.0	37%	1,297.0	0.512	0.512	0.00	0	10.0	10.0	$700	0.54
12041	Water Heating	Heat Pump Water Heater (non-electric heat)	MH	All	NC	3,460.0	60%	2,076.0	0.820	0.820	-7.38	0	10.0	10.0	$700	0.71
12042	Water Heating	CO2 Heat Pump Water Heater	MH	All	NC	3,460.0	66%	2,283.6	0.902	0.902	0.00	0	10.0	10.0	$3,800	0.18
12043	Water Heating	Solar Water Heating	MH	All	NC	3,460.0	64%	2,207.0	1.833	1.833	0.00	0	10.0	20.0	$9,506	0.14
12044	Water Heating	Drain Water Heat Recovery	MH	All	NC	3,460.0	6%	208.0	0.033	0.033	0.00	0	20.0	20.0	$1,022	0.10

APPENDIX C. Commercial Measure Detail

Measure Number	End Use	Measure Name	Annual kWh Saved	Percent Savings (kWh)	Summer KW Savings	Incremental Cost	Measure Useful Life	TRC
1	Interior Lighting	Compact Fluorescent	199	68%	0.036	$1	2	21.18
2	Interior Lighting	LED Exit Sign	89	82%	0.012	$30	16	3.37
3	Interior Lighting	High Performance T8 (vs T8) 4ft	46	17%	0.009	$18	15	2.25
4	Interior Lighting	Wall Mounted Occupancy Sensor	335	24%	0.068	$51	8	1.43
5	Interior Lighting	Fixture Mounted Occupancy Sensor	198	24%	0.040	$92	8	0.47
6	Interior Lighting	Remote Mounted Occupancy Sensor	568	24%	0.116	$101	8	1.23
7	Interior Lighting	High Bay 4 lamp HPT8 vs (Metal Halide 250W)	677	50%	0.138	$200	15	1.74
8	Interior Lighting	High Bay 8 lamp HPT8 vs (Metal Halide 400W)	1,492	53%	0.304	$250	15	3.07
9	Interior Lighting	High performance T5 (replacing T8)	238	22%	0.048	$100	15	1.23
10	Interior Lighting	CFL Hard Wired Fixture	199	69%	0.041	$38	12	2.26
11	Interior Lighting	CFL High Wattage 31-115	383	55%	0.078	$21	3	2.72
12	Interior Lighting	CFL High Wattage 150-199	1,088	58%	0.221	$57	3	2.60
13	Interior Lighting	Low Bay LED (vs T8HO)	306	42%	0.062	$331	15	0.48
14	Interior Lighting	High Bay LED (vs T8HO)	472	35%	0.096	$482	15	0.50
22	Interior Lighting	Switching Controls for Multi-Level Lighting	8,155	20%	1.407	$274	8	13.63
23	Interior Lighting	Central Lighting Controls	4,077	10%	0.704	$103	8	12.08
17	Interior Lighting	LED Screw-In Bulb	254	64%	0.043	$1	15	103.08
18	Interior Lighting	LED Downlight Fixtures	168	68%	0.034	$27	15	3.21
19	Interior Lighting	LED Linear Replacement Lamps	68	44%	0.014	$24	15	1.47
20	Interior Lighting	Light Tube	250	10%	0.000	$500	10	0.23
21	Interior Lighting	Lighting Power Density Reduction (NC)	2,669	10%	0.490	$220	15	9.09
15	Exterior Lighting	Outdoor LED (vs 100W Metal Halide)	348	63%	0.000	$190	15	2.48
16	Exterior Lighting	Outdoor LED (vs 250W Metal Halide)	792	57%	0.000	$355	15	1.73
24	Space Cooling - Unitary / Split	Split AC (14 SEER to 14.5 SEER), 5 ton	174	3%	0.109	$315	15	0.51
25	Space Cooling - Unitary / Split	Split AC (14 SEER to 15 SEER), 5 ton	337	7%	0.211	$315	15	0.98
26	Space Cooling - Unitary / Split	Split AC (14 SEER to 16 SEER), 5 ton	632	13%	0.396	$635	15	0.91
27	Space Cooling - Unitary / Split	Split AC (11.4 IEER to 13 IEER), 8.3 ton	1,274	12%	0.799	$523	15	2.24
28	Space Cooling - Unitary / Split	Split AC (11.4 IEER to 14 IEER), 8.3 ton	1,922	19%	1.206	$1,054	15	1.67
29	Space Cooling - Unitary / Split	Split AC (11.4 IEER to 15 IEER), 8.3 ton	2,484	24%	1.558	$1,054	15	2.16
30	Space Cooling - Unitary / Split	DX Packaged System (CEE Tier 2), 10 ton	2,382	19%	1.494	$1,270	15	1.72
31	Space Cooling - Unitary / Split	DX Packaged System (CEE Tier 2), < 20 ton	2,971	15%	1.863	$1,905	15	1.43
32	Space Cooling - Unitary / Split	DX Packaged System (CEE Tier 2), > 20 ton	7,802	18%	4.893	$3,810	15	1.88
51	Space Cooling - Unitary / Split	Integrated Building Design - Cooling	54,634	30%	12.834	$29,640	15	0.63
52	Space Cooling - Unitary / Split	Commercial Window Film - Cooling	143	5%	0.034	$67	10	0.53
35	Space Cooling - Unitary / Split	PTAC, 1/2 ton	200	23%	0.082	$42	15	3.42
36	Space Cooling - Unitary / Split	PTAC, 3/4 ton	254	22%	0.103	$63	15	2.88
37	Space Cooling - Unitary / Split	PTAC, 1 ton	359	23%	0.146	$84	15	2.75
38	Space Cooling - Unitary / Split	PTAC, 1 1/4 ton	422	20%	0.172	$105	15	1.87
39	Space Cooling - Unitary / Split	HVAC Tune-up, 5 Ton	354	7%	0.222	$175	3	0.37
40	Space Cooling - Unitary / Split	Ground Source Heat Pump, 5 Ton - Cooling	23	5%	0.014	$375	15	0.06
41	Space Cooling - Unitary / Split	Water Source Heat Pump, 5 Ton - Cooling	50	11%	0.031	$375	15	0.12
53	Space Cooling - Unitary / Split	High Performance Glazing - Cooling	1	6%	0.047	$14	20	0.04
43	Space Cooling - Unitary / Split	High Efficiency Pumps	201	8%	0.043	$68	15	1.55
44	Space Cooling - Unitary / Split	Cool Roof - Cooling	181	15%	0.091	$499	20	0.16
45	Space Cooling - Unitary / Split	Roof Insulation - Cooling	0	2%	0.000	$1	20	0.03
46	Space Cooling - Unitary / Split	Programable Thermostats - Cooling	960	10%	0.000	$45	4	2.51
47	Space Cooling - Unitary / Split	Hotel Guest Room Occupancy Control System - Cool	30	30%	0.015	$65	15	0.16
48	Space Cooling - Unitary / Split	EMS Installation - Michigan - Cooling	211	10%	0.011	$2	15	40.74
49	Space Cooling - Unitary / Split	Retrocommisioning - Cooling	1	9%	0.000	$0	15	7.85
50	Space Cooling - Unitary / Split	Commissioning - Cooling	2	9%	0.000	$0	15	3.58
33	Space Cooling - Chillers	Air Cooled Chiller, 20 ton	5,761	13%	2.428	$2,540	20	2.14
34	Space Cooling - Chillers	Air Cooled Chiller, 100 ton	28,806	13%	12.140	$12,700	20	2.14
42	Space Cooling - Chillers	Chiller Tune-up/Diagnostics, 100 Ton	16,193	8%	15.403	$283	5	22.10
140	Space Cooling - Chillers	Water Cooled Screw Chiller, 200 ton	69,518	9%	3.658	$7,952	20	8.25
141	Space Cooling - Chillers	Water Cooled Screw Chiller, 1000 ton	668,164	20%	74.215	$55,870	20	11.28
142	Space Cooling - Chillers	Water-Side Economizer - 200 Tons	209,500	70%	0.000	$10,000	15	7.14
54	Space Heating	PTHP, 1/2 ton	1,065	51%	0.057	$42	15	3.20
55	Space Heating	PTHP, 3/4 ton	1,299	49%	0.063	$63	15	7.48
56	Space Heating	PTHP, 1 ton	1,782	49%	0.099	$84	15	7.72
57	Space Heating	PTHP, 1 1/4 ton	2,144	46%	0.112	$105	15	7.42
58	Space Heating	Ground Source Heat Pump - Heating	329	0%	0.206	$375	15	0.36
59	Space Heating	Water Source Heat Pump - Heating	29	0%	0.018	$375	15	0.03
60	Space Heating	Cool Roof - Heating	91	15%	0.062	$499	20	0.08
61	Space Heating	Roof Insulation - Heating	0	2%	0.000	$1	20	0.02
62	Space Heating	Programable Thermostats - Heating	1,439	10%	0.000	$136	4	1.31
63	Space Heating	Hotel Guest Room Occupancy Control System - Heating	45	30%	0.022	$195	15	0.08
64	Space Heating	EMS Installation - Heating	106	10%	0.005	$2	15	7.38
65	Space Heating	Retrocommisioning - Heating	1	9%	0.000	$0	15	1.42
66	Space Heating	Commissioning - Heating	3	9%	0.000	$0	15	2.49
67	Space Heating	Integrated Building Design - Heating	81,891	30%	19.237	$111,149	15	0.26

Measure Number	End Use	Measure Name	Annual kWh Saved	Percent Savings (kWh)	Summer KW Savings	Incremental Cost	Measure Useful Life	TRC
68	Space Heating	Commercial Window Film - Heating	214	5%	0.051	$200	10	0.28
69	Space Heating	High Performance Glazing - Heating	2	6%	0.071	$41	20	0.02
70	Ventilation	VFD Supply and Return Fans, < 2 HP	2,497	30%	0.369	$1,330	15	0.67
71	Ventilation	VFD Supply and Return Fans, <3 to 10 HP	6,242	30%	0.922	$1,622	15	1.36
72	Ventilation	VFD Supply and Return Fans, 11 to 50 HP	37,450	30%	5.530	$3,059	15	4.34
73	Ventilation	Enthalpy Economizer	3,500	20%	0.000	$400	10	2.26
74	Ventilation	Improved Duct Sealing	70	23%	0.000	$108	18	0.47
75	Ventilation	Electronically-Commutated Permanent Magnet Motors	50,342	65%	0.000	$3,059	15	5.83
76	Ventilation	Destratification Fans	758	50%	0.000	$133	10	1.48
77	Ventilation	Demand Controlled Ventilation	718	1%	0.200	$115	15	232.94
78	Water Heating	High Efficiency Storage (tank)	9	0%	0.000	$70	15	0.04
79	Water Heating	Pre-Rinse Sprayer, Low flow, Commercial Application re	1,284	20%	0.000	$93	5	2.07
80	Water Heating	On Demand (tankless)	7,905	7%	0.000	$1,050	5	1.12
81	Water Heating	Tank Insulation	468	91%	0.053	$2	15	74.96
82	Water Heating	Heat Pump Water Heater	2,124	59%	0.000	$433	10	1.27
83	Refrigeration	Glass Door Freezer, <15-49 cu ft, Energy Star	3,595	43%	0.000	$166	12	6.39
84	Refrigeration	Glass Door Freezer, 50+ cu ft, Energy Star	9,804	45%	0.000	$407	12	7.10
85	Refrigeration	Solid Door Freezer, <15-49 cu ft, Energy Star	1,489	36%	0.000	$166	12	2.65
86	Refrigeration	Solid Door Freezer, 50+ cu ft, Energy Star	5,322	46%	0.000	$407	12	3.86
87	Refrigeration	Glass Door Refrigerator, <15 - 49 cu ft, Energy Star	828	36%	0.000	$164	12	1.49
88	Refrigeration	Glass Door Refrigerator, 50+ cu ft, Energy Star	1,577	35%	0.000	$249	12	1.87
89	Refrigeration	Solid Door Refrigerator, <15-49 cu ft, Energy Star	635	38%	0.000	$164	12	1.14
90	Refrigeration	Solid Door Refrigerator, 50+ cu ft, Energy Star	1,675	48%	0.000	$249	12	1.98
91	Refrigeration	Commercial Refrigeration Tune-Up, Medium Temp ,not	537	7%	0.099	$75	1	0.24
92	Refrigeration	Commercial Refrigeration Tune-Up, Low Temp, not self	1,388	7%	0.191	$75	1	0.63
93	Refrigeration	Anti-sweat heater controls on freezers	2,557	75%	0.000	$200	12	3.77
94	Refrigeration	Anti-sweat heater controls, on refrigerators	1,082	67%	0.000	$200	12	1.60
95	Refrigeration	Vending Miser, Cold Beverage	1,612	46%	0.000	$216	5	1.11
96	Refrigeration	Brushless DC Motors (ECM) for freezers and coolers	1,064	9%	0.121	$177	15	2.11
97	Refrigeration	Humidity Door Heater Controls for freezers and coolers	1,820	71%	0.000	$200	12	2.68
98	Refrigeration	Refrigerated Case Covers	945	9%	0.000	$252	5	0.55
99	Refrigeration	Zero Energy Doors for freezers and coolers	1,360	20%	0.131	$290	10	1.20
100	Refrigeration	Evaporator Coil Defrost Control	197	30%	0.405	$500	10	0.10
101	Refrigeration	Evaporator Fan Motor Control for freezers and coolers	1,524	36%	0.174	$291	16	1.94
102	Refrigeration	Ice Machine, Energy Star, Self-Contained	263	7%	0.041	$56	9	1.11
103	Refrigeration	LED Case Lighting (retrofit)	437	45%	0.000	$250	8	0.38
104	Refrigeration	Efficient Refrigeration Condenser	120	2%	0.000	$35	15	1.20
105	Refrigeration	Efficient low-temp compressor	875	1%	0.000	$552	13	0.50
106	Cooking	High Efficiency Combination Oven	6,368	35%	0.000	$10	12	189.87
107	Cooking	Induction Cooktop	784	20%	0.000	$3,000	11	0.07
108	Cooking	Electric Energy Star Fryers	3,126	17%	0.000	$276	12	3.38
109	Cooking	Electric Energy Star Steamers,3-6 pan	9,967	57%	0.000	$3,400	12	0.87
110	Cooking	Energy Star Convection Ovens	1,937	16%	0.000	$388	12	1.49
111	Cooking	Energy Star Griddles	1,909	12%	0.000	$860	12	0.66
112	Cooking	Energy Star Hot Food Holding Cabinet	1,730	53%	0.000	$902	12	0.57
113	Compressed Air	Automatic Drains	2,097	0%	0.000	$355	5	0.93
114	Compressed Air	Cycling and High Efficiency Dryers	4	35%	0.000	$6	10	0.18
115	Compressed Air	Efficient Air Compressors	914	18%	0.000	$250	15	1.36
116	Compressed Air	Low Pressure Drop-Filters	65	3%	0.000	$22	10	0.80
117	Compressed Air	Receiver Capacity Addition	9,159	10%	0.000	$2,000	10	1.24
118	Compressed Air	Engineered Nozzles for blow-off	22,230	71%	0.000	$14	15	590.56
119	Compressed Air	Compressed Air Leak Survey and Repair	496	50%	0.000	$6	1	2.96
120	Motors	VFD on Chilled Water Pump, 5 HP	28,580	15%	3.258	$1,330	15	7.08
121	Motors	VFD on Chilled Water Pump, 7.5 HP	42,870	15%	4.888	$1,622	15	8.70
122	Motors	VFD on Chilled Water Pump, 20 HP	171,480	15%	19.550	$3,059	15	18.46
123	Office Equipment	Commercial Plug Load - Smart Strip Outlets	23	15%	0.000	$15	8	0.34
124	Office Equipment	Plug Load Occupancy Sensor	169	15%	0.000	$70	8	0.52
125	Office Equipment	Energy Star Compliant Refrigerator	120	20%	0.000	$30	17	1.55
126	Office Equipment	Energy Star Computers	81	43%	0.000	$5	4	1.96
127	Office Equipment	Computer Power Management Software	161	46%	0.000	$29	5	0.82
128	Office Equipment	Energy Star UPS	105	11%	0.000	$1,303	10	0.02
129	Office Equipment	High Efficiency Hand Dryer	965	71%	0.000	$450	10	0.55
130	Office Equipment	Electrically Commutated Plug Fans in data centers	1,445	33%	0.000	$718	15	0.71
131	Office Equipment	High Efficiency CRAC unit	162	30%	0.000	$63	15	0.91
132	Office Equipment	Computer Room Air Conditioner Economizer	358	47%	0.000	$82	15	1.53
133	Office Equipment	Computer Room Hot Aisle Cold Aisle Configuration	125	13%	0.000	$156	15	0.28
134	Office Equipment	Computer Room Air Side Economizer	440	0%	0.000	$25	10	4.50
135	Office Equipment	VFD for Process Fans -CRAC units	2,279	78%	0.000	$200	15	4.19
136	Office Equipment	Vending Miser for Non-Refrig Equip	343	46%	0.000	$108	5	0.40
137	Pools	Heat Pump Pool Heater	5,732	61%	0.000	$4,000	10	0.37
138	Pools	High efficiency spas/hot tubs	375	15%	0.000	$300	10	0.32
139	Pools	VFD Retrofit on Pool Circulation Pump	1,425	35%	0.000	$200	12	2.10

APPENDIX D. Industrial Measure Detail

Measure Number	End Use	Measure Name	Annual kWh Saved	Percent Savings (kWh)	Summer KW Savings	Incremental Cost	Measure Useful Life	TRC
1	Computers & Office Equipment	Energy Star Compliant Single Door Refrigerator	120.0	20.0%	0.000	$30.00	17	1.6
2	Computers & Office Equipment	Energy Star computers	80.5	43.0%	0.000	$5.00	4	2.0
3	Computers & Office Equipment	High Efficiency CRAC Unit	162.3	30.0%	0.020	$62.50	15	0.9
4	Computers & Office Equipment	PC Network Energy Management Controls replacing no	161.0	46.0%	0.000	$29.00	5	0.8
5	Computers & Office Equipment	Energy Efficient "Smart" Power Strip for PC/Monitor/Pri	23.4	15.0%	0.000	$15.00	8	0.3
6	Computers & Office Equipment	Energy Star UPS	104.8	10.5%	0.000	$1,303.35	10	0.0
7	Water Heating	Tank Insulation (electric)	468.0	91.0%	0.000	$2.22	15	75.0
8	Water Heating	Process Cooling Condenser Heat Recovery	5,720.0	33.0%	1.205	$254.00	15	13.2
9	Water Heating	Heat Pump Water Heater	2,123.7	58.8%	0.000	$433.00	10	1.3
10	Water Heating	Electric Tankless Water Heater	7,905.0	7.4%	0.000	$1,050.00	5	1.1
11	Water Heating	Drain Water Heat Recovery Water Heater	546.0	25.0%	4.490	$631.00	25	0.7
12	Water Heating	High Efficiency Storage (tank)	8.6	0.2%	0.000	$70.00	15	0.0
13	Ventilation	VFD supply and return fans, 11 to 50 hp	37,450.0	30.0%	5.530	$3,059.00	15	4.3
14	Ventilation	Engineered CKV Hood	727.2	42.8%	0.288	$11.00	15	3.6
15	Ventilation	EMS for Manufacturing HVAC Fan	2,197.0	44.0%	0.250	$400.00	15	2.7
16	Ventilation	VFD supply and return fans, <3 to 10 hp	6,241.7	30.0%	0.922	$1,622.00	15	1.4
17	Ventilation	Destratification Fan (HVLS)	758.2	50.0%	0.000	$132.50	10	1.5
18	Ventilation	Economizer	136.600	0.120	0.001	123.000	12.500	0.241
19	Space Cooling - Chillers	EMS install	211.3	10.0%	0.011	$1.77	15	40.7
20	Space Cooling - Chillers	Retrocommissioning	0.9	9.0%	0.000	$0.04	15	1.4
21	Space Cooling - Chillers	Water Side Economizer	1,047.5	10.0%	0.000	$50.00	15	7.1
22	Space Cooling - Chillers	Chiller Tune Up	16,192.8	8.0%	15.403	$283.00	5	22.1
23	Space Cooling - Chillers	Water-Cooled Chiller > 1000 ton	######	19.5%	74.215	$55,870.00	20	11.3
24	Space Cooling - Chillers	Water-Cooled Chiller > 200 ton	69,518.0	9.2%	3.658	$7,952.00	20	8.3
25	Space Cooling - Chillers	Programmable Thermostats	960.0	10.0%	0.000	$45.25	4	2.5
26	Space Cooling - Chillers	Air-Cooled Chiller, 20 ton	5,761.2	13.1%	2.428	$2,540.00	20	2.1
27	Space Cooling - Chillers	Ceiling Insulation	65.5	8.0%	0.024	$47.16	20	1.7
28	Space Cooling - Chillers	Integrated Building Design	54,634.0	40.0%	12.830	$29,639.71	15	0.6
29	Space Cooling - Chillers	Energy Efficient Windows	170.4	13.9%	0.022	$272.96	25	0.5
30	Space Cooling - Chillers	Economizer	136.6	12.0%	0.001	$123.00	13	0.2
31	Space Cooling - Chillers	Roof Insulation	22.1	0.8%	0.014	$54.88	20	0.6
32	Space Cooling - Chillers	Improved Duct Sealing	37.6	1.4%	0.019	$107.91	18	0.4
33	Space Cooling - Chillers	Window Improvements	85.3	0.7%	0.033	$286.16	15	0.2
34	Space Cooling - Chillers	Cool Roofing	51.250	0.150	0.028	332.440	20.000	0.130
35	ace Cooling - Unitary and Split A	EMS install	211.3	10.0%	0.011	$1.77	15	40.7
36	ace Cooling - Unitary and Split A	Retrocommissioning	0.9	9.0%	0.000	$0.04	15	1.4
37	ace Cooling - Unitary and Split A	Programmable Thermostats	960.0	10.0%	0.000	$45.25	4	2.5
38	ace Cooling - Unitary and Split A	Split AC (11.4 to 13 IEER), 8.3 ton	1274.000	0.123	0.799	522.900	15.000	2.240
39	ace Cooling - Unitary and Split A	Ceiling Insulation	65.5	8.0%	0.024	$47.16	20	1.7
40	ace Cooling - Unitary and Split A	DX Packaged Sysytem >20 tons	7,801.9	18.2%	4.893	$3,810.00	15	1.9
41	ace Cooling - Unitary and Split A	Integrated Building Design	54,634.0	40.0%	12.830	$29,639.71	15	0.6
42	ace Cooling - Unitary and Split A	Economizer	136.600	0.120	0.001	123.000	12.500	0.241
43	ace Cooling - Unitary and Split A	Energy Efficient Windows	170.4	13.9%	0.022	$272.96	25	0.5
44	ace Cooling - Unitary and Split A	Roof Insulation	22.1	0.8%	0.014	$54.88	20	0.6
45	ace Cooling - Unitary and Split A	Improved Duct Sealing	37.6	1.4%	0.019	$107.91	18	0.4
46	ace Cooling - Unitary and Split A	HVAC Tune-up	58.600	0.068	0.079	32.400	3.000	0.370
47	ace Cooling - Unitary and Split A	Window Improvements	85.3	0.7%	0.033	$286.16	15	0.2
48	ace Cooling - Unitary and Split A	Cool Roofing	51.3	15.0%	0.028	$332.44	20	0.1
49	ace Cooling - Unitary and Split A	Water Loop Heat Pump (WLHP) - Cooling	49.8	11.5%	0.031	$375.00	15	0.1
50	ace Cooling - Unitary and Split A	Ground Source Heat Pump - Cooling	22.7	4.9%	0.014	$375.00	15	0.1
51	Lighting	LED Screw In Bulb	253.500	0.639	0.043	1.200	15.000	1.790
52	Lighting	Compact Fluorescent	198.8	67.8%	0.036	$1.20	2	21.2
53	Lighting	Central Lighting Control	4,077.3	10.0%	0.704	$103.00	8	12.1
54	Lighting	Switching Controls for Multilevel Lighting (Non-HID)	8,154.6	20.0%	1.407	$274.00	8	13.6
55	Lighting	Lighting Power Density - Interior	2,669.0	10.0%	0.490	$220.00	15	9.1
56	Lighting	LED Downlight	168.1	66.2%	0.034	$27.00	15	103.1
57	Lighting	CFL Hard Wired Fixture	199.000	0.690	0.041	37.500	12.000	2.260
58	Lighting	Occupancy Sensor	335.0	24.0%	0.068	$51.00	8	1.4
59	Lighting	High bay 4 lamp HPT8 vs (Metal halide 250 W)	677.0	50.1%	0.138	$200.00	15	1.7
60	Lighting	LED Exit Sign	88.6	81.8%	0.012	$30.00	16	3.4
61	Lighting	LED Linear Replacement Lamps	68.3	44.3%	0.014	$24.00	15	1.5
62	Lighting	Lamp & Ballast Retrofit (HPT8 Replacing Standard T8)	45.8	17.2%	0.009	$18.00	15	2.3
63	Lighting	High performance T5 (replacing T8)	238.2	22.4%	0.048	$100.00	15	1.2
64	Lighting	Exterior HID replaced with LED	792.3	56.9%	0.000	$355.00	15	1.7
65	Lighting	LED High Bay Lighting	471.8	35.0%	0.096	$482.00	15	0.5
66	Lighting	LED Low Bay Lighting	305.0	42.5%	0.062	$331.00	15	0.5
67	Lighting	Light Tube	250.0	10.0%	0.000	$500.00	10	0.2
68	Space Heating	EMS install	211.3	10.0%	0.011	$1.77	15	40.7
69	Space Heating	Retrocommissioning	0.9	9.0%	0.000	$0.04	15	1.4
70	Space Heating	Destratification Fan (HVLS)	758.2	50.0%	0.000	$132.50	10	1.5

Measure Number	End Use	Measure Name	Annual kWh Saved	Percent Savings (kWh)	Summer KW Savings	Incremental Cost	Measure Useful Life	TRC
71	Space Heating	Programmable Thermostats	960.0	10.0%	0.000	$45.25	4	2.5
72	Space Heating	PTHP, 1 ton	358.9	23.2%	0.146	$84.00	15	7.7
73	Space Heating	Ceiling Insulation	65.5	8.0%	0.024	$47.16	20	1.7
74	Space Heating	Integrated Building Design	54,634.0	40.0%	12.830	$29,639.71	15	0.6
75	Space Heating	Energy Efficient Windows	170.4	13.9%	0.022	$272.96	25	0.5
76	Space Heating	Economizer	136.6	12.0%	0.001	$123.00	13	0.2
77	Space Heating	Roof Insulation	22.1	0.8%	0.014	$54.88	20	0.6
78	Space Heating	Improved Duct Sealing	37.600	0.014	0.019	107.910	18.000	0.400
79	Space Heating	Window Improvements	85.3	0.7%	0.033	$286.16	15	0.2
80	Space Heating	Cool Roofing	51.3	15.0%	0.028	$332.44	20	0.1
81	Space Heating	Water Loop Heat Pump (WLHP) - Heating	49.785	0.115	0.031	375.000	15.000	0.030
82	Space Heating	Ground Source Heat Pump - Heating	22.7	4.9%	0.014	$375.00	15	0.4
83	Other	Engine Block Heater Timer	576.0	64.0%	0.800	$50.00	5	7.7
84	Other	Parking Garage Exhaust Fan CO Control	2,413.0	48.0%	0.275	$900.00	15	2.2
85	Other	High Efficiency Transformer, three-phase	0.4	2.5%	0.000	$0.44	30	2.0
86	Other	NEMA Premium Transformer, three-phase	0.2	2.5%	0.000	$0.18	30	0.8
87	Other	High Efficiency Transformer, single-phase	0.4	2.5%	0.000	$0.46	30	1.0
88	Other	NEMA Premium Transformer, single-phase	0.2	2.5%	0.000	$0.24	30	1.3
89	Other	Optimized Snow and Ice Melt Controls	0.1	92.0%	0.000	$15.15	15	0.3
90	Machine Drive	Compressed Air Low Pressure Drop Filters	64.7	1.3%	0.010	$22.00	10	1.2
91	Machine Drive	Efficient Air Compressors	957.6	18.0%	0.130	$177.78	14	2.0
92	Machine Drive	Compressed Air Pressure Flow Controller	73.0	1.5%	0.010	$25.00	15	1.7
93	Machine Drive	Compressed Air Nozzles	21,142.0	7.5%	6.340	$76.75	20	5.7
94	Machine Drive	Compressed Air Storage Tank	423.0	8.5%	0.059	$36.00	20	8.7
95	Machine Drive	VFD for Process Fans	707.0	28.0%	0.000	$46.00	15	10.0
96	Machine Drive	VFD for Process Pumps	1,082.0	29.0%	0.000	$94.00	15	7.6
97	Machine Drive	Compressed Air replacement with Air Blowers	5,587.7	8.5%	4.180	$620.00	15	14.0
98	Machine Drive	Pump System Efficiency Improvements	1.0	16.4%	0.000	$0.01	15	7.5
99	Machine Drive	Motor System Optimization (Including ASD)	1.0	19.0%	0.000	$0.01	15	6.7
100	Machine Drive	Compressed Air Automatic Drains	2,097.0	2.2%	0.332	$100.00	5	1.3
101	Machine Drive	Electric Supply System Improvements	1.0	3.0%	0.000	$0.01	15	6.3
102	Machine Drive	High Efficiency Pumps	201.0	7.4%	0.000	$31.00	15	7.2
103	Machine Drive	Sensors & Controls	1.0	3.0%	0.000	$0.01	15	4.5
104	Machine Drive	Compressed Air High Efficiency Dryers	48.0	1.0%	0.000	$10.00	15	3.1
105	Machine Drive	Compressed Air Audits and Leak Repair	496.1	8.0%	0.069	$8.00	1	3.1
106	Machine Drive	Industrial Motor Management	1.0	1.0%	0.000	$0.02	5	3.2
107	Machine Drive	Fan System Improvements	1.0	6.0%	0.000	$0.02	15	2.6
108	Machine Drive	Advanced Efficient Motors	1.0	2.3%	0.000	$0.04	20	2.0
109	Machine Drive	Compressed Air Outdoor Air Intake	109.8	2.2%	0.015	$5.00	20	16.3
110	Process Cooling & Refrigeration	Improved Refrigeration	1.0	10.0%	0.000	$0.00	15	19.2
111	Process Cooling & Refrigeration	Electric Supply System Improvements	1.0	3.0%	0.000	$0.01	15	6.2
112	Process Cooling & Refrigeration	Sensors & Controls	1.0	3.0%	0.000	$0.01	15	4.5
113	Process Cooling & Refrigeration	Energy Information System	1.0	1.0%	0.000	$0.06	15	1.0
114	Process Heating	Decrease Oven Exhaust Flow	399.0	60.0%	0.087	$1.00	20	24.9
115	Process Heating	Electric Supply System Improvements	1.0	3.0%	0.000	$0.01	15	6.2
116	Process Heating	Sensors & Controls	1.0	3.0%	0.000	$0.01	15	4.5
117	Process Heating	Energy Information System	1.0	1.0%	0.000	$0.06	15	1.0
118	Industrial Other	Barrel Insulation - Inj. Molding (plastics)	1,210.0	18.0%	0.291	$80.00	10	7.9
119	Industrial Other	High Efficiency Welders	761.0	12.0%	0.390	$200.00	20	8.7
120	Industrial Other	Dewpoint Sensor Control for Dessicant Plastic Dryer	565.0	8.5%	0.100	$150.00	15	1.2
121	Industrial Other	Pellet Dryer Insulation (plastics)	185.0	17.0%	0.100	$40.00	10	2.3
122	Industrial Other	3 Phase High Eff Battery Charger	2,595.0	8.0%	0.289	$872.50	20	2.1
123	Industrial Other	Injection Molding Machine - efficient (plastics)	223.0	51.0%	0.050	$125.00	20	1.6
124	Industrial Other	Fiber Laser Replacing CO2 laser (auto industry)	32,562.0	78.0%	5.000	$60,000.00	20	0.4
125	Agriculture	Fan Thermostat Controller	1,586.0	53.4%	0.000	$50.00	15	20.7
126	Agriculture	Evaporator Fan Motor Controls Ag	537.1	35.4%	0.270	$30.13	20	2.6
127	Agriculture	VFD for Process Fans - Agriculture	520.0	23.0%	0.000	$46.00	15	7.4
128	Agriculture	Milk Pre-Cooler Heat Exchanger	1.0	50.0%	0.000	$0.15	15	4.4
129	Agriculture	VFD for Process Pumps - Agriculture	290.0	43.0%	0.000	$46.00	15	4.1
130	Agriculture	Low Pressure Sprinkler Nozzles	5.0	15.0%	0.000	$1.00	15	3.3
131	Agriculture	Long Daylighting Dairy	6.2	30.0%	0.001	$1.79	16	1.7
132	Agriculture	VFD for Process Pumps - Irrigation	195.0	43.0%	0.000	$46.00	10	2.0
133	Agriculture	LED Poultry Lights	5.8	57.4%	0.001	$1.53	9	1.9
134	Agriculture	Variable Speed Drives for Dairy Vacuum Pumps	598.0	34.8%	0.000	$250.00	10	1.1
135	Agriculture	Grain Storage Temperature and Moisture Management (	349.0	49.0%	0.000	$233.00	15	1.0
136	Agriculture	Other Industrial -Low-Energy Livestock Waterer	1,593.0	47.7%	1.000	$788.00	10	0.9
137	Agriculture	Greenhouse Environmental Controls	98.0	10.0%	0.000	$125.00	15	0.5
138	Agriculture	Other Industrial -Dairy Refrigerator Tune-Up	0.1	4.0%	0.000	$0.05	5	0.5
139	Agriculture	Variable Speed Drive withHeat Exchanger, Milk	878.0	15.0%	0.000	$2,725.00	15	0.2
140	Agriculture	Scroll Compressor with Heat Exchanger for Dairy Refrig	190.0	10.5%	0.000	$1,500.00	15	0.1

APPENDIX E. Global Assumptions

GENERAL MODELING ASSUMPTIONS

Analysis Start Year	2019	
Length of Analysis	15	Years
Nominal Discount Rate	7.00%	
Inflation Rate	2.20%	
Reserve Margin Multiplier	3.00%	

	Avoided Costs (Nominal Dollars)								Retail Rates (Nominal Dollars)
Data Year	**Natural Gas Wholesale Forecast $/MMBTU**	**Winter Peak Energy $/kWh**	**Winter Off-Peak Energy $/kWh**	**Summer Peak Energy $/kWh**	**Summer Off-Peak Energy $/kWh**	**Summer Capacity $/kW-yr**	**Winter Capacity $/kW-yr**	**Avoided T&D Capacity $/kW-yr**	**Water $/gallon**
2019	$2.86	$0.035	$0.028	$0.033	$0.023	$27.93	$0.00	$19.89	$0.013
2020	$2.87	$0.035	$0.028	$0.033	$0.022	$42.73	$0.00	$20.34	$0.013
2021	$2.90	$0.035	$0.027	$0.033	$0.022	$44.43	$0.00	$20.81	$0.013
2022	$2.94	$0.036	$0.027	$0.034	$0.022	$47.48	$0.00	$21.29	$0.013
2023	$2.99	$0.035	$0.028	$0.034	$0.023	$55.47	$0.00	$21.78	$0.013
2024	$3.03	$0.035	$0.027	$0.035	$0.023	$58.37	$0.00	$22.28	$0.013
2025	$3.08	$0.035	$0.028	$0.035	$0.022	$73.28	$0.00	$22.79	$0.013
2026	$3.13	$0.035	$0.028	$0.034	$0.023	$83.62	$0.00	$23.32	$0.013
2027	$3.19	$0.036	$0.030	$0.034	$0.022	$100.54	$0.00	$23.85	$0.013
2028	$3.26	$0.038	$0.032	$0.036	$0.024	$106.44	$0.00	$24.40	$0.013
2029	$3.34	$0.040	$0.033	$0.038	$0.026	$114.52	$0.00	$24.96	$0.013
2030	$3.53	$0.042	$0.035	$0.040	$0.027	$122.37	$0.00	$25.54	$0.013
2031	$3.75	$0.043	$0.037	$0.042	$0.029	$126.89	$0.00	$26.13	$0.013
2032	$3.99	$0.046	$0.039	$0.044	$0.031	$134.16	$0.00	$26.73	$0.013
2033	$4.30	$0.049	$0.042	$0.047	$0.034	$132.55	$0.00	$27.34	$0.013
2034	$4.63	$0.053	$0.045	$0.051	$0.037	$144.50	$0.00	$27.97	$0.013
2035	$5.04	$0.057	$0.050	$0.055	$0.041	$140.69	$0.00	$28.61	$0.013
2036	$5.50	$0.062	$0.054	$0.060	$0.046	$145.79	$0.00	$29.27	$0.013
2037	$6.03	$0.069	$0.061	$0.066	$0.052	$147.54	$0.00	$29.95	$0.013
2038	$6.71	$0.076	$0.068	$0.073	$0.059	$148.12	$0.00	$30.63	$0.013
2039	$7.36	$0.084	$0.076	$0.081	$0.067	$151.08	$0.00	$31.34	$0.013
2040	$7.98	$0.087	$0.079	$0.088	$0.075	$154.11	$0.00	$32.06	$0.013
2041	$8.15	$0.089	$0.081	$0.090	$0.077	$157.19	$0.00	$32.80	$0.013
2042	$8.33	$0.091	$0.083	$0.092	$0.078	$160.33	$0.00	$33.55	$0.013
2043	$8.52	$0.093	$0.085	$0.094	$0.080	$163.54	$0.00	$34.32	$0.013
2044	$8.71	$0.095	$0.087	$0.097	$0.082	$166.81	$0.00	$35.11	$0.013
2045	$8.91	$0.098	$0.088	$0.099	$0.084	$170.14	$0.00	$35.92	$0.013
2046	$9.12	$0.100	$0.090	$0.101	$0.085	$173.55	$0.00	$36.75	$0.013
2047	$9.33	$0.102	$0.092	$0.103	$0.087	$177.02	$0.00	$37.59	$0.013

	Electric Line Losses				Demand Line Losses		
	Winter On Peak	**Winter Off Peak**	**Summer On Peak**	**Summer Off Peak**	**Winter Gen.**	**Summer Gen.**	**T&D Capacity**
Residential	1.076	1.076	1.076	1.076	1.076	1.076	1.076
C&I	1.076	1.076	1.076	1.076	1.076	1.076	1.076

APPENDIX F. Demand Response Methodology

1.1 DEMAND RESPONSE PROGRAM OPTIONS

Table F-1 provides a brief description of the demand response program options considered and identifies the eligible customer segment for each demand response program that was considered in this study.

Table F-1 // DEMAND RESPONSE PROGRAM OPTIONS AND ELIGIBLE MARKETS

DR Program Option	Program Description	Eligible Markets
DLC AC (Switch)	The compressor of the air conditioner is remotely shut off (cycled) by the system operator for periods that may range from ½ to 15 minutes during every 30-minute period (i.e., 25%-50% duty cycle) 7	Residential and Small Non-Residential Customers
DLC AC (Thermostat)	The system operator can remotely raise the AC's thermostat set point during peak load conditions, lowering AC load.	Residential and Small Non-Residential Customers
DLC Pool Pumps	The swimming pool pump is remotely shut off by the system operator for periods normally ranging from 2 to 4 hours.	Residential Customers
DLC Water Heaters	The water heater is remotely shut off by the system operator for periods normally ranging from 2 to 8 hours.	Residential and Small Non-Residential Customers
DLC Agricultural Irrigation	The irrigation pump is remotely shut off by the system operator for periods normally ranging from 2 to 4 hours.	Farms
Interruptible Rate	A discounted rate is offered to the customer for agreeing to interrupt or curtail load during peak period. The interruption is mandatory. No buy-through options are available.	Large Non-Residential Customers
Large C&I Behavioral	Participants are required to be available to curtail their load any non-holiday weekday during peak hours. Each event typically lasts 4 hours in duration.	Large Non-Residential Customers
Demand Buyback	A year-round, flexible, Internet-based bidding program that offers business customers credits for voluntarily reducing power when an event is called.	Large Non-Residential Customers

DR Program Option	Program Description	Eligible Markets
Critical Peak Pricing with Enabling Technology	A retail rate in which an extra-high price for electricity is provided during a limited number of critical periods (e.g. 100 hours) of the year. Market-based prices are typically provided on a day-ahead basis, or an hour-ahead basis. Includes enabling technology that connects technologies within building. Only for customers with AC.	Residential and Non-Residential Customers
Critical Peak Pricing without Enabling Technology	A retail rate in which an extra-high price for electricity is provided during a limited number of critical periods (e.g. 100 hours) of the year. Market-based prices are typically provided on a day-ahead basis, or an hour-ahead basis.	Residential and Non-Residential Customers
PEV Charging	Special rate service for electric vehicles that charge off-peak	Residential and Non-Residential Customers

1.2 DEMAND RESPONSE POTENTIAL ASSESSMENT APPROACH

The analysis for this study was conducted using the GDS DR Model. The GDS DR Model is an Excel spreadsheet tool that allows the user to determine the achievable potential for a demand response program based on the following two basic equations that can be chosen to be the model user.

TECHNICAL POTENTIAL ● All technically feasible demand reductions are incorporated to provide a measure of the theoretical maximum demand response potential. This assumes 100% of eligible customers will participate in all programs regardless of cost-effectiveness.

ECONOMIC POTENTIAL ● Economic potential is a subset of technical potential. Only cost-effective demand response program options are included in the economic potential. The cost-effectiveness test applied in this study is the TRC test. Only programs whose net present value of benefits exceed its costs will pass the economic screening.

ACHIEVABLE POTENTIAL ● The cost-effective demand response potential that can practically be attained in a real-world program delivery scenario, if a certain level of market penetration can be attained are included in this scenario. Achievable potential takes into account real-world barriers to convincing customers to participate in cost-effective demand response programs. Achievable savings potential savings is a subset of economic potential.

If the model user chooses to base the estimated potential demand reduction on a per customer CP load reduction value, then:

$$\textit{Achievable DR Potential} = \textit{Potentially Eligible Customers} \times \textit{Eligible Customer Participation Rate} \times \textit{CP kW Load Reduction Per Participant}$$

The framework for assessing the cost-effectiveness of demand response programs is based *on A Framework for Evaluating the Cost-Effectiveness of Demand Response, prepared for the National Forum on the National Action Plan (NAPA) on Demand Response*.[1] Additionally, GDS reviewed the May 2017 National Standard Practice Manual published by the National Efficiency Screening Project.[2] GDS utilized this guide to define avoided ancillary services and energy and/or capacity price suppression benefits. Appendix A contains a table from the report summarizing the energy efficiency cost and benefits including in all five major benefit cost tests.

The GDS Demand Response Model determines the estimated savings for each demand response program by performing an extensive review of all benefits and cost associated with each program. GDS developed the model such that the value of future programs could be determined and to help facilitate demand response program planning strategies. The model contains approximately 50 required inputs for each program including: expected life, CP kW load reductions, proposed rebate levels, program related expenses such as vendor service fees, marketing and evaluation cost and on-going O&M expenses. This model and future program planning features can be used to standardize the cost-effectiveness screening process between EKPC departments interested in the deployment of demand response resources.

For this study, the Total Cost Resource Cost (TRC) test was used to determine the cost-effectiveness of each demand response program. Benefits are based on avoided demand, energy (including load shifting), wholesale cost reductions and T&D costs. Costs include incremental program equipment costs (such as control switches or smart thermostats), fixed program capital costs (such as the cost of a central controller), program administrative, marketing, and evaluation costs. Incremental equipment program costs are included for both new and replacement units (such as control switches) to account for units that are replaced at the end of their useful life.

Achievable potential is broken into maximum and realistic achievable potential in this study:

MAP represents an estimate of the maximum cost-effective demand response potential that can be achieved over the 20-year study period. For this study, this is defined as customer participation in demand response program options that reflect a "best practices" estimate of what could eventually be achieved. MAP assumes no barriers to effective delivery of programs.

RAP represents an estimate of the amount of demand response potential that can be realistically achieved over the 20-year study period. For this study, this is defined as achieving customer participation in demand response program options that reflect a realistic estimate of what could eventually be achieved assuming typical or "average" industry experience. RAP is a discounted MAP, by considering program barriers that limit participation, therefore reducing savings that could be achieved.

This potential study evaluated DR potential for two achievable potential scenarios:

1) **Switch Scenario:** The switch scenario assumes that all cost-effective DR programs will be implemented by EKPC and load switches will be used to control central air conditioning. No utility spending caps are placed on the achievable potential for this scenario.

[1] Study was prepared by Synapse Energy Economics and the Regulatory Assistance Project, February 2013.
[2] National Standard Practice Manual for Assessing Cost-Effectiveness of Energy Efficiency Resources, May 18, 2017, Prepared by The National Efficiency Screening Project

2) **Smart Thermostat Scenario:** The smart thermostat scenario also assumes that all cost-effective DR programs will be implemented, but in this scenario controllable smart thermostats will be used to control central air conditioning. As in the switch scenario, no spending caps are placed on the achievable potential for this scenario.

1.3 AVOIDED COSTS AND OTHER ECONOMIC ASSUMPTIONS

The avoided costs used to determine utility benefits were provided by East Kentucky. Avoided electric generation capacity refers to the demand response program benefit resulting from a reduction in the need for new peaking generation capacity. Demand response can also produce energy related benefits. If the demand response option is considered "load shifting", such as direct load control of electric water heating, the consumption of energy is shifted from the control period to the period immediately following the period of control. For this study, GDS assumed that the energy is shifted with no loss of energy. For power suppliers, this shift in the timing of energy use can produce benefits from either the production of energy from lower cost resources or the purchase of energy at a lower rate. If the program is not considered to be "load shifting" the measure is turned off during peak control hours, and the energy is saved altogether. Demand response programs can also potentially delay the construction of new transmission and distribution lines and facilities, which is reflected in avoided T&D costs.

The discount rate used in this study is 7.0%. A peak demand line loss factor of 7.6% and a reserve margin of 3.0 % (for firm load reduction such as direct load control) were also applied to demand reductions at the customer meter. These values were provided by East Kentucky.

The useful life of a smart thermostat is assumed to be 15 years[3]. Load control switches have a useful life of 15 years[4]. This life was used for all direct load control measures in this study.

The number of control units per participant was assumed to be 1 for all direct load control programs using switches (such as water heaters and air conditioning switches), because load control switches can control up to two units. However, for controllable thermostats, some participants have more than one thermostat. The average number of residential thermostats per single family home was assumed to be 1.72[5].

1.4 CUSTOMER PARTICIPATION

The assumed level of customer participation for each demand response program option is a key driver of achievable demand response potential estimates. Customer participation rates reflect the total number of eligible customers that are likely to participate in a demand response program. An eligible customer is defined as a customer that is eligible to participate in a demand response program. For DLC programs, eligibility is determined by whether a customer has the end use equipment that will be controlled[6]. Each sector (residential and non-residential) was broken into sub-sectors. These sub-sectors include single family and multifamily for residential, and small, medium, and large non-residential. The eligible customers for each program is shown in Table F-2 and Table F-3.

[3] Indiana TRM
[4] Provided by Comverge
[5] EIA RECS table HC6.1

Table F-1 // ELIGIBLE RESIDENTIAL CUSTOMERS IN EACH DEMAND RESPONSE PROGRAM OPTION

DR Program Option	Saturation	Source / Description
DLC AC (Switch)	77% of residential customers	EKPC 2016 End Use Survey Data - % of residential homes with central AC
DLC AC (Thermostat)	17% of residential customers	77% of homes have central AC * 22.4% of homes have WiFi
DLC Pool Pumps	6% of residential customers	EKPC 2016 End Use Survey Data - % of residential homes with pools
DLC Water Heaters	87% of residential customers	EKPC 2016 End Use Survey Data - % of residential homes with electric water heaters
Critical Peak Pricing with Enabling Technology	77% of residential customers	EKPC 2016 End Use Survey Data - % of residential homes with central AC
Critical Peak Pricing without Enabling Technology	100% of residential customers	GDS Assumption
PEV Charging	100% of PEVs	GDS Assumption

Table F-2 // ELIGIBLE NON-RESIDENTIAL CUSTOMERS IN EACH DEMAND RESPONSE PROGRAM OPTION

DR Program Option	Saturation	Source / Description
DLC AC (Switch)	89% of small C&I customers	EKPC 2016 End Use Survey Data - % of businesses with central AC
DLC AC (Thermostat)	89% of small C&I customers	EKPC 2016 End Use Survey Data - % of businesses with central AC
DLC Water Heaters	59% of small C&I customers	CBECS 2012 - % of commercial customers in East South Central region with electric water heaters
DLC Agricultural Irrigation	100% of farms	GDS Assumption
Interruptible Rate	100% of large C&I customers	GDS Assumption
Large C&I Behavioral	100% of large C&I customers	GDS Assumption
Demand Buyback	100% of large C&I customers	GDS Assumption
Critical Peak Pricing with Enabling Technology	89% of C&I customers	EKPC 2016 End Use Survey Data - % of businesses with central AC
Critical Peak Pricing without Enabling Technology	100% of C&I customers	GDS Assumption

1.4.1 Existing Demand Response Programs

East Kentucky and its owner-member cooperatives have offered their Direct Load Control program since

2008. This program offers incentives to members who enroll central AC and electric water heaters. As of 2018, 20,298 switches had been installed. EKPC also has an existing interruptible rate program. Seven large customers had bid 140 MW at the time of this study.

1.4.2 Hierarchy

Double-counting savings from demand response programs that affect the same end uses is a common issue that must be addressed when calculating the demand response savings potential. For example, a direct load control program of air conditioning and a rate program both assume load reduction of the customers' air conditioners. For this reason, it is typically assumed that customers cannot participate in programs that affect the same end uses. This hierarchy where direct load control programs come before rate programs was chosen by East Kentucky. The order of the rest of the programs is based on savings. Programs with higher savings per customer are ranked as higher in the hierarchy.

Table F-3 // Demand Response Hierarchy

DR Program Option	Applicable Sector
DLC Programs	Residential, Small C&I
Interruptible Rate	Large C&I
Large C&I Behavioral Program	Large C&I
Demand Buyback	Large C&I
CPP with Enabling Technology	Residential, Small C&I, Large C&I
CPP without Enabling Technology	Residential, Small C&I, Large C&I

1.4.3 Participation Rates

The assumed "steady state" participation rates used in this potential study and the sources upon which each assumption is based are shown in Table F-4 for residential and non-residential customers, respectively. The steady state participation rate represents the enrollment rate once the fully achievable participation has been reached. Participation rates are expressed as a percentage of eligible customers. Program participation and impacts (demand reductions) are assumed to begin in 2018. The main sources of participant rates are several studies completed by the Brattle Group. Additional detail about participation rates and sources are shown in Appendix B.

Table F-4 // STEADY STATE PARTICIPATION RATES FOR DEMAND RESPONSE PROGRAM OPTIONS

DR Program Options	MAP Steady State Participation Rate	RAP Steady State Participation Rate	Source
RESIDENTIAL			
DLC AC (Switch)	31%	20%	GDS Survey of 20 Utilities (75th percentile for MAP, 50th percentile for RAP)
DLC AC (Thermostat)	36%	25%	Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016. (Participation in BYOD programs is estimated to be 5% higher than in DLC programs.

DR Program Options	MAP Steady State Participation Rate	RAP Steady State Participation Rate	Source
DLC Pool Pumps	38%	19%	Pool Pump Demand Response Potential, Design & Engineering Services Customer Service Business Unit Southern California Edison, June 2008 (76% of survey respondents expressed and interest in an incentive-based pool pump demand response program). For RAP it is assumed that 25% of interested customers will participate. For MAP it is assumed that 50% of interested customers will participate.
DLC Water Heaters	36%	23%	RAP: Assumed an additional 5% participation compared to DLC AC. Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016. Applied ratio of RAP to MAP for DLC- Central Air Conditioning.
Critical Peak Pricing with Enabling Technology	91%	22%	Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016. (Opt-Out for MAP, Opt-In for RAP)
Critical Peak Pricing without Enabling Technology	82%	17%	Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016. (Opt-Out for MAP, Opt-In for RAP)
PEV Charging	94%	57%	MAP: Used TOU with enabling technology take rate as most electric cars are equipped with a built-in technology that allows the vehicle to charge at specific times. (Opt-Out); RAP: Plug-in Electric Vehicle and Infrastructure Analysis September 2015, Prepared for the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy by Idaho National Lab. (Opt-In)
NON-RESIDENTIAL			
DLC AC (Switch)	14%	3%	Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016. (PacifiCorp 2014 Study, FERC 75th percentile MAP, FERC 50th percentile RAP)
DLC AC (Thermostat)	19%	8%	Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016. (Participation in BYOD programs is estimated to be 5% higher than in DLC programs.

DR Program Options	MAP Steady State Participation Rate	RAP Steady State Participation Rate	Source
DLC Water Heaters	16%	7%	FERC 2012 DR Survey Data (75th percentile for MAP, 50th percentile for RAP)
DLC Agricultural Irrigation	30%	15%	Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016. (Average of Range for MAP, Low End of Range for RAP)
Interruptible Rate	21%	12%	FERC 2012 DR Survey Data- 75th percentile for MAP; EKPC Input for RAP that they would realistically gain 1 new participant per year
Large C&I Behavioral	21%	3%	FERC 2012 DR Survey Data (75th percentile for MAP, 50th percentile for RAP)
Demand Buyback	9%	1%	MAP: Demand Response Market Potential in Xcel Energy's Northern States Power Service Territory, The Brattle Group, April 2014. Avg of Small/medium and large. RAP: 2015–2025 Demand Response Portfolio of Southern California Edison Company April 1, 2015 and 2013, 2014, and 2015 Load Impact of California Statewide Demand Bidding Programs for Non-Res Customers by Christensen Associates Energy Consulting and FERC 2012 Demand Response Study.
Critical Peak Pricing with Enabling Technology	69%	20%	Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016. (Opt-Out for MAP, Opt-In for RAP)
Critical Peak Pricing without Enabling Technology	63%	18%	Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016. (Opt-Out for MAP, Opt-In for RAP)

Customer participation in new demand response programs is assumed to reach the steady state take rate over a five-year period. The path to steady state customer participation follows an "S-shaped" curve, in which participation growth accelerates over the first half of the five-year period, and then slows over the second half of the period (see **FIGURE** F-1). Existing programs have already gone through this ramp-up period, so they were escalated linearly to the final participation rate.

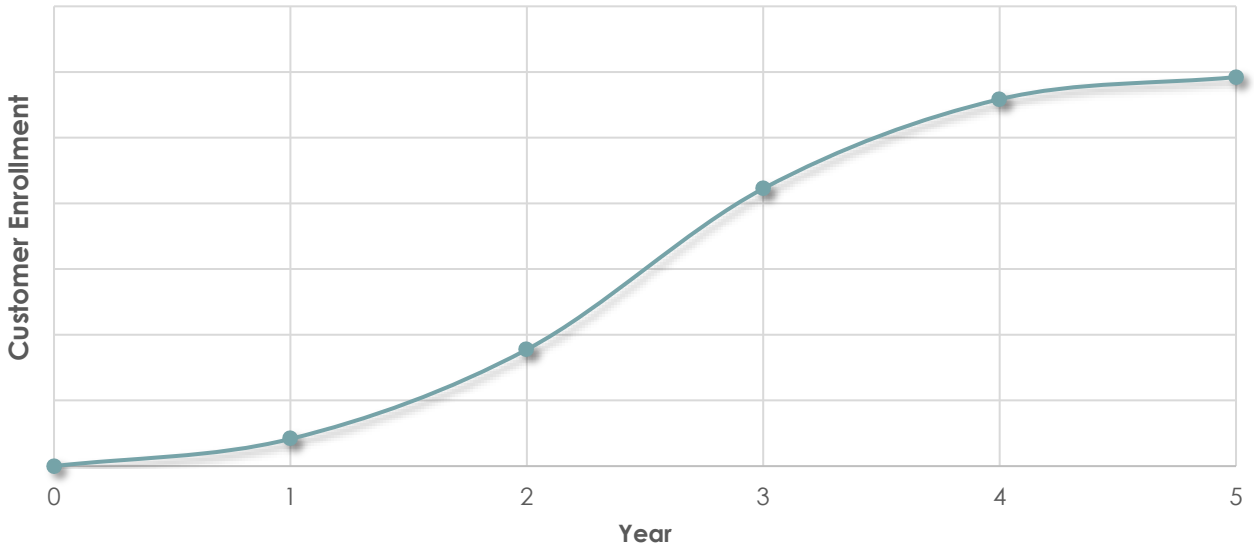


FIGURE F-1 // ILLUSTRATION OF S-SHAPED MARKET ADOPTION CURVE

1.5 LOAD REDUCTION ASSUMPTIONS

Table F-6 presents the residential and non-residential per participant CP demand reduction impact assumptions for each demand response program option at the customer meter. Demand reductions were based on load reductions found in East Kentucky's existing demand response programs, and various secondary data sources including the FERC and other industry reports, including demand response potential studies.

Table F-5 // PER PARTICIPANT CP DEMAND REDUCTION ASSUMPTIONS

DR Program Options	Per Participant CP Demand Reduction	Source
RESIDENTIAL		
DLC AC (Switch)	1 kW	EKPC 2016 Annual Report
DLC AC (Thermostat)	0.87 kW	87% of Load Switch Control. Sources: Smart Thermostats: An Alternative to Load Control Switches? Trends and Strategic Options to Consider for Residential Load Control Programs; 2016 Demand Response Potential Study Conducted by GDS for several Michigan utilities (Confidential pilot program report)
DLC Pool Pumps	1.36 kW	Southern California Edison Pool Pump Demand Response Potential Report, 2008.
DLC Water Heaters	0.37 kW Summer, 0.52 kW Winter	EKPC 2016 Annual Report
Critical Peak Pricing with Enabling Technology	31% of coincident peak load	Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016.

DR Program Options	Per Participant CP Demand Reduction	Source
Critical Peak Pricing without Enabling Technology	11.7% of coincident peak load	Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016.
PEV Charging	3.02 kW	GDS Calculation based on EIA Annual Energy Outlook PEV stock forecast; share state allocated to EKPC based on statewide customers in EKPC service area; DEPLOYMENT ROLLOUT ESTIMATE OF ELECTRIC VEHICLES, 2011-2015; DTE Energy Plug-In Electric Vehicles and Infrastructure Hawk Asgeirsson; Plug-in Electric Vehicle and Infrastructure Analysis September 2015
NON-RESIDENTIAL		
DLC AC (Switch)	1.6 kW	2012 FERC Demand Response Survey Data (Reported realized savings data for 14 utility programs, adjusted to account for peak summer temperature differences using NOAA Normal Max Summer Temperature Data, 1981-2010)
DLC AC (Thermostat)	1.39 kW	87% of Load Switch Control. Sources: Smart Thermostats: An Alternative to Load Control Switches? Trends and Strategic Options to Consider for Residential Load Control Programs; 2016 Demand Response Potential Study Conducted by GDS for several Michigan utilities (Confidential pilot program report)
DLC Water Heaters	1.2 kW Summer, 0.8 kW Winter	Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016.
DLC Agricultural Irrigation	44 kW	2012 FERC Demand Response Survey Data (Reported realized savings data for 17 utility programs)
Interruptible Rate	3 MW for RAP, 2.5 MW for MAP	EKPC Input, GDS assumed for MAP case, there would be more small customers, bringing the average load down
Large C&I Behavioral	35 kW	Assumptions for C&I DR 2015 IRP (Included in EKPC Data Response)
Demand Buyback	7% of coincident peak load	Average taken from: 2013, 2014, and 2015 Load Impact of California Statewide Demand Bidding Programs for Non-Res Customers by Christensen Associates Energy Consulting and FERC 2012 Demand Response Study.

DR Program Options	Per Participant CP Demand Reduction	Source
Critical Peak Pricing with Enabling Technology	21.5% of coincident peak load	Dynamic Pricing: Transitioning from Experiments to Full Scale Deployments, Michigan Retreat on Peak Shaving to Reduce Wasted Energy, The Brattle Group, August 06, 2014.
Critical Peak Pricing without Enabling Technology	4.2% of coincident peak load	Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016. (average of small, med, large C&I)

1.6 PROGRAM COSTS

Table F-7 shows the program costs that were assumed for each demand response program option. One-time program development costs included in the first year of the analysis for new programs. No program development costs are assumed for programs that already exist. It was assumed that there would be a cost of $50[7] per new participant for marketing for residential and small C&I programs. Large C&I programs require a higher marketing costs due to more time spent to acquire a participant, including potential site visits. Marketing costs are assumed to be 33.3% higher for MAP. There was assumed to be an annual administrative cost of $5,000 per program[8]. All program costs were escalated each year by the general rate of inflation assumed for this study.[9] Table F-8 shows the equipment cost assumptions.

Table F-6 // PROGRAM COST ASSUMPTIONS

DR Program Option	Program Development Cost	MAP Marketing Cost	RAP Marketing Cost
Residential			
DLC AC (Switch)	$0	$67 / new customer	$50 / new customer
DLC AC (Thermostat)	$0	$67 / new customer	$50 / new customer
DLC Swimming Pool Pumps	$0	$67 / new customer	$50 / new customer
DLC Water Heating	$0	$67 / new customer	$50 / new customer
Critical Peak Pricing with Enabling Technology	$100,000	$67 / new customer	$50 / new customer
Critical Peak Pricing without Enabling Technology	$100,000	$67 / new customer	$50 / new customer
PEV Charging	$133,333	$67 / new customer	$50 / new customer
Non-Residential			
DLC AC (Switch)	$0	$67 / new customer	$50 / new customer
DLC AC (Thermostat)	$0	$67 / new customer	$50 / new customer

[7] TVA Potential Study Volume III: Demand Response Potential, Global Energy Partners, December 2011
[8] Based on Input from EKPC.
[9] The general rate of inflation used for this study was 2.8%. This was provided by EKPC.

DR Program Option	Program Development Cost	MAP Marketing Cost	RAP Marketing Cost
DLC Water Heaters	$0	$67 / new customer	$50 / new customer
DLC Agricultural Irrigation	$100,000	$67 / new customer	$50 / new customer
Interruptible Rate	$0	$665 / new customer	$500 / new customer
Large C&I Behavioral	$133,333	$665 / new customer	$500 / new customer
Demand Buyback	$133,333	$665 / new customer	$500 / new customer
Critical Peak Pricing with Enabling Technology	$100,000	$67 / new customer	$50 / new customer
Critical Peak Pricing without Enabling Technology	$100,000	$67 / new customer	$50 / new customer

Table F-7 // EQUIPMENT COST ASSUMPTIONS

Device	Cost	Applicable DR Programs	Source
Two-way communicating load control switch using Wi-Fi	95	DLC programs controlled by switches	Comverge
Load control switch installation	200	All DLC programs controlled by switches	Comverge
Smart controllable thermostat (such as Nest or Ecobee)	249	DLC AC Thermostat	Nest / Ecobee

APPENDIX G. Annual Achievable Potential by Sector

Residential Sector

Cumulative Annual MWh	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Max Achievable															
Appliances	6,043	8,263	11,222	15,104	20,093	26,338	33,899	42,698	46,431	54,528	61,887	67,780	71,589	72,907	71,589
Behavioral	106,338	104,660	103,983	104,240	104,087	104,463	105,585	107,121	109,133	111,302	113,327	115,638	117,670	119,454	120,753
Bundles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clothes Washer/ Dryer	1,907	4,263	7,079	10,337	14,022	18,098	22,514	27,212	32,132	37,230	42,426	47,708	53,063	58,403	62,005
Dishwasher	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electronics	23,632	47,642	71,857	95,968	120,037	144,111	146,160	147,947	149,529	151,123	152,613	154,065	155,519	156,925	158,273
HVAC Shell	25,302	77,773	126,342	169,130	205,206	234,268	256,741	273,541	285,647	293,865	307,591	312,465	315,772	320,942	327,975
HVAC Equipment	13,365	33,737	55,628	79,070	102,407	128,351	155,524	183,691	212,559	244,631	274,577	305,004	335,815	367,035	398,293
Lighting	35,313	80,662	75,983	34,820	48,900	59,217	69,917	80,632	91,015	100,806	109,792	107,776	110,893	112,991	114,266
New Construction	3,078	6,967	11,480	16,319	21,580	27,347	33,582	40,247	47,217	54,486	61,460	68,389	75,368	82,153	88,678
Pool/Spa	624	1,278	1,955	2,649	3,356	4,074	4,791	5,508	6,225	6,942	7,036	7,101	7,142	7,166	7,177
Water Heating	4,661	15,157	25,175	34,741	43,949	53,625	62,413	73,595	82,688	92,171	100,315	104,533	110,157	116,927	125,569
Total	**220,263**	**380,402**	**490,703**	**562,378**	**683,638**	**799,891**	**891,126**	**982,192**	**1,062,574**	**1,147,083**	**1,231,023**	**1,290,460**	**1,352,988**	**1,414,902**	**1,474,578**
Realistic Achievable															
Appliances	4,287	5,862	7,961	10,715	14,255	18,685	24,050	30,292	32,940	38,685	43,906	48,087	50,789	51,724	50,789
Behavioral	35,184	34,775	34,734	34,971	35,097	35,400	35,951	36,639	37,479	38,338	39,226	40,143	40,948	41,653	42,196
Bundles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clothes Washer/ Dryer	1,958	4,249	6,844	9,696	12,776	16,050	19,482	23,037	26,685	30,404	34,151	37,889	41,627	45,355	47,305
Dishwasher	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electronics	22,195	44,763	67,537	90,213	112,851	135,492	137,442	139,128	140,610	142,103	143,498	144,858	146,219	147,536	148,798
HVAC Shell	11,695	42,336	68,056	88,840	105,142	117,537	126,354	131,935	135,925	145,514	149,020	153,394	159,320	167,111	176,882
HVAC Equipment	11,341	28,448	45,761	63,167	78,952	95,872	112,684	130,315	146,953	165,179	181,767	198,303	214,739	231,338	248,261
Lighting	36,518	81,340	71,978	33,398	45,728	53,275	60,732	67,901	74,630	80,837	86,410	83,420	84,711	85,461	85,714
New Construction	2,711	6,113	10,036	14,218	18,738	23,669	28,976	34,623	40,506	46,620	52,468	58,251	64,068	69,717	75,144
Pool/Spa	485	970	1,455	1,940	2,425	2,909	3,394	3,879	4,364	4,849	4,850	4,851	4,852	4,853	4,853
Water Heating	4,437	14,666	24,392	33,660	42,555	51,901	60,342	71,158	79,868	88,951	96,709	100,539	105,765	112,143	120,405
Total	**130,810**	**263,521**	**338,754**	**380,818**	**468,518**	**550,790**	**609,407**	**668,908**	**719,960**	**781,480**	**832,005**	**869,735**	**913,038**	**956,889**	**1,000,348**

Residential Sector

Cumulative Annual Summer MW	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Max Achievable															
Appliances	0.9	1.2	1.6	2.2	2.9	3.8	4.9	6.2	6.7	7.9	8.9	9.8	10.3	10.5	10.3
Behavioral	10.7	10.5	10.4	10.4	10.3	10.3	10.4	10.4	10.5	10.7	10.8	10.9	11.0	11.2	11.2
Bundles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Clothes Washer/ Dryer	0.2	0.5	0.9	1.3	1.8	2.3	2.9	3.5	4.1	4.8	5.5	6.1	6.8	7.5	8.0
Dishwasher	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electronics	4.3	8.7	13.2	17.6	22.1	26.5	26.9	27.3	27.5	27.8	28.1	28.4	28.6	28.9	29.1
HVAC Shell	4.6	13.3	21.3	28.3	34.1	38.8	42.4	45.1	47.0	48.2	50.7	51.5	52.1	53.2	54.6
HVAC Equipment	1.8	3.2	4.8	6.8	7.9	10.1	12.4	14.8	17.2	19.5	21.4	23.1	24.4	25.3	25.9
Lighting	4.3	9.8	8.2	4.2	5.9	7.1	8.4	9.6	10.9	12.0	13.1	12.8	13.1	13.4	13.5
New Construction	0.2	0.5	0.9	1.3	1.7	2.2	2.7	3.2	3.7	4.3	4.9	5.4	6.0	6.5	7.0
Pool/Spa	0.9	1.8	2.7	3.7	4.6	5.6	6.6	7.6	8.6	9.6	9.7	9.8	9.9	9.9	9.9
Water Heating	0.3	0.8	1.4	2.0	2.6	3.3	4.0	4.7	5.3	6.0	6.5	7.0	7.4	7.8	8.2
Total	**28.3**	**50.4**	**65.5**	**77.7**	**94.0**	**110.1**	**121.5**	**132.4**	**141.7**	**150.8**	**159.6**	**164.7**	**169.7**	**174.1**	**177.8**
Realistic Achievable															
Appliances	0.6	0.8	1.1	1.5	2.1	2.7	3.5	4.4	4.8	5.6	6.3	6.9	7.3	7.5	7.3
Behavioral	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.6	3.6	3.7	3.7	3.8	3.8	3.9	3.9
Bundles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Clothes Washer/ Dryer	0.3	0.5	0.9	1.2	1.6	2.1	2.5	3.0	3.4	3.9	4.4	4.9	5.4	5.8	6.1
Dishwasher	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electronics	4.3	8.6	13.0	17.4	21.8	26.1	26.5	26.9	27.1	27.4	27.7	27.9	28.2	28.4	28.7
HVAC Shell	2.2	7.7	12.3	16.0	19.0	21.2	22.8	23.9	24.6	26.5	27.1	28.0	29.1	30.6	32.4
HVAC Equipment	1.6	2.7	4.0	5.5	6.1	7.6	9.2	10.9	12.5	14.0	15.2	16.1	16.5	16.6	16.5
Lighting	4.5	9.9	7.8	4.1	5.6	6.5	7.4	8.2	9.0	9.7	10.4	10.0	10.1	10.2	10.2
New Construction	0.2	0.5	0.8	1.1	1.5	1.9	2.3	2.7	3.2	3.7	4.1	4.6	5.0	5.5	5.9
Pool/Spa	0.7	1.3	2.0	2.7	3.4	4.0	4.7	5.4	6.0	6.7	6.7	6.7	6.7	6.7	6.7
Water Heating	0.3	0.8	1.3	2.0	2.6	3.3	3.9	4.6	5.3	5.9	6.4	6.8	7.2	7.6	8.0
Total	**18.1**	**36.4**	**46.8**	**55.0**	**67.0**	**78.8**	**86.3**	**93.4**	**99.6**	**107.0**	**112.1**	**115.7**	**119.4**	**122.8**	**125.8**

Commercial Sector

Cumulative Annual MWh	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Max Achievable															
Lighting	4,454,018	8,908,036	13,362,054	17,816,072	22,270,090	26,724,108	31,178,126	35,632,143	40,086,161	44,540,179	48,994,197	53,448,215	57,902,233	62,356,251	66,810,269
Space Cooling - Chillers	1,698,693	3,397,386	5,096,079	6,794,772	8,493,465	10,192,158	11,890,851	13,589,544	15,288,237	16,986,930	18,685,623	20,384,316	22,083,009	23,781,701	25,480,394
Space Cooling - Unitary / Split	2,684,255	5,368,510	8,052,765	10,737,020	13,421,275	16,105,530	18,789,785	21,474,041	24,158,296	26,842,551	29,526,806	32,211,061	34,895,316	37,579,571	40,263,826
Space Heating	222,964	445,929	668,893	891,858	1,114,822	1,337,787	1,560,751	1,783,715	2,006,680	2,229,644	2,452,609	2,675,573	2,898,538	3,121,502	3,344,466
Ventilation	2,835,692	5,671,384	8,507,077	11,342,769	14,178,461	17,014,153	19,849,846	22,685,538	25,521,230	28,356,922	31,192,615	34,028,307	36,863,999	39,699,691	42,535,384
Motors	579,195	1,158,390	1,737,586	2,316,781	2,895,976	3,475,171	4,054,366	4,633,562	5,212,757	5,791,952	6,371,147	6,950,343	7,529,538	8,108,733	8,687,928
Water Heating	10,711	21,422	32,134	42,845	53,556	64,267	74,978	85,689	96,401	107,112	117,823	128,534	139,245	149,957	160,668
Cooking	77,116	154,232	231,347	308,463	385,579	462,695	539,811	616,926	694,042	771,158	848,274	925,389	1,002,505	1,079,621	1,156,737
Refrigeration	5,872,523	11,745,047	17,617,570	23,490,094	29,362,617	35,235,141	41,107,664	46,980,188	52,852,711	58,725,234	64,597,758	70,470,281	76,342,805	82,215,328	88,087,852
Office Equipment	174,122	348,244	522,366	696,488	870,611	1,044,733	1,218,855	1,392,977	1,567,099	1,741,221	1,915,343	2,089,465	2,263,587	2,437,710	2,611,832
Compressed Air	1,719,516	3,478,207	5,276,075	7,113,117	8,989,336	10,904,730	12,859,301	14,853,046	16,885,968	18,958,065	21,069,338	23,219,787	25,409,411	27,638,211	29,906,187
Pools	303,976	607,953	911,929	1,215,906	1,519,882	1,823,858	2,127,835	2,431,811	2,735,788	3,039,764	3,343,740	3,647,717	3,951,693	4,255,670	4,559,646
Total	**20,632,783**	**41,304,741**	**62,015,875**	**82,766,185**	**103,555,670**	**124,384,331**	**145,252,168**	**166,159,181**	**187,105,369**	**208,090,733**	**229,115,273**	**250,178,988**	**271,281,879**	**292,423,946**	**313,605,189**
Realistic Achievable															
Lighting	1,596,145	3,192,290	4,788,435	6,384,580	7,980,725	9,576,870	11,173,015	12,769,161	14,365,306	15,961,451	17,557,596	19,153,741	20,749,886	22,346,031	23,942,176
Space Cooling - Chillers	1,222,901	2,445,802	3,668,704	4,891,605	6,114,506	7,337,407	8,560,308	9,783,209	11,006,111	12,229,012	13,451,913	14,674,814	15,897,715	17,120,617	18,343,518
Space Cooling - Unitary / Split	1,920,476	3,840,951	5,761,427	7,681,903	9,602,379	11,522,854	13,443,330	15,363,806	17,284,281	19,204,757	21,125,233	23,045,709	24,966,184	26,886,660	28,807,136
Space Heating	146,568	293,137	439,705	586,273	732,841	879,410	1,025,978	1,172,546	1,319,115	1,465,683	1,612,251	1,758,820	1,905,388	2,051,956	2,198,524
Ventilation	2,010,915	4,021,829	6,032,744	8,043,658	10,054,573	12,065,487	14,076,402	16,087,316	18,098,231	20,109,145	22,120,060	24,130,974	26,141,889	28,152,803	30,163,718
Motors	419,260	838,520	1,257,780	1,677,040	2,096,300	2,515,560	2,934,820	3,354,080	3,773,340	4,192,600	4,611,860	5,031,120	5,450,380	5,869,639	6,288,899
Water Heating	7,403	14,806	22,209	29,612	37,015	44,419	51,822	59,225	66,628	74,031	81,434	88,837	96,240	103,643	111,046
Cooking	52,914	105,829	158,743	211,658	264,572	317,486	370,401	423,315	476,230	529,144	582,058	634,973	687,887	740,802	793,716
Refrigeration	5,212,260	10,424,520	15,636,780	20,849,040	26,061,300	31,273,560	36,485,820	41,698,080	46,910,339	52,122,599	57,334,859	62,547,119	67,759,379	72,971,639	78,183,899
Office Equipment	135,925	271,850	407,776	543,701	679,626	815,551	951,477	1,087,402	1,223,327	1,359,252	1,495,177	1,631,103	1,767,028	1,902,953	2,038,878
Compressed Air	1,190,658	2,406,957	3,648,898	4,916,480	6,209,704	7,528,569	8,873,075	10,243,223	11,639,012	13,060,443	14,507,515	15,980,228	17,478,583	19,002,579	20,552,217
Pools	192,202	384,403	576,605	768,807	961,009	1,153,210	1,345,412	1,537,614	1,729,816	1,922,017	2,114,219	2,306,421	2,498,623	2,690,824	2,883,026
Total	**14,107,627**	**28,240,896**	**42,399,805**	**56,584,357**	**70,794,549**	**85,030,384**	**99,291,859**	**113,578,976**	**127,891,734**	**142,230,134**	**156,594,175**	**170,983,858**	**185,399,182**	**199,840,147**	**214,306,754**

Commercial Sector

Cumulative Annual Summer MW	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Max Achievable															
Lighting	782.4	1,564.8	2,347.2	3,129.6	3,912.0	4,694.4	5,476.8	6,259.2	7,041.6	7,824.0	8,606.4	9,388.8	10,171.2	10,953.6	11,736.0
Space Cooling - Chillers	165.0	330.0	495.0	660.0	825.0	990.1	1,155.1	1,320.1	1,485.1	1,650.1	1,815.1	1,980.1	2,145.1	2,310.1	2,475.1
Space Cooling - Unitary / Split	1,294.8	2,589.5	3,884.3	5,179.1	6,473.9	7,768.6	9,063.4	10,358.2	11,653.0	12,947.7	14,242.5	15,537.3	16,832.1	18,126.8	19,421.6
Space Heating	11.2	22.5	33.7	44.9	56.1	67.4	78.6	89.8	101.0	112.3	123.5	134.7	145.9	157.2	168.4
Ventilation	175.8	351.6	527.4	703.1	878.9	1,054.7	1,230.5	1,406.3	1,582.1	1,757.8	1,933.6	2,109.4	2,285.2	2,461.0	2,636.8
Motors	66.0	132.1	198.1	264.1	330.2	396.2	462.2	528.3	594.3	660.3	726.4	792.4	858.4	924.5	990.5
Water Heating	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Cooking	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Refrigeration	330.6	661.2	991.8	1,322.4	1,653.0	1,983.6	2,314.2	2,644.7	2,975.3	3,305.9	3,636.5	3,967.1	4,297.7	4,628.3	4,958.9
Office Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Compressed Air	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pools	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**2,825.8**	**5,651.7**	**8,477.5**	**11,303.3**	**14,129.1**	**16,955.0**	**19,780.8**	**22,606.6**	**25,432.4**	**28,258.3**	**31,084.1**	**33,909.9**	**36,735.7**	**39,561.6**	**42,387.4**
Realistic Achievable															
Lighting	302.3	604.7	907.0	1,209.4	1,511.7	1,814.1	2,116.4	2,418.8	2,721.1	3,023.5	3,325.8	3,628.2	3,930.5	4,232.9	4,535.2
Space Cooling - Chillers	113.0	226.1	339.1	452.2	565.2	678.3	791.3	904.4	1,017.4	1,130.5	1,243.5	1,356.6	1,469.6	1,582.7	1,695.7
Space Cooling - Unitary / Split	936.8	1,873.5	2,810.3	3,747.0	4,683.8	5,620.5	6,557.3	7,494.0	8,430.8	9,367.5	10,304.3	11,241.0	12,177.8	13,114.5	14,051.3
Space Heating	7.4	14.8	22.2	29.6	37.0	44.4	51.8	59.2	66.6	74.0	81.4	88.8	96.2	103.6	111.0
Ventilation	119.0	237.9	356.9	475.8	594.8	713.8	832.7	951.7	1,070.7	1,189.6	1,308.6	1,427.5	1,546.5	1,665.5	1,784.4
Motors	47.8	95.6	143.4	191.2	239.0	286.8	334.6	382.4	430.2	478.0	525.8	573.6	621.4	669.2	717.0
Water Heating	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cooking	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Refrigeration	300.9	601.8	902.7	1,203.6	1,504.5	1,805.5	2,106.4	2,407.3	2,708.2	3,009.1	3,310.0	3,610.9	3,911.8	4,212.7	4,513.6
Office Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Compressed Air	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pools	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**1,827.2**	**3,654.4**	**5,481.6**	**7,308.9**	**9,136.1**	**10,963.3**	**12,790.5**	**14,617.7**	**16,444.9**	**18,272.2**	**20,099.4**	**21,926.6**	**23,753.8**	**25,581.0**	**27,408.2**

Industrial Sector

Cumulative Annual MWh	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Max Achievable															
Machine Drive	17,823	35,646	53,469	71,293	89,116	106,939	124,762	142,585	160,408	178,232	196,055	213,878	231,701	249,524	267,347
Lighting	10,677	21,353	32,030	42,706	53,383	64,059	74,736	85,412	96,089	106,765	117,442	128,118	138,795	149,471	160,148
Space Cooling	1,634	3,267	4,901	6,534	8,167	9,800	11,434	13,060	14,687	16,314	16,688	17,062	17,437	17,811	18,185
Ventilation	2,670	5,340	8,010	10,680	13,350	16,019	18,689	21,359	24,029	26,699	29,369	32,039	34,709	37,379	40,049
Process Heating and Cooling	3,789	7,578	11,367	15,156	18,946	22,735	26,524	30,313	34,102	37,891	41,680	45,469	49,259	53,048	56,837
Space Heating	1,181	2,363	3,544	4,726	5,907	7,089	8,270	9,452	10,633	11,814	12,733	13,652	14,571	15,490	16,409
Other	77	154	231	308	385	462	539	616	693	770	848	925	1,002	1,079	1,156
Agriculture	364	729	1,093	1,457	1,822	2,186	2,551	2,915	3,279	3,644	4,008	4,372	4,737	5,101	5,465
Water Heating	16	32	48	63	79	95	111	127	143	159	175	190	206	222	238
Computers & Office Equipmen	28	56	84	112	140	167	195	223	251	279	307	335	363	391	419
Total	**38,259**	**76,518**	**114,777**	**153,036**	**191,294**	**229,553**	**267,811**	**306,063**	**344,315**	**382,567**	**419,304**	**456,041**	**492,779**	**529,516**	**566,253**
Realistic Achievable															
Machine Drive	13,852	27,703	41,555	55,407	69,258	83,110	96,962	110,813	124,665	138,517	152,368	166,220	180,072	193,923	207,775
Lighting	5,232	10,465	15,697	20,930	26,162	31,395	36,627	41,860	47,092	52,324	57,557	62,789	68,022	73,254	78,487
Space Cooling	1,265	2,530	3,795	5,059	6,324	7,588	8,852	10,112	11,372	12,631	12,938	13,244	13,551	13,858	14,164
Ventilation	2,263	4,526	6,789	9,052	11,315	13,578	15,840	18,103	20,366	22,629	24,892	27,155	29,418	31,681	33,944
Process Heating and Cooling	2,662	5,325	7,987	10,649	13,312	15,974	18,636	21,299	23,961	26,623	29,286	31,948	34,610	37,273	39,935
Space Heating	862	1,725	2,587	3,450	4,312	5,174	6,037	6,899	7,761	8,624	9,313	10,002	10,691	11,380	12,069
Other	70	140	210	280	350	420	490	560	630	700	770	840	910	980	1,050
Agriculture	331	663	994	1,325	1,657	1,988	2,319	2,651	2,982	3,314	3,645	3,976	4,308	4,639	4,970
Water Heating	13	26	39	51	64	77	90	103	116	128	141	154	167	180	193
Computers & Office Equipmen	18	35	53	70	88	105	123	140	158	175	193	210	228	245	263
Total	**26,568**	**53,137**	**79,705**	**106,273**	**132,841**	**159,409**	**185,977**	**212,540**	**239,103**	**265,666**	**291,103**	**316,539**	**341,976**	**367,413**	**392,850**

Industrial Sector

Cumulative Annual Summer MW	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Max Achievable															
Machine Drive	3.4	6.9	10.3	13.8	17.2	20.7	24.1	27.6	31.0	34.4	37.9	41.3	44.7	48.2	51.6
Lighting	1.9	3.8	5.7	7.6	9.5	11.3	13.2	15.1	17.0	18.9	20.8	22.7	24.6	26.5	28.4
Space Cooling	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.5	0.6	0.6	0.7	0.8	0.8	0.9	0.9
Ventilation	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0
Process Heating and Cooling	0.6	1.3	1.9	2.6	3.2	3.9	4.5	5.2	5.8	6.5	7.1	7.8	8.4	9.1	9.7
Space Heating	0.0	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.6	0.6
Other	0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7
Agriculture	0.1	0.1	0.2	0.3	0.4	0.4	0.5	0.6	0.7	0.7	0.8	0.9	0.9	1.0	1.1
Water Heating	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Computers & Office Equipmen	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2
Total	**6.4**	**12.8**	**19.3**	**25.7**	**32.1**	**38.5**	**45.0**	**51.4**	**57.8**	**64.2**	**70.6**	**77.0**	**83.4**	**89.8**	**96.2**
Realistic Achievable															
Machine Drive	2.7	5.4	8.0	10.7	13.4	16.1	18.7	21.4	24.1	26.8	29.4	32.1	34.8	37.4	40.1
Lighting	1.9	3.8	5.7	7.6	9.5	11.3	13.2	15.1	17.0	18.9	20.8	22.7	24.6	26.5	28.4
Space Cooling	0.1	0.1	0.2	0.2	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8
Ventilation	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0
Process Heating and Cooling	0.5	0.9	1.4	1.8	2.3	2.8	3.2	3.7	4.1	4.6	5.1	5.5	6.0	6.5	6.9
Space Heating	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.4
Other	0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7
Agriculture	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.5	0.6	0.7	0.7	0.8	0.9	0.9	1.0
Water Heating	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Computers & Office Equipmen	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2
Total	**5.4**	**10.9**	**16.3**	**21.8**	**27.2**	**32.7**	**38.1**	**43.5**	**49.0**	**54.4**	**59.9**	**65.3**	**70.7**	**76.1**	**81.5**