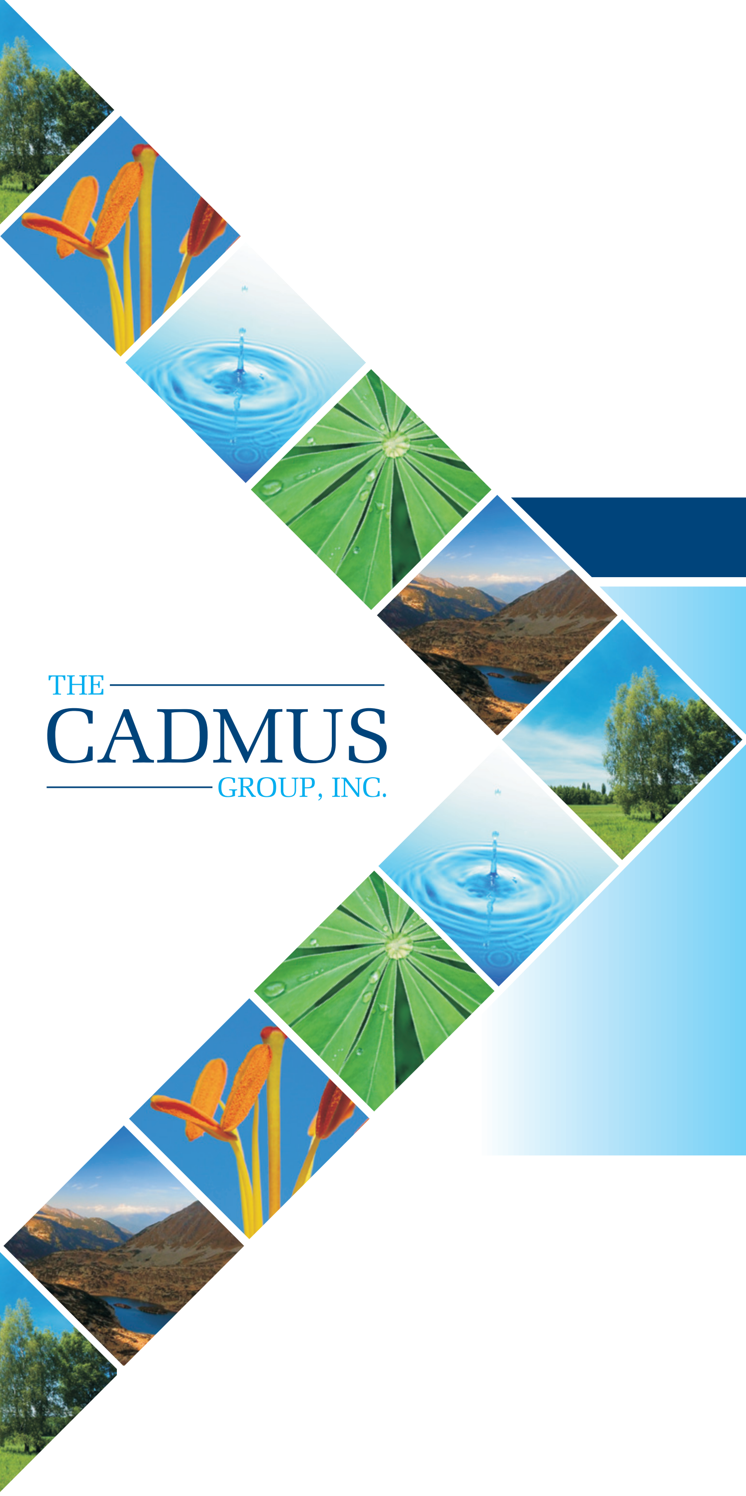

THE CADMUS GROUP, INC.

ASSESSMENT OF ELECTRIC AND NATURAL GAS ENERGY-EFFICIENCY POTENTIAL (2010–2016)

VOLUME I

FINAL REPORT

March 12, 2010

Prepared by:
The Cadmus Group, Inc. / Energy Services
720 SW Washington Street, Suite 400
Portland, OR 97205
503.228.2992
In Collaboration With Nexant, Inc.

Prepared for:
Ameren Illinois Utilities

Principal Investigators:

Hossein Haeri, Eli Morris, Scott Dimetrosky, Cheryl Winch, Aquila Velonis, Tony Larson, Scott Reeves, Noah Lieb, Danielle Kolp

The Cadmus Group

Terry Fry, Sam Mueller, Lynn Roy, Patrick Burns
Nexant, Inc.

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Executive Summary

This report summarizes the results of an independent study of electric and natural gas energy-efficiency potential in Ameren Illinois Utilities' (AIU) service territory from 2010 to 2016. AIU commissioned the study to investigate the levels of technical, economic and realistically achievable potentials in its service area. The results of this study will inform AIUs energy-efficiency planning and program design by identifying the quantity of available potential and how it is distributed by sector, market segment, and end use.

The study began with a primary data collection effort to assemble technical and market data specific to AIU's service territory. The Cadmus Group, Inc. (Cadmus), in collaboration with Nexant, Inc., conducted surveys of AIU customers in all major sectors as well as trade allies operating in AIU's territory. These surveys focused on compiling detailed information that inform the potentials estimates, including building characteristics, end-use and fuel saturations, energy systems, appliance and equipment stock, and current saturations of energy-efficiency measures.

These data, supplemented with information from secondary sources where necessary, provided a foundation for estimating technical, economic, and achievable potential, defined as follow:

- ***Technical potential*** assumes all technically feasible energy-efficiency measures may be implemented, regardless of their costs or market barriers.
- ***Economic potential*** represents a subset of technical potential, consisting only of measures meeting cost-effectiveness criteria based on AIU's avoided delivered electricity and natural gas costs.
- ***Achievable potential*** is defined as the portion of economic potential assumed to be reasonably achievable in the course of the planning horizon, given budgetary constraints and market barriers that may impede customers' participation in utility programs.

The method for estimating technical potential was based on the industry-standard, bottom-up approach. It began by considering a comprehensive set of electric and natural gas energy-efficiency measures applicable to each sector and market segment. Technical measure data were used in conjunction with market characteristics to determine likely long-term saturations of each measure in specific sectors and market segments. This assessment resulted in a technical potential supply curve at the measure level, which was then screened for cost-effectiveness to determine economic potential. Levels of achievable potential were determined largely by benchmarking against what has been found to be achievable in other jurisdictions.

Results Summary

Electricity

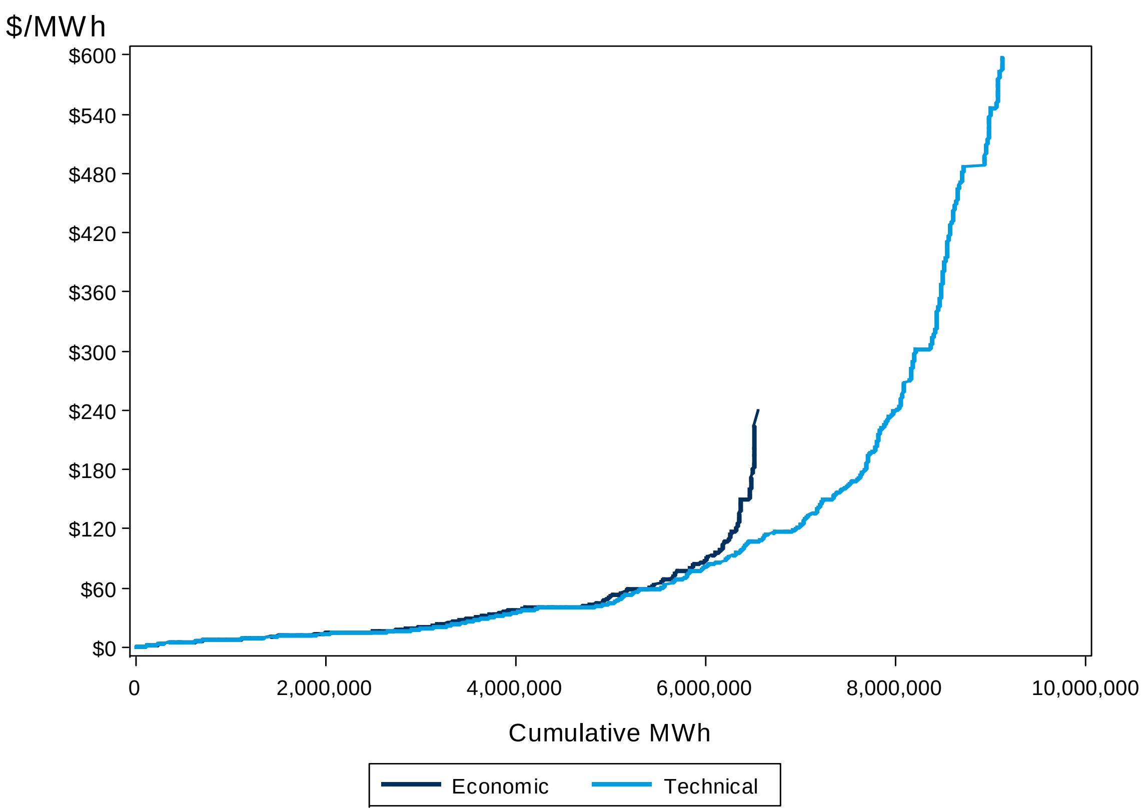
Table 1 shows AIU's baseline electric sales forecast along with estimated technical and economic potentials by the end of the seven-year planning horizon in 2016. The results of this study indicate 9,303 GWh of technically feasible electric energy-efficiency potential will be available by 2016. Once screened for cost-effectiveness, this technical potential translates into an economic potential of 6,551 GWh. Should all of this cost-effective potential be deployed, it would result in a 16% reduction in 2016 forecast retail sales, and would more than offset forecasted load growth from 2010 to 2016.

Table 1. Technical and Economic Electric Energy-Efficiency Potential in 2016 by Sector

Sector	Baseline 2016 Sales	Technical Potential (MWh)	Technical Potential as % of Baseline	Economic Potential (MWh)	Economic Potential as % of Baseline	Economic Potential (MW)	Average Levelized Measure Cost ($/kWh)
Residential	12,005,689	3,871,318	32%	2,429,693	20%	526	$0.05
Commercial	14,746,277	3,840,200	26%	2,530,294	17%	405	$0.04
Industrial	14,030,164	1,591,086	11%	1,591,086	11%	197	$0.01
Total	40,782,130	9,302,604	23%	6,551,073	16%	1,129	$0.04

The identified economic potential includes all measures with a benefit-to-cost ratio of greater than or equal to 1.0. Due to the hourly variations in energy costs as well as the variability in capacity benefits in the economic screening, certain measures pass the cost-effectiveness screen even though their levelized per-unit costs exceed the average levelized avoided cost of energy alone. Figure 1 shows the electric-efficiency supply curve, composed of individual measures. The curves show the quantities of cumulative potential (MWh) available at each per-unit price point ($/MWh).

Figure 1. Electric Energy-Efficiency Supply Curve



Due to uncertainties inherent in future markets for energy-efficiency products and services, as described in Section 0, this study did not attempt to develop a point estimate of achievable potential. Rather, a *range* of estimates were developed based on the fraction of economic potential expected to be achievable, based on the experiences of other utilities and the findings of energy-efficiency potential studies in other states. The expected low, medium, and high levels of electric energy-efficiency potential expected to be achievable over the course of the planning horizon are shown in Table 2. The range represents 40%, 60%, and 80% of the identified economic potential, respectively.

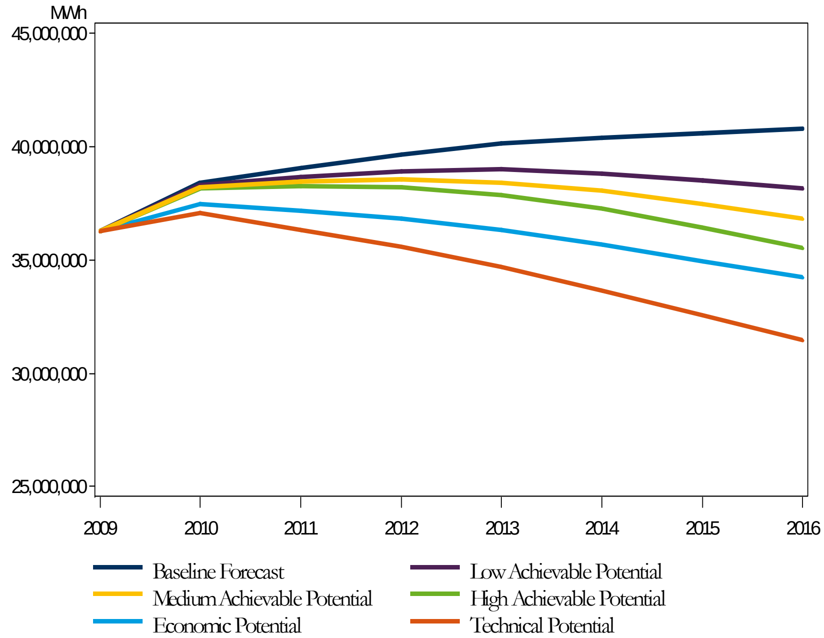
Table 2. Low, Medium, and High Electric Achievable Potential by Sector (Cumulative in 2016)

		Low Achievable Potential (40% of EP)		Medium Achievable Potential (60% of EP)		High Achievable Potential (80% of EP)	
Sector	Baseline 2016 Sales	MWh	% of Baseline	MWh	% of Baseline	MWh	% of Baseline
Residential	12,005,689	971,877	8%	1,457,816	12%	1,943,754	16%
Commercial	14,746,277	1,012,118	7%	1,518,176	10%	2,024,235	14%
Industrial	14,030,164	636,434	5%	954,652	7%	1,272,869	9%
Total	40,782,130	2,620,429	6%	3,930,644	10%	5,240,858	13%

Since only those measures known to be cost effective were considered in the industrial sector, the estimates of technical and economic potential are identical for this sector.

The results indicate a range of between 2.6 and 5.2 million MWh of achievable electricity savings, representing respectively 6% and 13% of retail sales in 2016. The medium level of achievable potential is expected at 3.9 million MWh, which represents 10% of the baseline sales. The high and medium estimates of achievable potential would meet the current Illinois legislative savings targets (estimated at 3.8 million MWh in 2016), while the low achievable estimate would not. The effects on annual forecast load of technical, economic and the three levels of achievable potential are illustrated in Figure 2.

Figure 2. Impacts of Achievable Potential Scenarios on Electric Load Forecast (2010-2016)



Natural Gas

Table 3 shows forecasted baseline natural gas sales, along with technical and economic potential, by sector in 2016, the end of the seven-year planning horizon. The study results indicate 416 million therms of technically feasible natural gas energy-efficiency potential will be available by 2016. This technical potential translates to an economic potential of 312 million therms. Should all of this cost-effective potential be realized, it would amount to a 20% reduction in 2016 forecast retail sales, and more than offset forecasted load growth.

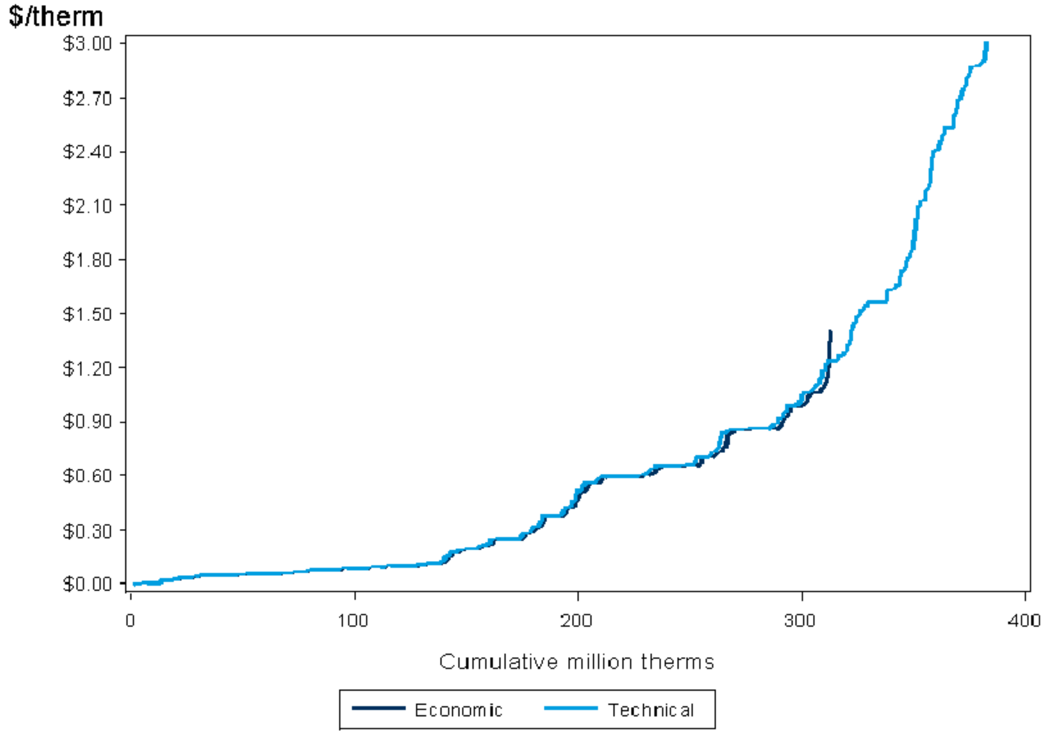
Table 3. Technical and Economic Natural Gas Energy-Efficiency Potential in 2016 by Sector

Sector	Baseline 2016 Sales	Technical Potential (therms)	Technical Potential as % of Baseline	Economic Potential (therms)	Economic Potential as % of Baseline	Average Levelized Measure Cost ($/therm)
Residential	567,406,647	207,360,263	37%	155,291,864	27%	$0.49
Commercial	270,157,950	91,837,062	34%	40,107,213	15%	$0.60
Industrial	732,369,238	116,830,571	16%	116,830,571	16%	$0.09
Total	1,569,933,835	416,027,896	26%	312,229,648	20%	$0.35

Because the industrial sector uses a "top-down" approach based on only cost-effective measures, the estimates of technical and economic potential are identical.

Figure 3 shows the natural gas efficiency technical and economic supply curves. Economic potential includes all measures with a benefit-to-cost ratio of greater than or equal to 1.0.

Figure 3. Natural Gas Energy-Efficiency Supply Curve



Achievable natural gas potentials were also defined as a range of possible outcomes, with the percentage of economic potential deemed achievable somewhat lower than electric resources (Table 4). Due to the relatively high up-front costs associated with much of the gas equipment, such as furnaces and water heaters, and the fact that this equipment is often replaced only upon burnout, achievable potential for natural gas tends to be lower than for electricity.

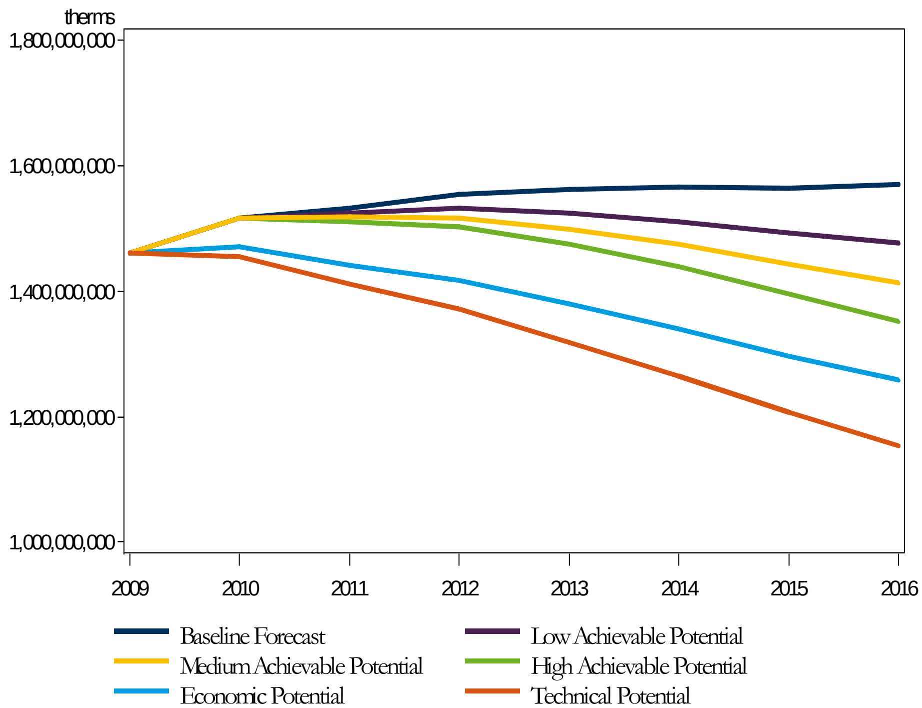
Table 4. Low, Medium, and High Natural Gas Achievable Potential by Sector (Cumulative in 2016)

		Low Achievable Potential (30% of EP)		Medium Achievable Potential (50% of EP)		High Achievable Potential (70% of EP)	
Sector	Baseline 2016 Sales	Therms	% of Baseline	Therms	% of Baseline	Therms	% of Baseline
Residential	567,406,647	46,587,559	8%	77,645,932	14%	108,704,305	19%
Commercial	270,157,950	12,032,164	4%	20,053,607	7%	28,075,049	10%
Industrial	732,369,238	35,049,171	5%	58,415,286	8%	81,781,400	11%
Total	1,569,933,835	93,668,894	6%	156,114,824	10%	218,560,754	14%

The results of this study suggest between 94 million and 218 million therms of natural gas savings are likely achievable. The medium level of achievable potential is expected at 156 million therms, which represents 10% of the baseline sales. All three estimated levels of achievable potential would meet the current Illinois legislative savings targets (estimated at 65.7

million therms in 2016). The effects on annual forecast load of technical, economic and the three levels of achievable potential are illustrated in Figure 4.

Figure 4. Impacts of Achievable Potential Scenarios on Natural Gas Sales Forecast (2010-2016)



Utility Program Costs

The analysis of economic potential is based on the total resource cost (TRC) test, which does not take into account whether measures are funded by the participant or the utility. Nor does it factor in the utility's administrative expenses. These, however, are important considerations in the determination of achievable potential.

For each of the achievable potential scenarios described above, estimates of required incentive and non-incentive (marketing, promotion, administration, etc.) costs were developed, using the experience of several major utilities with substantial experience with energy efficiency programs. The results, shown in Table 5, reflect the assumed program spending levels for each scenario and how these translate into AIU's costs per kWh or therm saved.

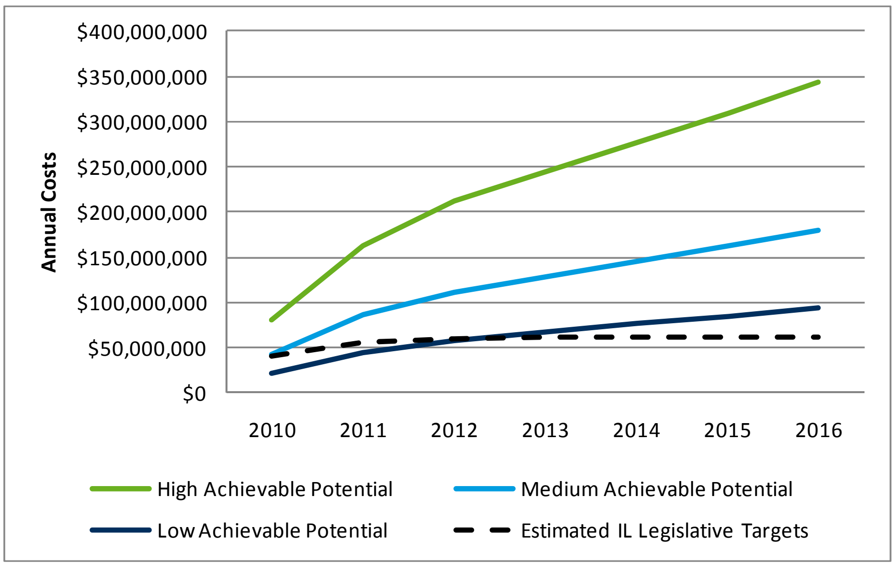
Table 5. Utility Cost Assumptions for Achievable Potential Scenarios

	Average Utility Costs as Percent of Measure Cost		Average Utility Cost per First Year Unit of Energy Saved	
Achievable Scenario	Incentive	Non-Incentive	Electricity ($/kWh)	Natural Gas ($/therm)
Low	40%	15%	$0.17	$1.86
Medium	50%	20%	$0.22	$2.36
High	70%	25%	$0.31	$3.37

For electricity, the average utility program cost of deploying the programs is estimated to fall between $0.17 and $0.31 per first-year kWh saved. This suggests that even for the most conservative scenario of electric achievable potential, with the lowest utility costs, the expected average expenditures are significantly above the average legislative expenditure cap of approximately $0.10 per kWh.

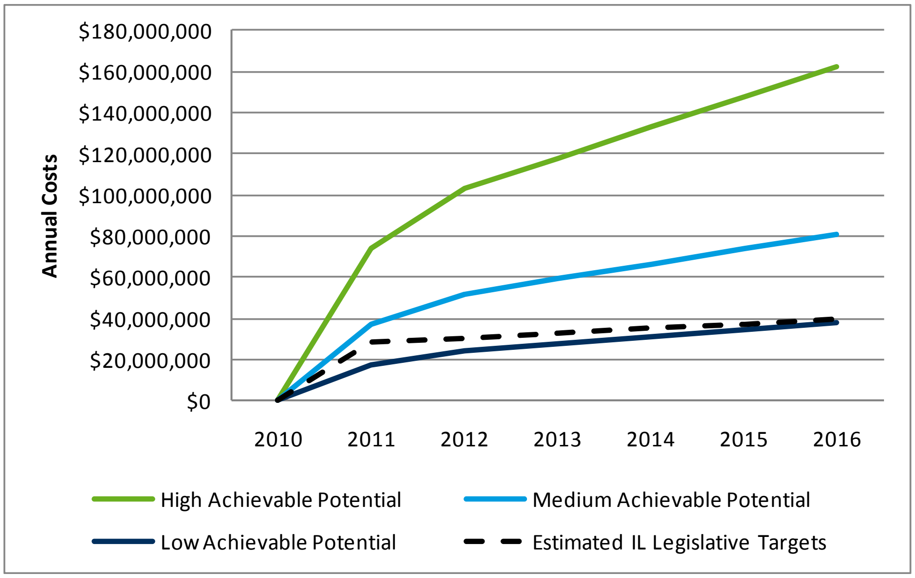
The expected annual program costs corresponding to the various levels of electric achievable potential, as well as the current legislative spending limits are shown in Figure 5. As illustrated, the expenditure caps fall well below the expected spending levels in all scenarios by the end of the study horizon. These results further suggest it is only during the first few years of the planning horizon that the spending levels allowed under the cap would likely cover the program deployment costs.

Figure 5. Annual Electric Achievable Acquisition Costs and Legislative Spending Caps



For natural gas, average per-unit cost for various levels of achievable potential are estimated to range between $1.86 and $3.37 per first-year therm saved. Unlike electric, the average natural gas expenditures allowed by the legislation – $3.10 per therm – allow at least the low level of achievable potential to come in under the budget caps. See Figure 6.

Figure 6. Annual Natural Gas Achievable Acquisition Costs and Legislative Spending Caps



Organization of This Report

This report is organized in two volumes. The present document, Volume I, presents methodologies and findings, and includes the following sections:

- Section 1, Approach to Estimating Potential, provides an overview of the methodology used for estimating technical, economic, and achievable potential in this study.
- Section 2, Primary Data Collection, presents the research approach, sample frames, and key findings of the primary data collection efforts.
- Section 3, Technical and Economic Potentials, presents the technical and economic potential available from energy-efficiency resources.
- Section 4, Achievable Energy Efficiency Potentials, describes the basis for, and results of, estimating realistically achievable energy efficiency potential.

Supplemental technical information, assumptions, data, and other relevant details are presented in Volume II as appendices. These include:

- Appendix A: Data Collection Instruments
- Appendix B: Summary of Findings from Primary Data Collection
- Appendix C: Measure Descriptions
- Appendix D: Measure Details
- Appendix E: Energy-Efficiency Inputs and Detailed Results
- Appendix F: List of Energy-Efficiency Potential Studies Used in Achievable Benchmarking

1. Approach to Estimating Potential

This section presents the general methodology used to estimate electric and natural gas energy-efficiency potentials, describing the inputs, outputs, and approaches used in this study. Consistent with industry standards, resource potentials are defined in four ways:

- ***Naturally occurring conservation*** refers to reductions in energy use that occur due to normal market forces, such as technological change, energy prices, market transformation efforts, equipment turnover, and improved energy codes and standards.
- ***Technical potential*** assumes all technically feasible DSM measures may be implemented, regardless of their costs or market barriers. For energy-efficiency resources, technical potential can be classified into three distinct classes: retrofit opportunities in existing buildings; equipment replacement in existing buildings; and new construction. The first class exists in current building stock and is available to acquire at any point in the planning horizon, while the timing of the other two classes is dictated by turnover of end-use equipment and new construction rates.
- ***Economic potential*** represents a subset of technical potential, consisting only of measures meeting the cost-effectiveness criterion, based on AIU avoided energy and capacity costs. For each energy-efficiency measure, the benefit-cost test is structured as the ratio of the net present values of the measure's benefits and costs. Only measures with a benefit-to-cost ratio of 1.0 or greater are deemed cost-effective.
- ***Achievable potential*** is defined as the portion of economic potential that might be assumed to be reasonably achievable in the course of the planning horizon, given market barriers that may impede customer participation in utility programs. Achievable potential can vary greatly based on program incentive structures, marketing efforts, energy costs, customer socio-economic characteristics, and other factors.

The types of potential have been estimated using the steps described below.

Collecting Baseline Data

Many data inputs are necessary to create a baseline forecast that accurately reflects consumption characteristics of AIU's customers. These key inputs include:

- Sales and customer forecasts;
- Major customer segments (e.g., residential dwelling types or commercial business types);
- End-use saturations;
- Equipment saturations;
- Fuel shares;
- Efficiency shares (the percent of equipment below, at, and above code); and
- Annual end-use consumption estimates by efficiency level.

Data specific to the AIU service territory provided the basis not only for baseline calibration, but for estimating technical potential. As described in the next section of this report, a significant primary data collection effort was undertaken to ensure the best available data were used. Additionally, AIU provided data on actual and forecasted sales and customers by sector.

Developing a Baseline Forecast

The baseline forecast is created by combining all baseline data described above to obtain average consumption estimates by customer segment, construction vintage, and end use, and summing the date to the sector level. The forecast's accuracy is determined by how well it tracks the utility's official forecast, and it is ultimately calibrated to that forecast. The key advantages of this approach are:

- Savings estimates are driven by a baseline calibrated to official sales forecasts, which requires a great deal of scrutiny to ensure underlying inputs and assumptions are reasonable and consistent with other known customer population characteristics. Other approaches may simply generate the total potential by summing individual measures' estimated impacts, which can result in total savings estimates representing an unrealistically high percentage of baseline sales.
- The forecasts incorporate the effects of both equipment standards and naturally occurring efficiency improvements emanating from reduction of usage as lower-efficiency units have been retired and replaced by higher-efficiency systems. Ensuring these effects are included in the baseline forecast prevents potential estimates from being inflated by naturally occurring conservation.
- The same assumptions underlying baseline forecasts are used to develop the energy efficiency measure inputs as well as estimates of technical, economic, and achievable potential, ensuring consistency across all parts of the study.
- The baseline is the clear product of separate inputs, which allows each to be scrutinized separately and altered, when appropriate, to examine different scenarios.

Compiling Energy-Efficiency Technology Data

Once AIU's customers were appropriately classified in the baseline forecast, a comprehensive list was created of electric and natural gas energy efficiency measures applicable to the service territory. This list includes all measures currently offered through AIU programs as well as measures offered by other utilities in the region, and those included in national and regional databases, such as California's Database for Energy Efficient Resources (DEER). The list includes over 270 unique electric measures and nearly 120 unique natural gas measures. This list then expands to all appropriate combinations of fuel, segment, end use, and construction type, leading to over 5,000 permutations of measures (Table 6).

Table 6. Number of Measures Included in Assessment

	Electricity		Natural Gas	
Sector	Unique Measures	Permutations	Unique Measures	Permutations
Residential	127	1,472	55	507
Commercial	128	1,881	56	1,073
Industrial	16	221	8	54
Total	271	3,574	119	1,634

These measures are classified into two categories:

- High-efficiency equipment measures, which affect end-use equipment directly (e.g. high-efficiency central air conditioners), and follow normal replacement patterns based on expected lifetimes.
- Non-equipment measures, which affect end-use consumption without replacing end-use equipment (e.g., insulation). These measures, which do not have timing constraints due to equipment turnover (with the exception of new construction), are discretionary because savings can be acquired at any point over the planning horizon.

These measures require a number of inputs to accurately assess their potential and cost-effectiveness. Whenever possible, these inputs were derived from primary data collection activities described in the report. These data were supplemented with local, regional, and national data, where appropriate. Relevant inputs for each type of measure are as follows.

Equipment and non-equipment measures:

- Equipment cost: full or incremental cost, depending on nature of the measure and application.
- Labor cost: cost of installing the measure, accounting for differences in labor rates by region, urban/rural, etc.
- Energy savings: average annual savings attributable to installing the measure, in absolute and/or percentage terms.

Non-equipment measures only:

- Technical feasibility: the percent of buildings where this measure can be installed, accounting for physical constraints.
- Percent incomplete: of buildings where the measure is technically feasible, the percent that have not already installed the measure.
- Measure share: for measures mutually exclusive (e.g., CFLs and LED interior lights), accounting for the percent of each likely to be installed to avoid double-counting savings.
- Measure interaction: accounts for end-use interactions (e.g., a decrease in lighting power density will cause heating loads to increase).

For detailed descriptions of measures analyzed as well as their inputs and outputs, see Appendix D.

Estimating Technical Potential

Once the measure database is fully populated, measure-level inputs are used to estimate technical potential over the planning horizon. This requires creating an alternate forecast, where consumption is reduced by installation of all technically feasible measures. This forecast is then subtracted from the baseline forecast to estimate the technical potential by customer segment, vintage, end use, year, and measure.

Many approaches to potentials estimation simply add individual measure impacts to arrive at a total, which tends to overstate the actual available potential. The approach described here has several advantages:

- Consistency with the baseline forecast: the same data underlie both forecasts, ensuring the technical potential accurately reflects the utility's customer characteristics and represents a reasonable amount of projected sales.
- Naturally occurring conservation: because measures anticipated to be installed in the absence of utility intervention are included in the baseline forecast (and, thus, the technical potential forecast), these savings will be removed from the technical potential estimates.
- Interactive effects: this approach accounts for three types of interactions:
  - Equipment and non-equipment measures. Installing high-efficiency equipment may reduce savings associated with some non-equipment measures.
  - Non-equipment measure interactions. The "measure share"—defined above—accounts for competing measures, ensuring savings are not double-counted.
  - Inter-end use interactions. Some measures may indirectly affect an end use. For example, installing more efficient lighting may increase heating loads. These impacts, where appropriate, are derived from DOE2 simulation analysis.

Potentials for equipment and non-equipment measures are estimated differently. In the technical potential scenario, it is assumed that, upon natural replacement of equipment, consumers would install the most efficient unit available, thus generating savings over standard equipment.

Estimating the potential for non-equipment (or "retrofit") measures requires assessing the collective impacts of a variety of measures with interactive effects. For each segment and end-use combination, the analysis objective is to estimate the cumulative effect of the bundle of eligible measures, and incorporate those impacts into the end-use model as a percentage adjustment to the baseline end-use consumption. In other words, the approach seeks to estimate the percentage reduction in end-use consumption that could be saved in a "typical" structure (multifamily dwelling, small office, etc.) by installing all available measures. The starting point for this approach is characterizing individual measure savings in terms of the percentage of end-use consumption rather than their absolute energy savings. For each individual non-equipment measure, savings are estimated using the following basic relationship:

$$SAVE_{ijm} = EUI_{ije} * PCTSAV_{ijem} * APP_{ijem}$$

where:

$SAVE_{ijm}$ = annual energy savings for measure m for end use j in customer segment i

EUI_{ije} = calibrated annual end-use energy consumption for the equipment e for end use j and customer segment i

$PCTSAV_{ijem}$ = the percentage savings of measure m relative to the base usage for the equipment configuration ije, taking into account interactions among measures, such as lighting and HVAC calibrated to annual end-use energy consumption

APP_{ijem} = measure applicability, a fraction that represents a combination of the technical feasibility, existing measure saturation, end-use interaction, and any adjustments to account for competing measures

It is appropriate to view a measure's savings in terms of what it saves as a percentage of baseline end-use consumption, given its overall applicability. In the case of wall insulation that saved 10% of space heating consumption, if the overall applicability is only 50%, the final percentage of the end use saved would be 5%. This value represents the percentage of baseline consumption the measure saves in an average home.

However, capturing all applicable measures requires examining many instances where multiple measures affect a single end use. To avoid overestimation of total savings, the assessment of cumulative impacts accounts for the interaction among the various measures, a treatment called "measure stacking." The primary means of accounting for stacking effects is to establish a rolling, reduced baseline, applied iteratively as measures in the stack are assessed. This is shown in the equations below, where measures 1, 2, and 3 are applied to the same end use:

$$SAVE_{ij1} = EUI_{ije} * PCTSAV_{ije1} * APP_{ije1}$$

$$SAVE_{ij2} = (EUI_{ije} - SAVE_{ij1}) * PCTSAV_{ije2} * APP_{ije2}$$

$$SAVE_{ij3} = (EUI_{ije} - SAVE_{ij1} - SAVE_{ij2}) * PCTSAV_{ije3} * APP_{ije3}$$

After iterating through all measures in a bundle, the final percentage of end-use consumption reduced is the sum of the individual measures' stacked savings, divided by the original baseline consumption.

Estimating Economic Potential

Once the technical potential is established, the next step is to determine how much of this potential is economic (cost-effective).

AIU data on avoided energy and capacity costs, line losses, discount rates, and so on, were incorporated with measure costs and savings to perform a full cost-benefit analysis for every sector, customer segment, vintage, end use, and measure combination. This method employs hourly end-use load shapes to account for seasonal differences and system peak coincidence among end uses. That is, a measure applying to cooling may be more cost-effective than a lighting measure with the same levelized cost.

For each measure, assessment of cost-effectiveness begins with valuation of the measure's gross benefits, as measured by long-run avoided costs and an accounting of the measure's total delivered costs. Measure cost-effectiveness is determined in terms of the expected net present value of its benefits, consistent with the Total Resource Cost (TRC) test. A measure is considered cost-effective if its net benefits are non-negative; in other words:

$$\frac{\text{TRC Benefits}}{\text{TRC Costs}} \geq 1$$

Where:

$$\text{TRC Benefitss} = NPV\left(\sum_{year=1}^{measurelife}\left(\sum_{i}^{i=8760}(impact_i \times avoided\ \cos t_i)\right)\right)$$

And:

$$\text{TRC Costs} = \text{NPV (incremental installed measure cost)}$$

Benefit Components

Benefits used in the TRC test calculation include the value of time- and seasonally-differentiated avoided energy and capacity costs. As these costs are typically measured at generation, they are adjusted for avoided T&D losses and externalities. For each electric conservation measure, hourly (8760) system avoided costs are adjusted by the measure's hourly load shape to capture the full value of time- and seasonally-differentiated impacts of the measure. Natural gas conservation measures are evaluated on a monthly basis. Only primary fuel benefits were considered in this analysis.

Measure Cost Components

The analysis cost component consists of incremental equipment and labor costs associated with the measure installation. In the economic potential, each measure is screened as though installed outside of a program. That is, no program administrative costs are included at this point in the analysis. When these measures are bundled into utility programs, administrative costs are added, which tend to decrease the cost-effectiveness of each. These costs can be organized into the five following categories:

- **Planning and design:** Expenses associated with program development, designing new programs, or modifying existing programs.
- **Program administration:** Costs associated with program support functions, such as ongoing operation, administration, trade ally management, and reporting.
- **Advertising and promotion:** Program-specific marketing, education, training, and demonstrations promoting the program.
- **Incentives:** Utility contributions provided to or on behalf of participants, including but not limited to: rebates, loan subsidies, payment to dealers, rate credits, bill credits, cost of energy audits, cost of equipment given to customers, and cost of installing such equipment. Note that rebate payments to customers are not included in TRC calculations.
- **Monitoring and evaluation:** Expenses associated with program evaluation, measurement, and verification.

Once all measures have been screened, the impacts of those deemed cost-effective are applied to baseline consumption estimates, and a separate forecast is created. The economic potential is calculated by subtracting this new forecast from the baseline forecast.

Estimating Achievable Potential

The quantity of cost-effective, energy-efficiency potential realistically achievable depends on multiple factors, including: customers' willingness to participate in energy-efficiency programs (partially a function of incentive levels); retail energy rates; and a host of market barriers, which have historically impeded consumers' adoption of energy-efficiency measures and practices.

This step's goal is to estimate what portion of the economic potential could be acquired through AIU programs over the course of the planning horizon. To estimate this achievable potential, this study primarily relied on benchmarking other utility program accomplishments and potentials assessments, as described in Section 0 of the report.

Effects of the Energy Independence and Security Act of 2007

While this analysis does not attempt to predict how energy codes and standards may change in the future, it does capture legislation already enacted, even if it will not go into effect for several years. Most notable of these is the Energy Independence and Security Act (EISA) of 2007, which sets new standards for general service lighting, motors, and other end-use equipment.

EISA also mandates higher-efficiency levels for light bulbs sold in or imported into the United States beginning in 2012, phased in by wattage range. As shown in Table 7, EISA's performance standards correspond to approximately 30% improvements in efficacy (measured in lumens-per-Watt) over current incandescent technology. The act includes an additional "backstop" provision requiring efficacy to reach near-CFL levels by 2020. It is important to note EISA is a performance-based standard; thus, standards are "blind" to technology and do not ban incandescent bulbs.

Table 7. EISA Requirements for General Service Incandescent Lamps

		EISA Requirements		
Lumen Output	Typical Wattage of Current Incandescent Technology	Maximum Wattage	Minimum Lifetime (hours)	Effective Date
1490–2600	100	72	1,000	1/1/2012
1050–1489	75	53	1,000	1/1/2013
750–1049	60	43	1,000	1/1/2014
310–749	40	29	1,000	1/1/2014

At this point, it remains unclear what the effect of these standards will be. Currently, CFLs are the only widely available and accepted technology meeting the prescribed efficacy levels; however, by 2012, there may be other options meeting the requirements. This uncertainty leads to two possible scenarios:

- ***EISA Minimum Scenario***. While EISA will preclude current incandescent technology, advanced incandescent bulbs may meet EISA's minimum standards. Advanced incandescent bulbs use a variety of approaches to increase efficacy, and some incandescent products already meet EISA requirements. These bulbs, however, currently cost $4 to $8 each (substantially more than the cost of a comparable CFL), and it is unknown how much the price might drop in the next few years. If the cost decreases and quality is similar to current incandescent bulbs, this may become the preferred choice of customers. In this scenario, potential from CFLs would remain, though the savings would be reduced from current levels due to a more efficient baseline technology.

- ***CFL Baseline Scenario***. If the technology described above does not become viable by the time the standards take effect, CFLs could become the de facto baseline, meaning that although CFLs are more efficient than minimum requirements, they are the only viable technology, and will be customers' primary options. This scenario would eliminate the potential for general service CFLs, though savings opportunities would remain in niche applications.

It is important to note that neither of these scenarios completely removes residential lighting potential. In addition to measures such as occupancy sensors, there would still be an opportunity for lighting with higher efficacy than CFLs (such as LEDs). Currently, though LEDs offer longer lifetimes and higher savings than CFLs, the up-front cost is high, and questions remain regarding the quality of light. However, over the course of this study, LEDs could become a viable option for savings beyond CFLs.

Clearly, the assumption regarding EISA's impact plays a crucial role in estimating technical, economic, and achievable potential, as lighting has historically represented the residential sector's largest portion of potential. For this study, it is assumed an intermediate "EISA Minimum" technology will become available by the time the standards take effect. Therefore, CFL potential, at a reduced level, will remain throughout the planning horizon.

2. Primary Data Collection

The assessment of energy-efficiency potential requires a broad range of technical and market data unique to the utility service territory. These include baseline data on equipment and fuel saturations and building characteristics as well as measure-specific data, such as costs, savings, and the current saturation of energy-efficiency measures.

A series of primary data collection efforts were undertaken to maximize the amount of available data specific to AIU's service territory. These efforts included surveys of residential and nonresidential customers as well as trade allies working in AIU's service territory. Cadmus conducted the trade ally and industrial interviews, and partnered with Nexant, Inc., to collect the residential telephone survey data and to conduct the residential and commercial site visits. In summary, the data collection activities were:

- Residential customer phone surveys
- Residential customer on-site surveys
- Nonresidential customer on-site surveys
- Interviews with large industrial customers
- Trade ally interviews

This section describes methods used to design and implement the surveys, and presents key findings for each surveyed group. Survey instruments and detailed results can be found in Appendices A and B, respectively.

Trade Allies

Research Approach

The trade ally sample was developed from a list of AIU trade partners, supplemented with a random search of the yellow pages. Trade groups were selected to represent primary influences for the purchase and installation of residential and commercial energy-consuming equipment. Table 8 shows trade groups surveyed as well as the number of surveys completed within each group. The surveys' key findings can be found in the residential and commercial sections below.

Table 8. Trade Ally Survey Sampling

Respondent Type	Completed Surveys
Retailers	5
Builders (Residential and Commercial)	12
Architecture & Engineering Firms	6
HVAC dealers	5
Plumbers	3
Mechanical contractors/wholesalers	5
Lighting vendors	6
Motor vendors	5
Industrial refrigeration vendors	2
Compressed Air vendors	3
Total	52

Residential Sector

Primary research in the residential sector focused on collecting several types of information vital to accurately assessing potential in AIU's service territory. These data included the following information necessary to characterize baseline consumption and assess the availability of energy-efficiency moving forward:

- ***Building characteristics:*** Square footage, insulation levels, foundation type, etc.
- ***Equipment saturation***: The percentage of customers that own specific equipment (e.g., the percent of single-family homes with air-conditioning).
- ***Fuel shares:*** The percent of equipment using electricity, natural gas, or another fuel (e.g., the percentage of furnaces fueled by electricity).
- ***Efficiency penetration:*** The percentage of installed equipment stock considered efficient (e.g., the percent of installed central air-conditioners exceeding SEER 13).
- ***Market share:*** The percentage of current equipment sales considered efficient (e.g., the percentage of central air-conditioner sales in the last 12 months that exceeded SEER 13).
- ***Construction practices:*** Information on current construction practices for new homes, including whether builders are meeting or exceeding energy codes.

Research Approach

To assemble these data, a three-pronged approach was employed, utilizing telephone and on-site surveys of residential customers as well as telephone calls to residential trade allies. Table 9, on the next page, summarizes the approach, including the survey's primary focus, the sample source, stratification method, and the number of completed surveys.

Table 9. Residential Primary Data Collection Efforts

Data Collection Effort	Method	Primary Focus	Sources	Stratification	Number of Surveys/ Visits
Residential Appliance Saturation Survey (RASS)	Telephone Survey	Residential Appliances and Household Characteristics	Illinois Single-Family Homeowners, Residents of Multi-Family Buildings, and Mobile/ Manufactured Home Residents identified from Database of Utility Customers	By Building Type, and location	401
Residential On-Site Surveys	In-Person On-Site Audits	Residential Appliances and Household Characteristics	Residential customers who did not participate in telephone survey	None	50
Residential Trade Ally Surveys	Telephone Survey	HVAC equipment, new home construction, retail sales of energy efficient equipment	Residential HVAC Dealers and Installers, Builders and Retailers Identified Through Yellow-Page Searches and Lists of Participating Trade Allies from AIU.	None	19
Total Residential Surveys					470

Table 10 presents a summary of information collected in each survey. To maximize data collection efforts' values as related to energy-efficiency potentials, certain measures expected to represent disproportionately large portion of the potentials were given the highest priority.

The phone survey covered a range of topics about household energy use and behavior, including:

- Household demographics (home size, age, etc.)
- Home heating, cooling and water heating equipment
- Major appliances
- Electronics
- Respondent demographics
- Energy reduction behaviors
- Receptiveness to energy-efficient measure incentives
- Motivations for participating in DSM programs

In addition to many of the items listed above, on-site auditors gathered information on the efficiency of major energy-using equipment and appliances (e.g., central air conditioners, refrigerators, etc.). They also conducted a lighting audit, collecting bulb counts and types in each room of the house to assess the penetration of efficient lighting. As shown in Table 10, residential sector trade allies surveyed included HVAC dealers, appliance retailers, and builders. These trade allies provided information on availability and popularity of efficiency equipment and building practices for new homes. A unique survey instrument was used for each trade group.

For various reasons, not all questions were asked in all surveys. For example, a telephone respondent might not, offhand, know the insulation level in his or her home; so this information was collected on-site. To maximize the value of data collection efforts related to energy-efficiency potentials, measures expected to represent the largest potential were given higher priority. Table 10 presents a summary of information collected in each survey.

Table 10. Summary of Data Sources for Residential Sector Measures

Measure Type	End-use Customer Telephone Surveys	Customer Site Visits	Trade Ally Surveys: HVAC Contractors	Trade Ally Surveys: Appliance Retailers	Trade Ally Surveys: Home Builders
Residential Central AC	✓	✓	✓		✓
Geothermal/Air Source Heat Pumps	✓	✓	✓		✓
Programmable Thermostats	✓	✓	✓	✓	✓
Clothes Washers	✓	✓		✓	
Water Heating	✓	✓		✓	✓
Clothes Dryers	✓	✓		✓	
Dishwashers	✓	✓		✓	
Windows		✓			✓
Insulation		✓			✓
Refrigerators	✓	✓		✓	
Electronic Equipment Plug Load	✓			✓	
CFLs	✓	✓		✓	✓

Sample Disposition

Sample populations for the telephone and on-site surveys were randomly selected from AIU's residential customer database, and were stratified by fuel and location to provide information across AIU's service territory. The telephone and on-site respondents were intentionally kept distinct to maximize available data from the surveys. Telephone respondents were given a $10 gift card, while on-site survey participants received $25.

Key Findings

Baseline Characterization

The data on equipment saturations and fuel shares collected through primary market research were combined with end use consumption estimates to develop a baseline for each segment. Residential customers were disaggregated into segments based on Census data, and these customer counts were multiplied by calculated average consumption to create a picture of residential energy consumption in terms of both segments and end uses in the base year. Figure 7 and Figure 8 show the sales breakdown by segment for electric and natural gas residential customers, respectively. As shown, the majority of both electricity and natural gas consumption occurs in single family dwellings.

Figure 7. Base Year Residential Electric Consumption by Segment

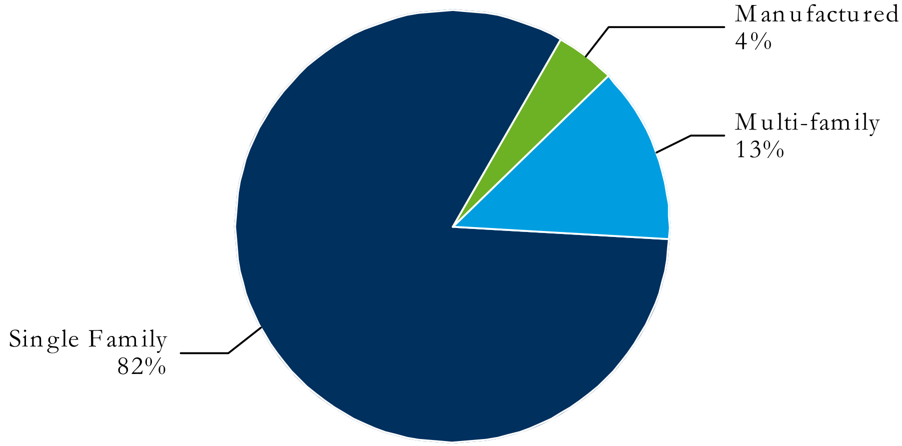


Figure 8. Base Year Residential Natural Gas Consumption by Segment

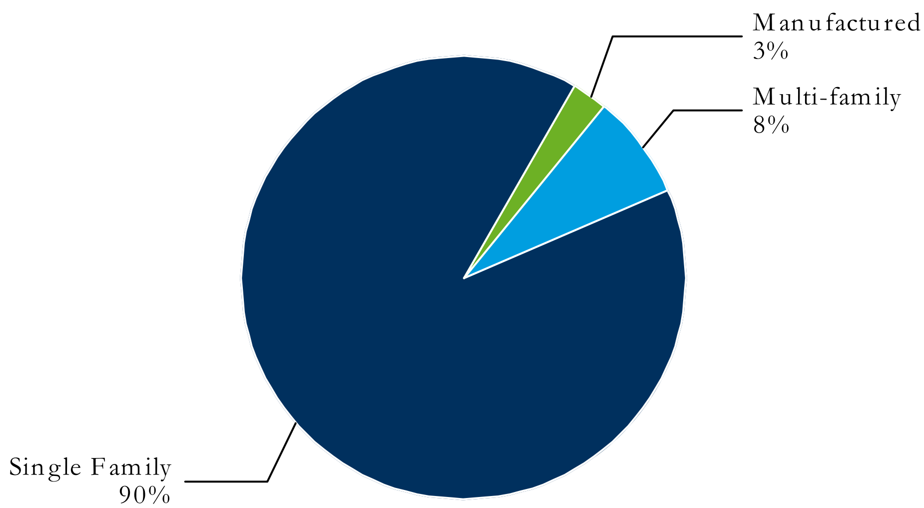


Figure 9 and Figure 10 show how residential electricity and natural gas sales are distributed by end use, respectively. Electric sales are roughly equally distributed between appliances, plug loads, cooling, and space heating, driven by relatively high electric shares of end use equipment. Space heating and water heating compose 89% of natural gas sales, with equipment such as dryers, ranges, and hot tubs accounting for the remaining 11%.

Figure 9. Base Year Residential Electric Consumption by End Use

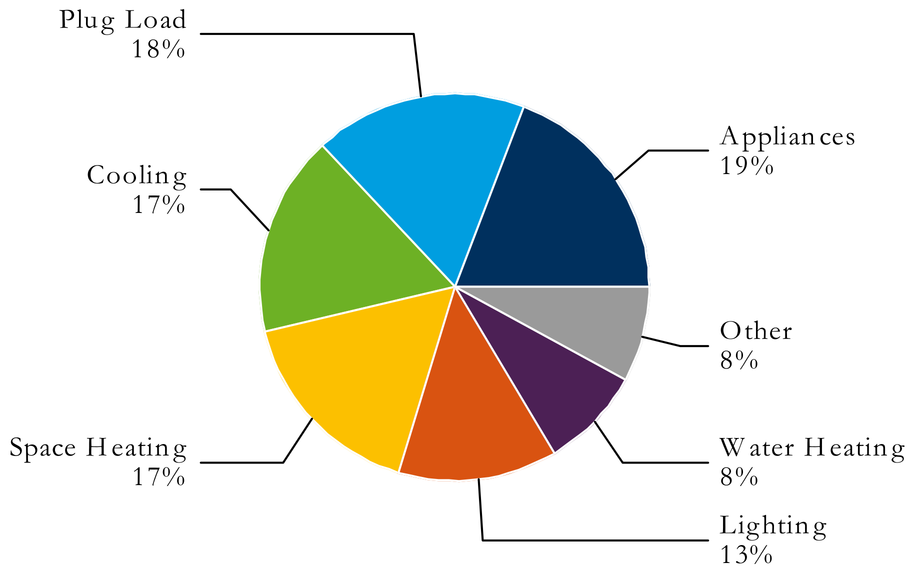
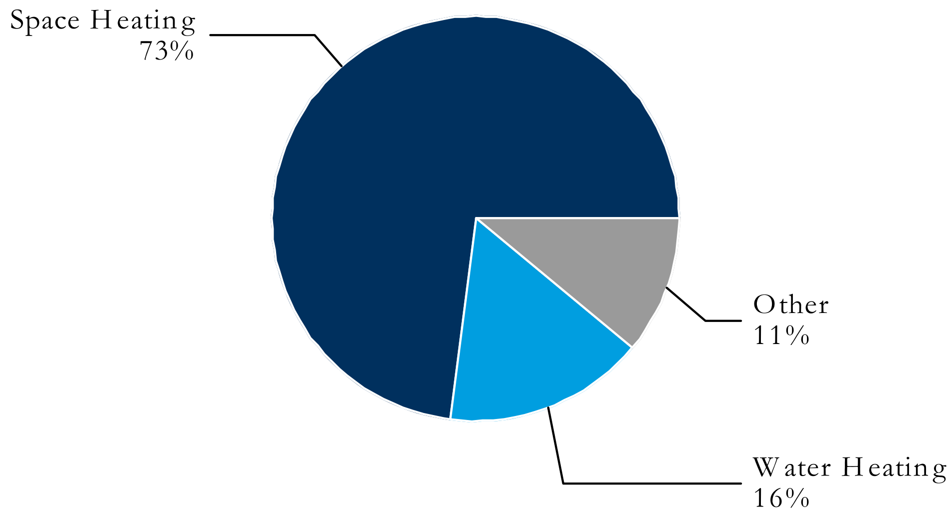


Figure 10. Base Year Residential Natural Gas Consumption by End Use



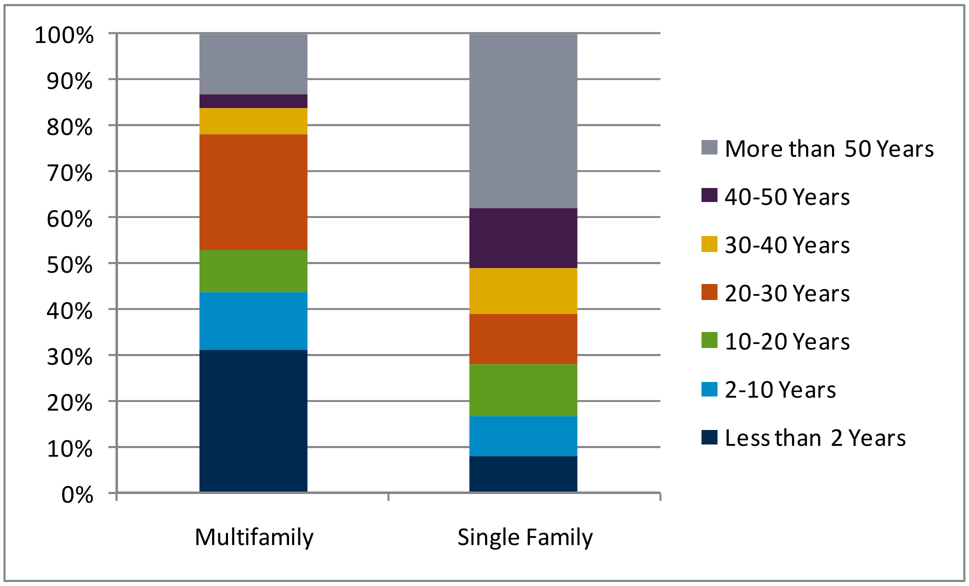
Household Characteristics

To understand energy consumption in an average home, it is important to understand the physical characteristics of that home, including: square footage, age of home, and foundation type.

A majority of respondents (58%) reported their homes were between 1,000 and 2,000 square feet. Nearly 20% reported their homes were between 2,000 and 3,000 square feet, while another 6% indicated their homes were larger than 3,000 square feet. A majority of multifamily homes were smaller, ranging from 500 to 1,000 square feet, as expected.

Respondents were asked the approximate ages of their homes (in years) as an open-ended question (Figure 11). For single-family homes, almost 40% of homes were over 50 years old, with remaining homes roughly equally distributed between other age groups. Multifamily respondents tended to live in newer homes.

Figure 11. Age of Home



One quarter of homes had finished basements with conditioned spaces requiring heating or cooling. Another third of respondents had unfinished basements with the potential for becoming a conditioned space.

Saturation of Space Heating, Cooling, and Water Heating

Most respondents (79%) cooled their home with a central air conditioner (see Figure 12). Another 14% reported they used room air conditioners; 3% indicate they used heat pumps; and the remainder used a ductless mini-split system or had no cooling equipment.

Figure 12. Distribution of Cooling Technologies

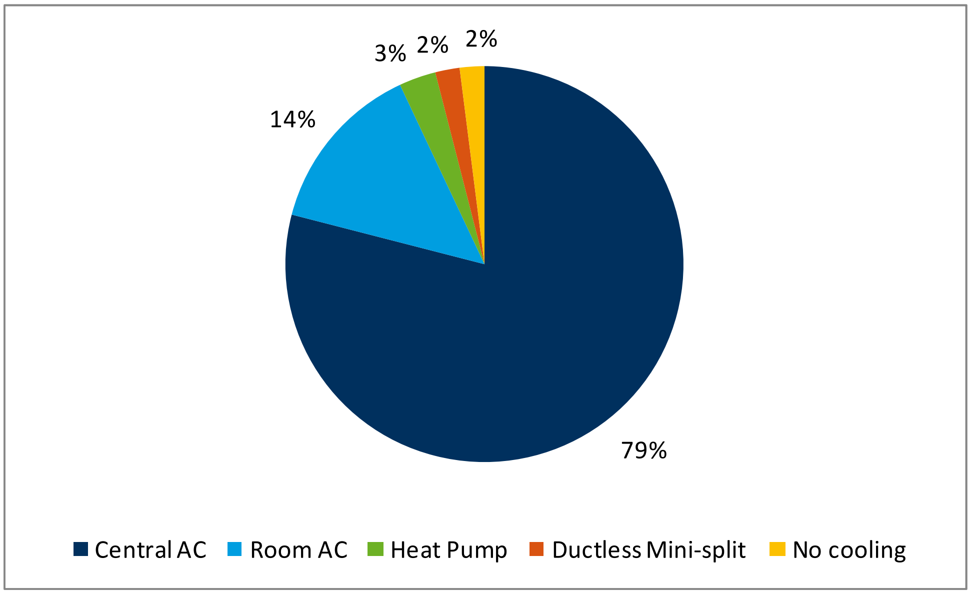
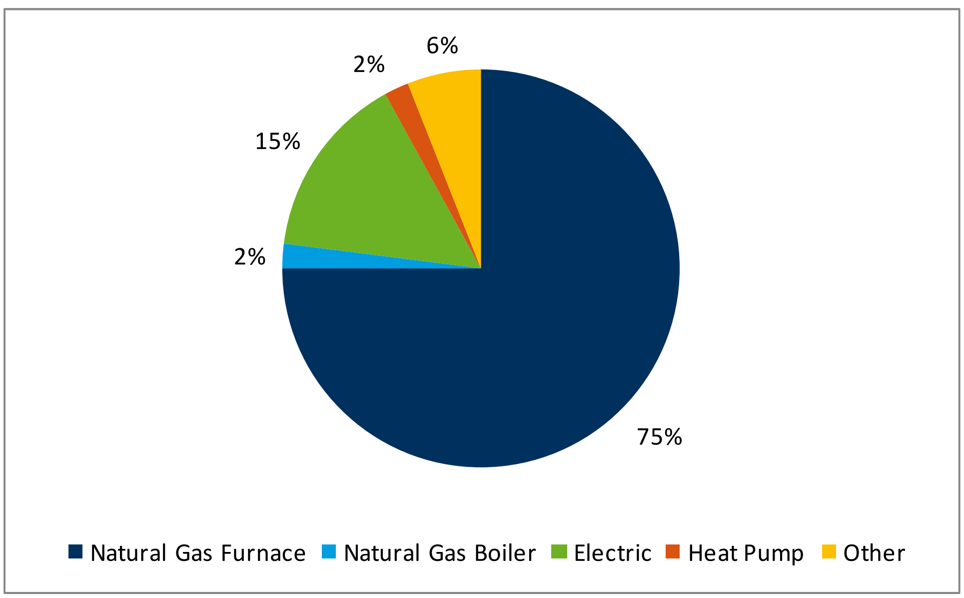


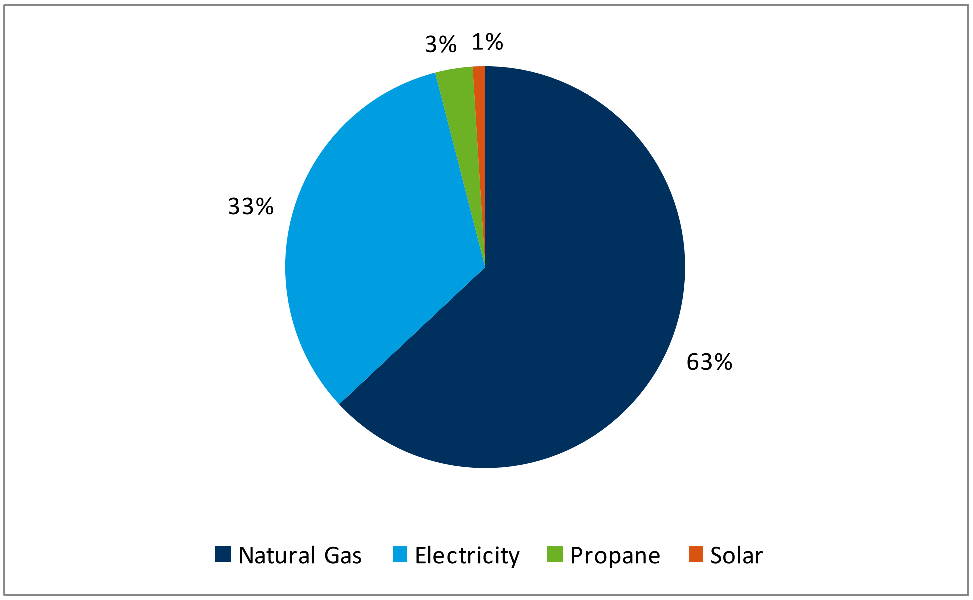
Figure 13 shows the distribution of space heating equipment. The majority of respondents (75%) used natural gas furnaces for space heating, followed by electric furnaces (15%). Remaining respondents indicated they used: natural gas boilers (2%), heat pumps (2%), or some other equipment fueled by an alternate fuel. Less than half (42%) of respondents had programmable thermostats, and, of those, only about half (46%) said they used the set-back features.

Figure 13. Distribution of Heating Technologies



As with space heating, a majority of respondents used natural gas (62%) for water heating (Figure 14). One-third of respondents (33%) reported having electric water heaters, while another 4% of respondents used other fuel types (e.g., propane) for water heating.

Figure 14. Distribution of Water Heating Fuel



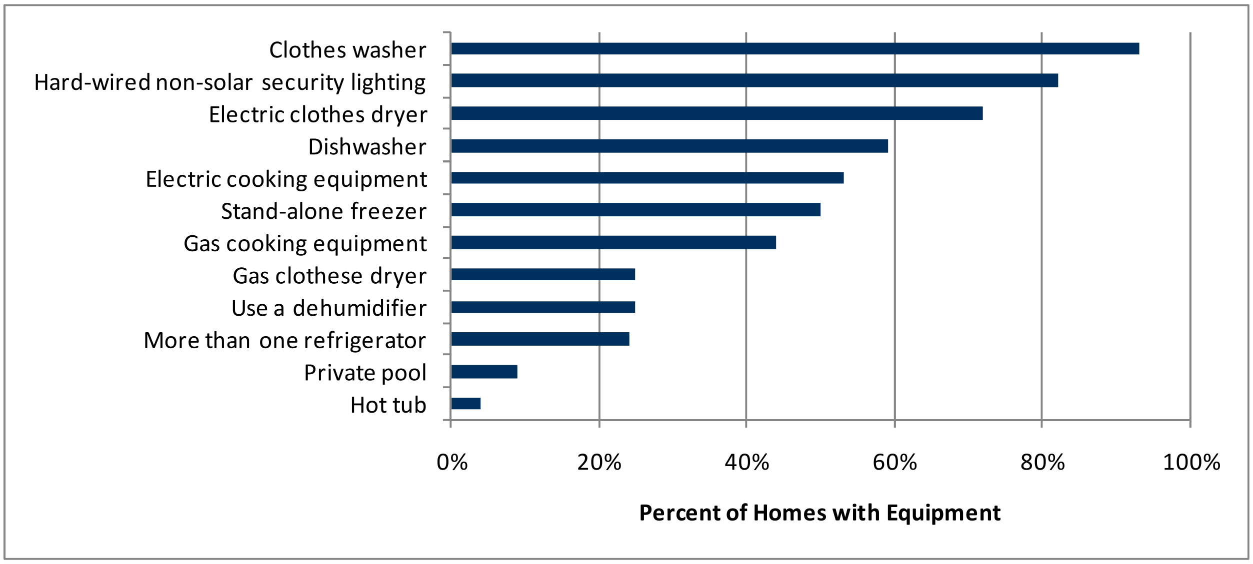
Findings for other water heater characteristics included:

- One quarter had a water heater tank wrap or insulation blanket.
- More than a third of respondents' water heaters were 10 years old or older.
- Approximately 7% of respondent water heaters had far outlived their expected useful life, at 20 years or older.

Appliances and Other End Uses

Figure 15 shows saturations of various common home appliances and equipment. The most commonly owned appliances were clothes washers (93%), followed by electric clothes dryers (72%), dishwashers (59%), electric cooking equipment (53%), and stand-alone freezers (50%). A quarter of respondents reported owning a dehumidifier, and another quarter (24%) had more than one refrigerator. Nine percent of respondents reported they had their own swimming pool, and another four percent had a hot tub.

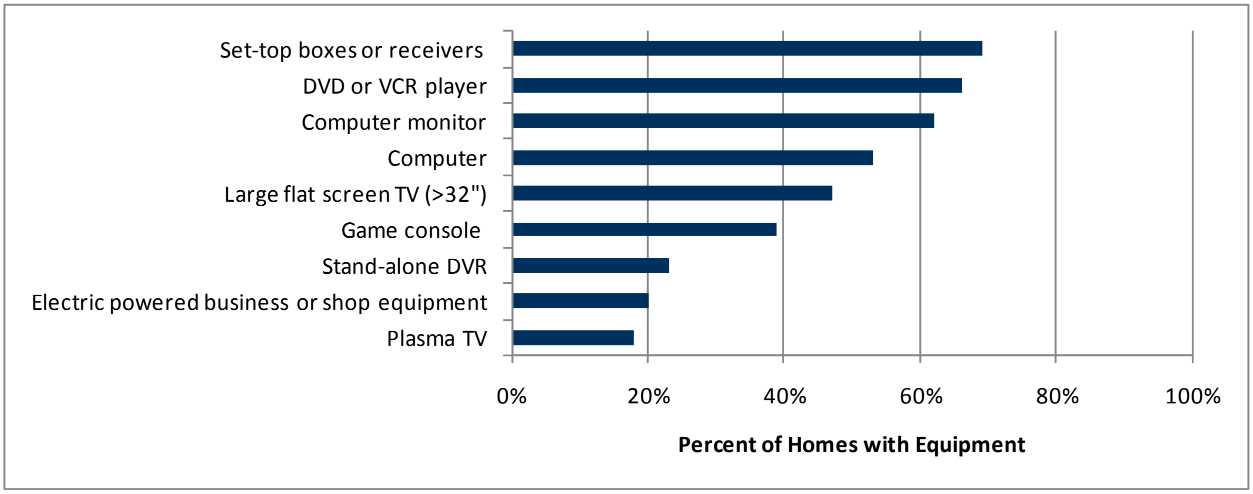
Figure 15. Appliance and Miscellaneous Equipment



Telephone and on-site surveys also gathered data on plug load equipment, which included typical electronics such as televisions and computers. Figure 16 shows the percent of households with different types of electronics.

Televisions were the most common equipment; data indicated AIU households had an average of 2.5 televisions per home. Only 1% of respondents indicated they did not have a television. Of televisions, about half of respondents (47%) reported they owned a flat screen television over 32 inches, and another 18% reported owning a plasma television. Many respondents owned set-top boxes or receivers (e.g., TiVo) (69%) and DVD or VCR players (66%). Game consoles (~40%) and stand-alone DVR devices (25%) were less common.

Figure 16. Plug Load Equipment

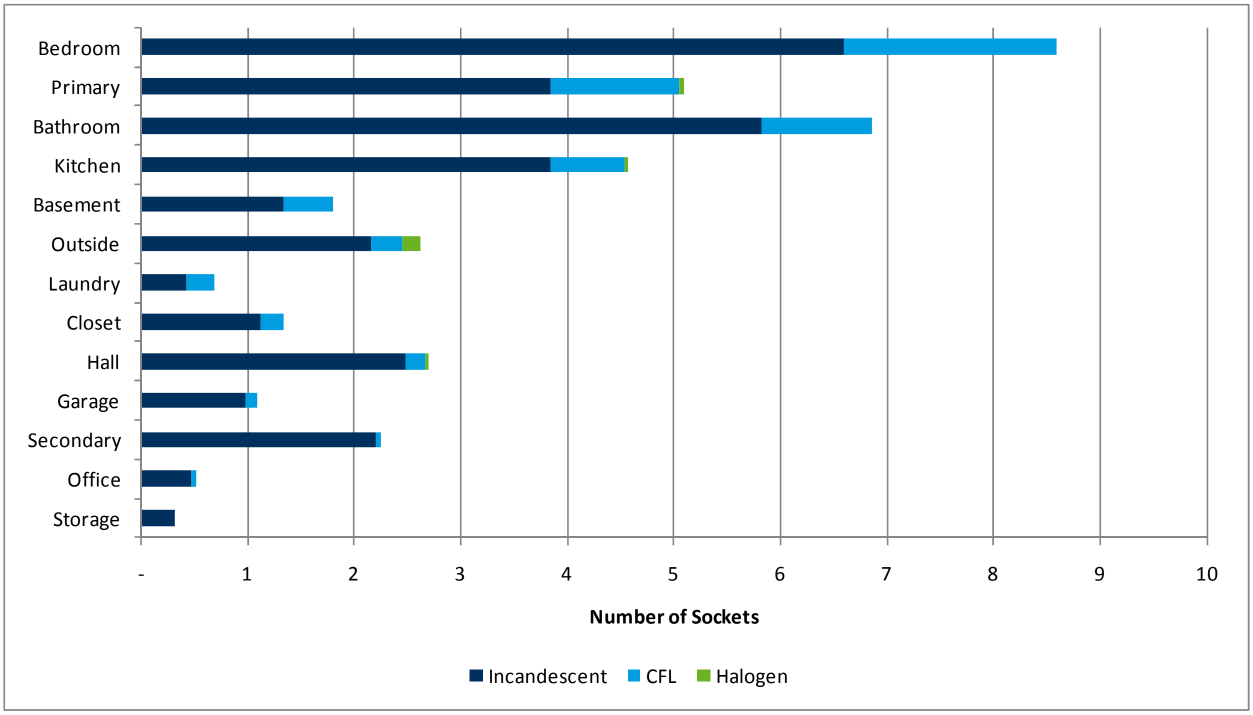


Lighting

Single-family homes had, on average, about 38 light sockets, seven of which (17%) contained CFLs. A majority of respondents (89%) were aware of CFLs. Of those aware, nearly all (93%) had at least one CFL installed in their homes.

Figure 17 shows the average number of sockets and distribution of technologies by room type. CFL penetrations were roughly equal, in percentage terms, in most room types.

Figure 17. Penetration of CFLs by Room Type in Single-Family Homes



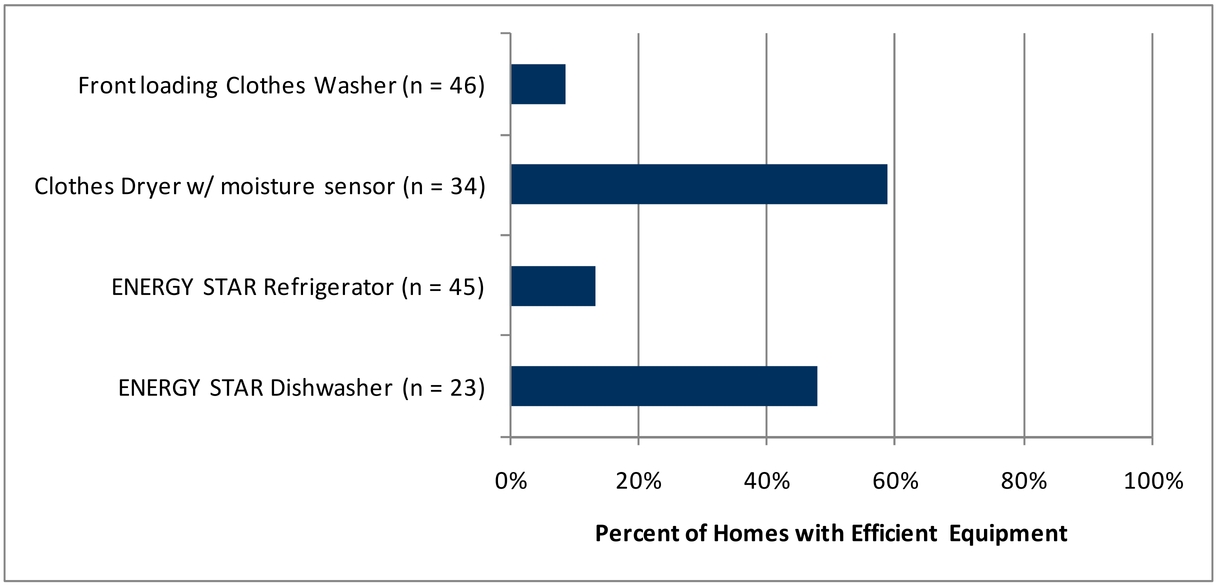
Penetration of Energy-Efficiency Measures

Auditors were able to collect cooling efficiency ratings on 21 of the AIU homes visited. The average Seasonal Energy Efficiency Rating (SEER) value was 11.4, with 43% of homes having SEER 10 units. On average, nineteen percent of homes had a unit rated at least SEER 13, the current federal standard.

Appliances

- On-site visits revealed 59% of homes had clothes dryers with a moisture sensor.
- Nearly half (48%) of homes visited had ENERGY STAR dishwashers.
- Another 13% had ENERGY STAR refrigerators.
- Of homes visited, only 9% had front-loading clothes washing machines.

Figure 18. Energy-Efficient Appliances



New Construction

Residential builders provided a number of valuable insights into current trends in new home construction, namely:

- The average size of a new home was just over 2,000 square feet.
- On average, 20% of new homes were built with air conditioning exceeding the 13 SEER code level.
- Builders report constructing a majority of new homes with gas-fueled water heating, but nearly 30% had electric hot water heaters.
- A large proportion of builders indicated they installed ENERGY STAR kitchen appliances (85%) and windows (81%) in new homes.

Additional Market Share Information

Retailers reported the proportion of ENERGY STAR refrigerators (43%) and room air conditioners (66%) sold for residential use exceeded the proportion sold in 2007 by ENERGY STAR National Partners,[1] reporting 31% and 51% for Illinois, respectively. Sales of ENERGY STAR clothes washers were in line with National Partner Sales (38% versus 40%). However, sales for ENERGY STAR dishwashers were lower than the National Partner sales (67% versus 80%).

[1] 2007 is the most current reference for National ENERGY STAR partner sales at this time.

Commercial Sector

Though estimating energy-efficiency potential in the commercial sector requires data similar to the residential sector, the approach is slightly different. Because systems are more complex and varied, on-site data collection is preferable to customer telephone surveys. These on-site surveys were again supplemented with telephone calls to key trade ally categories. Table 11, on the next page, summarizes the approach, including the survey's primary focus, sample source, stratification method, and number of completed surveys. Survey instruments and detailed tabulations of results for each of these efforts are presented in Appendix A and Appendix B, respectively.

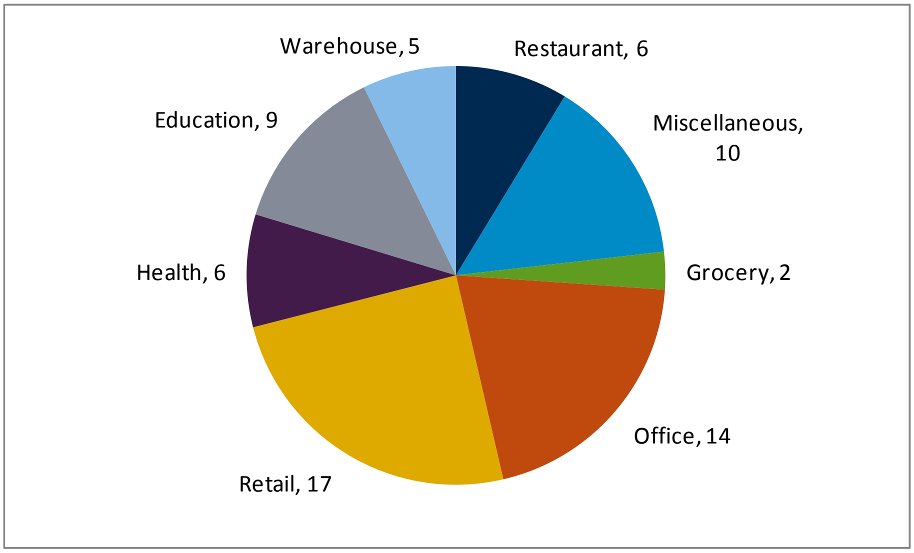
Table 11. Commercial Sector Primary Data Collection Efforts

Data Collection Effort	Method	Measures	Sources	Stratification	Number of Surveys/ Visits
Non-Residential End User Site Visits	In-Person On-Site Audits	Heating and Cooling Systems, Controls, Refrigeration, Water Heating, Commercial Kitchen Equipment, Lighting and Lighting Controls	Participants in Non-Residential End User Telephone Survey Agreeing to Site Visits	Customer Segment /Building Type	69
Non-Residential Trade Ally Surveys: Builders, Architects & Engineering Firms, Lighting vendors, Compressed Air vendors, Mechanical Contractors Refrigeration Specialists, Motors Vendors	Telephone Survey	Lighting and HVAC Controls, Sensors, Insulation Cool Roofs, Ducts, Lighting, Windows, Lighting Equipment, Compressed Air Equipment, Motors and Drives, Refrigeration Equipment, Insulation Measures, and Controls	Identified Through Yellow-Page Searches, Lists of Participating Trade Allies from AIU.	N/A	33
Total Non-Residential Surveys					102

Research Approach

Commercial segments were determined by analysis of the distribution of AIU commercial customers' energy usage by industry type, as identified by the North American Industry Classification System (NAICS) codes. Sixty-nine surveys were completed within the following segments: education, grocery, healthcare, lodging, small and large office; restaurant; retail; warehouse; and other commercial facilities. Quotas for each segment were determined based on AIU electricity and natural gas sales, giving priority to segments representing a large portion of sales (Figure 19). The sample was also stratified by location to ensure geographic representation, similar to residential sampling. Respondents to on-site surveys received a $25 Visa gift card.

Figure 19. Stratification for Commercial On-site Audits



The commercial survey focused on the number, type, and efficiency ratings of energy-using equipment, including the following:

- Building envelope (size, insulation, construction materials, etc.);
- Indoor and outdoor lighting;
- Heating, cooling, and water heating equipment;
- Major end uses such as refrigeration, motors, and compressed air; and
- Prevalence of energy-efficiency practices and technologies.

Table 12, on the next page, provides a summary of end-uses and technologies covered in each survey.

Table 12. Summary of Data Sources for Commercial Sector Measures

Measure Type	Customer Site Visits	Trade Ally Surveys: Builders / A&E Firms	Trade Ally Surveys: HVAC Contractors	Trade Ally Surveys: Mechanical Contractors	Trade Ally Surveys: Motor Vendor	Trade Ally Surveys: Lighting Vendors	Trade Ally Surveys: Compressed Air Vendors	Trade Ally Surveys: Refrigeration Vendors
Central Air Conditioning	✓	✓	✓	✓				
Furnaces	✓	✓	✓					
Geothermal/Air Source/Add on Heat Pump	✓	✓	✓	✓				
Boilers			✓					
Programmable Thermostats	✓	✓	✓	✓				
Building Energy Management Systems	✓	✓		✓				
Occupancy Sensors	✓	✓				✓		
Heat Recovery from Exhaust Air to Water Heating	✓	✓		✓				
Water Heating	✓	✓	✓					
Windows		✓						
Insulation		✓						
Motors/ASDs	✓	✓			✓			
Refrigeration	✓	✓						✓
CFLs/T8 Lighting/High Bay Lighting/LED Exit/Pulse Start Metal Halide	✓	✓				✓		
Compressed Air Systems and controls	✓						✓	

Key Findings

Baseline Characterization

The data on equipment saturations, fuel shares and square footage collected through primary market research were combined with end use consumption estimates to develop a baseline for each segment. Incorporating the number of customers in each segment from AIU's non-residential database provides a picture of the commercial sector in terms of consumption by segment and end use in the base year. Figure 20 and Figure 21 show the sales breakdown by segment for electric and natural gas commercial customers, respectively. The miscellaneous segment is a combination of customers who do not fit into one of the other segments, and those who would, had more data been available. Grocery falls into the "Other" category for natural gas, as it accounts for a small percentage of the base year sales.

Figure 20. Base Year Commercial Electric Consumption by Segment

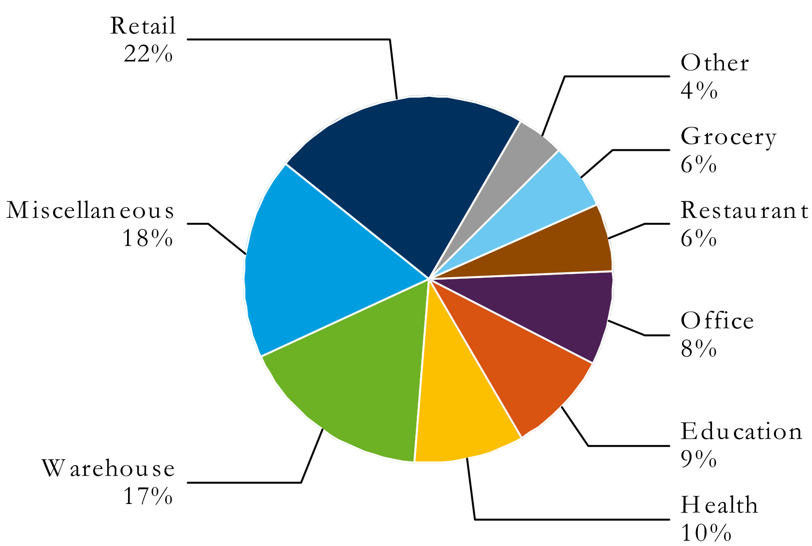


Figure 21. Base Year Commercial Natural Gas Consumption by Segment

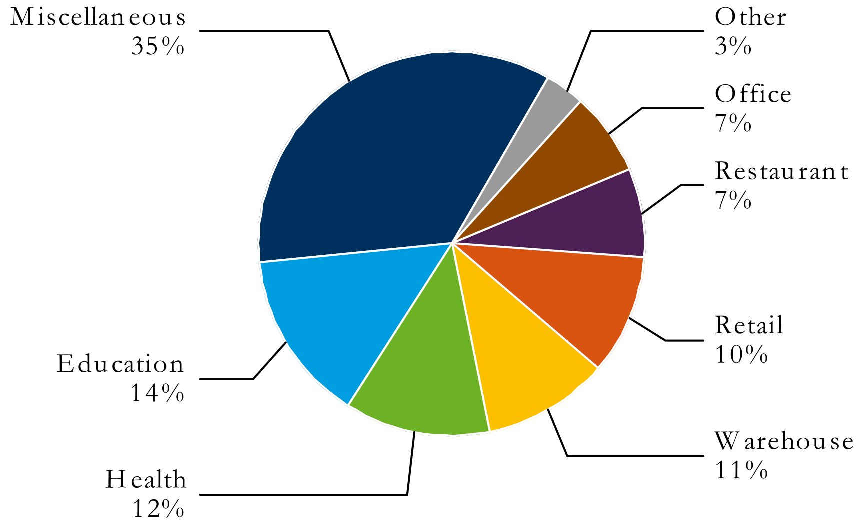


Figure 22 and Figure 23 show how commercial electricity and natural gas sales are distributed by end use, respectively. Lighting accounts for roughly half of electric consumption, whereas natural gas consumption is mostly space heating.

Figure 22. Base Year Commercial Electric Consumption by End Use

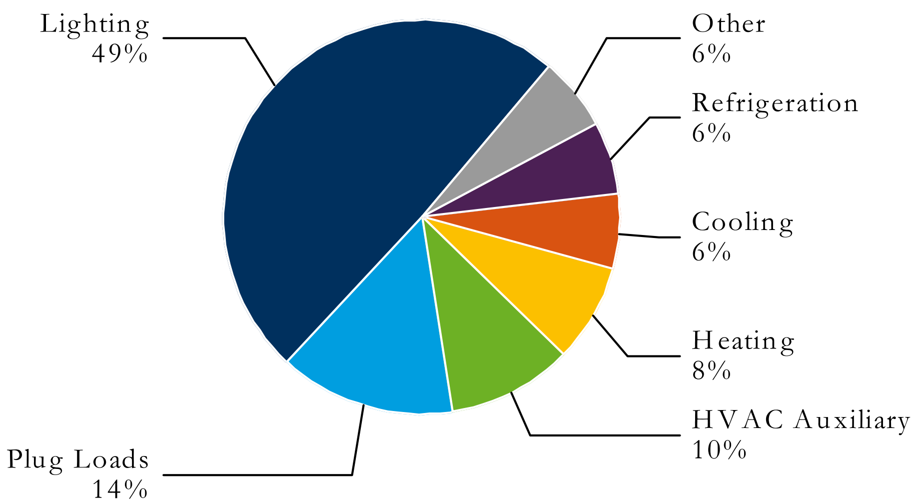
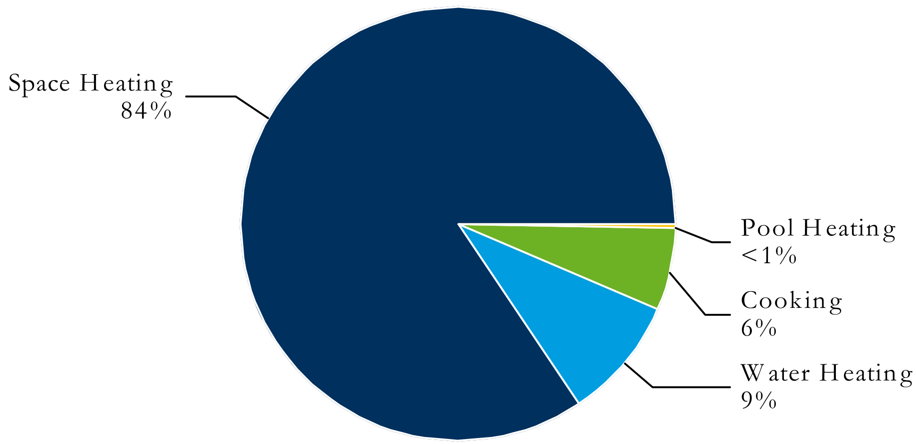


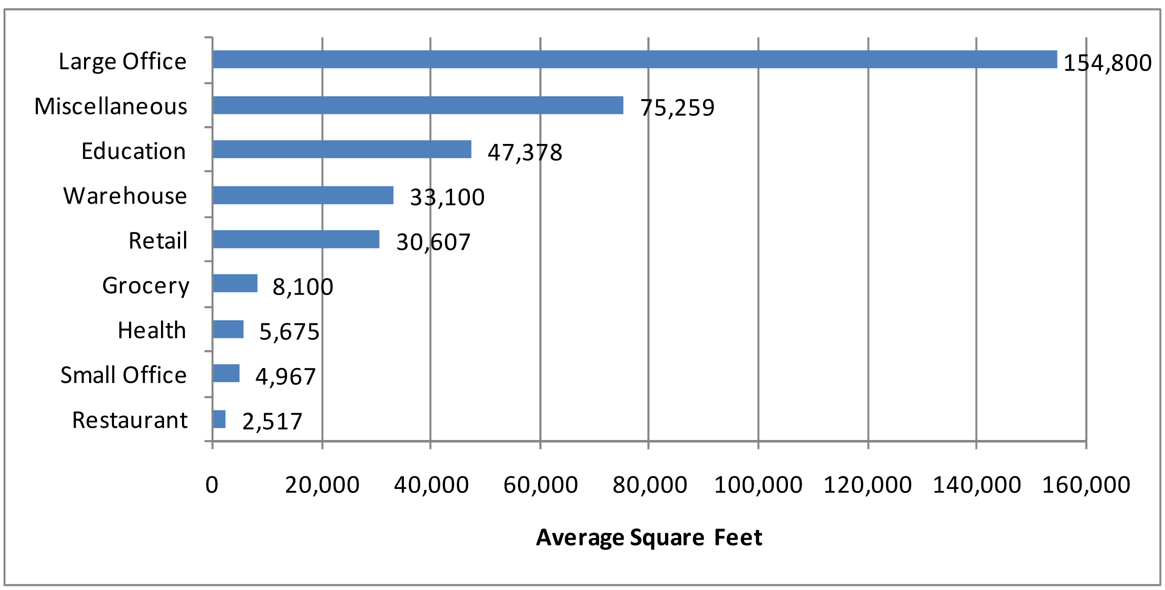
Figure 23. Base Year Commercial Natural Gas Consumption by End Use



Building Size

Large Office buildings were, on average, the largest facilities among segments surveyed, averaging over 150,000 square feet (Figure 24). Several warehouses were smaller than expected, but NAICS codes were confirmed and matched building functions.

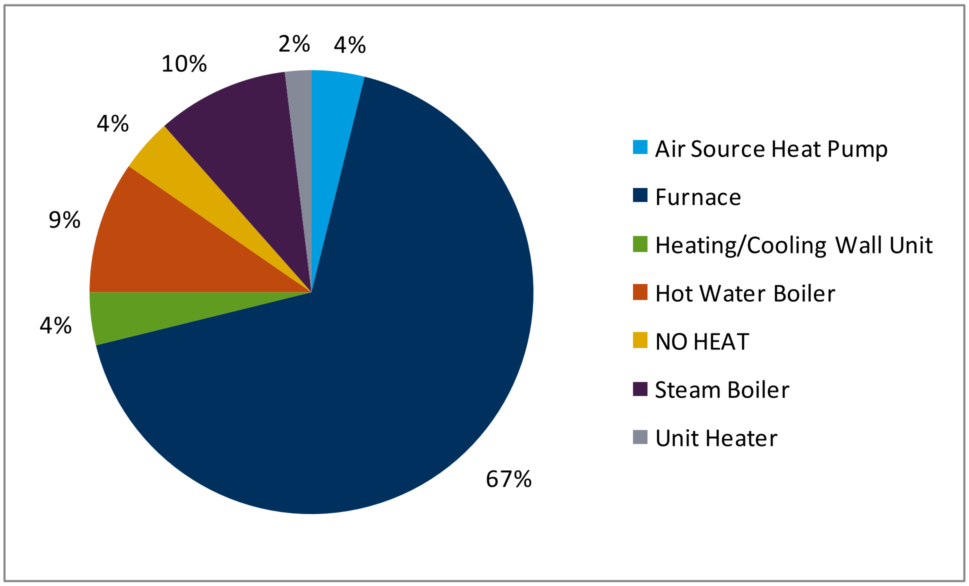
Figure 24. Average Size of Commercial Buildings Surveyed by Segment



Heating, Cooling, and Water Heating

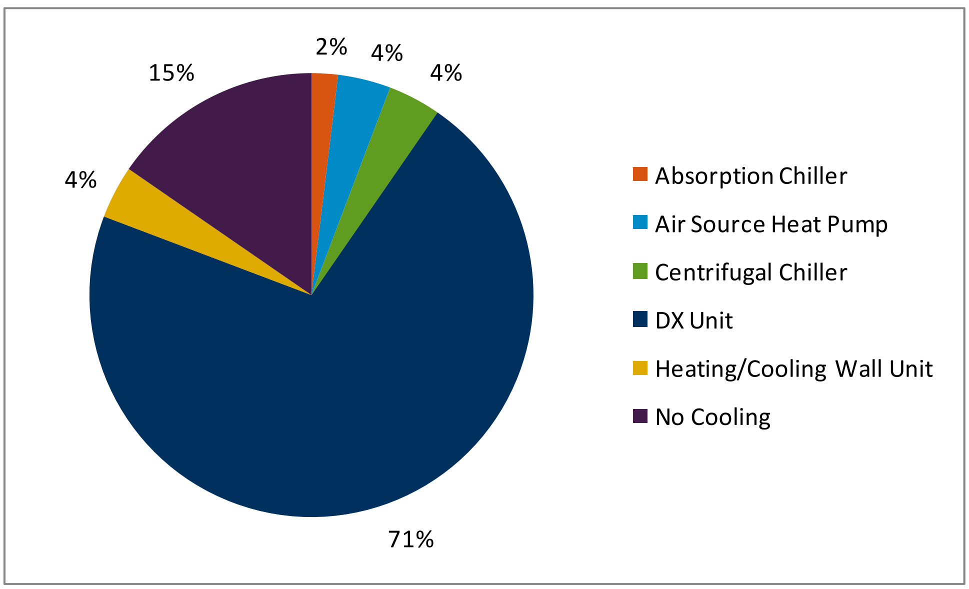
Auditors found heating systems in 96% of facilities. Furnaces represented the majority of these systems at 67%, with steam and hot water boilers making up another 19% (Figure 26). Just over one-quarter (28%) of these systems heated with electricity, while the remainder used natural gas or steam.

Figure 25. Types of Commercial Heating Equipment



Cooling systems were present in 85% of buildings, with 71% using direct expansion (DX) equipment. Six percent of facilities used chillers, with wall units and heat pumps accounting for the rest of the cooling systems (Figure 26).

Figure 26. Types of Commercial Cooling Equipment



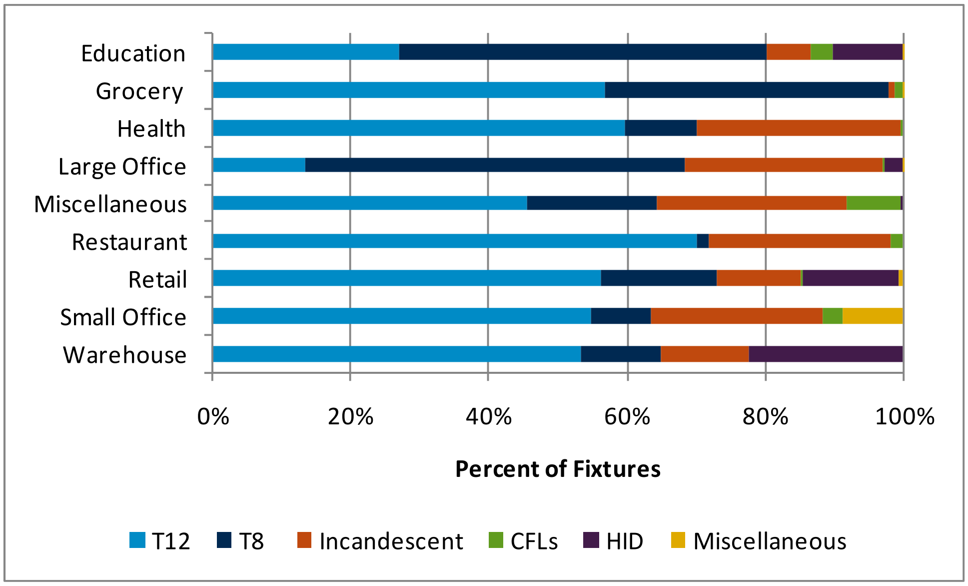
To control these heating and cooling loads, over two-thirds of facilities (68%) had manual HVAC controls: manual thermostats or on/off switches. Another 26% used programmable thermostats, and the remaining 6% had an Energy Management System in place.

Natural gas was used to heat water in 55% of facilities, with the other 45% using electricity. Most facilities (83%) had self-contained storage tanks, which, on average, had a capacity of 50 gallons and were about 10 years old.

Indoor Lighting

AIU commercial buildings indicated a large potential for efficient lighting, with about half (49%) using T-12 florescent lighting and another 19% using incandescent bulbs (Figure 27). The miscellaneous category in the chart below includes halogen bulbs and exit sign lighting of all types. With the highest proportion of T-12 lighting, restaurants and health care segments appear to be prime candidates for more efficient lighting. Large offices and educational buildings had the highest proportion of T8 lighting.

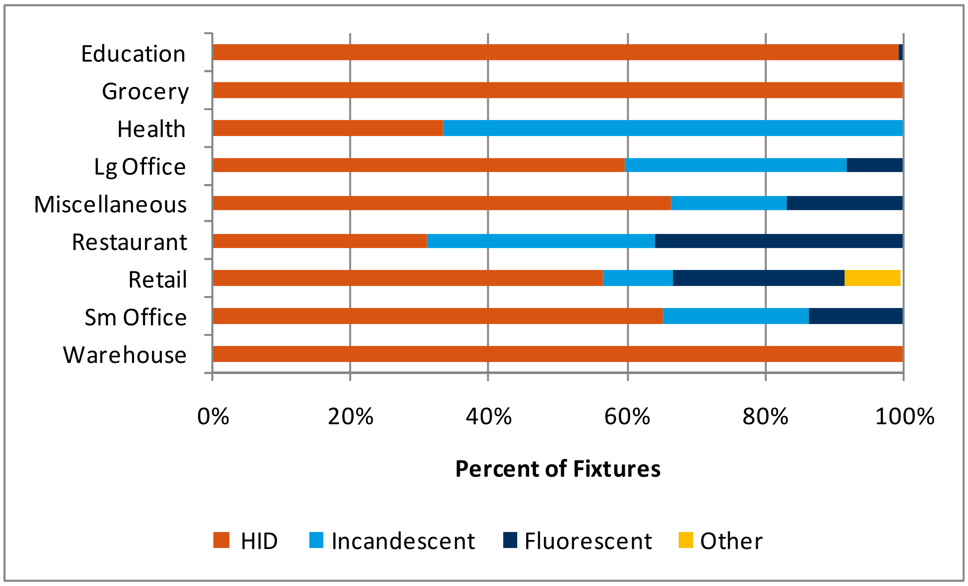
Figure 27. Indoor lighting by Segment



Outdoor Lighting

Figure 28 shows the distribution of outdoor lighting technologies across all segments. The grocery, warehouse, and education segments used High-Intensity Discharge (HID) lighting exclusively for outdoor lighting. Photocells were the most common outdoor lighting control type across all segments.

Figure 28. Outdoor Lighting Types by Segment



Industrial Sector

This study primarily relied on secondary regional and national data to characterize industrial customers' energy consumption and efficiency practices- primarily the Energy Information Administration's (EIA's) Manufacturing Energy Consumption Survey (MECS) and the Department of Energy's Industrial Assessment Center database. Applying this information to data on industrial customers from AIU's non-residential customer database allowed for characterization of base year sales by segment (industry) and end use category.

Figure 29 and Figure 30 show the sales breakdown by segment for electric and natural gas industrial customers, respectively. The three main industries for both fuels are food processing, metals, and petroleum, though in different proportions.

Figure 29. Base Year Industrial Electric Consumption by Segment

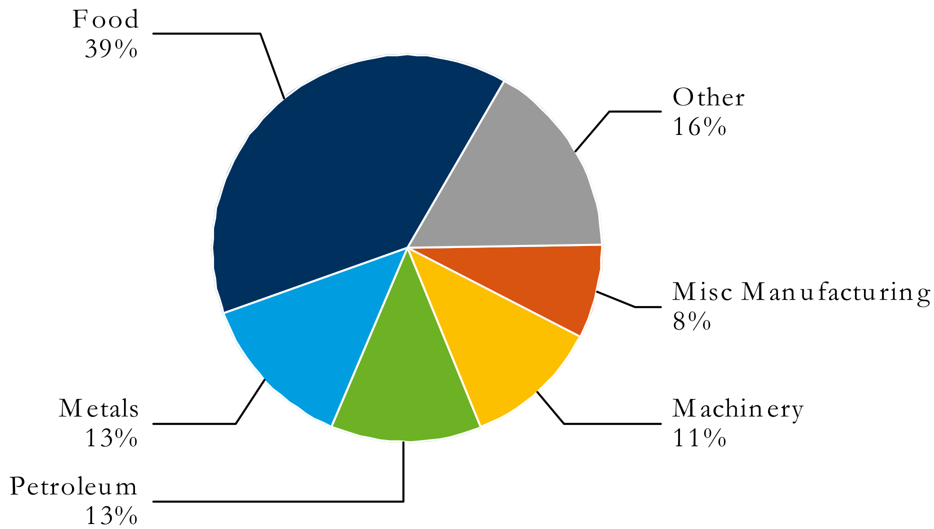
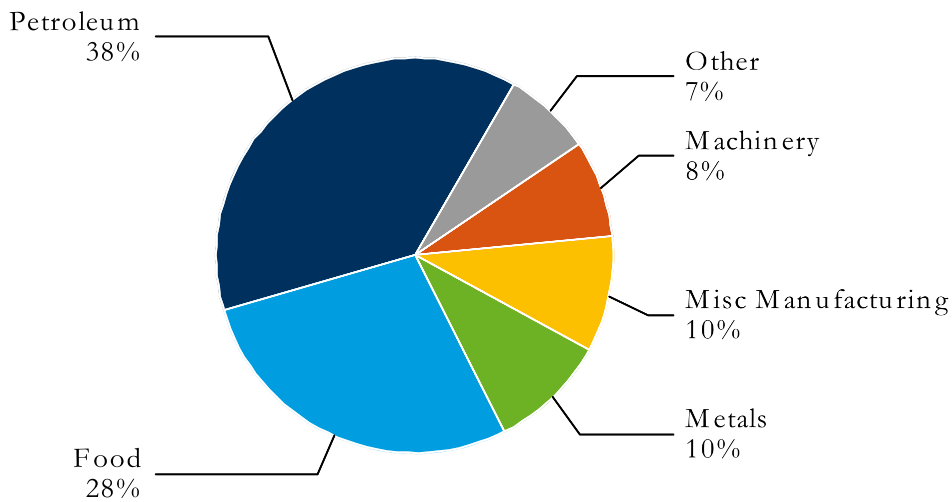


Figure 30. Base Year Industrial Natural Gas Consumption by Segment



Industrial energy consumption is largely due to industrial processes for both fuels (Figure 31 and Figure 32). Boilers also represent roughly a third of consumption for natural gas customers.

Figure 31. Base Year Industrial Electric Consumption by End Use

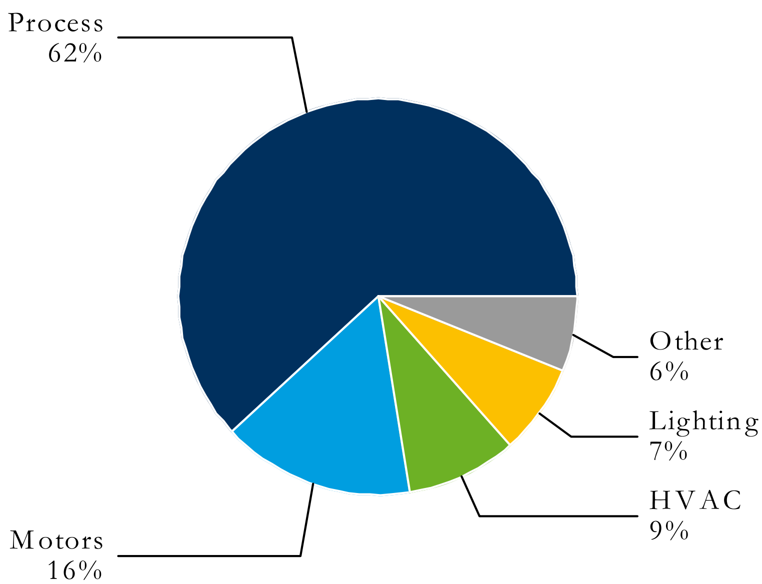
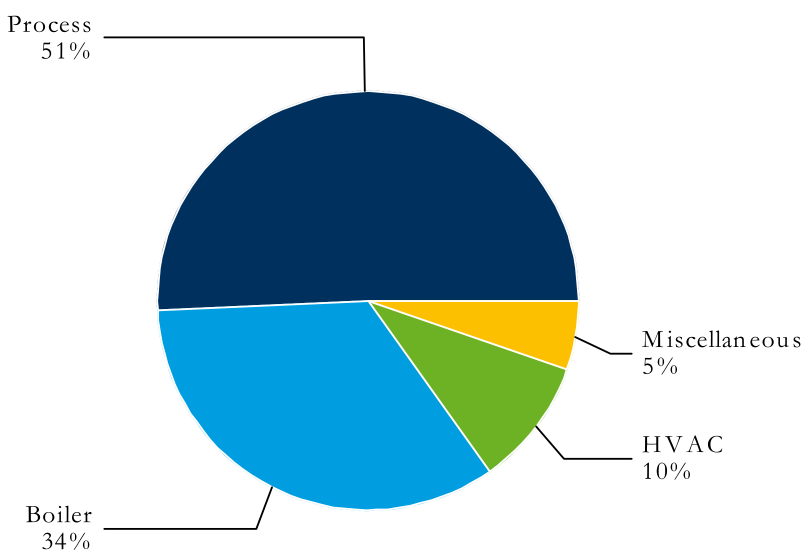


Figure 32. Base Year Industrial Natural Gas Consumption by End Use



Though this study relied primarily on secondary data, to understand possible differences between AIU's customers and regional or national averages, Cadmus visited a subset of customers targeted for their potential uniqueness and magnitude of load. Three customers were selected, and are discussed below: a large food processing firm; a manufacturer of infrastructure machinery; and a company cryogenically separating atmospheric gases for industrial use.

The industrial gas company was a large purchaser of electrical energy, and actively utilized the AIU "Act on Energy" program. They had just finished a piping insulation project, and were very happy with the results. They were anxious to use this program and any others that might become available from AIU. Except for one area (air compressors), future potential energy conservation projects could be inferred from typical measures for this type of company. Their electrical utility bill averaged $2,000,000 per month, and 70% of this usage was compressed air. They had 14,000 horsepower in multi-stage compressors housed in four-story machinery rooms. Future energy conservation potential would be heavily weighted toward air compressors and all accessory equipment, such as coolers, controls, and dryers. They also were interested in discussing what they termed “Spinning Reserves” with AIU, which may remove up to 8 megawatts from the system in a very short period of time.

The machinery company would be considered a classical manufacturing company, producing large rolling stock type equipment. Its future potential for energy conservation projects would fall in a typical mix of industrial projects relating to “assembly-line” type companies. This company would also be considered progressive in terms of corporate emphasis on energy management. Its corporate goals included a 20% energy-efficiency improvement and a 25% reduction of greenhouse gas emissions by 2020. In addition, the company’s goal was to increase to 75% renewable energy (wind, solar, etc.) by 2020. This company’s corporate headquarters were located in AIU service territory, and projects considered commercial in nature should be considered in the future.

The food processing company was one of the largest food companies (if not the largest) in the world. We met with the corporate electrical energy manager, and he emphasized typical industrial metrics for energy conservation projects were not applicable to their main manufacturing plant or any of their other plants. Consequently, the company had moved from a “Capital Project” approach to a “Management Behavior” approach to energy improvement, plant to plant. Each division had a “Division Energy Champion” meeting quarterly in an “Energy Working Group.” This group was responsible for promoting and emphasizing the company’s “Energy Policy” and “Energy Plan” in their respective divisions.

The main manufacturing plant purchased 130 GWh per month, and generated another 130 GWh by burning coal. We discovered they had 80 megawatts of compressed air and chillers, which would be potential project targets. This company plans to add 10 to 20 megawatts of load for producing Glycol from corn oil, a new process developed by its chemical engineering scientists. The corporate headquarters was very large, and could offer commercial building energy conservation opportunities similar to those of the machinery manufacturing company.

3. Technical and Economic Potentials

Scope of Analysis

This assessment's primary objective was to develop reasonable estimates of available energy-efficiency potential for use in AIU's program planning efforts. To support these efforts, Cadmus performed an in-depth assessment of technical, economic, and achievable potential for electric and natural gas resources in the residential, commercial, and industrial sectors.

Within each sector, the study distinguished between customer segments or facility types and their respective, applicable end uses. Segments analyzed included: six residential segments (existing and new construction for single-family, multifamily, and manufactured homes); 24 commercial segments (existing and new construction for 12 building types): and 11 industrial segments (10 specific facility types and a miscellaneous segment).

This section presents high-level technical and economic potential by fuel, followed by more detailed results for each fuel and sector combination. Further detail on the distribution of potential by fuel, sector, segment, and end use is provided in Appendix E.

Summary of Resource Potential—Electric

Table 13 shows baseline electric sales and potential forecast by sector in 2016, the end of the seven-year planning horizon. Study results indicated 9,303 GWh of technically feasible, electric energy-efficiency potential will be available by 2016. This technical potential translates into an economic potential of 6,551 GWh. The commercial sector had the largest economic potential (2,530 GWh), followed by the residential sector (2,430 GWh), and the industrial sector (1,591 GWh). If all of this cost-effective potential was realized, it would amount to a 16% reduction in 2016 forecast retail sales, and more than offset load growth forecast from 2010 to 2016. The amount of this economic potential deemed achievable is presented in Section 0.

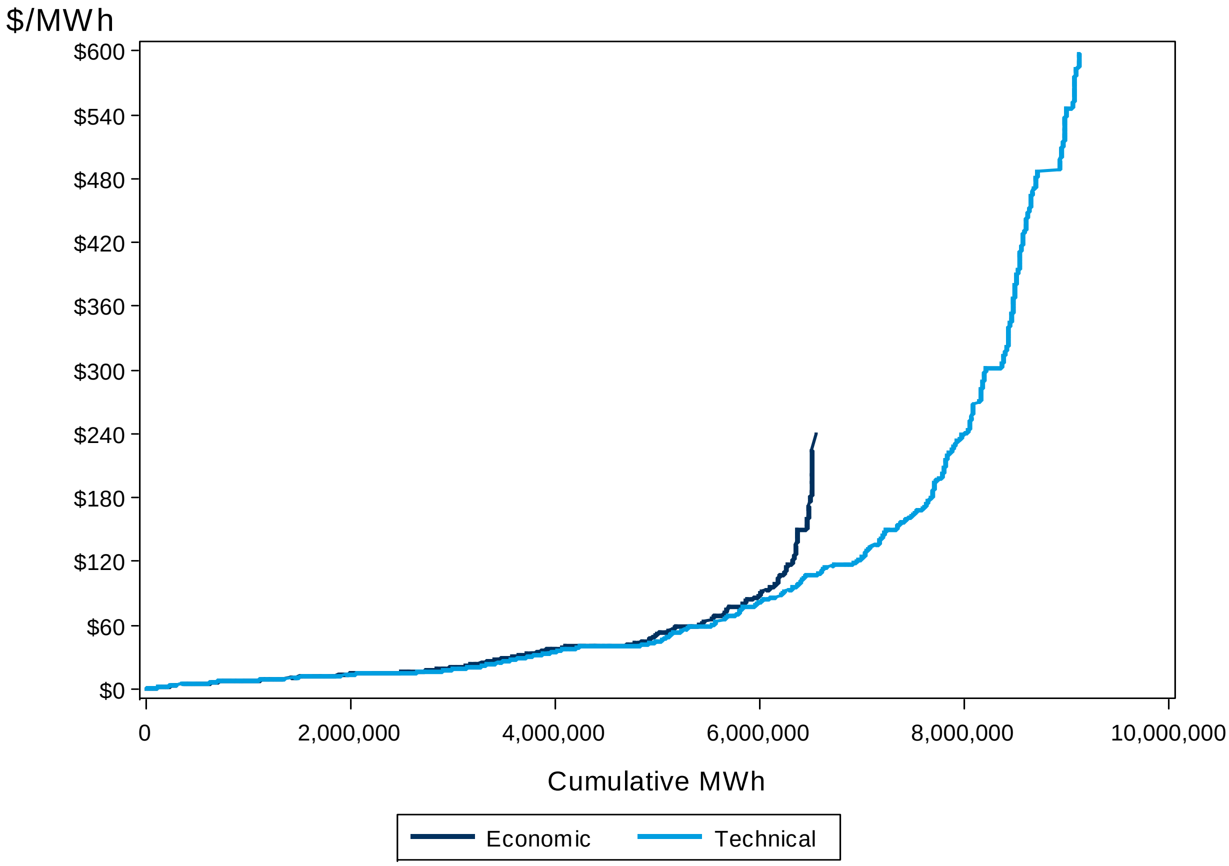
Table 13. Technical and Economic Electric Energy-Efficiency Potential in 2016 by Sector

Sector	Baseline 2016 Sales	Technical Potential (MWh)	Technical Potential as % of Baseline	Economic Potential (MWh)	Economic Potential as % of Baseline	Economic Potential (MW)	Average Levelized Measure Cost ($/kWh)
Residential	12,005,689	3,871,318	32%	2,429,693	20%	526	$0.05
Commercial	14,746,277	3,840,200	26%	2,530,294	17%	405	$0.04
Industrial	14,030,164	1,591,086	11%	1,591,086	11%	197	$0.01
Total	40,782,130	9,302,604	23%	6,551,073	16%	1,129	$0.04

Because the industrial sector uses a "top-down" approach based on cost-effective measures, estimates of technical and economic potential are identical.

Figure 33 presents a diagram of the efficiency supply curve. Economic potential includes all measures with a benefit-to-cost ratio of greater than or equal to 1.0. Due to the hourly variance of energy costs as well as the inclusion of capacity benefits in the economic screening, certain measures pass the cost-effectiveness screen even though their costs exceed the average levelized cost of energy alone.

Figure 33. Electric Energy-Efficiency Supply Curve



Summary of Resource Potential—Natural Gas

Table 14 shows baseline natural gas sales and potential forecast by sector in 2016, the end of the seven-year planning horizon. As shown, study results indicated 416 million therms of technically feasible, natural gas energy-efficiency potential will be available by 2016. This technical potential translates to an economic potential of 312 million therms. The residential sector represented the largest portion of economic potential (about 50%), followed by the industrial (37%) and commercial (13%) sectors. If all this cost-effective potential was realized, it would amount to an 20% reduction in 2016 forecast retail sales, and would more than offset forecasted load growth.

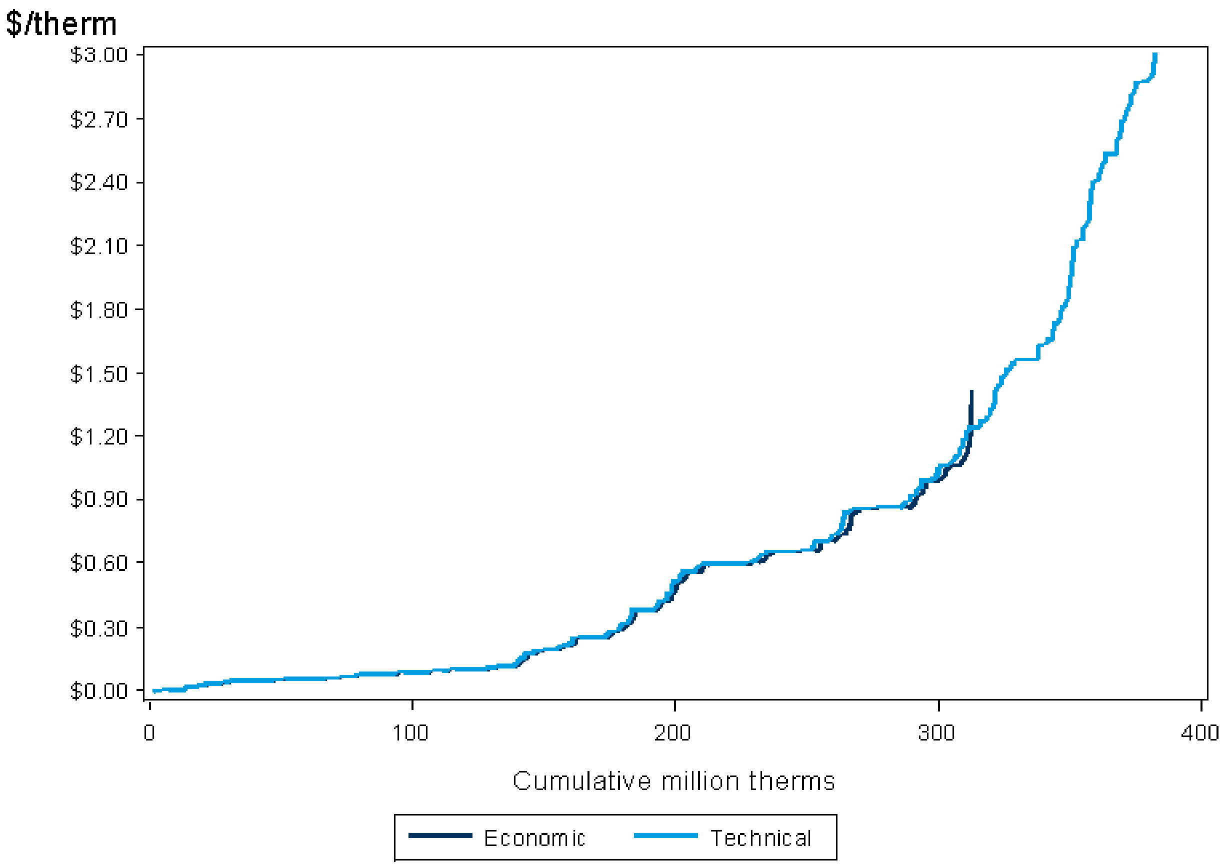
Table 14. Technical and Economic Natural Gas Energy-Efficiency Potential in 2016 by Sector

Sector	Baseline 2016 Sales	Technical Potential (therms)	Technical Potential as % of Baseline	Economic Potential (therms)	Economic Potential as % of Baseline	Average Levelized Measure Cost ($/therm)
Residential	567,406,647	207,360,263	37%	155,291,864	27%	$0.49
Commercial	270,157,950	91,837,062	34%	40,107,213	15%	$0.60
Industrial	732,369,238	116,830,571	16%	116,830,571	16%	$0.09
Total	1,569,933,835	416,027,896	26%	312,229,648	20%	$0.35

Because the industrial sector uses a "top-down" approach based on cost-effective measures, the estimates of technical and economic potential are identical.

Figure 34 presents a diagram of the efficiency supply curve. Economic potential includes all measures with a benefit-to-cost ratio of greater than or equal to 1.0.

Figure 34. Natural Gas Energy-Efficiency Supply Curve



Detailed Resource Potential

Residential Sector—Electric

The 1.1 million residential electric customers in AIU's service territory accounted for approximately 32% of baseline retail electricity sales in 2008. The single-family, multifamily, and manufactured dwellings comprising this sector presented a variety of potential savings sources, including: equipment efficiency upgrades (e.g., air conditioning, refrigerators); improvements to building shells (e.g., insulation, windows, air sealing); and increases in lighting efficiency (e.g., CFLs, LED interior lighting).

Electric economic potential in the residential sector was expected to be 2,430 GWh during the seven-year time horizon, corresponding to a 20% reduction of 2016 residential electricity consumption forecast at an average levelized cost of $0.05/kWh (Table 13).

As shown in Figure 35, single-family homes represented 87% of the total economic residential potential, followed by multifamily homes at 9%, and manufactured homes accounting for the remaining 4%. The main driver of these results was each home type's proportion of baseline sales, which were: 83% for single-family, 13% for multi-family, and 4% for manufactured homes. Other factors, however, such as the presence of cooling or the current CFL saturation, also played a role in determining potential.

Figure 35. Residential Sector Electric Economic Potential by Segment

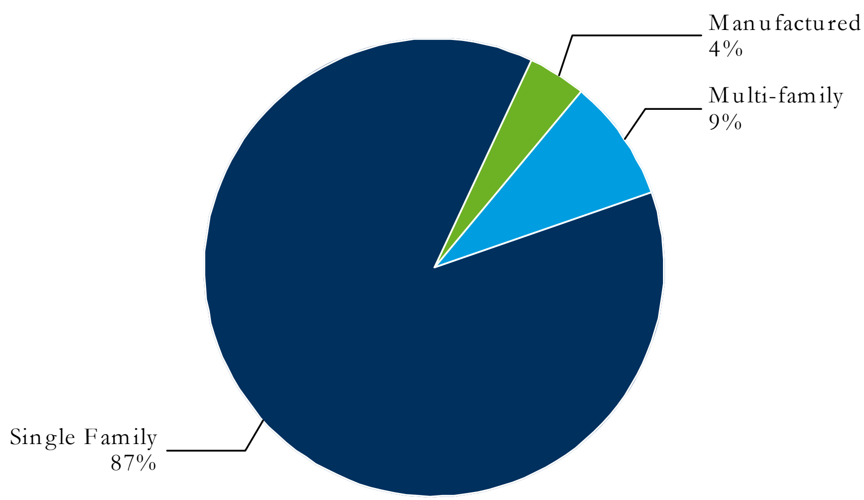


Figure 36 shows total economic potential by end-use group. Lighting represented the largest portion (30%) of economic potential, followed closely by cooling at 20%. Space heating and appliances (refrigerators, freezers, dryers, etc.) each represented approximately 14% of residential economic potential. Detailed sales and potentials by end use are presented in Table 15.

Figure 36. Residential Sector Electric Economic Potential by End Use

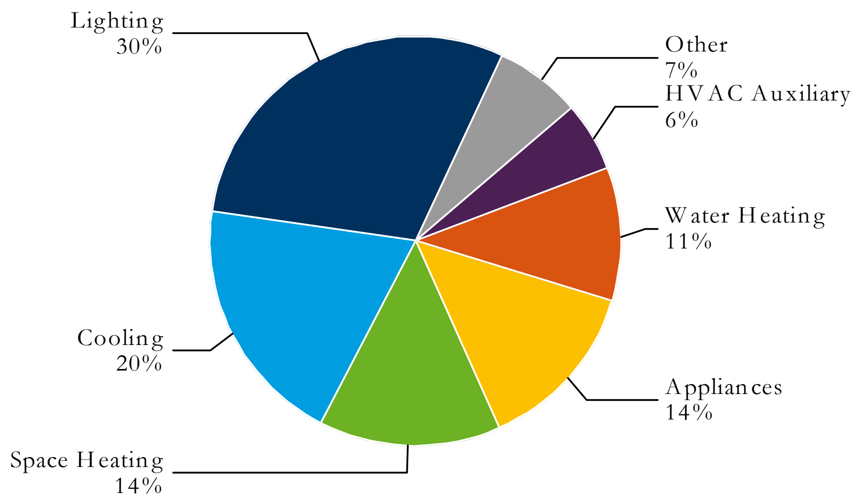


Table 15. Residential Sector Electric Energy-Efficiency Potential by End Use (MWh in 2016)

End Use	Baseline Sales	Technical Potential	Economic Potential
Central AC	1,628,747	1,071,020	451,207
Cooking	583,416	36,822	-
Dryer	517,268	35,701	12,588
Freezer	360,352	134,241	129,650
HVAC Auxiliary	618,212	173,015	133,806
Heat Pump	249,474	111,873	61,035
Lighting	1,598,189	819,980	719,846
Plug Loads	2,449,097	219,912	99,003
Pool Pump	111,249	3,962	3,962
Refrigerator	742,516	187,757	187,723
Room AC	157,167	75,298	28,260
Space Heating	1,994,355	693,993	346,982
Water Heat	995,645	307,744	255,629
Total	12,005,687	3,871,318	2,429,691

Figure 37 shows electric economic potential by vintage and measure type, grouped in the following manner:

- ***Existing retrofit*** represents retrofit opportunities in existing construction. Examples of measures in this group include: shell improvements (insulation, weather-stripping, etc.) and early equipment replacement. This potential is considered "discretionary" as it exists in existing building stock and is theoretically available for acquisition at any time during the study.

- ***Equipment replacement*** refers to efficiency upgrades during normal replacement of equipment in existing buildings. This includes efficient end-use equipment, such as central air conditioners and ENERGY STAR appliances. The availability of these resources is driven by equipment burnout rates, and, if the opportunity to upgrade is missed, it must wait until the new equipment burns out.

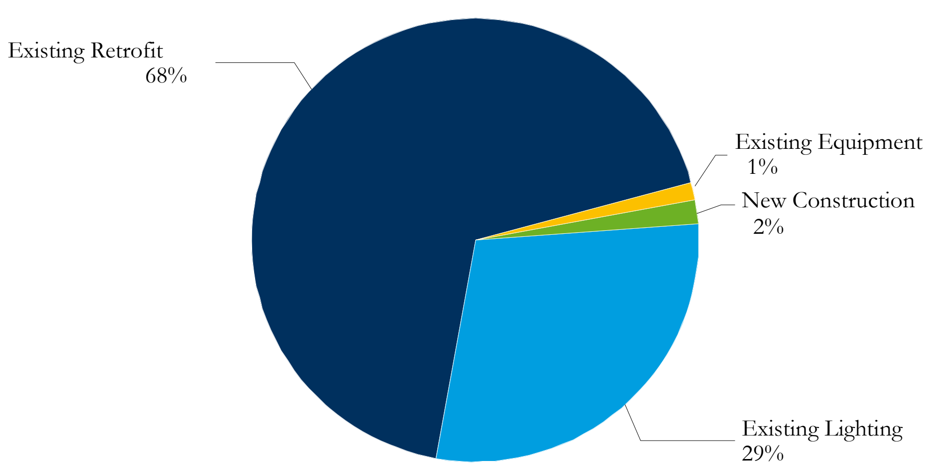
- ***Existing lighting*** depicts the portion of lighting savings in existing construction. This end use is broken out separately because it is essentially a hybrid of the above two categories. Some lighting will be replaced on burnout, like other equipment, but it can also be cost-effective as a retrofit, thus does not necessarily need to follow standard equipment decay patterns.

- ***New construction*** includes measures from the above two categories as they apply to new construction. For some retrofit measures, costs and savings will be different from existing construction due to differing baseline conditions (building code vs. existing conditions). The availability of this potential is driven by AIU's new construction forecast, and missed efficiency upgrades will typically need to wait until the installed technologies need to be replaced.

These distinctions are important in terms of timing resource availability and acquisition (discussed further in Section 0), as only certain portions of potential can be accelerated. Though program planning is outside the scope of this study, these considerations are vital for setting accurate annual program and portfolio goals.

Retrofits in existing construction accounted for the vast majority (68%) of economic potential, with lighting and equipment measures in existing construction representing 29% and 1% of economic potential, respectively. It is important to note existing lighting and retrofit savings were modeled to occur within the study's seven-year time horizon. Due to this study's relatively short time frame, new construction potential composed only 2% of the total economic potential.

Figure 37. Residential Sector Electric Economic Potential by Vintage and Resource Category



Residential Sector—Natural Gas

The 750,000 residential gas customers in AIU's service territory accounted for approximately 39% of baseline retail natural gas sales in 2008. The single-family, multifamily, and manufactured dwellings composing this sector presented a variety of potential savings sources, including equipment efficiency upgrades (e.g., space heating, water heating) and improvements to building shells (e.g., insulation, windows, air sealing).

Natural gas economic potential in the residential sector was expected to be 155 million therms during the seven-year planning horizon, corresponding to a 27% reduction of 2016 residential consumption forecast at an average levelized cost of $0.49/therm (Table 14).

As shown in Figure 38, single-family homes represented 91% of the total economic potential; multifamily homes accounted for 7%, and manufactured homes accounted for the remaining 2%. The main driver of these results was each home type's proportion of baseline sales, which were: 90% for single-family, 8% for multi-family, and 2% for manufactured homes.

Figure 38. Residential Sector Gas Economic Potential by Segment

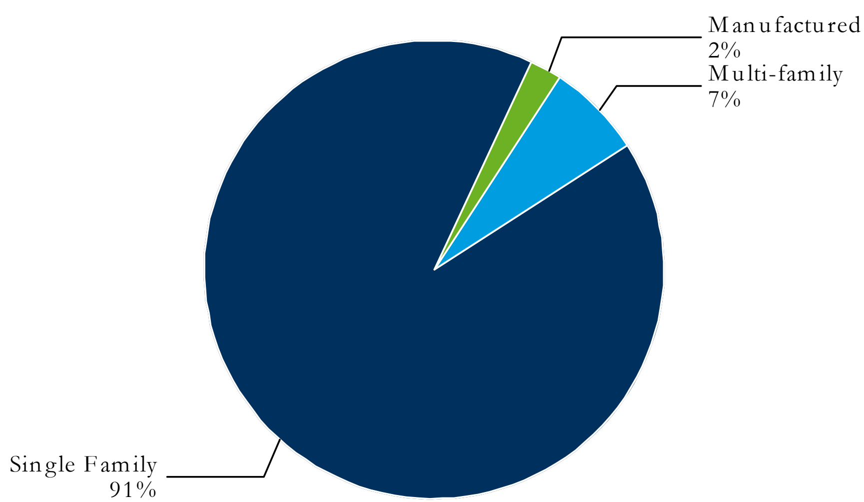


Figure 39 shows total economic potential by end-use group. Space heating represented the largest portion (86%) of economic potential, followed by water heating savings (14%). Dryers represented less than 1% of the residential economic potential, while none of the cooking or pool heating measures were deemed cost-effective. Table 16 presents detailed sales and potentials by end use.

Figure 39. Residential Sector Gas Economic Potential by End Use

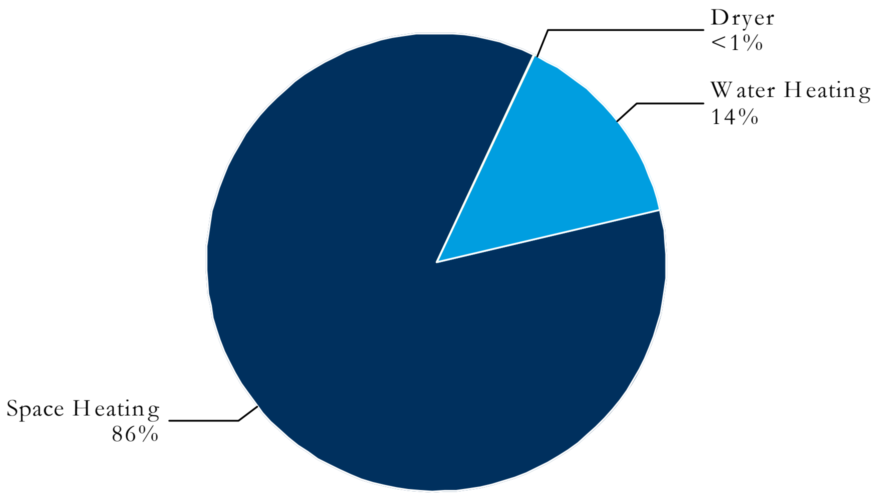
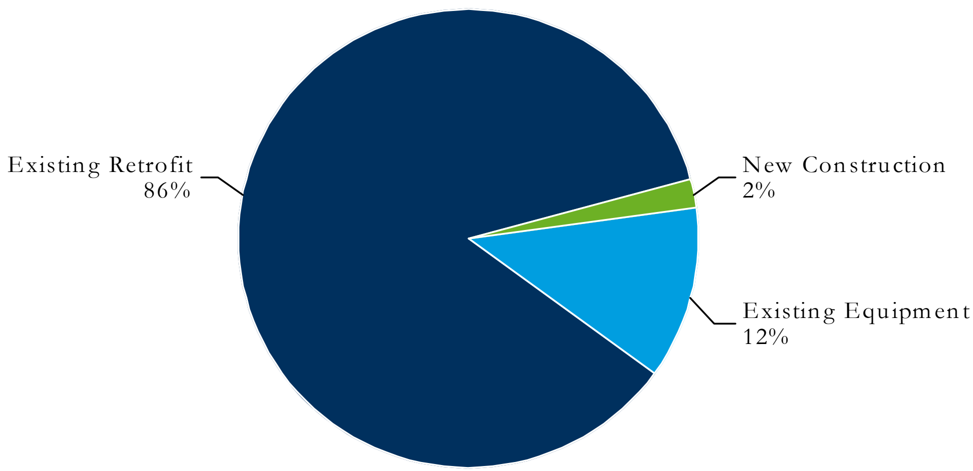


Table 16. Residential Sector Gas Energy-Efficiency Potential by End Use (therms in 2016)

End Use	Baseline Sales	Technical Potential	Economic Potential
Cooking	16,057,081	639,437	-
Dryer	6,700,998	1,163,334	141,499
Other	39,667,268	-	-
Pool Heating	1,548,427	48,444	-
Space Heating	411,105,383	173,866,670	132,926,574
Water Heat	92,327,490	31,642,377	22,223,791
Total	567,406,647	207,360,262	155,291,864

Figure 40 shows gas economic potential by vintage and measure type. The residential electric section, above, describes these categories.

Figure 40. Residential Sector Gas Economic Potential by Vintage and Resource Category

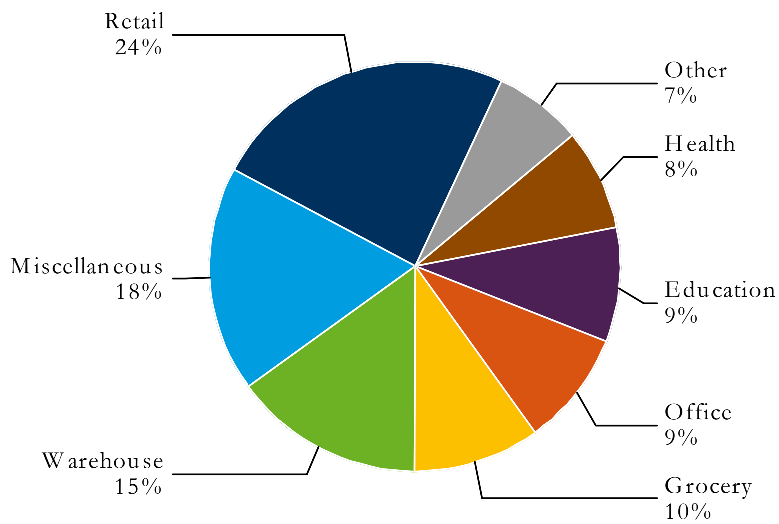


Commercial Sector—Electric

The 152,376 electric commercial customers in AIU's service territory accounted for approximately one-third (33%) of baseline electricity retail sales in 2008. Electric economic potential in the commercial sector was estimated to be 2,530 GWh during the seven-year time horizon, corresponding to a 17% reduction of commercial consumption forecast in 2016 at an average levelized cost of $0.04/kWh (Table 13).

Given the variety of business functions, operating hours, and building characteristics, the commercial segment was disaggregated into many more segments than the residential sector. As shown in Figure 41, retail and miscellaneous buildings represented the largest shares (24% and 18%, respectively) of economic potential in the commercial sector. The miscellaneous segment included customers not fitting into one of the other categories (e.g., public assembly), and those in the unclassified retail category. Considerable savings opportunities were also expected in the warehouse (15%) and grocery (10%) segments. Moderate savings were expected to be available in offices, education, health, restaurants, and lodging.

Figure 41. Commercial Sector Electric Economic Potential by Segment

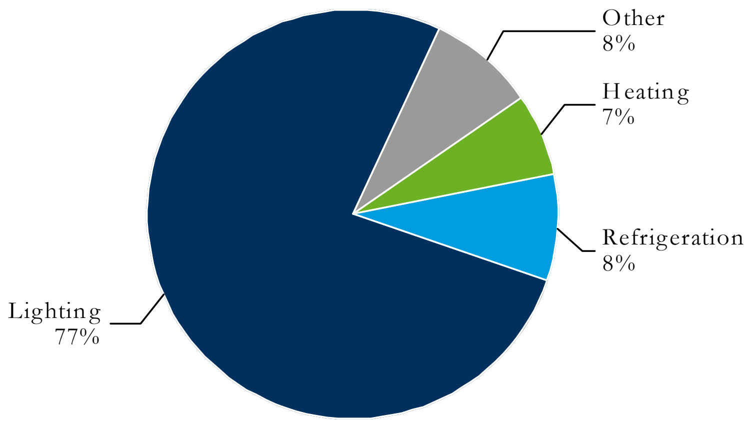


Lighting efficiency represented the vast majority of economic potential in the commercial sector (77%), followed by refrigeration (8%) and heating (7%), as shown in Table 17 and Figure 42. The large lighting potential included bringing existing buildings up to code and exceeding code in new and existing structures.

Table 17. Commercial Electric Energy-Efficiency Potential by End Use (MWh in 2016)

End Use	Baseline Sales	Technical Potential	Economic Potential
Cooking	67,679	6,383	4,696
Cooling Chillers	50,962	22,854	5,952
Cooling DX	816,841	344,601	53,798
HVAC Aux	1,497,696	121,112	28,247
Heat Pump	436,329	70,318	8,594
Lighting	7,255,756	2,543,346	1,940,656
Other	4,765	-	-
Plug Load	2,148,419	127,997	99,767
Refrigeration	892,949	252,728	211,919
Space Heat	1,200,593	319,279	165,753
Street Lighting	210,181	-	-
Water Heat	164,107	31,583	10,912
Total	14,746,277	3,840,200	2,530,294

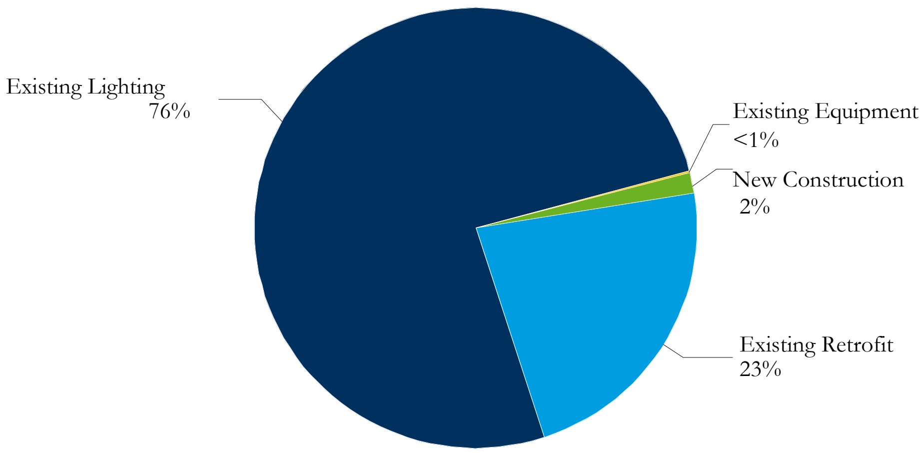
Figure 42. Commercial Sector Electric Economic Potential by End Use



Note: "Other" includes:
Plug Loads: 4%, Cooling: 2%, HVAC Auxiliary: 1%, Water Heating: <1%, Heat Pump: <1%, Cooking: <1%

Figure 43 shows electric economic potential by vintage (existing buildings vs. new construction) and resource type (equipment, retrofit, and lighting measures). As in the residential sector, most potential was found in lighting and retrofit measures in existing construction.

Figure 43. Commercial Electric Economic Potential by Vintage and Resource Category

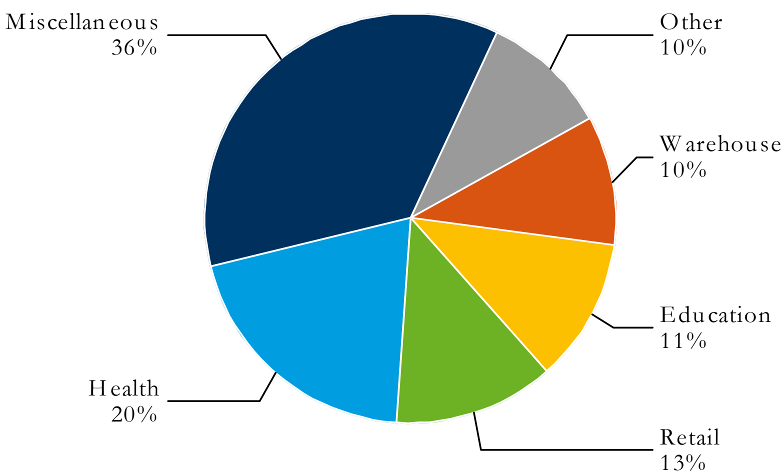


Commercial Sector—Natural Gas

The 68,190 commercial natural gas customers in AIU's service territory accounted for approximately one-sixth (16%) of baseline gas retail sales in 2008. Gas economic potential in the commercial sector was estimated to be roughly 40 million therms during the seven-year planning horizon, corresponding to a 9% reduction of commercial consumption forecast in 2016 at an average levelized cost of $0.60/therm (Table 14).

As shown in Figure 44, miscellaneous and health buildings represented the largest shares (36% and 20%, respectively) of gas economic potential in the commercial sector. Considerable savings opportunities were also expected in the retail (13%), education (11%), and warehouse (10%) segments. Moderate savings were expected to be available in restaurants, offices, lodging, and grocery stores.

Figure 44. Commercial Sector Gas Economic Potential by Segment



Note: "Other" includes:
Restaurant: 4%, Office: 3%, Lodging: 2%, Grocery: <1%

Space heating (both furnaces and boilers) efficiency represented the vast majority of gas economic potential in the commercial sector (77%), followed by water heating (22%), as shown in Table 18 and Figure 45.

Table 18. Commercial Sector Gas Energy-Efficiency Potential by End Use (therms in 2016)

End Use	Baseline Sales	Technical Potential	Economic Potential
Cooking	16,794,091	1,306,680	499,795
Pool Heat	953,547	184,476	158,527
Space Heat Boiler	75,613,065	24,951,191	8,124,343
Space Heat Furnace	153,025,888	53,389,185	22,772,639
Water Heat	23,771,359	12,474,063	8,743,756
Total	270,157,950	92,305,595	40,299,061

Figure 45. Commercial Sector Gas Economic Potential by End Use

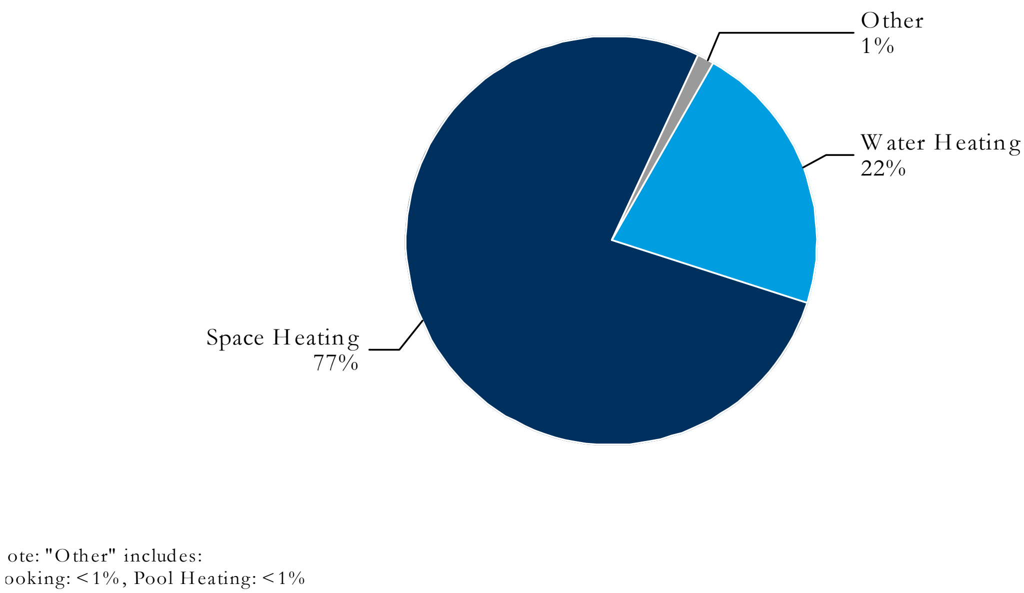
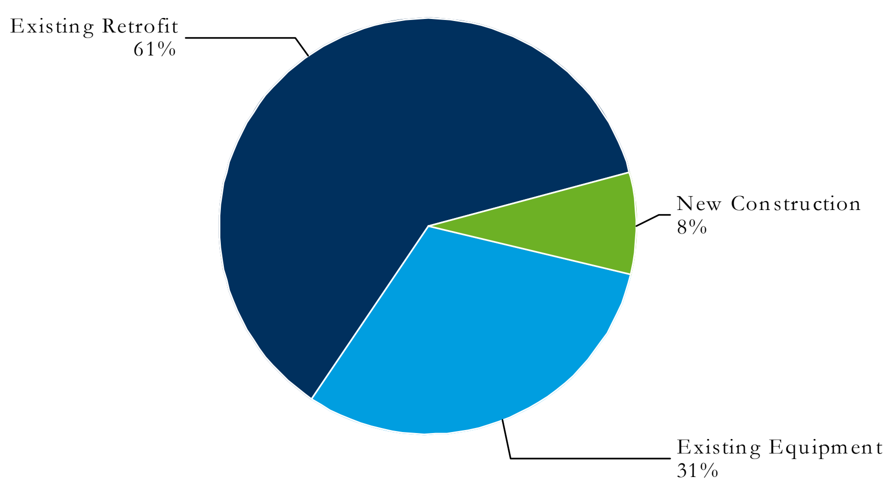


Figure 46 shows gas economic potential by vintage and resource type. While the majority of gas economic potential (61%) was from existing retrofit (discretionary) measures; equipment replacement accounted for 31% of the potential, and new construction represented about 8%.

Figure 46. Commercial Sector Economic Potential by Vintage and Resource Category

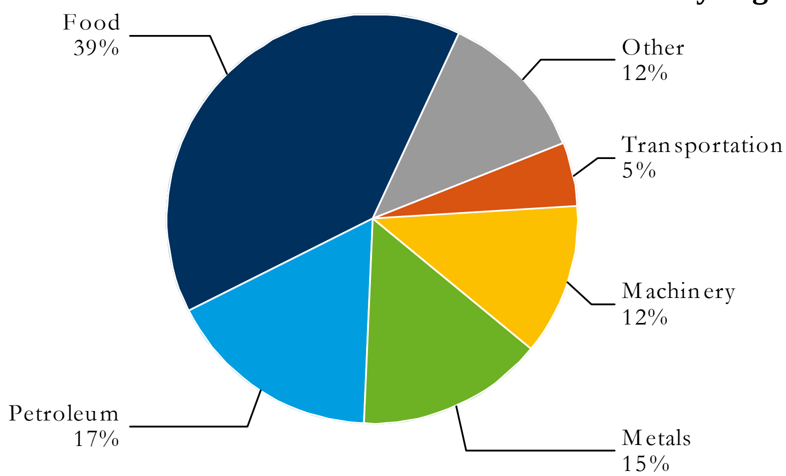


Industrial Sector—Electric

The 1,248 electric industrial customers in AIU's service territory accounted for approximately 34% of baseline retail electricity sales in 2008. Electric economic potential in the industrial sector was estimated to be 1,591 GWh over the seven-year planning horizon, corresponding to an 11% reduction in 2016 industrial consumption forecast at an average levelized cost of $0.01/kWh (Table 13).

Technical and economic energy-efficiency potentials were estimated for major end uses in the 10 major industrial segments in AIU's service territory. The largest portion of the electric economic potential was attributed to food processing (39%), followed by petroleum (17%) and metals (15%), as shown in Figure 47.

Figure 47. Industrial Sector Electric Economic Potential by Segment

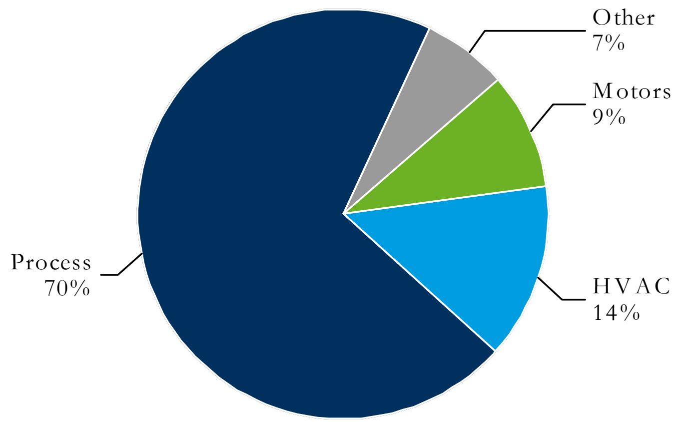


Note: "Other" includes:
Other Industrial: 4%, Plastic/Rubber: 4%, Minerals: 2%, Paper: 1%, Mining: <1%

The majority of electric economic potentials in the industrial sector (70%) was attributable to gains in process efficiency (heating, cooling, compressed air, etc.), followed by HVAC improvements (14%). Motors and lighting accounted for another 9% and 5% of economic potential, respectively. Figure 48 shows the allocation of economic potential by end use. Table 19 presents baseline energy usage by end use in MWh, and the corresponding technical and economic potential for each end use type.

Note all estimated technical potential in the industrial sector was considered economic. Because of the sector's tight cost margins, available measure data focused on technologies currently cost-effective. As such, the universe of available measures examined was smaller than that of other sectors, possibly influencing the technical potential downward.

Figure 48. Industrial Sector Electric Economic Potential by End Use



Note: "Other" includes:
Lighting: 5%, Miscellaneous: 2%, Boiler: <1%

Table 19. Industrial Sector Electric Energy-Efficiency Potential by End Use (MWh in 2016)

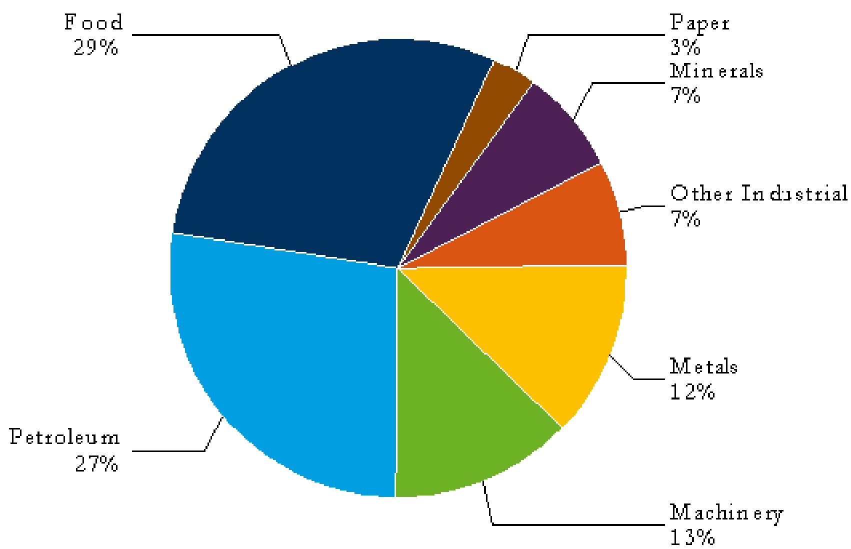
End Use	Baseline Sales	Technical Potential	Economic Potential
Fans	820,169	53,569	53,569
HVAC	1,259,425	220,561	220,561
Indirect Boiler	13,745	1,191	1,191
Lighting	1,034,345	72,254	72,254
Motors - Other	3,317,979	184,735	184,735
Other	834,044	33,005	33,005
Process - Air Compressors	871,045	252,291	252,291
Process - Cool	1,699,749	210,342	210,342
Process - Electro-Chemical	499,544	0	0
Process - Heat	1,214,429	271,912	271,912
Process - Other	48,472	7,564	7,564
Process - Refrigeration	1,029,254	191,421	191,421
Pumps	1,387,963	92,241	92,241
Total	14,030,164	1,591,086	1,591,086

Industrial Sector—Natural Gas

The 982 industrial gas customers in AIU's service territory accounted for approximately 45% of baseline retail gas sales in 2008. Gas economic potential in the industrial sector was estimated to be 117 million therms over the seven-year planning horizon, corresponding to a 16% reduction in 2016 industrial consumption forecast at an average levelized cost of $0.09/therm (Table 14).

As shown in Figure 49, food processing represented the largest share (29%) of gas economic potential in the industrial sector, followed by petroleum and coal products (27%), machinery manufacturing (13%) and metals (12%).

Figure 49. Industrial Sector Gas Economic Potential by Segment



The majority of gas economic potential in the industrial sector (59%) was attributable to gains in process efficiency (primarily heating), followed by boiler improvements (27%). HVAC improvements accounted for the remaining 14% of economic potential. Figure 50 shows the allocation of economic potential by end use. Table 20 presents baseline energy usage by end use in therms and the corresponding economic potential for each end-use type. Note all estimated technical potential in the industrial sector was considered economic. Because of the sector's tight cost margins, available measure data focused on technologies currently cost-effective. As such, the universe of available measures examined was smaller than that of the other sectors, possibly influencing the technical potential downward.

Figure 50. Industrial Sector Gas Economic Potential by End Use

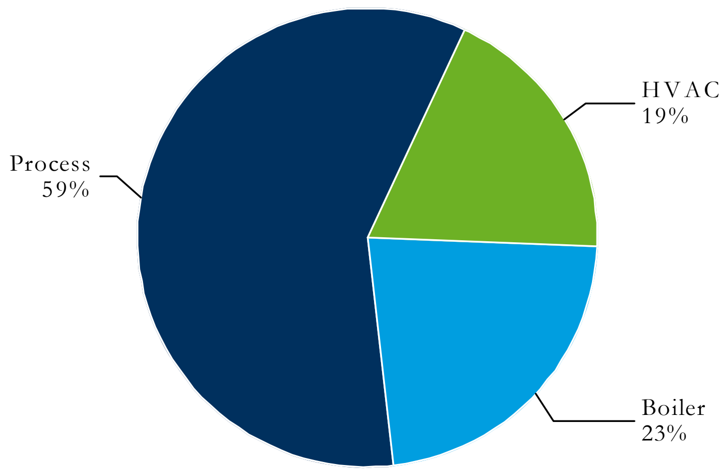


Table 20. Industrial Sector Gas Energy-Efficiency Potential by End Use (therms in 2016)

End Use	Baseline Sales	Technical Potential	Economic Potential
HVAC	72,554,340	15,860,497	15,860,497
Indirect Boiler	249,698,264	31,933,340	31,933,340
Other	38,804,432	0	0
Process Heat	368,331,189	68,956,357	68,956,357
Process Other	2,981,014	80,377	80,377
Total	732,369,238	116,830,571	116,830,571

4. Achievable Energy Efficiency Potentials

In this study, "achievable" (or "program") potential is defined as the portion of economic potential that can be targeted and acquired through AIU energy-efficiency programs. Therefore, we measure and express achievable potential as a fraction (%) of economic potential. While estimating technical and economic potentials are essentially engineering and mathematical endeavors, based on industry-standard practices and methodologies, achievable potential is more difficult to quantify and reliably predict as it depends on a large number of factors, which tend to change unpredictably over time.

A number of factors account for the gap between economic and achievable potential, including: customer awareness; perceptions of energy efficiency's value; and energy-efficiency measures' first cost. The utility can mitigate some of these market barriers through program design and delivery processes, while others are out of a utility's reach. For example, a utility can reduce first-cost barriers by providing financial incentives to lower front costs and improve customer payback. However, since utility incentives only cover the incremental cost for most measures, incentives may not be sufficient to motivate a customer to adopt energy-efficiency measures. This is particularly true for the commercial sector and large equipment in the residential sector, where front costs tend to be high. Thus, the task becomes one of assessing which barriers AIU can overcome over the course of the planning horizon, and how much economic potential can be deemed reasonably achievable.

Often, the best indicators of future achievements are past accomplishments. However, because AIU programs are relatively young, this study had to rely on benchmarking against the assumptions of other utilities' potential studies and what they have been able to accomplish. Consequently, this analysis began by compiling a library of studies from across the U.S.

Although studies of energy-efficiency potentials have largely used similar methods for estimating technical and economic potentials, less agreement exists on how to estimate achievable potential. Differences in the length of the planning period, the assumed incentive levels, types of measures deemed cost-effective, and the utility's historic conservation accomplishments can make it difficult to compare results across different studies. Moreover, some estimates of achievability factor in effects of market transformation and/or improvements in codes and standards, which tend to overstate what can be realistically achieved through utility-sponsored programs. Despite these differences, these studies provide upper and lower bounds on likely achievable potential, and can be used to estimate a reasonable range for AIU's planning purposes.

Cadmus conducted an independent review of 60 electric potential studies, covering 40 states, plus four national studies.[2] As technical and economic can vary greatly based on utility service area characteristics and economic assumptions, the key metric analyzed was the percentage of economic potential deemed achievable. As expected, this percentage greatly varied across these studies, from an average of 40% on the low end to around 80% on the high end. While these

[2] The full bibliography of studies is included in Appendix F.

studies represent a wide cross-section of utilities and regions, there are a number of caveats that should be considered in applying these numbers to an individual utility:

- ***Age of study.*** All of these studies were conducted between 2000 and 2009, and thus reflect different levels of codes and standards and measure saturations. For example, only recent studies may have taken into account the new lighting standards in EISA, which would tend to inflate the estimates in the earlier studies.
- ***Location.*** Because these studies are taken from across the country, they reflect a range of climate, demographics, and energy prices.
- ***Length of study.*** These studies typically assess potential over a ten or twenty year time horizon. As such, these estimates will be aggressive when applied to this study's seven-year planning horizon.
- ***Historic DSM accomplishments.*** These studies vary greatly in terms of the number of years utilities had been running programs at the time of the study. This can have a large effect on customer awareness, participation levels, and the saturation of measures, particularly low-cost options.

Additionally, energy-efficiency potentials studies rely on the best data available at a given time, and the amount of identified potential is subject to change over the planning horizon. Factors that could cause these changes generally fall into two categories:

- ***Changes in utility forecast data.*** These include forecasts of customers and sales as well as energy and capacity costs. Changes in the former two will affect the amount of technical potential available, as a portion of this potential is driven by customer and load growth. Changes in avoided costs (e.g., due to the future effects of carbon taxes) will affect the economic potential.

- ***Changes in measure assumptions and baselines.*** In this study, measure savings are based on current practices, codes, and standards, with costs based on current market conditions. Over time, measure costs may change, emerging technologies may become commercially available, and/or codes and standards may change. Changes in assumptions will affect one or more of the potential types described in this report.

Due to these uncertainties, and given the wide range of achievability estimates from national potential studies, it is appropriate to think about achievable potential as a range rather than a point estimate. The numbers presented above indicate this available electric potential can be reasonably expected to fall between roughly 40% and 80%, with a 60% midpoint as the medium achievable potential.

Table 21 shows electric achievable potential under each of these assumptions. Although different market barriers in each sector may lead to differences in achievability, for this analysis, percentages found through the benchmarking exercise have been applied across all sectors.

Table 21. Low, Medium, and High Electric Achievable Potential by Sector (Cumulative in 2016)

		Low Achievable Potential (40% of EP)		Medium Achievable Potential (60% of EP)		High Achievable Potential (80% of EP)	
Sector	Baseline 2016 Sales	MWh	% of Baseline	MWh	% of Baseline	MWh	% of Baseline
Residential	12,005,689	971,877	8%	1,457,816	12%	1,943,754	16%
Commercial	14,746,277	1,012,118	7%	1,518,176	10%	2,024,235	14%
Industrial	14,030,164	636,434	4%	954,652	7%	1,272,869	9%
Total	40,782,130	2,620,429	6%	3,930,644	10%	5,240,858	13%

While many sources are available to inform electric achievable potential, information on natural gas achievability is not as readily available or reliable. Far fewer potential studies have been conducted for natural gas, and program accomplishments are not reported consistently. There is, however, evidence that natural gas potential will be more difficult to achieve. This is primarily due to equipment's relatively high upfront costs and lack of many low-cost measures (such as CFLs). For this study, it is assumed the range of achievable potential will likely fall between 30% and 70%, with a midpoint of 50% of economic potential (Table 22).

Table 22. Low, Medium, and High Natural Gas Achievable Potential by Sector (Cumulative in 2016)

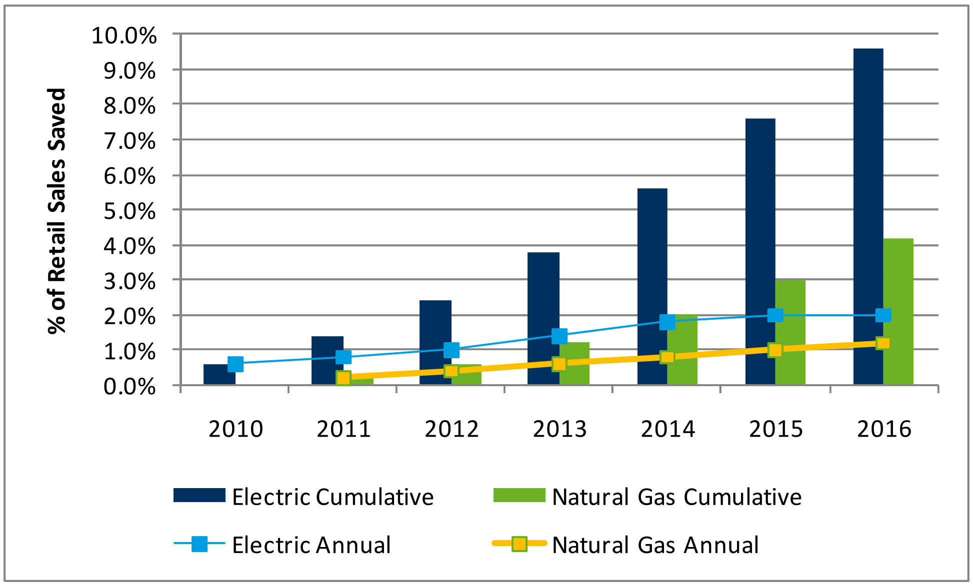
		Low Achievable Potential (30% of EP)		Medium Achievable Potential (50% of EP)		High Achievable Potential (70% of EP)	
Sector	Baseline 2016 Sales	therms	% of Baseline	therms	% of Baseline	therms	% of Baseline
Residential	567,406,647	46,587,559	8%	77,645,932	14%	108,704,305	19%
Commercial	270,157,950	12,032,164	5%	20,053,607	8%	28,075,049	11%
Industrial	732,369,238	35,049,171	5%	58,415,286	8%	81,781,400	11%
Total	1,569,933,835	93,668,894	6%	156,114,824	10%	218,560,754	14%

Efficiency Potential in the Context of Future Efficiency Goals

In June 2009, the Illinois Legislature passed Public Act 96-0033 (the Act), which sets annual conservation targets for electric and natural gas utilities, beginning in 2010. These targets are defined in terms of the percent of retail sales saved, and are accompanied by program spending caps in terms of percent of utility revenue. Figure 51 shows annual (lines) and cumulative (bars) targets as a percent of 2006 (year ending May 31, 2007) electric and natural gas retail sales.[3] As shown, in 2016, utilities are required to save 2% of electric sales and 1.2% of natural gas sales. Additionally, by the end of the 2016 program year (May 31, 2017), cumulative effects of electric and natural gas programs are required to be 9.6% and 4.2% of 2006 sales, respectively.

In addition to mandating energy-efficiency targets, the Act prescribes maximum amounts to be spent in acquiring these savings as a percentage of the amount customers paid per kWh or therm in 2006.[4] For electric programs, spending limits start at 1.5% of customer cost in 2010, then are 2% thereafter. This means allowed spending roughly levels off after 2011, while savings goals continue to increase. Based on AIU sales and revenue forecasts, this means costs are capped at $0.18 per first-year kWh saved in 2010, decreasing to $0.08 in 2016 (an average of $0.10 over the study horizon, as shown in Figure 52).

Figure 51. Annual and Cumulative Legislative Targets



3 The targets have an either/or clause relating to 2006 (year ending May 31, 2007) sales or growth from the previous year. To simplify the analysis, this study assumes all targets are relative to 2006 sales.

4 The spending limits have an either/or clause relating to 2006 (year ending May 31, 2007) sales or growth from the previous year. To simplify the analysis, this study assumes all targets are relative to 2006 sales.

Figure 52. Annual Electric Savings Targets and Spending Limits

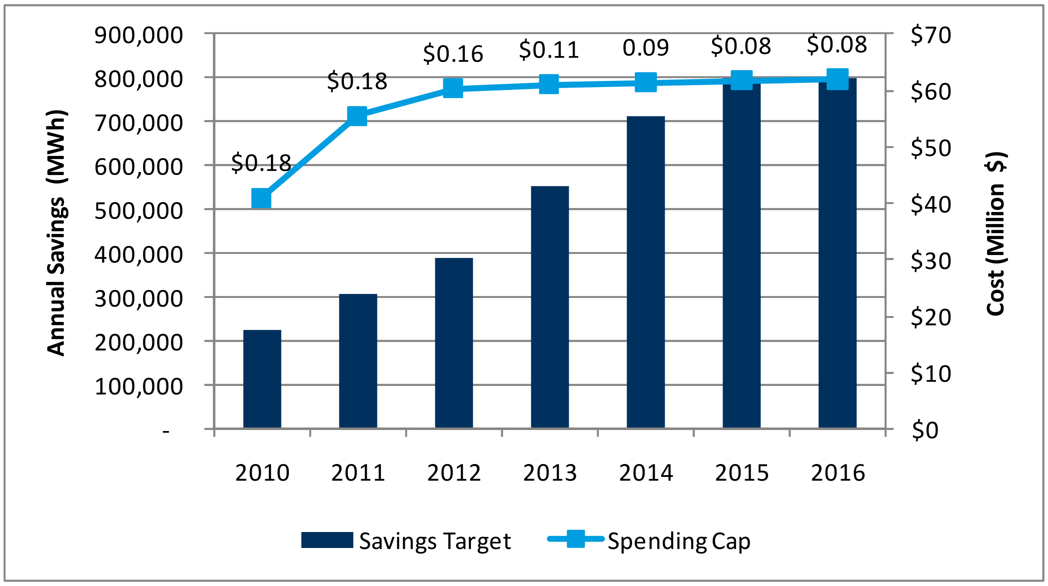
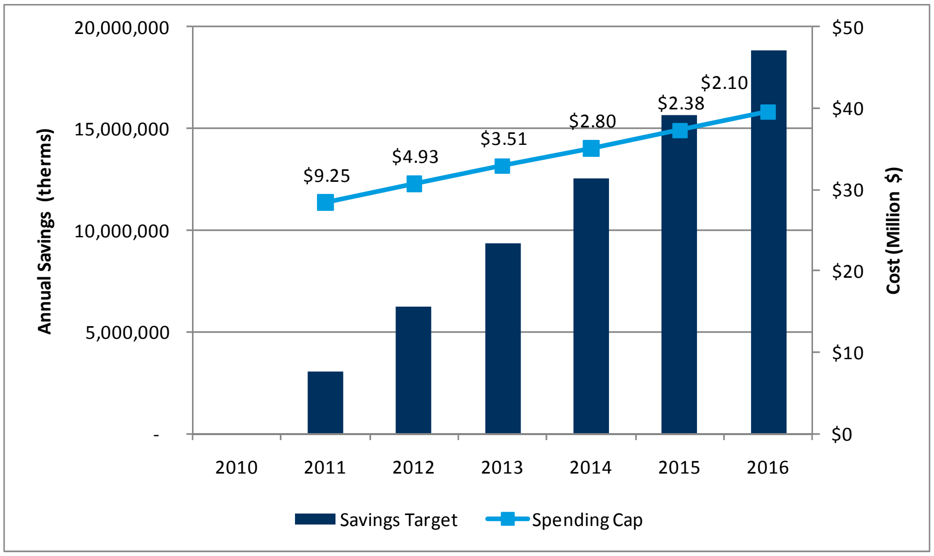


Figure 53 shows the savings targets and spending caps for natural gas, based on AIU sales and revenue forecasts. Though the legislation allows large customers to file for an exemption from these programs, these numbers are calculated assuming no large customers opt out of AIU programs. An analysis of the effects of large customers opting out is presented later in this section.

Figure 53. Annual Natural Gas Savings Targets and Spending Limits

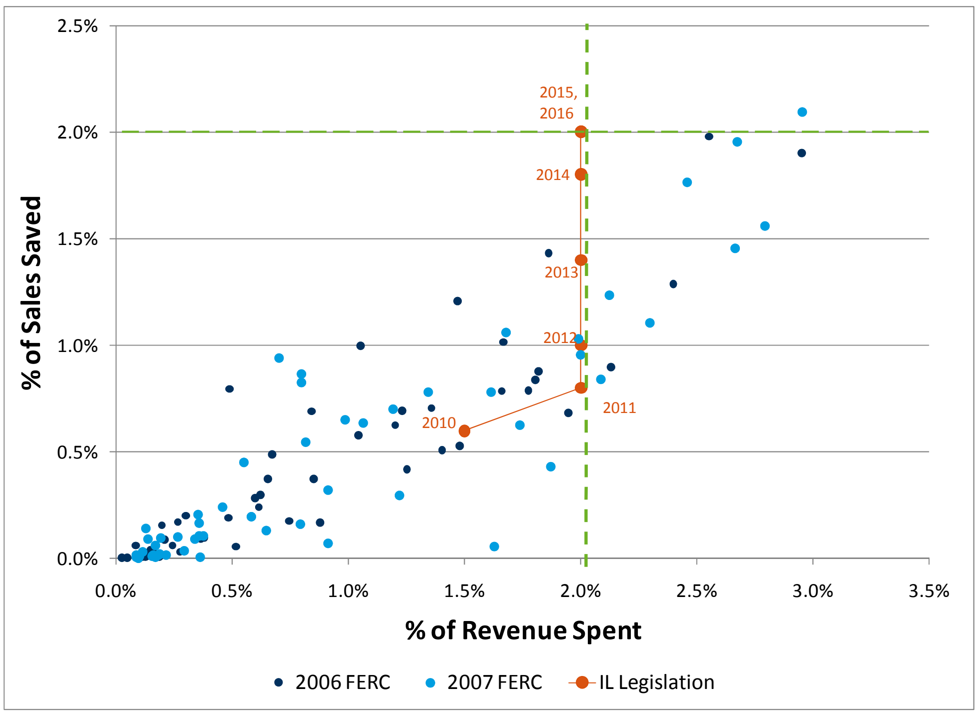


Benchmarking of Saving Targets and Allowed Expenditures

To provide a better perspective on the magnitude of saving targets and budget caps set by the Act, it is instructive to compare these targets against recent utility achievements and expenditures, available from FERC Form 861 in 2006 and 2007.[5]

Figure 54 shows the analysis results, with savings plotted (in terms of percent of retails sales saved) as a function of costs required to acquire these savings (in terms of the percent of revenues spent).[6] The dark and light blue dots represent reported utility achievements for 2006 and 2007, respectively, while the orange dots represent the Illinois legislative requirements from 2010 to 2016. The graph clearly shows a trend that increasing savings requires increased spending. As shown in 2006 and 2007, few utilities reported savings near 2% of retail sales, and those that did spent between 2.5% and 3.0% of revenues.

Figure 54. FERC Data Compared to IL Legislative Requirements—% Revenue vs. % Sales



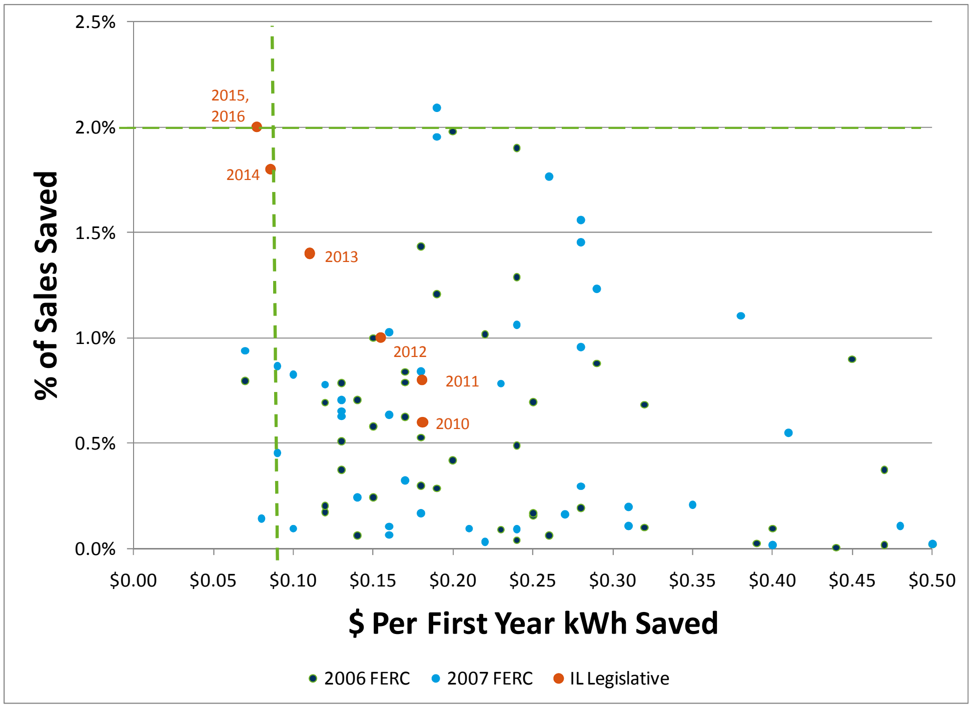
Another way to benchmark against other utilities' experience is to examine how much utilities spend per kWh to acquire these resources. These values can vary greatly based on program design and included measures. For example, a program composed mostly of CFLs will likely have a very low cost, while programs paying incentives for large equipment and less cost-effective measures may have a higher cost. Figure 55 shows this percentage of sales saved as a

[5] Investor-owned utility reporting on sales, revenues, and energy efficiency activity on Federal Energy Regulatory Commission (FERC) form 861, available through the Energy Information Administration (EIA). Data were compiled for 2006 and 2007, the two most recent years available.

[6] Due to inconsistency in utility reporting, outliers have been removed.

function of this cost, with Illinois legislative requirements included in orange.[7] Green lines represent required savings in the final years (2%) and the average allowed cost over the study's horizon ($0.10). The graph shows that for these two years, utilities approaching 2% savings tend to spend between $0.20 and $0.30 per kWh, which is well above the Illinois limits, particularly by 2016.

Figure 55. FERC Data Compared to IL Legislative Requirements—$/kWh vs. % Sales



While FERC represents the best source for these data, as noted, inconsistencies occur in utility reporting, and this analysis should be viewed as illustrative rather than as statistical evidence of the point. Additionally, because these data are from utilities across the country, it must be carefully applied to local conditions. That said, the data indicate spending caps currently included in the legislation could be significant barriers to AIU meeting prescribed savings targets.

As shown in the economic supply curve (Figure 33), even within the subset of potential deemed cost-effective, a range of measure costs occurs. As programs begin to saturate the market for low-cost measures, more expensive measures will have to be deployed, which will in turn escalate the costs of achieving potentials. However, given the spending caps, the incentive amounts may not be sufficiently high to achieve higher penetration for these measures, as they will require significant investment by participants. Therefore, the spending caps may tend to push achievable potential towards the lower end of the range discussed earlier in this section.

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7 Due to inconsistency in utility reporting, outliers have been removed. Data indicating costs above $0.50 per kWh have also been removed from this graph.

Utility Program Costs

The estimates of economic potential presented in this report were determined by screening measures for cost-effectiveness according to the total resource cost (TRC) test, which does not take into account the source of expenditures. Moreover, the economic potential did not incorporate the utility's essential program costs such as program development, marketing and operating expenses. These costs are, however, critical inputs in the determination of achievable potential and the inputs necessary for estimating actual energy efficiency resource deployment costs.

For each of the achievable potential scenarios described above, estimates of required incentive and non-incentive (marketing, promotion, administration, etc.) costs were developed. These estimates were informed by experience of several utilities who have been offering energy efficiency programs for a long period of time.

Given program spending assumptions, an estimate of AIU's average cost per unit of energy saved can be developed based on the economic potential. Table 23 presents the assumed program spending levels for each scenario and how these translate into AIU costs per first-year kWh or therm saved. Based on assumptions regarding incentive and non-incentive utility spending, utility costs in the achievable potential scenarios are expected to range from $0.17 to $0.31 per first year kWh and between $1.86 and $3.37 per first year therm. These calculated costs are in line with the results of the analysis of FERC data (Figure 55).

Table 23. Cost Assumptions for Achievable Potential Scenarios

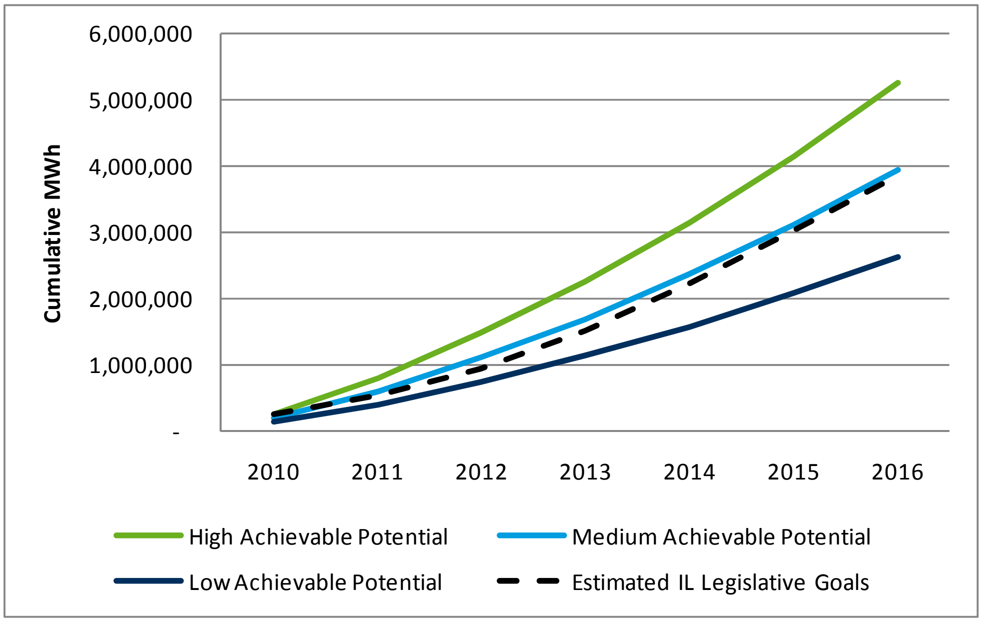
	Average Costs as Percent of Measure Cost		Average Utility Cost per First-Year Unit of Energy Saved	
Achievable Scenario	Incentive	Non-Incentive	Electricity ($/kWh)	Natural Gas ($/therm)
Low	40%	15%	$0.17	$1.86
Medium	50%	20%	$0.22	$2.36
High	70%	25%	$0.31	$3.37

Note that this analysis assumes that spending per unit of energy savings remains constant over time. In practice, required costs may change over time as the market for low-cost measures is saturated and more intensive marketing, including higher incentives, would be required to capture additional savings.

Costs of Electric Energy Efficiency

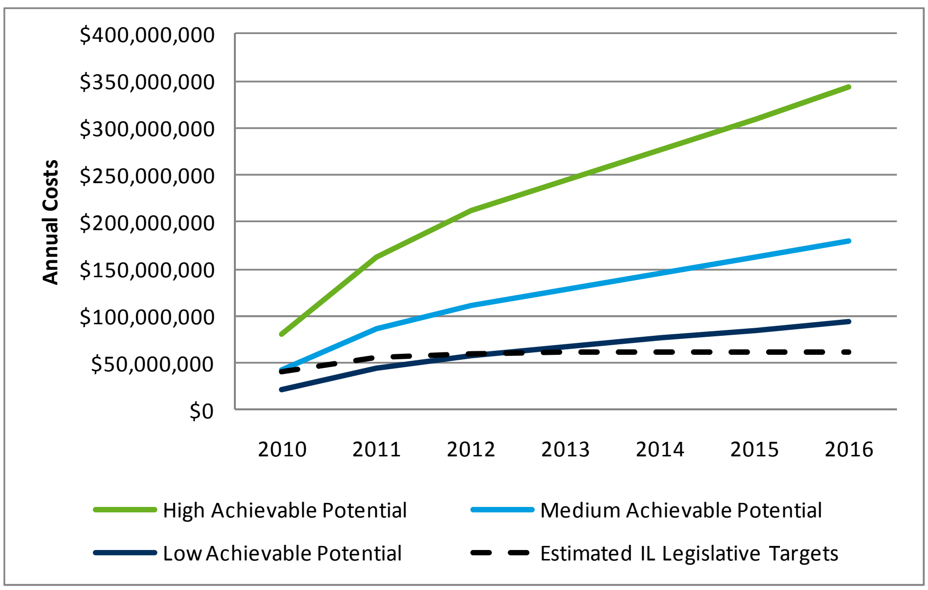
For the purpose of this analysis, it is assumed that the ramp rate for deployment of energy efficiency potential will correspond closely with the annual legislative targets shown in Figure 51 above. Figure 56 shows the assumed rate of acquisition under each achievable scenario (in cumulative MWh) along with the legislative targets. As can be seen, the medium achievable case is very close to the prescribed targets.

Figure 56. Cumulative Electric Achievable Potential and Legislative Targets



Given these acquisition schedules, and the corresponding assumptions regarding utility costs, estimates of annual utility expenditures can be developed. These expected costs, along with the legislative spending caps are presented in Figure 57. As shown, the caps are well below the estimated required spending levels in all scenarios by the end of the study horizon. This, again, is consistent with the FERC analysis which shows that utilities achieving high levels of savings tend to spend between 20 and 30 cents per kWh, whereas the legislative caps limit spending to an average of 10 cents per kWh.

Figure 57. Annual Electric Achievable Acquisition Costs and Legislative Spending Caps

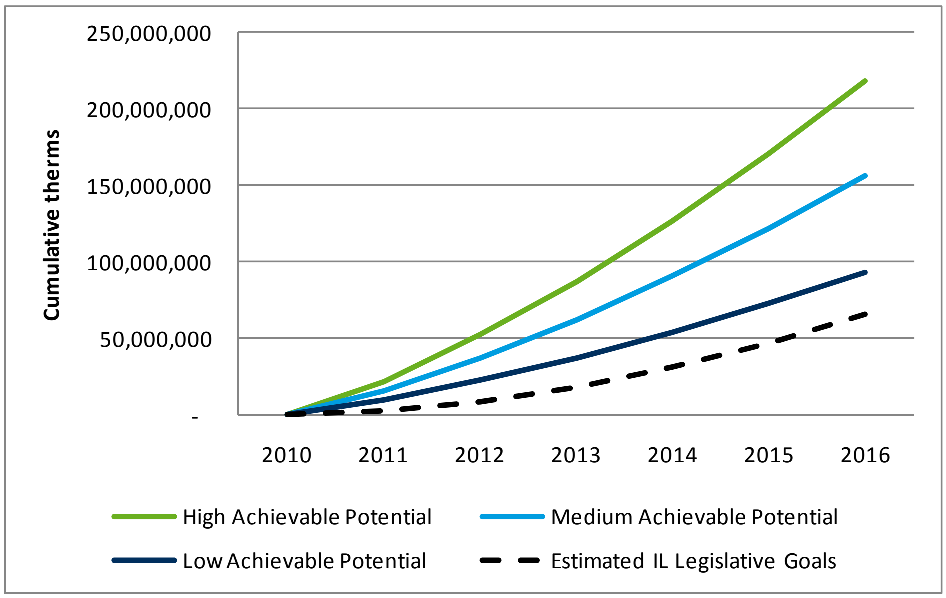


This is a simplified, high-level analysis based on the best available data, and, as such, does not attempt to determine whether or not it will be possible to meet the targets within the allowed spending limits. While the data indicate the spending caps will make achieving these goals difficult based on other utilities' experience, AIU's next three-year plan will provide detailed program- and measure-level assumptions regarding the expected costs of meeting the annual targets.

Costs of Natural Gas Energy Efficiency

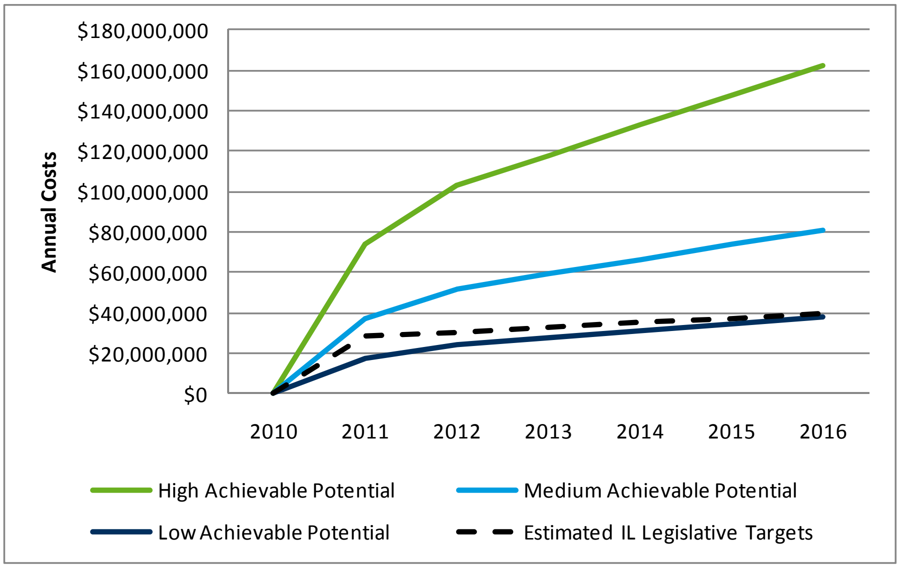
As with electric energy efficiency, an expected acquisition schedule was assumed for natural gas energy efficiency potential. Because there is no natural gas saving target in 2010, the curve is slightly different, but follows roughly the same trend as electric acquisition (Figure 58). Natural gas targets represent a smaller portion of sales than on the electric side (Figure 51), and these targets also translate into a smaller portion of the identified economic potential, coming in slightly under the low achievable potential.

Figure 58. Cumulative Natural Gas Achievable Potential and Legislative Targets



The estimated annual costs associated with each scenario are shown in Figure 59, along with the legislative spending caps. This analysis shows that the natural gas spending caps are in line with the estimated costs of the low achievable potential scenario.

Figure 59. Annual Natural Gas Achievable Resource Costs and Legislative Spending Caps



The technical, economic, and achievable potential analyses presented in this report are based on AIU's total residential, commercial, and industrial retail sales. However, the legislation allows the exclusion of two segments, thus reducing AIU's targets and spending limits: 1) transportation customers[8] and 2) qualifying large natural gas customers who choose to opt out. Given this uncertainty, to provide an estimate of the likely effect on targets and budgets, AIU identified customers representing roughly 40% of industrial sales who are eligible and have already expressed interest in exemptions. Using this figure as a rough approximation, targets, budgets, and achievable potential were re-calculated (

Figure 60 and Figure 61).

[8] Transportation customers are those who use AIU's delivery system but negotiate their own purchase of the natural gas commodity.

Figure 60. Cumulative Natural Gas Achievable Potential and Legislative Targets – Excluding Large Customer Opt-Outs

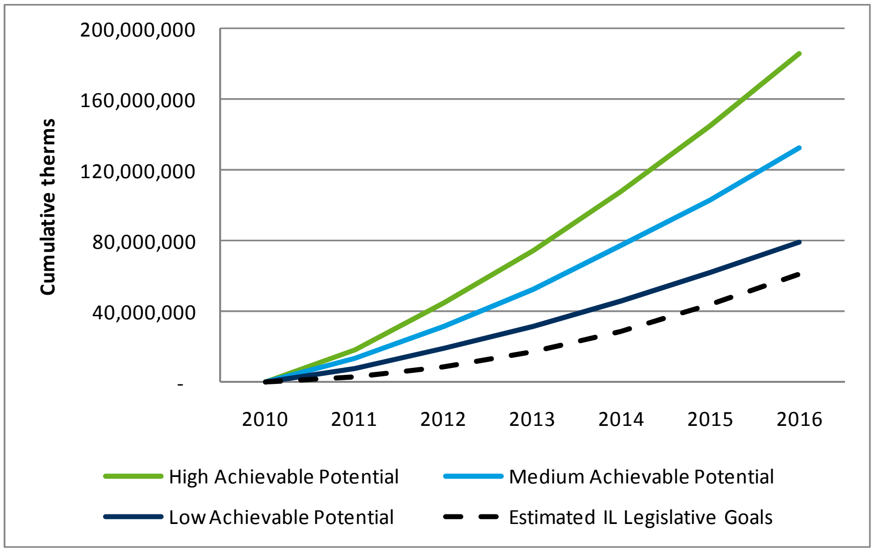
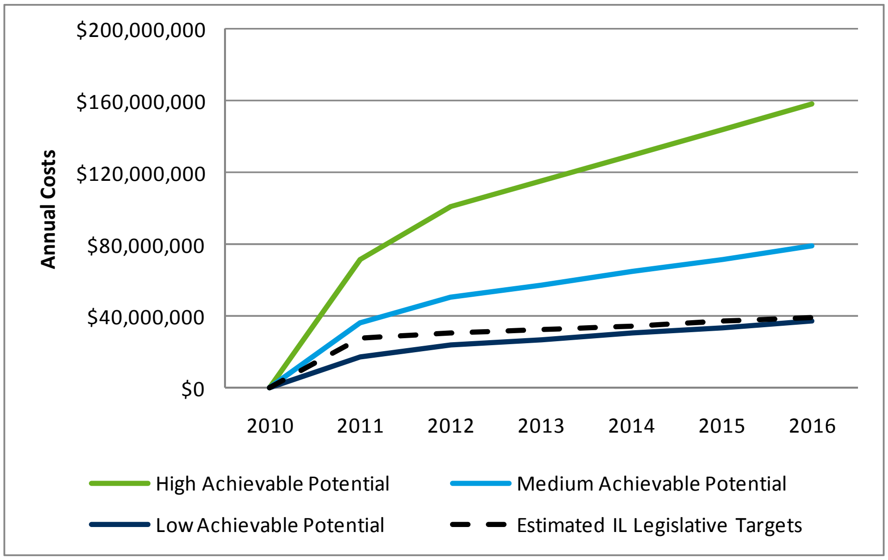


Figure 61. Annual Natural Gas Achievable Acquisition Costs and Legislative Spending Caps – Excluding Large Customer Opt-Outs



The results of this analysis indicate that the opt-out provision will lower the achievable potential; but targets will also be lowered. However, since the bulk of the opt-outs will be in the large industrial sector with comparatively low average per unit efficiency costs, the opt-out provision will cause average installed gas measure costs to increase by roughly 8% per therm saved.

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