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with the assistance of

- GDS Associates, Inc.

ENERGY EFFICIENCY AND DEMAND RESPONSE POTENTIAL FOR IOWA MUNICIPAL UTILITIES

FOR THE YEARS 2012 AND 2018

June 2009

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A Report for the Iowa Association of Municipal Utilities

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

EXECUTIVE SUMMARY

The Iowa Association of Municipal Utilities (IAMU) retained the Energy Center of Wisconsin (Energy Center) to conduct an empirical assessment of energy efficiency and demand response potential in IAMU member service territory. The Energy Center drew on the expertise of our co-consultants on this project, GDS Associates. One hundred and fifty four IAMU members elected to participate in this study. The study does not include energy efficiency potential in the service territories of the 17 non-participating IAMU member utilities.

METHODOLOGY

The Energy Center's Microsoft Excel®-based model was used to conduct cost-effectiveness screening and evaluate over 500 unique energy efficiency and demand response measures across three sectors: residential, commercial, and industrial. We employed a bottom-up approach for estimating energy efficiency potential in the residential sector, aggregating savings potential associated with individual types of energy-using equipment found in Iowa homes. We employed a top-down approach for assessing energy efficiency potential in the commercial and industrial sectors, disaggregating savings estimates based on an assumed distribution of energy use within each market segment.

Though we evaluated technical and economic efficiency potential, our analysis focused on estimating achievable energy efficiency potential, or the annual savings that could be achieved by utility programs in a given year. Achievable potential estimates consider cost-effectiveness as well as key time-related and program-related constraints, so they are generally more useful to decision-makers than estimates of technical or economic potential. For 2012 we project what could be achieved under a moderate level of program effort, and for 2018 we project what could be achieved under an aggressive level of program effort. We also conducted a sensitivity analysis to estimate energy efficiency and demand reduction potential under a scenario where carbon prices increase avoided costs by 35 to 70 percent.[1]

As a supplement to base estimates of energy efficiency and demand response potential, the Energy Center conducted additional analyses of demand reduction potential from dynamic energy pricing; estimated energy efficiency potential associated with improvements to utility distribution systems; and presented information on innovative energy efficiency program models that are well-suited for deployment in municipal utility service territories.

RESULTS

Under moderate levels of energy efficiency program effort, we estimate that by 2012 IAMU members could save 58.5 gigawatt hours (GWh) of electric energy per year, reduce peak electric demand by 14.5 megawatts (MW), and save 869,000 therms of natural gas/propane per year.[2] Expressed as a percentage of projected baseline energy sales for 2012, these results are equivalent to 1.1 percent of projected 2012 electricity sales, 1.2 percent of projected peak electric demand, and 1.0 percent of projected natural

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[1] Under the carbon scenario, on-peak avoided costs were increased by around 35 percent, and off-peak avoided costs were increased by around 70 percent.

[2] Throughout this study, references to natural gas savings potential include natural gas and propane savings resulting from installation of energy-efficient technologies.

gas/propane sales. Achieving these results would reduce greenhouse gas emissions by approximately 51,000 tons per year.

By 2018, IAMU members could save 69.4 GWh of electric energy per year, reduce peak electric demand by 23.5 MW, and save 1.5 million therms of natural gas/propane per year. These results are equivalent to 1.2 percent of projected 2018 electricity sales, 1.8 percent of peak electricity demand, and 1.8 percent of natural gas sales. Achieving these results would reduce greenhouse gas emissions by approximately 63,000 tons per year.

It is important to note that in the residential sector, natural gas savings estimates are particularly sensitive to input assumptions for a few key energy efficiency measures—specifically, geothermal (ground source) heat pumps and whole-home weatherization and direct install initiatives. These measures are close to the cost-effectiveness threshold, however, and slight changes to input assumptions have a significant effect on savings potential estimates. Our analysis found geothermal heat pumps to be a cost-effective measure for natural gas utilities, but the benefit/cost ratio is between 1.02 and 1.04. Similarly, our analysis found weatherization/direct install efforts for multifamily rental housing (1-4 units) to be cost-effective (benefit/cost ratio of 1.01-1.14), but weatherization/direct install for single family homes was slightly below the cost-effectiveness screen (benefit/cost ratio of 0.81-0.92).

Depending on local market conditions and cost-effectiveness screening assumptions, geothermal heat pumps may not represent an attractive opportunity for some utilities. Conversely, a single family home weatherization/direct install effort could be a desirable program offering for some utilities. Estimates of 2012 residential natural gas savings potential range from 105,000 therms to 560,000 therms, depending on whether these measures are included in the model or not. Estimating energy efficiency potential involves assessment of a broad range of technologies, and there is a range of uncertainty around each of the parameters used in evaluating cost-effectiveness (*e.g.*, incremental costs, measure lifetime, savings, etc.). When it comes to measures with significant energy savings potential, such uncertainty can have a significant effect on overall results. The development of an effective energy efficiency portfolio requires comprehensive planning at the local level, taking local policy objectives and market conditions into account.

We also conducted a sensitivity analysis to assess the effect of a carbon price on energy efficiency and demand reduction potential. We used a price of $30 per ton of carbon dioxide (CO_2) emitted, which increased utility avoided costs by around 35 percent for on-peak power and 70 percent for off-peak power, and around 20 percent for natural gas. With the carbon price in effect, electricity savings potential is approximately 11 percent higher in 2012 and 18 percent higher in 2018. Peak demand reduction potential is around eight percent higher in 2012 and nine percent higher in 2018. Natural gas savings potential is approximately 17 percent higher in 2012 and 25 percent higher in 2018.

Our analysis of the demand reduction potential associated with dynamic pricing estimates that residential time of use pricing could reduce projected 2012 peak demand by 0.4 percent. Critical peak pricing in the residential market is estimated to reduce 2012 peak demand by between 0.8 percent and 1.3 percent. Critical peak rates in the commercial sector are estimated to reduce 2012 peak demand by around 0.5 percent.

The Energy Center's assessment of energy efficiency opportunities on the utility distribution system focused on two technologies: energy efficient transformers and low-loss surge arresters. We estimate that these technologies could reduce distribution system losses by between 1,400 and 2,700 MWh each year, which is equivalent to 0.03 percent to 0.06 percent of total IAMU electricity sales.

Innovative energy efficiency program models that are well-suited for deployment in municipal utility service territories include community energy initiatives that conduct targeted energy efficiency outreach at the community level; neighborhood-based direct install and retrofit initiatives; behavior-based programs such as home energy audits targeting opportunities to reduce household plug load, and social marketing initiatives that provide feedback on household energy usage; and programs offering upstream incentives to retailers, equipment suppliers, or other market actors to reward increased sales of energy efficient products.

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INTRODUCTION

STUDY SCOPE

On behalf of IAMU, the Energy Center has developed estimates of energy savings and peak demand reduction that could be achieved in IAMU member service territories by the end of 2012 (in four years). Our analysis also includes a longer-range forecast of energy savings and peak demand reduction that could be achieved in IAMU member service territories by the end of 2018 (in ten years). It is important to note that 2012 and 2018 are intended as general reference points rather than absolute deadlines. Decisions about how quickly energy efficiency program activities should be ramped up from current levels to achieve projected levels of energy savings potential involve policy, resource allocation, and program design considerations that must be evaluated by each individual utility.

In general, we place greater emphasis on the 2012 estimates of energy efficiency potential, given the high level of uncertainty associated with a ten-year projection. Energy prices, technology costs, technology development, the state of the economy, and federal climate policy are all factors that will have a dramatic effect on energy efficiency potential in the coming decade. In the current economic downturn these factors are more difficult to predict than ever. As many of the policies and technologies that could have a significant impact in four years are at least visible on the horizon today, the four-year forecast entails a lower degree of uncertainty than the ten-year forecast.

Energy efficiency potential can be assessed at several levels:[3]

- ***Technical potential***: A measurement of the theoretical maximum level of potential energy savings, assuming immediate implementation of all technologically feasible energy efficient technologies regardless of cost-effectiveness.

- ***Economic potential***: A subset of technical potential, assuming immediate implementation of the most cost-effective energy efficient technology for any given application.

- ***Achievable potential***: A measurement of the level of savings that could realistically be achieved by energy efficiency programs within a specified time horizon, given limiting factors such as cost-effectiveness, capital constraints, the useful lifetime of existing installed equipment, program ramp-up time, and other barriers that affect adoption of energy efficiency measures.

As achievable potential estimates take cost-effectiveness as well as key time-related and program-related constraints into account, they are generally more useful to decision-makers than estimates of technical or economic potential. For the purposes of this study, we focus on achievable potential results, but provide context by summarizing technical and economic potential.

It is also important to distinguish between ***annual potential*** and ***cumulative potential***. Annual potential represents the first-year savings attributable to energy efficiency measures installed in a given year. Cumulative potential addresses a specified time period, and represents aggregate savings associated with

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[3] National Action Plan for Energy Efficiency (2007). *Guide for Conducting Energy Efficiency Potential Studies*. Prepared by Mosenthal and Jeffrey Loiter, Optimal Energy, Inc. Available at: www.epa.gov/eeactionplan.

measures installed within that time period, factoring in the useful lifetime of installed equipment. Study results are reported in terms of annual potential, unless otherwise indicated.

Efficiency potential estimates do not include the impacts of naturally-occurring efficiency improvement, as such effects are not attributable to energy efficiency program activity. Naturally-occurring efficiency includes energy savings that result from changes in federal equipment efficiency standards, as enacted through statutes such as the Energy Policy Act of 2005 (EPAct 2005) and the Energy Independence and Security Act of 2007 (EISA 2007). Naturally-occurring efficiency can also arise from established state or local codes and standards, such as energy-related building codes. The efficiency improvements associated with current and known future changes to codes and standards are included in the baseline, and thus are not part of the efficiency potential estimates in this study.

Potential estimates include the effects of measure interaction, where installation of an energy efficiency measure that has a primary effect on one end use (such as lighting) produces a corresponding secondary effect on another end use (such as heating or cooling). Interactive effects can cause an increase or decrease in the energy consumption associated with the secondary end use. The majority of interactive effects considered in the analysis are associated with fuel switching measures (e.g., switching from an electric water heater to a natural gas water heater), heating penalties and cooling benefits associated with installation of energy efficient lighting and equipment, and insulation/air sealing measures that save electricity used for cooling and natural gas used for heating. This approach provides accuracy beyond the level achieved by many potential studies, which consider the fuels separately. Failing to account for measure interaction has a significant impact on the accuracy of potential study results.

METHODOLOGY

Energy Efficiency Potential Model

The Energy Center developed an Excel-based model to conduct cost-effectiveness screening and develop energy efficiency potential estimates. This straightforward analytic tool was used to evaluate over 500 unique energy efficiency and demand response measures across three sectors: residential, commercial, and industrial. A list of global modeling assumptions is provided in Appendix A.

Key inputs in the energy efficiency potential model include: base energy consumption, disaggregated by market segment and end use; market saturation for standard efficiency equipment and energy efficient equipment; a technical feasibility factor;[4] primary fuel savings; demand reduction for electricity-saving measures; secondary fuel impacts caused by measure interactions;[5] measure costs (including incremental equipment costs, installation costs, and annual operations and maintenance costs); and measure lifetimes,

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[4] The technical feasibility factor was only used in estimating technical and economic potential. Estimates of achievable potential used an “achievable factor” which incorporates the effect of three key factors: (1) technical/engineering convertibility; (2) the share of the market that is not yet energy efficient (sometimes referred to as a “remaining factor”); and (3) the degree of influence an energy efficiency program is expected to have on market penetration of the technology.

[5] As noted above, the primary measure interactive effects considered in the analysis are associated with fuel switching, heating penalties and cooling benefits achieved through installation of energy efficient lighting, and insulation/air sealing measures that save electricity used for cooling and natural gas used for heating.

both for the energy efficient technology and the standard efficiency equipment it is replacing. Each technology is also assigned an "achievable factor," which quantifies the expected impact an energy efficiency program could have on the market penetration of that technology in a given year. This achievable factor is broader than the achievable factor definition typically used in potential studies. Here it accounts for convertibility (the technical/engineering feasibility of converting equipment to a more energy efficient alternative) and the amount of equipment that has not already been converted to a more energy efficient technology (sometimes referred to as a "remaining factor"), in addition to accounting for a program's ability to influence market penetration of the technology. (For additional information on the Energy Center's approach for developing achievable factors, see the "Survey of Experts" section below).

There are two primary analytical approaches to modeling energy efficiency potential: bottom-up and top-down. The bottom-up approach begins at the measure level, multiplying the costs and savings associated with deploying each energy efficient measure by the number of units of each measure expected to be installed during the study period, and aggregating the results. The top-down approach begins with a forecast of energy sales over the study period, and disaggregates this forecast within each sector by market segment and end use. Each energy efficient technology reduces the base forecast by a certain percentage, and the difference between the base forecast and the efficiency forecast represents efficiency potential.[6] As end use energy consumption is relatively homogeneous within the residential sector, the Energy Center was able to use a bottom-up approach for the residential market. The commercial and industrial (C&I) sectors require a top-down approach, given the variability in energy end use and technology installations across market segments and facility types.

In estimating energy efficiency potential, the model uses electricity and natural gas sales data by sector, as reported in the U.S. Department of Energy's Energy Information Administration (EIA) reports 861 and 176. As the most recent available sales data were from 2006, energy efficiency potential estimates were scaled up to projected 2012 and 2018 sales levels using sector-specific annual sales growth rates by fuel.[7] Annual sales growth rates by fuel and by sector are listed in Appendix A, *Global Modeling Assumptions*.

This analysis focused on developing estimates of annual energy efficiency potential for 2012 and 2018. These years were selected as general reference points to represent shorter-term and longer-term planning horizons, rather than definitive deadlines. We also developed rough estimates of cumulative energy savings through 2018. Cumulative potential estimates were developed by aggregating estimated annual savings through 2018, based on an assumed ramp-in from current energy efficiency program savings levels through projected annual savings levels in 2012 and 2018. IAMU provided data for each participating utility, showing annual electricity and/or natural gas savings resulting from energy efficiency programs in 2006.[8] Annual savings were ramped up from 2006 levels to projected 2012 and

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[6] National Action Plan for Energy Efficiency (2007). *Guide for Conducting Energy Efficiency Potential Studies*. Prepared by Mosenthal and Jeffrey Loiter, Optimal Energy, Inc. Available at: www.epa.gov/eeactionplan.

[7] As sales forecasts for IAMU member utilities were not available, we used average annual sales growth rates by sector and by fuel as forecast by Iowa investor-owned utilities (IOUs). These sales forecasts are reported in: Quantec (2008). *Assessment of Energy and Capacity Savings Potential in Iowa*. Prepared for the Iowa Utility Association in collaboration with Summit Blue Consulting, Nexant, Inc., A-TEC Energy Corporation, and Britt/Makela Group.

[8] In 2006, IAMU members reported average electric and natural gas savings of 0.2 percent of baseline sales. For the most part, reported savings results were not derived through an independent third party evaluation, so the Energy Center applied an assumed net-to-gross (NTG) ratio of 0.7, resulting in estimated net savings of 0.14 percent of

2018 levels using by assuming a constant annual growth rate from 2006 through 2012, and from 2012 through 2018.

As previously noted, the model accounts for the effects of measure interaction, where installation of an energy efficiency measure affects multiple energy end uses. In some cases, measure interaction also affects multiple fuels. For example, installation of a programmable thermostat saves electricity used for cooling and natural gas used for heating. However, the IAMU members participating in this study include single fuel utilities (providing either electric or natural gas service) as well as dual fuel utilities (providing electric and natural gas service). For that reason, secondary fuel effects have been subtracted from overall potential if they occur within the service territory of single-fuel utility. In the case of the programmable thermostat example described above, natural gas potential estimates are reduced to account for savings that would occur in areas where an IAMU member does not provide natural gas service.

Cost-Effectiveness Screening

Cost-effectiveness screening was conducted using the Total Resource Cost (TRC) test, which compares the net present value of benefits achieved over the lifetime of the measure with the costs incurred by the program and the participant.[9] Measures with a benefit/cost ratio of 1.0 or greater pass the TRC test and are cost-effective.

For the purposes of this analysis, quantified benefits include the avoided cost of conserved energy and an externality factor that accounts for the additional societal benefits associated with avoided energy consumption and demand reduction.[10] The benefits of secondary fuel savings are also included in the TRC, since these savings are realized at the customer level, regardless of whether the utility is single fuel or dual fuel.

Costs include all expenses associated with measure installation, including equipment and labor costs, as well as program administrative costs. Since incentives are essentially a transfer payment from program to participant, they represent a portion of the measure cost and are not disaggregated for the purposes of the TRC test.

Survey of Experts

The Energy Center used two key data sources in developing achievable factors for the energy efficiency measures addressed in this study: a survey of Wisconsin energy efficiency experts (with results modified for Iowa-specific attributes), and IAMU member surveys.

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electricity and natural gas sales, respectively, for 2006. The assumed NTG ratio is consistent with portfolio-level NTG ratios achieved by programs in other states.

[9] The societal test referenced in Iowa Administrative Code (199 IAC 25) is typically described as a variation of the TRC test. The key difference is that the societal test includes externality effects (avoided pollution, etc.), while the TRC typically does not. However, the version of the TRC test used in this analysis includes the externality factors specified in Iowa Administrative Code, so it approaches the societal test quite closely. Detailed information on economic screening methodology is available in the California Standard Practice Manual, available at: http://drrc.lbl.gov/pubs/CA-SPManual-7-02.pdf.

[10] The Energy Center used externality factors specified in the *Iowa Administrative Code* (Sec. 199—35.9(476) and 199—35.10(476)): a 10% adder for electricity, and a 7.5% adder for natural gas.

In the fall of 2008, the Energy Center surveyed more than 30 Wisconsin-based energy efficiency experts to obtain their estimates of future market penetration for a range of energy efficient technologies. Participants were asked to specify the level of market penetration that could be achieved through moderate and aggressive energy efficiency program efforts, as compared with a “no program” scenario. This survey provided a rich source of data on expected future trends for a wide array of energy efficient technologies. Supporting the application of Wisconsin survey data to the Iowa study, the two states have many similarities in terms of climate, demographics, and energy efficient technology markets. At the same time, there are important differences in terms of specific technology markets—for example, ground source heat pumps are more prevalent in Iowa, and there is wider use of central air conditioning. In addition, the energy efficiency program landscape is different. In Wisconsin, statewide energy efficiency programs have been in place since 2000, while IAMU members have varying degrees of experience with program implementation. In addition, assessing efficiency potential for a geographically dispersed group of municipal utilities requires a different approach than assessing statewide potential.

For these reasons, it was important to obtain IAMU member input on what they expect energy efficiency programs can achieve in their communities. One survey, sent to all IAMU members participating in the study, solicited member input on reasonable levels of program expenditures and energy savings for their service territory, and asked them to identify barriers to promoting greater levels of energy efficiency in their community. We also developed a targeted survey that was sent to 16 municipal utilities with existing energy efficiency programs to obtain their input on expected market penetrations for key technologies in 2012, based on a comparison with Wisconsin survey results. Survey instruments are provided in Appendix G.

The Energy Center used results from these surveys, as well as information on typical results achieved by best practice energy efficiency programs, to develop the achievable factors used in the IAMU potential study. Achievable factors were developed for 2012 and 2018. As some IAMU members do not have energy efficiency programs in place or are in the early stages of program planning, the 2012 achievable factors are based on an expectation of what could be achieved under a moderate level of program effort, and the 2018 achievable factors are based on an expectation of what could be achieved under an aggressive level of program effort.

It is important to note that a number of IAMU members already have well-established and successful energy efficiency programs in place. These utilities could be able to achieve the aggressive levels of energy efficiency projected for 2018 sooner than those utilities that do not yet have programs in place.

Allocation of Potential and Program Costs to IAMU Member Service Territory

The Energy Center conducted a high-level allocation of achievable energy efficiency potential and program costs to individual IAMU member service territories using utility-specific data on base energy sales by sector (residential, commercial, and industrial). EIA reports 861 and 176 were used to determine electricity and natural gas sales by sector for each utility participating in the study. Energy efficiency potential was allocated to individual utilities by multiplying total savings potential across all participating utilities by each utility’s individual share of aggregate sales. Potential was further disaggregated by sector, based on each utility’s relative share of residential, commercial, and industrial sales. A similar approach was used to estimate sector-level shares of energy efficiency program expenditures for each utility. This allocation process was conducted for the 2012 achievable potential and program cost estimates only. Allocation estimates are presented in Appendix F.

Sensitivity Analysis

As discussed above, the base analysis includes an externality factor to account for the additional societal benefits associated with avoided energy consumption and demand reduction—a 10 percent increase to avoided costs for electricity, and a 7.5 percent increase to avoided costs for natural gas. However, these externality costs are low compared with potential costs associated with carbon emissions, should federal legislation regulating carbon emissions be enacted. Therefore, we conducted a sensitivity analysis to estimate energy efficiency and demand reduction potential under a carbon cost scenario. We relied on the 2008 levelized carbon cost estimate reported by Synapse Energy Economics under its medium-range forecast, which equates to $30 per ton of CO_2 emitted.[11] Using Iowa emissions factors,[12] this carbon price equates to $0.0235/kWh and $0.18/therm, on top of base avoided costs. This carbon price is between three and seven times higher than the base analysis externality factor for electricity, and over two times higher than the base analysis externality factor for natural gas. (See Appendix A for a summary of avoided costs, externality factors, and carbon prices used in this analysis).

Supplementary Analyses

In addition to the primary analysis of energy efficiency and demand response potential which relied on the Excel-based model discussed above, the Energy Center conducted three supplementary analyses: (1) an assessment of demand reduction potential from dynamic energy pricing; (2) an assessment of energy efficiency opportunities resulting from improvements to utility distribution systems; and (3) descriptions of innovative energy efficiency program models that are well-suited for deployment in municipal utility service territories.

As depth pricing-based forecasting was beyond the scope of this study, we developed a first-order estimate of the demand reduction potential associated with dynamic pricing structures by applying general assumptions reported in the demand response section of the Iowa investor-owned utilities' (IOUs) 2008 potential study.[13] This approach was used to evaluate the demand reduction potential associated with time of use rates for residential customers, and critical peak pricing for residential and commercial customers.

To evaluate energy efficiency improvements on the utility distribution system, we considered two key opportunities: transformers and surge arrestors.[14] We conducted research into the potential savings associated with supply-side and demand-side transformers, and evaluated the effect that new federal standards for transformer efficiency are likely to have on energy savings potential. We conducted similar research and analysis for surge arrestors, a supply-side improvement opportunity.

Lastly, we conducted research on energy efficiency program best practices to identify a number of innovative program models that are well-suited for deployment in municipal utility service territory.

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[11] Synapse Energy Economics, Inc. (2008). *Synapse 2008 CO_2 Price Forecasts*.

[12] Center for Climate Strategies (2008). *Final Iowa Greenhouse Gas Inventory and Reference Case Projections 1990-2025*.

[13] Quantec (2008). *Assessment of Energy and Capacity Savings Potential in Iowa*. Prepared for the Iowa Utility Association in collaboration with Summit Blue Consulting, Nexant, Inc., A-TEC Energy Corporation, and Britt/Makela Group.

[14] Cooper Power Systems provided information on distribution system energy efficiency opportunities which was integral to this analysis. For additional information, please visit: www.cooperpower.com.

RESULTS

ENERGY EFFICIENCY

Combined Resource Potential: Technical, Economic, and Achievable

As discussed above, technical potential assumes that all technologically feasible energy efficient technologies are deployed immediately, regardless of cost-effectiveness. The Energy Center estimates that the technical energy efficiency potential in IAMU member service territory is equivalent to 33 percent of baseline electricity consumption, 52 percent reduction of peak electricity demand, and 28 percent of natural gas consumption. Economic potential—which assumes immediate deployment of all cost-effective energy efficient technologies—is equivalent to 22 percent of baseline electricity consumption, 39 percent reduction of peak electricity demand, and 21 percent of natural gas consumption.

Achievable potential is the more meaningful metric for the purposes of establishing energy savings goals and energy efficiency program planning, as this estimate takes into account the myriad factors that affect adoption of energy efficiency measures, including cost-effectiveness, capital constraints, the useful lifetime of existing installed equipment, and program ramp-up time. The Energy Center developed achievable potential estimates for 2012 and 2018, estimating the annual energy savings that IAMU member programs could achieve in those years. In 2012, under moderate levels of energy efficiency program investment, achievable potential is equivalent to 1.1 percent of baseline electricity consumption, 1.2 percent of peak electricity demand, and 1.0 percent of natural gas consumption. In 2018, under aggressive levels of energy efficiency program investment, achievable potential is equivalent to 1.2 percent of baseline electricity consumption, 1.8 percent reduction of peak electricity demand, and 1.8 percent of natural gas consumption.

Figures 1 through 3 compare technical and economic potential with 2012 and 2018 annual achievable potential in IAMU member service territory for electric efficiency, peak demand reduction, and natural gas efficiency, respectively.

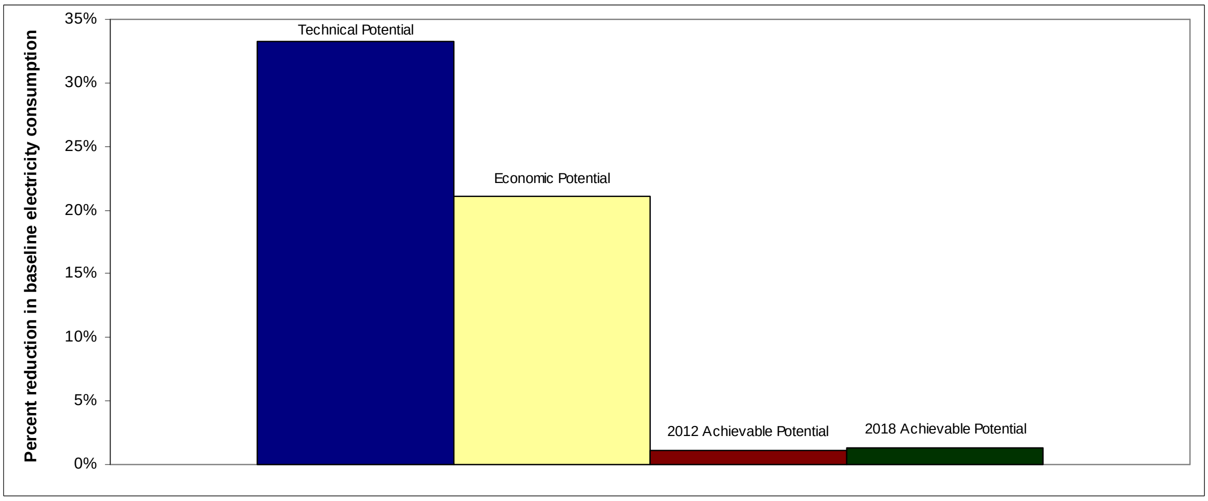

Figure 1: Comparison of Technical, Economic, and Achievable Potential for Electric Efficiency

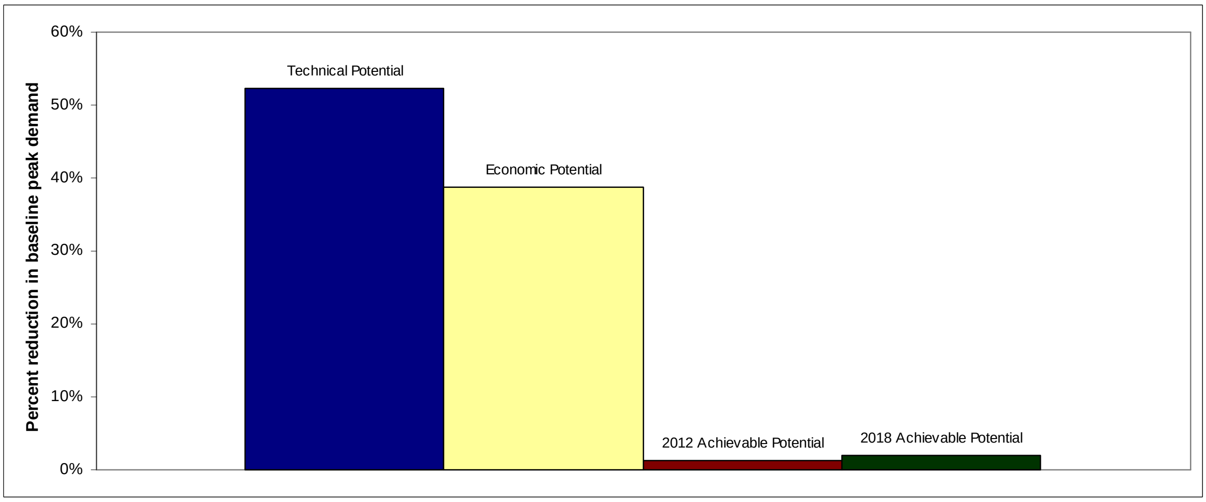

Figure 2: Comparison of Technical, Economic, and Achievable Potential for Peak Demand Reduction

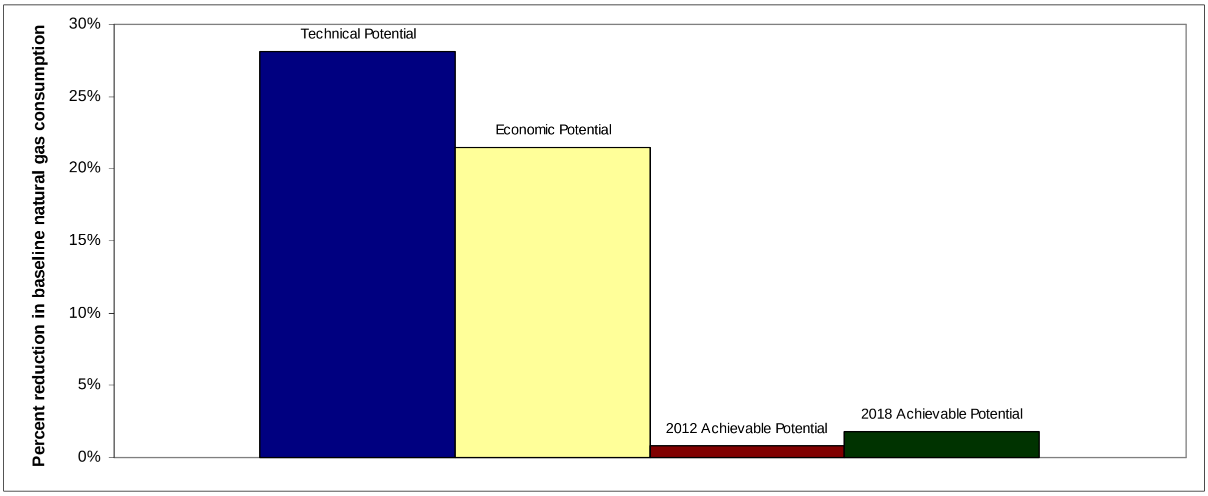

Figure 3: Comparison of Technical, Economic, and Achievable Potential for Natural Gas Efficiency

The annual achievable potential results presented above would produce a cumulative reduction in baseline electricity consumption of 4.3 percent by 2012 and 11 percent by 2018, and a cumulative reduction in baseline natural gas consumption of 4.1 percent by 2012 and 13 percent by 2018.[15] The cumulative energy savings potential trend is shown in Figure 4.

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[15] As discussed previously, cumulative potential represents the aggregate savings from each year of annual savings as energy efficiency programs ramp up from current levels to 2012 levels of moderate investment, and 2018 levels of aggressive investment.

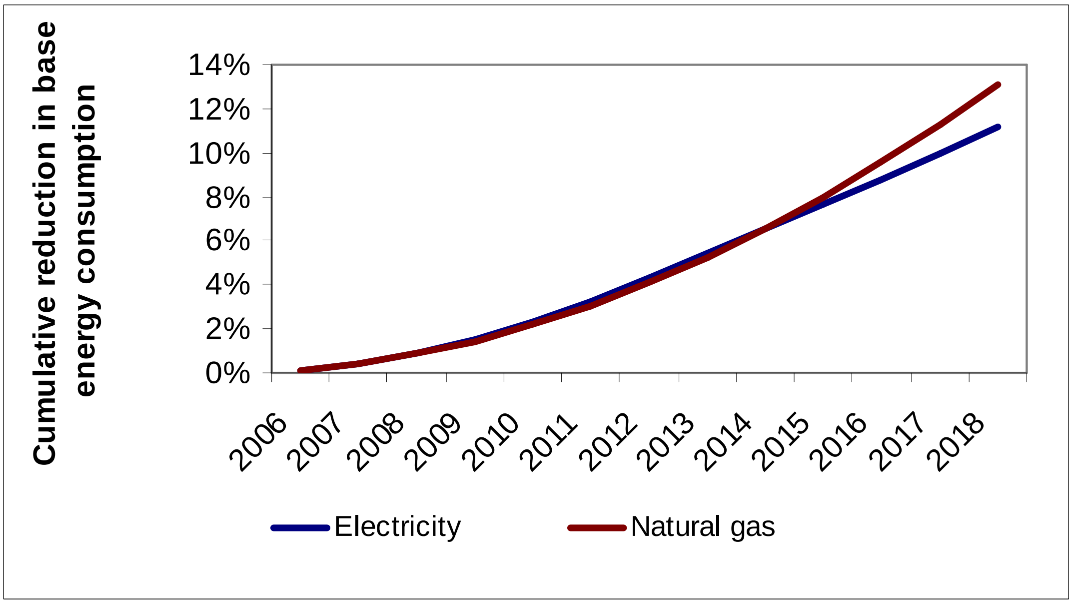

Figure 4: Cumulative Electricity and Natural Gas Achievable Potential through 2018

Costs and Benefits of Projected Energy Savings

The cost of achieving projected energy savings levels can be evaluated from a total resource cost perspective or from a program cost perspective. The total resource perspective considers the cost to consumers and businesses making the energy efficiency investments, as well as the cost of administering utility-funded energy efficiency programs. In the year 2012, the total resource cost of achieving projected levels of energy efficiency is $16 million. (Note that this estimate reflects the estimated costs incurred by programs and participants *in a single year*. If similar results were achieved the following year, an additional $16 million in costs would be incurred by program administrators and participants.)

The program perspective considers only those costs incurred by the utility—namely, incentives paid to program participants as well as the administrative costs associated with energy efficiency program delivery. (Administrative costs include all program costs *except* incentives: program planning and design costs, marketing costs, implementation costs, etc.) The Energy Center estimates that by 2012, annual energy efficiency program investments of between $9.4 million and $13 million would be necessary to achieve the results projected in this analysis.[16] Annual energy efficiency program investments would ramp up from current funding levels to achieve projected funding levels in 2012. To achieve similar results the following year, and additional $9.4 to $13 million program investment would be necessary.

Allocating estimated program costs by sector, approximately 52 percent of costs are for the residential market, approximately 33 percent are for the commercial market, and approximately 15 percent are for

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[16] The low end of this range assumes that programs pay for 50 percent of the incremental cost of energy efficiency measures, and the high end assumes that programs pay for 75 percent of the incremental cost.

the industrial market. Allocating estimated program costs by fuel, approximately 70 percent are for measures that primarily save electricity, and approximately 30 percent are for measures that primarily save natural gas.

Achieving projected 2012 levels of energy efficiency would produce *aggregate net benefits* of $39 million. In other words, the lifecycle savings associated with energy efficiency measures installed in 2012 would exceed the total resource cost by $39 million. An equivalent investment in the following year would produce an additional $39 million in aggregate net benefits. Achieving projected 2012 levels of energy efficiency would reduce greenhouse gas emissions by 51,000 tons per year. Achieving projected 2018 levels of energy efficiency would reduce greenhouse gas emissions by 63,000 tons per year.

Energy Savings Potential by Sector

Figure 5 presents each sector's contribution to annual achievable efficiency potential in 2012. The residential sector represents approximately half of the electricity savings potential and half of the natural gas savings potential, while the commercial and industrial sectors represent approximately 56 percent of the demand reduction potential. Table 1 presents these data in percentage terms.

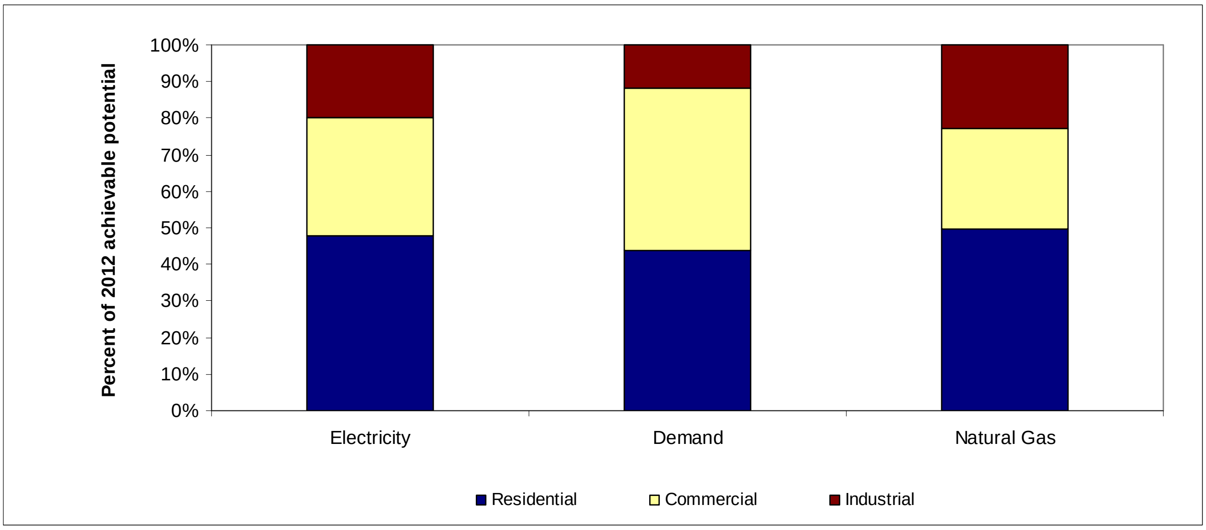

Figure 5: Sector Contributions to 2012 Achievable Potential

TABLE 1. SECTOR CONTRIBUTIONS TO 2012 ACHIEVABLE POTENTIAL

	Electricity Savings Potential (% of Total)	Demand Reduction Potential (% of Total)	Natural Gas Savings Potential (% of Total)
Residential	48%	44%	50%
Commercial	32%	45%	55%
Industrial	20%	12%	19%

Figures 6 and 7 present 2012 and 2018 annual achievable electricity and natural gas efficiency potential by sector, expressed as a percentage of baseline energy sales.

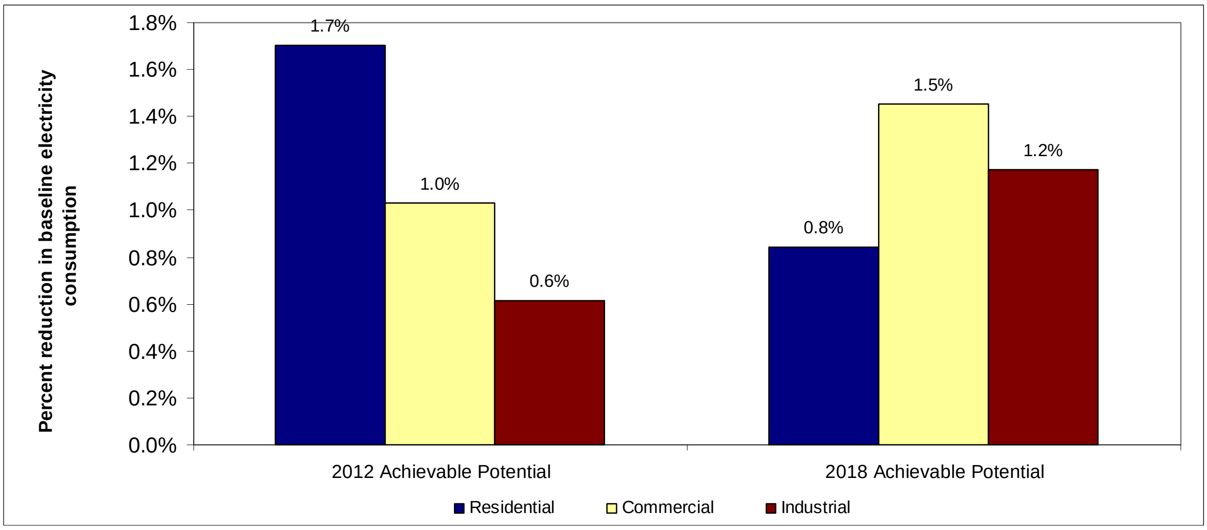

Figure 6: Achievable Electricity Savings Potential by Sector, Expressed as a Percentage of Baseline Sales

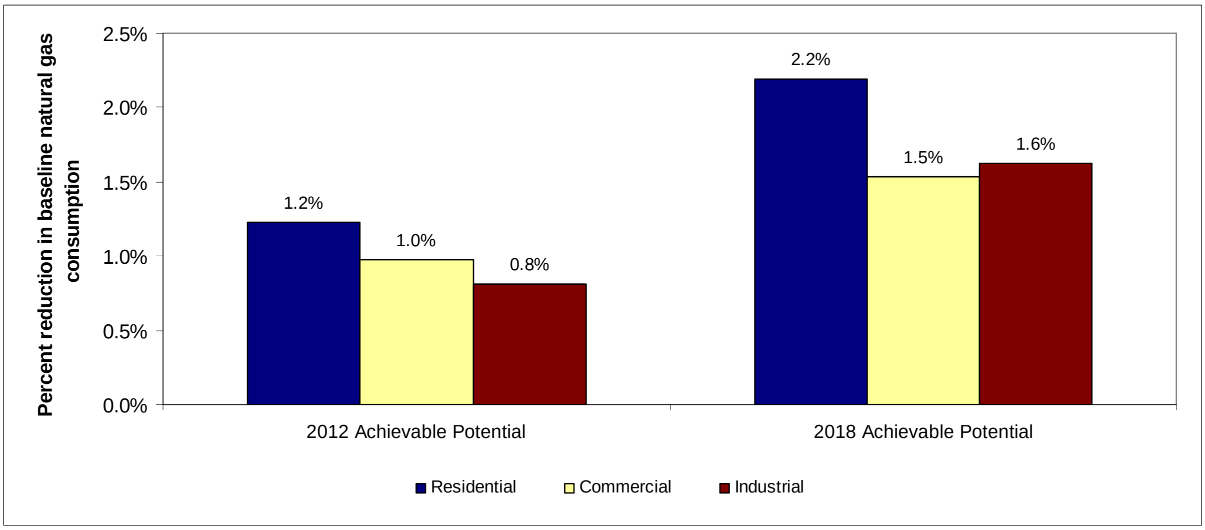

Figure 7: Achievable Natural Gas Savings Potential by Sector, Expressed as a Percentage of Baseline Sales

Figures 8 through 10 present annual achievable electricity savings, demand reduction, and natural gas savings potential in absolute terms. Table 2 presents a summary of sector results in table format.

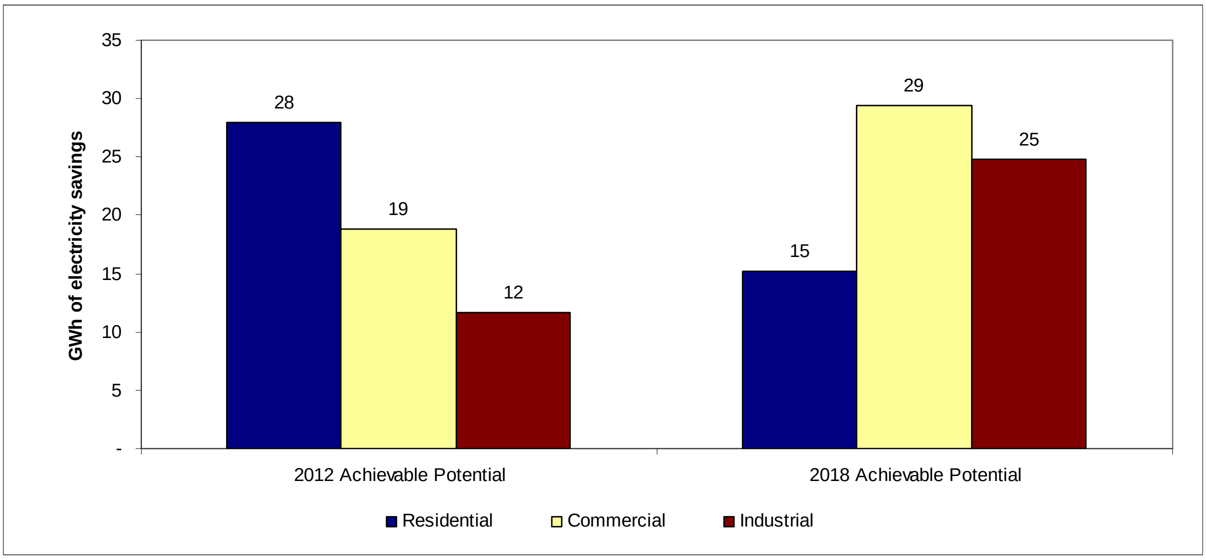

Figure 8: Achievable Electricity Savings Potential by Sector, 2012 and 2018

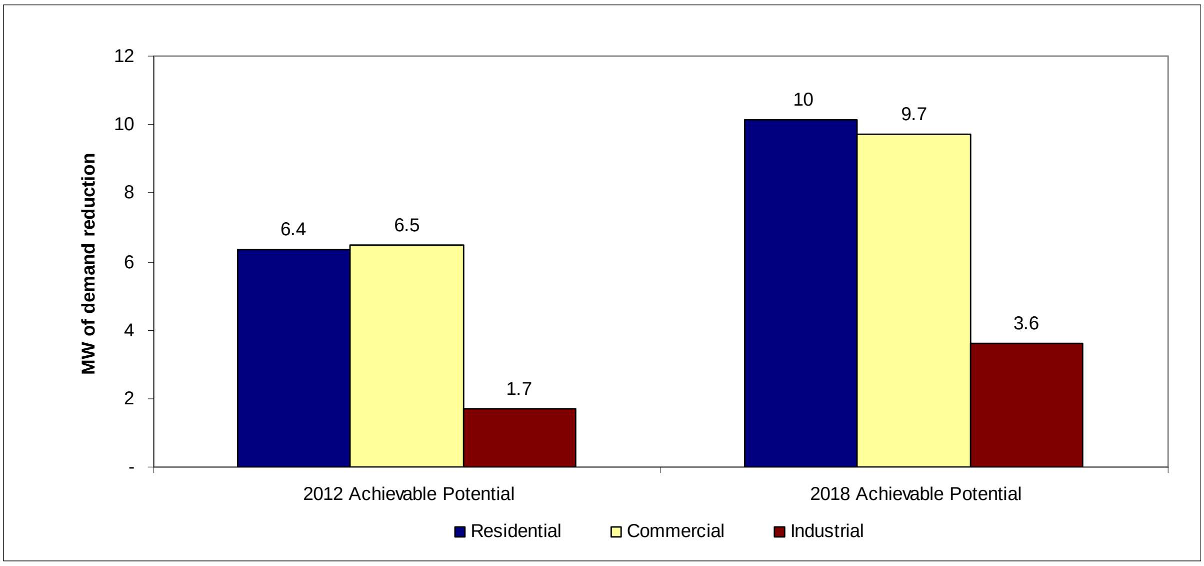

Figure 9: Achievable Demand Reduction Potential by Sector, 2012 and 2018

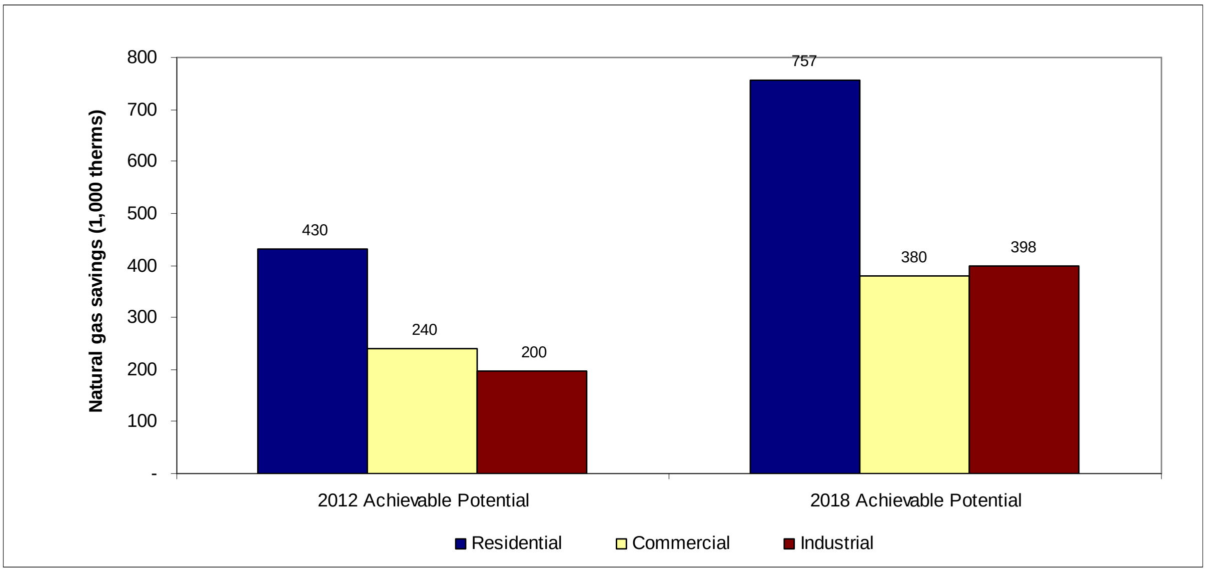

Figure 10: Achievable Natural Gas Savings Potential by Sector, 2012 and 2018

TABLE 2. 2012 AND 2018 ACHIEVABLE POTENTIAL BY SECTOR

	Electricity Savings Potential in 2012 (Annual GWh)		Demand Reduction Potential in 2012 (MW)		Natural Gas Savings Potential in 2012 (1000 therms)	
	2012	**2018**	**2012**	**2018**	**2012**	**2018**
Residential	28	15	6.4	10	430	760
Commercial	19	29	6.5	9.7	240	380
Industrial	12	25	1.7	3.6	200	400
TOTAL	**59**	**69**	**15**	**23**	**870**	**1,500**

Interpretation of Sector Results

There are several issues worth noting to aid interpretation of sector-level results. The data presented in the previous section show a substantial decrease in residential electricity savings potential from 2012 to 2018, and a substantial increase in natural gas savings potential. These trends are primarily the result of new federal efficiency standards for light bulbs which come into effect over the period.[17] Once high efficiency bulbs become mandated by law they are no longer within the purview of energy efficiency programs, and thus are no longer considered part of achievable potential (see the discussion of "naturally occurring efficiency in the *Methodology* section of this report). The estimated achievable potential for purchased replacement CFL bulbs in 2012 is approximately 22 GWh, but we project no savings for this technology in 2018. It is likely that emerging technologies such as LED lighting will develop to the point where they can begin to offset the effect that these new federal standards will have on residential lighting potential. However, given the uncertainties associated with the pace of technological development, it was not possible to account for such offsetting effects in this analysis.

The trend for residential natural gas potential is the flip side of the same coin, as there is a significant heating penalty associated with installation of energy-efficient lighting. More energy efficient bulbs give off less heat, causing a corresponding increase in natural gas consumption. The magnitude of this heating penalty is approximately 80,000 therms in 2012. With the phase-out of incandescent bulbs from 2012 to 2018 the magnitude of this interactive effect decreases, and we see the substantial increase in natural gas savings potential noted above.

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[17] These standards were enacted through the Energy Independence and Security Act of 2007 (EISA). Between 2012 and 2014, the energy efficiency of residential general purpose light bulbs will need to be 25 to 30 percent better than today's incandescent bulbs. The phase-in starts with 100-Watt bulbs in 2012 and ends with 40-Watt bulbs in 2014. By 2020, residential general purpose light bulbs must be 60 more efficient than today's incandescents—a threshold that CFL bulbs already meet.

It is also important to discuss the sensitivity of residential natural gas savings estimates to input assumptions for a relatively small number of measures. Geothermal heat pumps and whole-home weatherization and direct install initiatives offer significant opportunities for natural gas savings in the residential sector. Yet relatively minor changes to input assumptions for these measures—within the reasonable range of uncertainty—produce significant changes in estimated savings potential.

Of the fuel switching measures evaluated in our model, geothermal heat pumps represent the largest savings opportunity—approximately 74 percent of residential natural gas savings potential.[18] Though our base analysis finds that geothermal heat pumps would be a cost-effective energy efficiency measure for natural gas utilities, the benefit/cost ratio is only slightly above 1.0. Conversely, weatherization of single family homes fell slightly below the cost-effectiveness screen (benefit/cost ratio of 0.81-0.92), though weatherization of multifamily rental housing (1-4 units) was found to be cost-effective (benefit/cost ratio of 1.01-1.04). Depending on local market conditions, a comprehensive weatherization/direct install program could represent an attractive energy savings opportunity for a natural gas utility.

Modifying input assumptions to include all applications of geothermal heat pumps and weatherization/direct install efforts leads to an increase in residential natural gas savings potential of 30 percent. Leaving both technologies out of the model decreases residential natural gas savings potential by 75 percent. Including all weatherization measures but excluding geothermal heat pumps reduces residential natural gas savings potential by 42 percent.

Energy Savings Potential by End Use

Figures 11 through 19 disaggregate 2012 sector energy efficiency potential by end use and by fuel type, showing which end use categories represent the largest (and smallest) components of energy efficiency potential for each sector and each fuel. Some sectors show negative savings potential within the “all other” category, which is the result of measure interactions wherein an electricity- or natural gas-saving measure causes a corresponding increase in consumption of the other fuel.

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[18] Geothermal heat pumps represent a smaller, but still significant, energy savings opportunity in the commercial market: approximately 18 percent of natural gas savings potential.

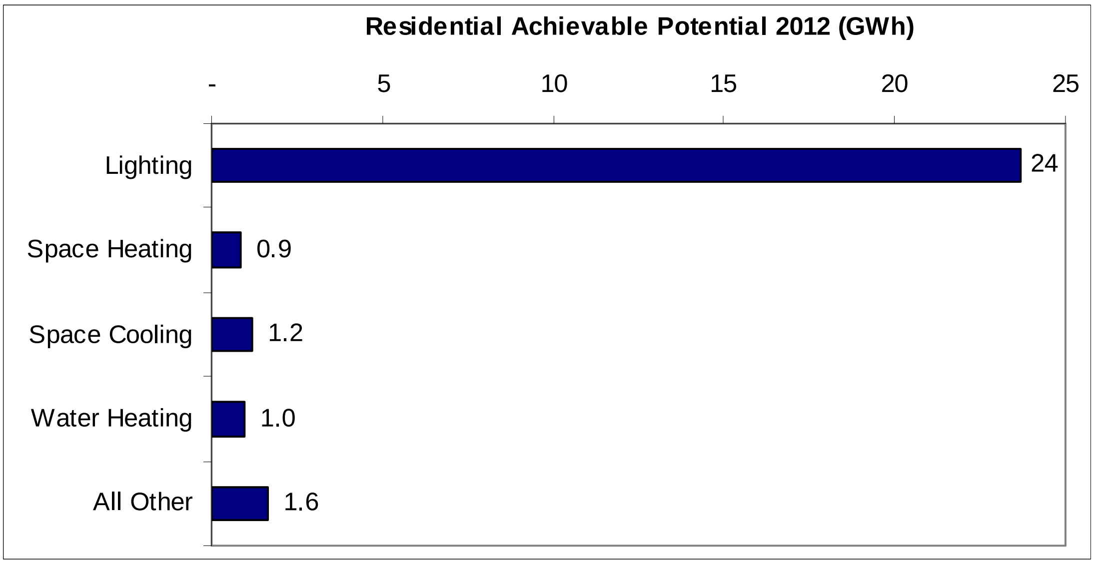

Figure 11: Achievable Residential Electric Efficiency Potential by End Use, 2012

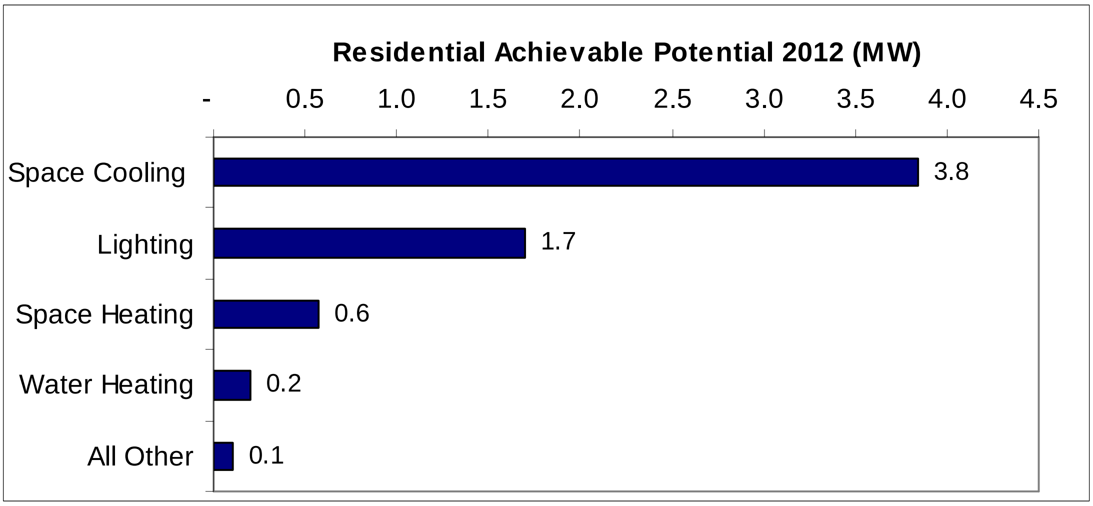

Figure 12: Achievable Residential Demand Reduction Potential by End Use, 2012

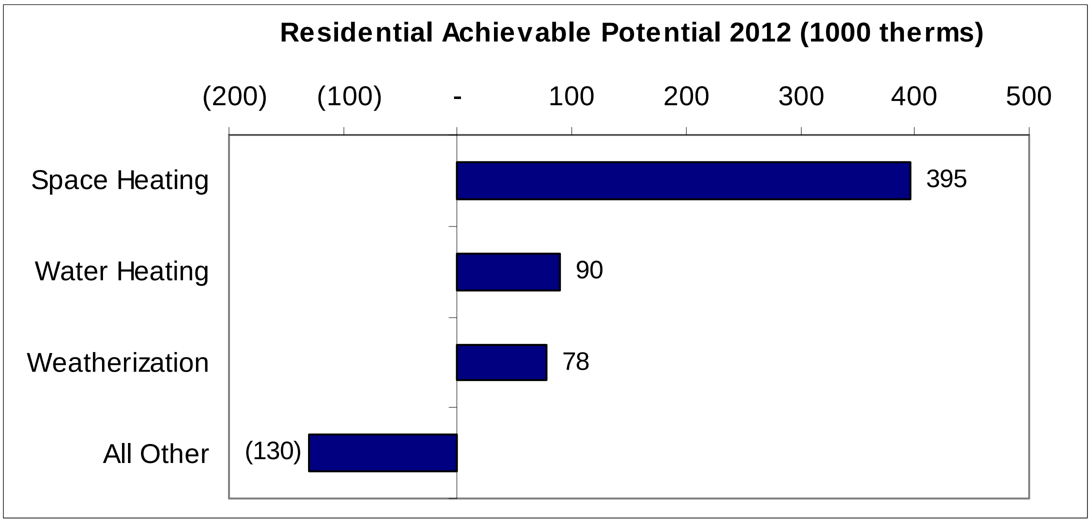

Figure 13: Achievable Residential Natural Gas Efficiency Potential by End Use, 2012[19]

In the residential sector, electricity-savings potential is dominated by lighting, where peak demand reduction potential is more evenly distributed across space cooling, lighting, and space heating measures (e.g., furnace motors). Space heating represents the largest opportunity for natural gas savings.

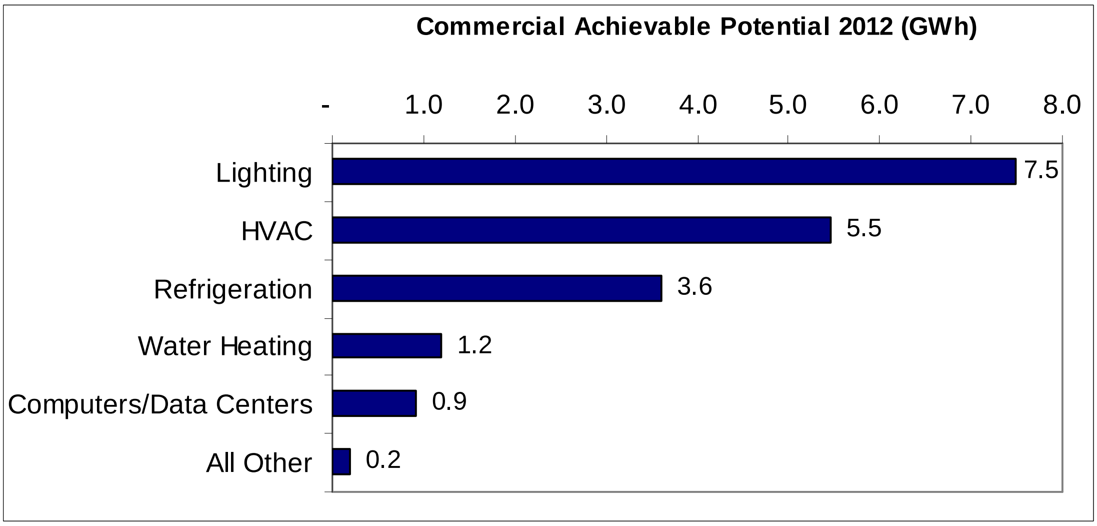

Figure 14: Achievable Commercial Electric Efficiency Potential by End Use, 2012

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[19] Negative potential in the “all other” category for residential natural gas consumption is primarily due to heating penalties associated with installation of energy efficient lighting.

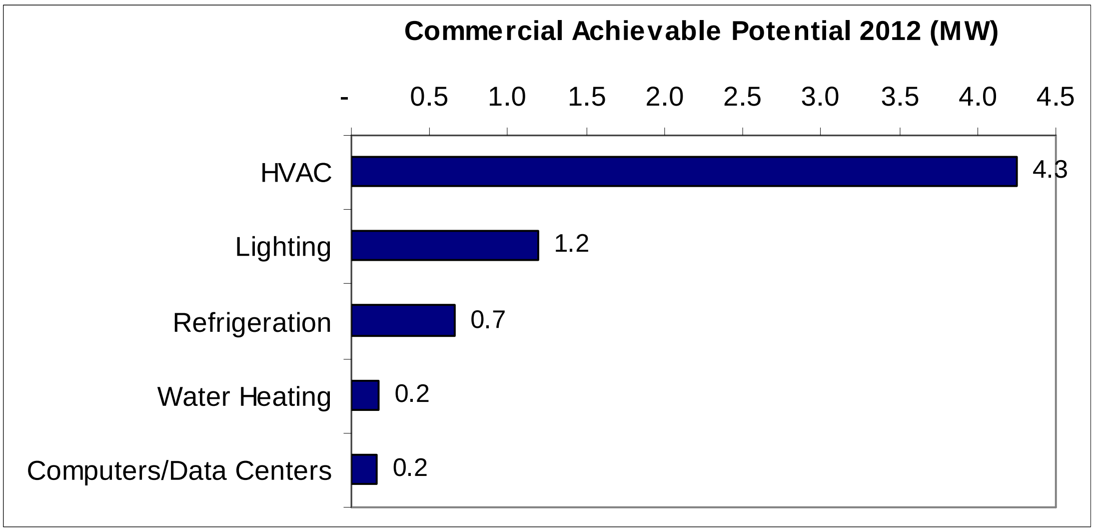

Figure 15: Achievable Commercial Demand Reduction Potential by End Use, 2012

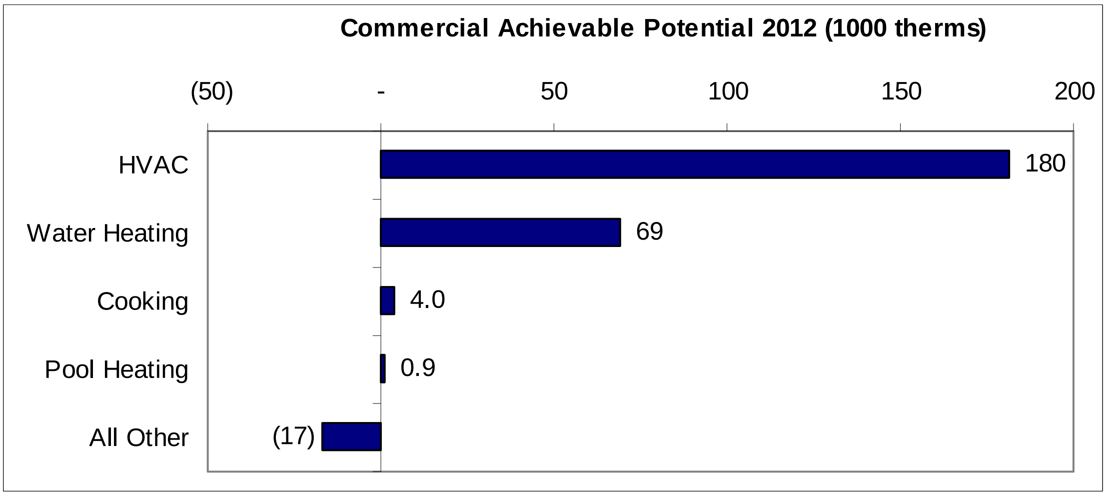

Figure 16: Achievable Commercial Natural Gas Efficiency Potential by End Use, 2012[20]

In the commercial market, lighting, refrigeration, and heating, ventilation, and air conditioning (HVAC), represent the major opportunities for electricity savings and peak demand reduction, while heating and water heating dominate natural gas savings potential.

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[20] Negative potential in the "all other" category for commercial natural gas consumption is primarily due to heating penalties associated with installation of energy efficient lighting and computer equipment.

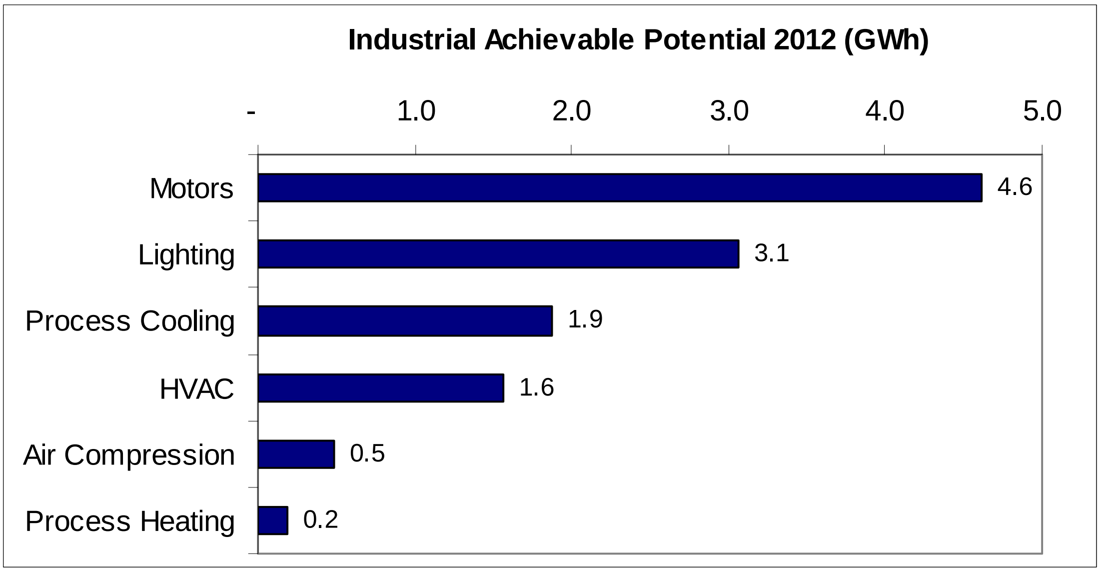

Figure 17: Achievable Industrial Electric Efficiency Potential by End Use, 2012

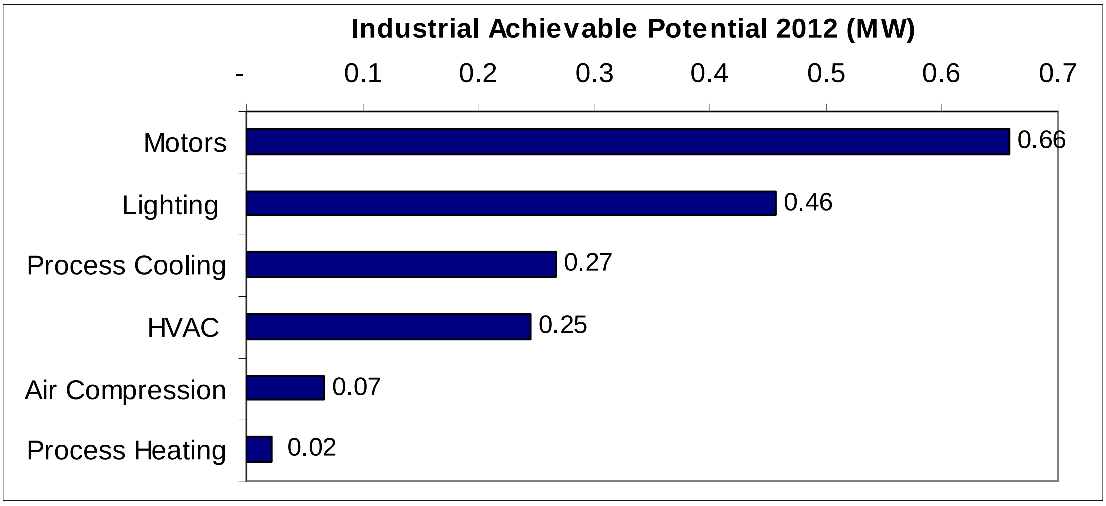

Figure 18: Achievable Industrial Demand Reduction Potential by End Use, 2012

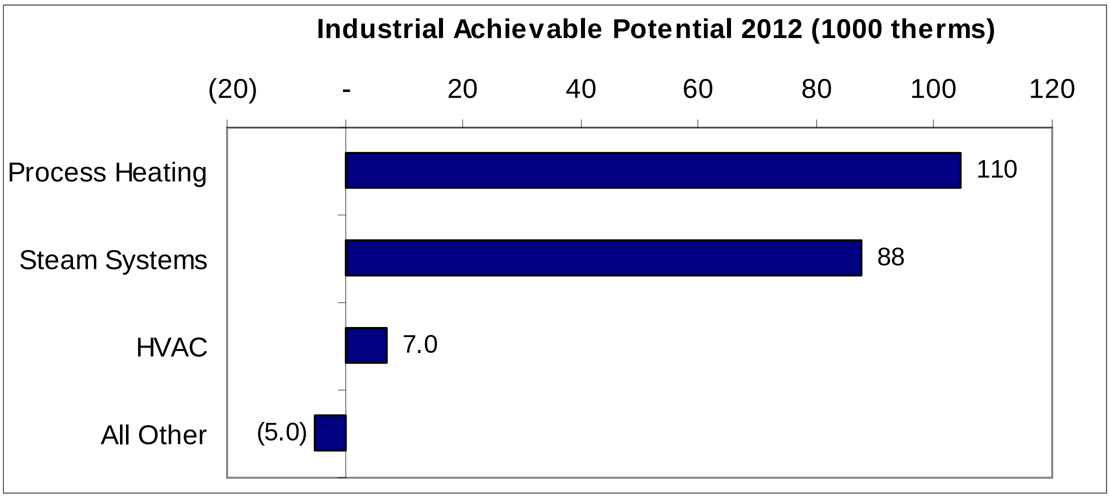

Figure 19: Achievable Industrial Natural Gas Efficiency Potential by End Use, 2012[21]

In the industrial sector, lighting and motors represent the major opportunities for electricity savings and peak demand reduction, while process heating and steam systems dominate natural gas savings potential.

Figures 20 through 28 show the largest energy-saving technology markets by sector. A definition of the measures included in each technology market is provided in Appendix B.

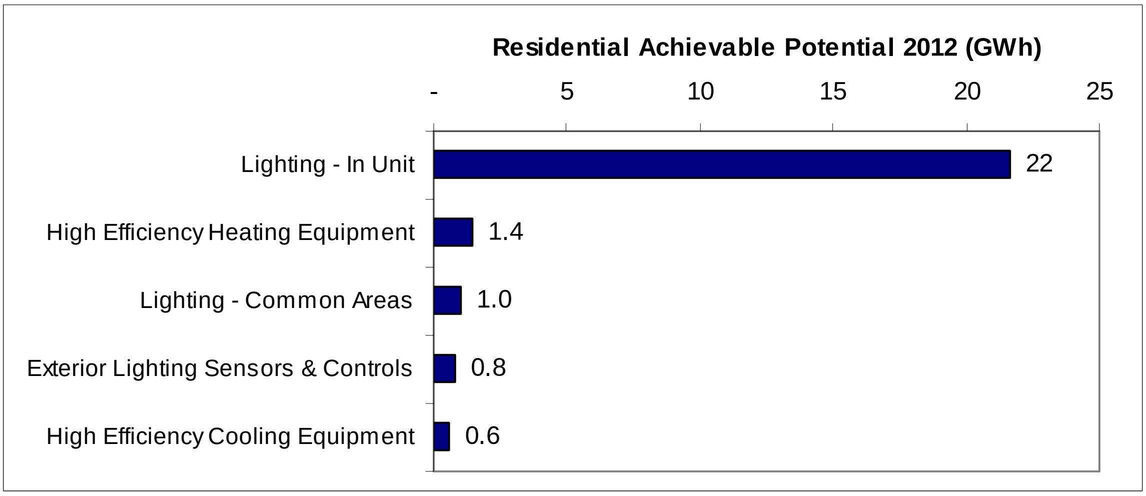

Figure 20: Top Residential Technology Markets: Electric Efficiency

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[21] Negative potential in the "all other" category for industrial natural gas consumption is due to heating penalties associated with installation of energy efficient lighting and motors.

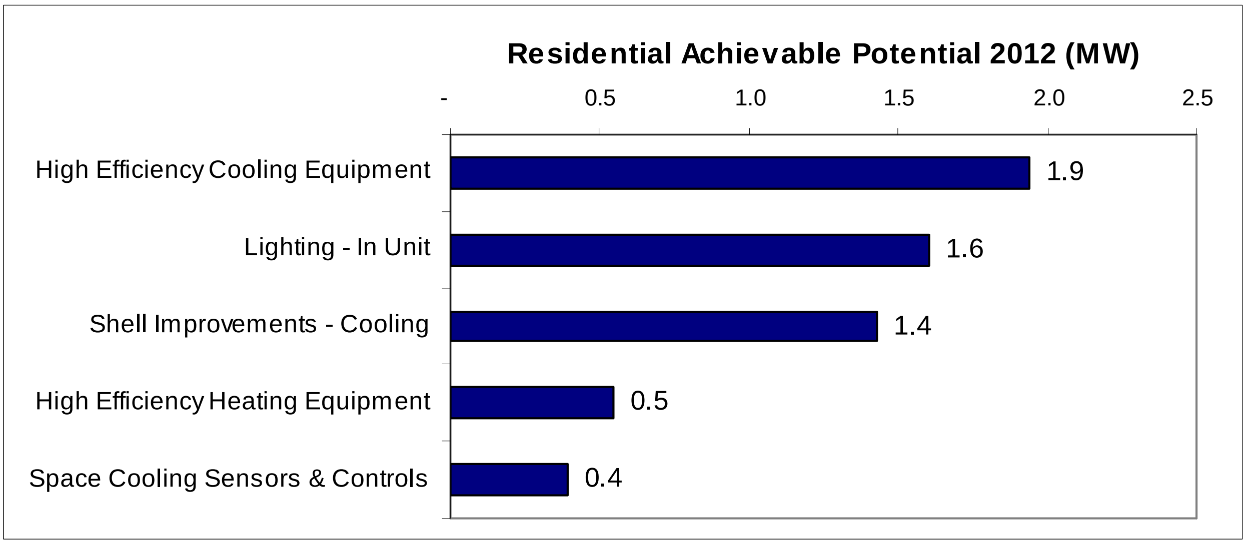

Figure 21: Top Residential Technology Markets: Electric Demand Reduction

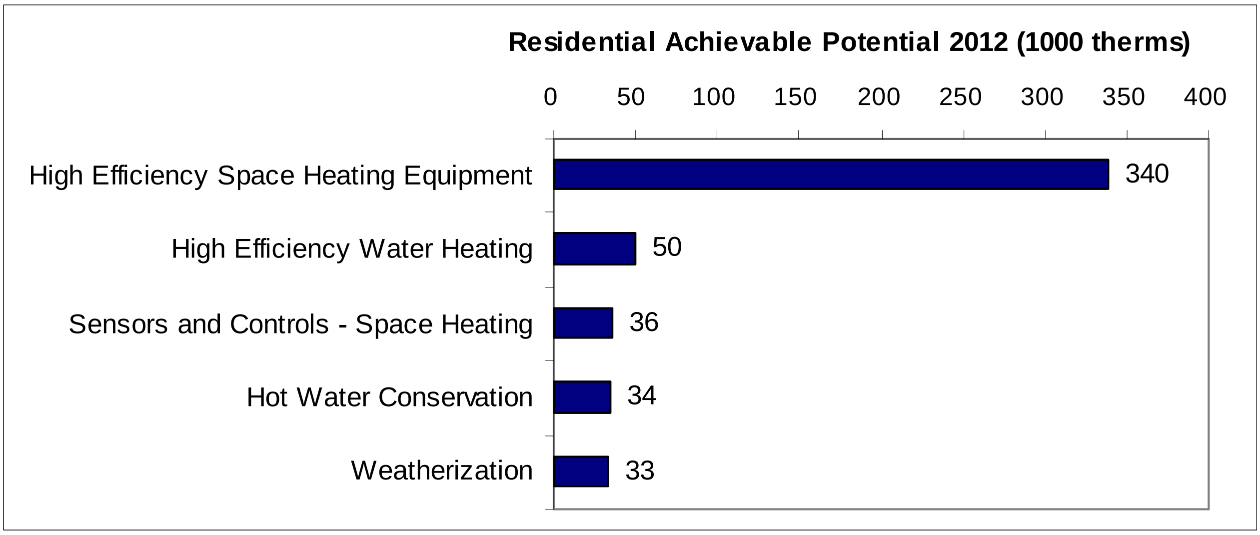

Figure 22: Top Residential Technology Markets: Natural Gas Efficiency

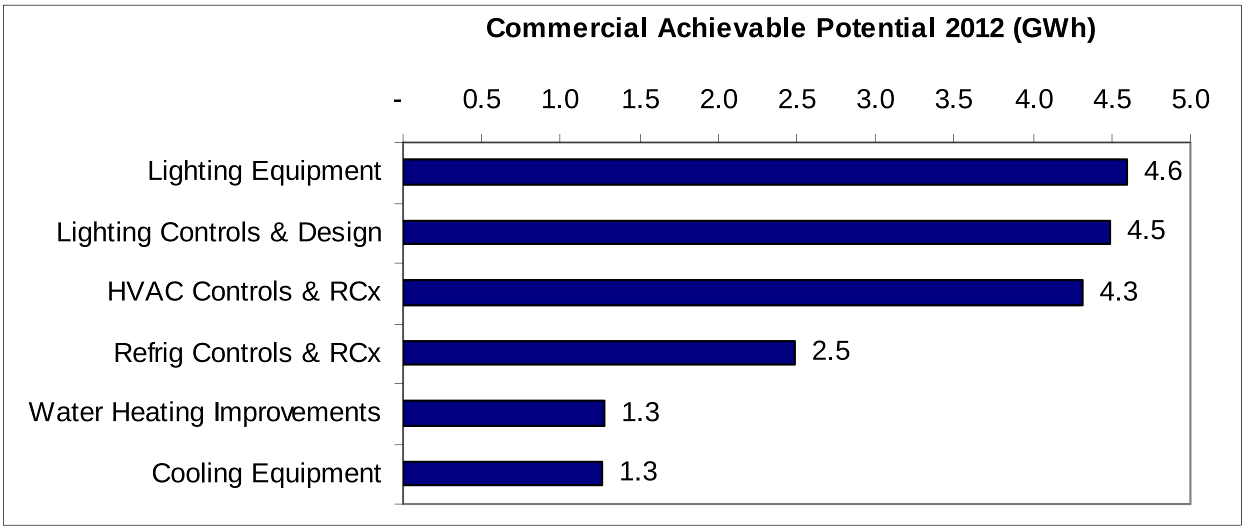

Figure 23: Top Commercial Technology Markets: Electric Efficiency

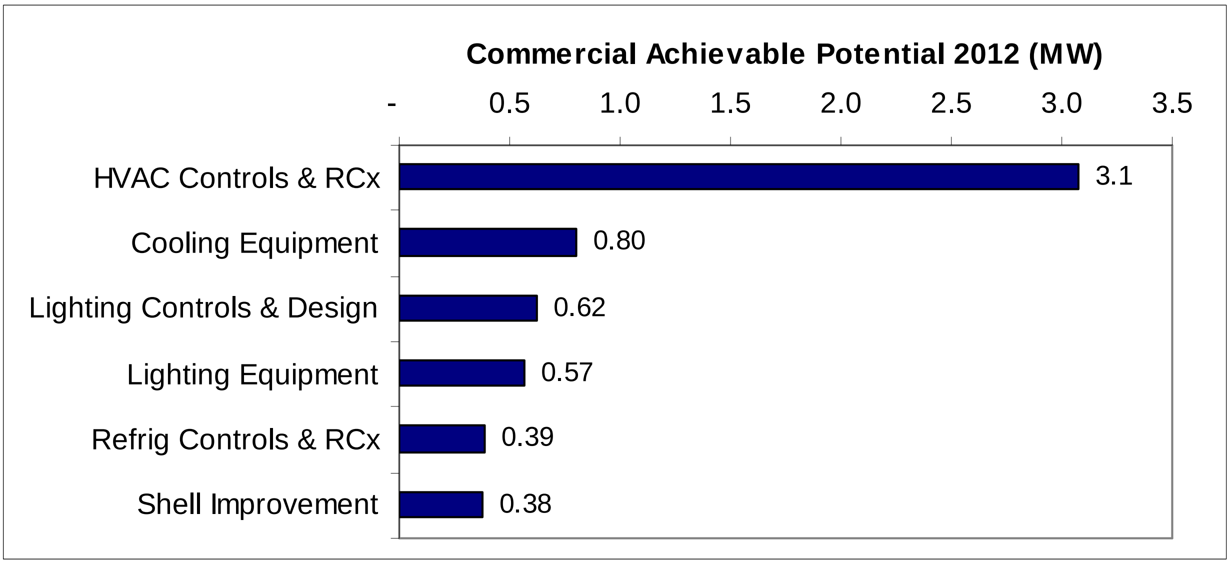

Figure 24: Top Commercial Technology Markets: Electric Demand Reduction

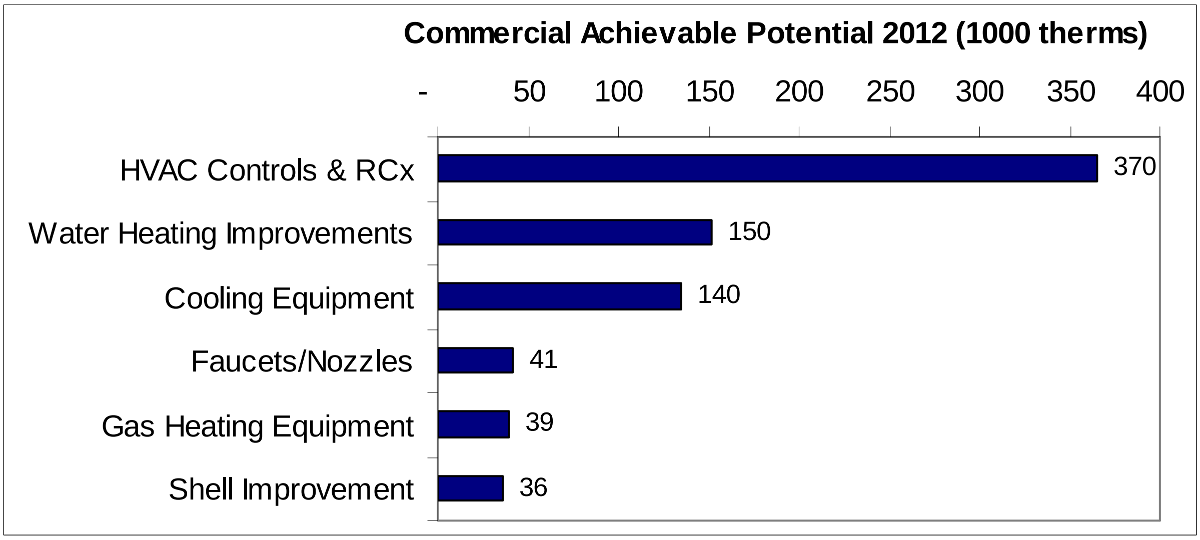

Figure 25: Top Commercial Technology Markets: Natural Gas Efficiency

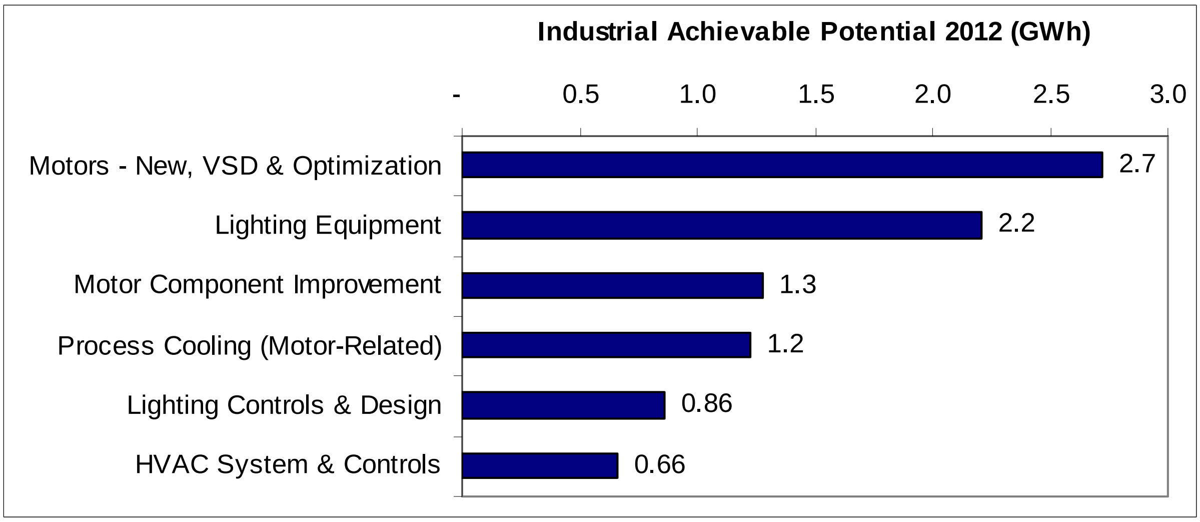

Figure 26: Top Industrial Technology Markets: Electric Efficiency

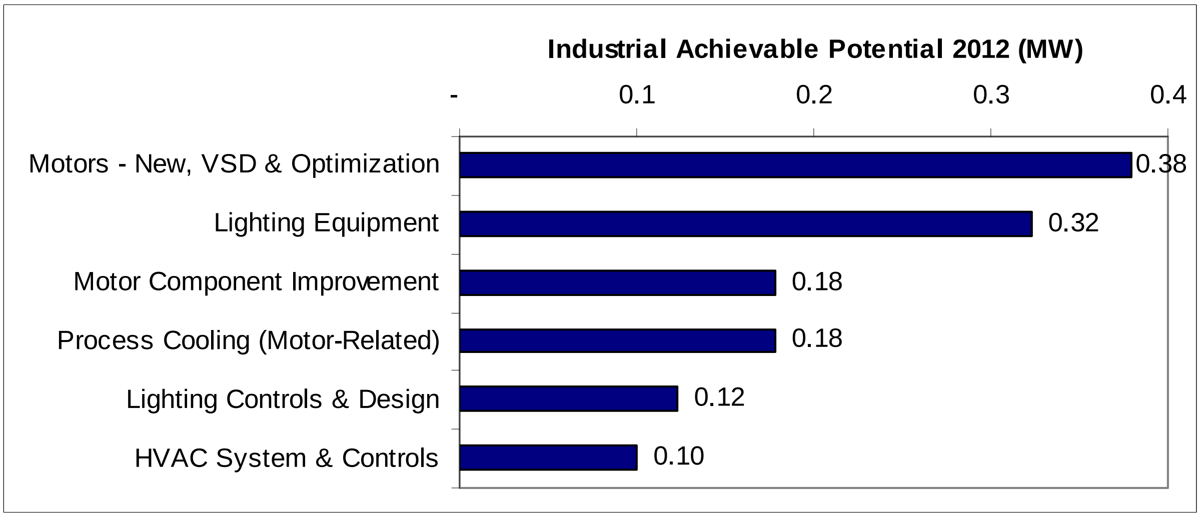

Figure 27: Top Industrial Technology Markets: Electric Demand Reduction

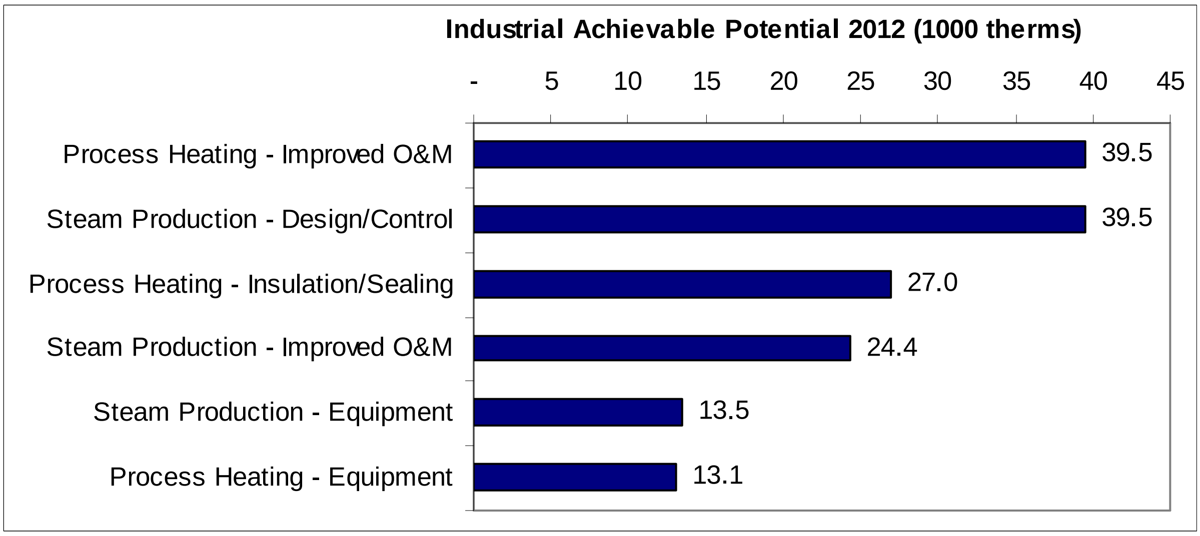

Figure 28: Top Industrial Technology Markets: Natural Gas Efficiency

Energy Savings Potential in Key Segments of the Commercial Market

Given the diverse array of facility types within the commercial sector, we provide additional details on energy-saving opportunities for key segments of the commercial market. Figures 29 and 30 compare electricity savings potential and natural gas savings potential by commercial market segment. Appendix E includes detailed data tables showing energy savings potential within commercial market segments.

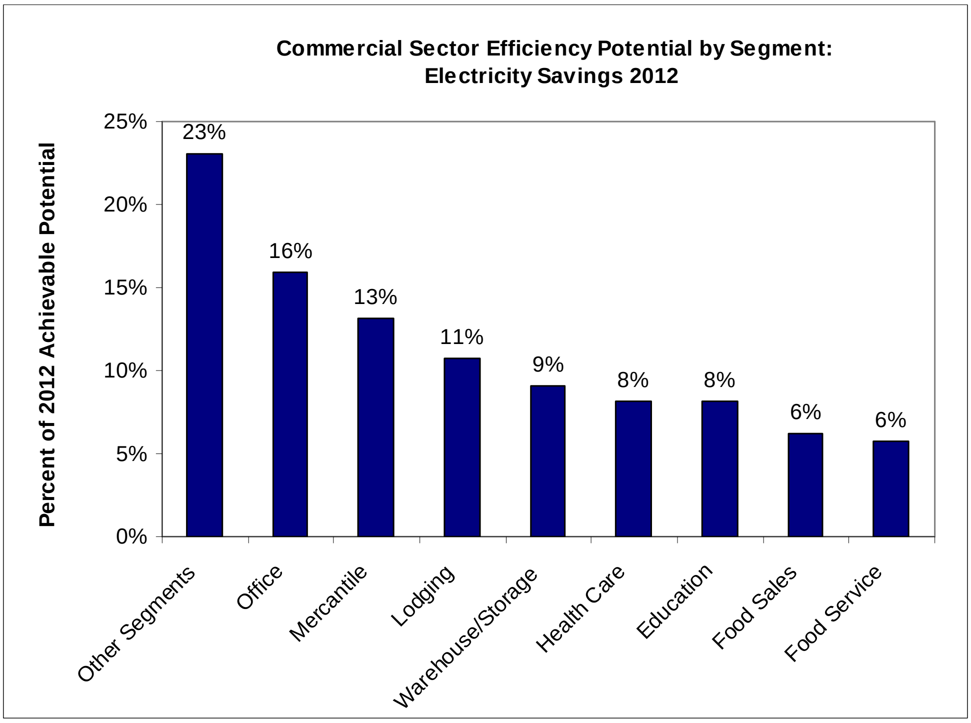

Figure 29: Top Commercial Market Segments: Electric Savings Potential

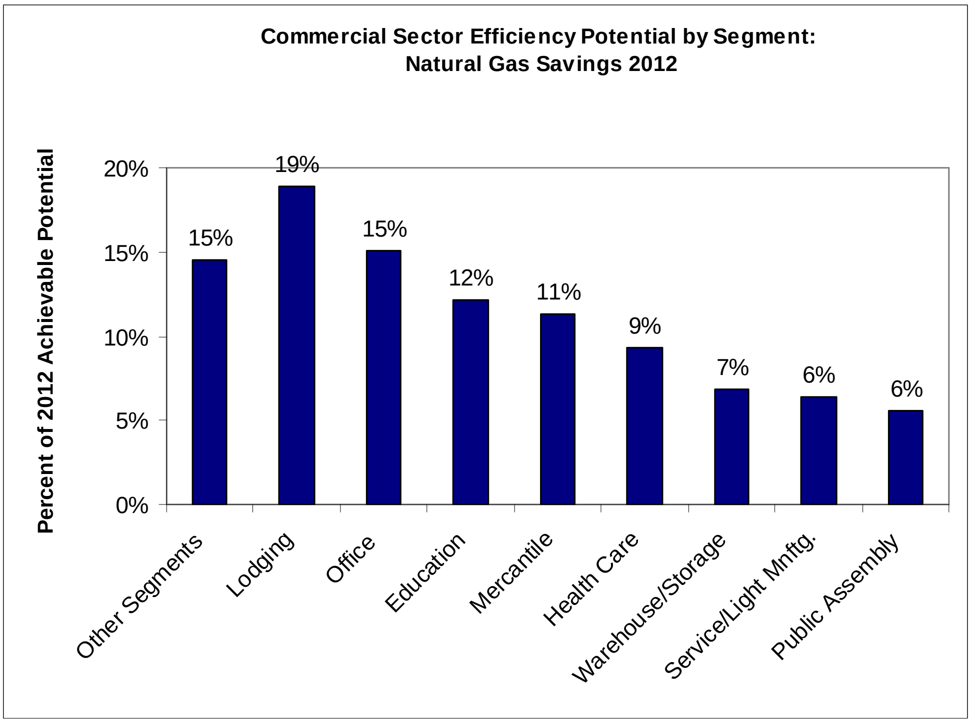

Figure 30: Top Commercial Market Segments: Natural Gas Savings Potential

As shown in the above figures, the largest areas of electricity savings potential are within office buildings (16 percent of commercial sector savings potential), mercantile/retail establishments (13 percent of potential), and lodging facilities (11 percent of potential). The largest areas of natural gas savings potential are within lodging facilities (19 percent of commercial sector savings potential), office buildings (15 percent of potential), and educational facilities (12 percent of potential).

Figure 31 compares the top electricity-saving technologies by commercial market segment.

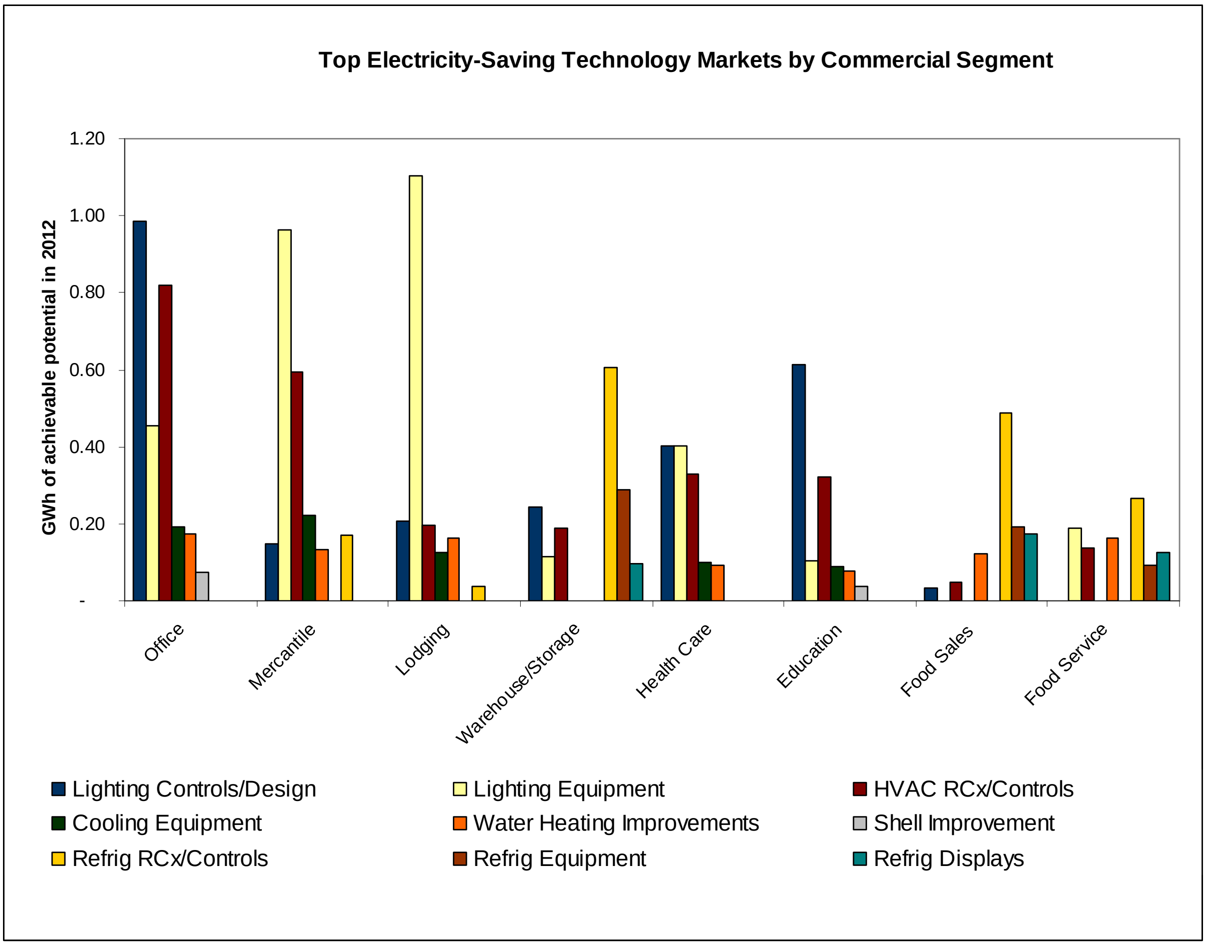

Figure 31: Top Electricity-Saving Technology Markets by Commercial Segment

Lighting measures are the largest component of electricity savings potential in most sectors, except for warehouse/storage facilities, food sales (grocery), and food service (restaurants), where refrigeration measures comprise a more significant portion of the potential. Control systems and retrocommissioning

(RCx) for existing HVAC systems, as well as new energy-efficient cooling equipment, are other key areas of opportunity across multiple segments of the commercial market.

Figure 32 compares the top natural gas-saving technologies by commercial market segment.

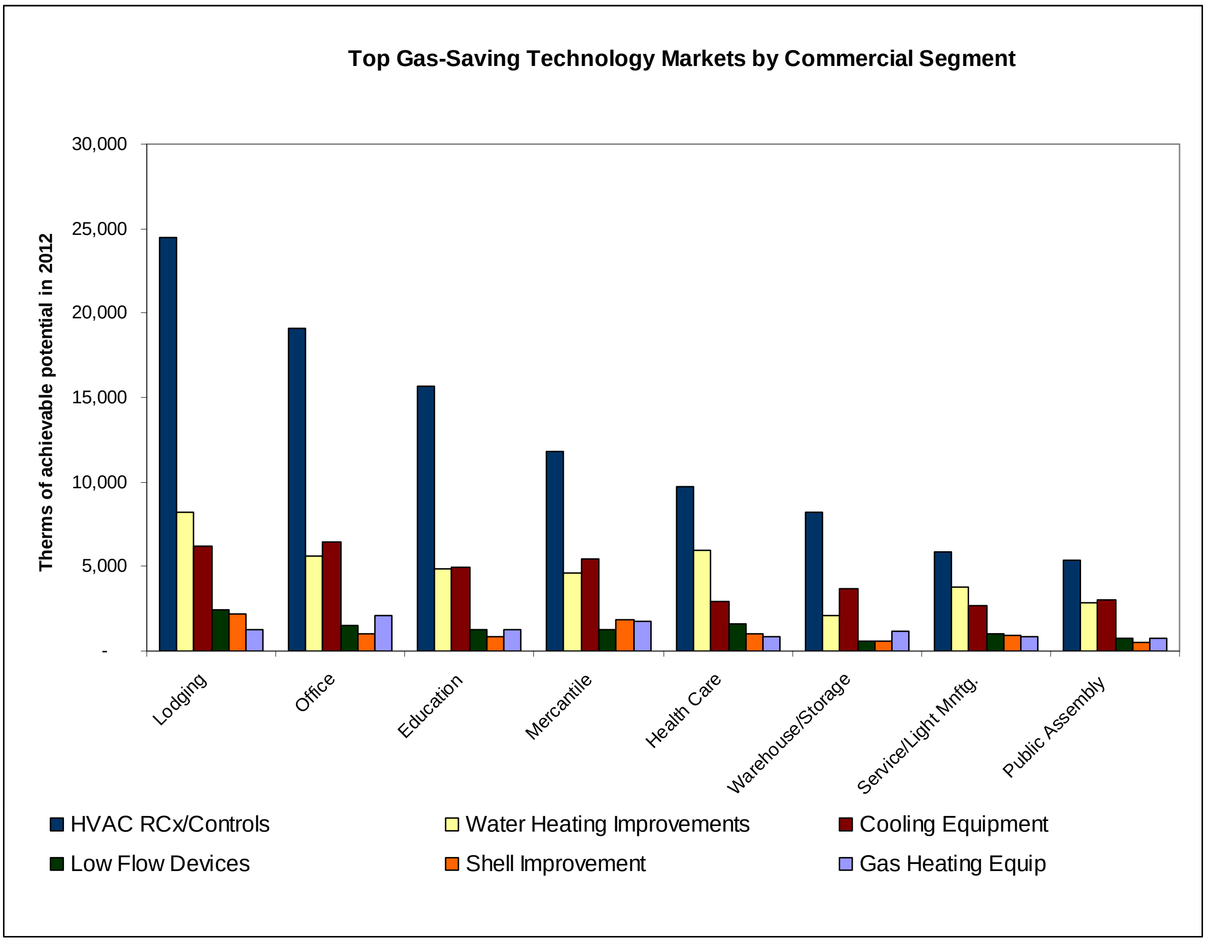

Figure 32: Top Natural Gas-Saving Technology Markets by Commercial Segment

Across all commercial segments, control systems and RCx for existing HVAC systems represent the largest opportunities, followed by water heating system improvements. The large potential associated with cooling equipment is due to geothermal heat pumps, which save significant amounts of natural gas in addition to reducing electricity consumption for cooling.

DEMAND RESPONSE

The Energy Center evaluated two types of demand response technologies within the energy efficiency potential model: (1) thermal energy storage for large C&I applications; and (2) direct load control (DLC) for residential and commercial applications. Results from our assessment of demand reduction potential from dynamic pricing are also included in this section.

Direct Load Control and Thermal Energy Storage

Quantitative estimates of demand response potential from DLC and thermal storage devices are part of (not additional to) the demand reduction estimates presented in the previous section. Thermal energy storage systems produce ice during off-peak periods which is then used to cool the building during the day. Large C&I facilities may pursue thermal energy storage as a strategy for reducing the costs associated with peak demand charges. However, under the MISO-based avoided costs used in the Energy Center's model, thermal energy storage systems were not cost-effective, so economic and achievable potential estimates do not include demand reduction associated with these measures.

DLC programs are the most common type of demand response strategy. To reduce electricity demand during times of peak system load, utilities use remote switches to interrupt or cycle energy-using equipment at the customer's home or business, generally with little or no advance notice to the customer. Participation is voluntary, and customers receive an annual incentive or bill discount for participating. DLC programs typically address central air conditioning loads, but may also include water heater loads. Load control devices have grown increasingly sophisticated in recent years. Where radio-controlled switches were used in early DLC programs, today's programs use digital paging networks that allow for independent control of individual pieces of equipment.[22] Some utilities are even deploying "smart thermostats" which allow remote adjustments to temperature settings.

The Energy Center's analysis included DLC for central air conditioners and water heaters in the residential and commercial markets. Results are presented in Table 1.

TABLE 1. DEMAND REDUCTION POTENTIAL FROM DIRECT LOAD CONTROL

Sector	2012 Achievable Potential (MW)	2018 Achievable Potential (MW)
Commercial	0.14	0.14
Residential	0.43	1.00
TOTAL	**0.57**	**1.14**

In the residential sector, DLC represents around seven percent of achievable peak demand reduction potential for 2012, and around ten percent of achievable peak demand reduction potential for 2018. In the

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[22] Federal Energy Regulatory Commission (2006). *Assessment of Demand Response and Advanced Metering*. Staff Report. Docket No. AD-06-2-000.

commercial sector, DLC represents around two percent of achievable peak demand reduction potential for 2012, and around one percent of demand reduction potential for 2018.

Advanced Rate Design

The Energy Center also conducted a high-level assessment of the impact that advanced rate design could have on peak electricity demand. The term "advanced rate design" refers to utility rate structures that employ dynamic pricing, where the retail cost of electricity varies according to electric demand. The most common dynamic rate structures include:[23]

- **Time of Use (TOU) Rates**: Rate structures that employ standard differentiated prices for electricity consumed during on-peak and off-peak periods, which are consistent throughout the year. In some cases TOU rates also include seasonal price differentiation.
- **Real Time Pricing (RTP)**: Rate structures that vary continuously according to the wholesale price of electric power.
- **Critical Peak Pricing (CPP):** Rate structures that employ a high price that comes into effect during "critical peak" periods of high electric demand, typically with some advance notice to the customer (as much as one day ahead or in some cases only a few hours ahead).

Though some studies show energy savings impacts resulting from dynamic rate offerings, historically the primary objective of these rate structures has been reducing peak electric demand. A recent survey of historical impacts resulting from dynamic pricing programs in the residential market concluded that:[24]

- Introducing time-of-use rates with *broadly-defined* on-peak and off-peak periods can reduce peak demand by three to six percent.
- Introducing time-of-use rates with *more-specific critical period pricing* can reduce peak demand by 13 to 20 percent.
- Introducing time-of-use rates with *more-specific critical period pricing* along with *providing consumers with advanced technologies* so that they can react to those prices, can reduce peak demand by 27 to 44 percent.

In depth pricing-based forecasting was beyond the scope of this study, but we developed a first-order estimate of the demand reduction potential associated with dynamic pricing structures by applying general assumptions reported in the 2008 potential study for Iowa IOUs.[25]

We considered four dynamic pricing strategies: (1) TOU rates for residential customers; (2) CPP rates without enabling technologies for residential customers; (3) CPP with enabling technologies for residential customers[26]; and (4) CPP rates with no enabling technologies for commercial customers.

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[23] U.S. Department of Energy and the U.S. Environmental Protection Agency. *National Action Plan for Energy Efficiency* (2006) Available at: www.epa.gov/eeactionplan.

[24] A. Faruqui and S. Sergici (November 2008). *Household Response to Dynamic Pricing of Electricity: A Survey of Seventeen Pricing Experiments*. The Brattle Group.

[25] Quantec (2008). *Assessment of Energy and Capacity Savings Potential in Iowa*. Prepared for the Iowa Utility Association in collaboration with Summit Blue Consulting, Nexant, Inc., A-TEC Energy Corporation, and Britt/Makela Group.

The Energy Center used participation rates and estimated gross load reductions from each dynamic pricing model as reported in the Iowa IOU study, with minor modifications under the two variants of CPP pricing in the residential sector. The IOU study did not specify whether enabling technologies were included in their residential CPP model, but the authors assumed a 27 percent reduction in customer load during critical peak events. The 2008 meta-study of dynamic pricing program impacts found that without enabling technologies, residential peak demand reduction was between 13 and 20 percent, and with enabling technologies residential peak demand reduction was between 27 and 44 percent.[27] To be conservative, we used the mid-point of the first range for non-technology-enabled CPP (16.5 percent reduction in peak demand), and assumed a 27 percent reduction in peak demand from technology-enabled CPP.

Results are presented in Table 2.

TABLE 2. DEMAND REDUCTION POTENTIAL FROM DYNAMIC PRICING

Dynamic Rate Offering	Sector	Eligible Load 2012 (MW)[28]	Program Partic. Rate	Event Partic. Rate	% of Gross Load Reduced	2012 Potential (MW)
TOU Rate	Res	382	8%	N/A	5%	1.53
CPP No Tech	Res	382	5%	95%	17%	3.03
CPP Tech-Enabled	Res	382	5%	95%	27%	4.90
CPP No Tech	Com	314	12%	56%	8%	1.69

The Energy Center estimates that peak demand within IAMU member service territory in 2012 will be approximately 1180 MW. Residential TOU pricing is estimated to reduce this peak by 0.4 percent. Critical peak pricing in the residential market is estimated to reduce this peak by around 0.8 percent without enabling technologies, and by around 1.3 percent with enabling technologies. CPP rates in the commercial sector are estimated to reduce peak demand by around 0.5 percent.

It is important to acknowledge that dynamic pricing structures could potentially lead to increased carbon emissions. Peaking plants that serve the mid-day summer loads are among the cleanest on the system as they are typically fired with natural gas. The majority of base load and intermediate load plants are coal-fired. Thus, shifting demand from the peak period to the shoulder period shifts generation responsibility

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[26] Enabling technologies automate the response to critical peak prices. One example of an enabling technology is a smart thermostat that increases temperature set-points in response to utility price signals.

[27] A. Faruqui and S. Sergici (November 2008). *Household Response to Dynamic Pricing of Electricity: A Survey of Seventeen Pricing Experiments*. The Brattle Group.

[28] IAMU did not have sector-level data on peak electric demand in member service territories. As a first order approximation, we used the average allocation of peak demand by sector for MidAmerican Energy and Alliant Energy, as reported in the 2008 Iowa IOU potential study (32 percent residential, 27 percent commercial, and 41 percent industrial).

from the natural gas-fired plants to the coal-fired units. While combustion of either natural gas or coal leads to CO_2 emissions, coal-fired plants produce greater emissions than are natural gas plants.

DISTRIBUTION SYSTEM EFFICIENCY OPPORTUNITIES

The Energy Center examined several key technologies for increasing energy efficiency on the utility distribution system: energy efficient transformers and low-loss surge arresters. The former represents a capital-intensive opportunity with potentially large per-unit savings for utilities and their customers. The latter offers the opportunity for significant savings through adoption of high-efficiency versions of common or highly “commoditized” power distribution equipment.

These opportunities for energy savings and demand reduction are distinct from the demand-side opportunities that are the primary focus of this report, as in many cases utilities can deploy energy efficient supply-side technologies without requiring any action on the part of their customers. However, there are also some demand-side opportunities for transformers.

The Energy Center estimates that the technologies discussed in this section could reduce losses by between 1,400 and 2,700 MWh each year, which is equivalent to 0.03 percent to 0.06 percent of total IAMU electricity sales.

Transformers

Transformer efficiency improvements can be categorized into two groups: demand-side and supply-side. On the demand side, secondary distribution transformers owned by large C&I customers are typically three-phase, low to medium voltage, dry-type transformers operating at between 35 and 50 percent of nameplate load. Over the past several decades, transformers of this type were purchased on a first cost basis, with relatively little emphasis on total ownership costs and efficiency ratings.[29] A different trend has typified supply-side transformers. Energy concerns in the late 1970s and the early 1980s prompted many utilities to adopt a “total ownership approach”, where the cost of lifetime losses was incorporated into transformer purchasing decisions. Not surprisingly, this attitude translated into a steady rise in the efficiency ratings of utility-owned liquid-immersed single and three-phase transformers. Some estimates suggest that only about 25 percent of newly sold liquid-immersed transformers and as much as 90 percent of newly sold dry-type transformers remain below NEMA TP-1 efficiency standards.[30]

Regardless of historical market trends, the energy savings stemming from newly enacted federal standards are likely to be significant. We estimate that replacement of failed supply-side transformers with newer, more efficient models could lead to annual loss reductions on the order of 1,260 to 2,100 MWh (0.03 to 0.04 percent of total IAMU sales).[31] Demand-side savings could be significant as well. Dependent upon assumed base saturation rates, standards pertinent to demand-side transformers could reduce the

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[29] Barnes et al. (1995). “*Determination Analysis of Energy Conservation Standard for Distribution Transformers*.” Oak Ridge National Laboratory, U.S. Department of Energy.

[30] American Council for an Energy Efficient Economy, et. al. (2004). *Distribution Transformer Efficiency Standards: What’s At Stake?*

[31] These estimates assume median useful lives of 30 years for existing transformers and a range of 0.5-1.0 percent for average efficiency gains between typical IAMU replacement units and those meeting new federal standards. Efficiency gains could be appreciably higher, depending upon the age and quality of existing transformers.

electricity consumed by IAMU C&I customers by as much as 145 to 580 MWh annually (0.003 percent to 0.01 percent of total IAMU sales, or 0.004 to 0.02 percent of IAMU C&I sales).[32]

Recent federal standards will affect the ability of municipalities to design and implement cost-effective incentive programs that are relevant to the bulk of the transformer market. The U.S. Department of Energy's (DOE) final rule on distribution transformers mandates that new transformers sold within the United States meet minimum efficiency standards by January 1, 2010. These federal standards cover a wide range of transformer sizes, types and applications. Both new and pre-existing standards will virtually invalidate the potential for "replace on burnout" (ROB) incentive programs, because the existence of a federal standard means that cost-effective, high-efficiency replacement equipment will be considered to be "naturally occurring" efficiency within the marketplace, and thus utility programs could not receive credit for associated savings. It is theoretically possible that incentive programs could be designed for transformers exceeding the new federal standards; however, DOE's process for constructing its final ruling used a rigorous benefit/cost ratio and lifecycle cost assessment. Consequently, it is not likely that devices exceeding the recently-enacted federal standards (at least for those devices demonstrating a significant margin of savings) would pass an economic screening process. In fact, the Energy Center's model suggests that TRC ratios for 'super-premium' or Tier II dry-type transformers, to the extent that they may currently exist, are below 1.00 (~0.25).

Several studies have been completed on alternatives to the traditional ROB program design. An immediate retrofit of inefficient transformers with high efficiency units has been found to be both cost-prohibitive and impractical.[33] However, a study by Oak Ridge National Laboratory (ORNL) found that foregoing the continued use of repaired or refurbished units removed during routine maintenance in favor of new, high-efficiency models was found to be cost-effective for transformers that have been in operation for 22 years or more.[34] In addition, the DOE's recent ruling omits refurbished or remanufactured devices from the new efficiency standards. Although some distributors of remanufactured devices claim that their products attain high levels of efficiency, it may be the case that such devices are less efficient due to their age. There is also the possibility that damage incurred during removal and repair could contribute to reductions in efficiency. Conceivably, IAMU could convince member utilities or their C&I customers to purchase new, high-efficiency models in lieu of remanufactured devices. This small niche market may provide some opportunity for programmatic efforts; however, questions surrounding verified savings and free-ridership could present challenges for such efforts.

Surge Arresters

We also examined the savings that could accrue by adopting energy efficient alternatives for common, 'commodity-type' distribution system equipment. One such technology is the low-loss surge arrester. Surge arrestors are ubiquitous protective devices that are found in a variety of locations and applications throughout municipal power distribution systems. To provide their protective function, arresters are

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[32] This estimate assumes between 20 and 40 percent saturation rates (the percentage of C&I load that passes through on-site, secondary distribution transformers) and efficiency gains between 0.75 and 1.5 percent.

[33] Barnes et al. found that such a strategy results in a B/C ratio close to 0.6. Interruption of service and national supply of suitable replacement units were offered as additional reasons as to why such a strategy would be impractical. Barnes et al., (1995). *The Feasibility of Replacing or Upgrading Utility Distribution Transformers During Routine Maintenance*. Oak Ridge National Laboratory, U.S. Department of Energy.

[34] *Ibid.*

continuously energized, thus inefficient models can accumulate non-negligible energy losses over time. Individual savings for efficient arresters are small (on the order of 3.5 kWh per year for arrestors serving residential customers); however, their prevalence within the distribution grid can lead to significant savings overall. We estimate that purchasing efficient surge arresters could lead to annual reductions of 27 MWh within IAMU's residential customer base alone.[35] As such, surge arresters demonstrate that often-overlooked commoditized items can lead to real supply-side energy savings.

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[35] Assumptions based on information supplied by Cooper Power Systems regarding the Evolution line of surge arresters. Key assumptions include annual savings of 3.54 kWh/arrester/year, 30 year useful life and saturation levels of 1.5 arresters per residential customer. An average incremental cost of $2-3/unit results in a TRC ratio greater than 1.0.

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SENSITIVITY ANALYSIS

It is likely that federal legislation regulating greenhouse gas (GHG) emissions will be enacted during the timeframe of this study. Therefore, we conducted a sensitivity analysis to estimate energy efficiency and demand reduction potential under a carbon cost scenario. We relied on the 2008 levelized carbon cost estimate reported by Synapse Energy Economics under its medium-range forecast, which equates to $30 per ton of carbon dioxide (CO_2) emitted.[36] Using Iowa emissions factors,[37] this carbon price equates to an increase of $0.0235/kWh and $0.18/therm over avoided costs used in the base analysis.

For comparison purposes, the increased avoided costs used in the carbon sensitivity scenario are within the range of estimated Iowa energy cost increases projected in a recent analysis sponsored by Midwest energy suppliers.[38] This analysis, completed in March 2009, analyzed a variety of scenarios for GHG allowance prices and carbon credit allocation mechanisms. By 2030 under the Moderate GHG Price scenario, Iowa energy prices are projected to increase by between 40 and 85 percent over 2005 energy prices. Starting with our base scenario avoided costs, such an increase would equate to between $0.09/kWh and $0.13/kWh for on-peak power, and $0.05/kWh and $0.7/kWh for off-peak power. At the carbon price of $30/ton used in the sensitivity analysis, on-peak avoided costs are $0.09/kWh and off-peak avoided costs are $0.6/kWh—consistent with the Energy Policy Group's Iowa projections under the Moderate GHG Price scenario.

Under the sensitivity scenario, electricity savings increase by 11 percent in 2012 and 18 percent in 2018, compared to the base scenario. Peak demand reduction potential increases by 8 percent in 2012 and nine percent in 2018, and natural gas savings increase by 17 percent in 2012 and 25 percent in 2018. The magnitude of avoided CO_2 emissions increases by around 11 percent in 2012 and 19 percent in 2018 under the sensitivity scenario.

Figure 33 compares 2012 and 2018 achievable potential for electricity savings, demand reduction, and natural gas savings under the base and sensitivity scenarios.

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[36] Synapse Energy Economics, Inc. (2008). *Synapse 2008 CO_2 Price Forecasts*.

[37] Center for Climate Strategies (2008). *Final Iowa Greenhouse Gas Inventory and Reference Case Projections 1990-2025*.

[38] Energy Policy Group, LLC (2009). *Analysis of the Electricity Price Impacts of Alternative Carbon Emission Cap-and-Trade Programs in the Midwest*. Prepared on behalf of Indiana Municipal Power Agency, Madison Gas and Electric Company, Missouri Joint Municipal Electric Utility Commission, Missouri River Energy Services, Southern Minnesota Municipal Power Agency, and WPPI Energy.

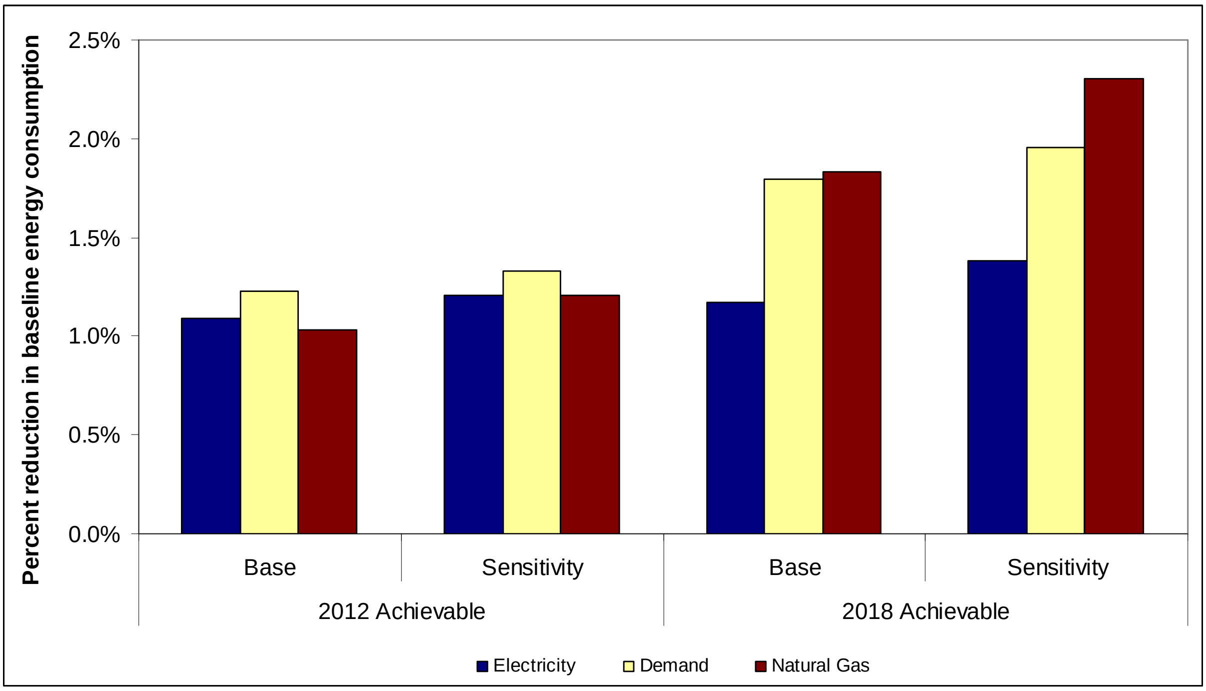

Figure 33: Comparison of Base and Sensitivity Scenarios, 2012 and 2018 Achievable Potential

While there are clearly some differences between the two scenarios, the gap is not as wide as one might anticipate. A number of measures that are not cost-effective in the base scenario pass the TRC screen in the sensitivity scenario, but the aggregate efficiency potential of these measures is not large. This result makes intuitive sense, as marginally cost-effective technologies that are associated with large savings potential represent attractive opportunities for research and development, leading to technological improvements that increase cost-effectiveness.

INNOVATIVE PROGRAM MODELS

A number of innovative energy efficiency program models are well-suited for deployment in municipal utility service territories, and have the potential to offer substantial increases in energy savings compared with standard program approaches. We provide a brief description of these innovative program models in the sections below.

Community Energy Initiatives

Community energy initiatives (CEIs) have recently been launched by WPPI Energy (a regional power company serving 50 municipal utilities in Wisconsin, Michigan, and Iowa) and Efficiency Vermont, among others.[39] CEIs seek to engage civic leaders in targeted energy efficiency outreach campaigns administered at the community level, and are tailored to meet the specific needs and opportunities of a given community. Such efforts often emphasize messaging around global warming and energy independence. CEIs may involve establishing local energy savings targets, increasing the energy efficiency of municipal facilities, raising awareness of energy efficiency opportunities through media outreach and local events, or leveraging local retailers in energy efficient product promotions. CEIs can also target local businesses, offering intensive account management services to identify energy efficiency opportunities through energy audits, energy analyses, and feasibility studies. CEIs may involve a direct installation component for small businesses and households, distributing low-cost measures such as CFLs and low-flow devices. Community groups, schools, and college/university campuses can be leveraged through events, volunteer opportunities, or comprehensive energy assessments of facilities and campuses. One recent advancement in CEIs is the introduction of competition, in which two communities set goals (individually or together) and compete to reach those goals first (or push past the goals). This model harnesses the natural inclination to outperform our peers, and has seen success particularly at the campus level.[40]

By nature, CEIs are scalable, and can be successful regardless of the size of the community. In fact, CEI's may be particularly well suited to small- to medium-sized municipalities such as those participating in the IAMU study, due to the greater sense of connection that may exist within small communities.

Neighborhood Blitz

The "neighborhood blitz" uses a community-based delivery approach to capture the substantial energy efficiency potential found in the residential retrofit market. All residences in a given neighborhood are informed that an audit crew will be in their area during a given week, and residents can sign up to receive an audit. Audit crews conduct walk-throughs and diagnostic tests (e.g., blower door tests, infrared scans) to identify opportunities for energy efficiency upgrades such as air sealing, increased wall and ceiling insulation, and replacement of inefficient heating, ventilation, and air conditioning (HVAC) equipment. Crews also offer direct installation of low cost measures such as low-flow showerheads, faucet aerators,

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[39] For additional information on Efficiency Vermont's Community Energy Mobilization Pilot, please see Efficiency Vermont's *2009-2011 Annual Plan*, available at: http://www.efficiencyvermont.org/stella/filelib/EVT%20Annual%20Plan%202009-2011.pdf.

[40] For information on the Minnesota Campus Energy Challenge, please visit: http://www.teammn.org/mcec.html. For information on the Oberlin College Campus Resource Monitoring System, please visit: http://www.oberlin.edu/dormenergy/.

and CFL bulbs. Implementation crews will return to the neighborhood at a specified time to implement the higher-cost upgrades that residents choose to receive. Similar to low income weatherization efforts, the program covers a substantial portion of the implementation cost—between 60 and 90 percent. The neighborhood blitz approach overcomes two barriers associated with retrofit opportunities. It addresses inertia barriers by coming to the customer and offering a comprehensive array of services, from identifying opportunities to implementing solutions. It addresses capital constraints by paying the lion's share of the implementation cost. A neighborhood blitz approach could also be adapted for small businesses. It could function as a stand-alone program, or be deployed as part of a CEI.

Behavior-Based Programs

Behavior-based programs include a broad cross-section of energy efficiency initiatives that seek to influence human choices affecting energy consumption. Such choices include purchasing decisions, operational and maintenance practices, equipment installation practices, or building design practices. Examples of behavior-based programs include informational campaigns; professional education for home builders, contractors, equipment suppliers, architects or engineers; feedback mechanisms that provide real-time information on energy usage; and social marketing efforts. Two approaches that are particularly well-suited for deployment in municipal utility service territories, and complement some of the other innovative program models discussed here include: (1) home visits that provide information on energy-savings opportunities, and (2) social marketing initiatives that provide bill-based feedback and information to households.

Program administrators have long used walk-through audits as a mechanism for providing information on saving energy. With increasing recognition of the energy impacts of growing household plug load, home visits can also be an effective mechanism for teaching households how to program thermostats and change power-saving settings and brightness levels on computers, televisions, and other home electronics. Programs can train volunteers to go into their community and deliver this type of information to consumers as part of a CEI, as Efficiency Vermont is doing through its Community Energy Mobilization Pilot.

Social science research has demonstrated that individuals often use the behavior of others as a guide in their own decision-making processes, so norms-based approaches to promoting energy efficiency improvement can be a powerful strategy for program administrators.[41] A number of utilities, including Sacramento Municipal Utility District (SMUD) and Puget Sound Energy, have launched pilots that provide customers with detailed information about their household energy consumption and information on how their usage compares with similar households in their area. SMUD found that customers who received a personalized energy report reduced their energy consumption by two percent, compared with customers who received a standard bill.[42] In addition to paper reports, some utilities are using web-based tools that provide enhanced usage information to their customers. Reports should include information on actions customers can take to reduce their bills, such as energy savings tips and information on available

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[41] ACEEE (2008). *Behavior, Energy, and Climate Change: Policy Directions, Program Innovations, and Research Paths*. Report No. E087. Available at: http://aceee.org/pubs/e087.pdf?CFID=3548193&CFTOKEN=16466493.

[42] Leslie Kaufman (January 30, 2009). "Utilities Turn Their Customers Green, With Envy." *New York Times*. Available at: http://www.nytimes.com/2009/01/31/science/earth/31compete.html?em.

rebates. It is also critical to provide regular updates so that customers can monitor their performance over time.[43]

Upstream Strategies

Most energy efficiency programs employ a downstream incentive strategy, offering consumer rebates to offset the higher cost of purchasing an energy efficient product as compared with a similar, standard efficiency product. However, a growing number of programs are pursuing upstream incentive strategies, offering incentives to retailers, equipment suppliers, or other market actors to reward increased sales of energy efficient products.[44]

Under an upstream approach, the equipment supplier receives an incentive for every unit of energy efficient equipment they sell, or for increasing sales by a certain percentage over a specified baseline. Basing incentive payments on an increase over an established sales baseline is preferable, as this approach awards incremental increases in equipment sales, reducing free ridership and conserving program resources. All upstream approaches require the supplier's willingness and ability to share sales data with the energy efficiency program manager; suppliers will typically require confidentiality of such data if it is proprietary.

Municipal utilities may have limited ability to leverage large national or regional retailers for reasons of scale. Upstream approaches present challenges in terms of ensuring that incentive-eligible equipment is installed within the municipal utility's service territory, where customers of multiple utilities are purchasing products from the same store. At the same time, local retailers are good candidates for municipal utility programs, and could be leveraged as part of a CEI. Local equipment suppliers, such as HVAC contractors or electrical suppliers, also represent good candidates for partnership, and it is easier for these market actors to provide documentation on where equipment is installed than it would be for a mass market retailer.

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[43] ACEEE (2008). *Behavior, Energy, and Climate Change: Policy Directions, Program Innovations, and Research Paths*. Report No. E087. Available at: http://aceee.org/pubs/e087.pdf?CFID=3548193&CFTOKEN=16466493.

[44] ACEEE's profile of the PG&E Motor and HVAC Distributor Program provides one example of a best practice upstream incentive program, available at: http://aceee.org/pubs/u081/ci-motor-hvac.pdf. This profile was published in ACEEE's 2008 report, *Compendium of Champions: Chronicling Exemplary Energy Efficiency Programs from Across the U.S.*

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