Ameren Illinois
Demand Side Management Market Potential Study: Volume 3 – Energy Efficiency Potential Analysis

Final Report

Applied Energy Group, Inc.
500 Ygnacio Valley Road
Suite 250
Walnut Creek, CA 94596
510.982.3525
www.appliedenergygroup.com

Prepared for:
Ameren Illinois

April 18, 2016

This report was prepared by

Applied Energy Group, Inc.
500 Ygnacio Valley Blvd., Suite 250
Walnut Creek, CA 94596

Project Director: I. Rohmund
Project Manager: D. Costenaro

Subcontractors:
The Brattle Group
LHK Partners
Washington University in St. Louis

Contents

List of Figures

List of Tables

SECTION 1

Introduction

Background

Ameren Illinois (AIC) selected Applied Energy Group (AEG) to conduct this Demand Side Management (DSM) Market Potential Study to assess the various categories of electric and natural gas energy efficiency potential in the residential, commercial, industrial, and street lighting sectors of the Ameren Illinois service territory. The key objectives of the study were to:

- Satisfy the legislative requirement to provide an electric potential study with the IPA incremental savings filing that is no less than 3 years old (last one completed in 2014). Ameren Illinois chose to include natural gas as well.
- Estimate demand-side savings associated with traditional end-use energy efficiency measures, behavioral measures, and combined heat and power (CHP) measures.
- Provide support for the development of an integrated gas and electric Cycle 4 (2017-2020) Plan.
- Update market research to provide insights and enhance the planning representations of customers in the AIC service territory.

The study assesses various tiers of energy efficiency potential including technical, economic, maximum achievable, and realistic achievable potential. The study developed updated baseline estimates with the latest information on federal, state, and local codes and standards for improving energy efficiency. The study consisted of three primary components: market research, a full energy efficiency potential analysis at the measure and program levels, and estimation of supply curves.

As part of the study, the AEG team conducted primary market research to collect data for the Ameren Illinois service territory, including: electric and natural gas end-use data, end-use saturation data, and customer psychographics, demographics, and firmographics. This information enables Ameren Illinois to understand how their customers make decisions related to their energy use and energy efficiency investment decisions.

Ameren Illinois will use the results of this study in its Demand Side Management (DSM) planning process to optimally implement energy efficiency related savings programs.

Report Organization

This report is presented in four volumes as outlined below. **This document is Volume 3: Energy Efficiency Potential Analysis.**

- Volume 1, Executive Summary
- Volume 2, Market Research Report
- Volume 3, Energy Efficiency Potential Analysis
- Volume 4, Appendices

Abbreviations and Acronyms

Throughout the report we use several abbreviations and acronyms. The table below shows the abbreviation or acronym, along with an explanation.

Explanation of Abbreviations and Acronyms

Acronym	Explanation
ACS	American Community Survey
AEO	Annual Energy Outlook forecast developed by EIA
BenCost	AEG's Program Design & Cost-Effectiveness tool for Program-Level Analysis
B/C Ratio	Benefit to Cost Ratio
BEST	AEG's Building Energy Simulation Tool
C&I	Commercial and Industrial
CAC	Central Air Conditioning
CFL	Compact fluorescent lamp
DEEM	AEG's Database of Energy Efficiency Measures
DSM	Demand Side Management
EE	Energy Efficiency
EIA	Energy Information Administration
EUL	Estimated Useful Life
EUI	Energy Usage Intensity
GW, GWh	Gigawatt, Gigawatt hour
HH	Household
HVAC	Heating Ventilation and Air Conditioning
kW, kWh	Kilowatt, Kilowatt hour
LED	Light emitting diode lamp
LoadMAP	AEG's Load Management Analysis & Planning™ tool for Measure-Level Analysis
MW, MWh	Megawatt, Megawatt hour
MMTherms	Million therm
NPV	Net Present Value
O&M	Operations and Maintenance
PCT	Participant Cost Test
RIM	Ratepayer Impact Measure
RTU	Roof top unit
SAG	Illinois' Stakeholder Advisory Group
SqFt	Square Feet
TRC	Total Resource Cost test
TRM	Technical Reference Manual
UCT	Utility Cost Test
UEC	Unit Energy Consumption

Analysis Approach and Data Development

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

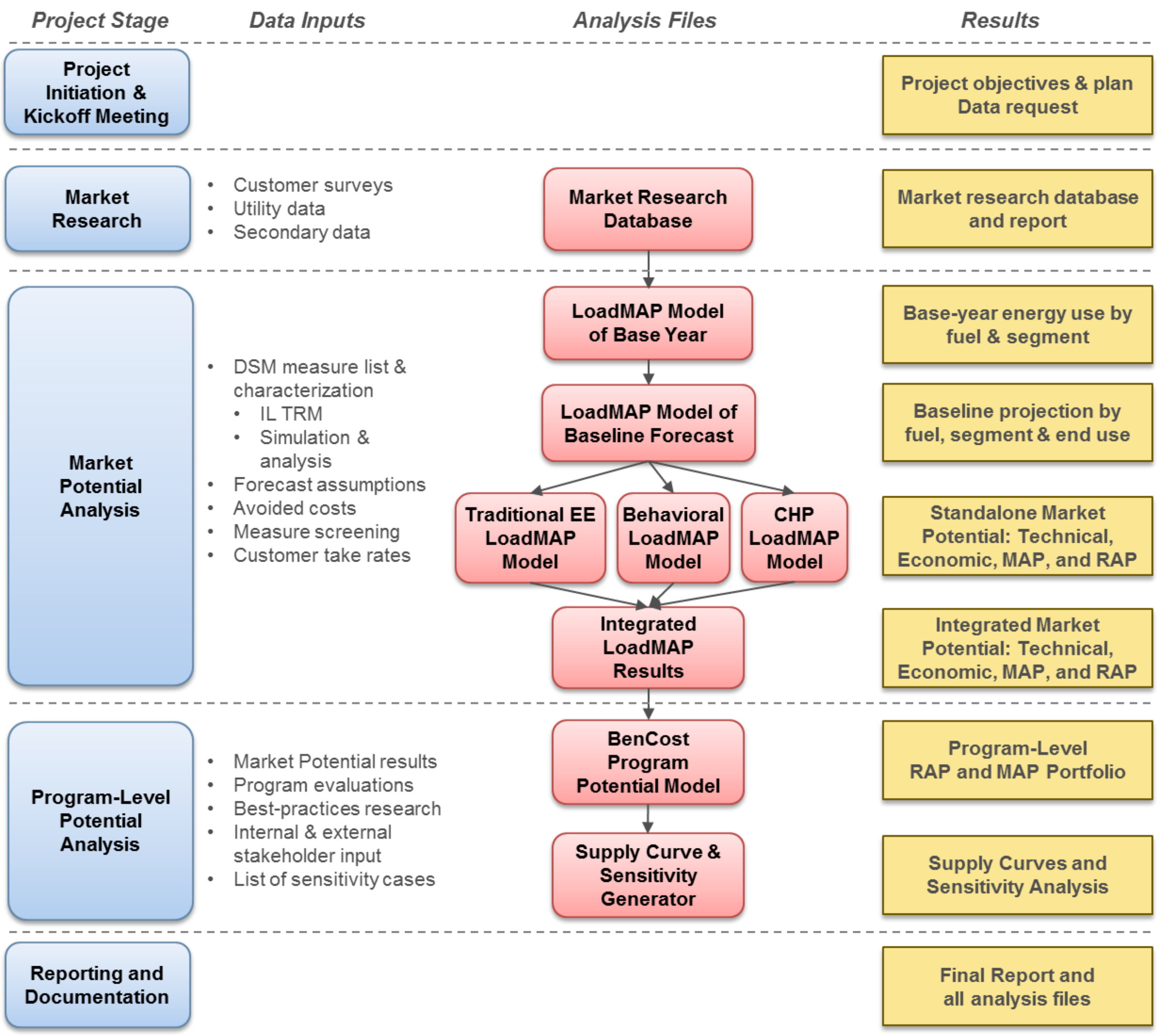
Overview of Analysis Approach

To perform the potential analysis, AEG used a bottom-up approach following the major steps listed below (shown in Figure 2-1). We describe these analysis steps in more detail throughout the remainder of this chapter.

1. Conducted primary market research (as detailed in Volume 2) to identify equipment saturations, building characteristics, measure applicability and saturations, occupant behavior, and customer interest in programs.[1]
2. Performed a market characterization to describe sector-level electricity and natural gas use for the residential, commercial, industrial, and street lighting sectors for the base year, 2014. This included using the results from the market research and other secondary data sources.
3. Developed a baseline projection of electricity and natural gas consumption by sector, segment, and end use for 2014 through 2036.
4. Defined and characterized several hundred measures to be applied to all sectors, segments, and end uses. Measure costs, savings, and lifetimes were taken from the Illinois TRM wherever available.
5. Estimated the market potential reductions to the baseline projection that could be expected from measures under four cases of energy-efficiency potential: *Technical, Economic, Maximum Achievable,* and *Realistic Achievable Potential*.
6. Developed estimates of program-level potential based on the market potential by assigning specific delivery mechanisms and program cost structures. Ameren Illinois' current DSM portfolio, as well as cross-cutting industry research and benchmarking, were used to inform this development and provide strategic program recommendations for achieving the identified savings.

[1] Details on the market research methodology and results are available in Volume 2, Market Research.

Figure 2-1 Potential Analysis Framework



Definitions of Potential

In this study, the energy efficiency potential estimates represent net savings[2] developed into several levels of potential. At the market or measure-level, before delivery mechanisms and program costs are considered, there are four levels: technical potential, economic potential, maximum achievable potential, and realistic achievable potential. Technical and economic potential are both theoretical limits to efficiency savings and would not be realizable in actual programs. The achievable potential cases embody a set of assumptions about the decisions consumers make regarding the efficiency of the equipment they purchase, the maintenance activities they undertake, the controls they use for energy-consuming equipment, and the elements of building construction. Because estimating achievable potential involves the inherent uncertainty of predicting human behaviors and responses to market conditions, we developed realistic and maximum achievable potential as boundaries for a likely range. Finally, at the program-level, delivery mechanisms and program costs are ascribed only to the achievable potential cases. The various levels are described below.

- **Technical Potential** is defined as the theoretical upper limit of energy efficiency potential. It assumes that customers adopt all feasible measures regardless of their cost. At the time of existing equipment failure, customers replace their equipment with the most efficient option

[2] Savings in "net" terms instead of "gross" terms mean that the baseline forecast does include naturally occurring efficiency. In other words, the baseline assumes that energy efficiency levels reflect that some customers are already purchasing the more efficient option.

available. In new construction, customers and developers also choose the most efficient equipment option.

Technical potential also assumes the adoption of every other available measure, where applicable. For example, it includes installation of high-efficiency windows in all new construction opportunities and air conditioner maintenance in all existing buildings with central and room air conditioning. These retrofit measures are phased in over a number of years to align with the stock turnover of related equipment units, rather than modeled as immediately available all at once.

- **Economic Potential** represents the adoption of all ***cost-effective*** energy efficiency measures. In this analysis, the cost-effectiveness is measured by the total resource cost (TRC) test, which compares lifetime energy and capacity benefits to the incremental cost of the measure. If the benefits outweigh the costs (that is, if the TRC ratio is greater than 1.0), a given measure is considered in the economic potential. Customers are then assumed to purchase the cost-effective option at any decision juncture.[3]
- **Achievable Market or Measure-Level Potential (Range between Maximum & Realistic)** refines economic potential by applying customer participation rates that account for market barriers, customer awareness and attitudes, program maturity, and other factors that affect market penetration of DSM measures. Maximum Achievable Potential assumes ideal market, implementation, and customer preference conditions, with well-established communication channels, trade allies and delivery partners, and high levels of incentives, administrative, and marketing costs. Realistic Achievable Potential reflects expected program participation given reasonable barriers to customer acceptance, non-ideal implementation conditions, and limited program budgets.
- **Achievable Program Potential (Range between Maximum & Realistic)** creates utility programs by bundling the individual measures and initiatives from the achievable market potential results. This includes the subset of measures that can realistically be implemented considering alignment with near-term implementation accomplishments and budgetary constraints, as well as long-term strategic goals and planning constraints. It ascribes delivery mechanisms and program costs to the market or measure-level achievable potential cases.

Models

AEG utilized two models to perform the potential analysis, detailed below.

LoadMAP Model

For the market characterization, baseline projection, and market potential analysis identified in steps 2 through 5 above, AEG used its Load Management Analysis and Planning tool (LoadMAP™) version 4.0. AEG developed LoadMAP in 2007 and has enhanced it over time, using it for the EPRI National Potential Study and numerous utility-specific forecasting and potential studies since. Built in Microsoft Excel®, the LoadMAP framework is both accessible and transparent and has the following key features.

- Embodies the basic principles of rigorous end-use models (such as EPRI's REEPS and COMMEND) but in a more simplified, accessible form.
- Includes stock-accounting algorithms that treat older, less efficient appliance/equipment stock separately from newer, more efficient equipment. Equipment is replaced according to the measure life and appliance vintage distributions defined by the user.
- Balances the competing needs of simplicity and robustness by incorporating important modeling details related to equipment saturations, efficiencies, vintage, and the like, where

[3] If faced with a mutually exclusive decision between multiple cost-effective options, the default model assumption is to assume the customer will select the option with the highest amount of energy savings.

market data are available, and treats end uses separately to account for varying importance and availability of data resources.

- Isolates new construction from existing equipment and buildings and treats purchase decisions for new construction and existing buildings separately.
- Uses a simple logic for appliance and equipment decisions. Other models available for this purpose embody complex decision choice algorithms or diffusion assumptions, and the model parameters tend to be difficult to estimate or observe and sometimes produce anomalous results that require calibration or even overriding. The LoadMAP approach allows the user to drive the appliance and equipment choices year by year directly in the model. This flexible approach allows users to import the results from diffusion models or to input individual assumptions.
- Includes appliance and equipment models customized by end use. For example, the logic for lighting is distinct from refrigerators and freezers.
- Can accommodate various levels of segmentation. Analysis can be performed at the sector level (e.g., total residential) or for customized segments within sectors (e.g., housing type or income level).
- Capable of incorporating energy-efficiency measures, demand-response options, combined heat and power (CHP) options, distributed generation options, and fuel switching.

Consistent with the segmentation scheme and the market profiles we describe below, the LoadMAP model provides forecasts of baseline energy use by sector, segment, end use, and technology for existing and new buildings. It also provides forecasts of total energy use and energy-efficiency savings associated with the various types of potential.[4]

BenCost Model

For the program-level potential analysis identified in step 6 above, AEG used its BenCost™ tool. This is a Microsoft Excel®-based modeling platform that uses the fundamental principles of cost-effectiveness economics and is consistent with industry best-practices, including the California Standard Practice Manual. Key features of the BenCost model include:

- Utility-Specific Inputs: BenCost is customized to accommodate inputs provided directly from the utility client. BenCost uses avoided costs, discounts rates, and DSM performance data provided by the client and can directly use client-specific results from AEG's LoadMAP model.
- Transparency: BenCost is not a "black-box" that obscures analysis details from users. The methodology, inputs, calculations, and assumptions used in the cost-effectiveness modeling are fully contained and populated when the model is delivered to our clients, along with training, in order to ensure understanding and transparency.
- Regulatory Compliance: AEG has submitted results from BenCost to regulatory agencies and stakeholder groups as part of formal DSM proceedings across multiple jurisdictions and regions of the country. Outputs are tailored to meet the precise reporting requirements established by regulatory commissions. For example, we routinely report results using various timeframes (annual, cumulative, etc.) and scenarios (net, gross, etc.).
- Rigorous Cost-Effectiveness Reporting: The model calculates all major benefit-cost tests and variants for each measure, program, and portfolio in each year examined; including the Total Resource Cost Test, Societal Cost Test, Participant Cost Test, Utility Cost Test (also known as the Program Administrator Cost Test) and Ratepayer Impact Measure Test. To support this and additional data interrogation, BenCost contains all the relevant metrics such as participation levels, net to gross ratios, per-unit savings, total savings, measure lifetimes,

[4] The model computes energy and peak-demand forecasts for each type of potential for each end use as an intermediate calculation. Annual-energy and peak-demand savings are calculated as the difference between the value in the baseline projection and the value in the potential forecast (e.g., the technical potential forecast).

benefit-to-cost ratios, levelized and first year cost per energy saved, net-present-values of costs and benefits, and others as required by the client.

Market Characterization

Now that we have described the modeling tools and provided the definitions of the potential cases, the first step in the analysis is market characterization. In order to estimate the savings potential from energy-efficient measures, it is necessary to understand how much energy is used today and what equipment is currently in service.

Segmentation for Modeling Purposes

The market characterization begins with a segmentation of Ameren Illinois's electricity and natural gas footprints to quantify energy use by sector, segment, fuel, end-use application, and the current set of technologies used. The segmentation scheme for this project is presented in Table 2-1.

Table 2-1 Overview of Ameren Illinois Analysis Segmentation Scheme

Dimension	Segmentation Variable	Description
1	Sector	Residential, commercial, industrial, street lighting
2	Segment	Residential (housing type) Commercial (Office, Restaurant, Retail, etc.) Industrial (Food Products, Petroleum, Metals, etc.) Street Lighting (Customer owned, Company owned)
3	Vintage	Existing and new construction
4	Fuel	Electricity, natural gas
5	End uses	Cooling, lighting, water heating, motors, etc. (as appropriate by sector)
6	Appliances/end uses and technologies	Technologies such as lamp type, air conditioning equipment, motors by application, etc.
7	Equipment efficiency levels for new purchases	Baseline and higher-efficiency options as appropriate for each technology

With the segmentation scheme defined, we then performed a high-level market characterization of electricity sales in the base year, 2014. We used Ameren Illinois billing and customer data, augmented by the market research and secondary sources as needed, to allocate energy use and customers to the various sectors and segments such that the total customer count and energy consumption matched the Ameren Illinois system totals from 2014 billing data. This information provided control totals at a sector level for calibrating the LoadMAP model to known data for the base-year.

Market Profiles

The next step was to develop market profiles for each sector, customer segment, end use, and technology. A market profile includes the following elements:

- **Market size** is a representation of the number of customers in the segment. For the residential sector, the unit we use is number of households. The commercial sector is floor space measured in square feet, the industrial sector in number of employees, and street lighting in number of fixtures.
- **Saturations** define the fraction of homes, square feet, or other market size unit that possess a given technology (e.g., homes with electric space heating).
- **UEC (unit energy consumption) or EUI (energy-use index)** describes the amount of energy consumed in the base year by a specific technology in buildings that have that

technology. UECs are expressed in kWh or therms per household for the residential sector. In the non-residential sectors, the same concept is referred to as EUIs, and is expressed in kWh or therms per square foot, per employee, or per fixture for the commercial, industrial, and street lighting sectors, respectively.

- **Annual Energy Intensity** for the residential sector represents the average energy use for the technology across all homes in the base year (2014). It is computed as the product of the saturation and the UEC and is defined as kWh per household for electricity and therms per household for natural gas. For the non-residential sectors, intensity is computed as the product of the saturation and the EUI, and represents the average use for the technology across all floor space, industrial employees, or fixtures in the base year.
- **Annual Usage** is the total annual energy used by each end-use technology in the segment. It is the product of the market size and intensity and is quantified in GWh or million therms (MMtherms).

The market characterization results are presented in Chapter 2.

Baseline Projection

The next step was to develop the baseline projections of annual electricity and natural gas use for 2014 through 2036 by customer segment and end use without new utility DSM programs. The end-use projection includes the relatively certain impacts of codes and standards that will unfold over the study timeframe. All such mandates that were defined as of June 2015 are included in the baseline. The baseline projection also includes projected naturally occurring energy efficiency during the potential forecast period. The baseline projection is the foundation for the analysis of savings from future efficiency cases and scenarios as well as the metric against which potential savings are measured.

Inputs to the baseline projection include:

- Current economic growth forecasts (i.e., customer growth, income growth)
- Electricity price forecasts
- Trends in fuel shares and equipment saturations
- Existing and approved changes to building codes and equipment standards
- Naturally occurring efficiency improvements, which include purchases of high-efficiency equipment options by early adopters.

We present the baseline-projection results for the system and each sector in Chapter 3.

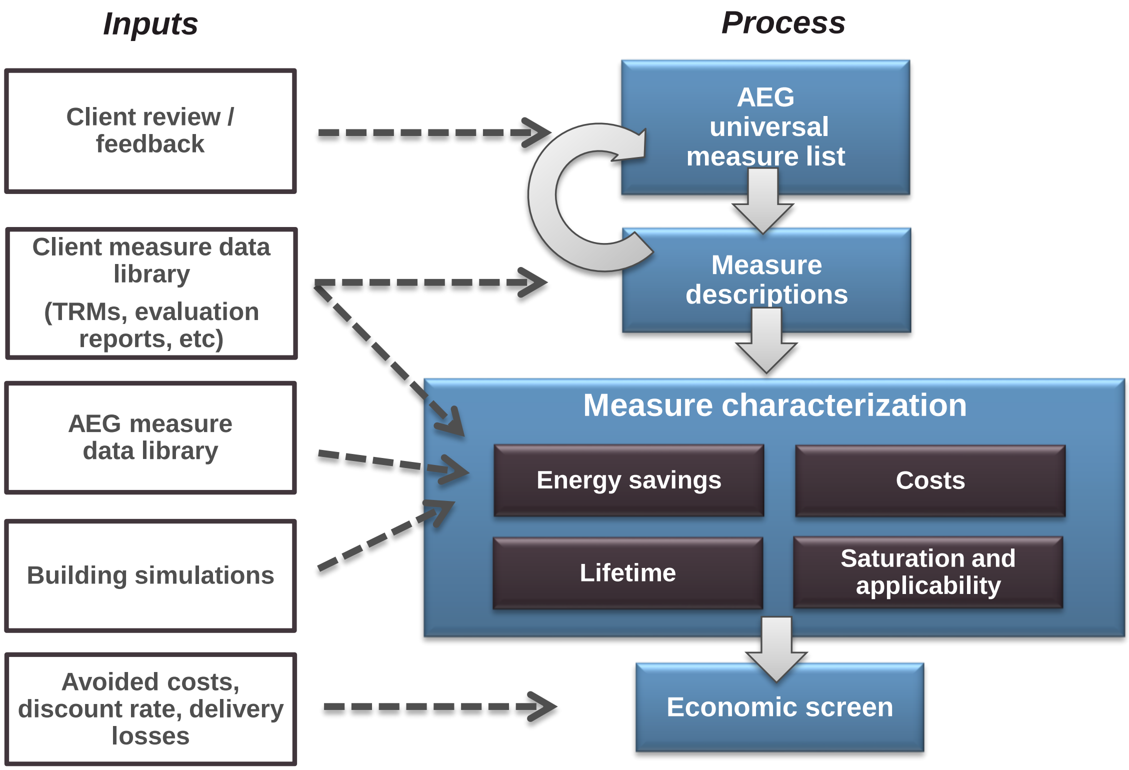
Energy Efficiency Measure Development

This section describes the framework used to assess the savings, costs, and other attributes of energy efficiency measures. These characteristics form the basis for measure-level cost-effectiveness analyses as well as for determining market savings. For all measures, AEG assembled information to reflect equipment performance, incremental costs, and equipment lifetimes. We used this information along with Ameren Illinois's avoided cost data in the economic screen to determine economically feasible measures.

Figure 2-2 outlines the framework for energy-efficiency measure analysis. The framework for assessing savings, costs, and other attributes of energy efficiency measures involves identifying the list of energy efficiency measures to include in the analysis, determining their applicability to each market sector and segment, fully characterizing each measure, and performing cost-effectiveness screening. Ameren Illinois provided feedback during each step of the process to ensure measure assumptions and results lined up with programmatic experience.

We compiled a robust list of energy efficiency measures for each customer sector, drawing upon Ameren Illinois program experience, the Illinois TRM, AEG's own measure databases and building simulation models, stakeholder input, and secondary sources. This universal list of EE measures covers all major types of end-use equipment, as well as devices and actions to reduce energy consumption. If considered today, some of these measures would not pass the economic screens but may pass in future years as a result of lower projected equipment costs or higher avoided cost benefits.

Figure 2-2 Approach for Energy-Efficiency Measure Assessment



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

- **Equipment measures** are efficient energy-consuming pieces of equipment that save energy by providing the same service with a lower energy requirement than a standard unit. An example is an ENERGY STAR refrigerator that replaces a standard efficiency refrigerator. For equipment measures, many efficiency levels may be available for a given technology, ranging from the baseline unit (often determined by code or standard) up to the most efficient product commercially available. For instance, in the case of central air conditioners, this list begins with the current federal standard SEER 13 unit and spans a broad spectrum up to a maximum efficiency of a SEER 24 unit.
- **Non-equipment measures** save energy by reducing the need for delivered energy, but do not involve replacement or purchase of major end-use equipment (such as a refrigerator or air conditioner). An example would be a programmable thermostat that is pre-set to run heating and cooling systems only when people are home. Non-equipment measures can apply to more than one end use. For instance, addition of wall insulation will affect the energy use of both space heating and cooling equipment. Non-equipment measures typically fall into one of the following categories:
    - Building shell (windows, insulation, roofing material)
    - Equipment controls (thermostat, energy management system)
    - Equipment maintenance (cleaning filters, changing setpoints)
    - Whole-building design (building orientation, passive solar lighting)

- Displacement measures (ceiling fan to reduce use of central air conditioners)
- Commissioning and retro commissioning (initial or ongoing monitoring of building energy systems to optimize energy use)

We developed a preliminary list of efficient measures, which was distributed to the Ameren Illinois team for review. The list was finalized after incorporating comments and is presented in the market potential, measure-level data as Volume 4, Appendix F.

Once we assembled the list of measures, AEG assessed their energy-saving characteristics. For each measure we also characterized incremental cost, service life, and other performance factors. Following the measure characterization, we performed an economic screening of each measure, which serves as the basis for developing the economic and achievable potential.

Representative Measure Data Inputs

To provide an example of the energy-efficiency measure data, Table 2-2 and Table 2-3 present examples of the detailed data inputs behind both equipment and non-equipment measures, respectively, for the case of residential central air conditioners in single-family homes. Table 2-2 displays the various efficiency levels available as equipment measures, as well as the corresponding useful life, energy usage, and cost estimates. The columns labeled On Market and Off Market reflect equipment availability due to codes and standards or the entry of new products to the market.

Table 2-2 Example Equipment Measures for Central AC – Single-Family Home

Efficiency Level	Useful Life (years)	Equipment Cost	Energy Usage (kWh/yr)	On Market	Off Market
SEER 13	12 to 24	$3,104	1,965	2014	n/a
SEER 14.5 (Energy Star)	12 to 24	$3,492	1,761	2014	n/a
SEER 15 (CEE Tier 2)	12 to 24	$3,880	1,703	2014	n/a
SEER 16 (CEE Tier 3)	12 to 24	$4,268	1,596	2014	n/a
SEER 18	12 to 24	$5,047	1,419	2014	n/a
SEER 21	12 to 24	$6,064	1,216	2014	n/a
SEER 24 (Ductless, Var. Ref. Flow)	12 to 24	$5,928	1,064	2014	n/a

Table 2-3 lists some of the non-equipment measures applicable to CAC in an existing single-family home. All measures are evaluated for cost-effectiveness based on the lifetime benefits relative to the cost of the measure. The total savings, costs, and monetized non-electric benefits are calculated for each year of the study and depend on the base year saturation of the measure, the applicability[5] of the measure, and the savings as a percentage of the relevant energy end uses.

Table 2-3 Example Non-Equipment Measures – Single Family Home, Existing

End Use	Measure	Saturation in 2013[6]	Applicability	Lifetime (years)	Measure Installed Cost	Energy Savings (%)
Cooling	Insulation - Ceiling	43%	75%	25	$779	5.2%
Cooling	Insulation - Ducting	52%	60%	20	$542	2.9%
Cooling	Insulation - Floor	49%	52%	25	$295	3.2%
Cooling	Building Shell - Air Sealing	34%	47%	15	$428	47.0%

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

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

Screening Measures for Cost-Effectiveness

Only measures that are cost-effective are included in economic and achievable potential. Therefore, for each individual measure, LoadMAP performs an economic screen. This study uses the TRC test that compares the lifetime energy and peak demand benefits of each applicable measure with its cost. The lifetime benefits are calculated by multiplying the annual energy and demand savings for each measure by all appropriate avoided costs for each year, and discounting the dollar savings to the present value equivalent. Lifetime costs represent incremental measure cost and annual O&M costs. The analysis uses each measure's values for savings, costs, and lifetimes that were developed as part of the measure characterization process described above.

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

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

- The economic evaluation of every measure in the screen is conducted relative to a baseline condition. For instance, in order to determine the kilowatt-hour (kWh) savings potential of a measure, kWh consumption with the measure applied must be compared to the kWh consumption of a baseline condition.
- The economic screening was conducted only for measures that are applicable to each building type and vintage; thus if a measure is deemed to be irrelevant to a particular building type and vintage, it is excluded from the respective economic screen.
- The economic screen at the measure level does not include any assumption about program delivery costs. Those are considered in the assessment of program potential.

Table 2-4 summarizes the number of electric measures evaluated for each segment within each sector. Table 2-5 does the same for natural gas measures. The total individual measure types are listed in the first column, each of which is considered independently for two construction vintages (existing buildings and new construction). This multiplies the number of modeled measure permutations by two. Then each measure is considered across all the relevant market segments in the sector, further multiplying the number of permutations. There are eight residential market segments as listed in Table 3-2, ten commercial segments as shown in Table 3-6, six industrial segments as shown in Table 3-10, and seven street lighting segments as shown in Table 3-14.

Table 2-4 Number of Electric Measures Evaluated

Sector	Total Measures	Measure Permutations w/ 2 Vintages	Measure Permutations w/ All Segments
Residential	82	164	1,312
Commercial	109	218	2,180
Industrial	80	160	960
Street Lighting	2	4	28
Total Measures Evaluated	**273**	**546**	**4,480**

Table 2-5 Number of Natural Gas Measures Evaluated

Sector	Total Measures	Measure Permutations w/ 2 Vintages	Measure Permutations w/ All Segments
Residential	38	76	608
Commercial	46	92	920
Industrial	31	62	372
Street Lighting	0	0	0
Total Measures Evaluated	**115**	**230**	**1,900**

Calculation of Energy Efficiency Potential

The approach we used for this study to calculate the energy efficiency potential adheres to the approaches and conventions outlined in National Action Plan for Energy-Efficiency (NAPEE) Guide for Conducting Potential Studies.[7] The NAPEE represents the most credible and comprehensive industry practice for specifying energy efficiency potential.

The calculation of **Technical** and **Economic Potential** is a straightforward algorithm, phasing in the theoretical maximum efficiency units and screening them for cost-effective economics. To develop estimates for **Achievable Potential**, we develop market adoption rates for each measure that specify the percentage of customers that will select the highest–efficiency economic option. The market adoption rates (or take rates) are developed based on the results of the program interest surveys that were conducted as part of the primary market research, as detailed in Volume 2 of this report. This allows us to most accurately reflect the attitudes and preferences of Ameren Illinois' customers.

For the Realistic Achievable case, we used the "base" take rates, which generally aligned with measures that have a moderate, 3-year payback period and no special factors increasing or decreasing the attractiveness. Take rates in the Maximum Achievable case were based on customer responses to measures in the surveys with the most attractive paybacks (1-year or instantaneous) and the most attractive contextual scenarios, including non-energy benefits, delivery mechanism, etc. The take rates developed in the surveys were compared to past program accomplishments at Ameren Illinois and other comparable utilities, as well as adoption rates used in other potential studies, and found to be in good alignment.

Based on AEG's experience with market research, program implementation, and program evaluation with utilities in this and other markets, we estimate that the take rates will increase slightly each year as the program and awareness ramps up. Therefore we increase the base year take rates by 0.5% per year. As an example, a take rate that begins in year 1 at 30% would rise to 30.5% in year 2, and eventually reach 40% by year 20 of the study.

Potential is divided into measures of three different categories at this stage:

- Traditional Measures
- Behavioral Measures (Those focused on habits, operations, and non-purchase behaviors; namely: Home Energy Reports, Strategic Energy Management, Commissioning, and Retrocommissioning)
- Combined Heat & Power Measures

The analytical treatment of these measure categories is one and the same as described above in this section, but these categories provide a useful framework for different application of policy and program planning.

The energy efficiency potential results are available in Chapter 5.

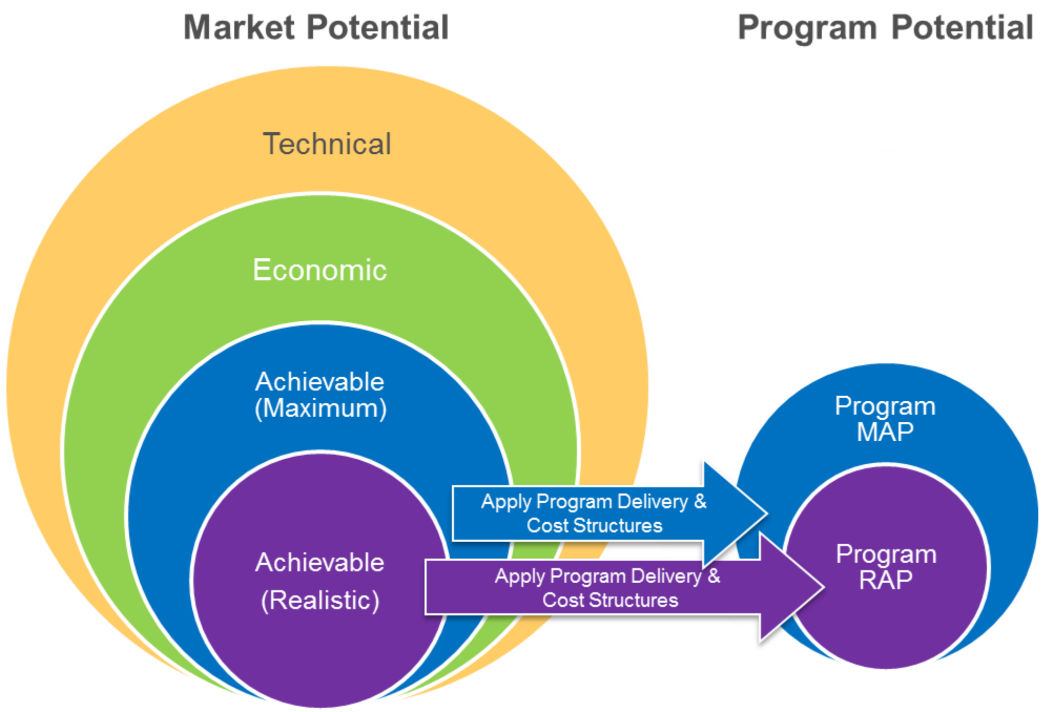
Development of Program Potential

Once the measure level results were developed, AEG worked closely with the Ameren Illinois team to develop effective programs based on their recent experience and industry best practices.

Technical & economic potential are theoretical constructs, and therefore cannot be realized in actual markets. Measure-level achievable potential is determined by applying take-rates for achievable customer adoption. Measure-level potential must be translated into programs with realizable delivery, measure-bundling, and cost structures.

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

Figure 2-3 Program Potential Levels



General considerations when translating from Measure-level potential to Program-level potential:

- Consider measure bundles that include measures that are not cost-effective on a stand-alone basis
- May include multiple efficiency levels for a particular technology
- May exclude some measures that have very small potential or are challenging to implement
- Adds program administrative & delivery costs may render certain measures or bundles not cost-effective
- May adjust participation rates to reflect priorities
- Net to gross and realization rates may affect savings

This study is developing preliminary estimates of program potential that will be refined into program designs in a separate effort in 2016

Details about program design are presented in Chapter 5.

Supply Curves

Based on the results of the program design step, AEG then developed several supply curves to match a variety of scenarios:

- Realistic and Maximum Achievable Program Potential for Residential and Business portfolios and programs
- Program Potential for Residential and Business portfolios and programs by 0.5% increments above rate cap spending limits all the way to the estimated limit of achievable potential

Additional information about supply curve development is presented in Chapter 6.

Data Development

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

Data Sources

The data sources are organized into the following categories:

- Ameren-specific data
- AEG's databases and analysis tools
- Other secondary data and reports

Ameren-Specific Data

Our highest priority data sources for this study were those that were specific to Ameren Illinois.

- **Utility 2014 billing data.** The data request included billing data for 2014, the most recent year that complete billing data was available. Ameren Illinois provided 2014 electricity sales, natural gas sales, customers by sector, and customer contact information for the primary market research, etc.
- **Utility forecasts:** Ameren Illinois provided a customer growth forecast by sector; energy (electricity and natural gas) and peak demand sales forecasts at the sector level; and retail price history and forecast, where available.
- **Economic information:** Ameren Illinois provided the avoided costs, discount rate, and line loss factor.
- **Primary market research:** As part of the study, AEG conducted customer surveys to characterize equipment and measure saturation, as well as customer interest in energy efficiency measures and programs.
- **Illinois Statewide Technical Reference Manual (TRM):** AEG used the latest version of the Illinois TRM (v4.0) that went into effect in June 2015. The TRM was used for characterizing the energy efficiency measures evaluated as part of the study.

AEG Data

AEG maintains several databases and modeling tools that we use for forecasting and potential studies. Relevant data from these tools has been incorporated into the analysis and deliverables for this study.

- **AEG's Database of Energy Efficiency Measures (DEEM).** AEG maintains an extensive database of measure data for our studies. Our database draws upon reliable sources including the California Database for Energy Efficient Resources (DEER), the EIA Technology Forecast Updates – Residential and Commercial Building Technologies – Reference Case, RS Means cost data, and Grainger Catalog Cost data.
- **AEG Energy Market Profiles.** For more than 10 years, AEG staff has maintained profiles of end-use consumption for the residential, commercial, and industrial sectors. These profiles include market size, fuel shares, unit consumption estimates, and annual energy use by fuel (electricity and natural gas), customer segment and end use for 10 regions in the U.S. The Energy Information Administration surveys (RECS, CBECS and MECS) as well as state-level statistics and local customer research provide the foundation for these regional profiles.
- **Building Energy Simulation Tool (BEST).** AEG's BEST is a derivative of the DOE 2.2 building simulation model, used to estimate base-year UECs and EUIs, as well as measure savings for the HVAC-related measures.
- **AEG's EnergyShape™.** This database of load shapes includes the following:

  - Residential – electric load shapes for ten regions, three housing types, 13 end uses
  - Commercial – electric load shapes for nine regions, 54 building types, ten end uses
  - Industrial – electric load shapes, whole facility only, 19 2-digit SIC codes, as well as various 3-digit and 4-digit SIC codes
- **Recent studies**. AEG has conducted numerous studies of EE potential in the last five years. We checked our input assumptions and analysis results against the results from these other studies. In addition, we used the information about impacts of building codes and appliance standards from recent reports for the Edison Electric Institute[8].

Other Secondary Data and Reports

Finally, a variety of secondary data sources and reports were used for this study. The main sources are identified below.

- **Annual Energy Outlook**. The Annual Energy Outlook (AEO), conducted each year by the U.S. Energy Information Administration (EIA), presents yearly projections and analysis of energy topics. For this study, we used data from the 2015 AEO.
- **American Community Survey.** The US Census American Community Survey is an ongoing survey that provides data every year on household characteristics. Data for Ameren Illinois were available for this study. http://www.census.gov/acs/www/
- **Local Weather Data**. Weather from NOAA's National Climatic Data Center for Springfield, IL was used where applicable.
- **EPRI End-Use Models (REEPS and COMMEND)**. These models provide the energy-use elasticities we apply to electricity prices, household income, home size and heating and cooling.
- **Database for Energy Efficient Resources (DEER).** The California Energy Commission and California Public Utilities Commission (CPUC) sponsor this database, which is designed to provide well-documented estimates of energy and peak demand savings values, measure costs, and effective useful life (EUL) for the state of California. We used the DEER database to cross check the measure savings we developed using BEST and DEEM.
- **Northwest Power and Conservation Council workbooks.** To develop its Power Plan, the Council and its Regional Technical Forum maintain workbooks with detailed information about measures.
- **Other relevant regional sources:** These include reports from the Consortium for Energy Efficiency, the EPA, and the American Council for an Energy-Efficient Economy.

Application of Data to the Analysis

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

Data Application for Market Characterization

To construct the high-level market characterization of electricity use and market size units (households for residential, floor space for commercial, employees for industrial, and fixtures for street lighting), we primarily used Ameren Illinois billing data as well as secondary data from AEG's Energy Market Profiles database.

[8] AEG staff has prepared three white papers on the topic of factors that affect U.S. electricity consumption, including appliance standards and building codes. Links to all three white papers are provided:
http://www.edisonfoundation.net/IEE/Documents/IEE_RohmundApplianceStandardsEfficiencyCodes1209.pdf
http://www.edisonfoundation.net/iee/Documents/IEE_CodesandStandardsAssessment_2010-2025_UPDATE.pdf.
http://www.edisonfoundation.net/iee/Documents/IEE_FactorsAffectingUSElecConsumption_Final.pdf

Data Application for Market Profiles

The specific data elements for the market profiles, together with the key data sources, are shown in Table 2-6 below. To develop the market profiles for each segment, we used the following approach:

1. Developed control totals for each segment. These include market size, segment-level annual electricity use, and annual intensity.
2. Ameren Illinois customer surveys to allocate residential customers by housing type. This was compared to American Community Survey (ACS) and other Ameren Illinois studies.
3. Ameren Illinois billing data and customer surveys to estimate sales and square footage by building type for the commercial sector. The estimates were also compared with EIA, AEO 2015 and our Energy Market Profiles Database.
4. Ameren Illinois billing data and customer surveys to estimate energy use by industry type and employment for the industrial sector. These estimates were then compared to EIA, Bureau of Labor Statistics and AEO 2015 data.
5. Ameren Illinois billing data to develop the energy use and fixture count by category for the street lighting sector.
6. Ensured calibration to control totals for annual electricity and natural gas sales in each sector and segment.
7. Compared and cross-checked with other recent AEG studies.
8. Worked with Ameren Illinois staff to vet the data against their knowledge and experience.

Table 2-6 Data Applied for the Market Profiles

Model Inputs	Description	Key Sources
Market size	Base-year residential dwellings, commercial floor space, industrial employment, street lighting fixture count.	Ameren Illinois account database Primary market research surveys Ameren Illinois Load Forecasting AEO 2015
Annual intensity	Residential: Annual use per household Commercial: Annual use per square foot Industrial: Annual use per employee Street Lighting: Annual use per fixture	Ameren Illinois account database Primary market research surveys AEG's Energy Market Profiles AEO 2015 Other recent studies
Appliance/equipment saturations	Fraction of dwellings with an appliance/technology Percentage of C&I floor space/employment with equipment/technology	Primary market research surveys American Community Survey AEG's Energy Market Profiles Ameren Illinois Load Forecast
UEC/EUI for each end-use technology	UEC: Annual electricity use in homes and buildings that have the technology EUI: Annual electricity use per square foot/employee for a technology in floor space that has the technology	HVAC uses: BEST simulations using prototypes developed for Ameren Illinois Engineering analysis AEG's DEEM Recent AEG studies
Appliance/equipment age distribution	Age distribution for each technology	AEG's DEEM Recent AEG studies
Efficiency options for each technology	List of available efficiency options and annual energy use for each technology	IL TRM AEG's DEEM AEO 2015 NWPCC workbooks, RTF, DEER Recent AEG studies
Load Shapes	Share of technology energy use that occurs during each hour of the year	AEG EnergyShape database

Data Application for Baseline Projection

Table 2-7 summarizes the LoadMAP model inputs required for the baseline projection. These inputs are required for each segment within each sector, as well as for new construction and existing dwellings/buildings.

Table 2-7 Data Applied for the Baseline Projection in LoadMAP

Model Inputs	Description	Key Sources
Customer growth forecasts	Forecasts of new construction / new customers in all sectors	Ameren Illinois load forecast AEO 2015 economic growth forecast
Equipment purchase shares for baseline projection	For each equipment/technology, purchase shares for each efficiency level; specified separately for existing equipment replacement and new construction	Shipments data from AEO AEO 2015 regional forecast assumptions[9] Appliance/efficiency standards analysis Ameren Illinois program results and evaluation reports
Electricity prices	Forecast of average energy and capacity avoided costs and retail prices	Ameren Illinois forecasts
Utilization model parameters	Price elasticities, elasticities for other variables (income, weather)	EPRI's REEPS and COMMEND models AEO 2015

In addition, assumptions were incorporated for known future equipment standards as of June 2015, as shown in Table 2-8, Table 2-10 and

Table 2-12. The assumptions tables here extend through 2025, after which all standards are assumed to hold steady.

Note that we have anticipated one equipment standard that has not officially been signed into law yet, and that is the revision of the once-repealed but re-drafted residential natural gas furnace efficiency standard. We have assumed that the current talks among DOE and industry stakeholders will result in a natural gas furnace standard of 0.92 AFUE beginning in 2021.

[9] We developed baseline purchase decisions using the Energy Information Agency's *Annual Energy Outlook* report (2015), which utilizes the National Energy Modeling System (NEMS) to produce a self-consistent supply and demand economic model. We calibrated equipment purchase options to match distributions/allocations of efficiency levels to manufacturer shipment data for recent years and then based naturally occurring efficiency in the market's purchase decisions on AEO's projections into the future.

Table 2-8 Residential Electric Equipment Standards

2013 Efficiency or Standard Assumption
1st Standard (relative to 2013's standard)
2nd Standard (relative to 2013's standard)

End Use	Technology	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Cooling	Central AC	SEER 13												
	Room AC	EER 9.8	EER 11.0											
Space Heating	Electric Resistance	Space Heating												
Cooling/Heating	Heat Pump	SEER 13.0/HSPF 7.7		SEER 14.0/HSPF 8.0										
Water Heating	Water Heater (<=55 gallons)	EF 0.90		EF 0.95										
	Water Heater (>55 gallons)	EF 0.90		Heat Pump Water Heater										
Lighting	Screw-in/Pin Lamps	Incandescent	Advanced Incandescent - tier 1 (20 lumens/watt)						Advanced Incandescent - tier 2 (45 lumens/watt)					
	Linear Fluorescent	T8 (89 lumens/watt)					T8 (92.5 lumens/watt)							
Appliances	Refrigerator	NAECA Standard	25% more efficient											
	Freezer	NAECA Standard	25% more efficient											
	Clothes Washer	MEF 1.26 for top loader		MEF 1.72 for top loader			MEF 2.0 for top loader							
	Clothes Dryer	Conventional (EF 3.01)		5% more efficient (EF 3.17)										
Miscellaneous	Furnace Fans	Conventional						40% more efficient						

Table 2-9 Residential Natural Gas Equipment Standards

2013's Efficiency or Standard Assumption
1st Standard (relative to 2013's standard)
2nd Standard (relative to 2013's standard)

End Use	Technology	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Space Heating	Furnace	AFUE 78%/AFUE 75% (MH)		AFUE 80% (Non-weatherized)/ AFUE 81% (weatherized)						AFUE 92% (not yet signed into law)				
	Boiler	AFUE 82%												
Water Heating	Water Heater (<=55 gallons)	EF 0.59		EF 0.62										
	Water Heater (>55 gallons)	EF 0.59		Condensing Technology										
Appliances	Clothes Dryer	Conventional (EF 2.67)		EF 3.30										

Table 2-10 Commercial Electric Equipment Standards

- 2013 Efficiency or Standard Assumption
- 1st Standard (relative to 2013's standard)
- 2nd Standard (relative to 2013's standard)

<table>
<tr><th>End Use</th><th>Technology</th><th>2013</th><th>2014</th><th>2015</th><th>2016</th><th>2017</th><th>2018</th><th>2019</th><th>2020</th><th>2021</th><th>2022</th><th>2023</th><th>2024</th><th>2025</th></tr>
<tr><td rowspan="3">Cooling</td><td>Chillers</td><td colspan="13">2007 ASHRAE 90.1</td></tr>
<tr><td>Roof Top Units</td><td colspan="13">EER 11.0/11.2</td></tr>
<tr><td>Packaged Terminal AC/HP</td><td colspan="13">EER 11.0/11.2</td></tr>
<tr><td>Cooling/Heating</td><td>Heat Pump</td><td colspan="13">EER 11.0/COP 3.3</td></tr>
<tr><td>Ventilation</td><td>Ventilation</td><td colspan="13">Constant Air Volume/Variable Air Volume</td></tr>
<tr><td rowspan="3">Lighting</td><td>Screw-in/Pin Lamps</td><td>Incandescent</td><td colspan="6">Advanced Incandescent - tier 1 (20 lumens/watt)</td><td colspan="6">Advanced Incandescent - tier 2 (45 lumens/watt)</td></tr>
<tr><td>Linear Fluorescent</td><td colspan="5">T8 (89 lumens/watt)</td><td colspan="8">T8 (92.5 lumens/watt)</td></tr>
<tr><td>High Intensity Discharge</td><td colspan="4">EPACT 2005 (Mercury Vapor Fixture Phase-out)</td><td colspan="9">Metal Halide Ballast Improvement</td></tr>
<tr><td>Water Heating</td><td>Water Heater</td><td colspan="13">EF 0.97</td></tr>
<tr><td rowspan="6">Refrigeration</td><td>Walk-in Refrigerator/Freezer</td><td colspan="4">EISA 2007 Standard</td><td colspan="9">10-38% more efficient</td></tr>
<tr><td>Reach-in Refrigerator</td><td colspan="4">EPACT 2005 Standard</td><td colspan="9">40% more efficient</td></tr>
<tr><td>Glass Door Display</td><td colspan="4">EPACT 2005 Standard</td><td colspan="9">12-28% more efficient</td></tr>
<tr><td>Open Display Case</td><td colspan="4">EPACT 2005 Standard</td><td colspan="9">10-20% more efficient</td></tr>
<tr><td>Vending Machines</td><td colspan="13">33% more efficient than EPAC 2005 Standard</td></tr>
<tr><td>Ice maker</td><td colspan="5">2010 Standard</td><td colspan="8">15% more efficient</td></tr>
<tr><td>Miscellaneous</td><td>Non-HVAC Motors</td><td colspan="3">EISA 2007 Standards</td><td colspan="10">Expanded EISA 2007 Standards</td></tr>
</table>

Table 2-11 Commercial Natural Gas Equipment Standards

- 2013 Efficiency or Standard Assumption

<table>
<tr><th>End Use</th><th>Technology</th><th>2013</th><th>2014</th><th>2015</th><th>2016</th><th>2017</th><th>2018</th><th>2019</th><th>2020</th><th>2021</th><th>2022</th><th>2023</th><th>2024</th><th>2025</th></tr>
<tr><td rowspan="2">Space Heating</td><td>Furnace</td><td colspan="13">80% thermal efficiency</td></tr>
<tr><td>Boiler</td><td colspan="13">80% thermal efficiency</td></tr>
<tr><td>Water Heating</td><td>Water Heater</td><td colspan="13">80% thermal efficiency</td></tr>
<tr><td>Miscellaneous</td><td>Pool Heater</td><td colspan="13">EF 0.82</td></tr>
</table>

Table 2-12 Industrial Electric Equipment Standards

2013 Efficiency or Standard Assumption
1st Standard (relative to 2013's standard)
2nd Standard (relative to 2013's standard)

End Use	Technology	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Cooling	Chillers	2007 ASHRAE 90.1												
	Roof Top Units	EER 11.0/11.2												
	Packaged Terminal AC/HP	EER 11.0												
Cooling/Heating	Heat Pump	EER 11.0/COP 3.3												
Ventilation	Ventilation	Constant Air Volume/Variable Air Volume												
Lighting	Screw-in/Pin Lamps	Incandescent	Advanced Incandescent - tier 1 (20 lumens/watt)						Advanced Incandescent - tier 2 (45 lumens/watt)					
	Linear Fluorescent	T8 (89 lumens/watt)					T8 (92.5 lumens/watt)							
	High Intensity Discharge	EPACT 2005 (Mercury Vapor Fixture Phase-out)				Metal Halide Ballast Improvement								
Motors	Pumps, Fans & Blowers, Compressed Air, Material Handling and Processing	EISA 2007 Standards			Expanded EISA 2007 Standards									

Table 2-13 Industrial Natural Gas Equipment Standards

2013 Efficiency or Standard Assumption

End Use	Technology	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Space Heating	Furnace	80% thermal efficiency												
	Boiler	80% thermal efficiency												

Energy Efficiency Measure Data Application

Table 2-14 details the energy-efficiency data inputs to the LoadMAP model. It describes each input and identifies the key sources used in the Ameren Illinois analysis.

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

Model Inputs	Description	Key Sources
Energy Impacts	The annual reduction in consumption attributable to each specific measure. Savings were developed as a percentage of the energy end use that the measure affects.	IL TRM AEG's DEEM AEO 2015 AEG's BEST Other secondary sources
Peak Demand Impacts	Savings during the peak demand periods are specified for each electric measure. These impacts relate to the energy savings and depend on the extent to which each measure is coincident with the system peak.	IL TRM 8760 Hourly load shapes developed from AEG's EnergyShape database
Costs	Equipment Measures: Includes the full cost of purchasing and installing the equipment on a per-unit basis. Non-equipment measures: Existing buildings – full installed cost. New Construction - the costs may be either the full cost of the measure, or as appropriate, it may be the incremental cost of upgrading from a standard level to a higher efficiency level.	IL TRM AEG's DEEM AEO 2015 RS Means Other secondary sources
Measure Lifetimes	Estimates derived from the technical data and secondary data sources that support the measure demand and energy savings analysis.	IL TRM AEG's DEEM AEO 2015 Other secondary sources
Applicability	Estimate of the percentage of dwellings in the residential sector, square feet in the commercial sector, employees in the industrial sector, or fixtures in the street lighting sector where the measure is applicable and where it is technically feasible to implement.	IL TRM Primary market research surveys AEG's DEEM NWPCC workbooks, RTF, DEER Other secondary sources
On Market and Off Market Availability	Expressed as years for equipment measures to reflect when the equipment technology is available or no longer available in the market.	AEG appliance standards and building codes analysis

Data Application for Cost-effectiveness Screening

To perform the cost-effectiveness screening, a number of economic assumptions were needed. All cost and benefit values were analyzed as real 2014 dollars. We applied a discount rate of 5.47% in real dollars, which corresponds to a nominal discount rate of 7.58% with inflation of 2.00% annually.

All impacts in this report are presented at the customer meter. Electric energy delivery losses of 6.72% and natural gas delivery losses of 0.006% were provided by Ameren Illinois and used to convert impacts to the system level for economic analysis.

Estimates of Customer Adoption

To estimate achievable potentials, three sets of parameters were developed to account for the decision-making behavior of humans in the efficiency marketplace.

- **Adoption curves for non-equipment measures**. Equipment measures are installed when existing units fail. Non-equipment measures, however, do not have this natural periodicity. Rather than installing all available non-equipment measures in the first year of the projection (instantaneous potential), they are phased in according to adoption schedules that vary based on cost and complexity. The adoption rates used in this analysis take several factors into account to determine how quickly the market can absorb these measures. Typically, measures that cause disruption to the building, such as wall insulation in existing buildings, receive longer adoption curves, while those with drop-in installations, such as programmable thermostats in new buildings, receive shorter ones. High capital cost measures will also receive longer adoption curves than ones with low capital cost. These adoption rates are used within LoadMAP to generate the Technical and Economic potentials. In general, the rates align with the diffusion of similar equipment measures.
- **Maximum Achievable adoption rates**. These factors are applied to Economic potential to estimate the upper bound of Maximum Achievable potential. These estimate customer adoption of economic measures when delivered through efficiency programs under ideal market, implementation, and customer preference conditions. Information channels are assumed to be established and efficient for marketing, educating consumers, and coordinating with trade allies and delivery partners. These adoption rates are based on the responses of Ameren Illinois customers to market research surveys as calibrated to actual Ameren program history, as described in Volume 2 of this report. The MAP adoption rates come from the survey questions with the fastest economic paybacks and the best non-economic situations and scenarios. Maximum Achievable Potential establishes a maximum target for the EE savings that an administrator can hope to achieve through its EE programs and involves incentives that represent a substantial portion of the incremental cost combined with high administrative and marketing costs.
- **Realistic Achievable adoption rates**. These factors are applied to Economic potential to calculate Realistic Achievable Potential. The Realistic Achievable adoption rates are based on the market research as described in Volume 2, similar to the MAP adoption rates, except that they align with the medium or middle-range economic payback scenarios with no special boost from non-economic factors such as better features, non-energy benefits, optimal delivery mechanism, etc. These adoption rates reflect expected program participation given realistic barriers to customer acceptance, non-ideal implementation conditions, and limited program budgets.

Realistic Achievable and Maximum Achievable adoption rates are presented in Volume 4 Appendix C. The development of the take rates are detailed in Volume 2.

Market Characterization

In this section, we describe how customers in the Ameren Illinois service territory use electricity in the base year of the study, 2014. It begins with a high-level summary of energy use across all sectors and then delves into each sector in more detail.

Overall Energy Use Summary

The total consumption figures for Ameren Illinois in 2014 were 36,307 GWh and 787 million therms. As shown in Figure 3-1 and Table 3-1, the residential, commercial, and industrial sectors comprise a relatively even split for electricity consumption, accounting for 32%, 34%, and 34% of annual energy use respectively. Street lighting is a relatively small portion at 1%. For natural gas, the largest relevant load is residential at 46%, while commercial and industrial are smaller at 16% and 38% respectively. The relevant industrial natural gas load for this study is smaller than Ameren Illinois' actual system load since there is a downward adjustment of approximately one half of this sector to account for large self-direct customers. These opt-out customers have been removed since they have elected not to participate in energy efficiency programs and are therefore not applicable to the analysis.

Figure 3-1 Ameren Illinois Sector-Level Energy Use in Base Year, 2014

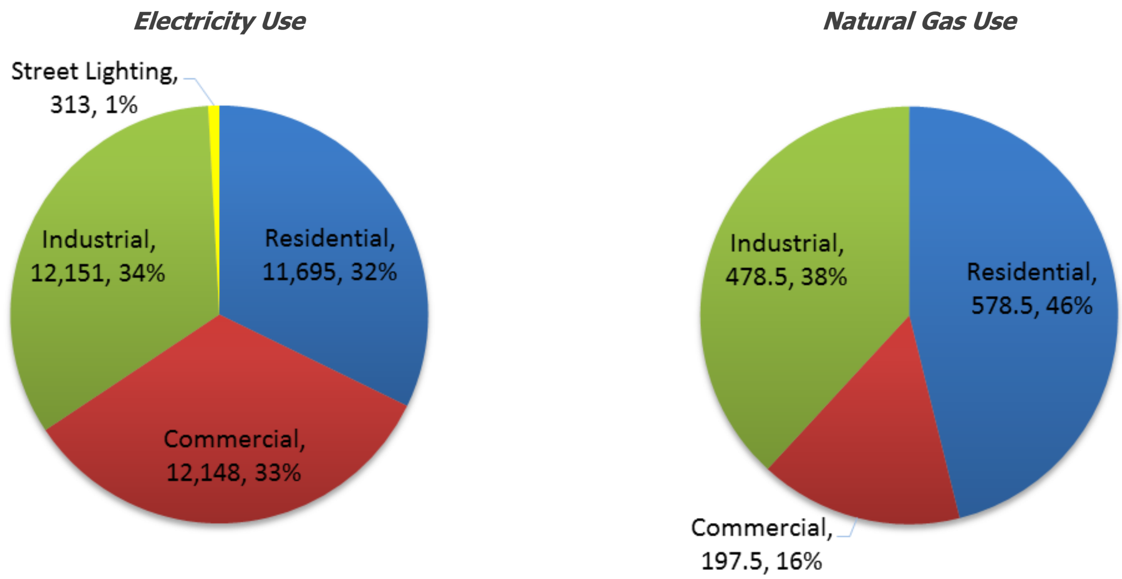


Table 3-1 Ameren Illinois Sector Control Totals (2014)

Sector	Number of Electric Customers	Annual Electricity Use (GWh)	% of Annual Use	Number of Natural Gas Customers	Annual Natural Gas Use (MMtherms)	% of Annual Use
Residential	1,062,644	11,695	32.2%	747,088	578.5	46.1%
Commercial	154,997	12,148	33.5%	62,549	197.5	15.7%
Industrial	1,004	12,151	33.5%	175	478.5	38.1%
Street Lighting	-	313	0.9%	-	-	-
Total	**1,218,645**	**36,307**	**100%**	**809,812**	**787.3**	**100%**

Residential Sector

In 2014, there were over 1 million households in the Ameren Illinois territory that used a total of 11,695 GWh. Therefore, average electricity use per household was 11,006 kWh, including both electric and non-electric heat. The survey data were used to estimate controls total for each of the eight residential segments, as shown in Table 3-2. Individual household consumption varies according to house size, house age presence of natural gas or secondary heat, and appliance holdings.

Table 3-2 Residential Electricity Sector Control Totals (2014)

Segment	Number of Customers	Electricity Sales (GWh)	% of Total Usage	Avg. Use / Customer (kWh)	Peak Demand Summer (MW)	Peak Demand Winter (MW)
Single Family	463,394	5,232	45%	11,290	1,588	1,130
Multi Family	41,784	325	3%	7,776	72	88
Single Family - Elec Heat	93,187	1669	14%	17,907	267	558
Multi Family - Elec Heat	23431	229	0.02	9784	32	84
Single Family - Low Income	258192	2475	0.21	9586	783	498
Multi Family - Low Income	69582	459	0.04	6603	148	107
Single Family - Low Income, Elec Heat	46,114	728	6%	15,796	112	238
Multi Family - Low Income, Elec Heat	66,960	578	5%	8,630	79	205
Total	**1,062,644**	**11,695**	**100%**	**11,006**	**3,082**	**2,908**

Figure 3-2 shows the average distribution of annual electricity use by end use for all customers. Four main electricity end uses — appliances, cooling, electronics, and heating — account for 65% of total use. Appliances include refrigerators, freezers, stoves, clothes washers, clothes dryers, dishwashers, and microwaves. The remainder of the energy falls into water heating, lighting, and the miscellaneous category – which is comprised of furnace fans, pool pumps, and other "plug" loads (all other usage, such as hair dryers, power tools, coffee makers, etc.). Figure 3-2 would look significantly different for natural gas versus and electrically heated homes. Based on the market research, an average of 26% of survey respondents use electricity for space heating (see Volume 2).

Overall, lighting and electronics usage has decreased since the 2013 potential study. Between the two studies, efficient lamp purchases increased, resulting in efficient lighting comprising a larger portion of the equipment stock. Households have replaced large PCs with tablets/laptops and set-top boxes with streaming devices.[10]

Figure 3-3 presents the electricity intensities by end use and housing type. Single family, non-low income homes with electric heat have the highest use per customer at 17,907 kWh/year, reflecting a higher saturation of electric space heating.

[10] "Ameren Illinois Energy Efficiency Market Potential Study Assessment." July 2013. http://www.ilsag.info/potential-studies.html

Figure 3-2 Residential Electricity Use by End Use (2014)

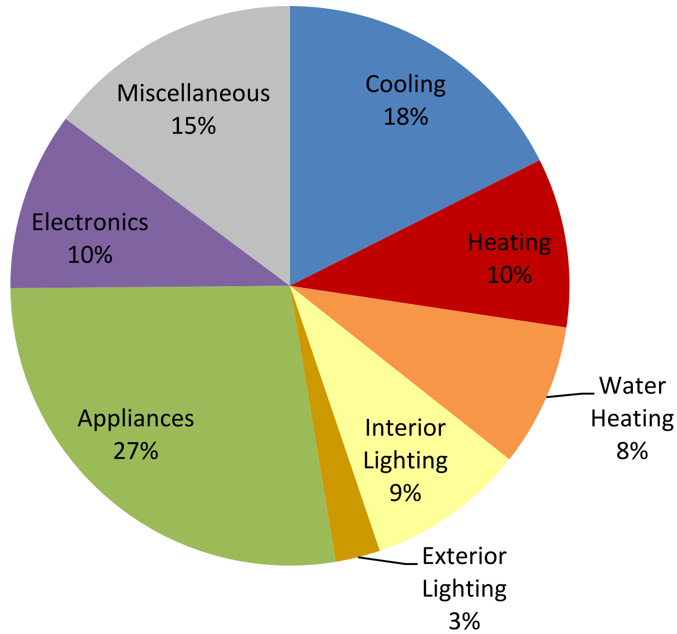
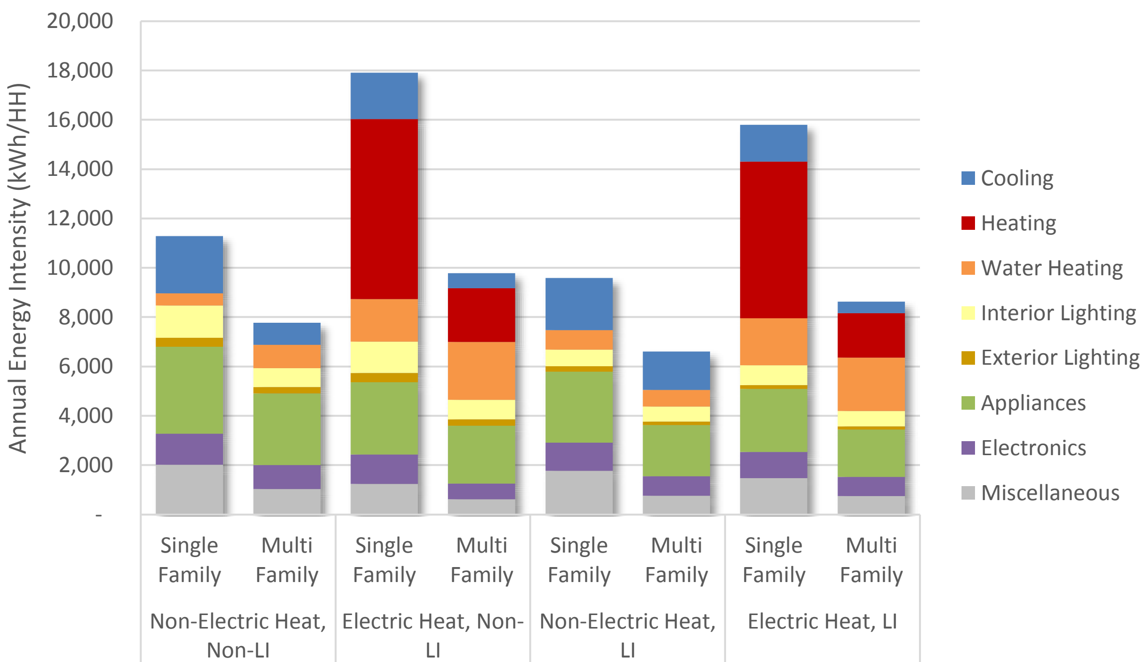


Figure 3-3 Residential Electricity Intensity by End Use and Segment (Annual kWh/HH, 2014)



As we describe in the previous chapter, the market profiles provide the foundation for development of the baseline projection and the potential estimates. The average market profile for the residential sector is presented in Table 3-3. Segment-specific market profiles are presented in Volume 4 Appendix A.

Table 3-3 Average Electricity Market Profile for the Residential Sector, 2014

End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (GWh)
Cooling	Central AC	80.6%	2,219	1,788	1,899.8
Cooling	Room AC	14.2%	802	114	121.2
Cooling	Air-Source Heat Pump	0.8%	1,772	14	15.0
Cooling	Geothermal Heat Pump	1.3%	1,552	19	20.7
Heating	Electric Furnace	13.2%	6,652	880	935.4
Heating	Electric Room Heat	6.3%	1,854	117	124.7
Heating	Air-Source Heat Pump	0.8%	4,946	40	42.0
Heating	Geothermal Heat Pump	1.3%	3,265	41	43.5
Water Heating	Water Heater (<= 55 Gal)	24.4%	2,864	699	742.7
Water Heating	Water Heater (> 55 Gal)	5.7%	3,663	210	223.4
Interior Lighting	General Service Screw-In	100.0%	682	682	724.4
Interior Lighting	Linear Lighting	100.0%	118	118	125.9
Interior Lighting	Exempted Screw-In	100.0%	207	207	220.0
Exterior Lighting	Screw-in	100.0%	285	285	302.7
Appliances	Refrigerator	100.0%	796	796	845.6
Appliances	Second Refrigerator	27.6%	948	262	277.9
Appliances	Freezer	42.7%	645	276	293.0
Appliances	Clothes Washer	92.8%	95	88	93.5
Appliances	Clothes Dryer	72.8%	829	604	641.4
Appliances	Dishwasher	66.9%	428	286	303.9
Appliances	Stove	55.8%	457	255	271.1
Appliances	Microwave	98.6%	138	136	145.0
Appliances	Dehumidifier	17.4%	1,080	187	199.2
Appliances	Air Purifier	11.6%	1,168	135	143.6
Electronics	Personal Computers	68.0%	199	136	144.0
Electronics	Monitor	81.8%	84	69	73.1
Electronics	Laptops	116.8%	52	61	64.9
Electronics	Printer/Fax/Copier	102.2%	65	66	70.2
Electronics	TVs	279.5%	178	497	527.7
Electronics	Set top Boxes/DVRs	211.8%	120	254	269.5
Electronics	Devices and Gadgets	100.0%	54	54	57.6
Miscellaneous	Electric Vehicles	1.5%	3,895	60	63.9
Miscellaneous	Pool Pump	5.8%	2,327	134	142.8
Miscellaneous	Pool Heater	3.1%	2,351	73	77.7
Miscellaneous	Furnace Fan	71.1%	782	555	590.3
Miscellaneous	Bathroom Exhaust Fan	33.2%	155	52	54.7
Miscellaneous	Well Pump	7.5%	619	47	49.6
Miscellaneous	Miscellaneous	100.0%	709	709	753.6
Total				**11,006**	**11,695.4**

The total number of residential households and natural gas sales for the service territory were obtained from Ameren Illinois's customer database. In 2014, there were approximately 750 thousand households in the Ameren Illinois territory that used a total of 578 MMtherms. Therefore, average natural gas use per household was 774 therms. Individual household consumption may vary due to multiple parameters, such as house size, age, and presence of natural gas or secondary heat.

Table 3-4 Residential Natural Gas Sector Control Totals (2014)

Segment	Number of Customers	Natural Gas Sales (MMtherms)	% of Total Usage	Avg. Use / Customer (therms)
Single Family – Non-Elec Heat, Non-Low Income	325,787	328	57%	1,006
Multi Family– Non-Elec Heat, Non-Low Income	29,376	20	4%	697
Single Family - Elec Heat, Non-Low Income	65,515	13	2%	194
Multi Family - Elec Heat, Non-Low Income	16,473	2	0%	112
Single Family - Low Income, Non-Elec Heat	181,521	169	29%	930
Multi Family - Low Income, Non-Elec Heat	48,919	35	6%	723
Single Family - Low Income, Elec Heat	32,420	6	1%	177
Multi Family - Low Income, Elec Heat	47,076	6	1%	124
Total	**747,088**	**578**	**100%**	**774**

Figure 3-4 shows the average distribution of annual natural gas use by end use for <u>all</u> customers. Two main natural gas end uses — heating and water heating — account for 90% of total use. The remainder of the energy falls into the appliance and miscellaneous category – which is comprised of pool heaters and other equipment.

Figure 3-5 presents the natural gas intensities by end use and housing type. Single family, non-electric heat and non-low income have the highest use per customer at 1,006 therms/year, reflecting less efficient construction and equipment options as well as a higher saturation of natural gas heating.

Figure 3-4 Residential Natural Gas Use by End Use (2014)

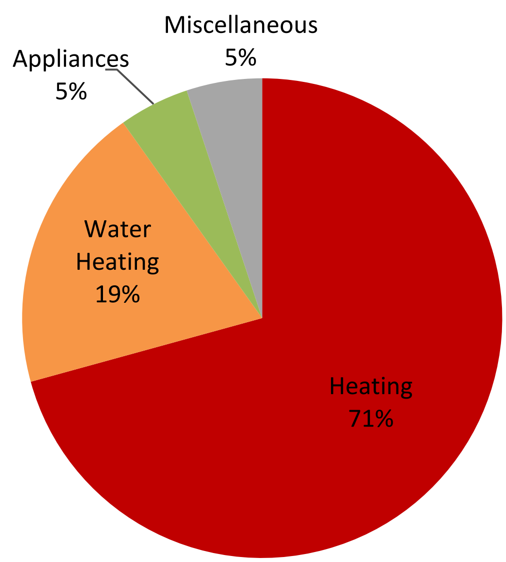


Figure 3-5 Residential Natural Gas Intensity by End Use and Segment (Annual therms/HH, 2014)

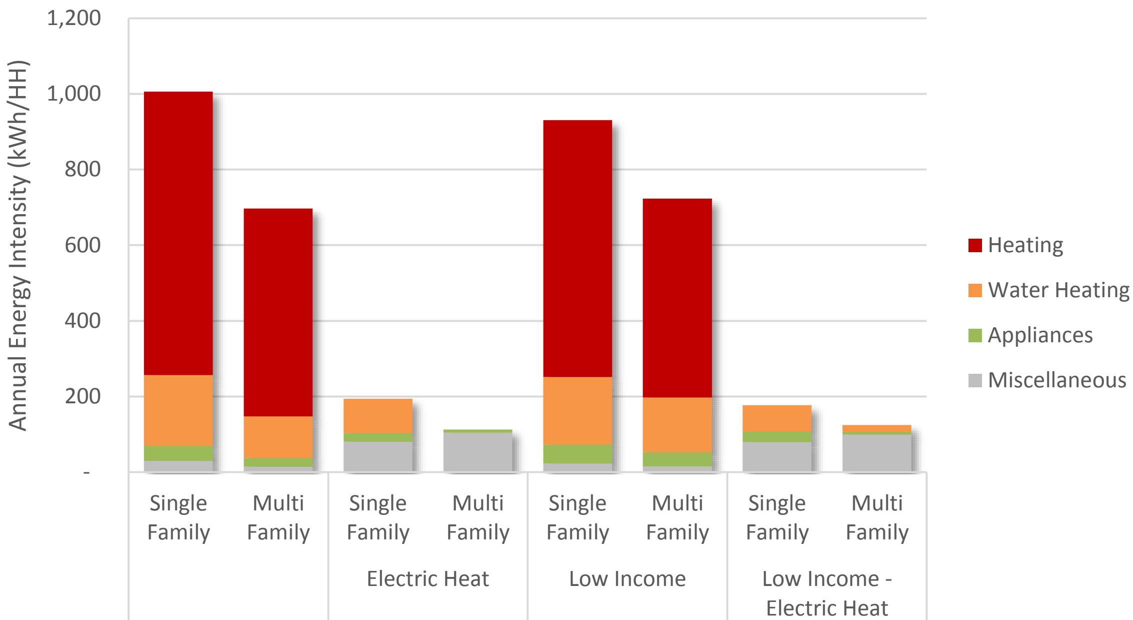


Table 3-5 Average Natural Gas Market Profile for the Residential Sector, 2014

End Use	Technology	Saturation	EUI (therms)	Intensity[11] (therm/HH)	Usage (MMtherms)
Heating	Furnace	57.8%	723	418	395.4
Heating	Boiler	2.0%	712	15	13.7
Water Heating	Water Heater (<= 55 Gal)	49.8%	185	92	87.2
Water Heating	Water Heater (> 55 Gal)	13.9%	192	27	25.2
Appliances	Clothes Dryer	24.1%	26	6	6.0
Appliances	Stove	41.3%	55	23	21.5
Miscellaneous	Pool Heater	1.8%	221	4	3.8
Miscellaneous	Miscellaneous	100.0%	27	27	25.6
Total				**612**	**578.5**

Commercial Sector

In 2014, 12,148 GWh were consumed by commercial customers in Ameren Illinois's service area. The commercial and industrial saturation survey and Ameren Illinois billing data were used to develop estimates of annual energy use, intensity, floor space and summer and winter peak estimates for 10 building types, as shown in Table 3-6. The Miscellaneous segment includes accounts that did not fit into the standard building types, such as flower shops, fire stations, and the Ameren Illinois Dome.

[11] Natural gas intensity values in this table are relative to all Ameren Illinois customers that have natural gas service, regardless of whether they receive that gas from Ameren. This will make the values slightly different than all Ameren Illinois natural gas customers, due to estimations of non-Ameren natural gas consumption by Ameren electric customers that were required for consistency within the modeling.

Table 3-6 Commercial Electricity Sector Control Totals (2014)

Segment	Electricity Sales (GWh)	% of Total Usage	Floor Area (million ft²)	Avg. Use / Square Foot (kWh/ft²)	Peak Demand Summer (MW)	Peak Demand Winter (MW)
Office	1,946	16%	173	11.2	263	282
Restaurant	752	6%	22	33.6	106	98
Retail	1,931	16%	216	8.9	342	261
Grocery	624	5%	14	44.1	77	69
College	2,455	20%	208	11.8	662	241
School	617	5%	88	7.0	222	65
Health	1,888	16%	119	15.8	283	266
Lodging	332	3%	41	8.0	33	32
Warehouse	482	4%	128	3.8	133	73
Miscellaneous	1,121	9%	183	6.1	226	185
Total	**12,148**	**100%**	**1,194**	**10.18**	**2,347**	**1,574**

Figure 3-6 shows the distribution of annual electricity consumption by end use across all commercial buildings. The majority of consumption is associated with lighting and HVAC usage, which comprises 71% of annual electricity usage.

Figure 3-6 Commercial Sector Electricity Consumption by End Use (2014)

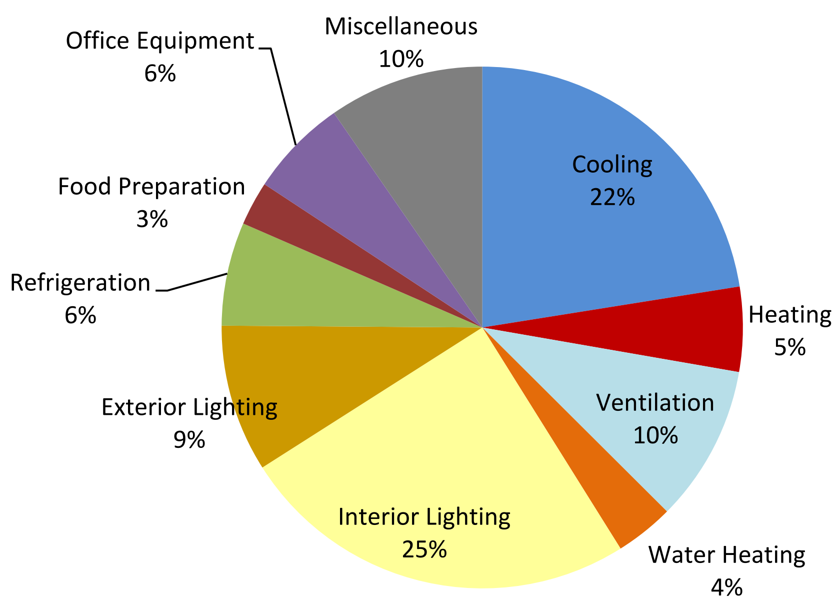


Figure 3-7 presents the electricity intensities by end use and segment. The grocery segment has the highest use per square foot at 47 kWh/sq.ft.

Figure 3-7 Commercial Electricity Intensity by End Use and Segment (Annual kWh/sq. ft., 2014)

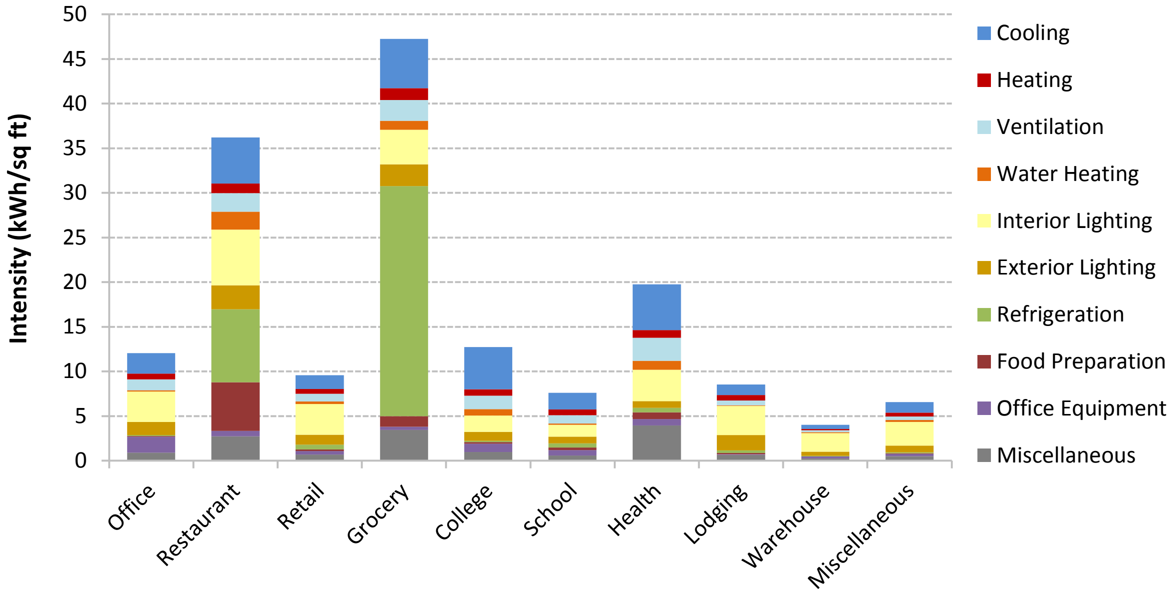


Table 3-7 shows the average market profile for electricity of the commercial sector as a whole, representing a composite of all segments and buildings. Market profiles for each segment are presented in Volume 4 Appendix A.

Table 3-7 Average Electricity Market Profile for the Commercial Sector, 2014

End Use	Technology	Saturation	EUI (kWh)	Intensity[12] (kWh/Sqft)	Usage (GWh)
Cooling	Air-Cooled Chiller	13.2%	3.36	0.44	482.1
Cooling	Water-Cooled Chiller	24.2%	4.64	1.12	1,217.3
Cooling	RTU	19.5%	3.26	0.64	688.8
Cooling	Central AC	3.2%	3.51	0.11	121.2
Cooling	Room AC	2.7%	3.06	0.08	91.2
Cooling	Air-Source Heat Pump	0.7%	4.29	0.03	32.4
Cooling	Geothermal Heat Pump	1.8%	2.93	0.05	56.8
Cooling	PTHP	1.4%	2.68	0.04	41.6
Heating	Electric Furnace	6.8%	5.14	0.35	381.1
Heating	Electric Room Heat	2.1%	4.56	0.10	104.0
Heating	Air-Source Heat Pump	0.7%	3.92	0.03	29.6
Heating	Geothermal Heat Pump	1.8%	4.57	0.08	88.4
Heating	PTHP	1.4%	2.23	0.03	34.7
Ventilation	Ventilation	100.0%	1.09	1.09	1,181.1
Water Heating	Water Heater	33.9%	1.20	0.41	441.9
Interior Lighting	Screw-in	100.0%	0.41	0.41	447.7
Interior Lighting	High-Bay Fixtures	100.0%	0.95	0.95	1,024.6
Interior Lighting	Linear Lighting	100.0%	1.43	1.43	1,550.4
Exterior Lighting	Screw-in	100.0%	0.09	0.09	95.4
Exterior Lighting	Area Lighting	100.0%	0.69	0.69	747.5
Exterior Lighting	Linear Lighting	100.0%	0.25	0.25	266.3
Refrigeration	Walk-in Refrig/Freezer	6.3%	0.92	0.06	62.8
Refrigeration	Reach-in Refrig/Freezer	14.4%	0.23	0.03	36.1
Refrigeration	Glass Door Display	48.9%	0.40	0.20	214.2
Refrigeration	Open Display Case	5.8%	5.23	0.30	329.1
Refrigeration	Icemaker	25.7%	0.39	0.10	109.4
Refrigeration	Vending Machine	15.9%	0.16	0.03	27.2
Food Preparation	Oven	18.6%	0.13	0.02	26.5
Food Preparation	Fryer	12.4%	0.41	0.05	55.0
Food Preparation	Dishwasher	32.3%	0.51	0.17	179.3
Food Preparation	Hot Food Container	15.3%	0.14	0.02	24.0
Food Preparation	Steamer	4.1%	0.48	0.02	21.3
Food Preparation	Griddle	9.2%	0.26	0.02	25.7
Office Equipment	Desktop Computer	100.0%	0.39	0.39	420.4
Office Equipment	Laptop	99.6%	0.04	0.04	48.5
Office Equipment	Server	69.3%	0.16	0.11	122.4
Office Equipment	Monitor	100.0%	0.07	0.07	74.2
Office Equipment	Printer/Copier/Fax	100.0%	0.05	0.05	54.3
Office Equipment	POS Terminal	47.7%	0.04	0.02	22.5
Miscellaneous	Non-HVAC Motors	8.7%	0.19	0.02	17.6
Miscellaneous	Pool Pump	30.4%	0.02	0.01	6.6
Miscellaneous	Pool Heater	6.4%	0.03	0.00	2.3
Miscellaneous	Other Miscellaneous	100.0%	1.06	1.06	1,144.3
Total				**11.21**	**12,147.6**

[12] Electric intensity values in this table are relative to all Ameren Illinois customers that have electric service, regardless of whether they receive that electricity from Ameren. This will make the values slightly different than all Ameren Illinois electric customers, due to estimations of non-Ameren electric consumption by Ameren gas customers that were required for consistency within the modeling.

In 2014, Ameren Illinois's commercial customers consumed 765 million therms. Ameren Illinois billing data, forecast results and secondary data were used to allocate this energy usage among ten commercial segments and to develop estimates of energy intensity (annual therms/sqft).

Table 3-8 Commercial Natural Gas Sector Control Totals (2014)

Segment	Natural Gas Sales (MMtherms)	% of Total Usage	Floor Area (million ft²)	Avg. Use / Square Foot (therms/ft²)
Office	19	9%	111	0.17
Restaurant	12	6%	14	0.85
Retail	39	20%	139	0.28
Grocery	3	1%	9	0.30
College	40	20%	133	0.30
School	13	7%	56	0.24
Health	35	18%	77	0.46
Lodging	6	3%	26	0.24
Warehouse	9	5%	82	0.11
Miscellaneous	21	10%	117	0.17
Total	**198**	**100%**	**765**	**0.26**

Figure 3-8 shows the distribution of annual natural gas consumption by end use across all commercial buildings. The majority of consumption is associated with heating and water heating, which comprises 88% of annual natural gas usage.

Figure 3-8 Commercial Sector Natural Gas Consumption by End Use (2014)

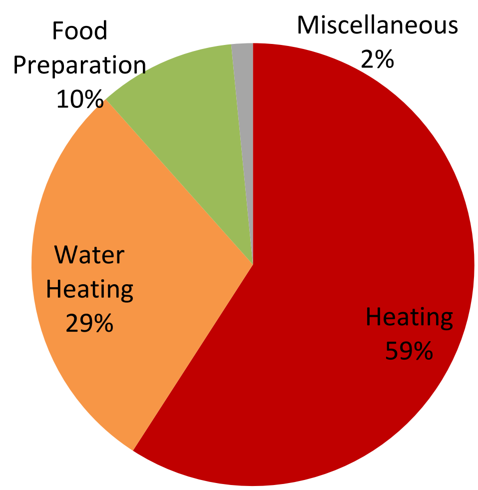


Figure 3-9 presents the natural gas intensities by end use and segment. Restaurants have the highest use per square foot at 0.85 therms/sq.ft.

Figure 3-9 Commercial Natural Gas Intensity by End Use and Segment (Annual therms/sq. ft., 2014)

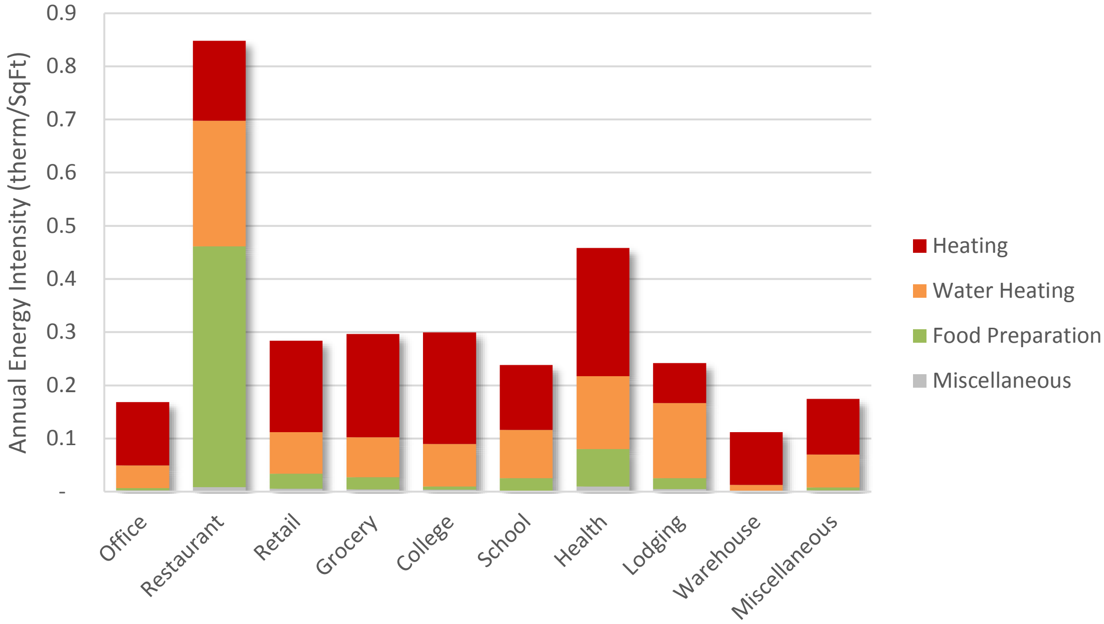


Table 3-9 shows the average market profile for natural gas of the commercial sector as a whole, representing a composite of all segments and buildings. Market profiles for each segment are presented in Volume 4 Appendix A.

Table 3-9 Average Natural Gas Market Profile for the Commercial Sector, 2014

End Use	Technology	Saturation	EUI (therms)	Intensity[13] (therm/Sqft)	Usage (MMtherms)
Heating	Furnace	31.4%	0.21	0.07	45.4
Heating	Boiler	30.9%	0.32	0.10	67.6
Heating	Unit Heater	4.7%	0.12	0.01	3.8
Water Heating	Water Heater	66.1%	0.13	0.08	57.9
Food Preparation	Oven	19.2%	0.02	0.00	2.9
Food Preparation	Fryer	8.9%	0.12	0.01	7.1
Food Preparation	Broiler	12.7%	0.04	0.00	3.1
Food Preparation	Griddle	15.4%	0.02	0.00	2.6
Food Preparation	Range	18.1%	0.03	0.01	3.6
Food Preparation	Steamer	3.0%	0.02	0.00	0.5
Food Preparation	Com Food Prep Other	0.4%	0.00	0.00	0.0
Miscellaneous	Pool Heater	0.8%	0.00	0.00	0.0
Miscellaneous	Other Miscellaneous	100.0%	0.00	0.00	3.1
Total				**0.29**	**197.5**

[13] Natural gas intensity values in this table are relative to all Ameren Illinois customers that have natural gas service, regardless of whether they receive that gas from Ameren. This will make the values slightly different than all Ameren Illinois natural gas customers, due to estimations of non-Ameren natural gas consumption by Ameren electric customers that were required for consistency within the modeling.

Industrial Sector

In 2014, Ameren Illinois's industrial customers consumed 12,151 GWh. As with the commercial sector, the C&I survey and Ameren Illinois billing data were used to estimate the key controls totals shown in Table 3-10.

Table 3-10 Industrial Electricity Sector Control Totals (2014)

Segment	Electricity Sales (GWh)	% of Total Usage	Avg. Use / per Employee (kWh/ employee)	Peak Demand Summer (MW)	Peak Demand Winter (MW)
Industrial Machinery	1,535	13%	18,277	437	236
Petroleum	512	4%	181,782	82	74
Food Production	1,641	14%	29,872	315	249
Chemicals	3,521	29%	370,610	704	497
Primary Metal	1,897	16%	70,748	332	275
Other Industrial	3,045	25%	11,620	827	484
Total	**12,151**	**100%**	**27,608**	**2,697**	**1,815**

Ameren's load forecast, AEG building simulations and secondary sources were used to allocate usage among end uses. Figure 3-10 shows the distribution of annual electricity consumption by end use for all industrial customers. Motors are the largest overall end use for the industrial sector, accounting for 50% of energy use. Note this end use includes a wide range of industrial equipment, such as air and refrigeration compressors, pumps, conveyor motors, and fans. The process end use accounts for 25% of annual energy use, which includes heating, cooling, refrigeration, and electro-chemical processes. Lighting is the next highest, followed by cooling, ventilation, and miscellaneous.

Figure 3-10 Industrial Electricity Use by End Use (2014), All Industries

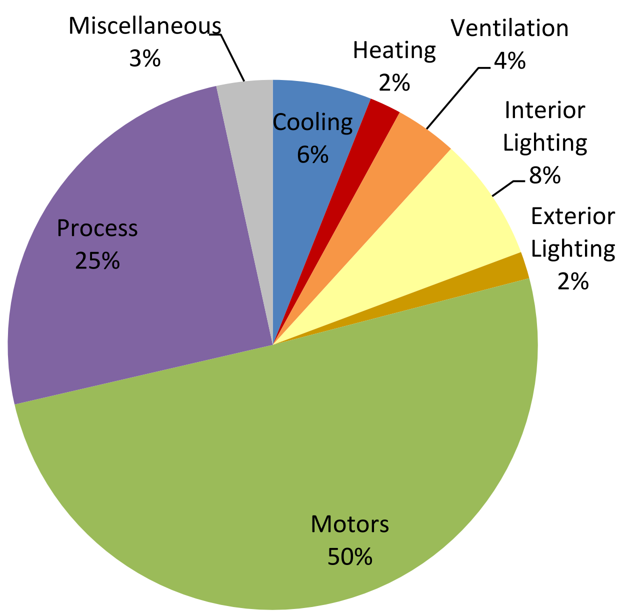


Figure 3-11 presents the electricity intensities by end use and segment. Industrial chemicals have the highest use at 370,610 GWh.

Figure 3-11 Industrial Electricity Intensity by End Use and Segment (Annual GWh, 2014)

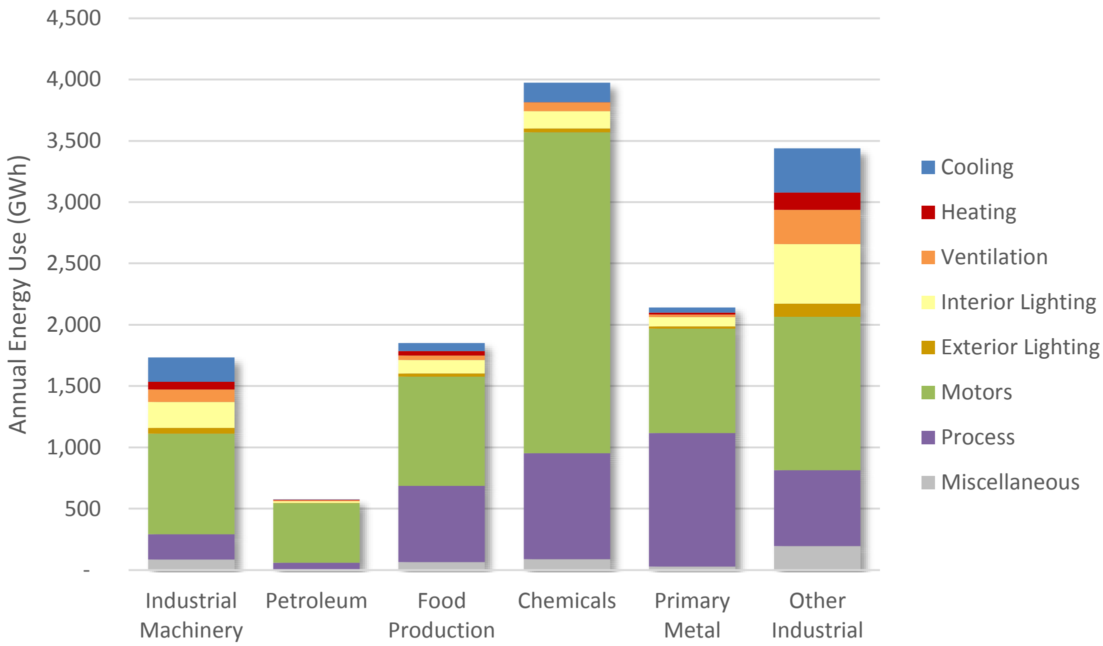


Table 3-11 shows the composite market profile for the industrial sector. Segment-level detail was included in the analysis of the industrial sector, but excluded from the report to prevent disclosure of data that may be sensitive for some of Ameren Illinois's larger customers.

Table 3-11 Average Electricity Market Profile for the Industrial Sector, 2014

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/employ)	Usage (GWh)
Cooling	Air-Cooled Chiller	2.0%	11,605	233	102.5
Cooling	Water-Cooled Chiller	4.8%	9,980	476	209.6
Cooling	RTU	6.6%	13,853	916	403.1
Cooling	Air-Source Heat Pump	0.2%	10,996	19	8.3
Cooling	Geothermal Heat Pump	0.4%	4,765	21	9.3
Heating	Electric Furnace	1.3%	28,331	377	165.9
Heating	Electric Room Heat	0.2%	29,633	46	20.2
Heating	Air-Source Heat Pump	0.2%	26,533	46	20.1
Heating	Geothermal Heat Pump	0.4%	14,226	63	27.7
Ventilation	Ventilation	100.0%	1,046	1,046	460.5
Interior Lighting	Screw-in	100.0%	96	96	42.3
Interior Lighting	High-Bay Fixtures	100.0%	1,713	1,713	754.0
Interior Lighting	Linear Lighting	100.0%	279	279	122.8
Exterior Lighting	Screw-in	100.0%	19	19	8.4
Exterior Lighting	Area Lighting	100.0%	361	361	159.1
Exterior Lighting	Linear Lighting	100.0%	74	74	32.6
Motors	Pumps	100.0%	2,809	2,809	1,236.2
Motors	Fans & Blowers	100.0%	2,095	2,095	922.0
Motors	Compressed Air	100.0%	2,757	2,757	1,213.3
Motors	Conveyors	100.0%	5,616	5,616	2,472.0
Motors	Other Motors	100.0%	647	647	284.9
Process	Process Heating	100.0%	3,368	3,368	1,482.6
Process	Process Cooling	100.0%	1,104	1,104	486.0
Process	Process Refrigeration	100.0%	1,104	1,104	486.0
Process	Process Electrochemical	100.0%	1,133	1,133	498.7
Process	Process Other	100.0%	244	244	107.3
Miscellaneous	Miscellaneous	100.0%	945	945	415.9
Total				**27,608**	**12,151.3**

In 2014, Ameren Illinois's industrial customers consumed 478.5 million therms. Ameren Illinois billing data, forecast results and secondary data were used to allocate this energy usage among six industrial segments and to develop estimates of energy intensity (annual therms/employee).

Table 3-12 Industrial Natural Gas Sector Control Totals (2014)

Segment	Natural Gas Sales (MMtherms)	% of Total Usage	Avg. Use / per Employee (therm/ employee)
Industrial Machinery	47.0	10%	834.54
Petroleum	8.8	2%	4,667.59
Food Production	60.6	13%	1,645.66
Chemicals	29.3	6%	4,595.76
Primary Metal	60.2	13%	3,347.54
Other Industrial	272.7	57%	1,552.91
Total	**478.5**	**100%**	**1,622.33**

Figure 3-12 shows the distribution of annual natural gas consumption by end use for all industrial customers. Heating is the largest overall end use for the industrial sector, accounting for 51% of energy use. The process end use accounts for 45% of annual energy use, which includes heating, cooling, refrigeration, and electro-chemical processes.

Figure 3-12 Industrial Natural Gas Use by End Use (2014), All Industries

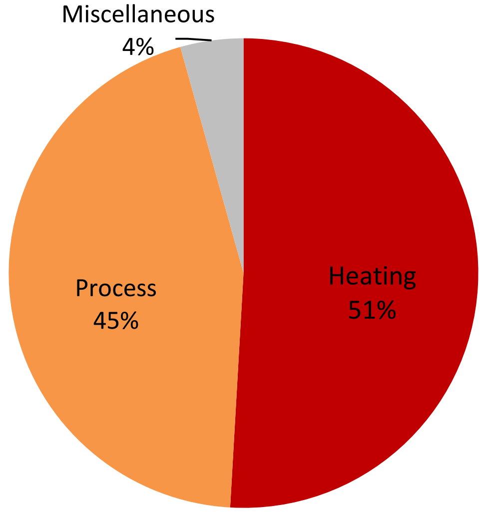


Figure 3-13 presents the natural gas intensities by end use and segment. Other Industrial have the highest use at 272.7 million therms.

Figure 3-13 Industrial Natural Gas Intensity by End Use and Segment (Annual MMtherm, 2014)

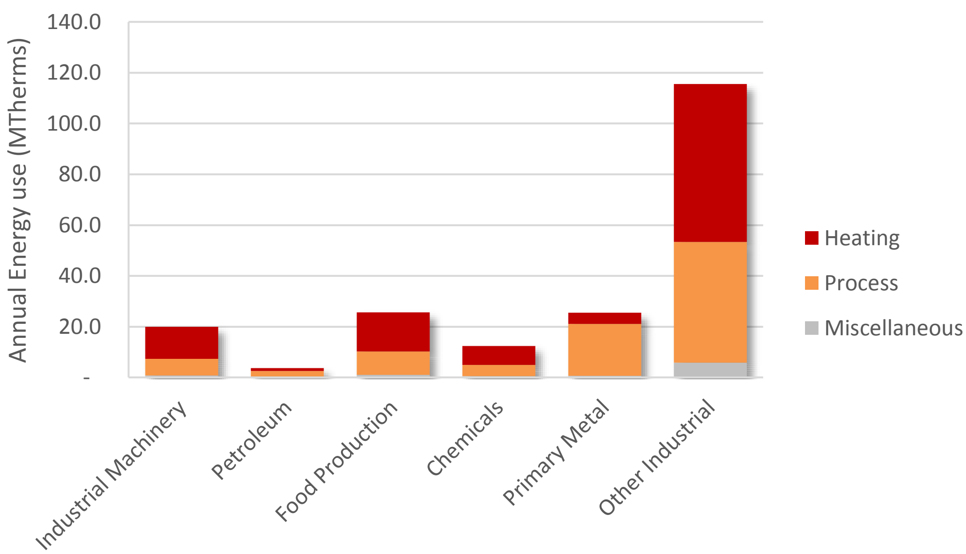


Table 3-13 shows the composite market profile for the industrial sector. Segment-level detail was included in the analysis of the industrial sector, but excluded from the report to prevent disclosure of data that may be sensitive for some of Ameren Illinois's larger customers.

Table 3-13 Average Natural Gas Market Profile for the Industrial Sector, 2014

End Use	Technology	Saturation	EUI (therms)	Intensity[14] (therm/ employee)	Usage (MMtherms)
Heating	Furnace	16.7%	468	78	2.2
Heating	Boiler	3.4%	405	14	0.4
Heating	Unit Heater	1.1%	328	4	0.1
Process	Process Boiler	100.0%	112	112	3.1
Process	Process Heating	100.0%	166	166	4.6
Process	Process Cooling	100.0%	1	1	0.0
Process	Other Process	100.0%	15	15	0.4
Miscellaneous	Miscellaneous	100.0%	18	18	0.5
Total				**408**	**11.3**

Street Lighting Sector

The total electric energy consumed by street lighting in Ameren Illinois's service area in 2014 was 313 GWh. Inventory of fixtures, wattages, and usage was provided by Ameren Illinois. We define fixtures as our unit of analysis within LoadMAP, each represented by an average lamp wattage.

Table 3-14 Street Lighting Sector Control Totals (2014)

Segment	Number of Fixtures	Electricity Sales (GWh)	% of Total Usage	Avg. Use / Fixture (kWh)
Company <200W	224,103	149	48%	665
Company 200-299W	50,611	68	22%	1,344
Company 300-400W	37,542	82	26%	2,184
Customer <200W	5,436	3	1%	630
Customer 200-299W	3,650	4	1%	1,199
Customer 300-400W	3,130	6	2%	1,858
Customer >400W	156	0	0%	2,961
Total	**324,628**	**313**	**100%**	**965**

[14] Natural gas intensity values in this table are relative to all Ameren Illinois customers that have natural gas service, regardless of whether they receive that gas from Ameren. This will make the values slightly different than all Ameren Illinois natural gas customers, due to estimations of non-Ameren natural gas consumption by Ameren electric customers that were required for consistency within the modeling.

Baseline Projection

Prior to developing estimates of energy-efficiency potential, a baseline end-use projection was developed to quantify what the consumption is likely to be in the future in absence of any energy efficiency programs. The savings from past programs are embedded in the forecast, but the baseline projection assumes that those past programs cease to exist in the future. Thus, the potential analysis captures all possible savings from future programs.

The baseline projection incorporates assumptions about:

- 2014 account data classified by sector and building types and rate classes
- Customer population and economic growth
- Appliance/equipment standards and building codes already mandated (see Section 2)
- Appliance/equipment purchase decisions frozen at contemporary levels throughout (except where superseded by a code or standard)
- Forecasts of future electricity prices
- Ameren Illinois load forecast by rate class as of October 2015
- Residential, commercial, and industrial building stock assessments
- Trends in fuel shares and appliance saturations and assumptions about miscellaneous electricity growth

Although it aligns closely, the baseline projection is not Ameren Illinois's official load forecast. Rather it was developed as an integral component of our modeling construct to serve as the metric against which energy efficiency potentials are measured. This chapter presents the baseline projections we developed for this study.

Below, we present the baseline projections for each sector as well as a summary across all sectors.

Residential Sector Baseline Projection

Table 4-1 and Figure 4-1 present AEG's independent baseline projection for electricity at the end-use level for the residential sector as a whole. Overall, residential use decreased 4% between 2015 and 2026, from 11,209 GWh to 10,341 GWh, respectively. Most noticeable is that lighting use decreases throughout the time period as the lighting standards from EISA come into effect. The projection is in general alignment with Ameren Illinois's residential load forecast. Specific observations include:

1. Lighting use declines as a result of the EISA lighting standards which ratchets minimum efficacies higher in 2020 as well as naturally occurring efficiency in the adoption of LED lamps.
2. Appliance energy use experiences significant efficiency gains from new standards, but this is offset by customer growth.
3. Although estimates of electronics consumption have decreased since the previous study, the growth rate over the next 20 years is still substantial and reflects an increase in the saturation of electronics and gadgets. Growth in other miscellaneous use is also substantial. This end use has grown consistently in the past and we incorporate future growth assumptions that are consistent with the Annual Energy Outlook.

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

End Use	2015	2017	2018	2019	2026	2036	% Change ('15-'36)
Cooling	1,996	1,984	1,976	1,967	1,931	1,978	-3.2%
Heating	923	935	940	943	966	1,008	4.7%
Water Heating	951	958	959	959	959	1,004	0.8%
Interior Lighting	1,008	957	922	882	555	507	-45.0%
Exterior Lighting	286	271	262	250	131	104	-54.2%
Appliances	3,142	3,160	3,163	3,164	3,186	3,373	1.4%
Electronics	1,202	1,228	1,224	1,220	1,257	1,509	4.6%
Miscellaneous	1,701	1,727	1,736	1,740	1,771	1,859	4.1%
Total	**11,209**	**11,219**	**11,182**	**11,125**	**10,756**	**11,341**	**-4.0%**

Figure 4-1 Residential Electric Baseline Projection by End Use (GWh)

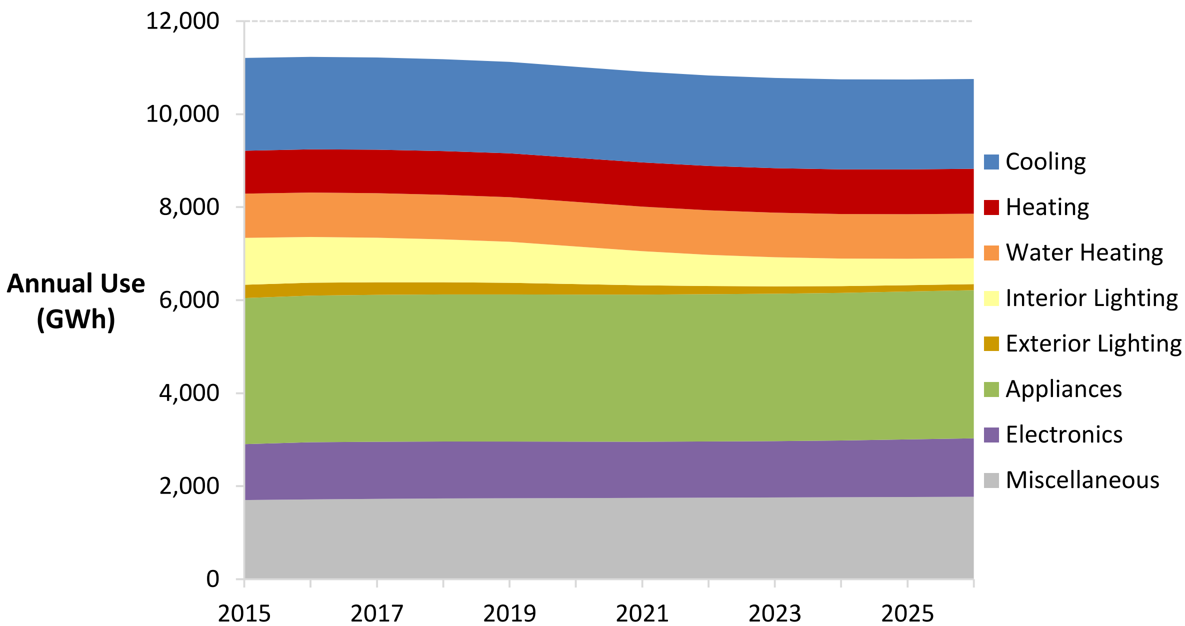
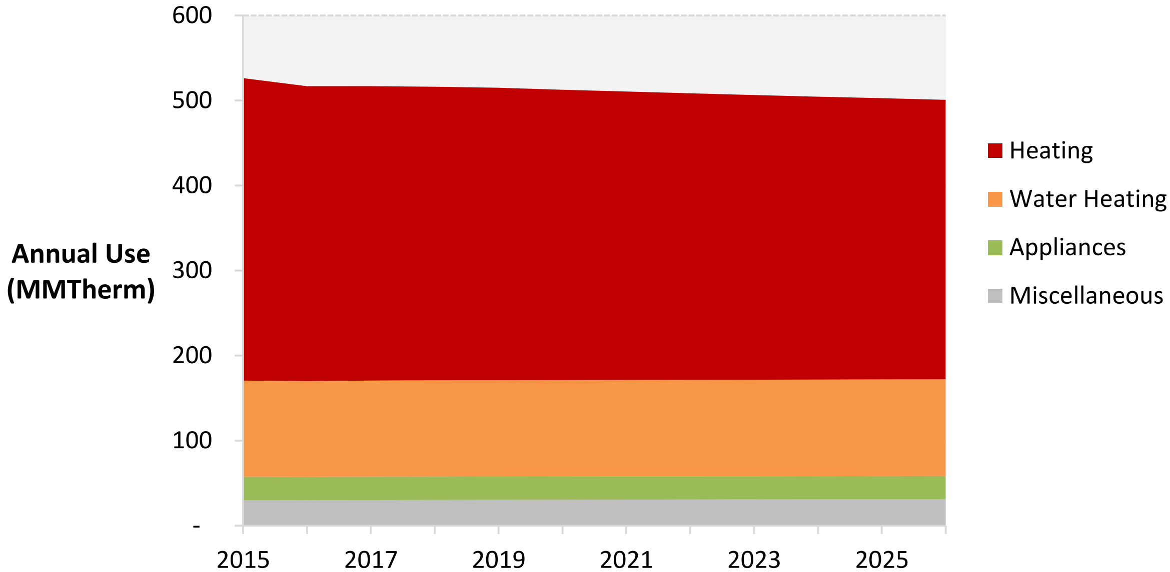


Table 4-2 and Figure 4-2 present AEG's independent baseline projection for natural gas at the end-use level for the residential sector as a whole. Overall, residential use decreases from 2015 to 2026, from 526 million therms to 497 million therms, respectively. This projection is in general alignment with Ameren Illinois's residential load forecast.

Table 4-2 Residential Natural Gas Baseline Projection by End Use (MMtherms)

End Use	2015	2017	2018	2019	2026	2036	% Change ('15-'36)
Heating	356	346	345	344	329	319	-10%
Water Heating	113	113	113	113	114	118	4%
Appliances	28	27	27	27	27	28	0%
Miscellaneous	30	30	30	30	31	33	10%
Total	**526**	**517**	**516**	**515**	**501**	**497**	**-6%**

Figure 4-2 Residential Natural Gas Baseline Projection by End Use (MMtherms)



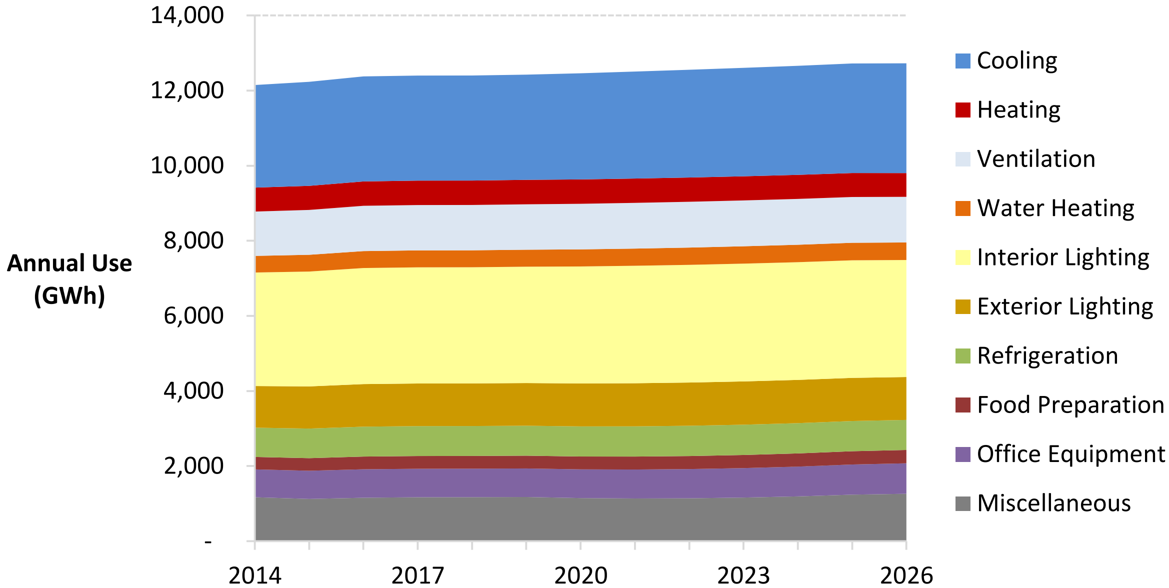
Commercial Sector Baseline Projection

Annual electricity use in the commercial sector grows 4% during the first ten years of the forecast, starting at 12,233 GWh in 2015 and increasing to 12,725 in 2026. Table 4-3 and Figure 4-3 present the baseline projection at the end-use level for the commercial sector as a whole. Lighting usage is declining throughout the forecast, largely due to the phasing in of codes and standards, such as the EISA 2007 lighting standards, as well as embedded market practices of stocking and purchasing high efficiency lamps. Growth in miscellaneous use is significant. This end use has grown consistently in the past and we incorporate future growth assumptions that are consistent with the Annual Energy Outlook.

Table 4-3 Commercial Electric Baseline Projection by End Use (GWh)

End Use	2015	2017	2018	2019	2026	2036	% Change ('15-'36)
Cooling	2,770	2,797	2,797	2,802	2,923	2,951	6.5%
Heating	641	650	650	651	632	588	-8.3%
Ventilation	1,194	1,207	1,207	1,209	1,214	1,165	-2.4%
Water Heating	447	452	452	453	467	479	7.2%
Interior Lighting	3,058	3,093	3,093	3,098	3,116	2,655	-13.2%
Exterior Lighting	1,122	1,135	1,135	1,137	1,143	950	-15.3%
Refrigeration	788	797	797	798	800	751	-4.7%
Food Preparation	335	339	339	340	355	372	11.0%
Office Equipment	750	759	759	760	812	948	26.3%
Miscellaneous	1,126	1,170	1,173	1,177	1,263	1,597	41.8%
Total	**12,233**	**12,399**	**12,401**	**12,424**	**12,725**	**12,457**	**1.8%**

Figure 4-3 Commercial Electric Baseline Projection by End Use (GWh)



Screw-in lighting technologies decrease in consumption significantly over the forecast period as a result of efficiency standards. The effects of the T12 linear lighting standard are already embedded in the 2014 baseline, so declines in linear lighting are not as precipitous. The miscellaneous end use has a large growth rate, but starts from a low initial value and is not a large driver of the potential results.

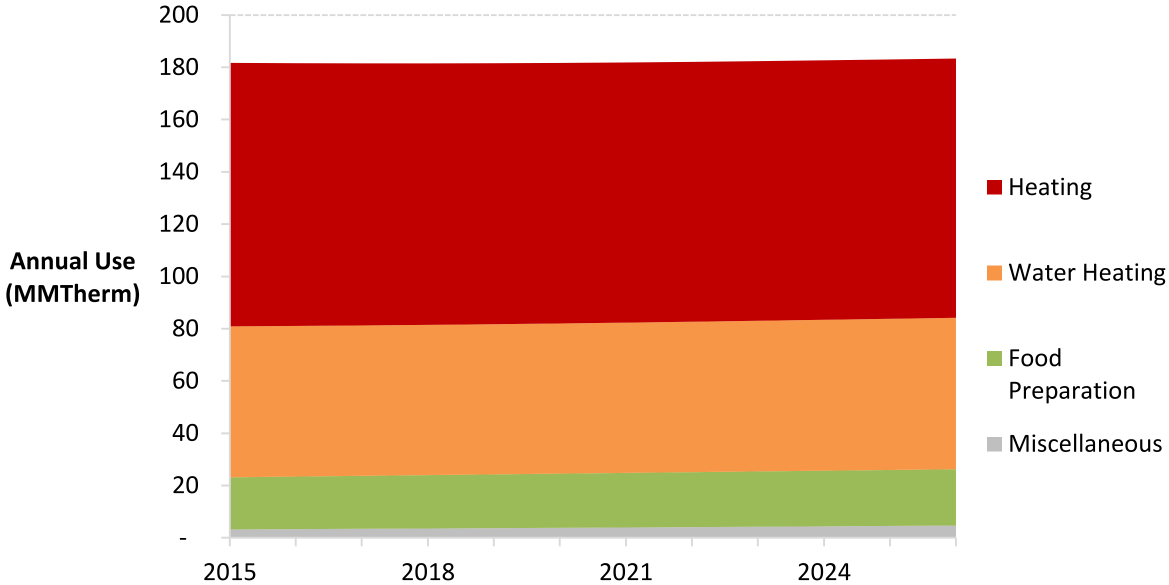
Annual natural gas use in the commercial sector grows 0.9% during the first ten years of the forecast horizon, starting at 182 million therms in 2015 and increasing to 183 million therms in 2026. Table 4-4 and

Figure 4-4 present the baseline projection at the end-use level for the commercial sector as a whole.

Table 4-4 Commercial Natural Gas Baseline Projection by End Use (MMtherms)

End Use	2015	2017	2018	2019	2026	2036	% Change ('15-'36)
Heating	101	100	100	100	99	99	-1.4%
Water Heating	58	58	57	57	58	59	2.3%
Food Preparation	20	20	20	21	22	22	12.0%
Miscellaneous	3	3	4	4	5	7	106.6%
Total	**182**	**181**	**181**	**182**	**183**	**187**	**3.2%**

Figure 4-4 Commercial Electric Baseline Projection by End Use (MMtherms)



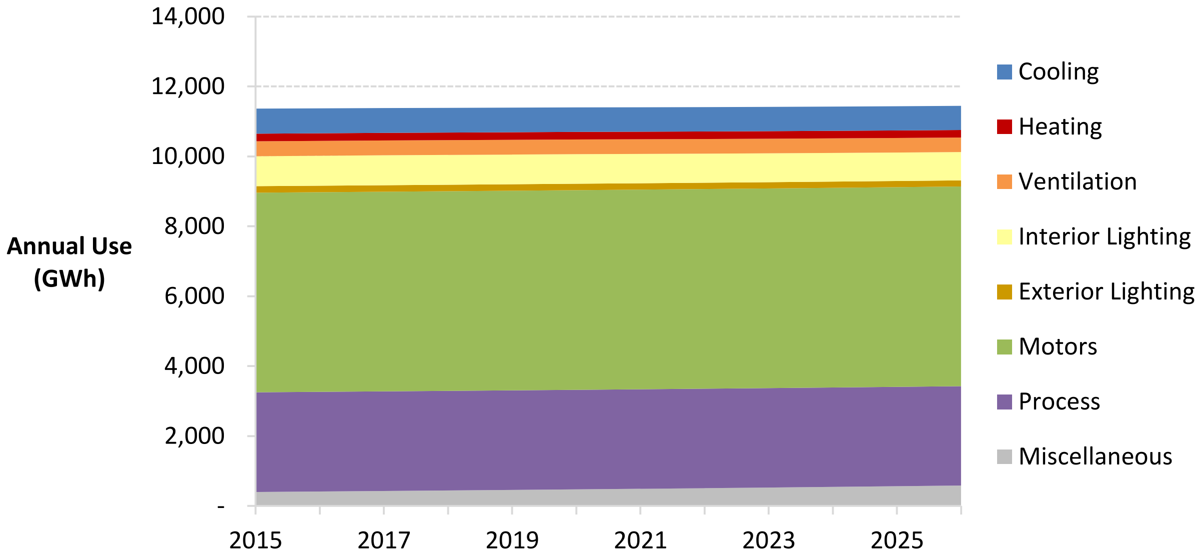
Industrial Sector Baseline Projection

Annual industrial use remains relatively flat throughout the forecast horizon. Table 4-5 and Figure 4-5 present the projection at the end-use level. Most end uses are flat, while lighting is declining aggressively due to codes and standards and naturally occurring efficiency. The miscellaneous end use has a large growth rate, but starts from a low initial value and is not a large driver of the potential results. Overall, industrial annual electricity use increases from 11,368 GWh in 2015 to 11,447 GWh in 2026. This comprises an overall increase of 0.7%.

Table 4-5 Industrial Electric Baseline Projection by End Use (GWh)

End Use	2015	2017	2018	2019	2026	2036	% Change ('15-'36)
Cooling	717	710	707	704	691	689	-4%
Heating	218	217	217	217	215	213	-2%
Ventilation	428	424	423	421	416	416	-3%
Interior Lighting	856	856	853	850	810	720	-16%
Exterior Lighting	186	186	186	185	176	155	-17%
Motors	5,710	5,710	5,711	5,711	5,712	5,714	0%
Process	2,852	2,850	2,849	2,848	2,841	2,832	-1%
Miscellaneous	401	430	445	460	586	827	106%
Total	**11,368**	**11,383**	**11,389**	**11,396**	**11,447**	**11,565**	**2%**

Figure 4-5 Industrial Electric Baseline Projection by End Use (GWh)

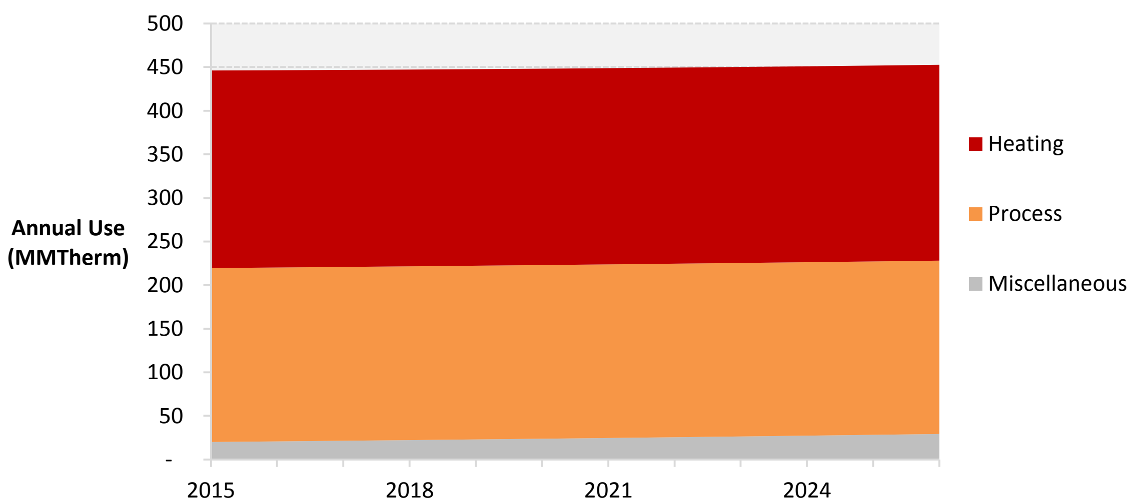


Annual industrial natural gas use remains relatively flat throughout the forecast horizon. Table 4-6 and Figure 4-6 present the projection at the end-use level. Overall, industrial annual natural gas use increases from 446 million therms in 2015 to 453 million therms in 2026, comprising an overall increase of 1.5%.

Table 4-6 Industrial Natural Gas Baseline Projection by End Use (MMtherms)

End Use	2015	2017	2018	2019	2026	2036	% Change ('15-'36)
Heating	227	226	226	225	225	225	-1%
Process	200	199	199	199	199	198	0%
Miscellaneous	20	21	22	23	29	41	46%
Total	**446**	**447**	**447**	**448**	**453**	**464**	**4%**

Figure 4-6 Industrial Natural Gas Baseline Projection by End Use (MMtherms)



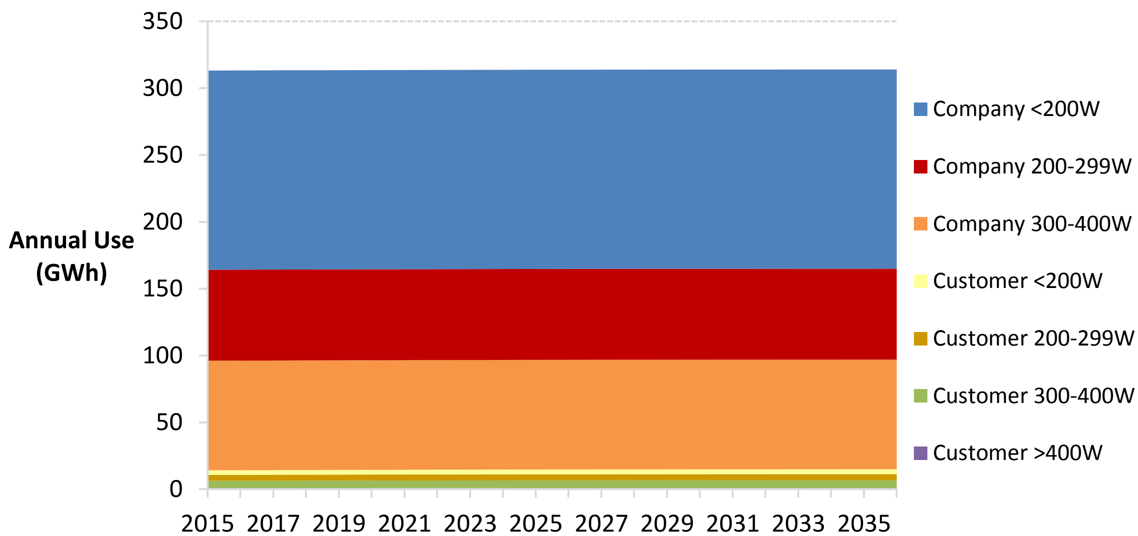
Street Lighting Sector Baseline Projection

Annual electricity use in the street lighting sector grows during the overall forecast horizon, starting at 313 GWh in 2015 and increasing to 314 GWh in 2026, an increase of 0.2%. Table 4-7 and Figure 4-7 present the baseline projection at the fixture level for the street lighting sector as a whole.

Table 4-7 Street Lighting Electric Baseline Projection by End Use (MWh) [15]

	2015	2017	2018	2019	2026	2036	% Change ('15-'36)
Company <200W	149	149	149	149	149	149	0%
Company 200-299W	68	68	68	68	68	68	0%
Company 300-400W	82	82	82	82	82	82	0%
Customer <200W	3	3	4	4	4	4	5%
Customer 200-299W	4	4	4	4	5	5	4%
Total	**313**	**313**	**313**	**314**	**314**	**314**	**0%**

Figure 4-7 Street Lighting Electric Baseline Projection by End Use (GWh)



Summary of Baseline Projections across Sectors

Table 4-8 and Figure 4-8 provide a summary of the baseline projection for annual use by sector for the entire Ameren Illinois service territory. Overall, the forecast shows essentially flat growth in electricity use, showing the countervailing effects of customer growth forecasts and future Codes and Standards that will be enacted per all current legislation.

Table 4-8 Electric Baseline Projection Summary (GWh)

Sector	2015	2017	2018	2019	2026	2036	% Change ('15-'36)
Residential	11,209	11,219	11,182	11,125	10,756	11,341	1.2%
Commercial	12,233	12,399	12,401	12,424	12,725	12,457	1.8%
Industrial	11,368	11,383	11,389	11,396	11,447	11,565	1.7%
Street Lighting	313	313	313	314	314	314	0.3%
Total	**35,123**	**35,314**	**35,285**	**35,259**	**35,242**	**35,677**	**1.6%**

[15] Values in this table have been converted to MWh as Street Lighting is comparatively smaller than other sectors.

Figure 4-8 Electric Baseline Projection Summary (GWh)

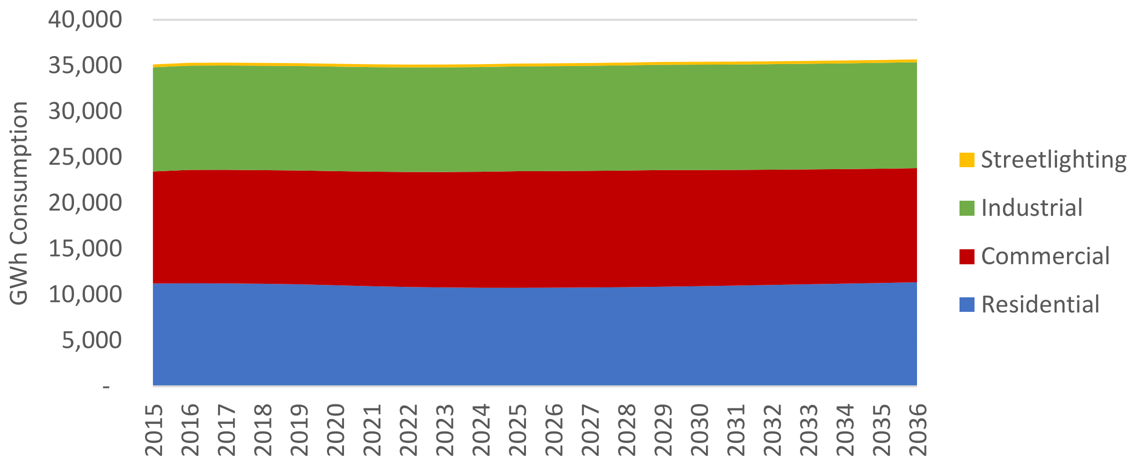
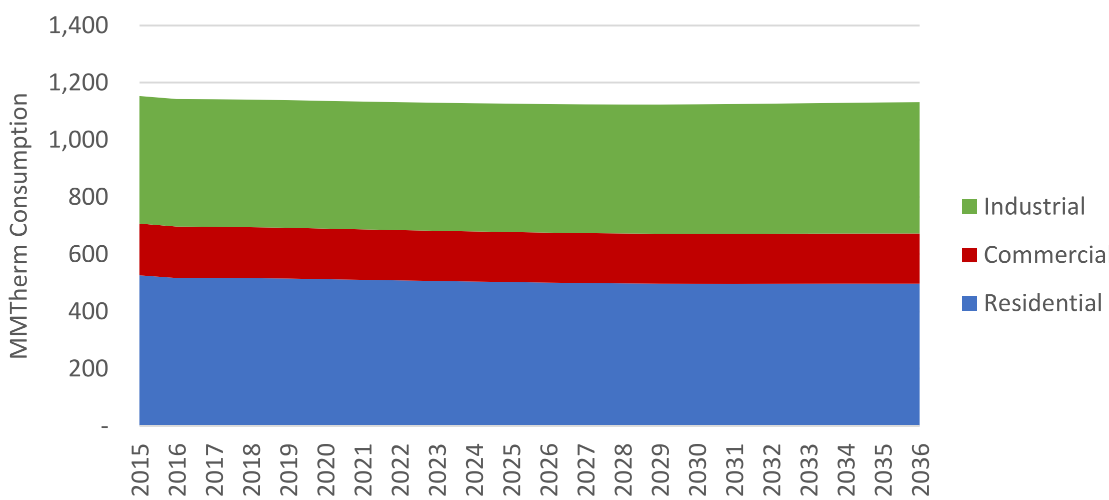


Table 4-9 and Figure 4-9 provide a summary of the baseline projection for annual natural gas use by sector for the entire Ameren Illinois service territory. Overall, the forecast shows a slight decline in natural gas use, driven primarily by the effects of future Codes and Standards and customer growth trends.

Table 4-9 Natural Gas Baseline Projection Summary (MMtherms)

Sector	2015	2017	2018	2019	2026	2036	% Change ('15-'36)
Residential	526	517	516	515	501	497	-5.5%
Commercial	182	181	181	182	183	187	2.7%
Industrial	446	447	447	448	453	464	4.0%
Total	**1154**	**1145**	**1144**	**1145**	**1137**	**1148**	**-0.5%**

Figure 4-9 Natural Gas Baseline Projection Summary (MMtherms)



The fact that Ameren Illinois generally projects flat or negative sales growth rates reflects the momentum of existing DSM programs as well as future codes & standards and embedded naturally occurring energy efficiency. This also has a meaningful impact on the magnitude of new DSM potential, as newly growing markets and customers will be largely unavailable for programs to pursue.

Market Potential for Energy Efficiency

This chapter presents the market potential for energy efficiency measures and initiatives identified in this study, prior to being packaged and refined into preliminary program potential. The market potential results are first presented in aggregate for all sectors and all measure categories, first for electricity and second for natural gas. Afterwards, the results are presented by sector, and finally by measure category.

Overall Potential

Overall Electric Potential

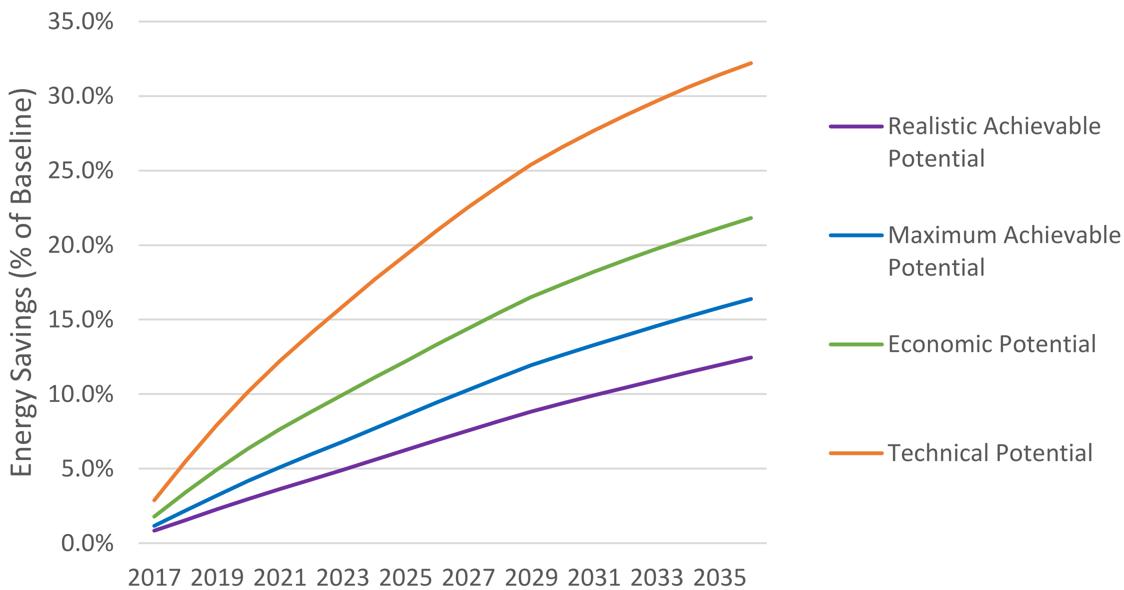
Table 5-1 and Figure 5-1 summarize the electric energy efficiency savings across all sectors and measure categories in terms of annual energy use for four levels of potential relative to the baseline projection. Savings are represented in cumulative terms, which reflect the effects of persistent savings in prior years in addition to new savings.

- **Technical Potential** reflects the adoption of *all* energy efficiency measures regardless of cost-effectiveness. Cumulative net savings by 2019 are 2,803 GWh, or 7.9% of the baseline projection. By 2036, cumulative savings reach 11,486 GWh, or 32.2% of the baseline.
- **Economic Potential** refines technical potential by applying a cost-effectiveness screen, allowing only measures with a total resource cost (TRC) ratio greater than 1.0 to be included. Cumulative net savings by 2019 are 1,743 GWh, or 4.9% of the baseline projection. By 2036, cumulative savings reach 7,779 GWh, or 21.8% of the baseline.
- **Maximum Achievable Potential** further refines economic potential by applying customer participation rates that account for market barriers, customer awareness and attitudes, program maturity, and other factors that affect market penetration of energy efficiency measures. MAP applies the most aggressive customer adoption rates developed. Cumulative net savings by 2019 are 1,134 GWh, or 3.2% of the baseline projection. By 2036, cumulative savings reach 5,846 GWh, or 16.4% of the baseline.
- **Realistic Achievable Potential** further refines economic potential in the exact same way that Maximum Achievable does, but with a less aggressive set of customer adoption rates. Cumulative net savings by 2019 are 802 GWh, or 2.3% of the baseline projection. By 2036, cumulative savings reach 4,447 GWh, or 12.5% of the baseline.

Table 5-1 Total System Electric Potential (Annual Energy, GWh)

	2017	2018	2019	2026	2036
Baseline Forecast (GWh)	**35,315**	**35,285**	**35,257**	**35,241**	**35,676**
Cumulative Savings (GWh)					
Realistic Achievable Potential	299	551	802	2,441	4,447
Maximum Achievable Potential	411	776	1,134	3,330	5,846
Economic Potential	634	1,204	1,743	4,697	7,779
Technical Potential	1,019	1,939	2,803	7,395	11,486
Energy Savings (% of Baseline)					
Realistic Achievable Potential	0.8%	1.6%	2.3%	6.9%	12.5%
Maximum Achievable Potential	1.2%	2.2%	3.2%	9.5%	16.4%
Economic Potential	1.8%	3.4%	4.9%	13.3%	21.8%
Technical Potential	2.9%	5.5%	7.9%	21.0%	32.2%

Figure 5-1 Total System Electric Potential (Cumulative Savings as a Percent of Baseline Projection)



Overall Natural Gas Potential

Table 5-2 and Figure 5-2 summarize the natural gas energy efficiency savings across all sectors and measure categories in terms of annual energy use for four levels of potential relative to the baseline projection. Again, savings are represented in cumulative terms, which reflect the effects of persistent savings in prior years in addition to new savings.

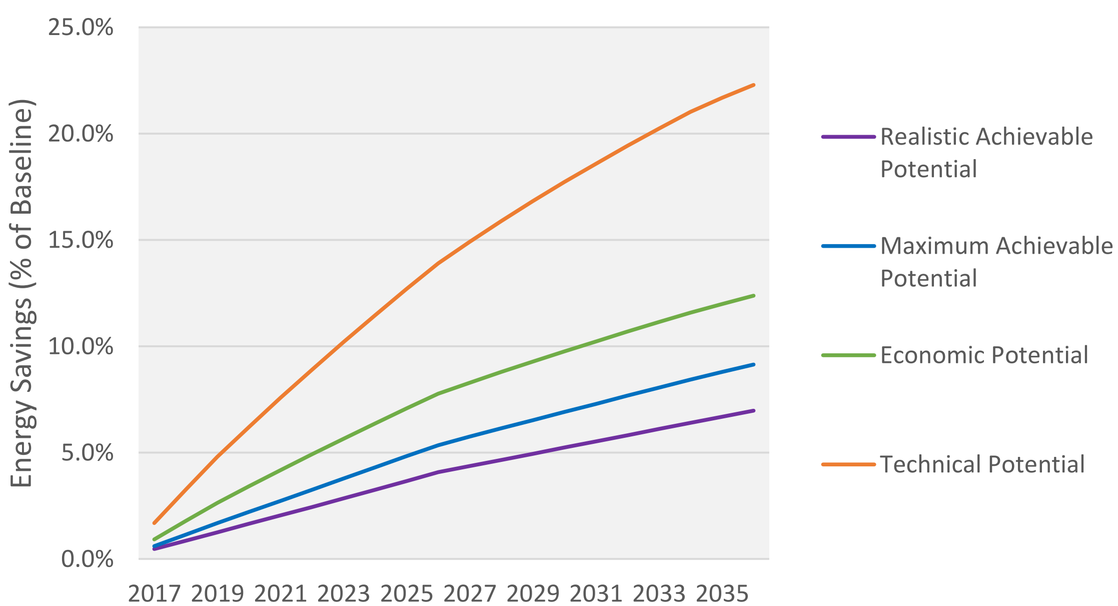
- **Technical Potential** reflects the adoption of *all* energy efficiency measures regardless of cost-effectiveness. Cumulative net savings by year 3 of the study are 54.8 MMtherms, or 4.8% of the baseline projection. By year 20 (2036), cumulative savings reach 252 MMtherms, or 22.3% of the baseline.
- **Economic Potential** refines technical potential by applying a cost-effectiveness screen, allowing only measures with a total resource cost (TRC) ratio greater than 1.0 to be included. Cumulative net savings by year 3 of the study are 30.1 MMtherms, or 2.6% of the baseline projection. By year 20 (2036), cumulative savings reach 140.1 MMtherms, or 12.4% of the baseline.

- **Maximum Achievable Potential** further refines economic potential by applying customer participation rates that account for market barriers, customer awareness and attitudes, program maturity, and other factors that affect market penetration of energy efficiency measures. MAP applies the most aggressive customer adoption rates developed. Cumulative net savings by year 3 of the study are 19.3 MMtherms, or 1.7% of the baseline projection. By year 20 (2036), cumulative savings reach 103.6 MMtherms, or 9.2% of the baseline.
- **Realistic Achievable Potential** further refines economic potential in the exact same way that Maximum Achievable does, but with a less aggressive set of customer adoption rates. Cumulative net savings by year 3 of the study are 14.4 MMtherms, or 1.3% of the baseline projection. By year 20 (2036), cumulative savings reach 78.9 MMtherms, or 7.0% of the baseline.

Table 5-2 Total System Natural Gas Potential (Annual Energy, MMtherms)

	2017	2018	2019	2026	2036
Baseline Forecast (MMtherms)	**1,142**	**1,140**	**1,139**	**1,125**	**1,132**
Cumulative Savings (MMtherms)					
Realistic Achievable Potential	5.3	9.8	14.4	45.9	78.9
Maximum Achievable Potential	6.9	13.1	19.3	60.3	103.6
Economic Potential	10.6	20.5	30.1	87.4	140.1
Technical Potential	19.3	37.3	54.8	156.3	252.2
Energy Savings (% of Baseline)					
Realistic Achievable Potential	0.5%	0.9%	1.3%	4.1%	7.0%
Maximum Achievable Potential	0.6%	1.1%	1.7%	5.4%	9.2%
Economic Potential	0.9%	1.8%	2.6%	7.8%	12.4%
Technical Potential	1.7%	3.3%	4.8%	13.9%	22.3%

Figure 5-2 Total System Natural Gas Potential (Cumulative Savings as a Percent of Baseline Projection)



Potential by Sector

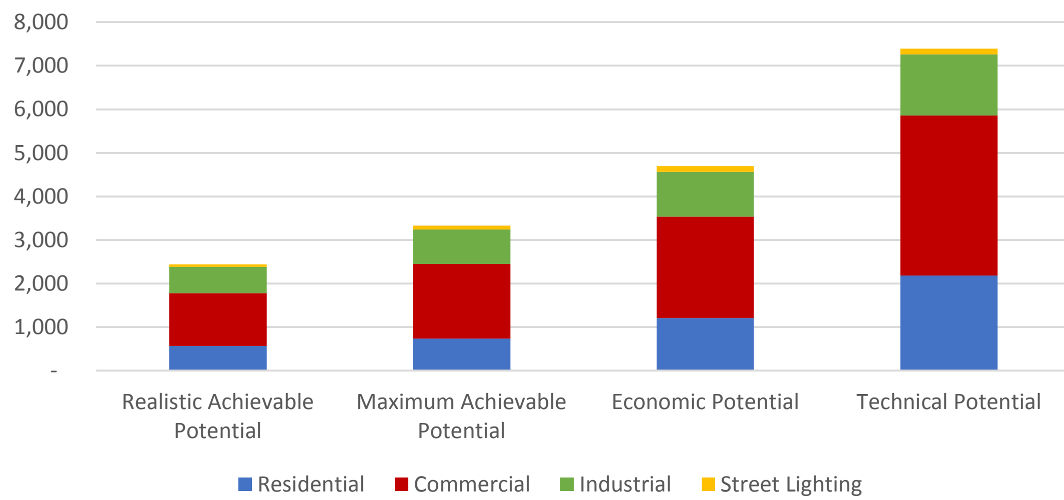
Electric Potential by Sector

Table 5-3 and Figure 5-3 summarize the electricity potential by sector in 2026, ten years into the forecast. The commercial sector is the highest, with nearly twice the potential savings of either the residential and industrial sectors. Street lighting has a relatively small share of total baseline use and also comprises a small component of the potential savings. Sector allocation is roughly consistent across the various cases/scenarios of potential, as well as across the study's time horizon in other years not pictured.

Table 5-3 Total System Electric Potential by Sector (Cumulative 2026 GWh)

	Residential	Commercial	Industrial	Street Lighting	Total
Realistic Achievable Potential	567	1,213	601	59	**2,441**
Maximum Achievable Potential	734	1,716	791	89	**3,330**
Economic Potential	1,209	2,328	1,030	130	**4,697**
Technical Potential	2,187	3,672	1,399	137	**7,395**

Figure 5-3 Total System Electric Potential by Sector (Cumulative 2026 GWh)



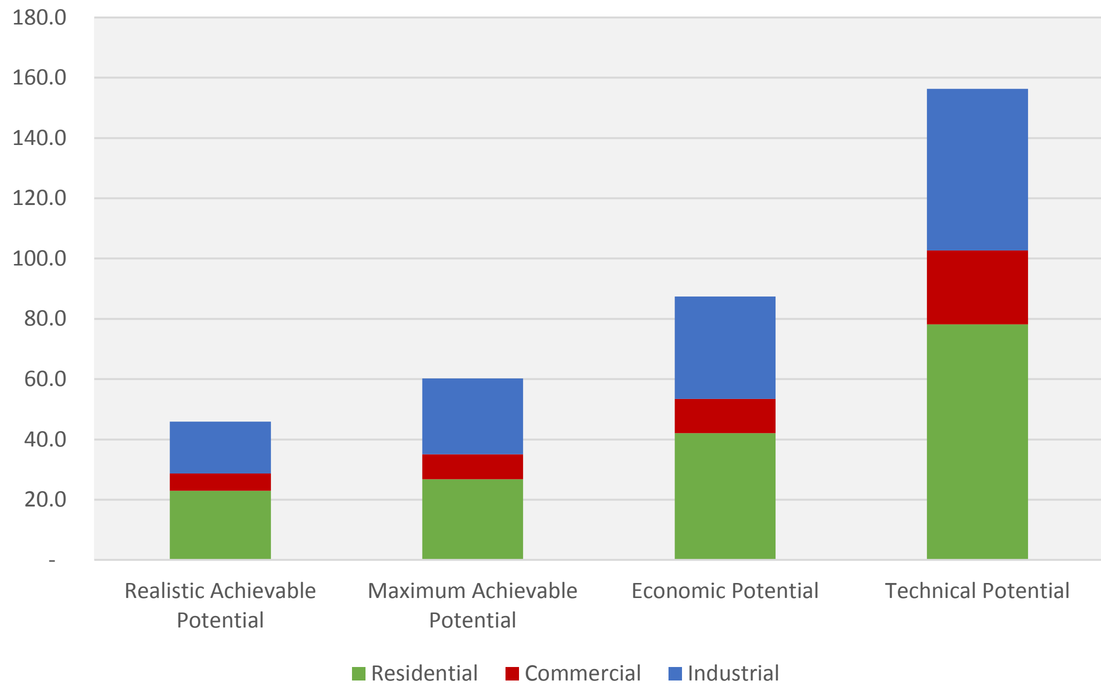
Natural Gas Potential by Sector

Table 5-4 and Figure 5-4 summarize the potential for natural gas by sector in 2026. The industrial sector has the highest savings, due largely to its large share of baseline consumption. The commercial sector, with the lowest share of baseline use, has the least opportunity for savings. Sector allocation is roughly consistent across the various cases/scenarios of potential, as well as across the study's time horizon in other years not pictured.

Table 5-4 Total System Natural Gas Potential by Sector (Cumulative 2026 MMtherms)

	Residential	Commercial	Industrial	Street Lighting	Total
Realistic Achievable Potential	23.0	5.7	17.2	-	**45.9**
Maximum Achievable Potential	26.8	8.3	25.2	-	**60.3**
Economic Potential	42.0	11.4	33.9	-	**87.4**
Technical Potential	78.2	24.5	53.6	-	**156.3**

Figure 5-4 Total System Natural Gas Potential by Sector (Cumulative 2026 MMtherms)



Potential by Measure Category

The energy efficiency potential identified in this study is distinguished at the measure level into three main categories:

1. **Traditional Energy Efficiency Measures**
2. **Behavioral Measures** focus on habits, operations, and non-purchase behaviors; namely: Home Energy Reports in the residential sector and Strategic Energy Management, Commissioning, and Retrocommissioning in the commercial and industrial sectors)
3. **Combined Heat & Power Measures**

The analytical treatment of these measure categories is the same, with the savings applied to the same market segments and baseline projections, but the planning, policy, and philosophical implications of the underlying initiatives makes their distinction useful for downstream strategic considerations.

Savings potential for these three, separate components are examined and described in the following sections, first for electricity and second for natural gas:

As shown in Table 5-5 and Table 5-6, traditional energy efficiency, such as equipment- or purchase-based measures, comprise a large majority of the savings, roughly four out of every five units of energy saved in both the electric and natural gas portfolios. Behavioral, or non-purchase measures and actions, are the next largest, with combined heat and power representing the smallest amount of potential and only applicable in the non-residential sectors.

Table 5-5 Total System Electric Potential by Measure Category (Cumulative Annual Savings, GWh)

Realistic Achievable Potential	2017	2018	2019	2026	2036
Traditional EE Measures	230	454	674	2,079	3,704
Behavioral Initiatives	68	94	121	315	632
Combined Heat & Power	-	2	8	46	111
Total	**299**	**551**	**802**	**2,441**	**4,447**
Maximum Achievable Potential					
Traditional EE Measures	331	649	957	2,822	4,829
Behavioral Initiatives	80	123	166	449	879
Combined Heat & Power	-	3	10	60	139
Total	**411**	**776**	**1,134**	**3,330**	**5,846**

Table 5-6 Total System Natural Gas Potential by Measure Category (Cumulative Annual Savings, MMTherms)

Realistic Achievable Potential	2017	2018	2019	2026	2036
Traditional EE Measures	4.1	8.2	12.4	41.1	69.1
Behavioral Initiatives	1.2	1.6	2.0	4.8	9.8
Combined Heat & Power	-	-	-	-	-
Total	**5.3**	**9.8**	**14.4**	**45.9**	**78.9**
Maximum Achievable Potential					
Traditional EE Measures	5.5	11.1	16.6	53.4	89.8
Behavioral Initiatives	1.4	2.0	2.7	6.8	13.7
Combined Heat & Power	-	-	-	-	-
Total	**6.9**	**13.1**	**19.3**	**60.3**	**103.6**

Note that zero natural gas impacts are recorded for combined heat and power initiatives. This is a result of an adjustment made per section 4.4.32 of the Illinois Technical Reference Manual, where the electricity savings are discounted by a factor of 0.70 for accounting purposes to reflect the fact that CHP systems have a net increases in natural gas consumption as fuel.

Traditional Energy Efficiency Potential

This section delves into some of the underlying detail behind the primary source of savings in this study: traditional, purchase-based energy efficiency measures. It does so first for electric measures by sector, and second for natural gas measures by sector.

Electric Traditional Energy Efficiency Potential

Residential Electric EE Potential

Table 5-7 identifies the top 20 residential measures by cumulative 2019 savings, which corresponds to the end of the next 3-year planning cycle. The top measure is interior screw-in lighting as a result of purchases of LED lamps which are cost effective throughout the forecast horizon. Other LED lamp categories, exterior and exempted/specialty lamps, are also among the very highest energy savers.

The number two measure is the smart thermostat, which is generating significant interest in DSM pilots and full-scale program rollouts all around the nation. Smart thermostats take a traditional programmable thermostat and add new features and technologies that are becoming cheaper and more widely available, such as occupancy sensors, learning algorithms, and web- and mobile-enabled communication capabilities. For more background on smart thermostats, please see the detailed research findings in Volume 4, Appendix B.

Ranked number 9 is another important and emerging measure: the tier 2 or second generation smart power strip. These devices, like the first generation smart power strip, will turn off auxiliary equipment when they interpret from a primary or trigger device that they are not being used. For example, if a computer is the primary device on a smart power strip, when it is shut down it can trigger the smart power strip to turn off other devices such as printers, monitors, and task lights that would only be on if the computer were operating. The tier 2 smart power strips also employ occupancy sensors, communication technologies, and other more advanced features to enable higher savings levels.

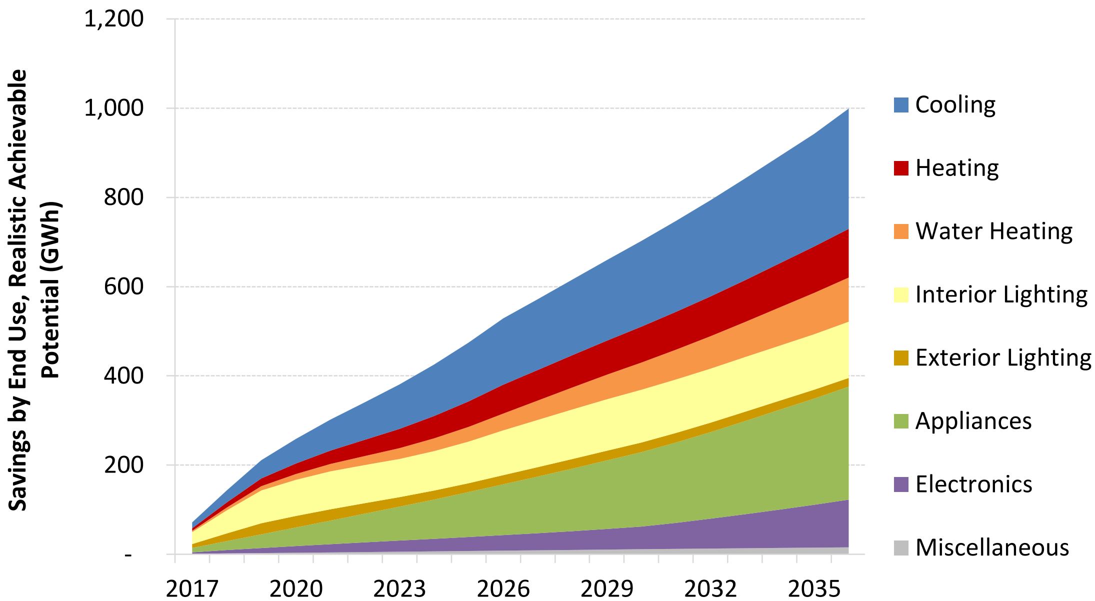
In several housing segments, HVAC and water heating equipment replacements were found not to be cost effective based on both Ameren Illinois's low avoided costs. Ductless mini-split heat pumps were found to be cost-effective in some niche applications and market segments, but due to the Illinois climate, housing stock, and avoided cost economics, they are not as prominent in the potential results as they are in other parts of the country and world.

Table 5-7 Residential Electric Top Measures in 2019

Rank	Measure / Technology	2017-2019 Realistic Achievable Cumulative Savings (GWh)	% of Savings
1	Interior Lighting - General Service Screw-In LED	58.5	27.7%
2	Smart Thermostat - Programmable/Interactive	30.5	14.4%
3	Exterior Lighting - Screw-in LED	23.0	10.9%
4	Interior Lighting - Exempted Screw-In LED	15.1	7.1%
5	Refrigerator - Decommissioning and Recycling	11.2	5.3%
6	Freezer - Decommissioning and Recycling	7.6	3.6%
7	Cooling - Central AC Upgrade	7.2	3.4%
8	Building Shell - Air Sealing Enhancement	7.1	3.3%
9	Electronics - Smart Power Strips, Tier 2	5.9	2.8%
10	Water Heating – Heat Pump Water Heater (<= 55 Gal)	5.1	2.4%
11	Appliances – Refrigerator Upgrade	4.0	1.9%
12	Appliances - Efficient Air Purifier	3.4	1.6%
13	Windows - Install Reflective Film	3.2	1.5%
14	Electronics – Efficient Personal Computers	2.6	1.2%
15	Insulation – Add to Wall Cavity	2.6	1.2%
16	Ducting - Repair and Sealing	2.2	1.1%
17	Windows - High Efficiency	1.8	0.8%
18	Exterior Lighting - Photovoltaic Installation	1.7	0.8%
19	Appliances – Efficient Dehumidifier	1.6	0.8%
20	Electronics – Efficient Laptops	1.4	0.7%
	Total	**195.6**	**92.7%**
	Total Cumulative Savings in 2019	**211.1**	**100.0%**

Figure 5-5 presents forecasts of cumulative residential energy savings by end use for the full 20-year study time horizon. LED lighting savings quickly ramp up as a substantial portion of the savings in the beginning of the planning horizon, but the growth begins to taper off as other factors start to come into play, such as: slower socket turnover due to longer-lived LED bulbs in the equipment stock, naturally occurring LED lamp purchases that are embedded in the baseline, and the EISA federal standard which imposes a step-change in the efficacy of baseline units in 2020. Cooling, appliance, water heating, and electronics savings then begin to grow significantly in the last decade of the time horizon.

Figure 5-5 Residential Electric RAP – Cumulative Savings by End Use (Annual GWh)



Commercial Electric EE Potential

Table 5-8identifies the top 20 commercial-sector measures by cumulative 2019 savings, or after the third year of the forecast. The top measure are predominantly lighting measures, led by LED replacements for screw-in and linear-fluorescent style lighting applications. Due to recent reductions in fixture costs, the price of linear LED panels and tubes have been significantly reduced. This has resulted in LED panels passing the TRC economic screen and contributing highly to the overall potential. There is a rapid ramp up in the available potential of lighting savings in the early years of the study, which just as in residential, slows and plateaus toward the latter half of the study. The acceleration continues significantly longer, however, as linear fixtures are not affected by the 2020 EISA standard change, and these fixtures are projected to yield cost-effective LED replacement opportunities for years to come.

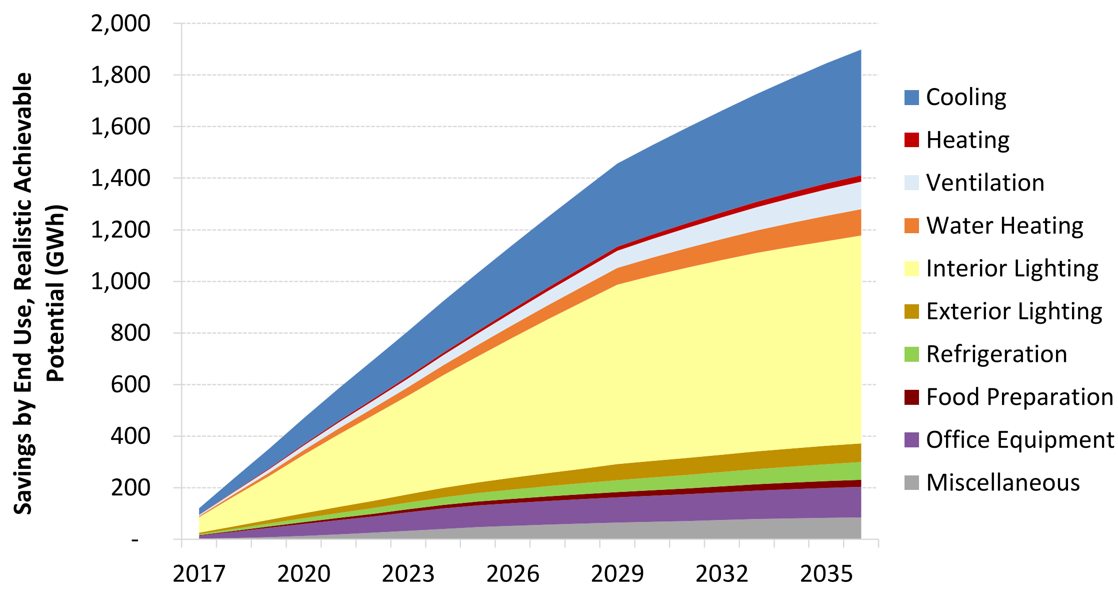
Retrofit HVAC measures and water heating equipment were also found to be sources of cost-effective potential.

Table 5-8 Commercial Electric Top Measures in 2019

Rank	Measure / Technology	2017-2019 Realistic Achievable Cumulative Savings (GWh)	% of Savings
1	Interior Lighting - Screw-in LED	37.8	11.6%
2	Interior Lighting - Occupancy Sensors	34.2	10.4%
3	Interior Lighting - Linear Lighting LED	33.9	10.4%
4	Cooling - Water-Cooled Chiller Upgrade	26.0	8.0%
5	Office Equipment – Efficient Desktop Computer	21.0	6.4%
6	Interior Fluorescent - Delamp and Install Reflectors	16.3	5.0%
7	Interior Lighting - High-Bay Fixtures LED	13.9	4.3%
8	Chiller - Chilled Water Reset	13.5	4.1%
9	Office Equipment – Efficient Server	9.6	2.9%
10	Cooling - Air-Cooled Chiller Upgrade	9.1	2.8%
11	Exterior Lighting - Screw-in LED	8.1	2.5%
12	HVAC – Economizer	7.9	2.4%
13	Ventilation – Efficient System Upgrade	7.5	2.3%
14	Water Heating – Heat Pump Water Heater	6.7	2.1%
15	Ventilation - Variable Speed Control	6.5	2.0%
16	Miscellaneous – Efficient Pool Pump	6.2	1.9%
17	Exterior Lighting - Area Lighting LED	5.4	1.6%
18	Destratification Fans (HVLS)	5.1	1.5%
19	Water Heater - Faucet Aerators/Low Flow Nozzles	4.2	1.3%
20	Interior Fluorescent - Bi-Level Fixture	3.6	1.1%
	Total	**276.3**	**84.5%**
	Total Cumulative Savings in 2019	**327.0**	**100.0%**

Figure 5-6 presents forecasts of cumulative commercial energy savings by end use. Savings from lighting and cooling systems account for the lion's share of potential throughout the forecast horizon.

Figure 5-6 Commercial Electric RAP – Cumulative Savings by End Use (Annual GWh)



Industrial Electric EE Potential

Table 5-9 identifies the top 20 industrial measures by cumulative 2019 savings. LED lighting replacements and occupancy sensors represent large savings opportunities in the industrial sector. High bay LED applications make up a majority of the fixtures, and are highly cost-effective.

Another large opportunity is the optimization and control of motor and drive systems. This end use has the largest baseline energy consumption for industrial customers, and small improvements to timing, control, speed, and operation can accrue to large savings.

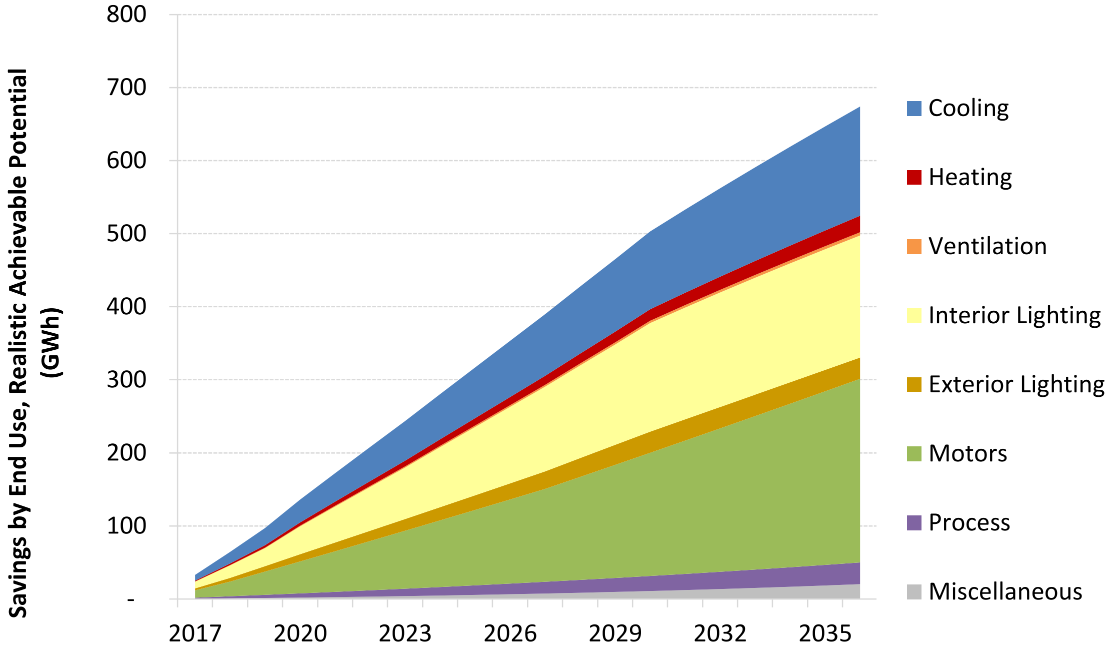
Nonetheless, a significant number of applications for variable frequency drives (VFDs) that were included in Ameren Illinois's achievable potential in the 2013 study have now become non-cost-effective. Lower avoided cost benefits and refined measure inputs with higher installation costs cause some marginal applications to fall off the table.

Table 5-9 Industrial Electric Top Measures in 2019

Rank	Measure / Technology	2019 Realistic Achievable Cumulative Savings (GWh)	% of Savings
1	Interior Lighting - High-Bay Fixtures LED	9.4	9.7%
2	Interior Lighting - Occupancy Sensors	9.0	9.2%
3	Process - Timers and Controls	7.6	7.8%
4	Exterior Lighting - Area Lighting LED	6.8	7.0%
5	Destratification Fans (HVLS)	6.6	6.8%
6	HVAC – Economizer	6.5	6.7%
7	Pumping System - Variable Speed Drive	5.6	5.8%
8	Pumping System - System Optimization	5.1	5.2%
9	Compressed Air - Leak Management Program	4.8	4.9%
10	Cooling - Water-Cooled Chiller Upgrade	3.7	3.8%
11	Fan System - Flow Optimization	3.3	3.4%
12	Interior Lighting - Screw-in LED	3.0	3.1%
13	Interior Lighting - Linear Lighting LED	2.7	2.8%
14	Compressed Air - System Controls	2.6	2.7%
15	Chiller - Chilled Water Reset	2.5	2.5%
16	Insulation – Add to Wall Cavity	2.3	2.4%
17	Cooling – RTU Upgrade	2.2	2.2%
18	Agriculture - High Speed Fans	1.8	1.9%
19	Pumping System - Equipment Upgrade	1.7	1.7%
20	Cooling - Air-Cooled Chiller Upgrade	1.6	1.6%
	Total	**88.8**	**91.3%**
	Total Cumulative Savings in 2019	**97.2**	**100.0%**

Figure 5-7 presents forecasts of cumulative industrial energy savings by end use. Motor-related measures account for a substantial portion of the savings throughout the forecast horizon. Savings associated with lighting and cooling measures are also significant throughout the forecast.

Figure 5-7 Industrial Electric RAP – Cumulative Savings by End Use (Annual GWh)



Street Lighting Electric EE Potential

Cost effective potential in this sector is mainly attributable to the installation of LED lighting fixtures. AEG used assumptions from Ameren Illinois' operational team for labor and O&M of LED retrofit costs, which were comparable to other utility figures from around the region and country. Importantly, this included the baseline cost of replacing the alternative high intensity lamps multiple times during the baseline fixture lifetime. Considering this, LED fixtures are cost-effective before even considering energy savings.

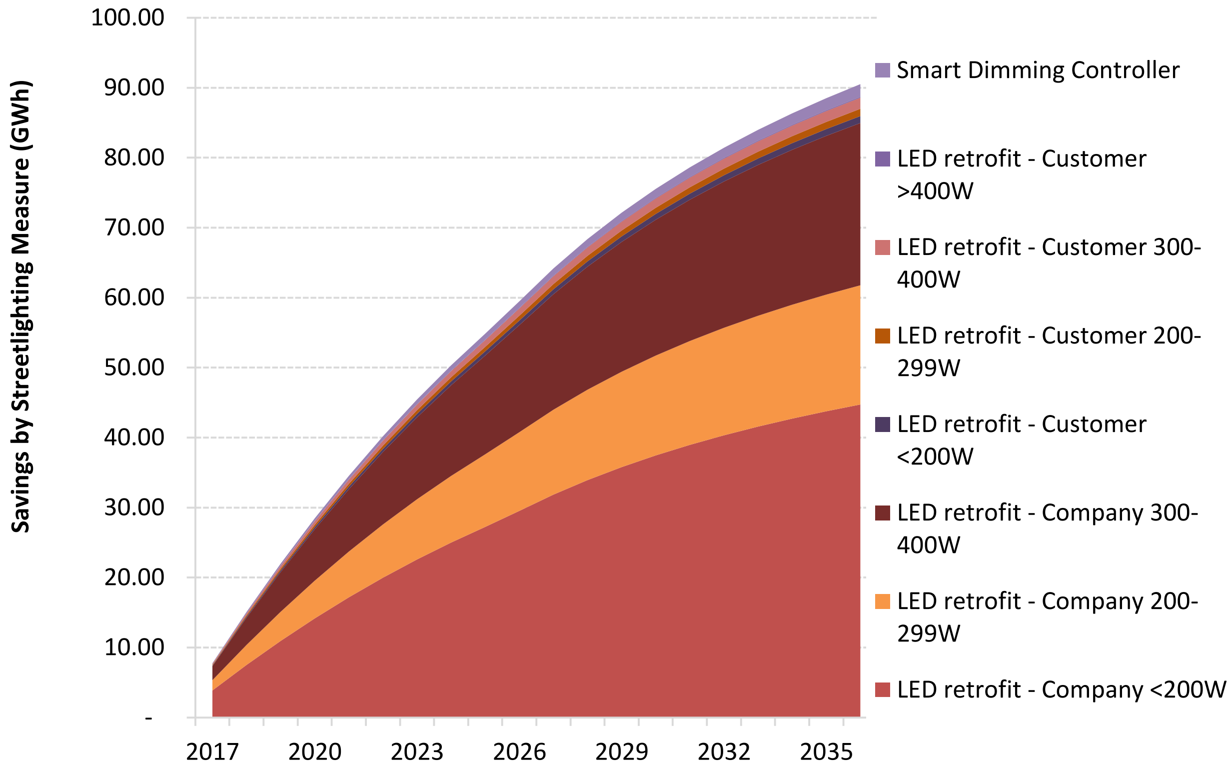
The smart-dimming controller measure is also cost effective for select applications, where lumen levels can be dimmed during periods of low use, occupancy, or traffic; but still maintain some amount of brightness for safety, aesthetics, and other reasons.

Table 5-10 identifies the top street lighting measures from the perspective of cumulative energy savings in 2019. Figure 5-8 presents forecasts of cumulative street lighting energy savings by measure. Company-owned fixtures represent the largest potential savings, and the smaller sized lamps, being more numerous, have the largest potential among the various company fixtures.

Table 5-10 Street Lighting Electric Top Measures in 2019

Rank	Measure / Technology	2017-2019 Realistic Achievable Cumulative Savings (GWh)	% of Total
1	LED retrofit - Company <200W	10.9	49.7%
2	LED retrofit - Company 300-400W	5.7	25.8%
3	LED retrofit - Company 200-299W	4.2	19.0%
4	LED retrofit - Customer 300-400W	0.4	1.8%
5	Smart Dimming Controller	0.3	1.3%
6	LED retrofit - Customer 200-299W	0.3	1.2%
7	LED retrofit - Customer <200W	0.2	1.1%
8	LED retrofit - Customer >400W	0.0	0.1%
	Total	**22.0**	**100.0%**
	Total Cumulative Savings in 2019	**22.0**	**100.0%**

Figure 5-8 Street Lighting Electric RAP – Cumulative Savings by Measure (Annual GWh)



Natural Gas Traditional Energy Efficiency Potential

Residential Natural Gas EE Potential

Table 5-11 identifies the top residential measures by cumulative 2019 savings. The top measure is the smart thermostat, which also generates significant electric savings and as mentioned above is creating industry-wide interest in DSM pilots and full-scale program rollouts. For more background on smart thermostats, please see the detailed research findings in Volume 4, Appendix B.

Furnace upgrades are cost-effective in a small number of homes and market segments, but are anticipated to be removed from programs and institutionalized in federal minimum codes shortly after the end of the next 3-year implementation cycle. A residential natural gas furnace efficiency standard was proposed by the DOE in 2011, but halted by lawsuits in 2012 through 2014 that questioned the rulemaking process. The DOE is expected to redraft a new standard in 2016 with input from industry stakeholders, and we have assumed for this analysis that these talks will result in a natural gas furnace standard of 0.92 AFUE beginning in 2021.[16]

Building shell measures also show gas energy savings, but low avoided costs contribute to a lower incidence of cost-effective opportunities relative to the previous Ameren Illinois potential study.

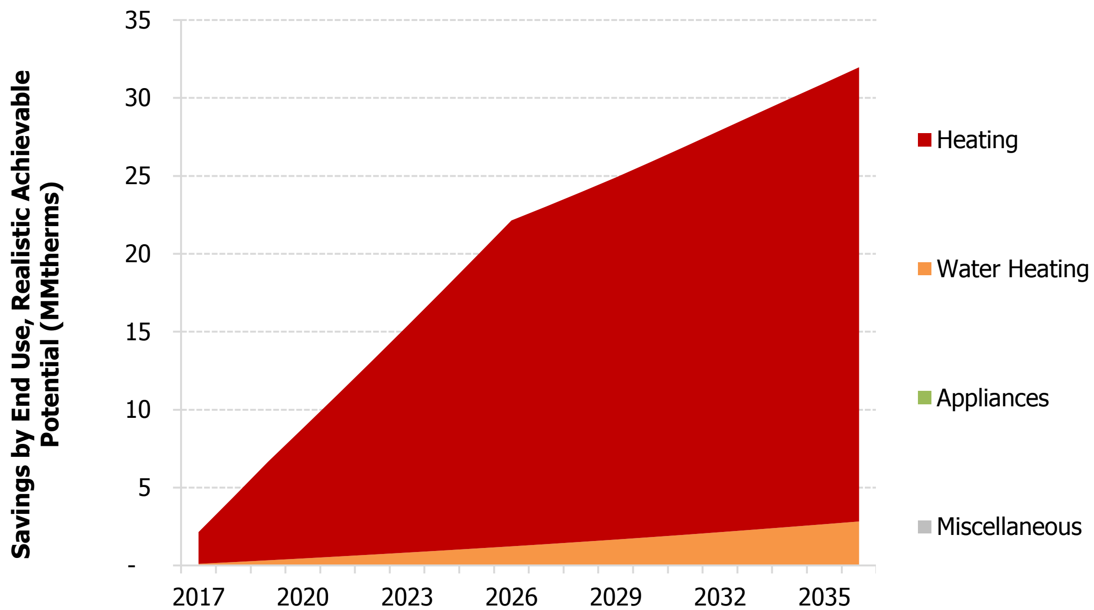
Table 5-11 Residential Natural Gas Top Measures in 2019

Rank	Measure / Technology	2017-2019 Realistic Achievable Cumulative Savings (GWh)	% of Savings
1	Smart Thermostat - Programmable/Interactive	4.1	61.1%
2	Ducting - Repair and Sealing	0.6	8.4%
3	Heating – Furnace Upgrade	0.5	7.3%
4	Building Shell - Air Sealing	0.5	7.3%
5	Insulation - Radiant Barrier	0.2	2.8%
6	Insulation – Add to Wall Cavity	0.2	2.4%
7	Windows - High Efficiency	0.2	2.4%
8	Insulation – Add to Ceiling	0.1	1.8%
9	Water Heater - Tank Wrap	0.1	1.4%
10	Water Heater - Low-Flow Showerheads	0.1	1.3%
11	Water Heater - Pipe Insulation	0.1	0.8%
12	Insulation – Add to Floor	0.0	0.7%
13	Boiler - Maintenance	0.0	0.6%
14	Water Heater - Thermostatic Restrictor Shower Valve	0.0	0.5%
15	Water Heater – Low-Flow Faucet Aerators	0.0	0.4%
16	Water Heater - Upgrade	0.0	0.4%
17	Water Heater - Temperature Setback	0.0	0.3%
18	Boiler - Pipe Insulation	0.0	0.1%
19	Insulation - Basement Sidewall	0.0	0.1%
20	Heating – Boiler Upgrade	0.0	0.0%
	Total	**6.7**	**100.0%**
	Total Cumulative Savings in 2019	**6.7**	**100.0%**

Figure 5-9 presents forecasts of cumulative residential energy savings by end use. The savings are primarily from space heating measures with some contribution from water heating measures.

[16] http://www.appliance-standards.org/product/furnaces

Figure 5-9 Residential Natural Gas RAP – Cumulative Savings by End Use (Annual MMtherms)



Commercial Natural Gas EE Potential

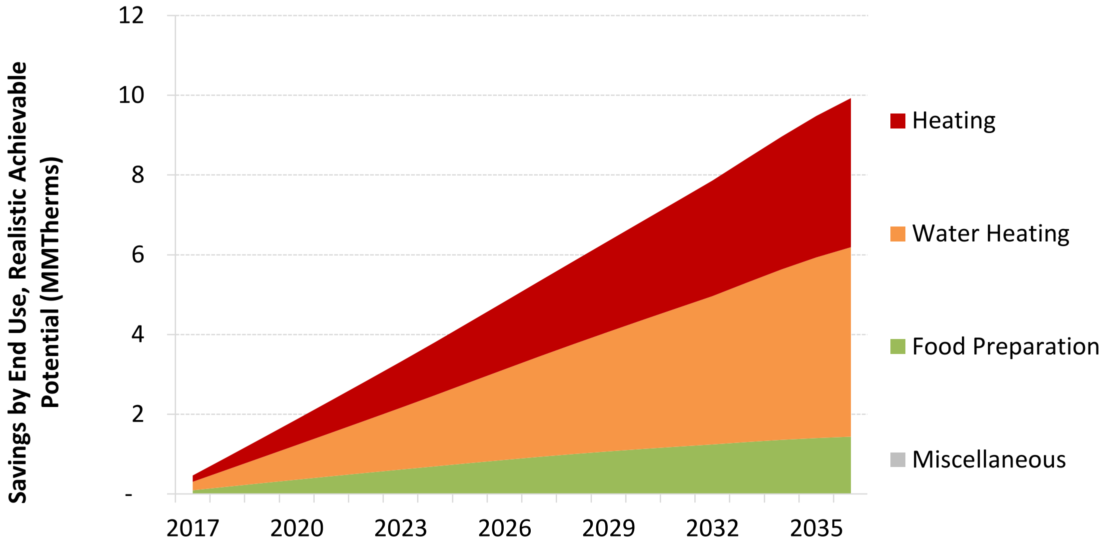
Table 5-12 identifies the top commercial-sector measures in 2019. There are few cost-effective opportunities to achieve gas savings in commercial facilities. Water heating equipment upgrades are the top measure, moving to high-efficiency units with condensing combustion systems.

Table 5-12 Commercial Natural Gas Top Measures in 2019

Rank	Measure / Technology	2017-2019 Realistic Achievable Cumulative Savings (MMTherms)	% of Savings
1	Water Heating – Equipment Upgrade	0.4	28.8%
2	Insulation – Add to Wall Cavity	0.2	17.2%
3	Gas Boiler - Hot Water Reset	0.1	10.8%
4	Food Preparation - Fryer	0.1	10.8%
5	Destratification Fans (HVLS)	0.1	10.0%
6	Water Heater - Central Controls	0.1	9.4%
7	Food Preparation - Oven	0.0	3.3%
8	Food Preparation - Steamer	0.0	2.6%
9	Food Preparation - Griddle	0.0	2.2%
10	Steam Trap Maintenance	0.0	1.5%
11	Heating - Boiler	0.0	1.3%
12	Insulation - Foundation	0.0	1.2%
13	Advanced New Construction Designs	0.0	1.0%
14	Food Preparation - Broiler	0.0	0.8%
	Total	**1.4**	**100.0%**
	Total Cumulative Savings in 2019	**1.4**	**100.0%**

Figure 5-10 presents forecasts of cumulative commercial energy savings by end use for the full 20-year study time horizon. Water heating savings are the largest portion of the savings throughout the forecast horizon, followed by space heating and food preparation end uses.

Figure 5-10 Commercial Natural Gas RAP – Cumulative Savings by End Use (Annual MMtherms)



Industrial Natural Gas EE Potential

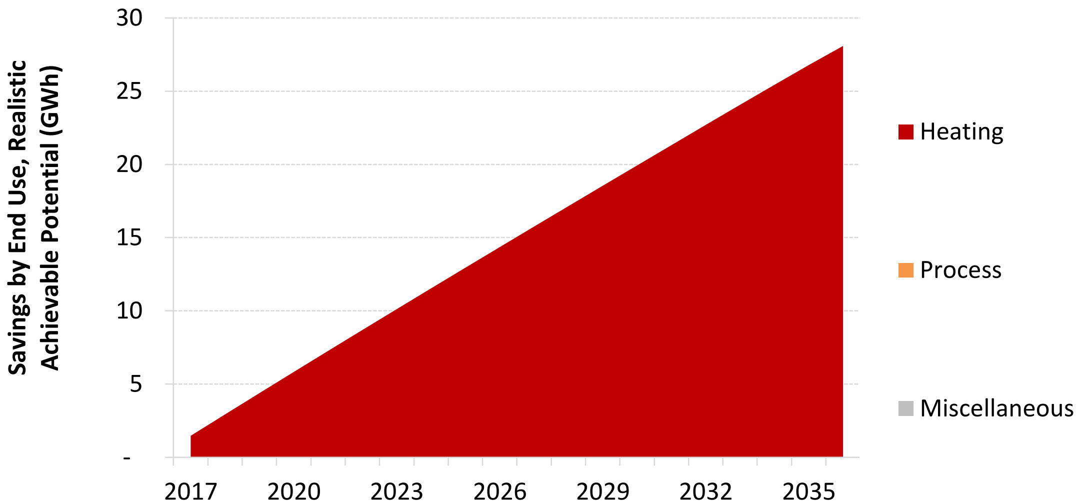
Table 5-13 identifies the top industrial natural gas measures by 2019. Like the commercial sector, there are few cost-effective opportunities to achieve gas savings in industrial facilities. Wall cavity insulation is the top measures, followed by destratification fans (or high volume, low speed, HVLS), which slowly mix the air inside tall-ceilinged industrial facilities for more efficient space conditioning. Boiler measures and steam trap maintenance are also opportunities.

Table 5-13 Industrial Natural Gas Top Measures in 2019

Rank	Measure / Technology	2017-2019 Realistic Achievable Cumulative Savings (MMTherms)	% of Total
1	Insulation – Add Wall Cavity	1.9	44.6%
2	Destratification Fans (HVLS)	1.6	36.9%
3	Heating - Process Boiler Upgrade	0.7	15.2%
4	Heating – Boiler Upgrade	0.1	1.8%
5	Gas Boiler - Hot Water Reset	0.0	0.9%
6	Steam Trap Maintenance	0.0	0.6%
	Total	**4.4**	**100.0%**
	Total Cumulative Savings in 2019	**4.4**	**100.0%**

Figure 5-11 presents forecasts of cumulative industrial energy savings by end use for the full 20-year study time horizon.

Figure 5-11 Industrial Natural Gas RAP – Cumulative Savings by End Use (Annual MMtherms)



Behavioral Initiatives

This section discusses some of the detail behind behavioral initiatives, the group of programs that focuses on energy savings from habits, operations, and other non-purchase behaviors. Unlike the traditional energy efficiency measures discussed in the previous section, there is no tangible item or widget that can produce these savings without the program being in place. Therefore, program potential and market/measure-level potential are identical since an economic and realizable delivery structure is a precondition for the initiatives' existence.

The three initiatives included in this analysis are described below:

- **Residential Behavioral Modification**. Many approaches are currently employed in the energy efficiency marketplace to promote behavioral savings through programmatic activities, but for the purpose of this study, we have used the Home Energy Reports approach that Ameren Illinois has already been implementing for several years. This program chooses a portion of the population and randomly assigning some to receive informational home energy reports and messaging, while others are assigned to serve as a control group that receives no such treatment. Energy savings are periodically and routinely estimated based on a statistical comparison of the report recipients' and control group's energy usage. Based on Ameren's implementation experience and benchmarking research, we have modeled each participating home with annual electricity savings of 1.55% and natural gas savings of 0.82% of total home energy consumption. For more background please see the detailed research findings on residential behavioral savings in Volume 4, Appendix B.
- **C&I Strategic Energy Management.** This program provides energy education, technical assistance, and company-wide coaching to large commercial and industrial customers to drive behavioral change and transformation of company culture with respect to energy use and management. It is a systematic approach to delivering persistent energy savings to organizations by integrating energy management into regular business practices. The program involves appointment of an energy liaison(s) and a team within participating organizations who regularly correspond with program representatives.

  This program can be delivered by borrowing portions of the ISO 500001 standard, but is more commonly a customized offering where large C&I accounts are engaged on their terms. To avoid double counting of savings, any equipment- or widget-based measures that arise as a result of these initiatives are routed through the Standard and Custom project infrastructure. In addition to identifying and routing such measures, the program focuses on creating incremental behavioral and operational savings, which are the only savings for which it pays and takes credit within its portfolio line-item.

- **C&I Retro-Commissioning**. This program begins with engineering support for an on-site facility and system assessment to identify behavioral, operational, and low- or no-cost opportunities to reduce facility energy use. Engineering support is then provided periodically, usually for at least a year, to track the changes made and to support the participants in monitoring energy use performance and improving facility performance. The best segments to target are office buildings, hospitals, colleges, large institutional buildings, and large industrial facilities where processes with control systems account for a substantial percentage of overall energy use.

We look at the behavioral savings estimates below, first for electricity savings and then natural gas savings.

Electric Behavioral Potential

Table 5-14 shows the electricity savings potential from behavioral programs starting at 68 GWh in 2017 and rising to 632 GWh by the end of the 20-year planning horizon. This is 1.77% of the baseline forecast in 2036.

Residential savings are the largest in the early years, but are already at a point of market saturation where most of the available and cost-effective opportunities are already being deployed. Over time, the total level of savings for the residential program actually decreases due to a declining energy use per household. As other DSM programs, federal codes and standards, and naturally occurring energy efficiency make households more efficient; there is less behavioral "slack" to tighten up in the home.

Commercial and industrial savings from behavioral initiatives start relatively small, but grow over time. The opportunity space for these programs is much larger since the more heterogeneous landscape of business customers has more custom opportunities for energy savings that are not reached by codes and standards and are routinely overlooked by managers and workers as they focus on their core business. These are the wider opportunities that can be reached with behavioral and operational initiatives; and once practices and habits are institutionalized in company policy, there is more persistence (i.e. longer measure lifetime) than has been evaluated in residential behavioral programs.

Table 5-14 Electric Savings from Behavioral Programs (RAP)

Behavioral Program Cumulative Savings (GWh)	2017	2018	2019	2026	2036
Residential					
Behavioral Programs	42.4	41.9	41.4	38.5	36.9
Commercial & Industrial					
Strategic Energy Management	10.7	21.7	32.9	118.4	262.4
Retro-Commissioning	15.2	30.5	46.1	158.3	332.3
C&I Subtotal	*25.8*	*52.2*	*79.1*	*276.7*	*594.7*
Total	**68.2**	**94.1**	**120.5**	**315.2**	**631.6**
Total as % of Baseline Forecast	**0.19%**	**0.27%**	**0.34%**	**0.89%**	**1.77%**

Natural Gas Behavioral Potential

Table 5-15 below shows the natural gas savings potential from behavioral programs starting at 1.25 million therms in 2017 and rising to 9.8 million therms by the end of the 20-year planning horizon. This is 0.87% of the baseline forecast in 2036. The same trends are visible here as those discussed for electric savings: residential gas savings decline slightly over time, but C&I savings show significant growth potential.

Table 5-15 Natural Gas Savings from Behavioral Programs (RAP)

Behavioral Program Cumulative Savings (MMTherms)	2017	2018	2019	2026	2036
Residential					
Behavioral Programs	0.90	0.90	0.89	0.86	0.85
Commercial & Industrial					
Strategic Energy Management	0.15	0.30	0.46	1.65	3.68
Retro-Commissioning	0.20	0.41	0.63	2.30	5.27
C&I Subtotal	*0.35*	*0.71*	*1.09*	*3.95*	*8.95*
Total	**1.25**	**1.61**	**1.98**	**4.81**	**9.80**
Total as % of Baseline Forecast	**0.11%**	**0.14%**	**0.17%**	**0.43%**	**0.87%**

Combined Heat and Power

This section delves into some of the detail of the CHP potential savings identified in this study. Four types of CHP systems were considered in the applicable commercial and industrial segments, listed below in ascending order of size or capacity:

- Fuel Cells with Heat Recovery
- Reciprocating Engines with Heat Recovery
- Micro-turbines with Heat Recovery
- Combustion Turbines with Heat Recovery

We found that no instances of natural gas fuel cells were economic in the market segments analyzed, but opportunities do exist for the remaining three technologies as shown in Table 5-16. Electricity savings potential reaches 111 GWh by the end of the 20-year planning horizon, or 0.31% of the baseline forecast in 2036. The largest impacts are from the industrial sector and from Combustion Turbines with Heat Recovery, which are the largest systems in terms of capacity, indicating that economies of scale are vital to these technologies.

Table 5-16 Combined Heat & Power Adjusted Electric Savings (RAP)

CHP Cumulative Savings (Adjusted GWh)	2017	2018	2019	2026	2036
Commercial					
Reciprocating Engine w/ Heat Recovery	0.0	0.1	0.3	2.4	5.6
Micro-turbine w/ Heat Recovery	0.0	0.0	0.0	0.1	1.9
Combustion Turbine w/ Heat Recovery	0.0	0.0	0.1	0.7	2.0
Commercial Subtotal	*0.0*	*0.1*	*0.5*	*3.3*	*9.5*
Industrial					
Reciprocating Engine w/ Heat Recovery	0.0	0.5	1.6	9.6	23.4
Micro-turbine w/ Heat Recovery	0.0	0.5	1.6	9.5	22.6
Combustion Turbine w/ Heat Recovery	0.0	1.3	4.0	23.9	56.0
Industrial Subtotal	*0.0*	*2.4*	*7.2*	*43.0*	*101.9*
Total	**0.0**	**2.5**	**7.6**	**46.3**	**111.4**
Total as % of Baseline Forecast	**0.00%**	**0.01%**	**0.02%**	**0.13%**	**0.31%**

For each of the CHP systems, there is a net increase in natural gas fuel consumption in order to power the electricity generation; but this is offset partially by the energy savings from captured waste heat such that the total system efficiency is very high. This means, however, that deployment is limited to facilities (of sufficient scale) that can capture and find use for the waste heat.

Note that, for the counting of savings achievements toward goals and targets, the Illinois TRM section 4.4.32 prescribes an adjustment to the accounting of electric and natural gas inputs and outputs such that electric savings are discounted to 70% of actual production and net natural gas consumption is discounted to zero. This effectively trades the net natural gas increases for a slightly lower value of electric savings. The values presented here have therefore been adjusted downward by 30% according to this process. This is for counting achievements toward targets only, and should not be used directly for load forecasting or related purposes.

Additionally, since there is currently no Ameren Illinois CHP incentive program, we assume that program savings begin in the second year of the analysis to allow time for program development and design of applicable rates and tariffs.

Program-Level Potential

This section covers the program-level potential, where all the components of energy efficiency measures discussed in the previous chapter are integrated and bundled to develop a realizable portfolio of DSM resources.

Development of Program Potential

Program potential is defined as the portion of the achievable potential that might be reasonably achieved given the realities of implementation and the constraints of program resources. It is a subset of market potential that is aligned with recent implementation accomplishments, available future budget, and long-term strategic goals.

This study developed preliminary estimates of program potential that will be refined into program designs in a separate effort in 2016.

We used program design, incentive structures, marketing approaches, budgets, and levels of staffing and field experience to refine delivery assumptions and participation rates to a level that can be accomplished given Ameren Illinois' current state of operations and to reflect the ramp-up time necessary for new initiatives. Additionally, adjustments were made to incentive amounts and administrative budgets associated with getting new initiatives into the marketplace. We made these adjustments based on discussions with Ameren Illinois staff and review of existing budget and staff projections.

When translating from the market potential in the previous chapter to program-level potential, we applied the following adjustments:

- Excluded any measure that did not pass the TRC screen
- Allocated each passing measure to one or more program
- Added program administrative & delivery costs
- Ensured the most recent and relevant net-to-gross ratios were reflected
- Considered measure bundling, delivery mechanisms, and program-level cost-effectiveness. For example, at this stage we excluded efficient residential electronic equipment measures since there is no viable delivery method for a utility program in this market. We also excluded Appliance Recycling since the program bundle is no longer cost-effective due to progressively lower levels of unit energy savings and program net-to-gross ratios.

The programs identified, shown below in Table 6-1, are very similar to those currently being offered in the Ameren Illinois service territory:

Table 6-1 List of Programs in Modeled Ameren Illinois DSM Portfolio

Residential Programs	Business Programs
Lighting	C&I Standard
Behavior Modification	C&I Custom
New Homes	Retro-commissioning
Whole Home	Small Business Direct Install
HVAC	Strategic Energy Management
Multifamily	Street Lighting
School Kits	Combined Heat and Power
Rural Kits	Institutional & Public Facilities
Moderate Income	
Smart Thermostats	
Low Income - Single Family	
Low Income - Multifamily	

As previously noted, this study developed preliminary estimates of program potential that will be refined into program designs in a separate effort in 2016. Therefore, the programs are discussed only at a high-level. Detailed delivery mechanisms, implementation and marketing strategies, and budgets will be determined during the separate program design efforts scheduled throughout 2016. The high-level residential and business DSM programs are described in Table 6-2 and Table 6-3.

Table 6-2 Summary of Residential Programs Modeled in Ameren Illinois DSM Portfolio

Residential Programs	High-Level Description and Notes
Lighting	Instant incentives at qualifying retailers for CFLs and LEDs. The net to gross ratio for this planning study has been increased from 0.47 (per Ameren Illinois' PY6 Evaluation) to 0.70 to account for the transition from a CFL to an LED world. This aligns with the 2015 SAG NTG working group recommendations.
Behavior Modification	Behavioral program utilizing customized energy reports sent periodically to households to encourage energy efficient behaviors that affect both electric and natural gas consumption.
New Homes	Incentives and technical support for new home builders to construct buildings that exceed building energy efficiency codes.
Whole Home	This is a holistic program that aims at increasing efficiency across multiple systems in a customer's home, with measures that affect all end uses and the building shell.
HVAC	This program aims at increasing the level of efficiency of customer heating, ventilation, and air conditioning equipment above minimum standards and typical market practices. Note that avoided costs for cooling in the HVAC program have been adjusted upward by 10 to 20% to account for increased seasonal (summer) energy costs. Without this adjustment, many installations of cooling measures are not cost effective.
Multifamily	This program aims to provide direct install measures and other follow-on measures to the multifamily space.
School Kits	This program provides take-home kits for school children that include some simple measures like efficient light bulbs, and also includes an educational, classroom component.
Rural Kits	This program sends mail kits for households that are outside of typical urban centers with comprehensive program and contractor coverage. Kits include some simple measures like efficient light bulbs.
Moderate Income	This is a holistic program that aims at increasing efficiency across multiple systems in a customer's home, with measures that affect all end uses and the building shell. It provides full or heavy subsidization for these measures and focuses on households that fall above 150% of the federal poverty level of, but are still below 300% of the federal poverty level and would otherwise have difficulty affording energy efficient investments.
Smart Thermostats	This effort would incentivize the adoption of smart, programmable, learning, and Wi-Fi-enabled thermostats to increase heating and cooling savings for both electricity and natural gas. These assets could also potentially be tapped for demand response purposes if deemed appropriate to program management.
Low Income - Single Family	This is a holistic program that aims at increasing efficiency across multiple systems in a customer's home, with measures that affect all end uses and the building shell. It provides full or heavy subsidization for these measures and focuses on single family households that fall below 150% of the federal poverty level and would otherwise have difficulty affording energy efficient investments.
Low Income - Multifamily	This is a holistic program that aims at increasing efficiency across multiple systems in a customer's home, with measures that affect all end uses and the building shell. It provides full or heavy subsidization for these measures and focuses on multifamily households that fall below 150% of the federal poverty level and would otherwise have difficulty affording energy efficient investments.

Table 6-3 Summary of Business Programs Modeled in Ameren Illinois DSM Portfolio

Business Programs	High-Level Description and Notes
C&I Standard	One of the largest programs in the portfolio in terms of budget and energy savings, this program allows customers to receive incentives by installing efficient measures from a pre-qualified list of options.
C&I Custom	The other largest program in the portfolio in terms of budget and energy savings, this program provides a place for customers to propose, qualify, and complete energy efficient projects that are not explicitly identified in the prescriptive list of C&I Standard measures. Incentives are paid based on a dollar per unit of energy saved basis.
Retro-commissioning	Initial or ongoing monitoring of building energy systems to optimize energy use, focusing at least initially on low-cost or no-cost measures and actions.
Small Business Direct Install	Rapidly deployable measures that target the often overlooked small businesses. Define customer eligibility at below a certain size threshold. Measures are typically heavily subsidized or financed to account for the fact that cash flow is typically a challenge in this segment
Strategic Energy Management	Provide energy education, technical assistance, and coaching for large commercial and industrial customers in order to drive behavioral change and transformation of the company culture.
Street Lighting	New program that would retrofit existing exterior lighting assets with LED technologies and smart sensors.
Combined Heat and Power	Installation of generation at customer sites where waste heat can be utilized. Increases overall system efficiency by re-use of waste heat.
Institutional & Public Facilities	Measures and energy savings that are targeted to the institutional and public building space (government buildings, schools, etc.) with a structure similar to the Standard and Custom programs.

Portfolio Modeling Notes

Regarding customer participation, based on our customer interest research, the maximum achievable potential case attains participation levels that are approximately 50% higher than the realistic achievable program potential case. This incremental participation comes at a cost, however, as programs must expend more resources in terms of marketing dollars, recruitment efforts, and higher incentive levels to attract the additional customers.

The cost structure for Program RAP has incentives and administrative costs that align with levels observed in the Ameren Illinois current DSM *Act On Energy* programs. The Program MAP portfolio of programs, however, increases incentive levels such that they reach 100% of incremental cost where applicable, increase the amount of payout for programs that use $/first-year-kWh or -therm payments, and generally aims to create faster economic paybacks to increase customer interest. Since administrative and other non-incentive costs are derived as a percentage of the incentive budget, these cost components also scale up proportionally when moving from RAP to MAP.

It is also worth noting that Low & Moderate Income Programs generally subsidize the full measure cost in order to achieve the installations and savings that the target populations would rarely if ever adopt on their own or even with standard levels of programmatic incentives. This results in large dollar expenditures, but they are considered justified since these programs are not required to be cost-effective. Nonetheless, we applied some constraints to the program design to prevent the budget allocation for income qualified programs from increasing beyond a reasonable proportion of the portfolio total. Rather than completely eliminate the economic screen, we applied a very loose one by taking only measures with a TRC ratio greater than 0.50. After this, we subjective removed of measures and scaled back participation until the program budgets as a percentage of the total residential portfolio was less than or equal to the representation of income qualified households in the greater customer population (41%).

Finally, with respect to the Behavioral Modification program, this was modeled as a continuation of Ameren Illinois' current Home Energy Reports program. The RAP scenario assumes that participation holds steady at current levels of around 250,000 households. The MAP scenario rolls the program out more widely such that by the end of a 3 year ramp up there are 300,000 households being supplied with the home energy reports. This level then holds steady for all years afterward.

New Initiatives in Preliminary Program Potential

Below we highlight several new initiatives and technologies that are critical additions to the DSM portfolio in the study's time horizon.

- LED lighting - Solid state lighting has now become a mainstream technology that will be taking the place of fluorescent lamps in all aspects of the portfolio over the planning horizon. Lamp efficacies for screw-in, linear, and panel LEDs are improving and costs are declining, and these technologies will be a large part of the portfolio, particularly in the business programs, in the coming years.
- Combined Heat & Power – This study models a new CHP incentive program as coming online in the second year of the coming implementation cycle. This will allow for time to establish the details of the program and related rates and tariffs.
- Smart Thermostats - In Illinois and indeed all around the country, capabilities and market adoption are growing in the realm of smart, programmable, learning, and wifi-enabled thermostats. Ameren Illinois is planning to incentivize and evaluate smart thermostats in a large number of customer households over the next implementation cycle, and is planning for a large portion of the incremental energy savings to come from these devices.
- Street Lighting - LED retrofits and smart-dimming technologies provide a largely untapped source of cost-effective savings in a program that is new to the portfolio.
- Smart Power Strips - We have modeled and included the second generation of smart, sensing power strips that combine occupancy, load, and other sensors to enable higher savings for electronics end uses, both in the office and at home.
- Retrocommissioning - The existing Ameren Illinois RCx program can be bolstered by the use of more powerful Building Analytics software that is rapidly permeating the industry.
- Strategic Energy Management - Ameren Illinois' Large C&I customer program will continue to focus on customized efficiency plans and cultural change, and can capitalize on national best practices in the SEM area, including lessons learned from implementations of ISO-500001.

Portfolio Impacts and Budgets

Figure 6-1 and Figure 6-2 show the cumulative impacts of energy savings for the various potential cases in the electric and natural gas portfolios respectively. The technical potential is tempered severely by the low regional avoided cost values, resulting in the green line of economic potential. This value is then decremented by the customer adoption factors or take rates to account for the various cases of achievable potential. The market achievable potential (solid lines) is distinct from the program achievable potential (dotted lines) due to the factors and adjustments discussed in the preceding paragraphs to translate the measures into actionable programs.

Figure 6-1 Cumulative Electric Energy Savings (% of Baseline)

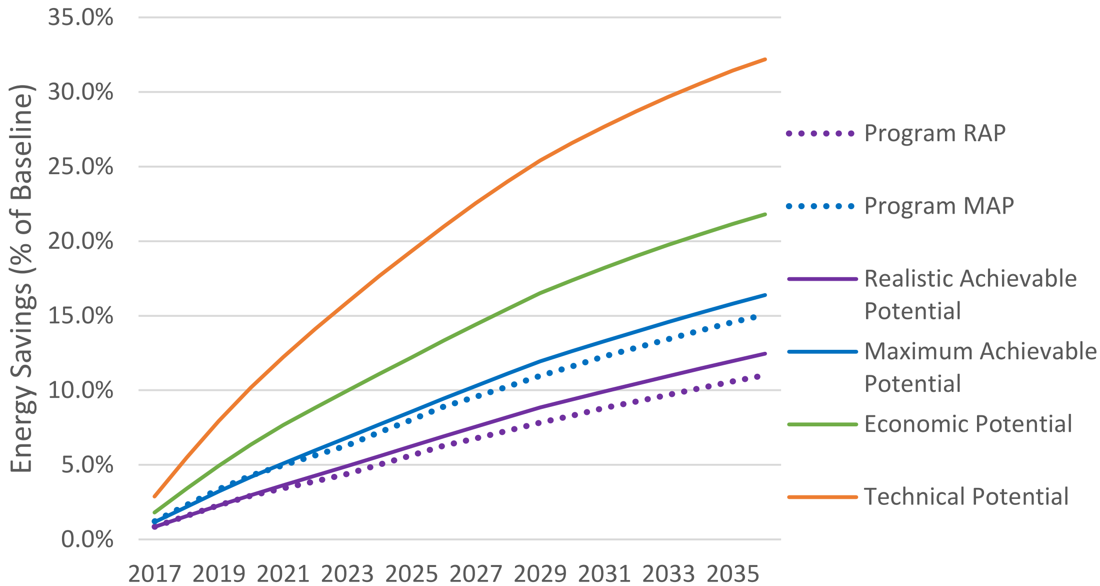


Figure 6-2 Cumulative Natural Gas Energy Savings (% of Baseline)

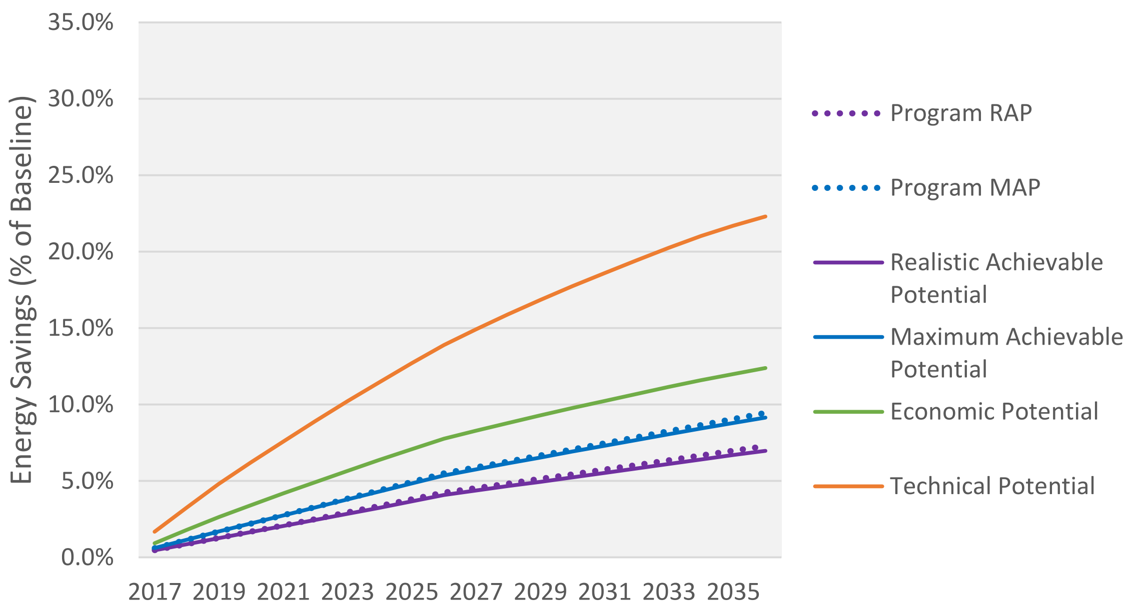


Figure 6-3 shows the net incremental electric energy savings for all DSM programs in the Ameren Illinois service territory. The most recent years (PY8 and PY9) are based on plans from Ameren, IPA, and DCEO. The corresponding program potential from this study for the first three years of the analysis horizon (i.e. Plan 4) is shown as a range between Program RAP and Program MAP. It can be seen that drawing a trajectory based on previous year savings would mark a line somewhere within this range. Figure 6-4 presents the same information for the natural gas net incremental savings.

Figure 6-3 Net Incremental Electricity Savings (MWh)

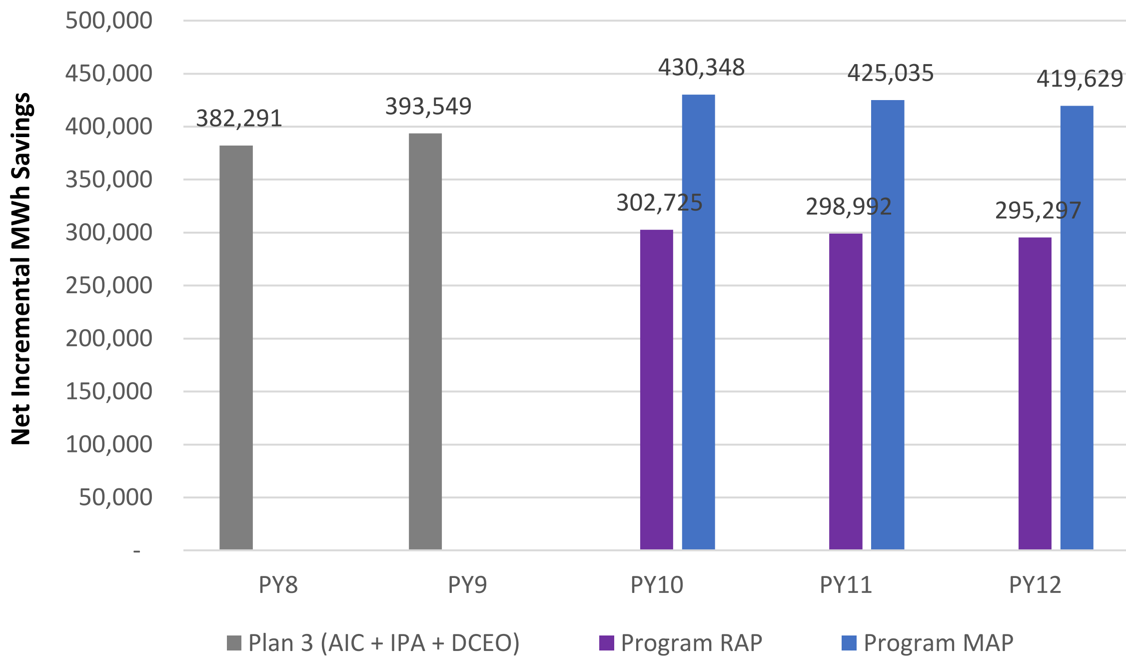


Figure 6-4 Net Incremental Natural Gas Savings (therms)

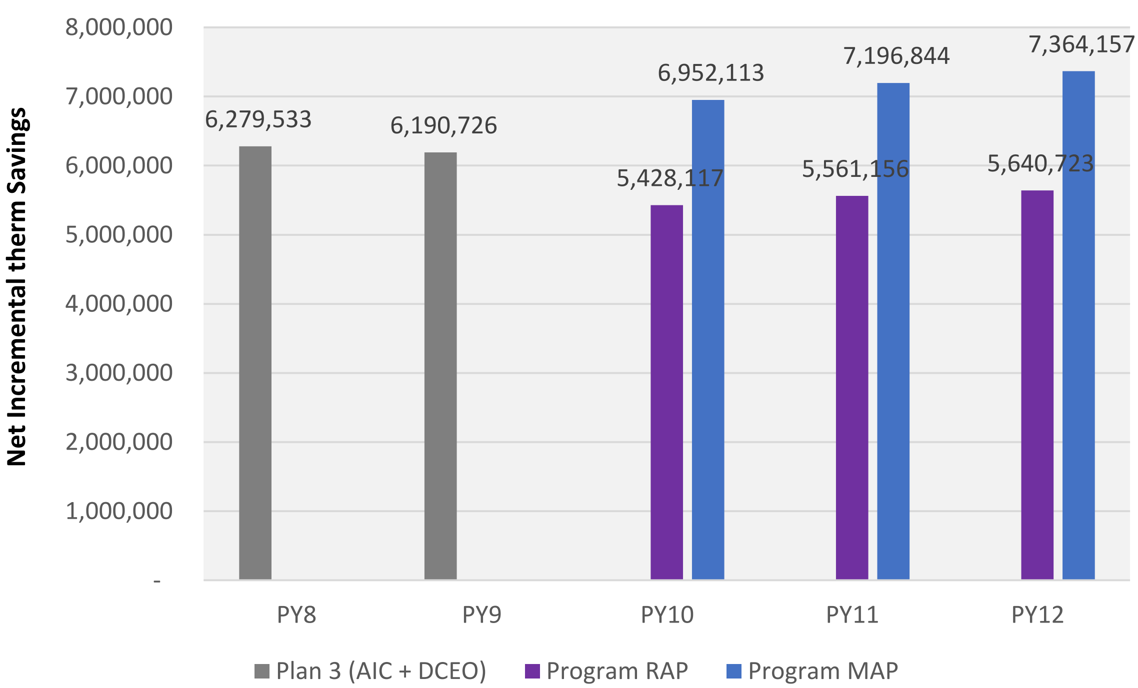


Figure 6-5 and Figure 6-6 show the electric and natural gas total program budgets.

Figure 6-5 Electric Program Budgets ($ Millions)

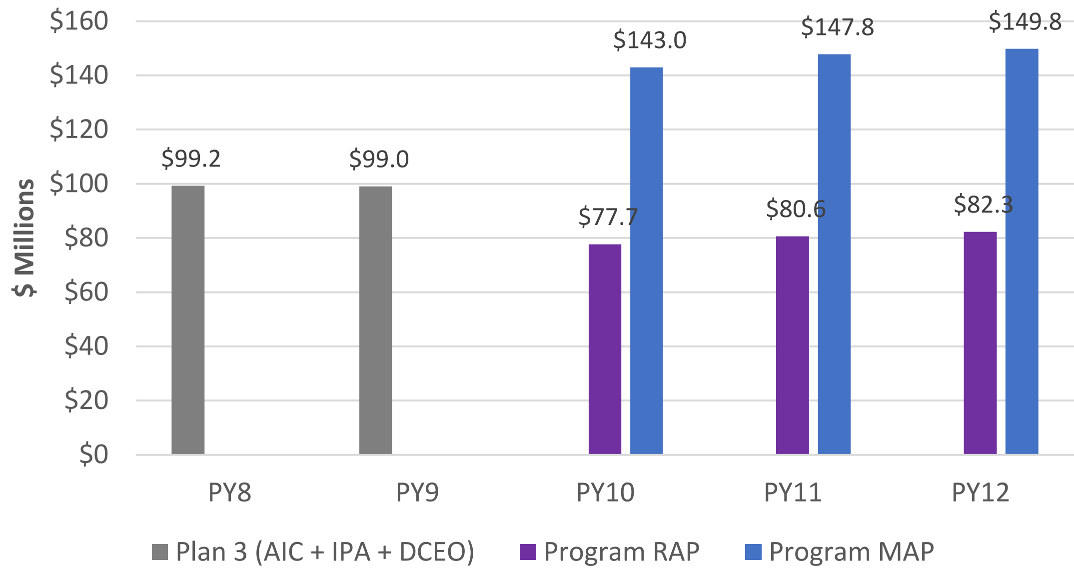
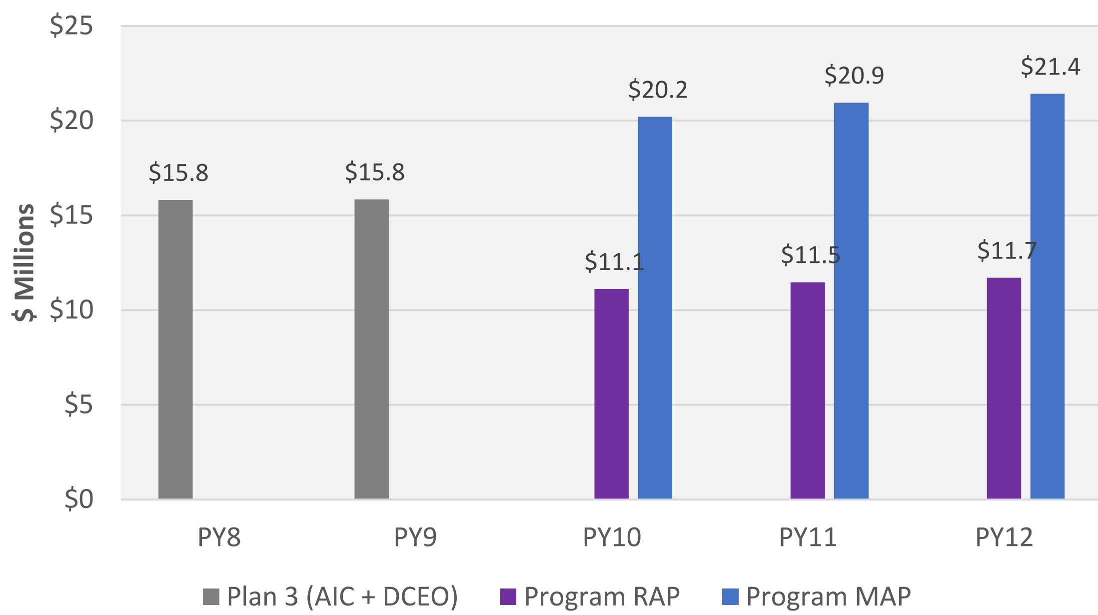


Figure 6-6 Natural Gas Program Budgets ($ Millions)



Impact and Budget details by program are provided below for the various cases and fuels. Table 6-4 details overall data for the Program RAP portfolio, while

Table 6-5 provides this for the electric side and Table 6-6 for the natural gas side, with the addition of a lifetime savings metric, which is a sum of each measure installations' savings multiplied by its lifetime.

Similarly, Table 6-7 provides detail for the Program MAP portfolio, with Table 6-8 and Table 6-9 giving information for the electric and natural gas sides of the portfolio respectively.

It should be noted here that 2017 is meant to correspond with Program Year 10, which is actually June 1, 2017 through May 31, 2018.

Table 6-4 Program RAP Summary Table

Program	Total Budget (000s)			Net Incremental Electric Savings (MWh)			Net Incremental Gas Savings (therms)		
	2017	2018	2019	2017	2018	2019	2017	2018	2019
Lighting	$3,813	$3,541	$3,174	35,964	33,530	30,232	-	-	-
Behavior Modification	$2,320	$2,320	$2,320	42,383	41,932	41,449	897,815	895,152	891,628
New Homes	$735	$735	$735	999	999	999	13,794	13,794	13,794
Whole Home	$2,524	$3,179	$3,259	9,647	9,915	10,045	372,390	438,954	453,914
HVAC	$3,604	$3,932	$3,752	4,602	5,011	4,694	384,348	391,420	397,780
Multifamily	$375	$371	$360	1,653	1,596	1,504	60,369	61,801	63,453
School Kits	$219	$207	$190	853	798	725	29,038	27,360	25,016
Rural Kits	$219	$207	$190	853	798	725	29,038	27,360	25,016
Moderate Income	$6,093	$6,368	$6,358	4,951	4,830	4,582	247,335	253,654	260,317
Smart Thermostats	$5,368	$5,547	$5,727	7,280	7,416	7,556	1,213,459	1,240,537	1,266,905
Low Income SF	$3,580	$3,739	$3,742	2,327	2,274	2,165	118,445	121,480	124,707
Low Income MF	$3,961	$3,982	$3,986	3,686	3,552	3,378	171,470	175,735	180,790
C&I Standard	$21,683	$22,257	$23,048	81,673	79,321	78,275	978,684	987,463	996,334
C&I Custom	$15,296	$15,701	$16,258	33,376	32,415	31,987	406,992	410,642	414,331
Retro-commissioning	$2,600	$2,696	$2,794	15,152	15,371	15,590	201,321	207,497	213,757
Small Business Direct Install	$5,451	$5,439	$5,443	16,774	15,525	14,539	59,917	60,503	61,083
Strategic Energy Management	$2,511	$2,629	$2,750	10,698	10,980	11,261	148,054	152,051	156,047
Street Lighting	$582	$588	$588	7,749	7,503	7,244	-	-	-
Combined Heat and Power	$0	$458	$973	-	2,469	5,177	-	-	-
Institutional & Public Facilities	$7,883	$8,215	$8,324	22,105	21,700	20,953	95,647	95,754	95,850
Residential Total:	$32,811	$34,129	$33,793	115,198	112,650	108,052	3,537,502	3,647,245	3,703,321
Business Total:	$56,006	$57,982	$60,179	187,527	186,342	187,245	1,890,614	1,913,911	1,937,402
Portfolio Total:	$88,817	$92,111	$93,972	302,725	298,992	295,297	5,428,117	5,561,156	5,640,723
% of Baseline Forecast				0.86%	0.85%	0.84%	0.48%	0.49%	0.50%

Table 6-5 Electric Program RAP Summary Table

Program	Electric Budget (000s)			Net Incremental Electric Savings (MWh)			Net LIFETIME Electric Savings (MWh)		
	2017	2018	2019	2017	2018	2019	2017	2018	2019
Lighting	$3,813	$3,541	$3,174	35,964	33,530	30,232	237,502	220,354	197,306
Behavior Modification	$1,160	$1,160	$1,160	42,383	41,932	41,449	42,383	41,932	41,449
New Homes	$514	$514	$514	999	999	999	29,966	29,966	29,966
Whole Home	$2,272	$2,861	$2,933	9,647	9,915	10,045	102,951	107,353	108,308
HVAC	$3,244	$3,539	$3,377	4,602	5,011	4,694	43,539	51,053	44,082
Multifamily	$337	$334	$324	1,653	1,596	1,504	12,184	11,863	11,307
School Kits	$209	$197	$181	853	798	725	7,528	7,034	6,384
Rural Kits	$209	$197	$181	853	798	725	7,528	7,034	6,384
Moderate Income	$5,484	$5,731	$5,722	4,951	4,830	4,582	46,846	46,401	44,129
Smart Thermostats	$3,221	$3,328	$3,436	7,280	7,416	7,556	72,798	74,156	75,559
Low Income SF	$3,222	$3,365	$3,368	2,327	2,274	2,165	22,323	22,151	21,158
Low Income MF	$3,564	$3,584	$3,587	3,686	3,552	3,378	27,444	26,728	25,665
C&I Standard	$19,515	$20,031	$20,743	81,673	79,321	78,275	977,104	968,136	973,004
C&I Custom	$13,766	$14,130	$14,632	33,376	32,415	31,987	399,297	395,633	397,622
Retro-commissioning	$2,340	$2,426	$2,514	15,152	15,371	15,590	45,456	46,114	46,769
Small Business Direct Install	$4,906	$4,895	$4,899	16,774	15,525	14,539	162,637	156,328	150,941
Strategic Energy Management	$2,260	$2,366	$2,475	10,698	10,980	11,261	32,093	32,940	33,784
Street Lighting	$582	$588	$588	7,749	7,503	7,244	116,232	112,542	108,657
Combined Heat and Power	$0	$458	$973	-	*2,469*	*5,177*	-	*40,881*	*84,704*
Institutional & Public Facilities	$7,095	$7,393	$7,492	22,105	21,700	20,953	273,589	276,963	271,912
Residential Total:	$27,248	$28,352	$27,957	115,198	112,650	108,052	652,994	646,026	611,697
Business Total:	$50,464	$52,288	$54,317	187,527	186,342	187,245	2,006,409	2,047,056	2,103,695
Portfolio Total:	**$77,712**	**$80,640**	**$82,275**	**302,725**	**298,992**	**295,297**	**2,659,403**	**2,693,082**	**2,715,392**
% of Total Revenue or Baseline	2.62%	2.65%	2.63%	0.86%	0.85%	0.84%			

Table 6-6 Natural Gas Program RAP Summary Table

Program	Natural Gas Budget (000s)			Net Incremental Gas Savings (therms)			Net LIFETIME Gas Savings (therms)		
	2017	2018	2019	2017	2018	2019	2017	2018	2019
Lighting	$0	$0	$0	-	-	-	-	-	-
Behavior Modification	$1,160	$1,160	$1,160	897,815	895,152	891,628	897,815	895,152	891,628
New Homes	$220	$220	$220	13,794	13,794	13,794	971,994	971,994	971,994
Whole Home	$252	$318	$326	372,390	438,954	453,914	5,985,713	6,980,858	7,150,048
HVAC	$360	$393	$375	384,348	391,420	397,780	4,257,471	4,337,010	4,405,847
Multifamily	$37	$37	$36	60,369	61,801	63,453	924,432	946,943	969,320
School Kits	$11	$10	$10	29,038	27,360	25,016	281,942	265,648	242,894
Rural Kits	$11	$10	$10	29,038	27,360	25,016	281,942	265,648	242,894
Moderate Income	$609	$637	$636	247,335	253,654	260,317	3,941,235	4,039,284	4,131,112
Smart Thermostats	$2,147	$2,219	$2,291	1,213,459	1,240,537	1,266,905	12,134,592	12,405,368	12,669,046
Low Income SF	$358	$374	$374	118,445	121,480	124,707	1,906,472	1,954,109	1,998,888
Low Income MF	$396	$398	$399	171,470	175,735	180,790	2,206,133	2,257,828	2,308,192
C&I Standard	$2,168	$2,226	$2,305	978,684	987,463	996,334	16,123,010	16,279,315	16,437,966
C&I Custom	$1,530	$1,570	$1,626	406,992	410,642	414,331	6,588,730	6,652,605	6,717,438
Retro-commissioning	$260	$270	$279	201,321	207,497	213,757	610,599	629,331	648,317
Small Business Direct Install	$545	$544	$544	59,917	60,503	61,083	1,142,434	1,153,036	1,163,484
Strategic Energy Management	$251	$263	$275	148,054	152,051	156,047	444,161	456,154	468,141
Street Lighting	$0	$0	$0	-	-	-	-	-	-
Combined Heat and Power[17]	$0	$0	$0	-	-	-	-	-	-
Institutional & Public Facilities	$788	$821	$832	95,647	95,754	95,850	1,889,469	1,890,921	1,892,150
Residential Total:	$5,563	$5,777	$5,836	3,537,502	3,647,245	3,703,321	33,789,741	35,319,842	35,981,864
Business Total:	$5,542	$5,694	$5,862	1,890,614	1,913,911	1,937,402	26,798,403	27,061,361	27,327,496
Portfolio Total:	**$11,106**	**$11,471**	**$11,697**	**5,428,117**	**5,561,156**	**5,640,723**	**60,588,144**	**62,381,203**	**63,309,360**
% of Total Revenue or Baseline	1.38%	1.38%	1.37%	0.48%	0.49%	0.50%			

[17] Note that, for the counting of CHP savings achievements toward goals and targets, the Illinois TRM section 4.4.32 prescribes an adjustment to the accounting of electric and natural gas inputs and outputs such that electric savings are discounted to 70% of actual production and net natural gas consumption is discounted to zero. This is for counting achievements toward targets only, and should not be used directly for load forecasting or related purposes

Table 6-7 Program MAP Summary Table

Program	Total Budget (000s)			Net Incremental Electric Savings (MWh)			Net Incremental Gas Savings (therms)		
	2017	2018	2019	2017	2018	2019	2017	2018	2019
Lighting	$10,258	$9,484	$8,423	55,353	51,380	45,969	-	-	-
Behavior Modification	$2,320	$2,552	$2,784	40,468	43,560	46,580	861,902	963,355	1,063,231
New Homes	$1,102	$1,102	$1,102	999	999	999	13,794	13,794	13,794
Whole Home	$6,866	$8,565	$8,688	14,535	14,745	14,766	555,305	647,278	662,465
HVAC	$6,373	$6,942	$6,572	6,987	7,580	7,062	569,007	573,767	577,888
Multifamily	$953	$936	$895	2,540	2,434	2,274	80,836	82,054	83,674
School Kits	$331	$312	$285	1,245	1,156	1,045	41,983	39,391	35,894
Rural Kits	$331	$312	$285	1,245	1,156	1,045	41,983	39,391	35,894
Moderate Income	$7,892	$8,194	$8,114	6,492	6,279	5,892	298,816	304,165	310,177
Smart Thermostats	$12,923	$13,354	$13,786	7,646	7,755	7,888	1,280,550	1,308,228	1,336,056
Low Income SF	$3,990	$4,139	$4,108	2,617	2,535	2,388	123,280	125,465	127,954
Low Income MF	$5,179	$5,170	$5,135	5,108	4,886	4,609	218,216	221,994	227,009
C&I Standard	$41,195	$41,926	$43,054	124,314	119,769	117,243	1,486,986	1,487,712	1,488,825
C&I Custom	$27,897	$28,392	$29,156	50,801	48,944	47,912	618,372	618,674	619,137
Retro-commissioning	$5,306	$5,455	$5,610	23,187	23,328	23,470	308,312	315,363	322,502
Small Business Direct Install	$9,916	$9,814	$9,740	25,529	23,458	21,803	89,204	89,476	89,746
Strategic Energy Management	$4,789	$4,960	$5,135	16,323	16,570	16,817	225,965	229,586	233,218
Street Lighting	$891	$897	$894	11,863	11,438	10,999	-	-	-
Combined Heat and Power	$0	$1,037	$2,179	-	*3,355*	*6,961*	-	-	-
Institutional & Public Facilities	$14,641	$15,163	$15,255	33,097	32,269	30,923	137,602	137,151	136,694
Residential Total:	$58,518	$61,060	$60,176	145,235	144,467	140,517	4,085,672	4,318,881	4,474,035
Business Total:	$104,635	$107,642	$111,021	285,114	280,569	279,112	2,866,441	2,877,963	2,890,122
Portfolio Total:	**$163,154**	**$168,703**	**$171,197**	**430,348**	**425,035**	**419,629**	**6,952,113**	**7,196,844**	**7,364,157**
% of Baseline Forecast				1.22%	1.20%	1.19%	0.61%	0.63%	0.65%

Table 6-8 Electric Program MAP Summary Table

Program	Electric Budget (000s)			Net Incremental Electric Savings (MWh)			Net LIFETIME Electric Savings (MWh)		
	2017	2018	2019	2017	2018	2019	2017	2018	2019
Lighting	$10,258	$9,484	$8,423	55,353	51,380	45,969	365,673	337,783	299,558
Behavior Modification	$1,160	$1,276	$1,392	40,468	43,560	46,580	40,468	43,560	46,580
New Homes	$772	$772	$772	999	999	999	29,966	29,966	29,966
Whole Home	$6,180	$7,709	$7,819	14,535	14,745	14,766	154,477	158,900	158,420
HVAC	$5,736	$6,247	$5,915	6,987	7,580	7,062	65,930	77,112	66,164
Multifamily	$858	$842	$806	2,540	2,434	2,274	18,549	17,893	16,886
School Kits	$315	$296	$270	1,245	1,156	1,045	10,941	10,147	9,163
Rural Kits	$315	$296	$270	1,245	1,156	1,045	10,941	10,147	9,163
Moderate Income	$7,102	$7,375	$7,302	6,492	6,279	5,892	60,970	59,812	56,194
Smart Thermostats	$7,754	$8,012	$8,272	7,646	7,755	7,888	76,465	77,555	78,879
Low Income SF	$3,591	$3,725	$3,697	2,617	2,535	2,388	24,936	24,505	23,128
Low Income MF	$4,661	$4,653	$4,621	5,108	4,886	4,609	37,550	36,246	34,474
C&I Standard	$37,076	$37,733	$38,748	124,314	119,769	117,243	1,483,423	1,457,917	1,453,711
C&I Custom	$25,108	$25,553	$26,240	50,801	48,944	47,912	606,207	595,783	594,065
Retro-commissioning	$4,775	$4,910	$5,049	23,187	23,328	23,470	69,562	69,984	70,411
Small Business Direct Install	$8,924	$8,832	$8,766	25,529	23,458	21,803	246,326	234,991	225,180
Strategic Energy Management	$4,310	$4,464	$4,621	16,323	16,570	16,817	48,968	49,710	50,451
Street Lighting	$891	$897	$894	11,863	11,438	10,999	177,940	171,577	164,978
Combined Heat and Power	$0	$1,037	$2,179	-	*3,355*	*6,961*	-	*55,550*	*113,913*
Institutional & Public Facilities	$13,177	$13,647	$13,729	33,097	32,269	30,923	403,874	406,661	396,728
Residential Total:	$48,700	$50,687	$49,559	145,235	144,467	140,517	896,866	883,627	828,574
Business Total:	$94,261	$97,071	$100,226	285,114	280,569	279,112	3,036,300	3,065,980	3,118,258
Portfolio Total:	**$142,961**	**$147,758**	**$149,786**	**430,348**	**425,035**	**419,629**	**3,933,165**	**3,949,607**	**3,946,832**
% of Total Revenue or Baseline	4.82%	4.85%	4.79%	1.22%	1.20%	1.19%			

Table 6-9 Natural Program MAP Summary Table

Program	Natural Gas Budget (000s)			Net Incremental Gas Savings (therms)			Net LIFETIME Gas Savings (therms)		
	2017	2018	2019	2017	2018	2019	2017	2018	2019
Lighting	$0	$0	$0	-	-	-	-	-	-
Behavior Modification	$1,160	$1,276	$1,392	861,902	963,355	1,063,231	861,902	963,355	1,063,231
New Homes	$331	$331	$331	13,794	13,794	13,794	971,994	971,994	971,994
Whole Home	$687	$857	$869	555,305	647,278	662,465	8,926,502	10,294,896	10,434,810
HVAC	$637	$694	$657	569,007	573,767	577,888	6,282,189	6,343,949	6,393,549
Multifamily	$95	$94	$90	80,836	82,054	83,674	1,283,440	1,302,136	1,321,788
School Kits	$17	$16	$14	41,983	39,391	35,894	407,627	382,459	348,507
Rural Kits	$17	$16	$14	41,983	39,391	35,894	407,627	382,459	348,507
Moderate Income	$789	$819	$811	298,816	304,165	310,177	4,919,045	4,998,899	5,074,003
Smart Thermostats	$5,169	$5,341	$5,515	1,280,550	1,308,228	1,336,056	12,805,496	13,082,278	13,360,562
Low Income SF	$399	$414	$411	123,280	125,465	127,954	2,046,659	2,079,634	2,110,849
Low Income MF	$518	$517	$513	218,216	221,994	227,009	2,867,111	2,912,144	2,957,234
C&I Standard	$4,120	$4,193	$4,305	1,486,986	1,487,712	1,488,825	24,479,803	24,509,086	24,545,623
C&I Custom	$2,790	$2,839	$2,916	618,372	618,674	619,137	10,003,766	10,015,732	10,030,663
Retro-commissioning	$531	$546	$561	308,312	315,363	322,502	935,100	956,487	978,137
Small Business Direct Install	$992	$981	$974	89,204	89,476	89,746	1,698,602	1,703,087	1,707,495
Strategic Energy Management	$479	$496	$513	225,965	229,586	233,218	677,895	688,758	699,653
Street Lighting	$0	$0	$0	-	-	-	-	-	-
Combined Heat and Power[18]	$0	$0	$0	-	-	-	-	-	-
Institutional & Public Facilities	$1,464	$1,516	$1,525	137,602	137,151	136,694	2,716,218	2,706,556	2,696,772
Residential Total:	$9,818	$10,374	$10,617	4,085,672	4,318,881	4,474,035	41,779,592	43,714,204	44,385,035
Business Total:	$10,374	$10,571	$10,795	2,866,441	2,877,963	2,890,122	40,511,382	40,579,706	40,658,344
Portfolio Total:	**$20,193**	**$20,945**	**$21,412**	**6,952,113**	**7,196,844**	**7,364,157**	**82,290,974**	**84,293,910**	**85,043,379**
% of Total Revenue or Baseline	2.51%	2.53%	2.51%	0.61%	0.63%	0.65%			

[18] Note that, for the counting of CHP savings achievements toward goals and targets, the Illinois TRM section 4.4.32 prescribes an adjustment to the accounting of electric and natural gas inputs and outputs such that electric savings are discounted to 70% of actual production and net natural gas consumption is discounted to zero. This is for counting achievements toward targets only, and should not be used directly for load forecasting or related purposes

Cost Effectiveness

Given the budgets and impacts for the program potential presented above, AEG performed the Total Resource Cost test (TRC) as required by Illinois regulations in order to gauge the economic merits of the portfolio. The cost-effectiveness analysis was conducted with AEG's BenCost software at the program and portfolio levels. The resulting benefits and costs of the DSM initiatives are all defined in terms of net present value of future cash flows.

For the TRC test, the benefits are defined as the lifetime avoided energy costs and avoided capacity costs. Benefits for Illinois require that both electric and natural gas benefits be included. The costs in this test are the incremental measure costs plus all administrative costs spent by the program administrator.

The cost-effectiveness results for the Ameren Illinois Program RAP portfolio are shown below in Table 6-10. The 3-year TRC ratio for the portfolio is 1.31, while a 20-year projected TRC ratio is 1.41. Also provided are the levelized cost of energy saved, at $0.052/kWh for the electric portfolio and $0.33/therm for the natural gas portfolio. Finally, the unit costs at the portfolio level of first-year savings for electricity are $0.268/kWh and $2.06 per therm for natural gas.

All programs that do not have a TRC benefit to cost ratio greater than 1.0 are highlighted in pink. These are the income-qualified programs, which are not required to be cost-effective as long as the portfolio as a whole is still cost-effective. Also with marginal economics are individual years of the Behavioral Modification program. This program is considered to have persistence effects even after the treatment of home energy reports is stopped, but in reality, the reports continue to be sent year after year, so a measure life longer than 1 year is not consistent if the program is effectively "renewing" the measure each successive year. To recognize this persistence, we have modeled the final year of the 3-year implementation cycle as having a 2-year measure life, which thereby increases the cost-effectiveness in that year (highlighted in yellow) and in the program as a whole.

The cost-effectiveness results for the Ameren Illinois Program MAP portfolio are shown below in Table 6-11. The 3-year TRC ratio for the portfolio is 1.17, while a 20-year projected TRC ratio is 1.22. The levelized cost of energy saved at the portfolio level is $0.065/kWh for electric savings and $0.46/therm for natural gas savings. Finally, the unit costs at the portfolio level of first-year savings for electricity are $0.345/kWh and $2.91 per therm for natural gas.

Table 6-10 Program RAP Cost Effectiveness

TRC Ratio	2017	2018	2019	3-Year TRC Ratio (2017-2019)	20-Year TRC Ratio (2017-2036)	Levelized Elec $/kWh (2017-2036)	Levelized Gas $/therm (2017-2036)	First-Year Elec $/kWh (2017-2019)	First-Year Gas $/therm (2017-2019)
Lighting	1.37	1.42	1.46	1.41	2.11	$0.013	n/a	$0.106	n/a
Behavior Modification	0.94	1.03	2.33	1.41	1.30	$0.029	$1.33	$0.028	$1.30
New Homes	1.35	1.39	1.43	1.38	1.55	$0.034	$0.44	$0.515	$15.98
Whole Home	1.64	1.49	1.52	1.55	1.52	$0.038	$0.08	$0.272	$0.71
HVAC	1.09	1.13	1.21	1.14	1.30	$0.106	$0.16	$0.710	$0.96
Multifamily	1.26	1.31	1.37	1.31	1.54	$0.040	$0.04	$0.209	$0.60
School Kits	1.56	1.58	1.60	1.58	1.68	$0.034	$0.04	$0.247	$0.38
Rural Kits	1.56	1.58	1.60	1.58	1.68	$0.034	$0.04	$0.247	$0.38
Moderate Income	0.60	0.60	0.61	0.60	0.62	$0.181	$0.27	$1.179	$2.47
Smart Thermostats	1.77	1.86	1.93	1.85	2.02	$0.060	$0.24	$0.449	$1.79
Low Income SF	0.48	0.49	0.50	0.49	0.50	$0.224	$0.33	$1.472	$3.03
Low Income MF	0.53	0.55	0.56	0.54	0.60	$0.204	$0.22	$1.011	$2.26
C&I Standard	1.59	1.55	1.55	1.56	1.62	$0.038	$0.30	$0.252	$2.26
C&I Custom	1.20	1.17	1.17	1.18	1.16	$0.066	$0.52	$0.435	$3.84
Retro-commissioning	1.48	1.61	1.69	1.59	1.60	$0.069	$0.51	$0.158	$1.30
Small Business Direct Install	1.20	1.14	1.15	1.16	1.27	$0.056	$0.91	$0.314	$9.00
Strategic Energy Management	1.34	1.50	1.61	1.48	1.55	$0.093	$0.74	$0.216	$1.73
Street Lighting	4.60	4.44	4.30	4.45	4.81	$0.007	n/a	$0.078	n/a
Combined Heat and Power	n/a	2.18	2.19	2.19	2.18	$0.014	$0.00	$0.187	n/a
Institutional & Public Facilities	1.25	1.13	1.15	1.18	1.27	$0.050	$0.98	$0.339	$8.50
Residential Total:	1.15	1.18	1.29	1.20	1.31	$0.065	$0.23	$0.249	$1.58
Business Total:	1.39	1.35	1.38	1.38	1.45	$0.049	$0.46	$0.280	$2.98
Portfolio Total:	**1.30**	**1.29**	**1.35**	**1.31**	**1.41**	**$0.052**	**$0.33**	**$0.268**	**$2.06**

Table 6-11 Program MAP Cost Effectiveness

TRC Ratio	2017	2018	2019	3-Year TRC Ratio (2017-2019)	20-Year TRC Ratio (2017-2036)	Levelized Elec $/kWh (2017-2036)	Levelized Gas $/therm (2017-2036)	First-Year Elec $/kWh (2017-2019)	First-Year Gas $/therm (2017-2019)
Lighting	1.10	1.14	1.17	1.14	1.64	$0.024	n/a	$0.184	n/a
Behavior Modification	0.89	0.98	2.21	1.37	1.24	$0.031	$1.35	$0.029	$1.33
New Homes	1.13	1.17	1.20	1.17	1.30	$0.050	$0.67	$0.772	$23.97
Whole Home	1.23	1.11	1.13	1.15	1.12	$0.069	$0.14	$0.493	$1.29
HVAC	1.04	1.07	1.16	1.09	1.24	$0.124	$0.20	$0.827	$1.16
Multifamily	1.02	1.06	1.11	1.06	1.23	$0.068	$0.08	$0.346	$1.13
School Kits	1.49	1.52	1.53	1.51	1.60	$0.036	$0.05	$0.256	$0.40
Rural Kits	1.49	1.52	1.53	1.51	1.60	$0.036	$0.05	$0.256	$0.40
Moderate Income	0.56	0.56	0.57	0.56	0.57	$0.184	$0.29	$1.167	$2.65
Smart Thermostats	1.41	1.47	1.52	1.47	1.58	$0.140	$0.56	$1.032	$4.08
Low Income SF	0.45	0.45	0.46	0.46	0.46	$0.227	$0.35	$1.460	$3.25
Low Income MF	0.52	0.53	0.54	0.53	0.58	$0.201	$0.22	$0.954	$2.32
C&I Standard	1.46	1.43	1.42	1.44	1.46	$0.047	$0.37	$0.314	$2.83
C&I Custom	1.08	1.06	1.06	1.07	1.04	$0.079	$0.61	$0.521	$4.60
Retro-commissioning	1.11	1.20	1.26	1.19	1.20	$0.092	$0.68	$0.211	$1.73
Small Business Direct Install	1.10	1.05	1.05	1.07	1.11	$0.067	$1.14	$0.375	$10.98
Strategic Energy Management	1.07	1.20	1.29	1.19	1.23	$0.116	$0.92	$0.269	$2.16
Street Lighting	4.60	4.44	4.30	4.45	4.79	$0.007	n/a	$0.078	n/a
Combined Heat and Power	n/a	2.01	2.02	2.02	1.96	$0.023	$0.00	$0.312	n/a
Institutional & Public Facilities	1.12	1.02	1.03	1.06	1.10	$0.062	$1.41	$0.421	$10.95
Residential Total:	1.00	1.02	1.10	1.04	1.13	$0.085	$0.35	$0.346	$2.39
Business Total:	1.26	1.23	1.25	1.25	1.26	$0.061	$0.57	$0.345	$3.68
Portfolio Total:	**1.16**	**1.15**	**1.20**	**1.17**	**1.22**	**$0.065**	**$0.46**	**$0.345**	**$2.91**

Definition of Savings: Incremental vs Cumulative vs Lifetime

Several methods of expressing energy efficiency savings can be used in the DSM industry, and so it is worth pausing for a moment to clarify the differences and provide a comparison of the various methods. The interpretation of savings values can become complicated because there are multiple timelines and perspectives to consider. The methods are as follows:

- **Incremental Savings** represents the annualized, first-year savings that come only from measures installed in the given year. This is a perspective that is commonly associated with program implementation, as it focuses on resource acquisition targets in the present. This is also the perspective that we focus on primarily for the 3-year implementation cycle in Chapter 5 on Program-Level Potential.
- **Running Sum of Incremental Savings** simply adds all the incremental savings that are installed within a given timeframe, and does not consider the fact that some measures early in a timeframe will burn out or expire. This is not the same as Cumulative Savings.
- **Cumulative Savings** describes the amount of savings that are active across a portfolio which have been installed up to that point in time and which have not yet burned out or expired. This is a snapshot perspective that is commonly associated with long-term resource planning and load forecasting, as it focuses on resource and system needs at specific times over long periods. This is also the perspective that we focus on primarily for the Market Potential in Chapter 4.
- **Lifetime Savings Installed** represents all of the savings projected to accrue over the lifetime of measures installed in a particular year. It takes a particular cohort of measures and projects their effects into the future, but does not consider the effects of any measures that may be installed in the years before or after the installation year. The math is simply the incremental savings multiplied by the effective useful life for each measure.[19]
- **Running Sum of Lifetime Savings Installed** simply adds all the lifetime savings of measures that are installed in a given timeframe.

The following tables and figures illustrate the Ameren Illinois estimates of Program RAP for each of the five perspectives discussed above, first for electric savings and second for natural gas savings. Depending on the perspective taken, the results can appear vastly different. It is important to keep this in mind to enable apples-to-apples comparisons when referencing historic Ameren data or benchmarks from other utility programs.

[19] This is the most frequent case; but note that the math is slightly more complicated for measures whose annual savings change over time due to degradation, changing baselines, or similar effects.

Table 6-12 Electric Program RAP for Multiple Definitions of Savings (GWh)

	2017	2018	2019	2026	2036
Program RAP Savings (GWh)					
Incremental Savings	303	299	295	375	556
Running Sum of Incremental Savings	303	602	897	3,162	8,013
Cumulative Savings	303	559	810	2,214	3,923
Lifetime Savings Installed	3,785	3,787	3,779	4,871	6,544
Running Sum of Lifetime Savings Installed	3,785	7,572	11,351	41,176	100,086

Figure 6-7 Electric Program RAP for Multiple Definitions of Savings (GWh)

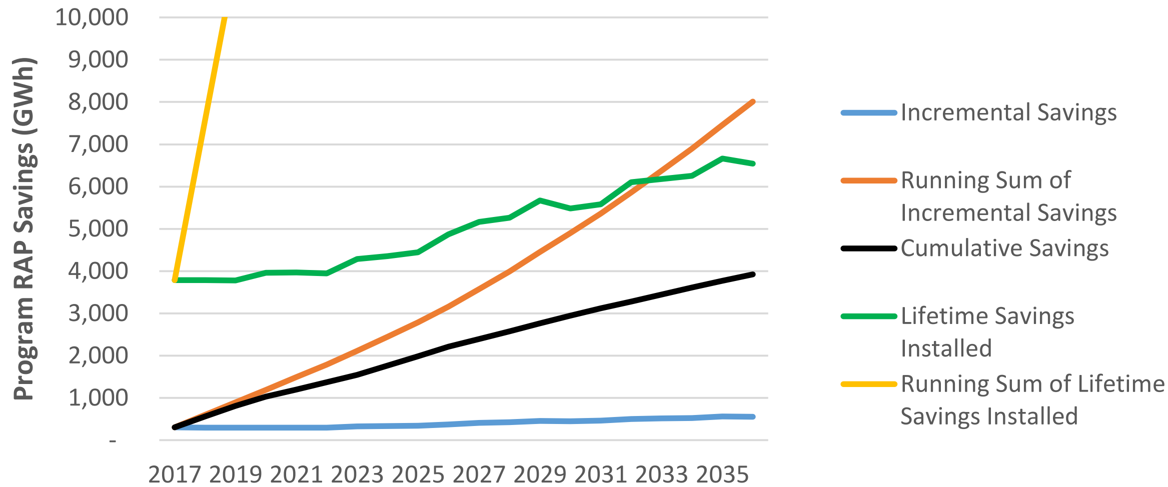
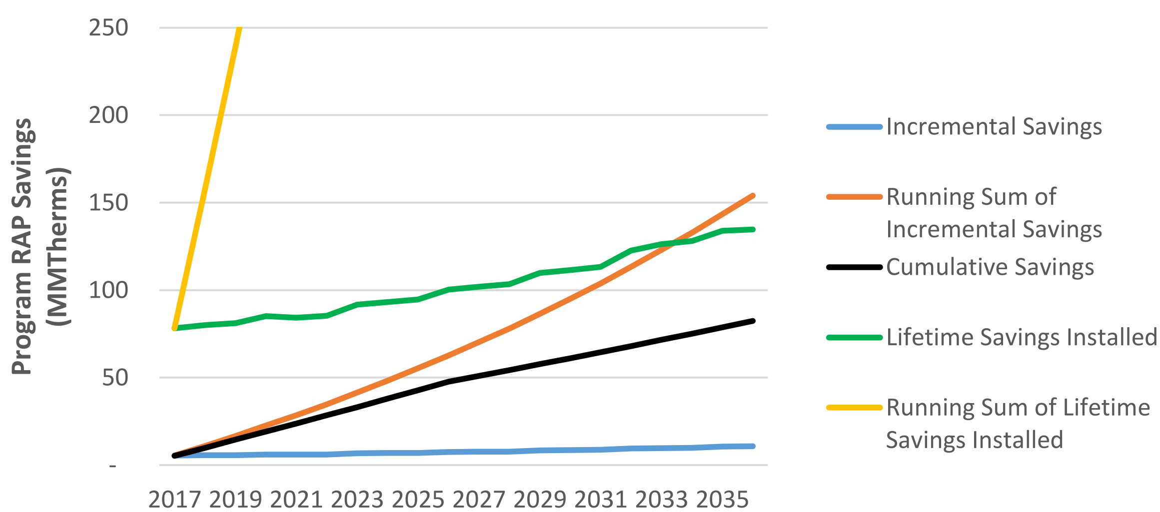


Table 6-13 Natural Gas Program RAP for Multiple Definitions of Savings (MMTherms)

	2017	2018	2019	2026	2036
Program RAP Savings (MMTherms)					
Incremental Savings	5	6	6	7	11
Running Sum of Incremental Savings	5	11	17	63	154
Cumulative Savings	5	10	15	48	82
Lifetime Savings Installed	78	80	81	100	135
Running Sum of Lifetime Savings Installed	78	158	239	874	2,059

Figure 6-8 Natural Gas Program RAP for Multiple Definitions of Savings (MMTherms)



Supply Curves

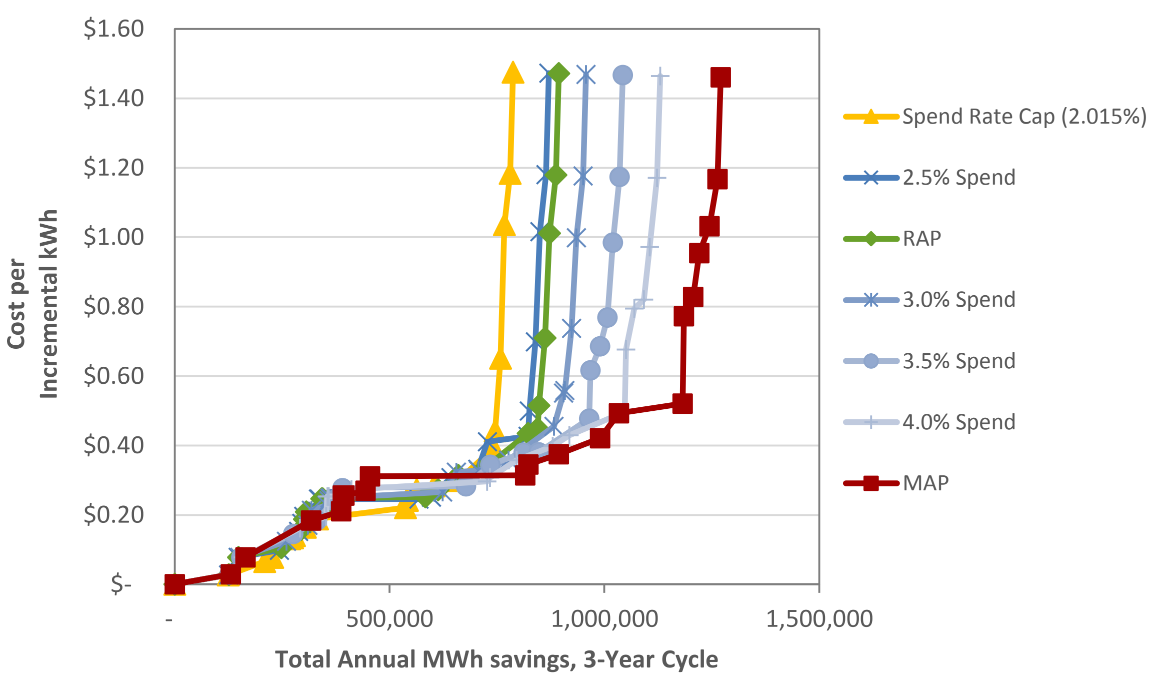
The purpose of DSM supply curves is to better understand the relationship between energy savings impacts and the costs required to obtain those impacts. DSM programs and their associated impacts are rank-ordered according to their cost per unit of savings. The two data points (unit cost and savings impacts) are plotted on a line chart. The exponentially upward curve of the line indicates where it becomes increasingly expensive to achieve marginally higher savings as a portfolio is progressively built. By looking at the planning assumptions in this way, supply curves can yield insights about a portfolio of DSM programs that may not be apparent when looking at overall, aggregate-level impacts and costs.

This is done first for Program RAP and MAP, and then for a number of other portfolio cases that are developed by interpolating or extrapolating based on the RAP and MAP programs to target budgets at strategically relevant levels corresponding to certain percentages of Ameren Illinois' electric retail revenues.

Portfolio Supply Curves

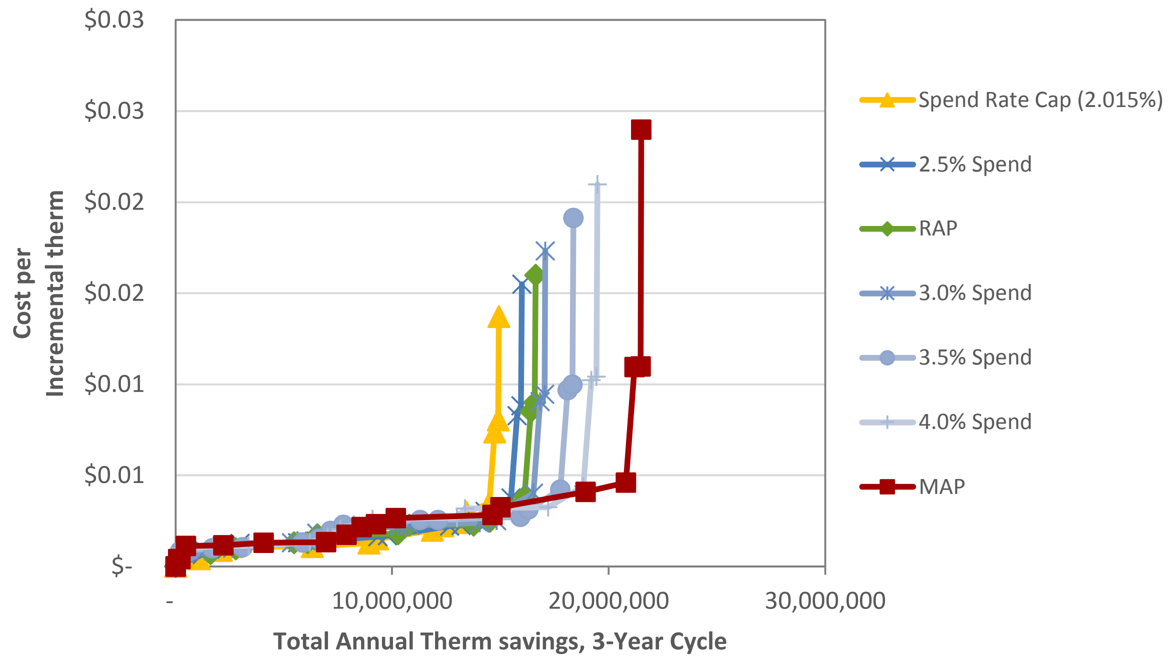
The various electric portfolios assembled from the program design and supply curve exercises are compared at aggregated levels below in Figure 7-1.

Figure 7-1 Electricity Supply Curves by Portfolio Case, PY10-PY12



The various natural gas portfolios assembled are compared at aggregated levels below in Figure 7-2. Note that the Natural Gas portfolios are developed in proportion to the Electric portfolios, so the various rate caps and spending as a percent of revenue are all with respect to the electricity program budget.

Figure 7-2 Natural Gas Supply Curves by Portfolio Case, PY10-PY12



High Level Comparison of Portfolio Cases

The various electric portfolios assembled from the program design and supply curve exercises are compared at aggregated levels below. Figure 7-3 and Table 7-1 show the electric budgets, while Figure 7-4 and Table 7-2 show the electric savings. The Program RAP portfolio spends slightly more than the Illinois state electricity DSM budget caps at 2% of revenues.

Figure 7-3 Total Electric Program Costs by Portfolio Case ($ million)

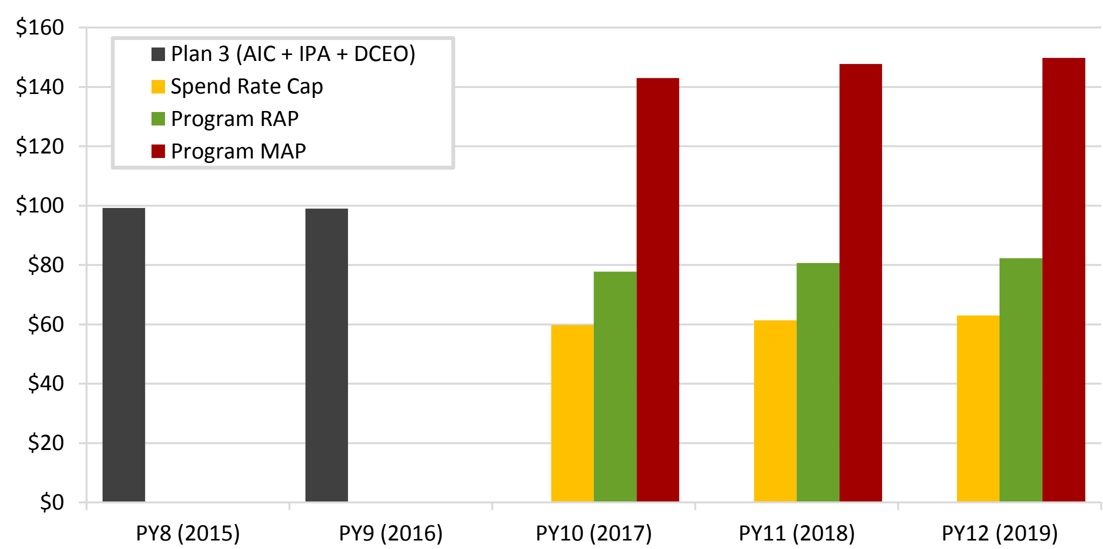


Table 7-1 Total Electric Program Costs by Portfolio Case

	PY8 (2015)	PY9 (2016)	PY10 (2017)	PY11 (2018)	PY12 (2019)
Total Electric Program Costs ($ million)					
Plan 3 (AIC + IPA + DCEO)	$99.2	$99.0			
Spend Rate Cap			$59.8	$61.4	$63.0
Program RAP			$77.7	$80.6	$82.3
Program MAP			$143.0	$147.8	$149.8
Spending as % of Revenue					
Plan 3 (AIC + IPA + DCEO)	3.34%	3.34%			
Spend Rate Cap			**2.015%**	**2.015%**	**2.015%**
Program RAP			2.62%	2.65%	2.63%
Program MAP			4.82%	4.85%	4.79%

Figure 7-4 Net Incremental Electric Savings by Portfolio Case (MWh)

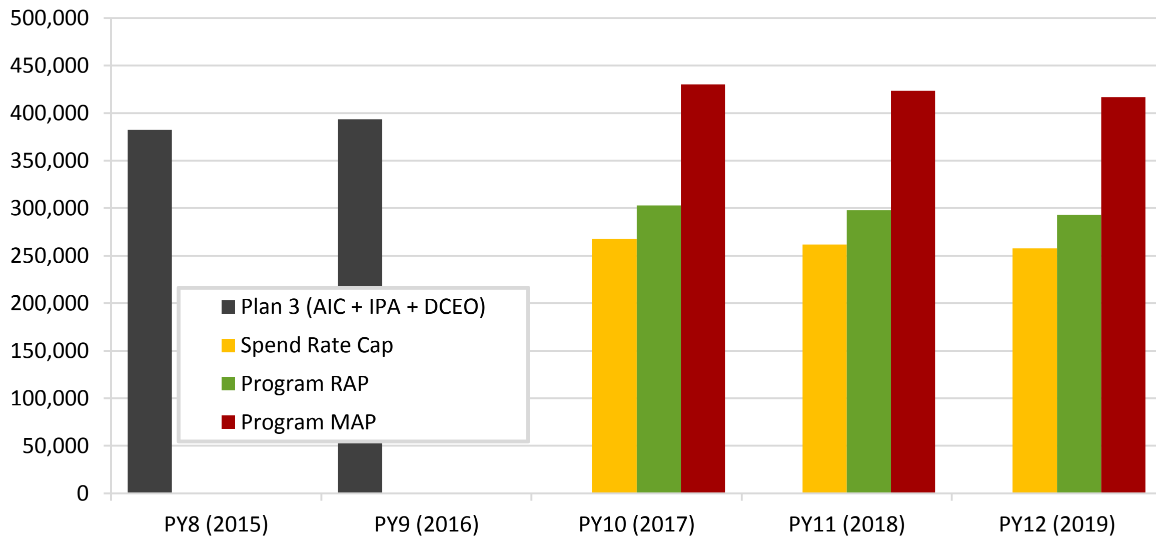


Table 7-2 Net Incremental Electric Savings by Portfolio Case

	PY8 (2015)	PY9 (2016)	PY10 (2017)	PY11 (2018)	PY12 (2019)
Net Incremental Savings (MWh)					
Plan 3 (AIC + IPA + DCEO)	382,291	393,549			
Spend Rate Cap			267,692	261,856	257,739
Program RAP			302,725	297,934	293,079
Program MAP			430,348	423,598	416,646
Savings as a % of Baseline					
Plan 3 (AIC + IPA + DCEO)	1.08%	1.12%			
Spend Rate Cap			0.76%	0.74%	0.73%
Program RAP			0.86%	0.84%	0.83%
Program MAP			1.22%	1.20%	1.18%

The various natural gas portfolios assembled from the program design and supply curve exercises are compared at aggregated levels below. Figure 7-5 and Table 7-3 show the natural gas budgets, while Figure 7-6 and Table 7-4 show the natural gas savings. The Natural Gas portfolios are developed in proportion to the Electric portfolios, so the various rate caps and spending as a percent of revenue are all with respect to the electricity program budget.

Figure 7-5 Total Natural Gas Program Costs by Portfolio Case ($ million)

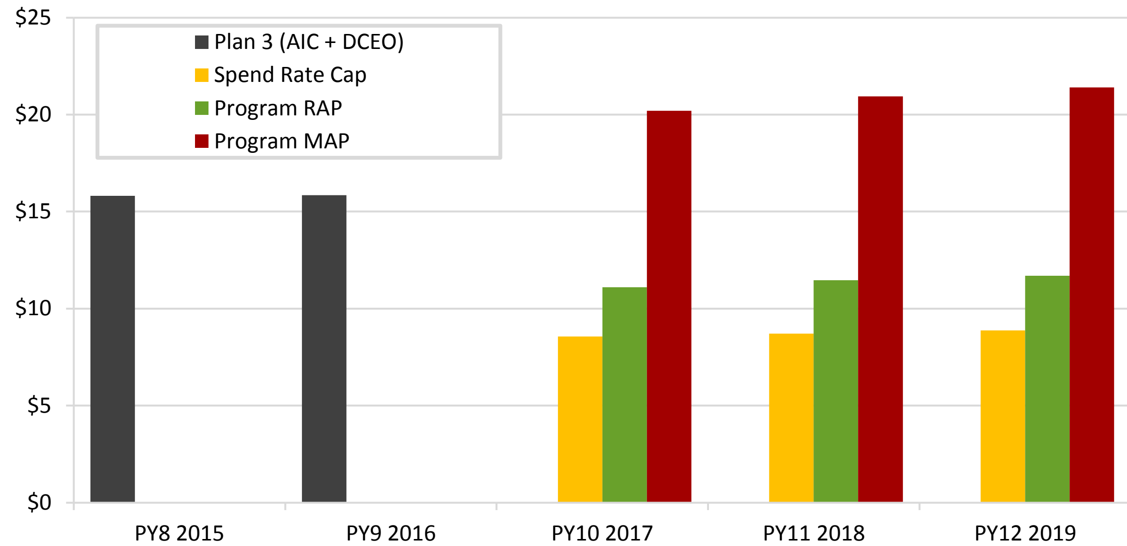


Table 7-3 Total Natural Gas Program Costs by Portfolio Case

	PY8 2015	PY9 2016	PY10 2017	PY11 2018	PY12 2019
Total Gas Program Costs ($ million)					
Plan 3 (AIC + DCEO)	$15.8	$15.8			
Spend Rate Cap			$8.6	$8.7	$8.9
Program RAP			$11.1	$11.5	$11.7
Program MAP			$20.2	$20.9	$21.4
Spending as % of Revenue					
Plan 3 (AIC + DCEO)	1.97%	1.97%			
Spend Rate Cap			1.07%	1.05%	1.04%
Program RAP			1.38%	1.38%	1.37%
Program MAP			2.51%	2.53%	2.51%

Figure 7-6 Net Incremental Natural Gas Savings by Portfolio Case (Therms)

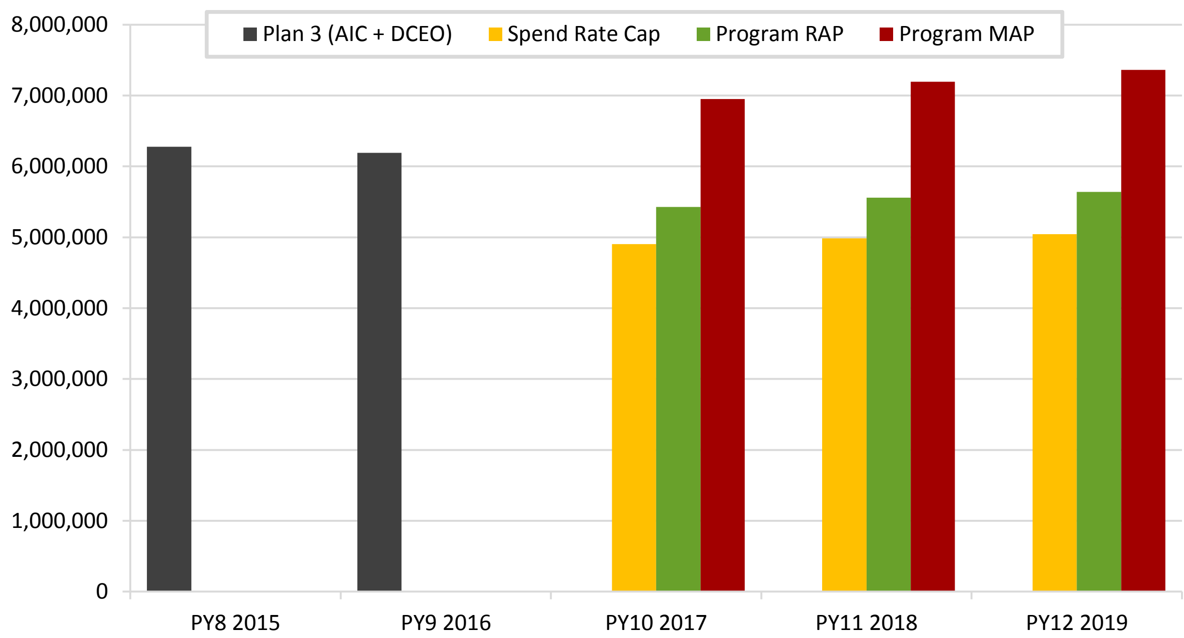


Table 7-4 Net Incremental Natural Gas Savings by Portfolio Case

	PY8 2015	PY9 2016	PY10 2017	PY11 2018	PY12 2019
Net Incremental Savings (Therms)					
Plan 3 (AIC + DCEO)	6,279,533	6,190,726			
Spend Rate Cap			4,904,060	4,987,753	5,046,341
Program RAP			5,428,117	5,561,156	5,640,723
Program MAP			6,952,113	7,196,844	7,364,157
Savings as a % of Baseline					
Plan 3 (AIC + DCEO)	0.55%	0.54%			
Spend Rate Cap			0.43%	0.44%	0.44%
Program RAP			0.48%	0.49%	0.50%
Program MAP			0.61%	0.63%	0.65%

Applied Energy Group, Inc.
500 Ygnacio Valley Road, Suite 250
Walnut Creek, CA 94596

P: 510.982.3525