LG&E KU

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PUBLIC SERVICE COMMISSION

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Jeff DeRouen
Executive Director
Kentucky Public Service Commission
211 Sower Boulevard
Frankfort, Kentucky 40601

December 6, 2013

RE: ***Joint Application of Louisville Gas and Electric Company and Kentucky Utilities Company for a Certificate of Public Convenience and Necessity and Site Compatibility Certificate for the Construction of a Combined Cycle Combustion Turbine at the Cane Run Generating Station and the Purchase of Existing Simple Cycle Combustion Turbine Facilities from Bluegrass Generation Company, LLC in LaGrange, Kentucky***
Case No. 2011-00375

Dear Mr. DeRouen:

Pursuant to the Commission's Order of May 3, 2012, in the above-referenced proceeding, Ordering Paragraph No. 4, Louisville Gas and Electric Company and Kentucky Utilities Company (collectively "the Companies") notified the Commission on August 3, 2012, that the Companies had selected The Cadmus Group to conduct an Energy Efficiency Potential Study.

Pursuant to Ordering Paragraph No. 5, the Companies hereby submit a copy of the Energy Efficiency Potential Study.

The Energy Efficiency Potential Study found that the Companies' energy-efficiency resource portfolio currently includes a wide range of energy-efficiency measures and services. The study noted that the Companies' current demand-side management plan provides demand-side management and energy efficiency offerings projected to achieve an average annual electricity savings of 140,000 MWh for the residential sector and 60,000 MWh for the commercial sector.

Compared to the estimated annual potential developed by The Cadmus Group, the Companies' current plan targets are well above the 53,000 MWh estimated achievable annual potential from the residential and commercial sectors.

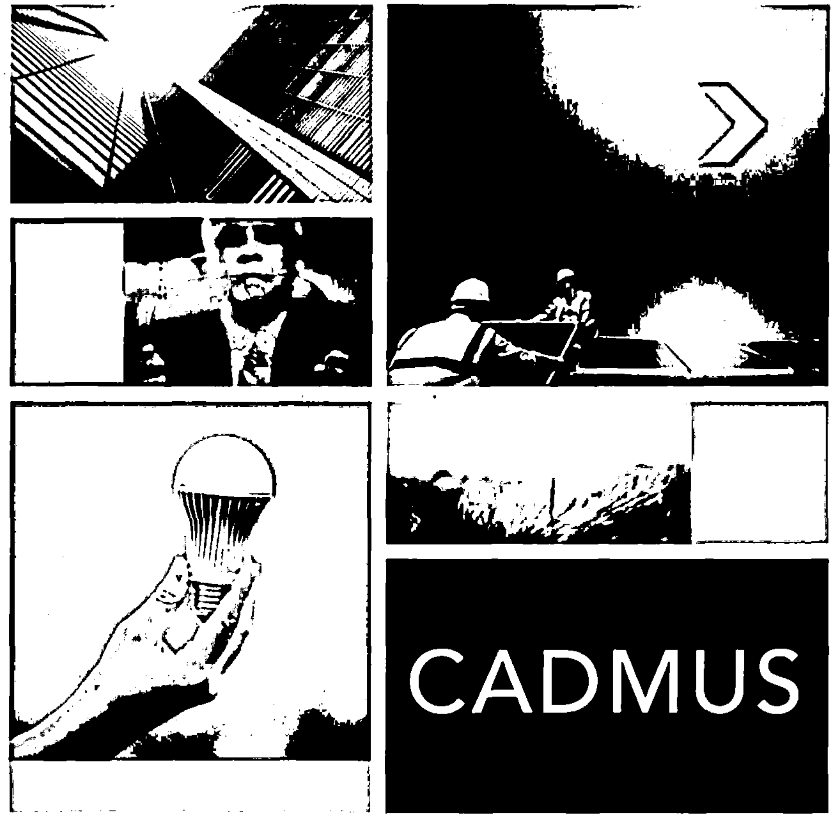
The Energy Efficiency Potential Study highlights that over time, as the Companies implement the planned energy efficiency programs, the cost of achieving additional savings will likely rise as the market for certain energy efficient equipment become saturated, low-cost saving opportunities are exhausted, or baseline energy use is lowered by stringent energy efficiency codes and standards.

Should you have any questions, please do not hesitate to contact me.

Sincerely,

Rick E. Lovekamp

Rick E. Lovekamp



In Collaboration with: EHI Consultants

Energy Efficiency Potential Study

December 2013

Louisville Gas and Electric Company and Kentucky Utilities Company
220 West Main Street
Louisville, Kentucky 40202

The Cadmus Group, Inc.

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CADMUS

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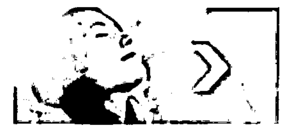

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Executive Summary

Overview

This report summarizes the results of an independent study of the long-run technical, economic, and achievable potential for electric and natural gas energy efficiency for the residential and commercial sectors in the service territories of Louisville Gas and Electric Company (LG&E) and Kentucky Utilities Company (KU)—collectively referred to as "the Company"— from 2014 to 2033.[1] The Company commissioned this study to comply with the Kentucky Public Service Commission's Order Case No. 2011-00375. While this analysis focuses primarily on electric efficiency, Cadmus conducted a preliminary study of natural gas efficiency potential.

The study involved separate assessments of energy-efficiency potential for electricity and natural gas in the residential and commercial sectors, considering a comprehensive set of energy efficient technologies. For each utility, the study covered the complete range of market segments, dwelling types, vintage, and applicable end uses, including six residential market segments (existing and new construction for single-family, multifamily, and manufactured homes);[2] and twenty-two commercial segments (existing and new construction for 11 building types).

Cadmus relied on secondary and primary data to conduct the analysis. Secondary data included the Company's official load forecasts, long-term avoided costs (including annual energy and capacity values), system loss factors, and discount rate. Since the Company had already vetted the data, Cadmus did not validate them and used the data as provided. The study also included a primary data collection effort to assemble critical technical and market information specific to the Company's service territory. Cadmus, in collaboration with EHI Consultants and Thoroughbred Research Group, conducted phone surveys of LG&E and KU residential and commercial customers as well as on-site audits of commercial customers. This primary data collection effort provided current data and a representative sample of actual market conditions in the Company's service area.

Cadmus supplemented primary data with information from secondary sources.[3] Together, they provided the foundation for estimating technical, economic, and achievable potential, defined as follows:

1. ***Technical potential*** assumes all technically feasible, energy-efficiency measures may be implemented, regardless of their costs or market barriers.

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1 This assessment did not include the industrial sector.

2 Cadmus did not model manufactured homes for LG&E's service territory due to the small number of manufactured homes in Louisville.

3 Secondary sources are different from "secondary data." Secondary sources provide information not directly gathered or compiled by Cadmus, but that we consider accurate. Examples of secondary sources include the U.S. Census and Energy Information Administration websites, where we obtained supplemental technical and market data.

2. ***Economic potential*** represents a subset of technical potential, consisting only of measures meeting cost-effectiveness criteria based on the Company's avoided supply costs for delivering electricity and natural gas and avoided line losses. Cadmus determined the economic potential using a total resource cost test (TRC), which compares the net benefits of energy-efficiency measures with their costs.[4]
3. ***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. In this study, Cadmus relied on the results of stratified, representative samples of residential and commercial customers to assess the consumers' willingness to adopt energy-efficiency measures under three scenarios, depending on the fraction of the measure's incremental cost covered by the Company incentives: (1) none, (2) 50% and (3) 75%.

To estimate technical potential, Cadmus used the industry-standard, bottom-up approach. This approach is consistent with energy-efficiency studies by Cadmus and others consultants in various jurisdictions in the United States. We began with a comprehensive review of electric and natural gas energy-efficiency measures applicable to each of the Company's sector and market segments. Using technical measure data and market characteristics, we estimated 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 we then screened for cost-effectiveness to determine the economic potential. The study determined achievable levels of energy-efficiency potential by assessing customers' willingness to pay for energy-efficiency measures, based on survey results.

Summary of Results

This study quantifies the amount of energy and demand the Company can save in its service territory from 2014 to 2033. The Company can achieve these savings through adopting proven, commercially available energy-efficient technologies, while accounting for:

1. Changes in codes and standards (taking effect from 2014 to 2033)
2. Technical feasibility and limitations (technical potential)
3. Cost-effectiveness (economic potential); using the TRC
4. Consumers' willingness to adopt energy-efficiency measures (achievable potential)

Electric Potential

Study results indicate a cumulative 5,390 gigawatt hours (GWh) of technically feasible, electric energy-efficiency potential by 2033, the end of the 20-year study horizon, with approximately 2,527 GWh (47%)

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4 For a description of the method for calculating the total resource costs test, see the *California Standard Practice Manual: Economic Analysis of Demand-Side Management Programs*. California Public Utilities Commission. October 2001.

of these savings proving cost-effective. The estimated amount of economic potential is equivalent to 10% of the Company's 2033 sales forecast. Economic potential is the first step in determining how much energy-efficiency potential the Company should expect to achieve from its programmatic efforts. However, it does not represent the amount which the Company might realistically expect to achieve due to well-documented market barriers, which we address in the section entitled Achievable Potential.

The residential sector represents the largest source of energy-saving potential, accounting for approximately 3,689 GWh of technically feasible, electric energy-efficiency potential and 1,716 GWh of economic potential (as shown in Table 1). The residential sector accounts for 68% of both total technical and economic potential. The commercial sector represents the largest share of the demand-saving potential, accounting for approximately 413 MW of technical potential and 238 MW of economic potential.

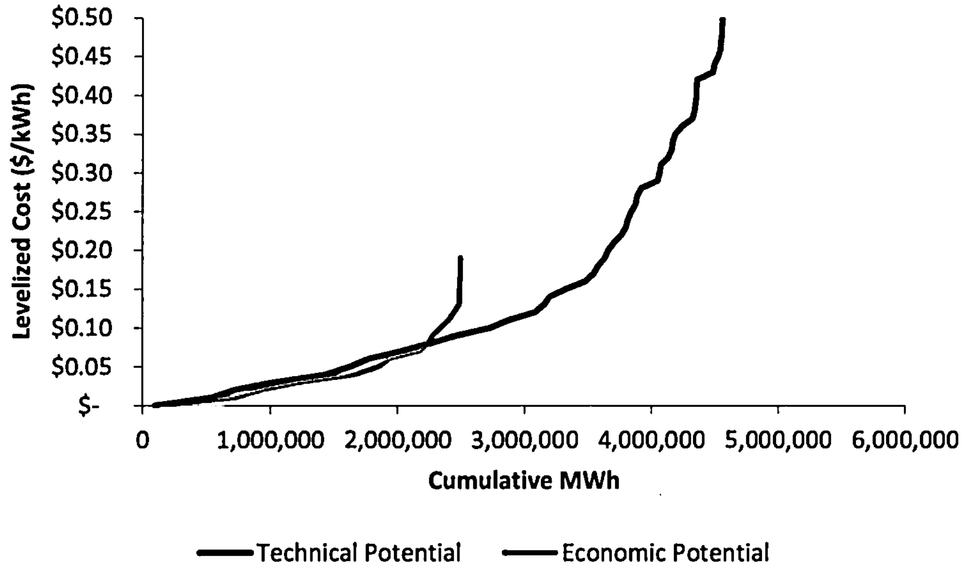
Commercial demand represents 57% of total technical potential and 62% of total economic potential. The estimated electric technical potential in the residential and commercial sectors translate into 726 megawatts (MW) of which 384 MW is economic savings at the time of the Company's system peak, defined as the 15th hour of the first Wednesday in August.

Table 1. Technical and Economic Electric Energy-Efficiency Potential (Cumulative 2033) by Sector

Sector	Base Case Sales (MWh)	Technical Potential			Economic Potential				
		MWh	Percent of Base Sales	MW	MWh	Percent of Base Sales	MW	Percent of Technical Potential - Energy	Percent of Technical Potential - Demand
Residential	14,225,644	3,689,033	26%	313	1,716,264	12%	147	47%	47%
Commercial	9,990,199	1,701,619	17%	413	810,866	8%	238	48%	58%
Total	24,215,844	5,390,653	22%	726	2,527,130	10%	384	47%	53%

Figure 1 shows the electric technical and economic energy-efficiency supply curve. The curves represent the quantity of cumulative potential (MWh) available at each levelized per-unit price point ($/kWh).

Figure 1. Electric Energy-Efficiency Supply Curve



It is difficult to compare estimates of technical electric potential across jurisdictions. This is because the potential depends on the unique characteristics of local markets based on critical variables such as fuel and equipment saturations, climate, and historical levels of energy-efficiency programmatic activities. Notwithstanding, when Cadmus compared its estimate of technical electric potential to the Company's sales forecast for the final year of the analysis, we found the Company's results were largely comparable with the results of other electric-efficiency potential studies in other jurisdictions. For example, a review of 90 electric-efficiency potential studies completed from 2001 to 2010 showed the electric technical potential averaging at about 24% of retail sales for all sectors (within a range of about 13% to 45%).[5] Cadmus' study estimates the Company has a technical potential of 22%, which is well within the range of the studies conducted in other jurisdictions.

The estimate of electric economic potential, measured as the percentage of retail sales, is lower than the range of 15% to 35% found in the reviewed studies for other jurisdictions. However, the difference can largely be attributed to the avoided costs and lower natural gas prices. Although the relationship between avoided costs and economic potential is not linear, avoided energy and capacity costs are the key determinants of economic potential.

Due to uncertainties inherent in future markets for energy-efficiency products and services (described in the Achievable Potential section) Cadmus did not attempt to develop a point estimate of achievable potential in this study. Rather, we developed a *range* of estimates, based on the fraction of economic potential we expect to be achievable, given customers' willingness to adopt energy-efficiency measures.

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5 Haeri, Hossein. "Frontiers of Efficiency." Public Utilities Fortnightly: pp. 39-44. April 2011.

Cadmus gathered primary data by asking customers about their willingness to invest in energy efficiency if the Company subsidized the investment by paying 0%, 50%, or 75% of the energy-efficiency measure's incremental cost. The incentive level—0%, 50%, and 75%— was not related to the Company's avoided cost of energy or capacity. Cadmus designed this effort to gather information on which incentive levels would motivate customers to install energy efficiency measures. Table 2 shows the low, medium, and high levels of cumulative, electric energy-efficiency potential the Company can expect to be achievable over the course of this study's 20-year horizon.

Table 2. Achievable Electric Energy-Efficiency Potential (Cumulative 2033) by Sector

Sector	Base Case Sales (MWh)	Low Achievable (No Incentive)		Medium Achievable Incentives Covering 50% or Incremental Costs		High Achievable Incentives Covering 75% of Incremental Costs	
		MWh	Percent of Base Sales	MWh	Percent of Base Sales	MWh	Percent of Base Sales
Residential	14,225,644	602,136	4.2%	920,185	6.5%	1,005,172	7.1%
Commercial	9,990,199	339,437	3.4%	461,670	4.6%	473,173	4.7%
Total	24,215,844	941,572	3.9%	1,381,855	5.7%	1,478,345	6.1%

Results indicate a range of 941 GWh to 1,478 GWh of achievable electricity savings, representing, respectively, 3.9% to 6.1% of retail sales in 2033. The estimated savings have a medium achievable value of 1,381 GWh, which represents 5.7% of the baseline sales.

Natural Gas Potential

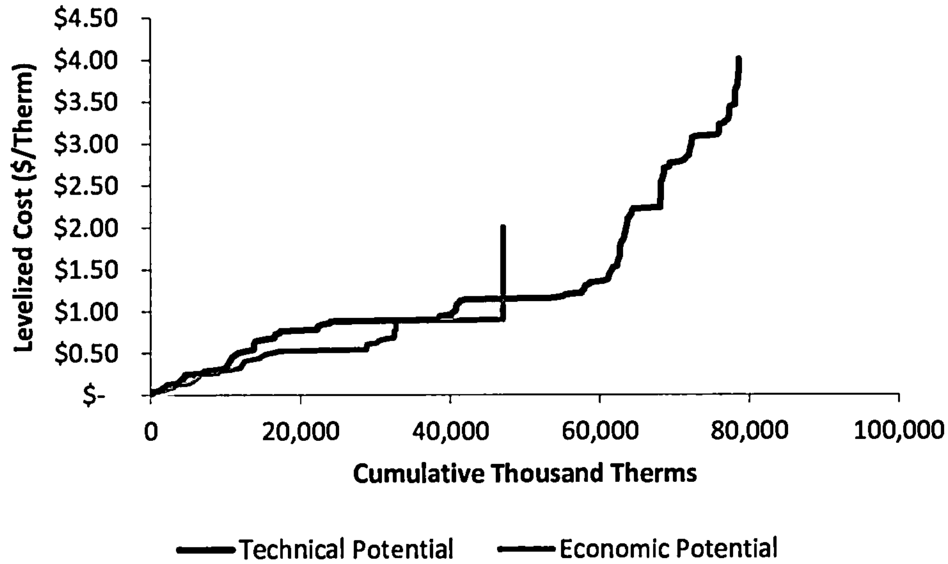
Study results indicate 96 million therms of natural gas energy-efficiency potential are technically feasible by 2033. Using the Company's avoided natural gas commodity costs to screen measures for cost-effectiveness, we expect nearly one-half of this potential (47 million therms) will be economic. This level of cost-effective potential represents 16% of the Company's projected sales in 2033.

Table 3. Technical and Economic Natural Gas Energy-Efficiency Potential (Cumulative 2033) by Sector

Sector	Base Case Sales (Thousand Therms)	Technical Potential		Economic Potential		
		Thousand Therms	Percent of Base Sales	Thousand Therms	Percent of Base Sales	Percent of Technical Potential
Residential	186,454	66,230	36%	34,523	19%	52%
Commercial	102,299	30,069	29%	12,626	12%	42%
Total	288,753	96,299	33%	47,149	16%	49%

Figure 2 shows the technical and economic natural gas efficiency supply curves. Economic potential includes all measures with a benefit-to-cost ratio greater than or equal to 1.0, according to the TRC criterion.

Figure 2. Natural Gas Energy-Efficiency Supply Curve



The study results suggest about 15 million to 26 million therms of natural gas savings are achievable over the course of 20-year planning period. The results indicate the Company can expect a medium level (24 million therms) of achievable potential, representing 8% of the Company's baseline sales forecast (as shown in Table 4).

Table 4. Achievable Natural Gas Energy-Efficiency Potential (Cumulative 2033) by Sector

Sector	Base Case Sales (Thousand Therms)	Low Achievable (No Incentives)		Medium Achievable Incentives Covering 50% or Incremental Costs		High Achievable Incentives Covering 75% of Incremental Costs	
		Thousand Therms	Percent of Base Sales	Thousand Therms	Percent of Base Sales	Thousand Therms	Percent of Base Sales
Residential	186,454	10,052	5%	16,695	9%	17,449	9%
Commercial	102,299	4,659	5%	7,603	7%	8,564	8%
Total	288,753	14,711	5%	24,298	8%	26,013	9%

Planning Implications

Studies of energy-efficiency potential provide detailed information on the magnitude and timing of energy-efficiency likely to be available at the sector, market segment and end-use levels. This information is intended to provide a basis for developing and refining its portfolio of energy-efficiency programs.

Energy-efficiency measures generally fall into two categories, discretionary (retrofit) or non-discretionary (lost opportunity), differentiated primarily in terms of their availability. Discretionary measures (e.g., lighting upgrades in the commercial sector) are measures that are expected to be available immediately. Non-discretionary measures include measures that are typically implemented only on burnout of the existing equipment (normal turnover) or new construction. The key difference between the two groups of measures is that, unlike retrofit measures which, financial and practical considerations notwithstanding, may be deployed at the program administrator's discretion, the availability of lost-opportunity resources is determined by market forces that are outside the program administrator's control.

Adoption of retrofit measures is also subject to a number of constraints, primarily the customers' willingness to adopt energy-efficiency measures, the maturity of the technology, and customer awareness. The Company may overcome these barriers to some degree through programmatic efforts to raise awareness and provide financial incentives.

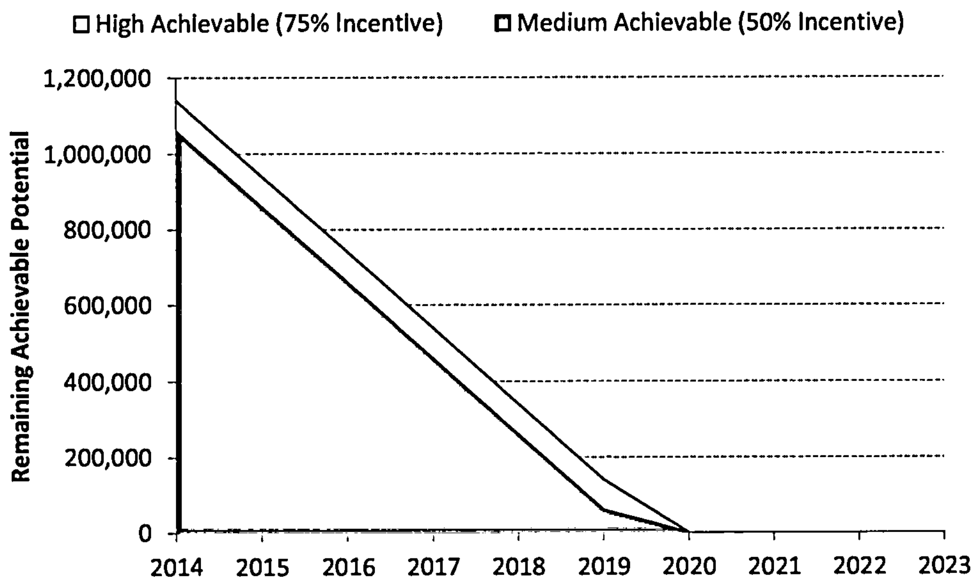
The results of this study show that about three-quarters (1,060 GWh) of the estimated medium-case 20-year achievable electric efficiency potential of 1,382 GWh consist of discretionary measures. Of this amount, 67% (706 GWH) is in the residential sector and 33% (354 GWh) is in the commercial sector. This translates into a levelized annual savings of roughly 35,000 MWh in the residential sector and less than 18,000 MWh per year in the commercial sector—a total of 53,000 MWh per year over the 20-year planning horizon on average.

The Company's energy-efficiency resources portfolio currently includes a wide range of energy-efficiency measures and services. In its 2012-2018 demand-side management plan, the Company expanded these offerings to achieve average annual electricity savings of 140,000 MWh for the residential sector and 60,000 MWh for the commercial sector— a combined savings of 200,000 MWh annually.

Compared to the estimated annual potential, the Company's targets are well above the 53,000 MWh estimated annual potential from the residential and commercial sectors. As illustrated in Figure 3, the results of this study indicate that the Company's planned acquisition rate of 200,000 MWh per year would deplete the medium-case achievable discretionary potential of 1,060,000 MWh in less than six years.

Moreover, over time, as the Company implements its planned programs, the cost of achieving additional savings will likely rise as the market for certain energy-efficient equipment become saturated, low-cost saving opportunities are exhausted, or baseline energy use is lowered by stringent energy-efficiency codes and standards. To achieve this remaining potential, the Company will likely have to invest additional resources to intensify marketing efforts.

Figure 3. Remaining Medium-Case Achievable Discretionary Electric Energy-Efficiency Potential



Additional electric potential will be available in the form of non-discretionary savings from new construction and replacement of existing equipment upon burnout. Potential declines in the cost of existing energy-efficiency technologies and the emergence of new technologies might also provide additional small opportunities for further savings - although Cadmus' analysis of energy-efficiency potential is based solely on proven, commercially available technologies and current market costs.

For natural gas, the discretionary potential is 19,544 therms and the lost opportunity is 4,753 therms out of the total 24,298 therms through 2033. Unlike electric energy-efficiency, 80% of gas energy-efficiency potential comes from retrofit measures. This means savings is less dependent on new construction rates and the natural turnover of equipment.

Potential studies help inform the energy-efficiency portfolio design and program planning processes by identifying the amount and timing of energy-efficiency savings available in various end uses and market segments. Assessing the potential for energy efficiency also requires compiling a large set of data from multiple sources and applying complex calculations. These studies also rely on a large number of assumptions about future market conditions and, in the case of achievable potential, consumers' behavior. The results of these studies are also sensitive to technical and macro-economic changes that may undermine the validity of these underlying assumptions. Therefore, the Company should consider the findings and conclusions of this study as indicative of actual long-term potential and, to the extent possible, revisit the underpinning data and assumptions of the study periodically.

Organization of Report

This report presents the study's findings in two volumes. Volume I (this document), presents methodologies and findings and includes the following four sections:

1. **General Approach and Methodology** provides an overview of the methodology Cadmus used to estimate technical, economic, and achievable potential.
2. **Primary Data Collection** presents the research approach, sample frames, and key findings from the primary data collection efforts. It also summarizes the secondary data sources used.
3. **Technical and Economic Potential** presents the technical and economic potential available from energy-efficiency resources.
4. **Achievable Potential** describes the basis for and results of estimating realistically achievable energy-efficiency potential.

Volume II presents supplemental technical information, assumptions, data, and other relevant details as the following appendices:

1. Appendix A: Data Collection Instruments
2. Appendix B: Summary of Findings from Primary Data Collection
3. Appendix C: Baseline Data
4. Appendix D: Measure Descriptions
5. Appendix E: Measure Details

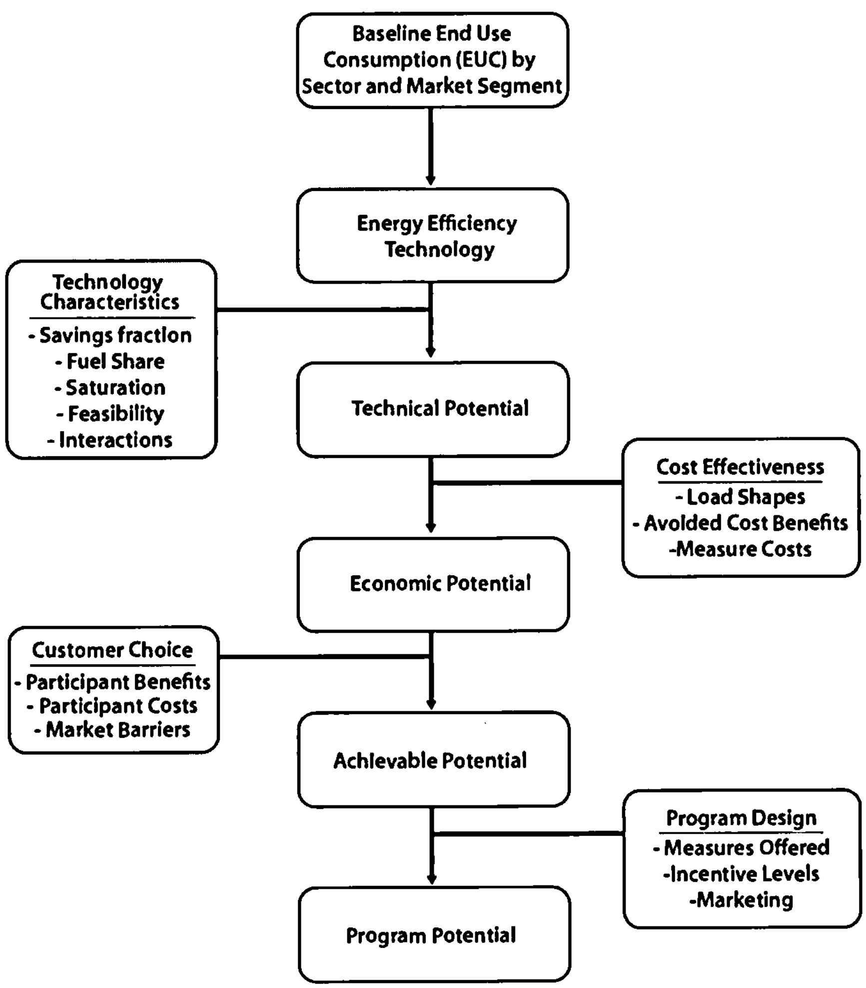
General Approach and Methodology

This assessment relies on industry best practices, analytic rigor, and flexible and transparent tools to accurately estimate the potential for energy and capacity savings in the Company's service territory, between 2014 and 2033. This section describes each step in the assessment process and summarizes the results. The appendices in Volume II of this report provide detailed study results and supplemental materials.

General Approach

The methodology used for estimating the technical, economic, and achievable energy-efficiency potential drew upon standard industry practices. Figure 4 presents the general methodology and illustrates how baseline and efficiency data are combined to estimate savings for each type of potential.

Figure 4. General Methodology for Assessment of Energy-Efficiency Potentials



In this study, Cadmus quantified three types of potential: technical, economic, and achievable. A fourth type of potential, naturally occurring efficiency, is also accounted for. However, Cadmus did not separately analyze naturally occurring efficiency because it is embedded in estimates of baseline consumption and reflected in the Company's load forecast. The types of potential are described as follow.

- ***Naturally occurring efficiency*** refers to reductions in energy use occurring due to normal market forces, such as technological change, energy prices, market transformation efforts, equipment turnover, and improved energy codes and standards. This analysis accounted for naturally occurring conservation in three ways:
  - First, the assessment accounted for gradual efficiency increases due to the retirement of older equipment in existing buildings, and its subsequent replacement with units meeting minimum standards (at the time of replacement). For some end uses, the technical potential associated with certain energy-efficiency measures assumed a natural adoption rate. For example, savings associated with ENERGY STAR appliances accounted for current trends in customer adoption.
  - Second, the assessment accounted for energy consumption characteristics of new construction reflecting Kentucky's adoption of the 2009 IECC building code.
  - Third, the assessment accounted for pending improvements to equipment efficiency standards, which will take effect during the planning horizon. The assessment did not, however, forecast changes to standards that have yet to pass; rather, it treated these at a "frozen" efficiency level.
- ***Technical potential*** assumes all technically feasible demand-side management measures may be implemented, regardless of their costs or market barriers. For energy-efficiency resources, technical potential can be divided into three distinct classes: retrofit opportunities in existing buildings; equipment replacements in existing buildings; and new construction. The first class, existing in current building stock, can be acquired at any point in the planning horizon, while end-use equipment turnover rates and new construction rates dictate the timing of the other two classes.
- ***Economic potential*** represents a subset of technical potential, consisting only of measures meeting the cost-effectiveness criteria based on the Company's avoided energy and capacity costs. For each energy-efficiency measure, the study structures the benefit-cost test as the ratio of the net present values of the measure's benefits and costs, and only measures with a benefit-to-cost ratio of 1.0 or greater can be deemed cost-effective.
- ***Achievable potential*** derives from the portion of economic potential that might be assumed reasonably achievable in the course of the planning horizon, given market barriers that might 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.

This report does not consider program potential: the amounts of energy savings likely to be achievable annually once the utility's specific program design components—such as measures offered, incentive structures, marketing efforts, and program budget constraints—have been taken into account.

Overview of Approach

Estimating energy-efficiency potential is based on a sequential analysis of various energy-efficiency measures in terms of technical feasibility (technical potential), cost-effectiveness (economic potential), and expected market acceptance, considering normal barriers possibly impeding measure implementation (achievable technical potential). The assessment followed four steps:

1. ***Developing baseline forecast:*** Determining 20-year future energy consumption by fuel, sector, market segment, and end use. The study calibrated the base year, 2013, to the Company's sector load forecasts. As previously described, baseline forecasts shown in this report include estimates of naturally occurring potential.
2. ***Estimating technical potential:*** Estimating technical potential, based on alternative forecasts that reflect technical impacts of specific energy-efficiency measures.
3. ***Estimating economic potential:*** Estimating technical potential, based on forecasts that reflect technical impacts of cost-effective energy-efficiency measures.
4. ***Estimating achievable potential:*** Achievable potential, calculated by applying ramp rates and an achievability percentage to cost-effective measures (as detailed later in this section).

Developing Baseline Forecast

Collecting Baseline Data

Creating a baseline forecast requires multiple data inputs to accurately characterize energy consumption in the Company's service area. 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 percentage of equipment below, at, and above code); and
- Annual end-use consumption estimates, by efficiency level.

Data specific to the Company's service territory not only provided the basis for baseline calibration, but supported estimation of technical potential. As described in the Primary Data Collection section, the assessment conducted a significant primary data collection effort to ensure use of the best available data. The Company also provided data on actual and forecasted sales and customers by sector. Table 5 identifies sources for key data.

Table 5. Data Sources

Data	Residential	Commercial
Baseline sales and customers	Company actual	Company actual
Forecasted sales and customers	Company forecast	Company forecast
Percent of sales by building type	Company customer database	Company customer database
End-use energy consumption	Company load forecast, building simulations, Energy Information Agency (EIA) *Residential Energy Consumption Survey* (RECS), ENERGY STAR, and others.	Company load forecast, EIA *Commercial Building Energy Consumption Survey* (CBECS)
Saturations and fuel shares	Company *Residential Appliance Saturation Survey* (RASS), Cadmus phone survey, RECS	Company saturation survey, Cadmus phone survey and site visits, CBECS
Efficiency shares	Company RASS, Cadmus phone survey, RECS	Company saturation survey, Cadmus phone survey and site visits, CBECS
Energy-efficiency measures	Cadmus measure list	Cadmus measure list

Preparing the Baseline Forecast

The baseline forecast for each customer sector derived from the baseline data (described above) to obtain estimates of average consumption by market segment, construction vintage, and end use; and then summing the data to the sector level. The end-use and customer sector forecasts were then calibrated to the Company's official forecast to evaluate the accuracy of Cadmus' forecast and to ensure its consistency with the Company forecast. This approach offered the following key advantages:

- The method derived savings estimates using a baseline calibrated to official sales forecasts, which required care to ensure underlying inputs and assumptions were reasonable and consistent with other known customer characteristics.
- The forecasts incorporated the effects of equipment standards and naturally occurring efficiency improvements resulting from usage reductions, upon the retirements of lower-efficiency equipment and their replacement with higher-efficiency units. Ensuring that the baseline forecast accounted for these effects prevented potential estimates from being inflated by naturally occurring efficiency, thus double-counting the potential.
- The same assumptions underlying the baseline forecasts were used to develop the energy-efficiency measure inputs as well as estimates of technical potential, ensuring consistency.

Incorporating Impending Codes and Standards

The importance of accurately accounting for changes in codes and standards over the planning horizon cannot be overstated. Not only do these changes affect customers' energy consumption patterns and behaviors, but they determine which energy-efficiency measures continue to produce savings over minimum requirements. This study captured current efficiency requirements as well as those enacted, but not yet taking effect.

Cadmus' analysis did not attempt to predict how energy codes and standards might change in the future; rather it factored in only the enacted legislation, notably, the provisions of the 2007 Energy Independence and Security Act (EISA), known to take effect over the course of this analysis.

EISA requires general service lighting to become roughly 30% more efficient than current incandescent technology, with standards phased in by wattage from 2012 to 2014. In addition to the 2012 phase-in, EISA includes a backstop provision, requiring still higher-efficiency technologies beginning in 2020. Capturing the effects of this legislation proved especially important, as residential lighting has played a large role in the Company's energy-efficiency programs over the past several years.

Moreover, this study explicitly accounted for several other pending federal codes and standards. For the residential sector, these include appliances, HVAC, and water heating standards. For the commercial sector, these include appliances, motors, water heating, HVAC, and lighting standards. Table 6 provides a comprehensive list of standards considered in this study.

Table 6. Federal Equipment Standards

Equipment Type	Existing (Baseline) Standard	New Standard	Sector	Year Effective*
Appliances				
Clothes Washer	MEF 1.48 and WF 9.5 (Electric DHW & Dryer)	Federal Standard 2016 Clothes Washer, MEF 1.72 and WF 8.0 (Electric DHW & Dryer)	Residential	2016
Clothes Washer	MEF 1.48 and WF 9.5 (Electric DHW & Dryer)	Federal Standard 2018 Clothes Washer, MEF 2.0 and WF 6.0 (Electric DHW & Dryer)	Residential	2018
Commercial Refrigeration Equipment (semi-vertical and vertical cases)	Commercial refrigeration equipment 2010 (varies by equipment class)	Commercial Refrigeration Equipment 2012 (varies by equipment class)	Commercial	2012
Cooking Oven	National Appliance Energy Conservation Act 1990	Range and Oven Standards 2012	Residential	2012
Dehumidifier	Federal standard: 2007 dehumidifier	Federal Standard 2012 Dehumidifier	Residential	2013*
Dishwasher	Federal standard: 2010 dishwasher (355 kWh/yr and 6.5 gal/cycle)	Federal Standard 2014 Dishwasher, 307 kWh/yr and 5.0 gal/cycle	Commercial/Residential	2014*

Equipment Type	Existing (Baseline) Standard	New Standard	Sector	Year Effective*
Dryer	Standard dryer with controls and moisture sensor (CEF/EF 3.14/3.19)	Federal Standard 2015 Dryer, CEF/EF 3.73/3.83	Residential	2015
Freezer	Federal Standard, 2001 freezer	Federal Standard 2014 Freezer	Commercial/Residential	2015*
Refrigerator	Refrigerator: Federal standard 2001	Refrigerator, Federal Standard 2014	Commercial/Residential	2015
Vending Machines	Existing conditions (no Federal standard prior to 2012)	Vending Machines, Federal Standard 2012	Commercial	2012
Motors				
Small Electric Motors	NEMA standards, Publication MG1-1987	Small Electric Motor Standard 2015	Commercial	2015
Water Heaters				
Water heater > 55 gallons	Federal standard 2004 storage water heater (EF 0.87)	Federal Standard 2015 Heat Pump Water Heater, EF 1.97	Commercial/Residential	2015
Water Heater ≤ 55 gallons	Federal standard 2004 storage water heater (EF 0.92)	Federal Standard 2015 Storage Water Heater, EF 0.95	Commercial/Residential	2015
HVAC				
Boiler	National Appliance Energy Conservation Act of 1987 (80% AFUE)	Federal Standard 2012 Boiler, 82% AFUE	Commercial/Residential	2012*
Central Air Conditioner	Federal standard 2006 central air conditioner: SEER/EER 13/11 (split system)	Federal Standard 2015 Central Air Conditioner, SEER/EER 14/12 (split system)	Residential	2015
Heat Pump (Air Source)	Federal standard 2006 heat pump: SEER 13 and HSPF 7.7 (split system)	Federal Standard 2015 Heat Pump, SEER 14 and HSPF 8.2 (SPLIT SYSTEM)	Residential	2015
Lighting				
Lighting General Service Fluorescent Lamp (EISA)	Fluorescent linear tube standards, 1995	Linear Tube Fluorescent Lamp Standards 2012	Commercial/Industrial	2012
Lighting General Service Lamp (EISA)	Existing conditions (no federal standard prior to EISA 2007)	EISA of 2007 (phased in over 3 years)	Commercial/Residential	2012, 2013, 2014

Equipment Type	Existing (Baseline) Standard	New Standard	Sector	Year Effective*
Lighting General Service Lamp (EISA backstop provision)	Existing conditions (no federal standard prior to EISA 2007)	EISA Backstop Provision 2020	Commercial/Residential	2020
Lighting Specialty Lamp (EISA incandescent reflector lamps)	IRL standards, 1995	EISA of 2007 Impacts, 2.5 Inch Diameter Reflectors and Above 2012	Residential	2013

*Standards taking effect mid-year are assumed to begin on January 1 of the following year.

To ensure accurate assessment of the remaining potential, Cadmus accounted for the effects of future standards. Drawing upon a strict interpretation of the legislation, Cadmus's analysis assumed affected equipment would be replaced with more efficient alternatives that meet the minimum federal standards, in other words, complete compliance. Once fully implemented, the savings from pending federal standards are estimated to lower the residential and commercial electricity consumption respectively by 6% and 4% from their baseline levels.

Lighting standards are the primary cause of this lower consumption. This is mostly due to a fall in 2020 consumption stemming from the pending EISA backstop provision, which requires standard, screw-base bulbs to achieve a minimum efficacy of 45 lumens per watt. Figure 5 and Figure 6 break out the impacts of federal standards on the residential and commercial sector electric energy-efficiency potential. The dramatic change in Figure 6 in 2020 reflects the taking effect of EISA's backstop lighting provision.

Figure 5. Residential Electric Potential from Federal Standards by End Use

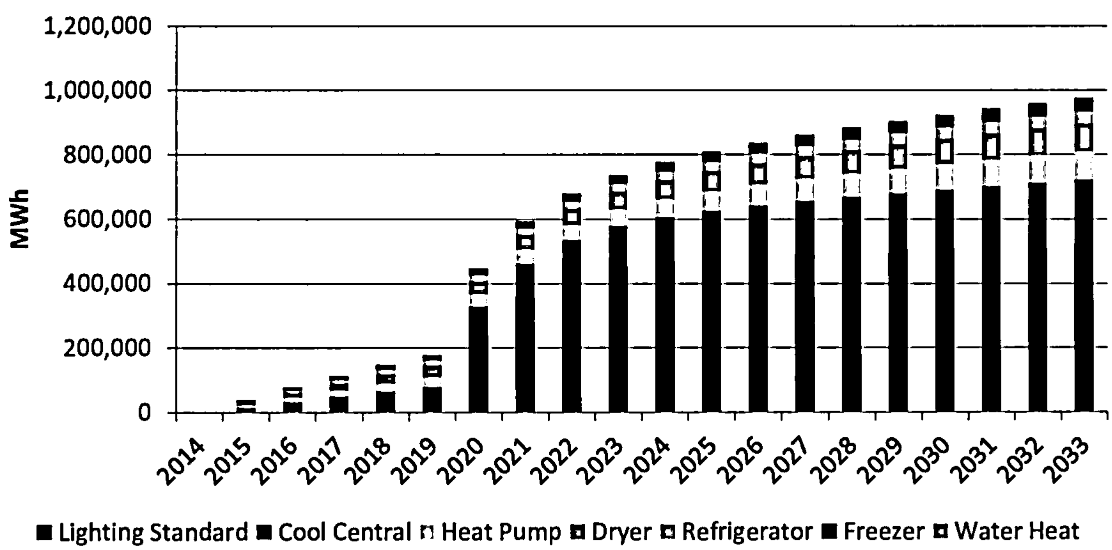
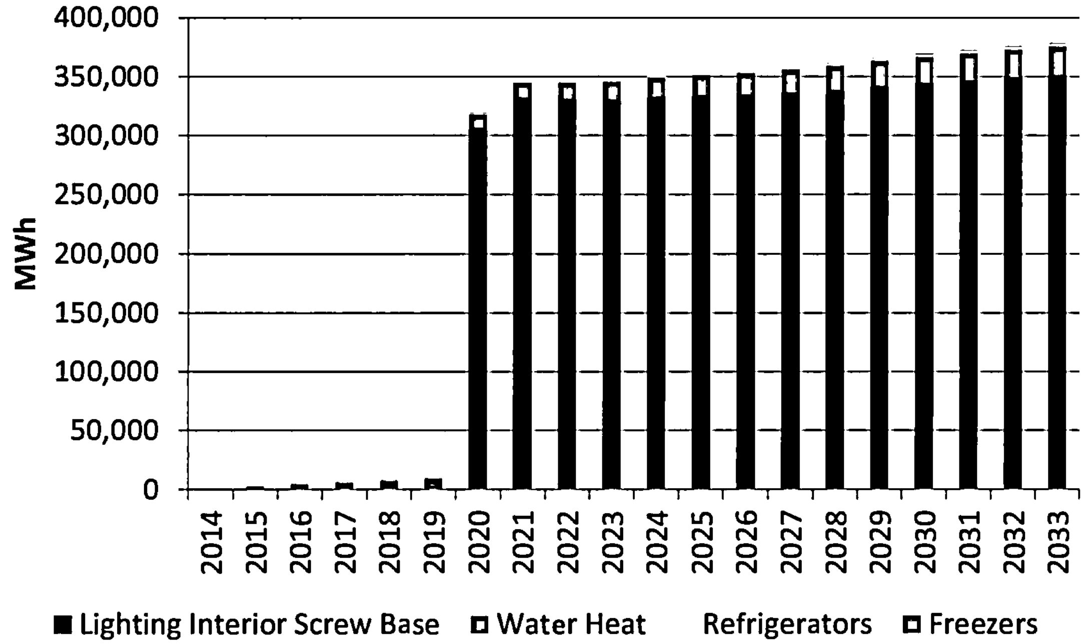


Figure 6. Commercial Electric Potential from Federal Standards by End Use



Compared to electricity, federal gas equipment federal standards are expected to have a much smaller impact on energy-efficiency potential. Pending federal natural gas standards account for 2% of residential natural gas sales and 1% of commercial natural gas sales.

Accounting for Naturally Occurring Efficiency

Cadmus' baseline forecast included naturally occurring efficiency—that is, reductions in energy use likely to occur from normal market forces (such as technological change, energy prices, market transformation efforts, and higher energy codes and standards). The analysis accounted for naturally occurring efficiency in four ways:

1. The potential associated with certain energy-efficiency measures assumed a natural adoption rate, net of current saturation. For example, total potential savings associated with ENERGY STAR appliances accounted for current adoption trends.
2. The assessment accounted for gradual efficiency increases due to retiring older equipment in existing buildings, followed by replacement with units meeting or exceeding minimum standards at the time of replacement.
3. The assessment accounted for pending improvements to equipment efficiency standards taking effect during the planning horizon (as discussed). The assessment did not, however, forecast changes to standards not yet adopted.
4. Estimates of energy consumption in new construction reflected 2009 IECC. All energy-efficiency measures in this study were assumed to meet or exceed 2009 IECC, and, where applicable, the study calculated energy savings using 2009 IECC as baseline. For example, current building code

requires R-38 ceiling insulation; so energy savings for all ceiling insulation measures in new construction were calculated with R-38 as a baseline. Consequently, this study did not attribute savings to ceiling insulation levels below R-38 in new construction. Note: building codes have the smallest impact of the four classes of naturally occurring efficiency, given they only apply to new construction.

Compiling Energy Efficiency Technology Data

Cadmus created a comprehensive list of electric and natural gas energy-efficiency measures applicable to the Company's service territory. This list included all measures currently offered through the Company's existing energy-efficiency programs as well as measures included in databases compiled in other jurisdictions, such as California's Database for Energy Efficient Resources (DEER).[6] Energy-efficiency measures were classified into two categories:

1. High-efficiency equipment measures (e.g., high-efficiency central air conditioners), which replace inefficient end-use equipment, and follow normal replacement patterns, based on expected lifetimes.
2. Non-equipment measures, which affect end-use consumption without replacing end-use equipment (e.g., insulation). Such measures, which do not include timing constraints from equipment turnover (except for new construction), should be considered discretionary (not dependent on equipment turnover), as savings can be acquired at any point over the planning horizon.

These measures required a number of inputs to accurately assess their saving potential and cost-effectiveness. Whenever possible, inputs derived from the primary data collection activities described in this report, supplementing data with local, regional, and national data, where appropriate. Descriptions follow of relevant inputs for each measure type.

Equipment and Non-equipment Measures

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

Non-equipment Measures Only

- Technical feasibility: the percentage of buildings where this measure can be installed, accounting for physical constraints.
- Percent incomplete: the percentage of buildings not already installing the measure, though its installation remains technically feasible.

[6] http://www.deeresources.com/

- Measure competition: for mutually exclusive measures, accounting for the percentage of each measure likely installed (to avoid double-counting savings).
- Measure interaction: accounting for end-use interactions (e.g., a decrease in lighting power density causing heating loads to increase).

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

Estimating Technical Potential

Once Cadmus fully populated the measure database, measure-level inputs were used to estimate technical potential over the planning horizon. This process began by estimating savings from all measures included in the analysis, and then aggregating the results to the end use, market segment, and sector levels.

This approach began by characterizing individual measure savings, first in terms of the percentage of end-use consumption. For each non-equipment measure, the study estimated absolute savings 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 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*, accounting for interactions among measures, such as lighting and HVAC calibrated to annual end-use energy consumption

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

For example, for wall insulation saving of 10% of space heating consumption, the final percentage of the end use saved would be 5%, assuming an overall applicability of 50%. This value represented the percentage of baseline consumption the measure saved in an average home.

However, capturing all applicable measures required examining many instances where multiple measures affected a single end use. To avoid overestimating total savings, assessing cumulative impacts accounted for interactions among the various measures—a treatment called "measure stacking." The primary method to account for stacking effects establishes a rolling, reduced baseline, applied sequentially upon assessment of measures in the stack. The equations below illustrate this technique, applying measures 1, 2, and 3 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 all measures in a bundle, the final percentage of the reduced end-use consumption provided the sum of the individual measures' stacked savings, divided by the original baseline consumption.

Economic Potential

The methodology for estimating economic potential was based on the methods described in the California Standard Practice Manual (SPM),[7] which establishes the procedures for economic evaluation from the perspectives of participants, utility (or program administrator), total resource cost, societal and all ratepayers. Consistent with standard practice in the industry, the analysis of economic potential in this study relied on the total resource cost (TRC) test as the criterion for screening energy efficiency measures for cost-effectiveness.

For each measure, the application of TRC began with the valuation of the measure's benefits, as measured by the avoided energy and capacity costs and avoided line losses, and comparing the result to the measure's costs. For equipment measures, costs were calculated based on the measure's incremental costs, compared with the cost of baseline technology. For retrofit measures, measure costs included the total installed cost of the measure. The study considered a measure cost-effective if it the net present value of its benefits exceeded the net present value of its costs as measured according to the TRC test, that is:

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

Where:

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

And:

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

Economic potential represented the savings from the subset of measures that passed the cost-effectiveness criterion according to the TRC test.

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7 California Standard Practice Manual for Economic Analysis of Demand-Side Programs and Projects, California Public Utilities Commission, 2002.

Calculating a measure's total resource benefits utilized the following data:

- **End-use load shapes:** End-use consumption patterns by costing period, applied to electric and natural gas measures, and capturing the time-differentiated value of energy savings, and determining the amount of savings during peak periods.
- **Line losses:** Representing energy lost between the generator and the customer meter. Thus, energy and capacity savings at the customer meter would be grossed up, capturing the true value of savings. Cadmus used electric line loss of 5.8% for LG&E, 6.2% for KU, and a natural gas line loss of 3.1%, provided by the Company.
- **Discount rate:** A discount rate of 6.86% for LG&E and 6.67% for KU, which represents the weighted average cost of capital.
- **Utility avoided energy costs:** Company's projections of time and seasonally differentiated electric energy and natural gas commodity costs.
- **Utility avoided capacity costs:** The Company's projections of the cost of supplying power during peak periods, estimated by the Company at $100/kW-year.

Line loss factor, discount rate, avoided energy and avoided capacity costs were provided to Cadmus by the Company.

Based on the results from the cost-effectiveness analysis, and using the same method described in the technical potential section, Cadmus developed an alternate supply curve consisting of measures passing the cost-effectiveness criterion from the TRC perspective.

Primary Data Collection

Overview

Assessment of the energy-efficiency potential required compiling technical and market data unique to the Company service territory. These data included 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.

The primary data collection was a joint effort between Cadmus and the Louisville-based firms of EHI Consultants, an engineering and planning firm and Thoroughbred Research Group, a market research firm. EHI Consultants conducted primary data collection for the residential phone surveys and the commercial site visits and Thoroughbred Research Group Conducted the commercial phone surveys.

Cadmus first reviewed the results of past surveys completed by the Company and identified areas where additional primary research was required. A series of primary data collection efforts were undertaken to supplement existing Company data and to maximize the amount of available data specific to the Company's service territory. These efforts included surveys of residential and nonresidential customers as well as nonresidential site visits. In summary, the data collection activities were:

- Residential customer phone surveys
- Nonresidential customer surveys
- Nonresidential customer on-site surveys

The principal objective in conducting the surveys and site visits was to produce estimates of equipment saturations, customer demographics, customers' attitudes towards energy efficiency, and customers' willingness-to-adopt various energy-efficiency measures. Cadmus produced a residential sample stratified by utility (LG&E or KU) and building type (single family, multifamily, and manufactured). Targets for each stratum reflect distributions provided by the Company. Table 7 shows targeted sample sizes for residential phone surveys.

Table 7. Residential Phone Survey Sample Targets

Building Type	LG&E	KU	Total
Single Family	150	142	292
Multifamily	50	48	98
Manufactured	0	10	10
Total	200	200	400

For commercial phone surveys and site visits, Cadmus focused on segments that represented the largest share of non-residential sales and the greatest energy-efficiency opportunities. The office, retail, and restaurant segments accounts for roughly 40% of the Company's non-residential load. Cadmus stratified phone survey samples by these segments, as well as by utility. Table 8 shows commercial phone survey sample targets.

Table 8. Commercial Phone Survey Sample Targets

Segment	LG&E	KU	Total
Small Retail	16	17	33
Large Retail	17	17	34
Small Office	17	17	34
Large Office	16	17	33
Restaurant	33	33	66
Total	99	101	200

For site visits, Cadmus focused on the two top-consuming commercial segments—retail and offices. We broke each segment into large and small strata. Cadmus identified large and small offices by looking at peak consumption. Cadmus considered offices with a peak of 100 kW of more, "Large" and retail facilities with a peak of 33 kW or more "large." Any buildings with demand below these thresholds fell into the "small" strata. Table 9 shows sample targets for commercial site visits.

Table 9. Commercial Site Visit Sample Targets

Utility	Facility Type				Total
	Retail		Office		
	Large	Small	Large	Small	
LG&E	6	7	6	6	25
KU	6	6	6	7	25
Total	12	13	12	13	50

The following 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.

Residential Phone Surveys

Cadmus and EHI Consultants completed 418 residential surveys to help inform the energy-efficiency potential study and program planning work. The purpose of these surveys was to gather primary research from the KU and LG&E's residential customers on the following research topics:

- Assess awareness, perceptions, actions related to energy efficiency
- Asses efficiency program awareness and perceptions
- Assess key factors affecting program participation
- Characterize customers' willingness to adopt energy-efficiency measures
- Gather customer demographic and household information
- Gather supplemental saturation data

Cadmus previously reported on the results of the energy-efficiency awareness, program awareness and perceptions, and program participation to the Company. The memo discussing these results is included in Appendix B. The remainder of this section discusses: customers' willingness to adopt efficiency measures, demographics and household information, and supplemental saturation data used in estimating potentials. Table 10 shows the number of surveys completed in each service territory for the single family, multifamily, and manufactured home segments.

Table 10. Completed Residential Phone Surveys

Segment	KU	LG&E	Total
Single Family (SF)	159	150	309
Multifamily (MF)	48	50	98
Manufactured Home (MH)	11	n/a	11
Total	218	200	418

The LG&E residential phone survey sample did not contain manufactured homes as these structures represent a small percentage of LG&E's residential customers.

Demographics and Household Information

The residential phone survey included several questions intended to gather additional, descriptive information about the housing stock. Though used for a number of purposes, this information primarily helped characterize the energy-efficiency measures' savings used in estimating the energy-efficiency potential. An important input to the engineering calculations was the average square footage of homes in the two service territories. Table 11 provides the results of the phone survey question asking respondents to provide their homes' square footage. Values in the "N" column indicate the number of valid (non-missing) responses.

Table 11. Average Home Square Footage

Utility	Segment	Average Square Feet	N
KU	SF	2,164	102
KU	MF	1,148	24
KU	MH	1,140	9
LG&E	SF	1,656	109
LG&E	MF	992	32

The average number of stories for single-family homes served as another important input into the engineering calculations for energy-efficiency savings.

Table 12 shows the average number of stories for single-family homes in KU's and LG&E's territories and the number of respondents to this question.

Table 12. Average Number of Stories for Single Family Homes

Utility	Average Number of Stories	N
KU	1.52	159
LG&E	1.53	146

The number of occupants per residential dwelling provides an important input in calculating savings for the number of energy-efficiency measures. **Error! Not a valid bookmark self-reference.** shows the average number of occupants for each dwelling type, according to survey respondents.

Table 13. Average Number of Occupants by Utility and Home Type

Utility	Segment	Average Number of Occupants	N
KU	SF	2.67	159
KU	MF	1.67	46
KU	MH	2.18	11
LG&E	SF	2.57	144

Supplemental Saturation Data

The residential phone survey sought to capture additional data on saturations of measures and end uses considered in the potential assessment, but not characterized by the secondary data sources. The majority of saturation data derived from surveys completed by the Company in 2010 and 2011. Once Cadmus reviewed these data sets, a small battery of questions was added to the residential phone surveys to capture the necessary data.

Table 14 provides saturation data gathered from the residential phone surveys for cable television receivers (also referred to as television set-top boxes) by segment, for both KU and LG&E.

Table 14. Average Number of Television Set Top Boxes

Utility	Segment	Average Number of Set Top Boxes	N
KU	SF	2.18	133
KU	MF	1.48	33
KU	MH	1.25	9
LG&E	SF	2.03	116
LG&E	MF	1.48	44

Table 15 provides saturation data gathered from the residential phone surveys for home audio systems by segment for both KU and LG&E.

Table 15. Average Number of Home Audio Systems

Utility	Segment	Average Number of Audio Systems	N
KU	SF	1.10	47
KU	MF	1.08	12
KU	MH	1.00	3
LG&E	SF	1.30	51
LG&E	MF	1.25	12

Table 16 provides saturation data gathered from the residential phone surveys for personal computers by segment, for both KU and LG&E.

Table 16. Average Number of Personal Computers

Utility	Segment	Average Number of Personal Computers	N
KU	SF	1.56	121
KU	MF	1.20	30
KU	MH	1.00	7
LG&E	SF	2.02	108
LG&E	MF	1.65	35

Table 17 provides saturation data gathered from the residential phone surveys for computer monitors by segment, for both KU and LG&E.

Table 17. Average Number of Computer Monitors

Utility	Segment	Average Number of Computer Monitors	N
KU	SF	1.02	122
KU	MF	0.70	30
KU	MH	0.71	7
LG&E	SF	1.08	105
LG&E	MF	0.79	33

Commercial Phone Surveys

The Cadmus team and Thoroughbred Research Group conducted 196 surveys to inform the energy-efficiency potential study and the program planning work. The surveys sought to gather primary research from KU's and LG&E's commercial customers in the office, retail, and restaurant segments regarding the following research topics:

- Assess awareness, perceptions, and actions related to energy-efficiency;
- Assess efficiency program awareness and perceptions;
- Assess key factors affecting program participation;

- Characterize customers' willingness to adopt energy-efficiency measures;
- Gather data to supplement existing saturation data; and
- Gather building characteristic information.

Table 18. Commercial Phone Surveys by Segment

Segment	Number of Respondents	Percent
Office Large	33	17%
Office Small	34	17%
Restaurant	58	30%
Retail Large	34	17%
Retail Small	37	19%
Total	196	100%

Commercial Supplemental Saturation Data

The commercial phone surveys provided supplemental saturation data that augmented the available information from existing data sources. The most important of these was water heating.

Given the upcoming change to the federal standard for water heating, Cadmus' potential modeling separated water heating into two end uses, based upon the size the water heater. The federal standard change in 2015 requires heat pump water heaters for electric systems larger than 55 gallons and condensing water heaters for gas systems of the same size. The heat pump water heater requirement does not apply to units with tanks that are 55 gallons or smaller.

Table 19 provides the saturation data for water heaters greater than (GT) 55 gallons and for those equal to or less than (LE) 55 gallons.

Table 19. Commercial Water Heater Size Breakout

Segment	End Use	Count	Saturation
Office Large	GT 55 Gal	13	35%
Office Large	LE 55 Gal	24	65%
Office Small	GT 55 Gal	2	5%
Office Small	LE 55 Gal	36	95%
Restaurant	GT 55 Gal	42	51%
Restaurant	LE 55 Gal	40	49%
Retail Large	GT 55 Gal	9	21%
Retail Large	LE 55 Gal	34	79%
Retail Small	GT 55 Gal	6	16%
Retail Small	LE 55 Gal	32	84%
Total	GT 55 Gal	72	30%
Total	LE 55 Gal	166	70%

In addition to capturing information on water heater tank size, Cadmus also assessed fuel saturations for the end use. Table 20 provides fuel shares from our survey data. Survey question counts did do not match those from the previous table due to a number of survey respondents knowing the number and heating source of the water heaters on their site, but not the size of the units.

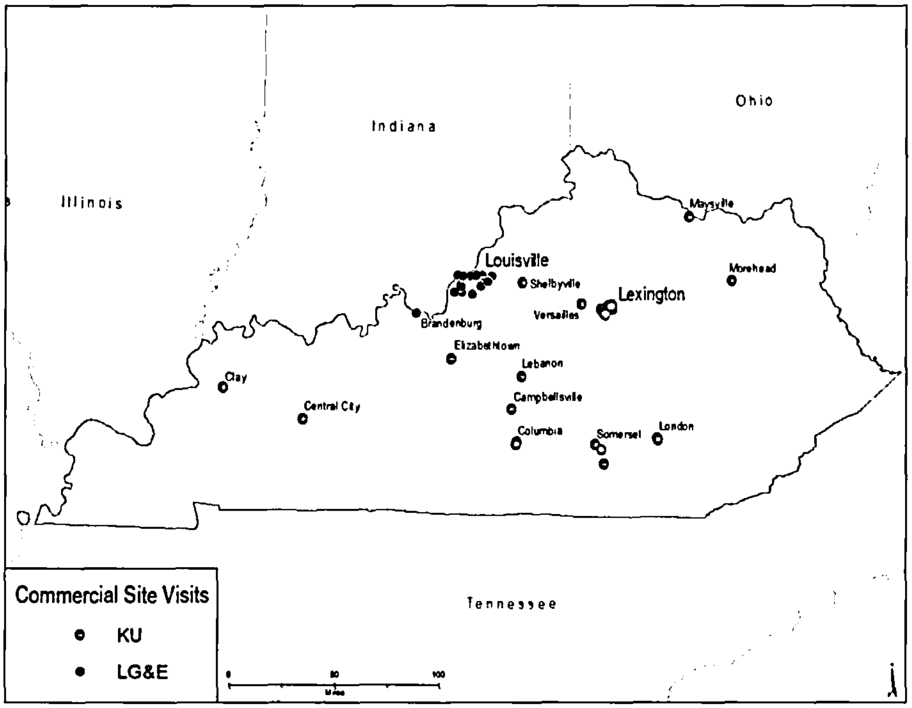
Table 20. Commercial Water Heater Fuel Shares

Segment	Fuel	Count	Fuel Share
Office Large	Electric	38	52%
Office Large	Natural Gas	35	48%
Office Small	Electric	32	55%
Office Small	Natural Gas	26	45%
Restaurant	Electric	53	45%
Restaurant	Natural Gas	64	55%
Retail Large	Electric	40	67%
Retail Large	Natural Gas	20	33%
Retail Small	Electric	42	72%
Retail Small	Natural Gas	16	28%
Total	Electric	205	56%
Total	Natural Gas	161	44%

Commercial On-Site Surveys

The Cadmus team visited 50 commercial sites, divided evenly between the KU and LG&E service territories. The two commercial segments were also divided evenly between office and retail. Figure 7 shows the geographic distribution of the visited sites. The surveys focused primarily on two commercial market segments: office buildings and retail facilities, which generally account for a significant portion of energy-efficiency potential in the commercial sector.

Figure 7. Commercial Site Visit Map



These surveys primarily sought to provide additional validation for the phone surveys and to collect data on system and equipment saturations, particularly interior lighting, which typically represents a significant source of energy savings. These data formed the basis for calculating lighting power density (LPD), a critical variable in calculations of savings potential. LPD is measured as the total number of watts of lighting usage, divided by the total square feet of the interior space. Table 21 shows the LPD values for retail and office building types in the commercial site visits.

Table 21. Commercial LPD

Segment	LPD (watts/sq. ft.)
Office (N = 24)	1.46
Retail (N = 23)	1.82

Survey results indicated retail facilities had a higher LPD (by 24%) than office buildings. For reference, the 2009 IECC requires an LPD of 1 watts/ft^2 for offices and 1.5 watts/ft^2 for retail. The site visit data also estimated the interior lighting percentages by lamp type. Each lamp type's saturation was expressed as its percentage share of the total watts within the interior space of the building surveyed. Table 22 provides saturations of interior lighting by lamp type for the office and retail segments.

Table 22. Interior Lighting Saturations by Lamp Type

Interior Lamp Type	Office (N = 24)	Retail (N = 23)
Fluorescent	80%	87%

CFL	8%	1%
Incandescent	10%	8%
Other	1%	4%

Cadmus' analysis separated interior lighting into fluorescent, HID, other, and screw-based lamp categories. The survey captured additional saturation information on these categories, with the results discussed below. Table 23 provides the saturation data for general linear fluorescent lighting lamp types as a percentage of the overall linear fluorescent wattage within the given segments. As seen, the penetration of efficient linear fluorescent lighting is low for both office and retail segments. The surveys provided adequate information on the saturation of HID lamps in the two segments.

Table 23. Distribution of Interior Linear Fluorescent Lamp Types

Fluorescent Lamp Type	Office (N = 24)	Retail (N = 23)
T12	61%	72%
Standard T8	29%	28%
Reduced Wattage T8	0%	0%
High Performance T8	8%	0%
T5	2%	0%
High Output T5	0%	0%

Table 24 provides saturation data for interior screw-based lighting lamp types as a percentage of the overall screw-based wattage within the given segments.

Table 24. Distribution of Interior Screw-Based Lighting by Bulb Type

Screw-based Lamp Type	Office (N = 24)	Retail (N = 23)
Incandescent	75%	84%
CFL	25%	16%

Technical and Economic Potential

Scope of Analysis

The study separately assessed technical and economic potential for electricity and natural gas in the residential and commercial sectors. Within each utility's sector-level assessment, the study further distinguished among market segments or business types, vintage, and applicable end uses within each, as follows:

- Six residential segments (existing and new construction for single-family, multifamily, and manufactured);[8] and
- Twenty-two commercial segments (11 building types within existing and new construction).

Analysis began by assessing the technical potential for 252 unique electric and 113 unique gas energy-efficiency measures (shown in Table 25), representing a comprehensive set of electric and natural gas energy-efficiency measures applicable to local climate and customer characteristics.

Table 25. Energy-Efficiency Measure Counts

Sector	Unique Measures	Permutations by Market Segment and Vintage
Electric		
Residential	95	1,677
Commercial	157	6,806
Natural Gas		
Residential	56	379
Commercial	57	1,464

Considering all permutations of these measures, across applicable customer sectors, market segments, fuels, and end uses, resulted in customized data, compiled and analyzed for over 10,000 measures. Appendix D describes all measures analyzed, and Appendix E provides technical details and the economic potential for all the permutations.

The remainder of this section presents:

- A summary of resource potentials by fuel; and
- Detailed sector-level results.

Summary of Results

Electric Energy Efficiency Potential

Table 26 and Table 27 show forecasted 2033 baseline electric sales and potential, by utility and sector, respectively.

8 Cadmus did not model manufactured homes for LG&E's service territory due to the small number of manufactured homes in Louisville.

Table 26. Technical and Economic Electric Energy-Efficiency Potential (Cumulative 2033) by Utility

Utility	Base Case Sales (MWh)	Technical Potential			Economic Potential		
		MWh	% of Base Sales	MW	MWh	% of Base Sales	MW
LG&E	10,866,812	2,217,527	20%	328	1,028,674	9%	169
KU	13,349,031	3,173,125	24%	398	1,498,456	11%	216
Total	24,215,844	5,390,653	22%	726	2,527,130	10%	384

Table 27. Technical and Economic Electric Energy-Efficiency Potential (Cumulative 2033) by Sector

Utility	Base Case Sales (MWh)	Technical Potential			Economic Potential		
		MWh	% of Base Sales	MW	MWh	% of Base Sales	MW
Residential	14,225,644	3,689,033	26%	313	1,716,264	12%	147
Commercial	9,990,199	1,701,619	17%	413	810,866	8%	238
Total	24,215,844	5,390,653	22%	726	2,527,130	10%	384

Study results indicate 5,390 GWh of technically feasible electric energy-efficiency potential by 2033, the end of the 20-year planning horizon, with approximately 2,527 GWh of these resources proving cost-effective. Identified economic potential amounts to 10% of forecast load in 2033.

Cadmus based savings on forecasts of future consumption, without consideration of expected savings from the Company's program savings. While consumption forecasts accounted for past savings each utility has acquired, estimated potential was inclusive of—not in addition to—current or forecasted program savings.

Cadmus calculated demand savings in the tables above using the Company's hourly end use-specific load shapes. We identified the Company's summer coincident peak hour and multiplied annual energy savings by the peak hour coincidence factor to determine demand savings for each measure.

As shown in Table 26 (above), utility-specific technical and economic potential, through a function of baseline sales, can be roughly compared when analyzed in percentage terms. Differences in customer distributions by segment and in other utility-specific customer characteristics drove differences in technical potential as a percent of baseline sales.

Table 27 (above) provides each sector's technical and economic potentials. The residential sector offers the largest portion of technical and economic potential, at 68%. The commercial sector accounts for the remaining 32% of technical and economic potentials.

Natural Gas Energy Efficiency Potential

Table 28 presents 2033 forecasted baseline sales and potential by sector. Study results indicate over 96 million therms of technically feasible, natural gas energy-efficiency potential by 2033. The identified economic potential of 47 million therms amounts to 16% of forecast load in 2033.

Table 28. Technical and Economic Natural Gas Energy-Efficiency Potential (Cumulative 2033) by Sector

Utility	Base Case Sales (Thousand Therms)	Technical Potential		Economic Potential	
		Thousand Therms	% of Base Sales	Thousand Therms	% of Base Sales
Residential	186,454	66,230	36%	34,523	19%
Commercial	102,299	30,069	29%	12,626	12%
Total	288,753	96,299	33%	47,149	16%

The residential sector accounts for 68% of the total technical and 73% of the total economic potential. The commercial sector accounts for the remaining 32% and 27% of technical and economic potential, respectively.

Detailed Energy-Efficiency Potentials

Residential Sector—Electric

Study results indicate residential customers account for about 58% of forecasted electricity retail sales. The single-family, manufactured, and multifamily potential savings sources include:

- 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).

Table 29 shows, based on resources included in this assessment, estimated residential sector electric economic potential of 1,716 GWh over 20 years, corresponding to a 12% reduction (10% for LG&E and 13% for KU) in 2033 residential consumption.

Table 29. Residential Sector Electric Energy-Efficiency Potential by Utility (Cumulative 2033)

Utility	Base Case Sales (MWh)	Technical Potential			Economic Potential		
		MWh	% of Base Sales	MW	MWh	% of Base Sales	MW
LGE	6,032,470	1,383,734	23%	126	627,913	10%	56
KU	8,193,174	2,305,299	28%	188	1,088,351	13%	91
Total	14,225,644	3,689,033	26%	313	1,716,264	12%	147

As shown in Figure 8, single-family homes represent 88% of total economic potential in the residential sector, followed by multifamily and manufactured homes. Each home type's proportion of baseline sales served as the primary drivers, but other factors, such as heating fuel sources, played important roles in determining potential.

For example, manufactured homes typically exhibit higher electric heating saturations than other home types, increasing their relative shares of the potential. Conversely, lower-use per customer for multifamily units decreases this potential, as some measures may not be cost-effective at lower consumption levels.

Figure 8. Residential Sector Electric Economic Potential by Segment

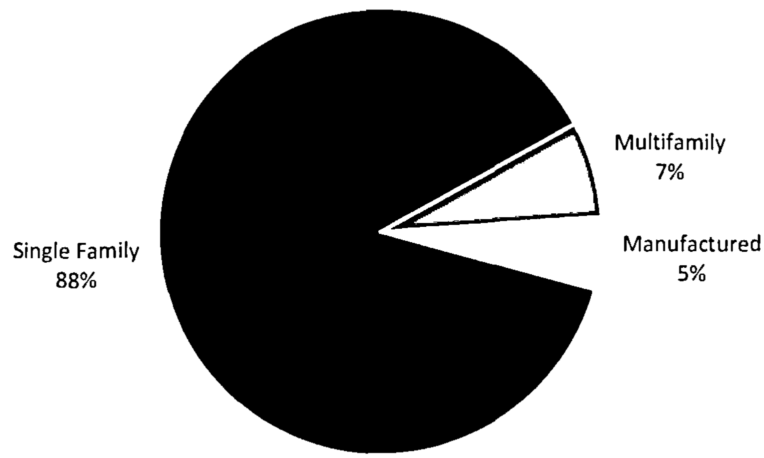
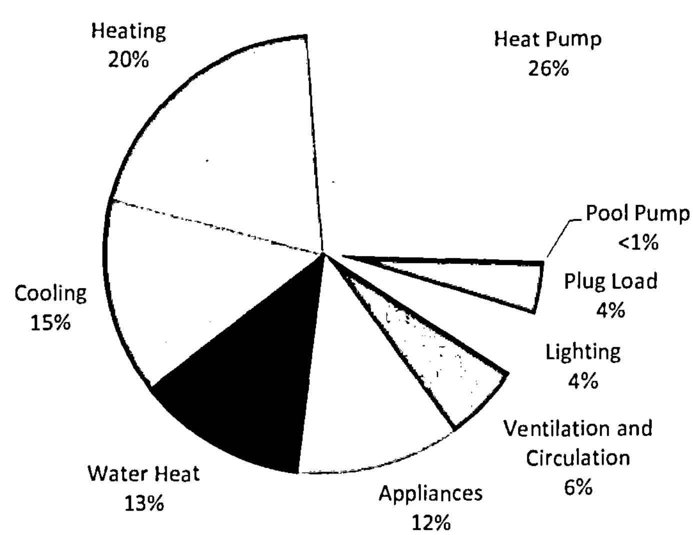


Figure 9 presents the distribution of electric economic potential by measure type.

Figure 9. Residential Sector Electric Economic Potential by Measure Type



As shown, the largest portion of economic potential in the residential sector (26%) results from heat pump savings, achieved through shell measures and upgrades to efficient equipment. Heating measures, insulation, and infiltration reduction account for the next largest slice (20%), followed by various cooling, appliances, and water heating end uses. Plug load end uses account for a small portion of economic potential due to high current market saturations of efficient equipment. Table 30 presents technical and economic potentials by end-use category. Base case sales presented in the table below reflect the end use forecast Cadmus developed for the purpose of modeling energy-efficiency potential, not the Company's load forecast.

Table 30. Residential Sector Electric Energy-Efficiency Potential by End-Use Category (Cumulative 2033)

Measure Type	End Use	Base Case Sales (MWh)	Technical Potential		Economic Potential	
			MWh	% of Base Sales	MWh	% of Base Sales
Appliances	Cooking Oven	72,292	1,169	2%	0	0%
	Dryer	541,145	7,315	1%	0	0%
	Freezer	130,394	56,814	44%	56,814	44%
	Refrigerator	563,826	186,048	33%	144,560	26%
Cooling	Cool Central	1,817,288	767914.5	42%	247,682	14%
	Cool Room	57,158	23,590	41%	0	0%
Heat Pump	Heat Pump	2,062,997	786,366	38%	469,400	23%
Heating	Heat Central	1,180,957	622,568	53%	333,742	28%
	Heat Room	75,500	26,536	35%	681	1%
Lighting	Lighting Interior Specialty	179,046	147,149	82%	74,912	42%
	Lighting Standard	418,036	128,548	31%	0	0%
Plug Load	Computer	276,776	19,494	7%	0	0%
	Copier	13,568	332	2%	332	2%
	Dehumidifier	159,180	12,193	8%	0	0%
	DVD	22,403	1,850	8%	0	0%
	Home Audio System	102,775	9,343	9%	0	0%
	Monitor	46,802	1,283	3%	1,283	3%
	Multifunction Device	127,473	6,257	5%	6,257	5%
	Plug Load Other	548,401	6,264	1%	0	0%
	Set Top Box	325,474	65,111	20%	65,111	20%
	TV	424,516	10,564	2%	0	0%
Pool Pump	Pool Pump	69,885	51,260	73%	2,261	3%
Ventilation and Circulation	Ventilation and Circulation	473,631	125,795	27%	100,161	21%
Water Heat	Water Heat GT 55 Gal	471,652	239,056	51%	76,713	16%
	Water Heat LE 55 Gal	887,758	386,215	44%	136,355	15%

Residential Sector – Natural Gas

As shown in Table 30, single-family homes represent 93% of total economic residential potential, followed by multifamily homes. Multifamily homes represent a smaller share of natural gas potential due to a lower saturation of gas furnaces (Figure 10).

Figure 10. Residential Sector Natural Gas Economic Potential by Segment (Cumulative 2033)

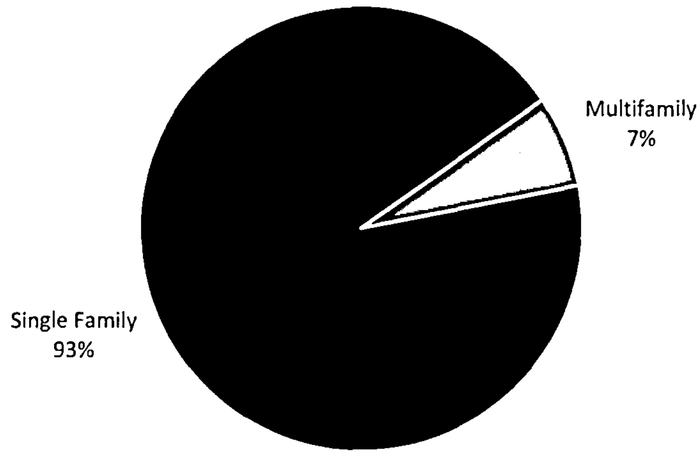


Figure 11 presents distributions of natural gas economic potential by measure type. The largest portion of economic potential in the residential sector (87%) derives from measures impacting heating end uses, followed by water heating (13%).

Figure 11. Residential Sector Natural Gas Economic Potential by Measure Type (Cumulative 2033)

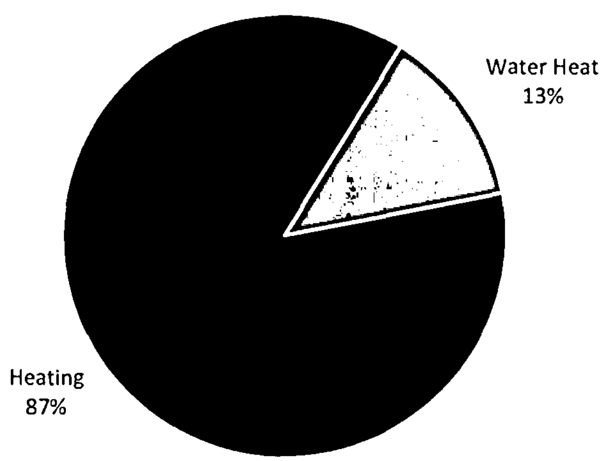


Table 31 provides technical and economic potential by end-use category. As shown, central gas furnaces offer significant technical potential of 46% and 25% of natural gas use that may be captured economically in this end use. Combined water heating measures show an economic potential equivalent to nearly 30% of the end use.

Table 31. Residential Sector Natural Gas Energy-Efficiency Potential by End-Use Category (Cumulative 2033)

End Use	Base Case Sales (Thousand Therms)	Technical Potential		Economic Potential	
		Thousand Therms	% of Base Sales	Thousand Therms	% of Base Sales
Cooking Oven	544	500	92%	0	0%
Dryer	403	52	13%	0	0%
Water Heat GT 55 Gal	12,151	3,289	27%	1,551	13%
Water Heat LE 55 Gal	21,380	8,039	38%	2,999	14%
Heat Central Furnace	118,508	54,070	46%	29,973	25%
Pool Heat	1,546	280	18%	0	0%

Commercial Sector – Electric

Table 32 shows, based on resources included in this assessment, estimated electric economic potential in the commercial sector at slightly more than 810 GWh over the 20-year planning horizon. This corresponds to an 8% reduction (8% for LG&E and 8% for KU) of forecasted 2033 commercial consumption. Cost-effective energy-efficiency measures equate to a 238 MW peak demand reduction in 2033.

Table 32. Commercial Sector Electric Energy-Efficiency Potential by Utility

Utility	Base Case Sales (MWh)	Technical Potential			Economic Potential		
		MWh	% of Base Sales	MW	MWh	% of Base Sales	MW
LG&E	4,834,342	833,793	17%	202	400,761	8%	113
KU	8,193,174	867,826	17%	210	410,104	8%	125
Total	14,225,644	1,701,619	17%	413	810,866	8%	238

As shown in Figure 12, large retail and miscellaneous buildings represent the largest shares (25% and 15%, respectively) of economic potential in the commercial sector. The miscellaneous segment combines: customers not fitting into the other categories; and those that would fit, but had insufficient information to be classified. The commercial sector also provides considerable savings opportunities in: large and small offices (11% each), retail (11%), and grocery (10%) segments. Moderate savings can be expected in education, health, restaurants, and lodging facilities.

Figure 12. Commercial Sector Electric Economic Potential by Segment (Cumulative 2033)

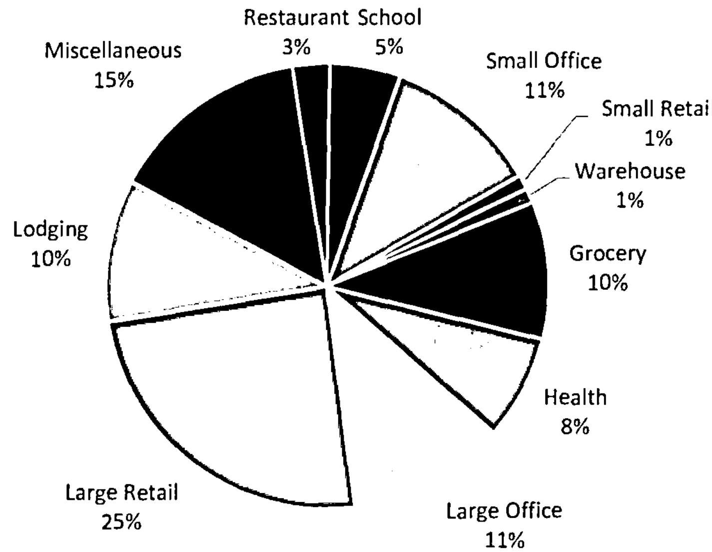


Figure 13 presents distributions of commercial sector electric economic potential by measure type. The largest portion of economic potential in the commercial sector (29%) derives from cooling measures, followed by lighting (24%). Ventilation and circulation (motors) account for 15% of economic potential. Table 33 provides technical and economic potential by end use.

Figure 13. Commercial Sector Electric Economic Potential by Measure Type (Cumulative 2033)

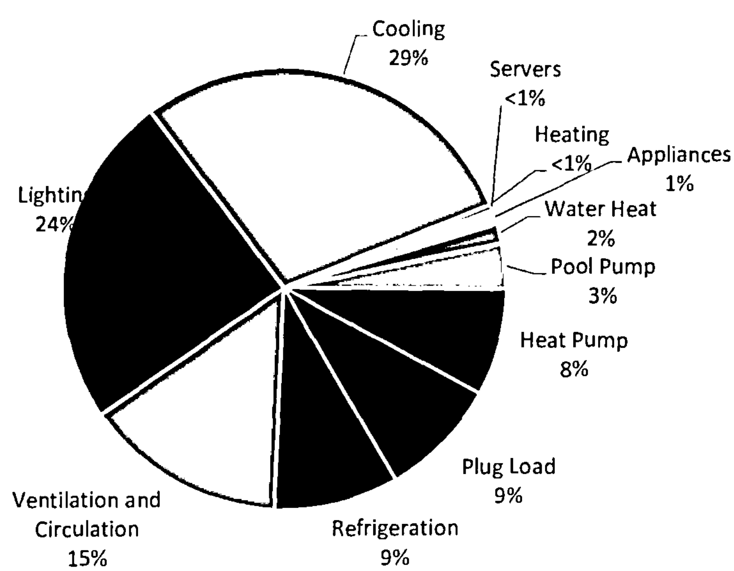


Table 33. Commercial Sector Electric Energy-Efficiency Potential by End-Use Category

Measure Type	End Use	Base Case Sales (MWh)	Technical Potential		Economic Potential	
			MWh	% of Base Sales	MWh	% of Base Sales
Appliances	Cooking	37,830	4,740	13%	262	1%
	Freezers	3,872	719	19%	719	19%
	Refrigerators	37,173	10,112	27%	7,957	21%
Cooling	Cooling Chillers	85,333	30,747	36%	13,838	16%
	Cooling Dx Evap	1,071,117	344,481	32%	221,630	21%
	Package Terminal AC	12,857	1,897	15%	495	4%
	Room Cool	12,007	1,065	9%	449	4%
Heat Pump	Heat Pump	290,369	78,116	27%	47,328	16%
	Package Terminal HP	110,506	22,385	20%	15,381	14%
Heating	Room Heat	8,375	927	11%	45	1%
	Space Heat	125,030	32,234	26%	136	0%
Lighting	Lighting Exterior	818,865	244,783	30%	30,447	4%
	Lighting Interior Fluorescent	2,588,902	253,268	10%	59,331	2%
	Lighting Interior Hid	527,861	48,494	9%	3,303	1%
	Lighting Interior Other	433,019	77,750	18%	16,427	4%
	Lighting Interior Screw Base	430,220	91,706	21%	87,705	20%
Plug Load	Computers	164,272	50,657	31%	50,103	30%
	Fax	5,091	1,738	34%	1,738	34%
	Flat Screen Monitors	34,601	183	1%	0	0%
	Other Plug Load	502,629	20,441	4%	4,000	1%
	Photo Copiers	8,442	60	1%	0	0%
	Printers	25,828	126	0%	126	0%
	Vending Machines	118,148	14,782	13%	14,782	13%
Pool Pump	Pool Pump	74,598	27,251	37%	27,251	37%
Refrigeration	Refrigeration	1,017,361	135,269	13%	73,744	7%
Servers	Servers	23,630	3,677	16%	3,107	13%
Ventilation and Circulation	Ventilation And Circulation	1,295,829	160,140	12%	119,317	9%
Water Heat	Water Heat Gt 55 Gal	30,206	8,339	28%	3,155	10%
	Water Heat Le 55 Gal	96,228	35,529	37%	8,090	8%

Commercial Sector—Natural Gas

As shown in Table 34, miscellaneous buildings and health facilities represent the largest shares of economic potential in the commercial sector (32% and 19%, respectively). As with the commercial electric sector, the miscellaneous segment includes: a combination of customers not fitting into the other categories, and those that would fit but presented insufficient information to be classified. Considerable savings opportunities can be expected in the commercial sector's retail (17%), office (7%), and lodging (13%) segments. Moderate savings amounts can be expected in restaurants and grocery facilities (Figure 14).

Figure 14. Commercial Sector Natural Gas Energy-Efficiency Economic Potential by Segment (Cumulative 2033)

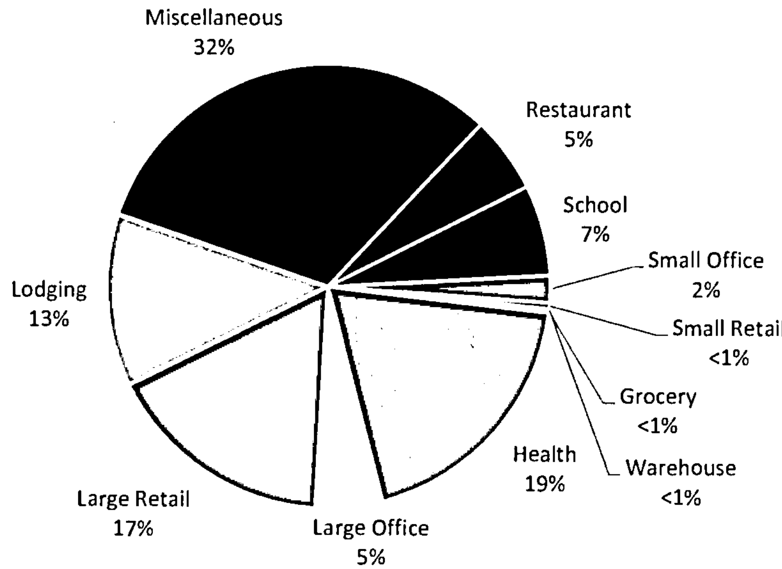


Figure 15 presents distributions of natural gas energy-efficiency economic potential by measure type. The largest portion of economic potential in the commercial sector (60%) comes from the furnace end use, followed by water heating (20%). Boilers account for 10% of economic potential, with pool heat and appliances accounting respectively for 7% and 2% of the remaining potential (as shown in Table 34).

Figure 15. Commercial Sector Natural Gas Energy-Efficiency Economic Potential by Measure Type (Cumulative 2033)

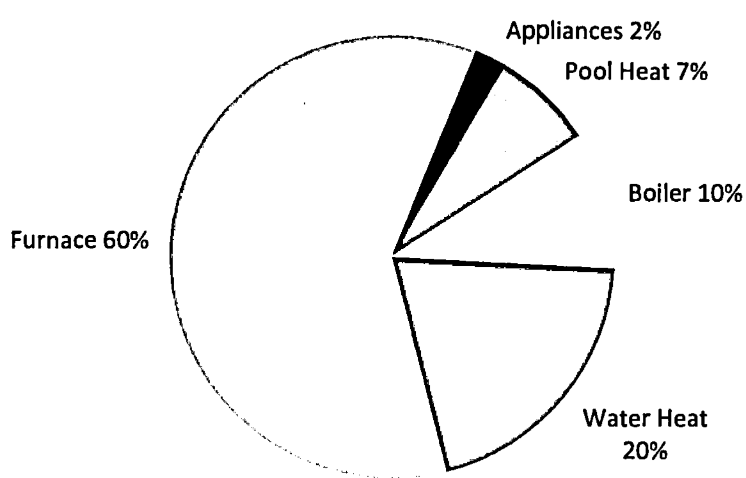


Table 34. Commercial Sector Gas Energy-Efficiency Potential by End Use (Cumulative 2033)

End Use	Baseline Sales (Thousand Therms)	Technical Potential		Economic Potential	
		Thousand Therms	% of Base Sales	Thousand Therms	% of Base Sales
Cooking	7,934	856	11%	293	4%
Space Heat Boiler	11,622	4,973	43%	1,253	11%
Space Heat Furnace	56,136	18,595	33%	7,585	14%
Water Heat Gt 55 Gal	5,154	1,671	32%	435	8%
Water Heat Le 55 Gal	8,481	3,006	35%	2,121	25%
Pool Heat	12,972	968	7%	939	7%

Achievable Potential

This study defines "achievable" potential as the portion of economic potential that can be targeted and acquired through energy-efficiency programs offered by the Company. Therefore, Cadmus measures and expresses achievable potential as a fraction (percent) of economic potential. While estimating technical and economic potentials remain fundamentally engineering and accounting 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 behavioral 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' upfront costs. In the case of new measures and programs, there are additional practical constraints regarding availability of delivery infrastructure. These barriers have been well documented in energy-efficiency literature.[9]

The utility can mitigate some of these market barriers through program design and delivery processes, while others remain out of a utility's reach. For example, a utility can reduce first-cost barriers by providing financial incentives to lower up-front costs and improve customer paybacks. However, since utility incentives only cover a portion of the incremental costs for most measures, incentives may not be sufficient to motivate a customer to adopt energy-efficiency measures. This particularly holds true for the commercial sector and large equipment in the residential sector, where up-front costs tend to be high. Thus, the task becomes one of assessing which barriers the Company can overcome over the course of the planning horizon, and how much economic potential can be deemed reasonably achievable.

To assess the fraction of customers who would likely adopt an energy-efficiency measure, the telephone surveys included a battery of questions to elicit information about customers' willingness to adopt measures under different *hypothetical* incentive scenarios. For a number of measure types (e.g., heating, cooling, lighting, weatherization), survey respondents were first asked if they would adopt efficient measures if the Company did not provide an incentive—corresponding to the low-achievable scenario. The Cadmus team then asked if the customer would adopt the efficient measure if the Company covered 50% of the measure's incremental cost (the cost to upgrade) —corresponding to the medium-achievable scenario. Finally, the surveys asked if a customer would adopt the efficient measure if the Company covered 75% of the measure's incremental cost—corresponding to the high-achievable scenario. Figure 16 and Figure 17 show residential and commercial customers' willingness-to-adopt efficient measures under the different incentive scenarios.

9 See for example William H. Golove and Joseph H. Eto, "Market Barriers to Energy Efficiency: A Critical Reappraisal of the Rationale for Public Policies to Promote Energy Efficiency," LBL-38059 UC-1322, March 1996.

Figure 16. Residential Willingness-To-Adopt by Measure Type

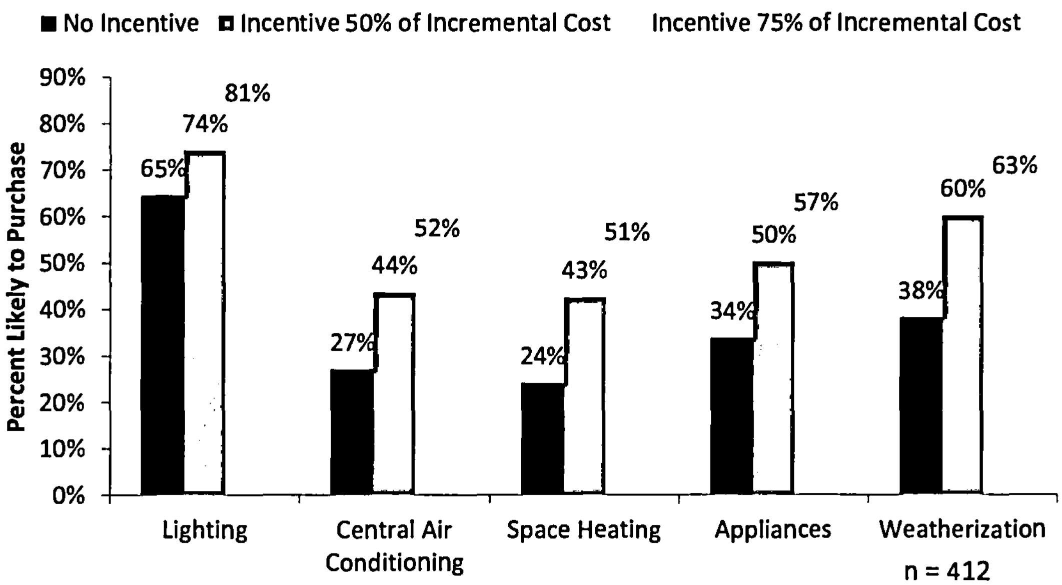
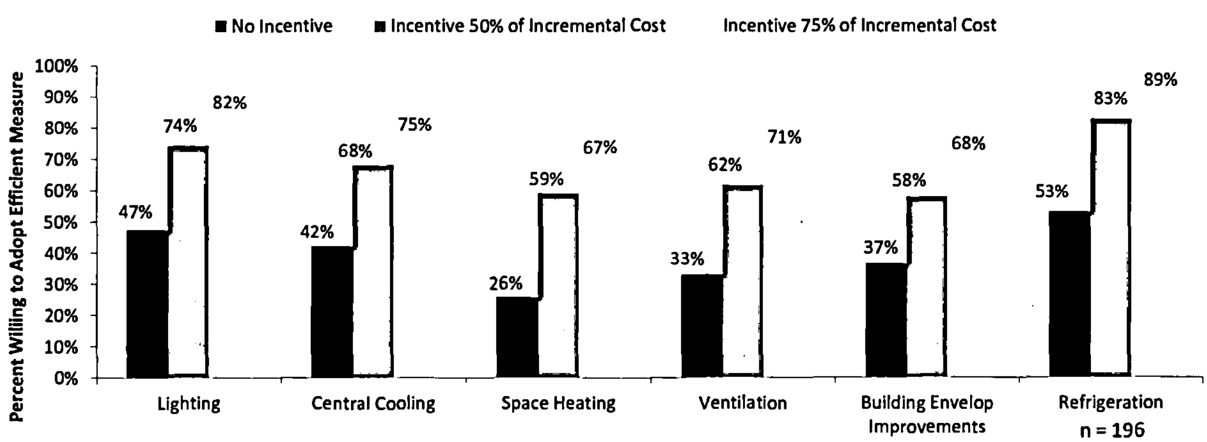


Figure 17. Commercial Willingness-To-Adopt by Measure Type



The Company's incentives cannot exceed their avoided cost of capacity. Cadmus determined the maximum incentive for each measure, based on the measure's demand savings and the Company's avoided costs. Cadmus then calculated the maximum one-time incentive (capped at $100/kW-year) that the Company could offer, and determined the corresponding percent of customers likely to adopt the measure under this "maximum incentive scenario."

The analysis of the incremental cost of measures included in this assessment indicates, for most measures, the maximum incentive of $100/kW-year translates to incentive amounts covering less than 50% of the measures' incremental cost. Thus, the maximum amount of achievable potential is expected to be limited to the fraction of customers likely to adopt the measure at a 50% incentive.[10] Figure 18 shows the weighted average, maximum, achievable potential for each measure group, corresponding with the maximum incentive. Table 35 summarizes electric achievable energy potential under low, medium, and high scenarios. Table 36 shows achievable demand savings (MW) in 2033.

Figure 18. Commercial Willingness-to-Adopt with Max ($100/kW-year) Incentive

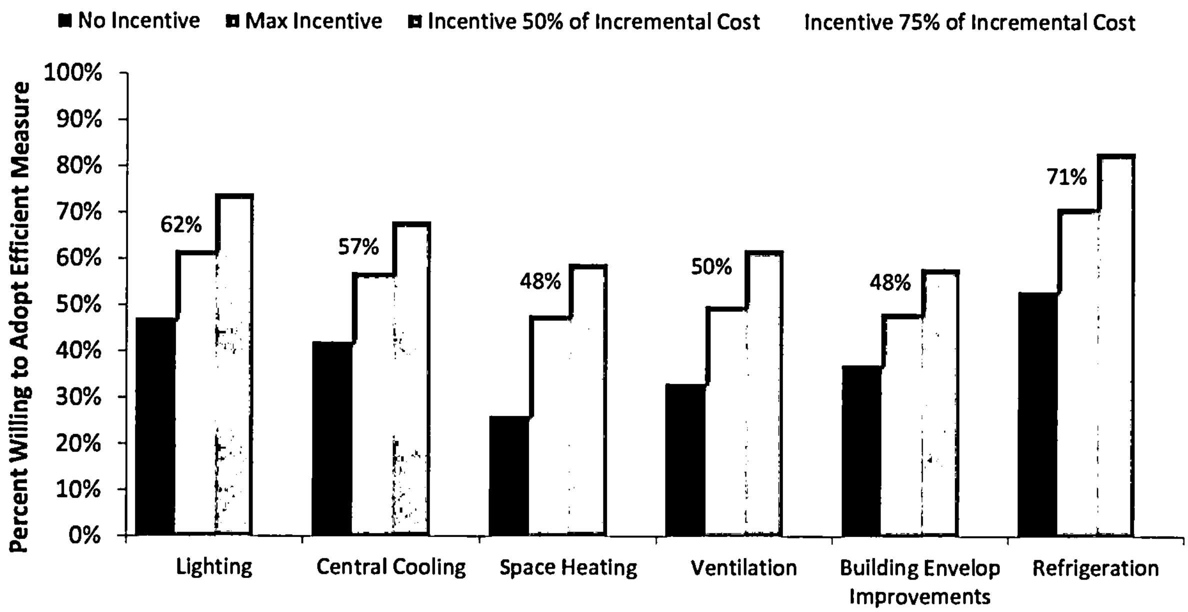


Table 35. Electric Achievable Energy Potential by Sector (Cumulative 2033)

		Low Achievable		Medium Achievable		High Achievable	
Sector	Base Case Sales (MWh)	MWh	% of Base Sales	MWh	% of Base Sales	MWh	% of Base Sales
Residential	14,225,644	602,136	4.2%	920,185	6.5%	1,005,172	7.1%
Commercial	9,990,199	339,437	3.4%	461,670	4.6%	473,173	4.7%
Total	24,215,844	941,572	3.9%	1,381,855	5.7%	1,478,345	6.1%

Table 36. Electric Achievable Demand Potential by Sector (In 2033)

Sector	Low Achievable - MW	Medium Achievable - MW	High Achievable - MW
Residential	51	78	86
Commercial	97	133	139
Total	148	211	225

[10] While the average maximum incentive for each measure group is less than 50% of the incremental cost, the maximum incentive exceeds 50% of the incremental cost for a handful of measures. For these measures, high achievability is greater than medium achievability.

Estimation of achievable potential for natural gas followed the same approach with two exceptions:

1. Unlike electric programs, where incentives are constrained by the Company's avoided capacity cost, cost-effectiveness for gas programs are determined on the basis of natural gas commodity costs. This means the high scenario reflects incentives that may cover up to 75% of a measure's incremental cost.
2. Natural gas measures are limited to a few end uses, namely space heating, water heating, and building envelope improvements. These measures generally have higher up-front costs than most electric measure. Most natural gas measures consist of equipment that generally tends to be replaced only upon burnout. Therefore, achievable potential for natural gas is expected to be lower than for electric measures.

Analysis results show similar levels of achievable natural gas efficiency potential in the residential and commercial sectors, representing about 8% to 9% of sales, as shown in Table 37.

Table 37. Gas Achievable Potential by Sector (Cumulative 2033)

		Low Achievable		Medium Achievable		High Achievable	
Sector	Base Case Sales (Thousand Therms)	Thousand Therms	% of Base Sales	Thousand Therms	% of Base Sales	Thousand Therms	% of Base Sales
Residential	186,454	10,052	5%	16,695	9%	17,449	9%
Commercial	102,299	4,659	5%	7,603	7%	8,564	8%
Total	288,753	14,711	5%	24,298	8%	26,013	9%

The results also show that, assuming incentives covering 50% of incremental measure costs, savings equal to approximately 8% of sales might be achieved in the residential and commercial sectors, combined. Moreover, higher incentives covering up to 75% of incremental measure costs can be expected to only marginally increase achievable potential.

Types of Energy-Efficiency Potential

Energy-efficiency measures generally fall into one of two discretionary (retrofit) or non-discretionary (lost opportunity) groups. Discretionary measures (e.g. lighting upgrades in the commercial sector) may be implemented immediately, financial and practical considerations notwithstanding. Non-discretionary measures include measures that are typically implemented only on burnout of the existing equipment (normal turn-over) and new construction. The key difference between the two measures types is that unlike retrofit measures, the availability of lost-opportunity resources is determined by market forces that are outside the program administrator's control.

As shown in Table 38 , over three-quarters (1,060 GWh) of the estimated medium-case achievable electric efficiency programs of 1,382 GWh is expected to consist of discretionary measures. For natural gas, the discretionary potential is 19,544 and the lost opportunity is 4,753 therms out of the total 24,298 through 2033.

For natural gas, of the nearly 24.3 million therms of medium-case achievable potential, 19.5 million therms are discretionary and about 4.8 million therms are lost-opportunity.

Table 38. Cumulative Electric and Natural Medium-Case Achievable Potential by Type (in 2033)

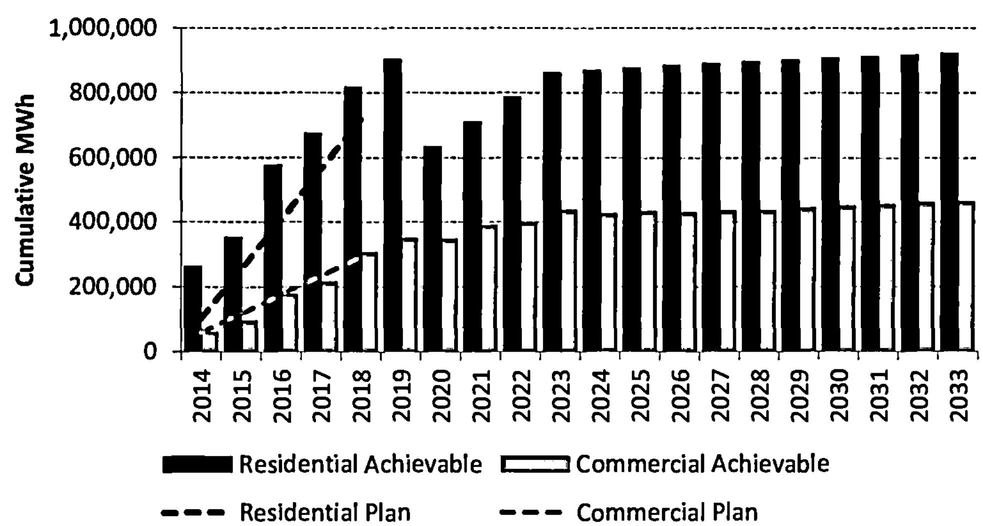
Measure Type	Electric Energy (MWh)	Electric Demand (MW)	Natural Gas (1000 Therms)
Discretionary	1,060,217	160	19,544
Lost Opportunity	321,638	51	4,753
Total	1,381,855	211	24,298

Planning Implications

For electricity, the cumulative achievable energy potential has been shown to be 1,060 GWh for the 20 year study period; where 67% is residential for 706 GWh and 33% is commercial for 354 GWh. This translates into a levelized annual savings of roughly 35,000 MWh in the residential and less than 18,000 MWh per year in the commercial sector, for a total of 53,000 MWh per year over the 20-year planning horizon on average.

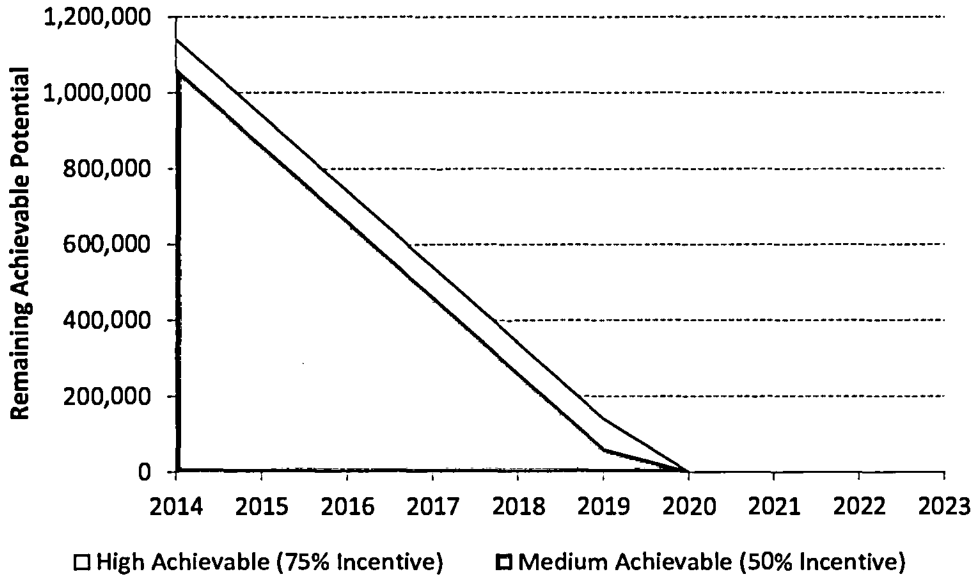
The Company's 2012-2018 demand-side management plan currently targets average annual electricity savings of 140,000 MWh for the residential and 60,000 MWh for the commercial sector. Maintaining existing targets would mean the Company would exhaust achievable electric efficiency potential in less than six years. Even under this accelerated acquisition, commercial achievable potential through 2018 is less than planned savings, as shown in Figure 19. Residential electric efficiency targets are less than cumulative achievable potential in the first five years of the study; however, it will be difficult for the company to sustain these targets in the long-run.

Figure 19. Comparison of Annualized Medium-Case Achievable Potential and 2012-2018 Annual Targets



Compared to the estimated annual potential, the Company's targets are well above the 53,000 MWh estimated annual potential from the residential and commercial sector. As Figure 20 illustrates, the results of this study indicate that the Company's planned acquisition rate of 200,000 MWh per year would deplete the medium-case achievable discretionary potential of 1,060,000 MWh in a little more than 5 years, starting in 2015.

Figure 20. Remaining Medium Case Achievable Discretionary Electric Energy-Efficiency Potential



Unlike electric energy-efficiency, eighty percent of gas energy-efficiency potential comes from retrofit measures. This means savings is less dependent on new construction rates and the natural turnover of equipment. Therefore, the Company has relatively more control over the timing of natural gas savings.

While this study indicates that the Company will exhaust the discretionary residential and commercial electric energy-efficiency potential in less than six years, small amounts of non-discretionary savings from new construction and replacement of existing equipment upon burnout will remain. While Cadmus only considered current equipment costs and existing technologies, potential declines in the cost of energy-efficient existing energy-efficiency technologies and emergence of new technologies could provide additional opportunities for further savings.