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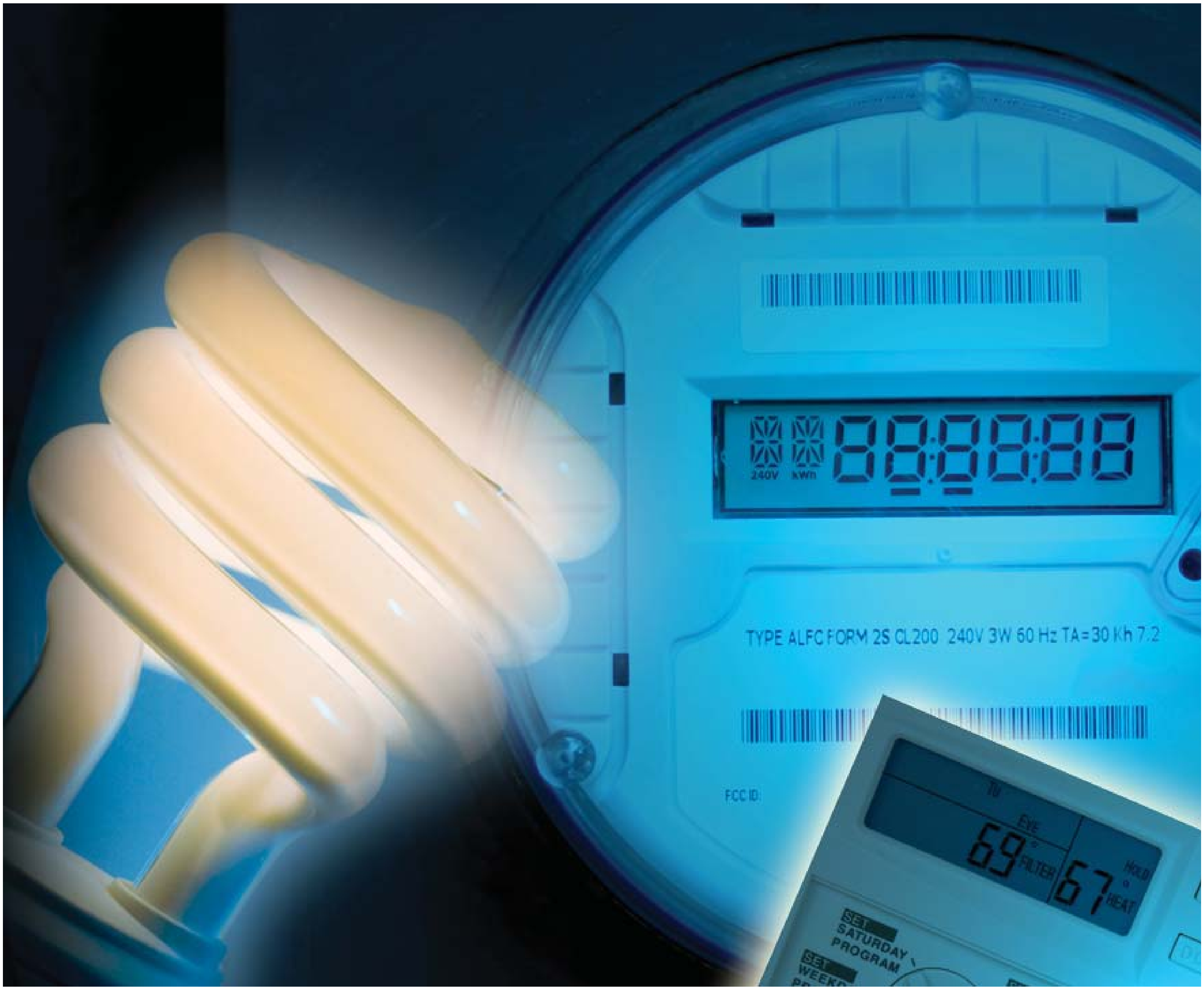
Assessment of Achievable Potential from Energy Efficiency and Demand Response Programs in the U.S.

(2010–2030)



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(2010–2030)

1016987

Technical Report, January 2009

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This report describes research sponsored by the Electric Power Research Institute (EPRI).

The report is a corporate document that should be cited in the literature in the following manner:

Assessment of Achievable Potential from Energy Efficiency and Demand Response Programs in the U.S.: (2010–2030). EPRI, Palo Alto, CA: 2009. 1016987.

PRODUCT DESCRIPTION

This report documents the results of an exhaustive study to assess the achievable potential for electricity energy savings and peak demand reduction from energy efficiency and demand response programs through 2030. This "achievable potential" represents an estimated range of savings attainable through programs that encourage adoption of energy-efficient technologies, taking into consideration technical, economic, and market constraints.

Results and Findings

The U.S. Energy Information Administration (EIA) in its 2008 Annual Energy Outlook (AEO 2008) projects that electricity consumption in the U.S. residential, commercial, and industrial sectors will grow at an annual rate of 1.07% from 2008 through 2030. Energy efficiency programs have potential to realistically reduce this growth rate to 0.83% per year from 2008 through 2030. Under an ideal set of conditions conducive to energy efficiency programs, this growth rate can be reduced to as low as 0.68% per year.

EIA projects that peak demand in the United States will grow at an annual rate of 1.5% from 2008 through 2030. The combination of energy efficiency and demand response programs has the potential to realistically reduce this growth rate to 0.83% per year. Under an ideal set of conditions conducive to energy efficiency and demand response programs, this growth rate can be reduced to as low as 0.53% per year.

These estimated levels of electricity savings and peak demand reduction are achievable through voluntary customer participation in energy efficiency and demand response programs implemented by utilities or state agencies. The estimated cost of implementing programs to achieve realistic potential savings ranges from $1 to $2 billion in 2010, growing to $8 to $20 billion by 2020, to $19 to $47 billion by 2030. This analysis does not assume enactment of new energy codes and efficiency standards; more progressive codes and standards would yield even greater levels of electricity savings and peak demand reduction.

Challenges and Objective(s)

Utilities and policy makers are looking to energy efficiency to help meet the challenges of maintaining reliable and affordable electric service, wisely managing energy resources, and reducing carbon emissions. As a consequence, many states have established, or are considering, legislation to mandate energy efficiency savings levels and regulatory mechanisms to allow utilities to make energy efficiency a sustainable business. Fundamental to such policies are fact-based estimates of the achievable potential for energy efficiency. This study's objective is to provide an independent, technically grounded estimate of the potential for electricity energy savings and peak demand reduction from energy efficiency and demand response programs through 2030 that can help inform decisions of both policy makers and electric utilities.

The study forecasts the adoption of currently available energy-efficient technologies through utility- or state-agency-sponsored programs, taking into consideration technical, economic, and market constraints. This analysis was informed by observations of actual program experiences, results, and best practices. Macro-economic conditions such as economic growth and the price of fuels and electricity were held consistent with the forecasts assumed by the EIA in its AEO 2008 Reference Case forecast. The impact of such factors as higher electricity prices, carbon costs, or a slowdown in economic growth, which could alter consumer behavior and reduce projected load growth, were not included in this analysis. EPRI is planning further studies to analyze the impact of alternate economic, political, and regulatory scenarios.

Applications, Values, and Use

This study is intended to inform utilities, policymakers, regulators, and other stakeholder groups. States and utilities can compare the results of their own potential assessments to the study's regional results. Variances may warrant more detailed assessment of end-uses with overstated or understated potential. Utilities can examine the major areas of energy efficiency potential specific to their region with their own allocation of resources and consider the following questions: How much resource are we allocating to savings in this area? What programs do we have addressing this market? What results have been achieved? What state or local codes and standards exist for this market beyond federal levels?

EPRI Perspective

Energy efficiency is a key component of a full portfolio approach to reducing carbon emissions, as documented in EPRI's Prism analysis. Energy efficiency represents the greatest near-term potential for carbon reduction, bridging the time for less carbon-intensive generation options to come online. The importance of energy efficiency in this regard underscores the need for a comprehensive, fact-based assessment of its achievable potential.

Approach

The project team applied a bottom-up methodology based on equipment stock turnover and adoption of energy efficiency measures at the technology and end-use levels for the four U.S. census regions (Northeast, South, Midwest, and West). This approach is grounded in actual technology efficiencies and costs as well as observations of customer participation in programs. This approach is consistent with most potential studies conducted for utilities or states, but is unique in its application to the United States as a whole, yielding detailed, granular results by region, sector, end-use, and technology. In contrast, most national studies of energy efficiency potential employ macro "top-down" approaches, which typically yield less detailed results that are highly sensitive to variations of a few key assumptions. While other studies co-mingle effects of existing and anticipated codes and standards with programmatic effects, this study isolates the impact of programs. As such, any new codes, standards, regulatory policies, or other externalities could contribute to greater levels of overall efficiency.

Keywords

Energy efficiency
Demand response
Demand-side management (DSM)
Potential
Forecasting

ACKNOWLEDGMENTS

EPRI would like to express its gratitude to Edison Electric Institute (EEI) for its cooperation throughout the course of this study. In particular, we would like to recognize Rick Tempchin, Interim Executive Director, Retail Energy Services, and Lisa Wood, Director of the Edison Foundation Institute for Electric Efficiency.

EPRI would also like to recognize the contributions of its member utility advisors and Public Advisory Group, which includes public utility regulators and representatives of state and federal governmental and non-governmental organizations and leading energy-efficiency and environmental organizations. In particular, the following individuals provided valuable commentary:

Tony Ahern, President and CEO, Buckeye Power

Clifton Below, Commissioner, New Hampshire Public Utilities Commission

Donald Brundage, Senior Engineer, Southern Company Services

Joe Bryson, U.S. Environmental Protection Agency

Kateri Callahan, President, Alliance to Save Energy

Sheryl Carter, Director, Natural Resources Defense Council

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Joe Loper, Vice President, Alliance to Save Energy

Steve Nadel, Executive Director, American Council for an Energy-Efficient Economy (ACEEE)

Susan Stratton, Executive Director, Energy Center of Wisconsin

The project team benefited greatly from the diversity of perspectives and feedback offered by these advisors.

EXECUTIVE SUMMARY

Utilities and policy makers are looking to energy efficiency to help meet the challenges of maintaining reliable and affordable electric service; wisely managing energy resources; and reducing carbon emissions. As a consequence, many states have established, or are considering, legislation to mandate energy efficiency savings levels and regulatory mechanisms to allow utilities to make energy efficiency a sustainable business. Fundamental to such policies are estimates of the potential for energy efficiency grounded in technological expertise and tempered by economic and market realities.

To help address this need, the Electric Power Research Institute (EPRI) commissioned a study to assess the potential of electric end-use energy efficiency and demand response programs to mitigate the projected growth of U.S. electricity consumption and summer peak demand through 2030. A key objective of the study is to inform utilities, electric system operators and planners, policymakers, and other electricity sector industry stakeholders in their efforts to develop actionable savings estimates for end-use energy-efficiency and demand-response programs.

The study began with development of baseline forecasts of electricity consumption and summer peak demand absent any new utility programs or other programs administered by state agencies or third parties. The forecasts are consistent with the U.S. Department of Energy (DOE) Energy Information Administration's (EIA's) "Reference Forecast" for electricity consumption as presented in its 2008 Annual Energy Outlook (AEO) and the North American Electric Reliability Corporation's (NERC's) 2007 Peak Demand and Energy Projection Bandwidths extrapolated to 2030. The study estimates the potential for annual energy-efficiency and demand-response savings for the years 2009 through 2030 at the end-use level for the residential, commercial, and industrial sectors. This analysis yields forecasts of changes in electricity use and summer peak demand[1], as well as changes in annual energy and summer peak-demand savings, for the U.S. and each of its four census regions.

Key Findings

Electricity Consumption

According to the Energy Information Administration's 2008 Annual Energy Outlook (AEO 2008) Reference Case, annual electricity consumption for the U.S. in the residential, commercial, and industrial sectors is estimated at 3,717 TWh in 2008. The AEO 2008 Reference Case

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[1] Non-coincident peak demand across four U.S. census regions.

forecasts this consumption to increase by 26% to 4,696 TWh in 2030, an annualized growth rate from 2008 to 2030 of 1.07%.[2]

The AEO 2008 Reference Case already accounts for market-driven efficiency improvements, the impacts of all currently legislated federal appliance standards and building codes (including the Energy Independence and Security Act of 2007) and rulemaking procedures. The AEO 2008 Reference Case is predicated on a relatively flat electricity price forecast in real dollars between 2008 and 2030. It also assumes continued contributions of existing utility- and government-sponsored energy efficiency and demand response programs established prior to 2008. The savings impact of energy efficiency programs "embedded" in the AEO 2008 Reference Case is estimated in Chapter 2 of the report. Removing this estimate of embedded savings from the AEO 2008 Reference Case results in an adjusted baseline forecast that is higher.

Energy efficiency programs have the potential to reduce electricity consumption in 2030 by 398 to 544 billion kWh. This represents a range of achievable potential reduction in electricity consumption in 2030 – from a "moderate case" or *realistic achievable potential* of 8% to a "high case" or *maximum achievable potential* of 11%.[3] [4]

Relative to the AEO 2008 Reference Case, which assumes a level of energy efficiency program impact, this study identifies between 236 and 382 billion kWh of *additional savings potential* from energy efficiency programs.

Therefore, energy efficiency programs have the potential to reduce the annual *growth rate* in electricity consumption forecasted in AEO 2008 between 2008 and 2030 of 1.07% by 22% to 36%, to an annual growth rate of 0.83% to 0.68%.

These estimated levels of electricity savings are achievable through voluntary energy efficiency programs implemented by utilities or similar entities. Our analysis does not assume the enactment of new energy codes and efficiency standards beyond what is already in law. More progressive codes and standards would yield even greater levels of electricity savings.

Peak Demand

Summer peak demand in the U.S., aggregated from non-coincident regional peaks, is projected to be 801 GW in 2008, and is expected to increase to 1,117 GW by 2030, an increase of 39%.

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[2] AEO 2008. Table 8: "Electricity Supply, Disposition, Prices, and Emissions". Electricity sales by sector for Residential, Commercial and Industrial sectors. Excludes Transportation and Direct Use.

[3] The values for realistic- and maximum- achievable potentials in 2030 measured with respect to the baseline forecast described in footnote 3 (and detailed in Chapter 2) are 398 and 544 billion kWh, respectively, or 8 to 11%. These values represent the total savings impact of energy efficiency programs in 2030 inclusive of savings embedded in the AEO 2008 Reference Case.

[4] Realistic Achievable Potential (RAP) can be thought of as a "moderate case" for the savings impact of energy efficiency programs; Maximum Achievable Potential (MAP) can be thought of as a "high case" for the savings impact of energy efficiency programs. Through the terms may be used interchangeably, the nomenclature of RAP and MAP are used throughout this report.

Summer peak demand is expected to grow at a faster annual rate than electricity use due primarily to the expected growth in the share of air conditioned homes and buildings.

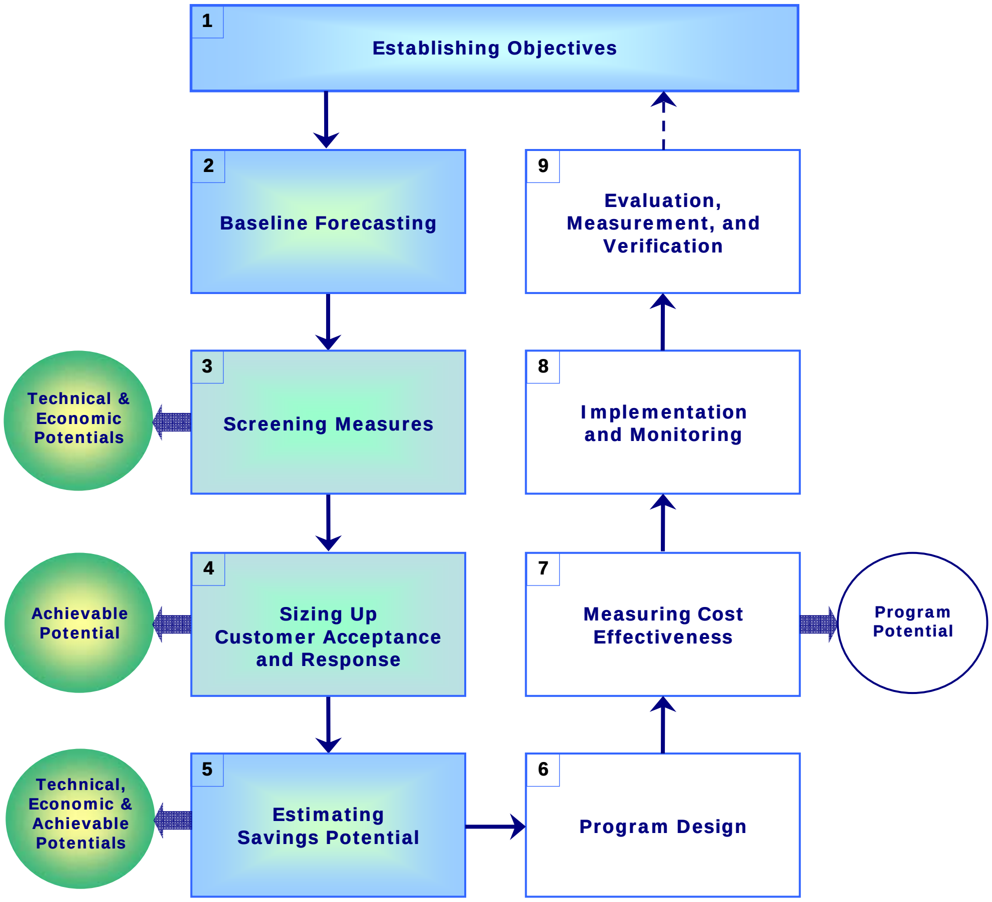
The combination of demand response and energy efficiency programs has the potential to reduce non-coincident summer peak demand by 157 GW to 218 GW. This represents a range of achievable potential reduction in summer peak demand in 2030 of 14% to 20%. This can also be expressed as a reduction in the forecasted growth rate in peak demand of 46% to 65% through 2030. Half the peak demand savings result from energy efficiency actions and the other half from activities specifically designed to reduce peak demand, referred to as demand response.

These estimated levels of peak demand reduction are achievable through voluntary energy efficiency and demand response programs implemented by utilities or similar entities. Our analysis does not assume the enactment of new energy codes and efficiency standards beyond what is already in law. More progressive codes and standards would yield even greater levels of peak demand reduction.

Analysis Approach

The study used an analysis approach that is consistent with the methods described in EPRI's "Energy Efficiency Planning Guidebook" published in June 2008 (as depicted in steps 1 through 5 of Figure ES-1) and the National Action Plan for Energy Efficiency (NAPEE) "Guide to Conducting Energy Efficiency Potential Studies," published in November 2007.

The study applied two distinct approaches to estimate electric energy efficiency: one for residential and commercial buildings and another for industrial facilities. For the residential and commercial sectors, the study implemented a bottom-up approach for determining electric energy efficiency savings potential. The residential and commercial approach begins with a detailed equipment inventory (e.g., the number of refrigerators), the average unit energy consumption (per household or per square foot in the commercial sector), and the diversified load during the non-coincident summer peak. In each sector, annual energy use and peak demand are the product of the number of units and the unit consumption annually, and at peak. This process is repeated for all devices across vintages and sectors. AEO 2008 provided both the number of units and the unit consumption. Diversified peak-load estimates were also developed as part of the study. For the industrial sector, the study applied a top-down approach in which the sector forecast is allocated to end uses and regions.



Source: Energy Efficiency Planning Guidebook, EPRI 1016273, June 2008

Figure ES-1
Energy Efficiency Analysis Framework

The savings potential of an individual energy-efficiency measure is a function of its unit energy savings relative to a baseline technology and its technical applicability, economic feasibility, the turnover rate of installed equipment, and market penetration. For a given end-use, a baseline technology represents a discrete technology choice that complies with minimum existing efficiency standards (to the extent such standards exist) and is generally the most affordable and prevalent technology option in its end-use category. For each end use category, several grades of higher-efficiency technology options are available beyond the baseline technology.

For example, for residential central air conditioning (CAC), the baseline technology is a unit with a seasonal energy efficiency ratio (SEER) of 13. In our modeling approach, the baseline SEER 13 unit, along with more efficient, and expensive, technology options (e.g., SEER 14, SEER 15, SEER 17, ductless inverter-driven mini-split heat pumps, etc.) are applicable in existing homes as replacements for CACs *that have reached the end of their expected useful life*. They are also applicable to new homes that are being built with CAC. In our modeling approach, they are not applicable to either existing or new homes with room air conditioners.

The study utilized a modeling tool for forecasting energy use, peak demand, and energy efficiency and demand response savings[5]. The modeling approach is consistent with EPRI's end-use econometric forecasting models, including Residential End-Use Econometric Planning System (REEPS) and the Commercial End-Use Planning System (COMMEND), which are detailed microeconomic models that forecast energy and peak demand at the sector, segment, and end-use levels. The modeling tool used in this study represents a simplification of these legacy EPRI models customized for the analytical task of estimating energy efficiency potential. The study incorporates a comprehensive technology database that includes the latest findings from EPRI energy efficiency research. Energy efficiency savings potentials are developed using a bottom-up approach, aggregating the impact of discrete technology options within end uses across sectors and regions. This approach follows industry best practices and has been applied successfully in numerous forecasting and potential studies for utilities.

Defining "Potential"

The primary focus of this study was to develop a range of **achievable** energy efficiency and demand response potentials. The approach for deriving *achievable potential* is predicated on first establishing the theoretical constructs of *technical potential* and *economic potential* and then discounting them to reflect market and institutional constraints. This study applies the condition that new equipment does not replace existing equipment instantaneously or prematurely, but rather is "phased-in" over time as existing equipment reaches the end of its useful life. All categories of potentials in this study conform to this condition, and may be termed "phase-in" potentials.[6]

This study employs the following categories of potential.

- **Technical Potential** represents the savings due to energy efficiency and demand response programs that would result if all homes and businesses adopted the most efficient, commercially available technologies and measures, *regardless of cost*. Technical potential provides the broadest and largest definition of savings since it quantifies the savings that would result if all current equipment, processes, and practices in all sectors of the market were replaced at the end of their useful lives by the most efficient available options. Technical potential does not take into account the cost-effectiveness of the measures or the rate of market acceptance of those measures (i.e. 100% customer acceptance assumed).

  Using the residential central air conditioning example from above, technical potential assumes that, each year, every home with a residential central AC unit that has reached the end of its useful life purchases and installs the most efficient technology as a replacement (i.e. ductless inverter-driven mini-split heat pumps), regardless of cost.

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[5] The modeling tool employed was Global Energy Partners' Load Management Analysis and Planning (LoadMAP)

[6] For the purposes of this study, no "mid-life" replacements of existing equipment for more efficient equipment are assumed, even though in some instances such replacements may be economically justifiable. Consumers or firms that initiate such replacements could be considered predisposed to efficiency or conservation, and their actions may be grouped in the category or market-driven or "naturally-occurring" savings if they would occur independent of an energy efficiency program.

- **Economic Potential** represents the savings due to programs that would result if all homes and business adopted the most efficient, commercially available *cost-effective* measures. It is a subset of the Technical Potential and is quantified only over those measures that pass a widely recognized economic cost-effectiveness screen. The cost-effectiveness screen applied in this study is a variation of the *Participant Test*, which compares the incremental cost to a consumer of an efficient technology relative to its baseline option, and the bill savings expected from that technology over its useful life. Only those technologies for which the net present value of benefits exceeds its incremental cost to consumers pass the test. Economic potential does not take into account the rate of market acceptance of those measures (i.e. 100% customer acceptance assumed).

  Economic potential assumes that, each year, every home with a residential central AC unit that has reached the end of its useful life purchases and installs the most efficient technology that passes a basic economic cost-effectiveness test as a replacement (e.g. SEER 14 – 17 depending upon the region).

- **Achievable Potential** refines economic potential by taking into account various barriers to customer adoption.
  - **Maximum Achievable Potential (MAP)** takes into account those barriers that limit customer participation under a scenario of perfect information and utility programs. MAP involves incentives that represent 100% of the incremental cost of energy efficient measures above baseline measures, combined with high administrative and marketing costs. These barriers could reflect customers' resistance to doing more than the absolute minimum required or a dislike of the technology option. For example, some customers might choose not to buy compact fluorescent lamps (CFLs) because they don't like the color or don't believe they work as well as incandescent lamps. When considering the purchase of major appliances, many customers consider price, aesthetics, and functional attributes before turning to energy efficiency and operational costs. Similarly, even though a financial incentive such as a rebate afforded by a program would bring the up-front cost of an energy-efficient product at parity with a standard product, some segment of customers are not be willing to go through the perceived hassle of a rebate application. This despite the clear economic benefits that would accrue from the monthly bill savings that result from a more efficient device. MAP is estimated by applying market acceptance rates (MARs) to the economic potential savings from each measure.
  - **Realistic Achievable Potential (RAP)**, unlike the other potential estimates, represents a forecast of likely customer behavior. It takes into account existing market, financial, political, and regulatory barriers that are likely to limit the amount of savings that might be achieved through energy-efficiency and demand-response programs. For example, utilities do not have unlimited budgets for energy efficiency and demand response programs. Political barriers often reflect differences in regional attitudes toward energy efficiency and its value as a resource. Market barriers reflect imperfect information. RAP also takes into account recent utility experience and reported savings. RAP is calculated by applying a program implementation factor (PIF) to MAP for each measure

The Starting Point: Base-Year Electricity Use by Sector and End Use

Before analysis of electricity savings can take place, it is critical to understand how customers use electricity today. This study begins with the 2008 AEO estimate of 3,717 TWh for U.S. electricity use in 2008 across the residential, commercial, and industrial sectors. Figure ES-2 illustrates the AEO breakdown by sector and end use. Residential is the largest sector at 38%, followed by commercial at 36% and industrial at 26%. In both residential and commercial sectors, lighting and cooling are major end uses. Both sectors also have a substantial "other" category which includes various so called "plug loads" (miscellaneous appliances and devices which can be "plugged" into conventional 120 volt outlets) not classified among the other end uses. Office equipment is another large use in the commercial sector. Machine drives (motors) are the largest electric end use in the industrial sector.

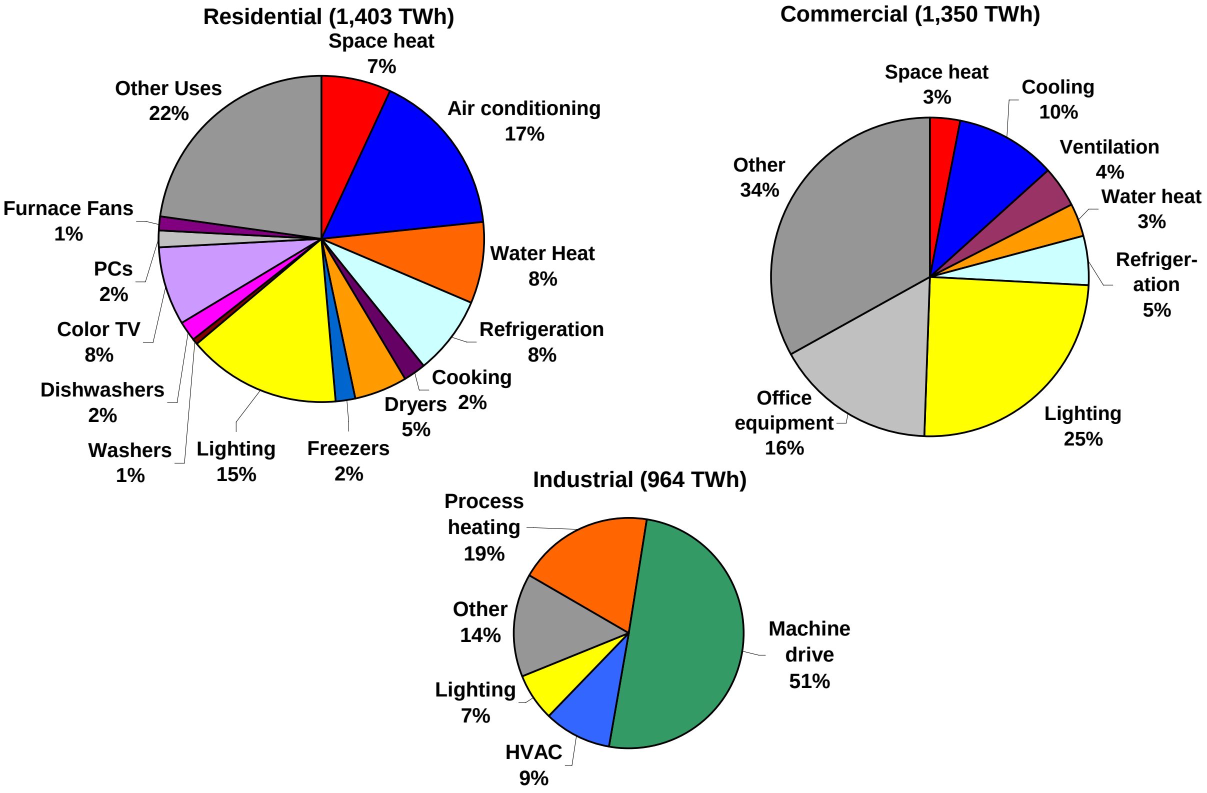
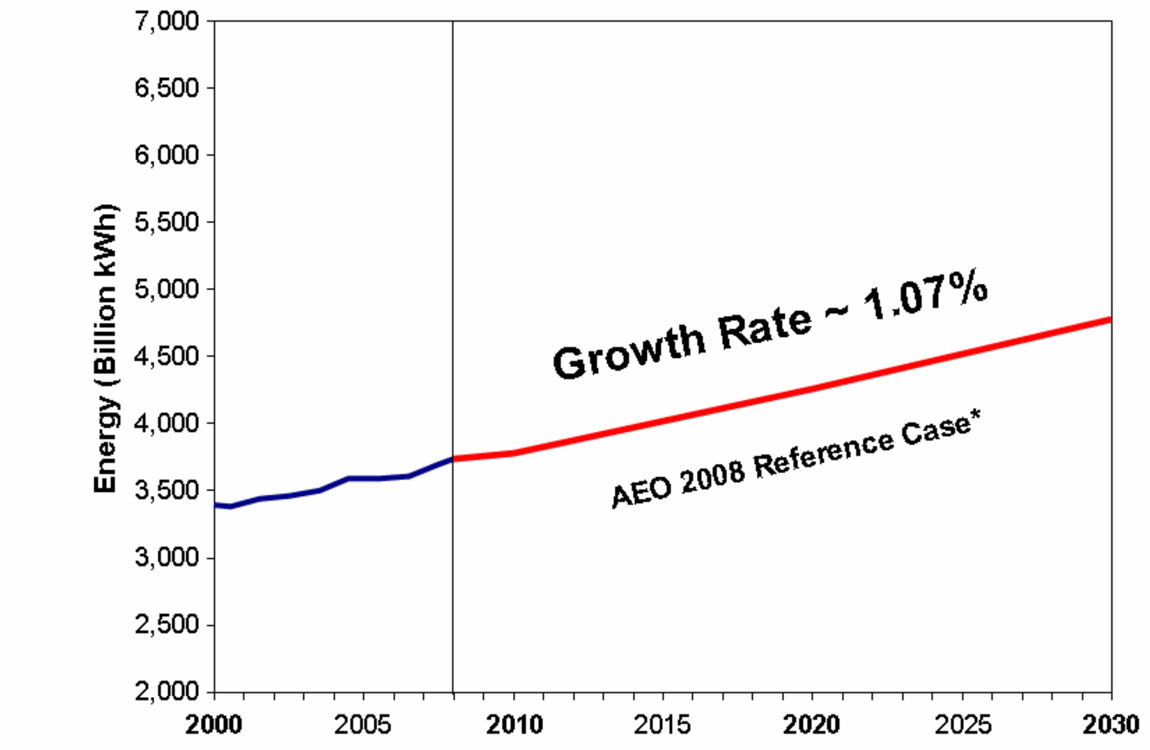


Figure ES-2
2008 U.S. Electricity Consumption by Sector and End Use from the 2008 Annual Energy Outlook (AEO 2008)

The Baseline Forecast

The U.S. Energy Information Administration's 2008 Annual Energy Outlook Reference Case for electricity consumption, confined to the three major sectors – Residential, Commercial, and Industrial – is presented in Figure ES-3.



* EIA Annual Energy Outlook 2008, Final Edition (Residential, Commercial, and Industrial sectors)

Figure ES-3
AEO 2008 Reference Case Electricity Consumption Forecast

Viewed in a historical context, the AEO 2008 projected growth in electricity consumption through 2030 is remarkably less than what has been observed in the post-World War II era. From 1950 through 1973 prior to the middle-east oil embargo, the average annual rate of electricity growth was 7.8%. From 1974 (post oil-shock) through 2007, the average rate of electricity growth has slowed to 2.3% per year.

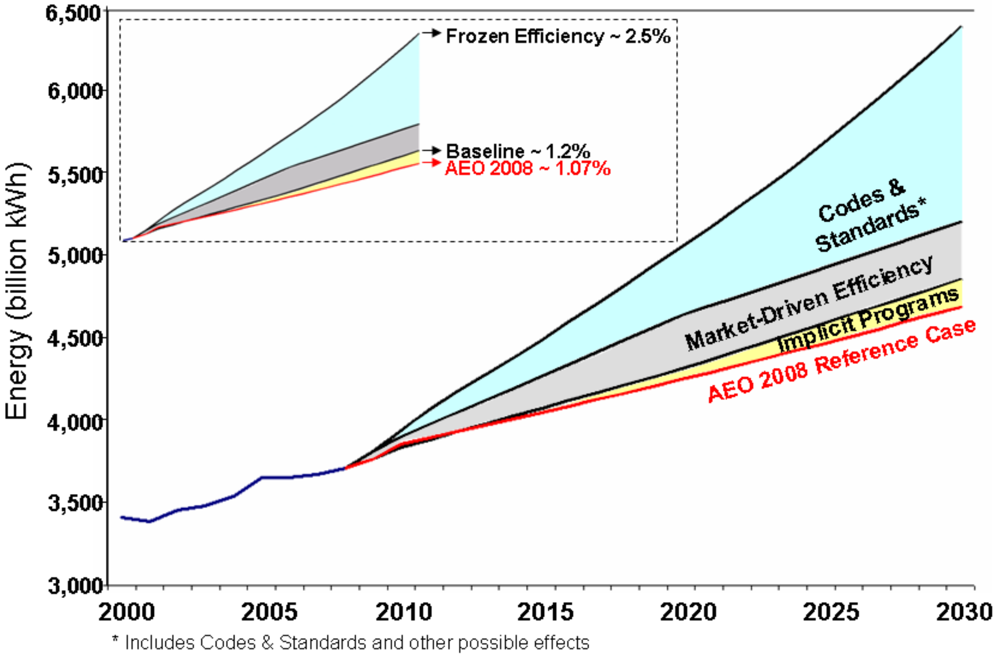
The macroeconomic drivers of the AEO forecast include U.S. population, employment, Gross Domestic Product (GDP), value of shipments, housing starts, and building construction. Average growth in GDP between 2008 and 2030 is 2.5%, more than double the rate of projected electricity growth. This implies a decline in the electricity intensity per GDP.

By 2030, electricity use is expected to increase to 4,696 TWh, a 26% increase over use in 2008. This Reference Case forecast already includes expected savings from several efficiency drivers including:

- Codes and Standards
  - Federal, state, and local building efficiency codes already enacted
  - Appliance and equipment standards already enacted; this includes the Energy Independence and Security Act of 2007, which, among its features, mandates higher lighting efficiency standards

  - Other possible related effects, including structural changes in the economy that impact overall electric energy intensity
- Market-Driven Efficiency
  - Trends in customer purchases of energy-efficient equipment attributable to market-driven effects outside of utility programs
- Implicit Programs
  - An estimate of the utility-based energy efficiency programs adopted prior to 2008, and an estimate of the impact of these existing programs

The study estimated the aggregate impact of these drivers by developing a "frozen efficiency" case that represents what consumption would be if the electricity energy intensity of the economy (expressed in terms of kWh per dollar of real U.S. GDP) were held fixed at 2008 levels (0.33 kWh/$GDP). This case, depicted in Figure ES-4, maintains the 2.5% growth rate of the previous three decades. The difference between the frozen efficiency forecast and the AEO 2008 Reference Case can be considered to be the cumulative impact of energy efficiency programs included in AEO 2008, market-driven efficiency, efficiency codes and standards, and other effects. Figure ES-4 illustrates the estimated of these components.



* Includes Codes & Standards and other possible effects

Figure ES-4
Estimated Impact of Energy Efficiency Drivers Inherent in AEO 2008 Reference Case

The estimated impact of energy efficiency programs “embedded” in the AEO 2008 Reference Case was “added back” to construct an adjusted “baseline” forecast, in accordance with standard industry practice. This baseline represents a projection of electricity consumption absent of any assumed impact of energy efficiency programs.

The baseline forecast does not assume any expected savings from future federal or state appliance and equipment standards or building codes not currently enacted. Finally, the baseline embodies the AEO 2008 price forecast, which is relatively flat in real terms over the forecast horizon.

The Potential for Electricity Savings from Utility Programs

The analysis of potential savings from utility programs began with a list of energy efficiency measures. This list includes high-efficiency appliances and equipment for most end uses, many of which have numerous efficiency levels, devices, controls, maintenance actions, and enabling technologies such as programmable thermostats. Table ES-1 summarizes the energy-efficiency measures included in the analysis.

Table ES-1
Summary of Energy-Efficiency Measures

Residential Sector Measures	Commercial Sector Measures
Efficient air conditioning (central, room, heat pump)	Efficient cooling equipment (chillers, central AC)
Efficient space heating (heat pumps)	Efficient space heating equipment (heat pumps)
Efficient water heating (e.g. heat pump water heaters & solar water heating)	Efficient water heating equipment (heat pumps)
Efficient appliances (refrigerators, freezers, dishwashers, clothes washers, clothes dryers)	Efficient refrigeration equipment & controls (e.g. efficient compressors, floating head pressure controls, anti-sweat heater controls, etc.)
Efficient lighting (CFL, LED, linear fluorescent)	Efficient lighting (interior and exterior; LED exit signs, task lighting)
Efficient power supplies for Information Technology and consumer electronic appliances	Lighting controls (occupancy sensors, daylighting, etc.)
Air conditioning maintenance	Efficient power supplies for Information Technology and electronic office equipment
Heat pump maintenance	Water temperature reset
Duct repair and insulation	Efficient ventilation (air handling and pumps; variable air volume)
Infiltration control	Economizers and energy management systems (EMS)
Whole-house and ceiling fans	Programmable thermostats
Reflective roof, storm doors, external shades	Duct insulation
Roof, wall and foundation insulation	Retro-commissioning
High-efficiency windows	**Industrial Sector Measures**
Faucet aerators and low-flow showerheads	Efficient process heating
Pipe insulation	High-efficiency motors and drives
Programmable thermostats	High-efficiency Heating, Ventilation and Air Conditioning (HVAC)
In-home energy displays	Efficient lighting

As described above, the full set of measures is included in the estimation of technical potential, while only the subset that passes the economic screen is included in economic and achievable potential.

Table ES-2 presents energy-efficiency potential estimates for the U.S. in 2020 and 2030. Relative to the baseline forecast, in 2030:

- Realistic Achievable Potential is 398 TWh, or an 8% reduction in projected consumption
- Maximum Achievable Potential is 544 TWh, or an 11% reduction in projected consumption

Relative to the AEO 2008 Reference Case, in 2030:

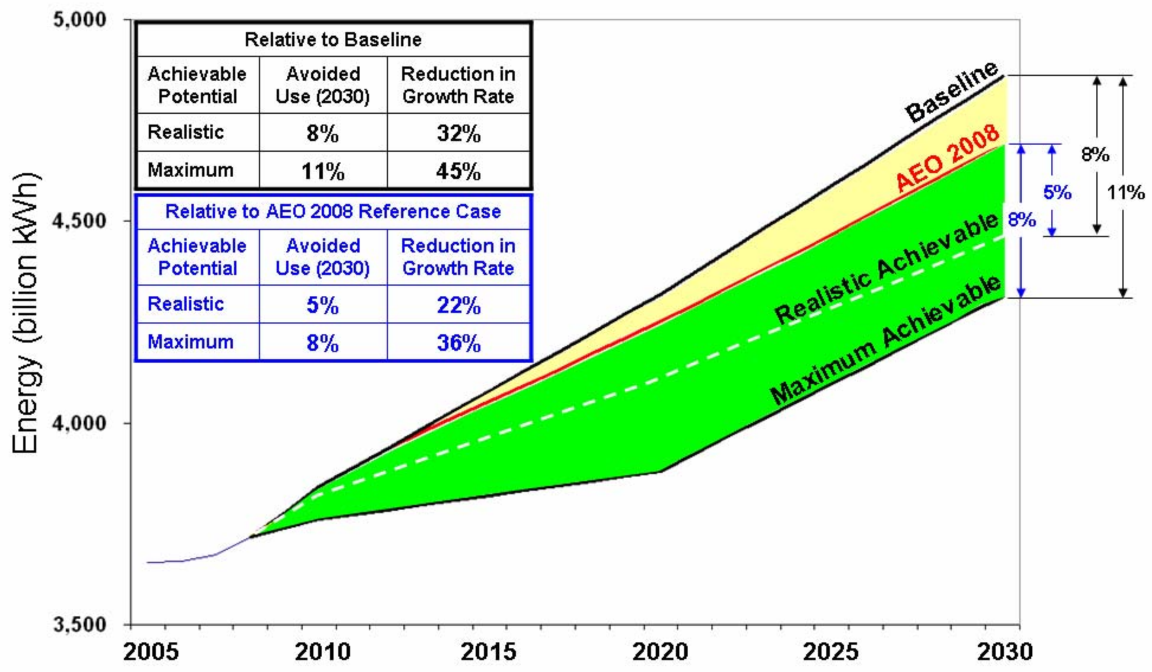
- Realistic Achievable Potential represents 236 TWh of *additional* energy efficiency savings, or a 5% reduction in projected consumption.
- Maximum Achievable Potential represents 382 TWh of *additional* energy efficiency savings, or an 8% reduction in projected consumption.

These estimates suggest that energy efficiency programs can realistically reduce the annual growth rate of U.S. electricity consumption from 2008 to 2030 projected by the AEO 2008 Reference Case by 22%, from 1.07% to 0.83%.

Table ES-2
Energy Efficiency Potential for the U.S.

	AEO 2008 Reference Case	Baseline Forecast	Realistic Achievable Potential	Maximum Achievable Potential
Forecasts (billion kWh)				
2020	4,253	4,319	4,112	3,881
2030	4,696	4,858	4,460	4,314
Savings Relative to AEO 2008 Reference Case (billion kWh)				
2020			141	372
2030			236	382
Savings Relative to Baseline Forecast (billion kWh)				
2020			207	438
2030			398	544

Figure ES-5 illustrates this achievable savings potential.



Relative to Baseline		
Achievable Potential	Avoided Use (2030)	Reduction in Growth Rate
Realistic	8%	32%
Maximum	11%	45%

Relative to AEO 2008 Reference Case		
Achievable Potential	Avoided Use (2030)	Reduction in Growth Rate
Realistic	5%	22%
Maximum	8%	36%

Figure ES-5
U.S. Energy Efficiency Achievable Potential

Below is an example of the residential air conditioner to illustrate the transition from technical potential to realistic achievable potential.

- **Technical Potential:** Central air conditioning (CAC) systems in existing homes are replaced, upon reaching the end of their useful lives, with the highest SEER level equipment available regardless of cost; in new homes, the highest SEER level available in each year is installed. In 2010, this is the SEER 20 air conditioner or the ductless (mini-split) heat pump with variable speed operation.
- **Economic Potential:** CAC systems in existing homes are replaced, upon reaching the end of their useful lives, with the highest SEER level CAC that passes the economic screen; in new homes, the highest SEER level CAC passing the economic screen is installed. The results of the economic screening vary by region. In the Southern region in 2010, for example, the highest-efficiency CAC that passes the economic screen is SEER 15.
- **Maximum Achievable Potential (MAP):** MAP applies a market-acceptance rate to the economic potential results, based on the best experiences of energy efficiency programs per technology or end-use category, as well as the considered judgment of industry experts. The market acceptance rate for the high-efficiency CAC unit is estimated to be 25% by 2010, and is projected to increase to 75% in 2020 and remain at that level through 2030.
- **Realistic Achievable Potential (RAP):** RAP applies a program implementation factor to MAP. The program implementation factor for the high-efficiency CAC unit is assumed to be 15% in 2010, and is projected to increase to 42% in 2020 and 70% in 2030. The combined

effect of the market acceptance rate and program implementation factor for residential central air conditioning gives a realistic achievable potential that is 4% of economic potential in 2010, 32% in 2020 and 53% in 2030. Program implementation factors vary by technology category.

Figure ES-6 identifies realistically achievable savings by sector and end use. Two broad categories of opportunity include the following:

- First, there continues to be a large opportunity for savings in end uses that already have a long history in energy efficiency, suggesting that there is potentially more “low-hanging fruit” to harvest. Commercial lighting, industrial motors, and residential cooling fall into this category.
- Second, the recent growth in consumer electronics and computing equipment has not only added to the baseline forecast, it creates a sizeable opportunity for efficiency improvements that will result in electricity savings. We are only beginning to understand what is possible for these end uses and to exploit the potential for savings.

Figure ES-7 displays the individual measures with the highest potential for savings across all the sectors. To emphasize, there is still tremendous opportunity for savings in commercial lighting and small-size industrial motors.

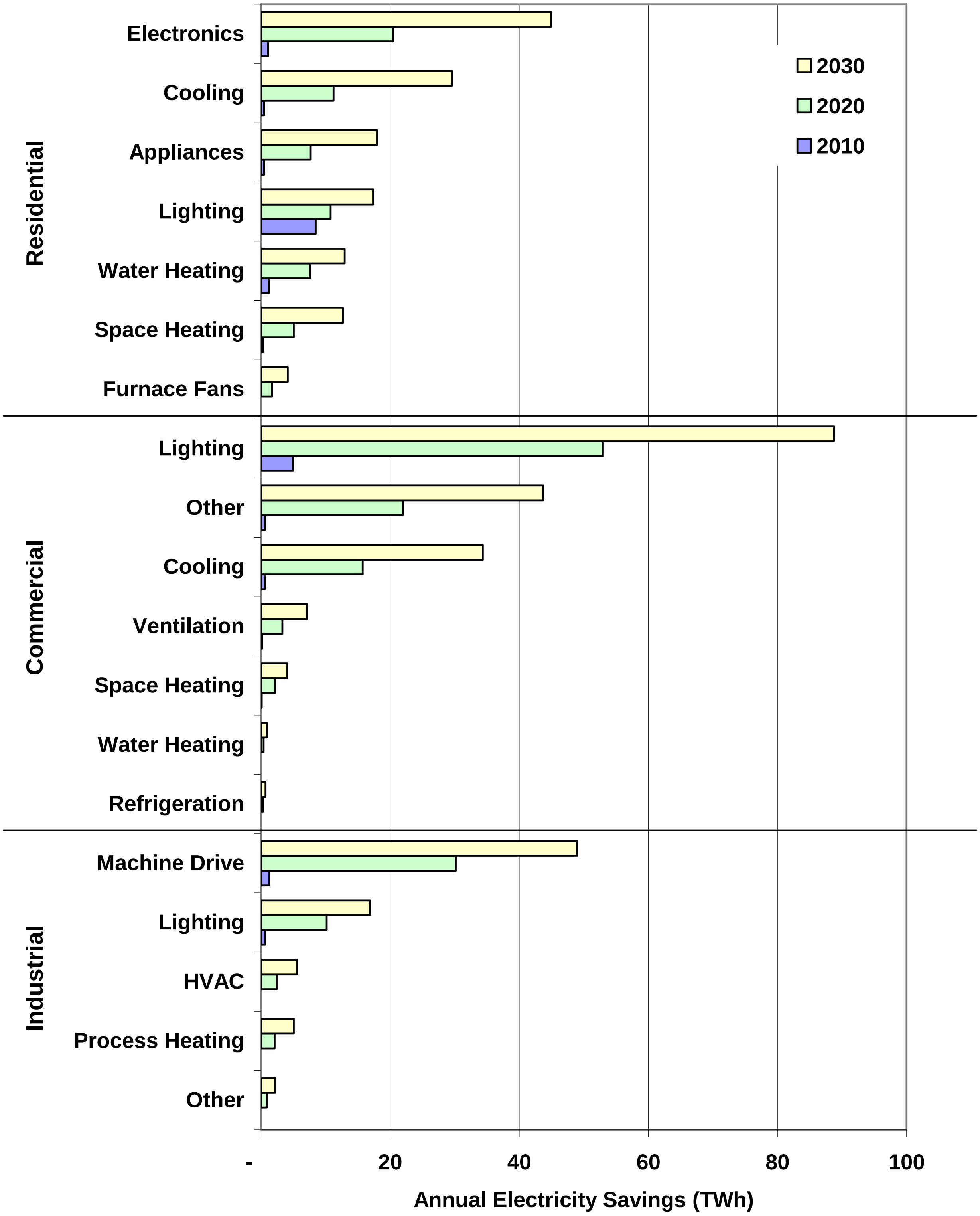


Figure ES-6
Realistic Achievable Potential by End-Use (Relative to Baseline)

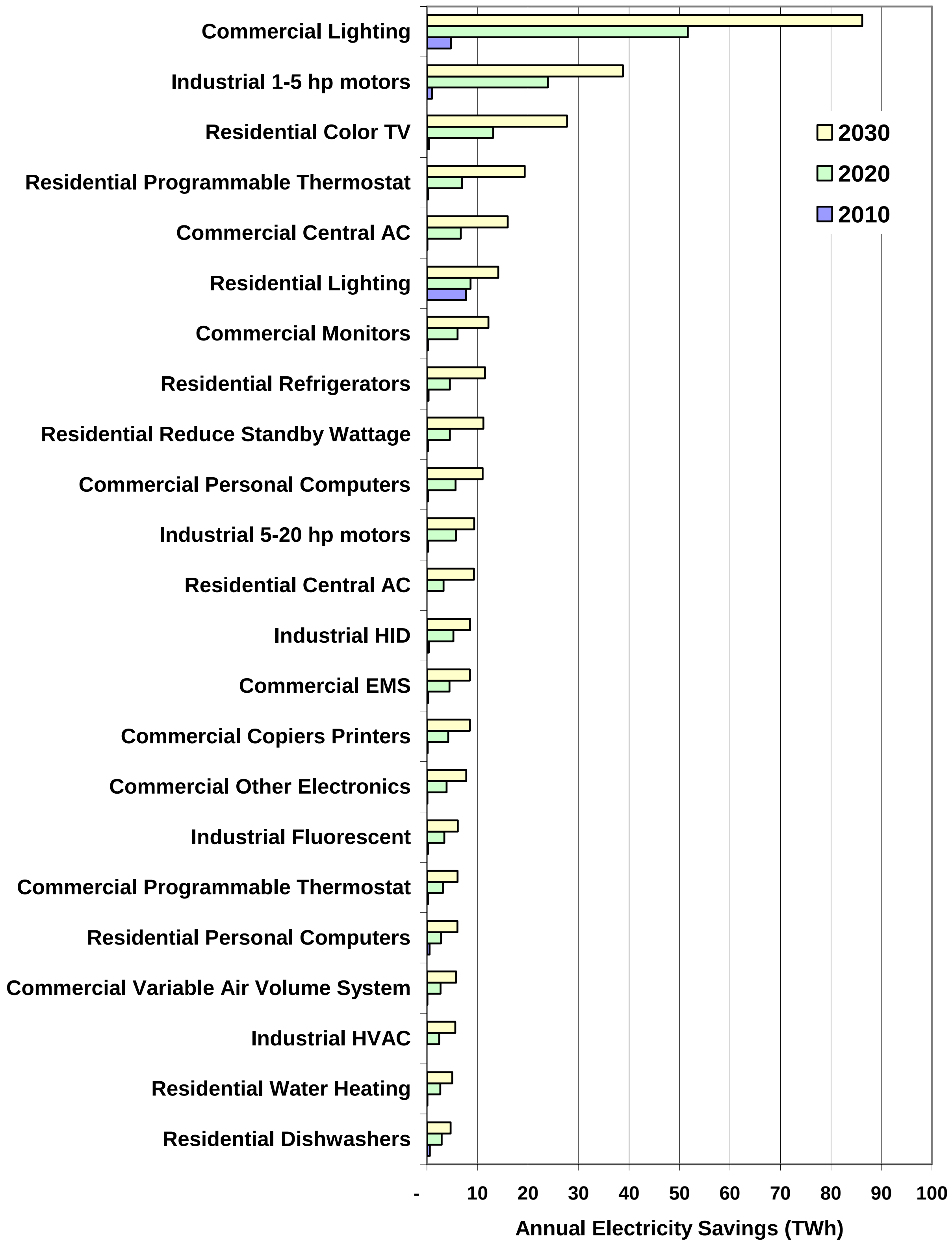


Figure ES-7
Realistic Achievable Potential by Technology (Relative to Baseline)

Energy Efficiency Savings Potential by U.S. Census Region

This study disaggregates electricity baseline consumption and potential energy efficiency savings by the four U.S. Census regions shown in Figure ES-6: Northeast, South, Midwest, and West.

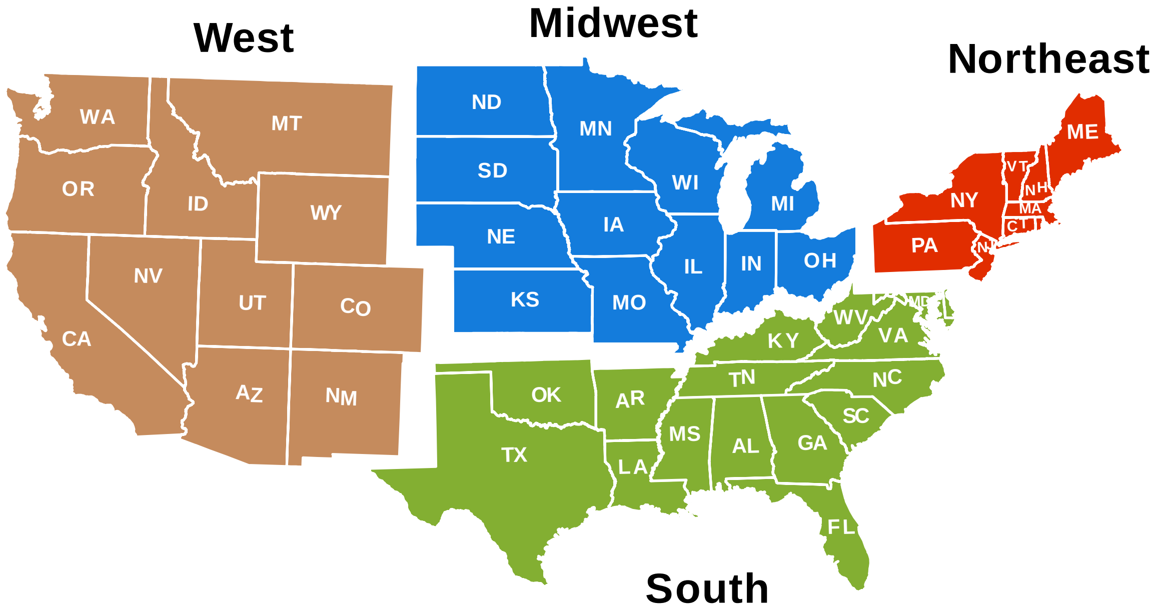


Figure ES-8
U.S. Census Regions

Figure ES-9 summarizes the realistic achievable potentials among the four census regions for the year 2030. Generally speaking, the Northeast and West regions have had a longer legacy of energy efficiency programs than the South and Midwest. Sub-regions of long-standing energy efficiency activity include California and the Pacific Northwest in the West, and the greater New England area in the Northeast.

- Electricity consumption is currently highest in the South, and is expected to grow at an annual rate of 1.4% through 2030. The South is also the region with the greatest potential for energy efficiency in absolute terms.
- Electricity consumption is currently lowest in the Northeast, and is expected to grow at an annual rate of 0.9% through 2030. The Northeast's energy efficiency potential is the smallest of the four regions, although by share of total load it ranks second.
- The Midwest is the second largest region in terms of both current and forecasted consumption, although its annual growth rate of 0.7% is the smallest of the four regions.
- Finally, the West is the region of most rapid forecasted growth at 1.6% per year, and has the largest potential for energy efficiency in percentage terms.

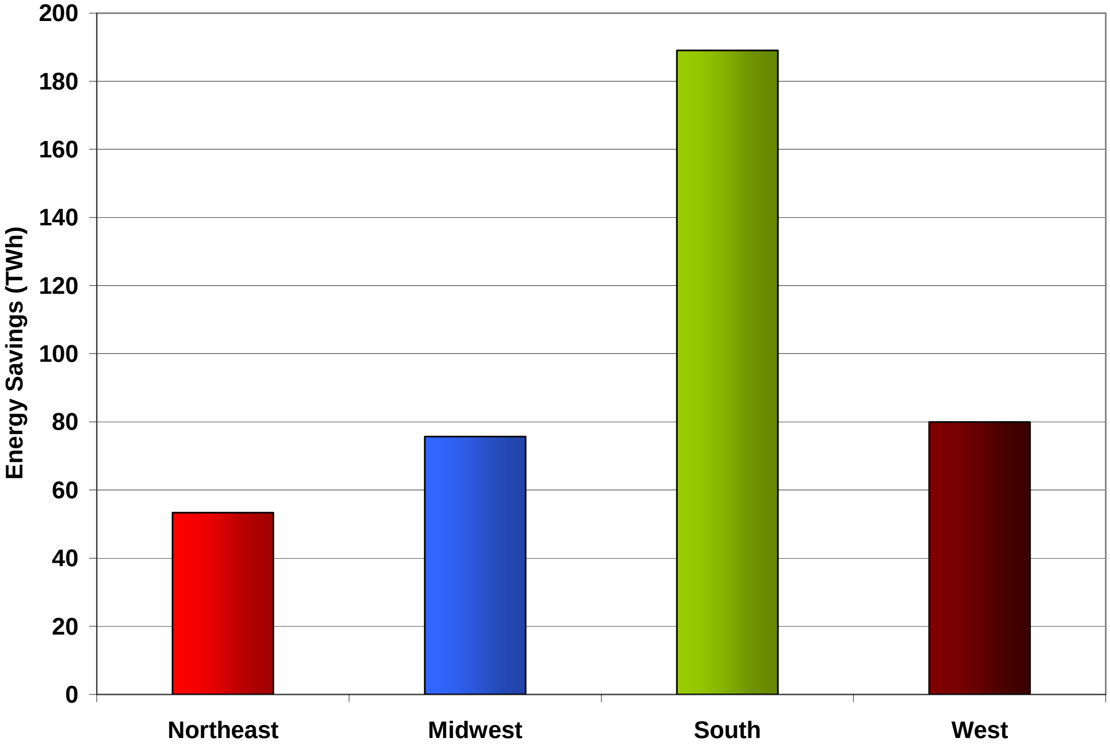


Figure ES-9
Realistic Achievable Potential by Region and End Use in 2030 (Relative to Baseline)

The top areas of potential within each region by sector (residential, commercial, industrial) and end use are shown in Figure ES-10. Key highlights are:

- Commercial lighting – inclusive of upgrading lighting systems, daylighting controls, occupancy sensors, and task lighting – represents the largest energy savings opportunity. This result contradicts a widespread belief that the opportunities for reducing commercial-sector lighting use have been exhausted. While some utilities have already undertaken substantial energy efficiency efforts in commercial lighting, most of these activities have addressed easier-to-implement lighting measures, leaving room for significant additional savings potential.
- Air conditioning in the commercial and residential sectors contributes significantly to savings potential, above and beyond savings from equipment standards.
- Efficiency savings from computers, other office equipment, and electronics are substantial. Utilities can achieve these savings through a variety of initiatives including educating customers and providing incentives for the purchase of high efficiency equipment.
- Numerous residential appliances, from water heaters to freezers, also contribute materially to savings potential, even beyond existing and soon to be implemented Federal appliance standards.
- In the industrial sector, electricity savings potential is pre-dominantly in motor-driven applications, above and beyond savings associated with long-standing motor efficiency standards.

The baseline forecast and associated end-use energy efficiency potentials have evolved during the course of this study, due chiefly to restatements of the EIA Annual Energy Outlook. In late 2007, the EIA revised forecast of economic growth changed substantially. In addition, passage of the Energy Information and Security Act of 2007 (EISA 2007) greatly impacted the estimated savings potential of residential lighting. Prior to these changes, our analysis showed that residential screw-in or pin lighting would contribute almost 90 TWh to total electricity savings in 2030. Since the efficiency standards for residential lighting set by EISA 2007 will effectively reduce baseline consumption, the potential residential lighting savings from utility programs in 2030 has been reduced to less than 20 TWh. Also, during the course of this study, the identification and incorporation of new "advanced" technologies has augmented efficiency potentials. For example, mounting evidence suggests that in-home displays can reduce energy consumption and the industry is beginning to add this technology to its list of viable energy efficiency measures. Similarly, technologies that are being adopted abroad, such as combined clothes washer/dryers, are assumed to have an impact in the forecast horizon.

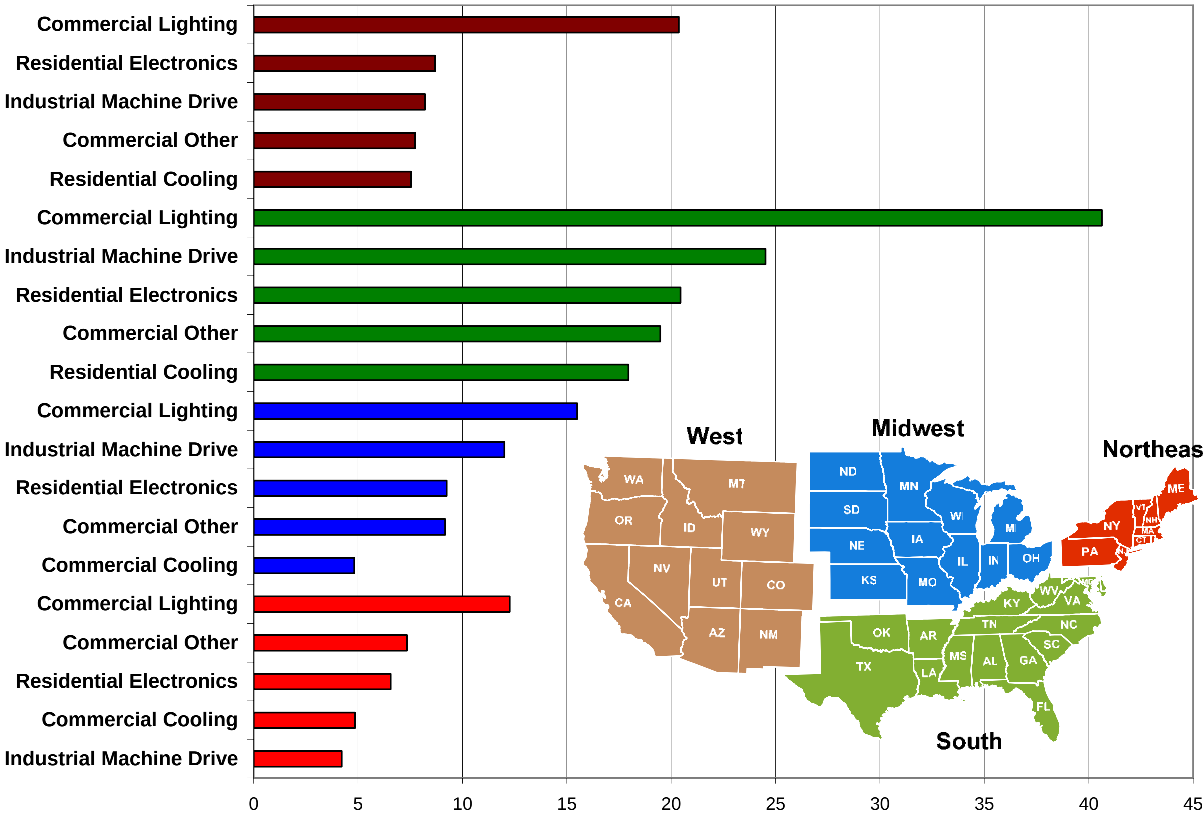


Figure ES-10
Realistic Achievable Potential (billion kWh) by Region and End Use in 2030 (Relative to Baseline)

The Potential for Summer Peak Demand Savings from Utility Programs

In addition to the impacts on annual electricity use, the study assessed two types of summer peak demand savings. First, energy-efficiency measures inherently reduce summer peak demand insofar as their usage is coincident to the overall summer peak. Second, utility demand response programs specifically targeted at peak demand reduction result in additional savings. Together, energy efficiency and demand response contribute to an achievable peak demand reduction potential of 157 to 218 GW in 2030, or 14 to 20% of projected U.S. summer peak demand in 2030.[7]

Table ES-3 and Figure ES-11 present the potential peak demand savings.

Table ES-3
Potential for U.S. Summer Peak Demand Savings (GW)

Realistic Achievable Potential	**2010**	**2020**	**2030**
Energy Efficiency	1.6	34.8	78.5
Demand Response	16.6	44.4	78.4
Total	18.2	79.2	156.9
Maximum Achievable Potential	**2010**	**2020**	**2030**
Energy Efficiency	10.8	81.7	117.0
Demand Response	29.8	65.9	101.1
Total	40.6	147.6	218.1

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[7] U.S. summer peak demand in this study represents an aggregation of “non-coincident” summer peak demand of each U.S. census region.

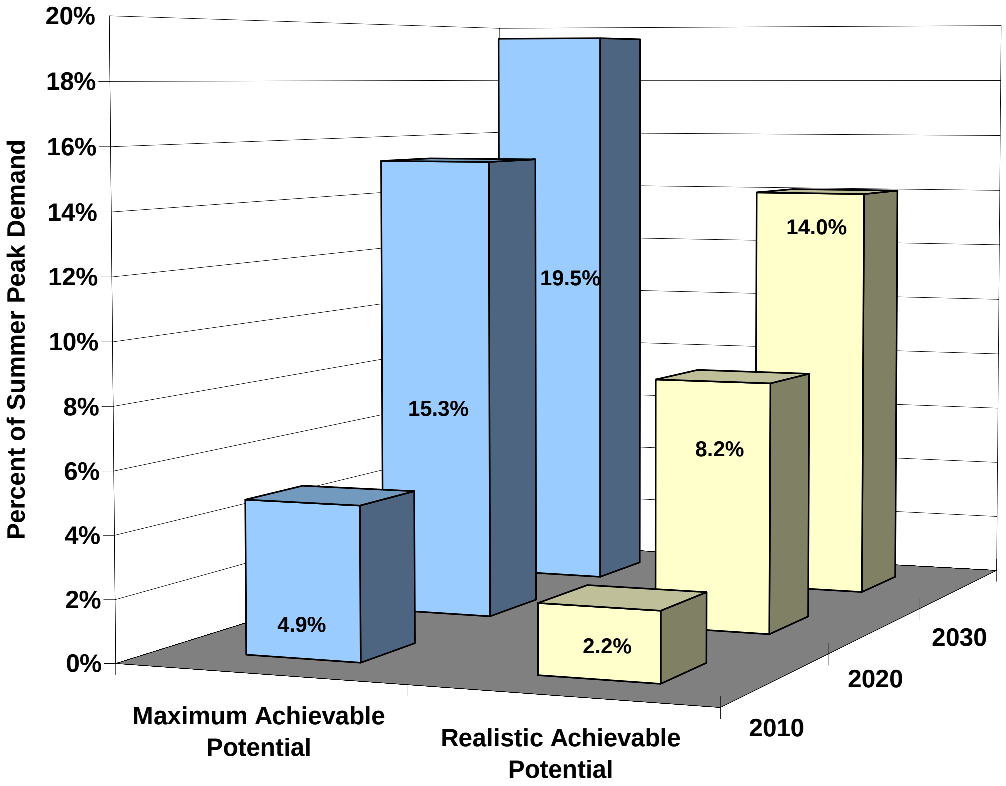

Figure ES-11
Potential for Summer Peak Demand Savings from Energy Efficiency and Demand Response

Demand response programs considered in the analysis include the following:

- Residential sector: direct load control (DLC) for air conditioning, direct load control for water heating, and dynamic pricing programs, including time-of-use (TOU), critical-peak pricing (CPP), real-time pricing (RTP, and peak time rebates.
- Commercial sector: direct control load management for cooling, lighting, and other uses; interruptible demand (e.g., interruptible, demand bidding, emergency, ancillary services); and dynamic pricing programs (TOU, CPP, RTP)
- Industrial sector: direct control load management for process; interruptible demand (e.g., interruptible, demand bidding, emergency, ancillary services); and dynamic pricing programs (TOU, CPP, RTP)

Based on our analysis, the range of achievable potential for demand response programs in 2030 is 7% to 9% of peak demand. The expected savings from demand response measures are roughly equal across the three sectors. The three categories of measures, direct load control, dynamic pricing, and interruptible demand, each deliver roughly the same level of savings. Tables ES-4 and ES-5 present the contributions of major types of demand response programs to peak demand reduction for realistic and maximum achievable potentials, respectively.

Table ES-4
Summer Peak Demand Savings from Demand Response
Realistic Achievable Potential (MW)

Residential DR	**2010**	**2020**	**2030**
DLC – Central AC	3,128	8,194	11,742
DLC – Water Heating	1,431	2,868	3,931
Price Response	1,539	6,918	10,967
Commercial DR	**2010**	**2020**	**2030**
DLC – Cooling	1,336	3,833	4,822
DLC – Lighting	364	1,049	1,358
DLC – Other	256	824	1,159
Interruptible Demand	4,337	8,806	19,450
Price Response	771	4,018	8,368
Industrial DR	**2010**	**2020**	**2030**
DLC – Process	413	1,124	2,245
Interruptible Demand	2,550	3,973	8,701
Price Response	515	2,765	5,697
TOTAL	**16,639**	**44,372**	**78,441**
Percentage of Peak	**2.0%**	**4.6%**	**7.0%**

Table ES-5
Summer Peak Demand Savings from Demand Response
Maximum Achievable Potential (MW)

Residential DR	**2010**	**2020**	**2030**
DLC – Central AC	4,119	9,498	12,558
DLC – Water Heating	1,960	3,473	4,503
Price Response	4,318	13,122	16,093
Commercial DR	**2010**	**2020**	**2030**
DLC – Cooling	1,766	4,309	5,099
DLC – Lighting	516	1,377	1,698
DLC – Other	508	1,316	1,623
Interruptible Demand	8,536	13,680	26,410
Price Response	2,180	7,600	12,418
Industrial DR	**2010**	**2020**	**2030**
DLC – Process	824	1,826	3,129
Interruptible Demand	3,572	4,554	9,142
Price Response	1,451	5,154	8,422
TOTAL	**29,750**	**65,910**	**101,093**
Percentage of Peak	**3.6%**	**6.8%**	**9.1%**

Figure ES-12 illustrates the realistic achievable potential of demand response for peak demand reduction by sector and program type.

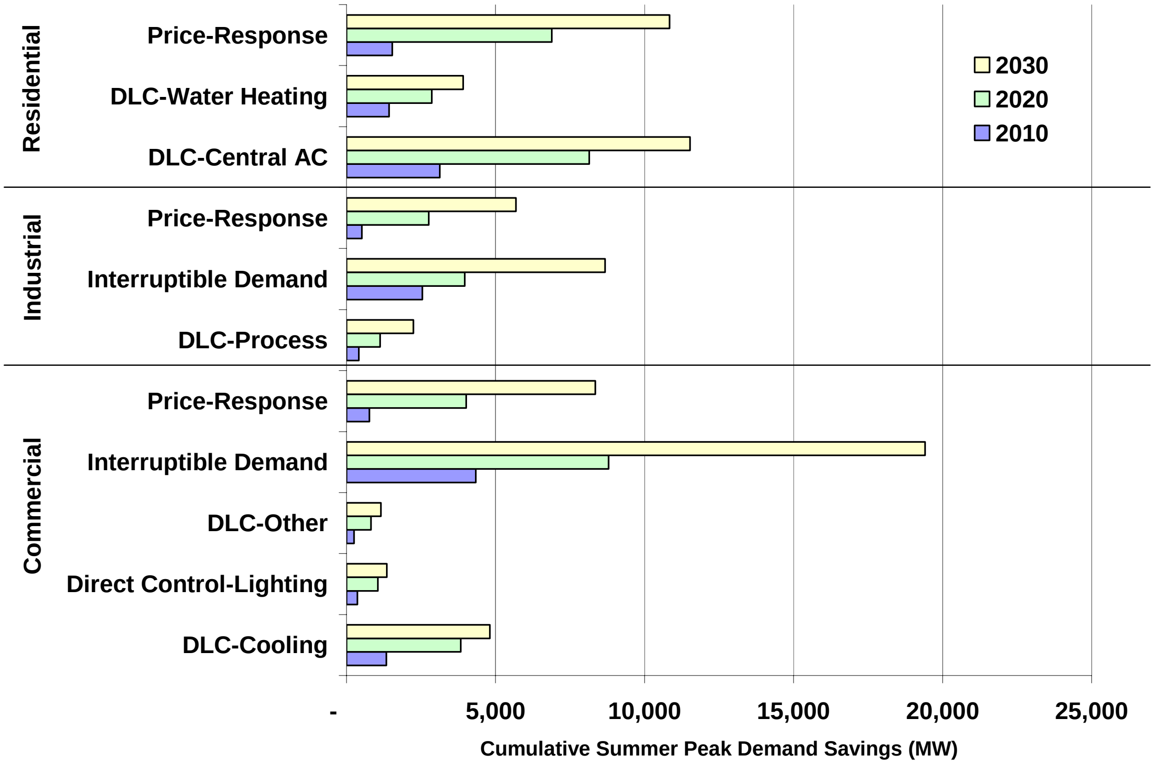

Figure ES-12
Realistic Achievable Potential for U.S. from Demand Response

The Cost of Achievable Potential

Achieving savings in electricity consumption and peak demand will require significant industry investment in energy efficiency and demand response programs. The total resource cost of achievable potential, inclusive of technologies or measures and the administration costs necessary for utilities or third-party entities to deliver that potential, was estimated based on published energy efficiency program cost data and program experiences.[8]

Table ES-6 summarizes, and Figure ES-13 illustrates, the estimated cost range to implement energy efficiency and demand response programs to realize the achievable potential.

Table ES-6
Estimated Cost Range of Achievable Potential

Achievable Potential	2010 ($ Billion)	2020 ($ Billion)	2030 ($ Billion)
Realistic (RAP)	1.3 – 2.3	8.2 – 20.0	18.7 – 46.5
Maximum (MAP)	3.2 – 7.0	15.6 – 40.7	25.1 – 63.1

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[8] A key reference for this cost estimate analysis was: *Gellings C., G. Wikler, and D. Ghosh. "Assessment of U.S. Electric End-Use Energy Efficiency Potential." The Electricity Journal, Volume 19, Issue 9. November 2006.*

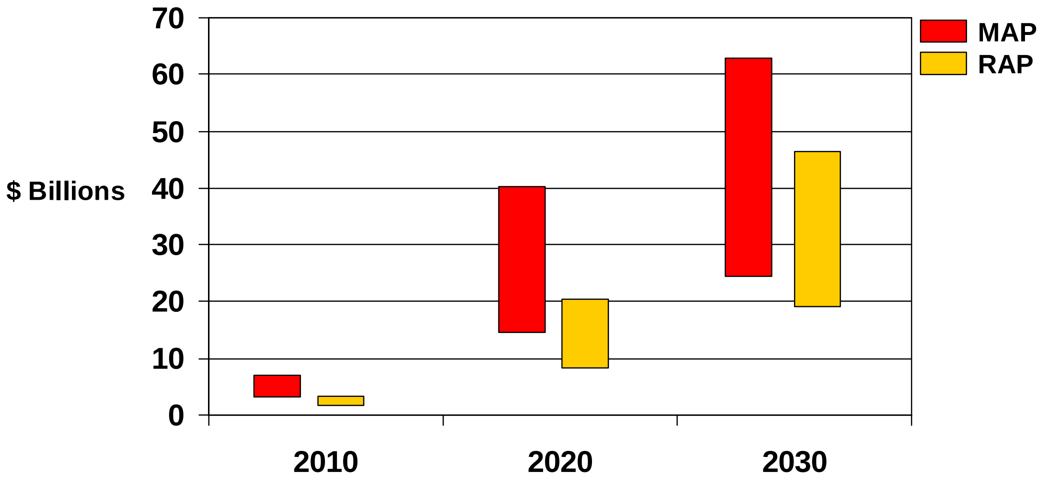

Figure ES-13
Estimated Cost Range of Achievable Potential

Conclusions and Implications

The potential for electricity and summer peak demand savings from energy-efficiency and demand-response programs is significant. Across the U.S., these programs have the potential to reduce the annual growth rate of electricity consumption from a historical 1.7% growth rate per year from 1996 to 2006 to a realistically achievable 0.83% growth rate per year from 2009 to 2030.

These programs also have the potential to reduce the annual growth rate of summer peak demand from a historical 2.1% growth rate per year from 1996 to 2006 to a realistically achievable 0.83% growth rate per year from 2009 to 2030.

Achieving these savings in electricity consumption and peak demand will require significant industry investment in energy efficiency and demand response programs.

Comparison with Actual Program Results

Over the period 2008 to 2030, the achievable potential of energy efficiency programs identified in this study equates to an annual incremental reduction in electricity consumption of 0.37% to 0.51%.per year.[9] Our analysis of energy efficiency potential is based on the turnover of currently installed energy-consuming devices (as well new construction) to efficient technologies commercially available today, and since most devices have a useful life of less than fifteen years, it is instructive to examine the results for the year 2020, by which time the existing stock of most energy-consuming devices has turned over. Over the twelve year period of 2008 through 2020, the achievable potential of energy efficiency programs identified in this study equates to an annual incremental reduction in electricity consumption of 0.40% to 0.85%.per year.

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[9] Computed by dividing the realistic- and maximum- achievable percentage savings in 2030 over the 22 year period spanning 2008 through 2030.

How do these estimates compare with recent program results for the nation? A recent study released by ACEEE has determined that energy efficiency programs operated in 2006 reduced electricity consumption in the U.S. by an average of 0.24% in 2006.[10] This finding underscores that, for the nation as a whole, current energy efficiency program efforts will need to expand by 40% to capture the moderate case (i.e. realistic achievable potential) for savings identified in this study. By the same token, according to the ACEEE study, in 2006 eighteen states attained annual electricity savings from programs within the range of the national achievable potential (i.e. above 0.40%). Of these eighteen states, in fact, three states – Rhode Island, Vermont, and Connecticut – implemented programs in 2006 that reduced electricity consumption that year by more than 1%.

For another perspective, the study analyzed data compiled by the EIA through utility Form 861 filings[11], which suggests that U.S. utilities achieved cumulative savings of 74 TWh between 1995 and 2006. More than half these savings come from the West Census region, primarily from California. A comparable time frame for this study is 2008 to 2020, which has a realistic achievable potential estimate of about 207 TWh. The disparity between historically-achieved and realistically-projected savings is clarified by the regional distinctions illustrated in Figure ES-13.

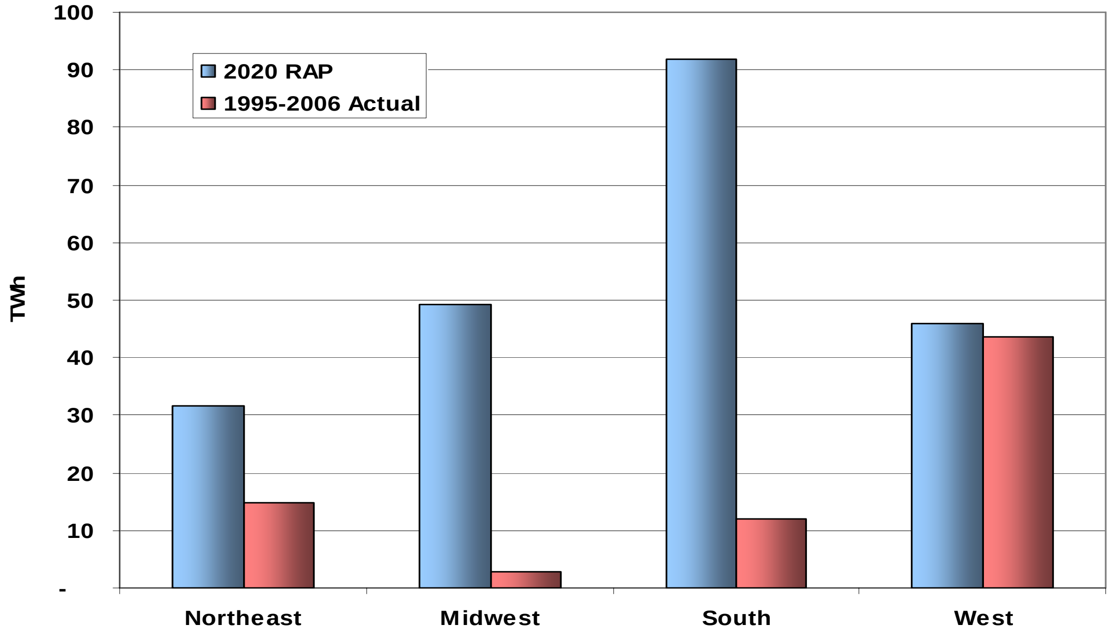

Figure ES-13
Realistic Achievable Potential by Region in 2020 – Historical Context

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[10] American Council for an Energy-Efficient Economy. “The 2008 State Energy Efficiency Scorecard.” ACEEE Report Number E086. October 2008.

[11] Form EIA-861 collects information from U.S. electric power companies on a variety of operational metrics, including the impact of energy efficiency and load management (demand-side management) activities.

The expected realistic savings exceed the savings that utilities reported between 1996 and 2006 in the Northeast and especially in the Midwest and South. By contrast, in the West the historical and projected savings are closely comparable, owing to the significant experience with energy efficiency programs in the region, particularly in California and the Pacific Northwest.

It is important to note that between 1995 and the early 2000s there were significant funding reductions in energy efficiency programs due largely to electric industry restructuring, a fact that may help explain the disparity between past and projected savings. While the electricity industry is different today, and it is reasonable to project higher expected energy efficiency savings, it should be recognized by all stakeholders that significant investment in energy-efficiency program infrastructure, consumer education, and enabling technology beyond current levels are needed to realize the achievable energy efficiency potential.

Applying the Results

This potential study represents a bottom-up study based on equipment stock turnover and adoption of energy-efficiency measures at the technology and end-use levels within sectors for four Census regions. Using a bottom-up, technology-based approach is consistent with the type of potential studies usually conducted by utilities or states. However, it is unique in its application to the U.S. as a whole. As such, it differs from most national studies of energy efficiency potential which employ macro "top-down" approaches. Top-down approaches are useful, but the results are typically highly sensitive to variations in a few key *qualitative* assumptions.

By contrast, the bottom-up approach is more *quantitative*, grounded in actual technology efficiencies and costs. This approach includes assumptions about customer adoption predicated on experience and observation of the range of results realized by program implementers. The bottom-up approach facilitates detailed segmentation of savings potential by region, sector, end use and technology, which provides insightful, actionable results.

It is worth emphasizing that while other studies co-mingle the effects of existing and anticipated codes and standards (i.e., those not yet legislated) with programmatic effects, this study isolates the impact of programs. As such, any new codes and standards or other externalities would contribute to greater levels of overall efficiency.

This study was undertaken to provide an independent, analytically-rigorous estimate of the electricity savings potential of energy efficiency and demand response programs to inform utilities, policymakers, regulators, and other stakeholder groups. The regional results in particular can serve as useful calibration points to compare against state or utility potential studies. Where variances may be observed, a detailed breakdown of potential by sector and end-use may be useful to identify areas of over- or under-stated potential.

Utilities can examine the major areas of energy efficiency potential specific to their region with their own allocation of resources. For example, an examination of the magnitude of commercial lighting potential – which is the largest area of potential energy savings in every region – should prompt questions such as:

- How much resource are we allocating to savings in this area?
- What programs do we have addressing this market? What results have been achieved?
- What state or local codes and standards exist for this market beyond federal levels?

This main body of this report provides a comprehensive explanation of the study's analytical approach and a detailed decomposition of electricity consumption and peak demand baseline and savings potential forecasts. To provide context, the report also includes a discussion of historical gains from energy efficiency programs and a comparison to the results of other notable energy efficiency potential studies. The report also details the estimated costs associated with achievable energy efficiency potentials.

Follow-on Research

The analysis of potential savings from energy efficiency and demand response programs detailed in this report is predicated on the identical set of macro-economic assumptions used by the EIA in its AEO 2008 reference case projections of electricity consumption and peak demand. This includes, for example, a relatively flat electricity price forecast in real dollars between 2008 and 2030. In addition, the study does not presume the future enactment of more stringent building codes, equipment standards, or other policies beyond what is currently mandatory. Moreover, the future enactment carbon legislation, which could create greater incentives for energy efficiency programs, was not considered.

EPRI plans to conduct follow-on analysis on the sensitivities of electricity use and savings potentials to alternate scenarios of electricity price levels, the establishment of national carbon legislation such as a cap and trade market, the expectation of new codes and standards, new utility regulatory incentives for energy efficiency, and greater investment in end-use technology innovation.

CONTENTS

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1
INTRODUCTION

It is no exaggeration to regard electricity as the lifeblood of modern society. As the most versatile refined form of energy, it plays an integral role in supporting the standard of living to which we have grown accustom, enabling comfort, convenience, health and safety, security, and productivity in its traditional end-use applications, including air conditioning, lighting, refrigeration, and motive power. Moreover, the computational and communications infrastructure of information technology depends on electricity – from powering data centers to charging ever-proliferating mobile electronic devices.

Our nation's usage of electricity to power homes, buildings, industrial facilities, and public areas is expected to increase by 26% between 2008 and 2030, according to the U.S. Energy Information Administration's "Reference Case" forecast of electricity consumption as presented in its 2008 Annual Energy Outlook (AEO 2008). Moreover, summer peak demand is expected to increase by 40% between 2008 and 2030 – outstripping growth in consumption – based on AEO 2008 and the National Electricity Reliability Council (NERC) 2007 Peak Demand and Energy Projection Bandwidths extrapolated to 2030.

This projected growth in the demand for electricity has profound implications for the electric utility industry and society. It drives the industry's plans for investment in the infrastructure required to generate, transmit, and distribute electricity, which represents a significant cost for utilities and, ultimately, ratepayers. Since fossil-fuels such as coal and natural gas will continue to generate most domestic electricity into the immediate future, growth in electricity consumption translates into increased emissions of greenhouse gases such as carbon-dioxide, which the scientific community has generally accepted as a contributor to global climate change.

Utilities and policy makers are looking to energy efficiency to help meet the challenges of maintaining reliable and affordable electric service, wisely managing energy resources, and reducing carbon emissions. As a consequence, many states have established, or are considering, legislation to mandate energy efficiency savings levels and regulatory mechanisms to allow utilities to make energy efficiency a sustainable business. Fundamental to such policies are estimates of the potential for energy efficiency grounded in technological expertise and tempered by economic and market realities.

To help address this need, the Electric Power Research Institute (EPRI) commissioned a study to assess the potential of electric end-use energy efficiency and demand response programs to mitigate the projected growth of U.S. electricity consumption and summer peak demand through 2030. A key objective of the study is to inform utilities, electric system operators and planners, policymakers, and other electricity sector industry stakeholders in their efforts to develop actionable savings estimates for end-use energy-efficiency and demand-response programs.

The study began with development of baseline forecasts of electricity consumption and summer peak demand absent any new utility programs or other programs administered by state agencies or third parties. The forecasts are consistent with the U.S. Department of Energy (DOE) Energy Information Administration's (EIA's) "Reference Forecast" for electricity consumption as presented in its 2008 Annual Energy Outlook (AEO) and the North American Electric Reliability Corporation's (NERC's) 2007 Peak Demand and Energy Projection Bandwidths extrapolated to 2030. The study estimates the potential for annual energy efficiency and demand response savings for the years 2009 through 2030 at the end-use level for the residential, commercial, and industrial sectors. This analysis yields forecasts of changes in electricity use and summer peak demand[12], as well as changes in annual energy and summer peak-demand savings, for the U.S. and each of its four census regions as shown in Figure 1-1.

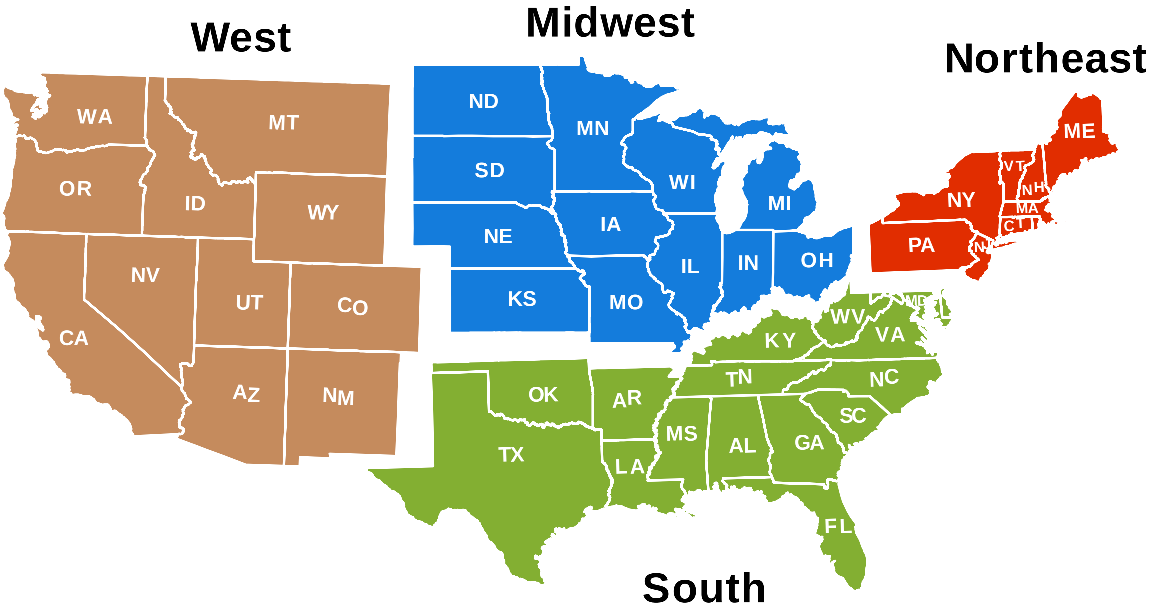

Figure 1-1
U.S. Census Regions

The study forecasts U.S. energy efficiency and demand response potential with respect to the U.S. DOE Energy Information Administration's "Reference Case" forecast for electricity consumption as presented in its 2008 Annual Energy Outlook (AEO 2008) and the National Electricity Reliability Council (NERC) 2007 Peak Demand and Energy Projection Bandwidths extrapolated to 2030.

Chapter 2 describes the methodology employed in this study, which features a micro-economic model based on equipment stock turnover to construct a "bottom-up" estimate of savings potential at the end-use level.

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[12] Non-coincident peak demand across four U.S. census regions.

The first key analytical step was to develop baseline forecasts of electricity consumption and summer peak demand consistent with the AEO 2008 and NERC forecasts, without the impact of utility programs, calibrated at the U.S. census region, sector, end-use, and technology levels. This procedure is described in Chapter 3.

Drawing from established databases of energy-efficient technology costs and savings, including EPRI research, and applying sequential technical, economic, and market screens, we estimated the potential annual savings achievable from energy efficiency and demand response programs for the years 2009 through 2030 at the end-use level for the residential, commercial, and industrial sectors for the U.S. and four census regions. Chapter 4 details the energy savings results and Chapter 5 details the peak demand reduction results.

Energy efficiency and demand response programs implemented by utilities or agencies require significant investments in administration, marketing, promotion, and financial incentives. Chapter 6 provides an estimated range of costs associated with achievable potential.

The potential impacts of energy efficiency and demand response programs detailed in Chapters 4 and 5 are predicated on the identical set of economic assumptions set forth by the EIA, including a relatively flat electricity price forecast in real dollars between 2008 and 2030, no presumption of carbon policy or monetization, and no presumption of new building efficiency codes or appliance efficiency standards beyond what has already been enacted.

To provide further context to the findings of this study, Chapter 7 compares and contrasts these results with several noteworthy studies of energy efficiency potential conducted by other organizations.

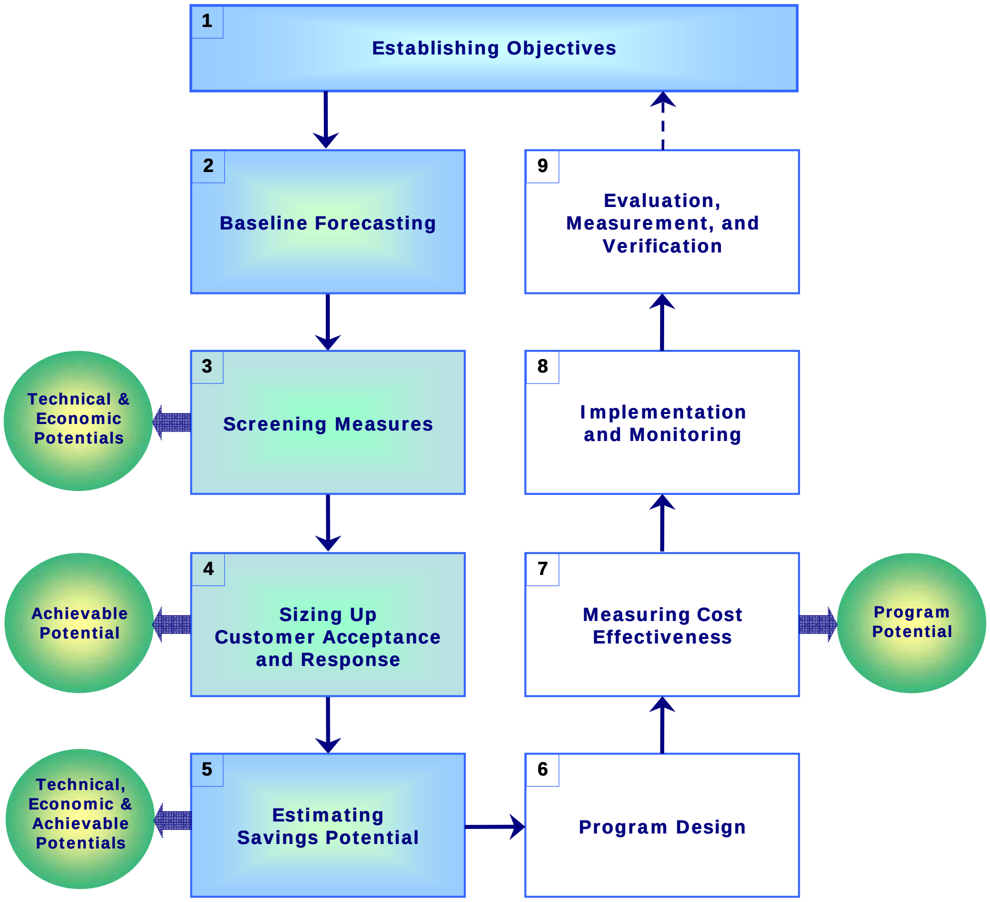
The study concludes with a summation in Chapter 8 and call for additional follow-on research to further the study of energy efficiency potential.

A series of appendices provide data for the energy-efficiency measures included in the study as well as potential estimates for each of the four census regions.

2

ANALYSIS APPROACH

This study implemented an analysis approach consistent with the methods described in EPRI's "Energy Efficiency Planning Guidebook," published in June 2008, and the National Action Plan for Energy Efficiency (NAPEE) "Guide to Conducting Energy Efficiency Potential Studies," published in November 2007. Figure 2-1 illustrates the framework for this analysis, represented as steps one through five of the energy efficiency planning process as documented in the EPRI Energy Efficiency Planning Guidebook.



Source: Energy Efficiency Planning Guidebook, EPRI 1016273, June 2008

Figure 2-1
General Energy Efficiency Analysis Framework

This section details the analysis approach and data development applied in this study, beginning with a description of the development of baseline electricity use in 2008. This is followed by a description of the development of baseline forecasts for annual electricity use and summer peak demand. The section concludes with a description of the modeling approach used to estimate annual electricity and peak demand savings through energy-efficiency and demand response programs.

Figure 2-2 illustrates the study's analysis approach, which begins with a thorough characterization of how customers use energy in the base year of 2008. Calculations of baseline forecasts and savings potentials are based on a detailed understanding of present day electricity consumption. As evident in the diagram, savings are estimated for both energy efficiency and demand response, which requires a coupling of their inherently distinct approaches. Finally, the modeling results are compiled and presented along with the baseline forecasts for both electricity consumption and peak demand.

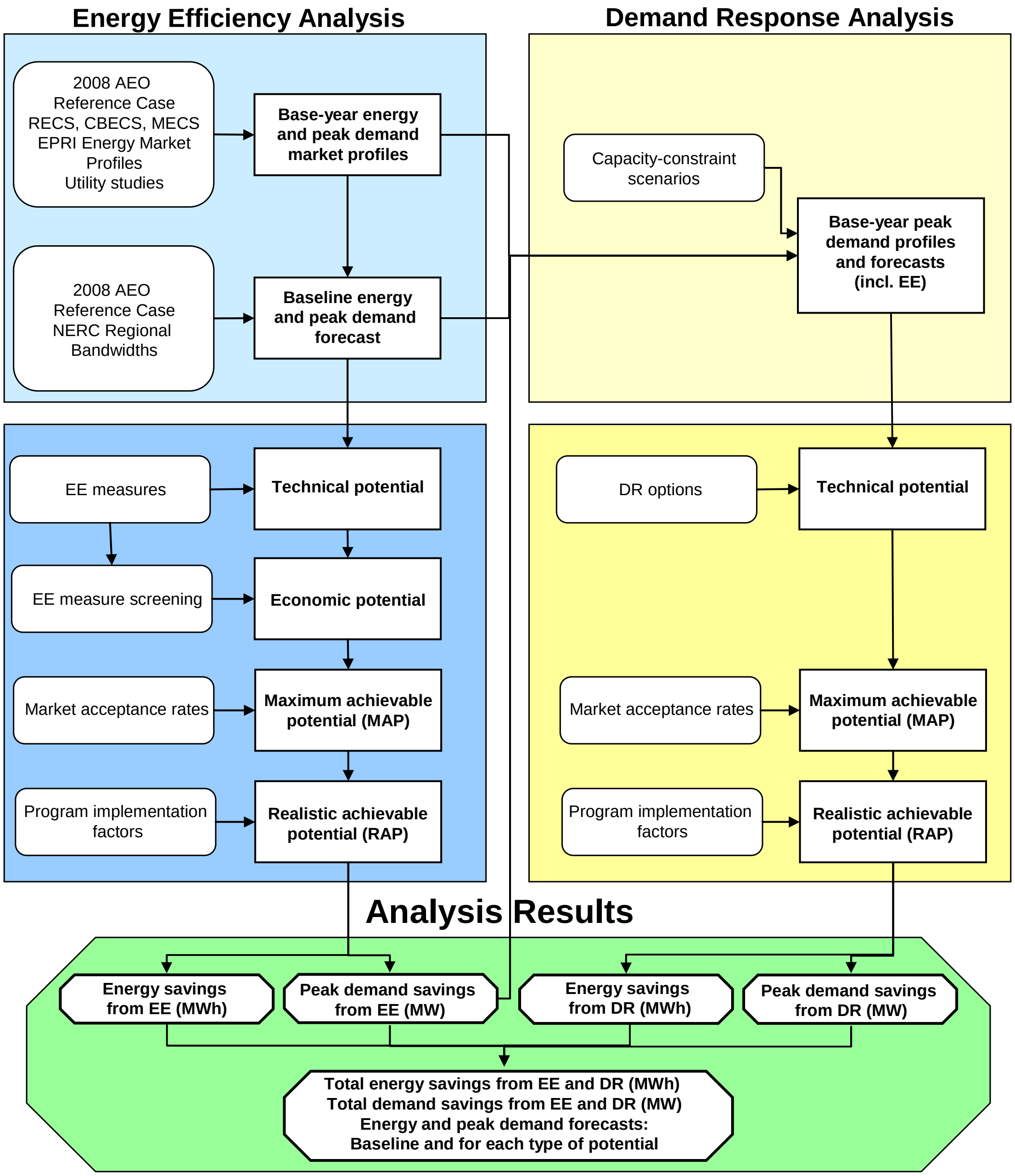


Figure 2-2
Overview of Analysis Framework

Estimates of baseline consumption and demand, as well as forecasts of program-based savings potentials, were developed for the U.S. as a whole and the four U.S. census regions. Electricity usage within each region was analyzed for the three principal customer segments – residential, commercial and industrial. In order to obtain the required resolution in both modeling and reporting, each sector was further divided by electricity end-use category and, ultimately, by power-consuming technology.

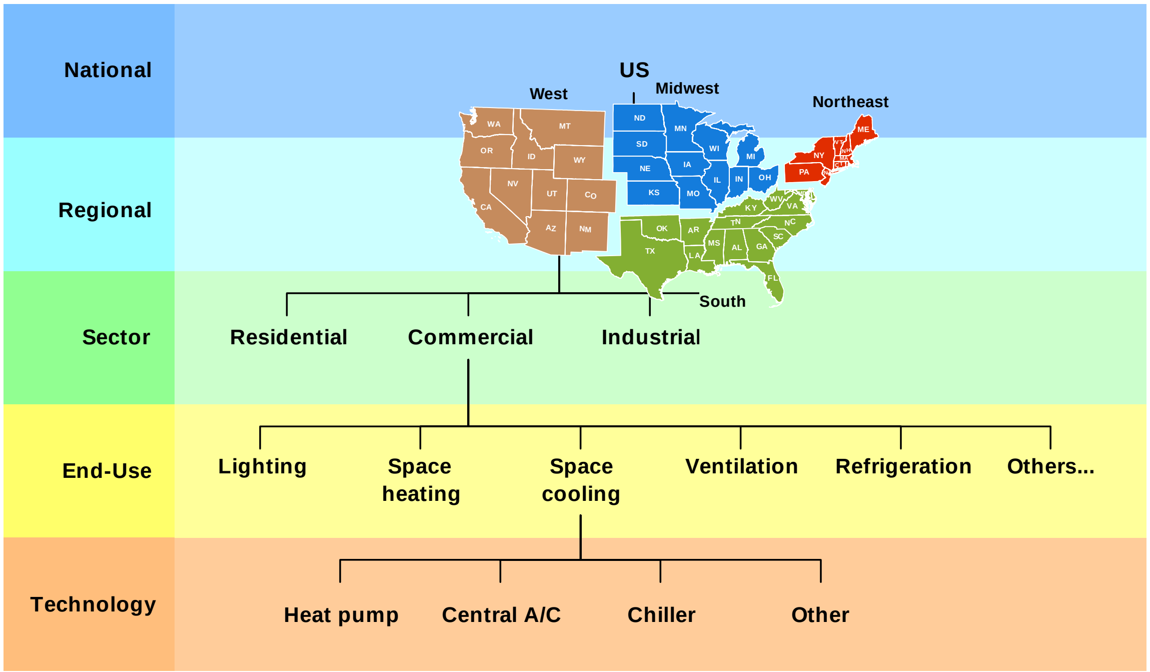


Figure 2-3
Segmentation of Electricity Consumption Applied in Modeling

Base-Year Market Profiles

As a first step to assessing the potential for energy efficiency[13], electricity usage in the base year (2008) was first analyzed along the dimensions outlined in Figure 2-3 above. This study applies the profiles of electricity use by sector and end use from the 2008 release of the Annual Energy Outlook (AEO 2008), produced by the US Department of Energy's Energy Information Administration (EIA). As part of its National Energy Modeling System (NEMS), the AEO forecast contains estimates of electricity consumption in each of the customer sectors. Electricity usage is segmented by end use and technology for the residential and commercial sectors, while for the industrial sector it is reported in aggregate and for each of eleven specified industry classifications. In addition to providing data by sector, AEO presents energy usage for each of the nine census divisions, aggregated in this study to the four census regions illustrated above.

As a supplement to the AEO baseline data, additional sources were incorporated into the analysis in order to attain a suitable level of resolution. EIA survey results from the Residential Energy Consumption Survey (RECS) in 2005, the Commercial Building Energy Consumption Survey (CBECS) in 2003, and the Manufacturing Energy Consumption Survey (MECS) in 2002 provide additional detail about the specific technologies, such as equipment vintage and unit energy consumption. Market saturation data, such as those available through the EPRI Energy Market Profiles and those available through the DOE/EPA Energy Star® Program, were also utilized to help understand present day electricity usage trends.

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[13] The term "energy efficiency" here refers to both energy efficiency and demand response programs. In industry parlance, this has been, and in some circles continues to be, labeled "demand-side management" (DSM).

The Baseline Forecast

The next step in the estimation of potential savings is the development of a baseline forecast. This provides insight into energy-saving opportunities as well as a context in which to interpret the results. The baseline forecast employed in this study, like the base-year consumption data, is grounded in the AEO 2008 forecast. As a widely recognized macroeconomic modeling effort spanning the entire energy industry, the AEO serves as a credible foundation to the present study. The AEO forecasts for both electricity consumption and peak demand were adjusted and resolved to meet the requirements for this study, as described below. The end result is the development of the two forecasts – energy and peak demand – for the years 2010, 2020, and 2030, presented in the following section.

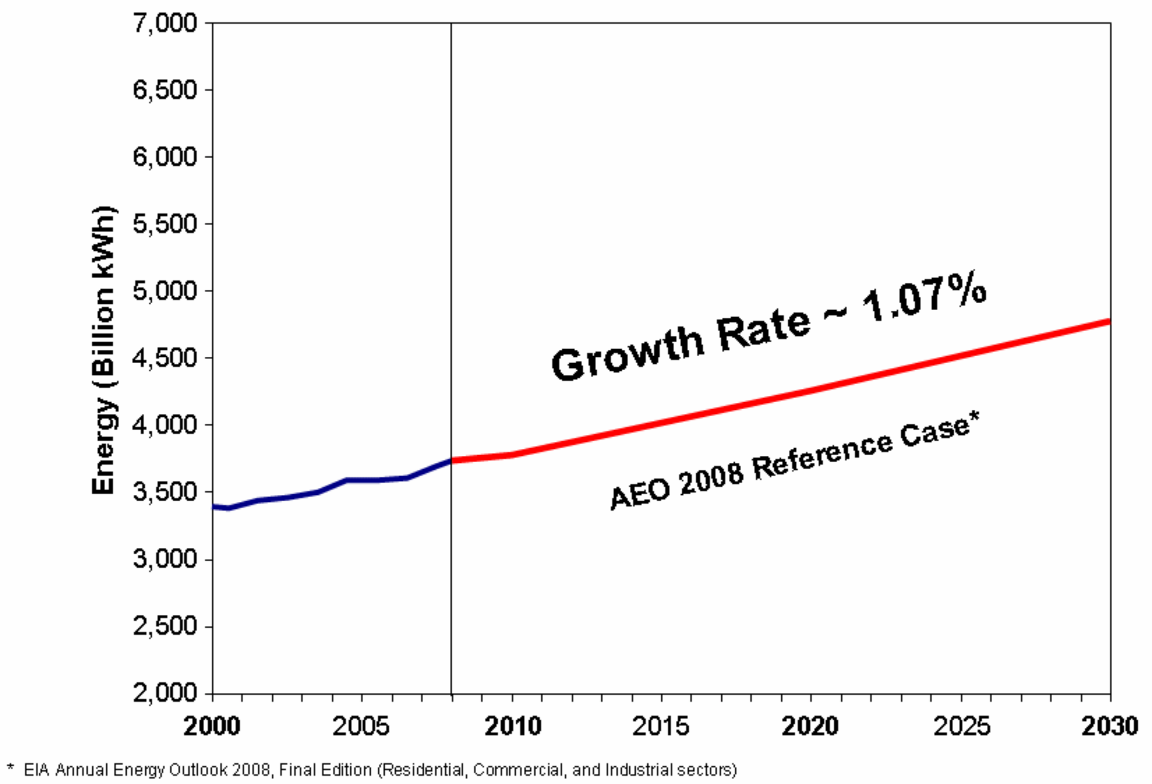
The baseline forecasts are broken down to the regional, sector, end use, and technology levels to provide the level of detail necessary to estimate the future potential of energy efficiency and demand response programs and activities implemented by utilities or other organizations. Detailed information at these levels brings to light regional differences in program barriers and market conditions that affect the savings potential of energy efficiency programs. In addition, because energy efficiency and demand response programs and activities are focused at the technology level, disaggregating the forecasts to the end-use and technology levels provides the most useful and insightful information.

The national forecast by sector was broken down into the four geographic regions used by the U.S. Census Bureau to project population and economic figures. As an example of the role of regional variations in the analysis, U.S. Census Bureau data show that over time, the population center of the U.S. is slowly moving towards the southwest as people move towards warmer, drier climates. This trend was incorporated into the baseline analysis, evident in the relative baseline cooling loads between the various regions.

Energy Forecast

The energy baseline forecast is derived from AEO 2008 projections generated by EIA using NEMS, as described above. In addition to its use in the development of the AEO projections, NEMS is also used in analytical studies for the U.S. Congress, the White House, and other offices within the Department of Energy. NEMS takes into account a multitude of economic, financial, technological, environmental, legislative, and regulatory assumptions to generate the projections.

The "EIA 2008 Reference Case," illustrated in Figure 2-4, is a policy-neutral case used as the starting point for the energy forecast, which assumes current policies affecting the energy sector remain unchanged throughout the projection period (2008 to 2030).



* EIA Annual Energy Outlook 2008, Final Edition (Residential, Commercial, and Industrial sectors)

Figure 2-4
Annual Energy Outlook 2008 Reference Case Electricity Forecast

The EIA 2008 Reference Case includes market-driven (or "naturally occurring") energy efficiency impacts and some level of future energy efficiency program impacts. Ideally, only naturally occurring impacts are included in the energy baseline since these impacts happen outside the influence of utility- or government-sponsored energy efficiency programs and are going to materialize anyway.

To avoid double-counting the impacts of energy efficiency measures identified in this study, the estimated impacts of future energy efficiency programs "embedded" in the AEO 2008 Reference Case must be removed. This operation is performed by first estimating this embedded program savings and then "adding it back" to the AEO 2008 Reference Case to construct an adjusted baseline forecast.

To estimate the embedded impact of energy efficiency programs, we compared the AEO 2008 Reference Case to another EIA forecast of electricity consumption known as the EIA Technology Case, which does not include the impacts of either energy efficiency programs or market-driven energy efficiency improvements. The difference between the two cases is attributable to market-driven energy efficiency and energy efficiency programs. A share of this difference was allocated to energy efficiency programs by sector, based on the expert judgment of experienced energy efficiency program practitioners, and this value was added back to the AEO 2008 Reference Case. The estimates of embedded energy efficiency impacts are summarized in Table 2-1 and illustrated in Figure 2-5.

Table 2-1
Effects of Existing Energy Efficiency Added into Baseline Energy Forecast

	2020	2030
AEO 2008 Reference Case (TWh)	4,253	4,696
Adjusted Baseline Forecast (TWh)	4,319	4,858
Embedded Savings (TWh)	66	162
Percentage of AEO 2008 Reference Case	1.6%	3.4%

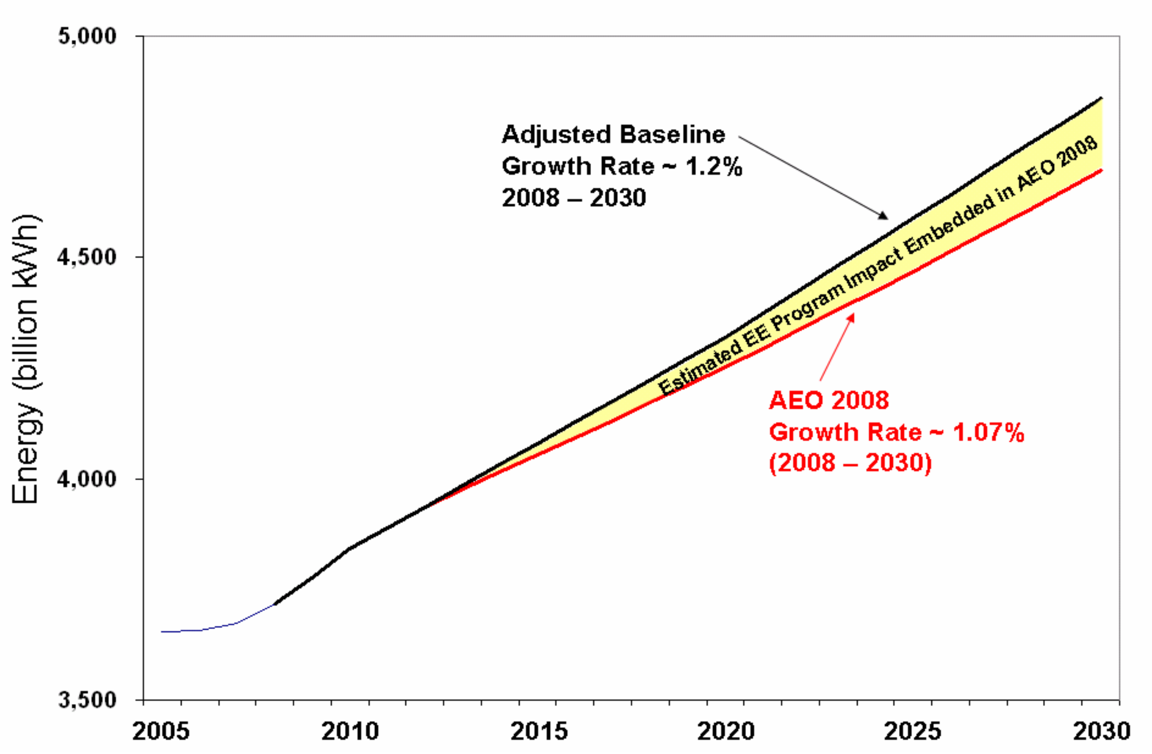


Figure 2-5
Comparison of AEO 2008 Reference Case and Adjusted Baseline Forecast

Forecast Assumptions

The macroeconomic drivers of the forecast include U.S. population, employment, Gross Domestic Product (GDP), value of shipments, housing starts, and building construction.

Table 2-2 presents recent history and forecasts of macroeconomic indicators from the 2008 AEO Reference Forecast. Average growth in GDP between 2008 and 2030 is 2.5%, more than double the rate of electricity growth. This implies a decline in the electricity intensity per GDP from 0.32 kWh per GDP in 2008 to 0.24 kWh/GDP in 2030, a decrease of almost 25%.

Table 2-2
2008 AEO Reference Case – Macroeconomic Indicators

(Billion year-2000 dollars, unless otherwise noted)

Macroeconomic Indicators	2007	2008	2009	2010	2015	2020	2025	2030	Avg. Growth 2008-30 (%/yr)
Real GDP	11,562	11,747	12,052	12,453	14,199	15,984	17,951	20,219	2.5%
Energy Intensity (kBtu per 2000 dollar of GDP)									
Delivered Energy	6.38	6.35	6.16	6.03	5.48	5.00	4.57	4.16	-1.9%
Total Energy	8.77	8.71	8.48	8.30	7.54	6.91	6.35	5.80	-1.8%
Value of Shipments (billion 2000 dollars)									
Total Industrial	5,781	5,680	5,782	5,997	6,659	7,113	7,546	7,997	1.6%
Non-manufacturing	1,446	1,352	1,349	1,419	1,583	1,619	1,663	1,715	1.1%
Manufacturing	4,334	4,329	4,432	4,577	5,076	5,493	5,883	6,283	1.7%
Energy Intensive	1,253	1,264	1,259	1,283	1,351	1,387	1,418	1,447	0.6%
Non-energy Intensive	3,081	3,065	3,173	3,295	3,725	4,107	4,465	4,836	2.1%
Population and Employment (millions)									
Population	302.8	305.5	308.2	310.9	324.3	337.7	351.4	365.6	0.8%
Population (16+)	237.7	240.2	242.6	244.9	255.3	266.0	277.3	289.3	0.8%
Population (65+)	38.0	38.9	39.6	40.4	47.0	54.9	63.8	71.6	2.8%
Employment, Non-farm	137.9	138.9	140.3	142.4	149.7	154.5	160.9	168.1	0.9%
Employment, Manufacturing	14.1	13.9	13.9	14.2	14.4	13.8	12.5	11.2	-1.0%
Key Labor Indicators									
Labor Force (mill.)	153.1	154.1	155.3	156.8	162.1	165.6	171.0	177.9	0.7%
Non-farm Labor Productivity (1992=1)	1.37	1.40	1.42	1.45	1.60	1.77	1.95	2.14	2.0%
Unemployment Rate (percent)	4.60	5.19	5.33	5.03	4.58	4.62	4.79	4.80	-0.4%
Key Indicators for Energy Demand									
Real Disposable Personal Income	8,657	8,852	9,138	9,472	11,055	12,654	14,349	16,246	2.8%
Housing Starts (millions)	1.44	1.09	1.35	1.68	1.88	1.78	1.74	1.70	2.0%
Commercial Floorspace (bill. ft^2)	75.8	76.8	77.8	78.8	83.9	89.3	94.8	100.8	1.2%

Source: Annual Energy Outlook 2008, Table 19. Macroeconomic Indicators – AEO 2008 Reference Forecast

Energy prices, particularly electricity prices, are another key driver in the electricity forecast.

Table 2-3 presents recent history and forecasts of U.S. electricity prices by sector. While capable of driving changes in consumption patterns and influencing the future role of energy efficiency programs, price plays a marginal role in this analysis because of the relatively flat trend in electricity prices assumed by the EIA in the AEO 2008. While electricity prices increased between 2005 and 2007, EIA only projects this increase to continue until 2009. Thereafter, EIA projects residential prices to remain relatively flat in real dollars until 2030, while it projects commercial and industrial prices to slightly decline over the same period. This trend is evident in Figure 2-6.

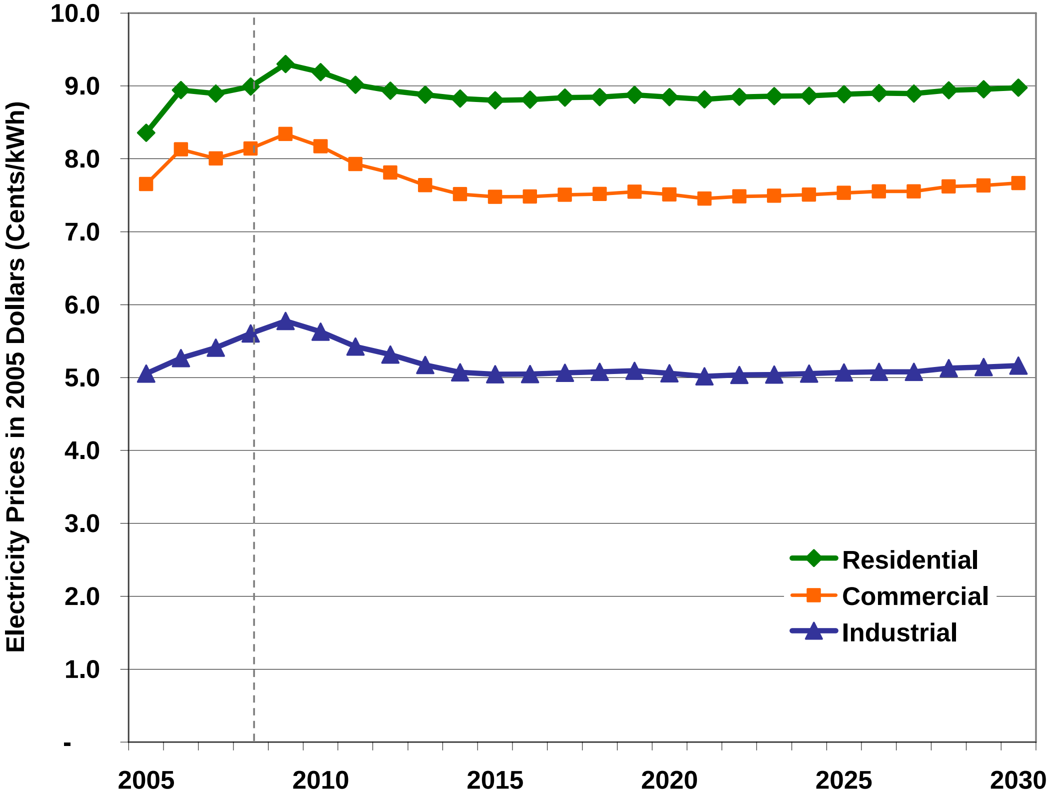


Figure 2-6
Retail Electricity Price Forecast by Sector (AEO 2008)

Natural gas prices are also assumed flat across all end-use sectors during the forecast period. Therefore, there is limited rationale to anticipate significant fuel switching during the forecast period.

Table 2-3
2008 AEO Reference Forecast – Electricity and Natural Gas Prices by Sector

Macroeconomic Indicators	2007	2008	2009	2010	2015	2020	2025	2030	Avg. Growth 2008-30 (%/yr)
Electricity Prices (2005 cents/kWh)									
Residential	8.90	8.99	9.30	9.19	8.80	8.85	8.89	8.98	0.0%
Commercial	8.00	8.14	8.34	8.17	7.48	7.51	7.53	7.67	-0.3%
Industrial	5.41	5.61	5.78	5.63	5.05	5.06	5.07	5.17	-0.4%
Natural Gas (2005 $/million Btu)									
Residential	12.52	12.66	12.65	12.15	11.20	11.39	11.94	12.91	0.1%
Commercial	10.75	11.08	11.15	10.59	9.68	9.91	10.47	11.43	0.1%
Industrial	7.04	7.42	7.60	7.21	6.15	6.21	6.56	7.29	-0.1%

In addition to the macroeconomic and social indicators assumed in the forecast, the baseline takes into consideration the effects of legislation enacted as of 2008. It assumes compliance with codes and standards already signed into law, while it does not presume the enactment of new efficiency codes and standards. This approach to the potential impacts of codes and standards on future energy use is consistent with the treatment employed in the AEO 2008 forecast. For example, the federal efficiency standard for central air conditioners (CACs) is SEER 13. The baseline forecast assumes that each CAC purchased in the future, whether for retrofit or new construction, will meet or exceed this level of efficiency. More recently, the Energy Independence and Security Act (EISA), signed into law in 2007, establishes new efficacy requirements for lighting technologies. This standard influences the baseline forecast for residential lighting, which is discussed later in this chapter.

Methodology

The EIA Reference Case provides energy consumption by end uses for the residential and commercial sectors. The end use shares derived from the Reference Case are used to segment the baseline forecast into end uses at the national level. The end use shares at the national level are allocated by region using a variety of proprietary and publicly available information. After the regional energy end use consumption values are established, the regional end uses are further segmented by technology type. The residential technology values are estimated using data from the EIA *Residential Energy Consumption Survey* (RECS), while the commercial technology values are estimated using data from the EIA *Commercial Building Energy Consumption Survey* (CBECS).

The EIA *Industrial Sector Energy Consumption Estimates by State* is used to segment the industrial forecast by region, and the EIA *Manufacturing Energy Consumption Survey* (MECS) is used to allocate the regional forecast into end use shares. Various industry reports are used to break down the end use shares into discrete technology categories.

Application of Baseline Forecast in Potential Modeling

These baseline forecasts, divided by sector, region, end use, and technology, are used to calculate the potential savings associated with energy efficiency and demand response programs. Adapting the AEO forecast to the appropriate level of resolution enables a bottom-up modeling approach, leading to potential savings estimates *at the technology level* for individual efficiency measures considered in this study. The analytical framework behind this modeling is addressed next.

Peak Demand Forecast

While qualitatively similar to the energy forecast and requiring the same level of resolution for each of the forecast years considered, the peak demand forecast represents an independent effort with a unique set of developmental challenges. For instance, in order to discuss peak demand it is first necessary to define a peak period for which to base the estimates. For this study, the few hours with the highest demand during the summer are considered, typically falling in the weekday afternoon period.

The peak demand forecast, like the energy forecast, is derived from NEMS modeling in AEO 2008. This not only makes the peak demand forecast inherently consistent with the energy forecast, it also affords the same benefits from applying a widely accepted and rigorously valid statistical analysis at the core of the forecast. However, as with the energy forecast, it was necessary to modify the output from AEO in order to obtain the necessary precision and resolution for the potential modeling, as well as to ensure consistency with other data sources.

First, the AEO 2008 peak demand projection was compared to a similar projection developed by the North American Electric Reliability Corporation (NERC) in 2007. Several differences between EIA and NERC should be pointed out before contrasting these two forecasts. First, NERC maintains a unique geographic break-out of the U.S. and also considers parts of Canada and Mexico, while EIA is specifically concerned with the U.S. and reports most results by census region. Second, the principal purpose of NERC is to ensure reliability in the electric grid, while EIA is concerned with accurate reporting of energy statistics. Third, NERC compiles a set of independent projections developed by each constituent NERC regions that make it up, resulting in eight forecasts with no accounting for interactions between them. Through the NEMS modeling, EIA develops a self-consistent model for the nation as a whole. With these differences in mind, it is expected that the stated values for present and future peak electric demand vary between the two sources. The absolute difference is displayed in Figure 2-7.

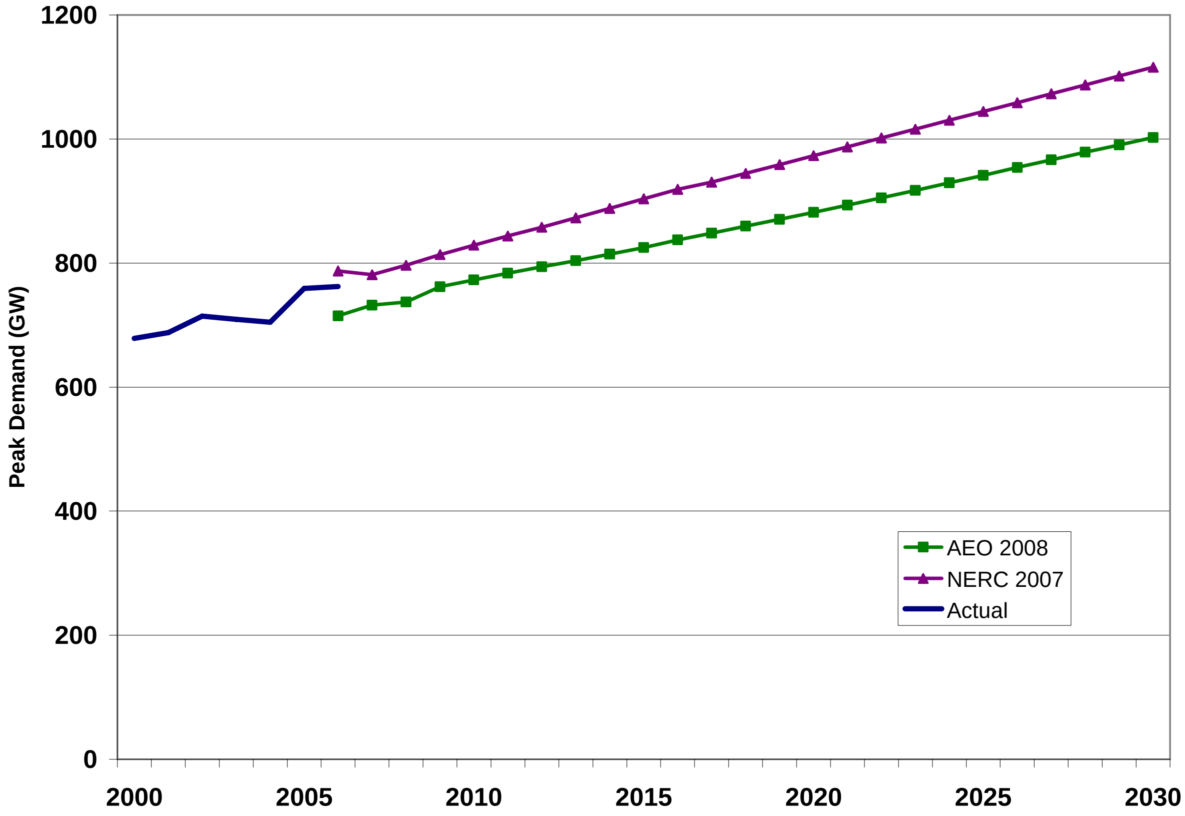


Figure 2-7
Comparison between AEO and NERC Forecasts of Peak Demand

Two phenomena are evident when comparing the two forecasts. First, the magnitude in peak demand differs by approximately 60 GW in 2008, with the NERC value about 8% higher than that included in AEO. This difference could suggest a difference in reporting methodology including factors such as definition of peak and geographical boundaries. Second, the two forecasts follow diverging trends, with the NERC projection growing at roughly 1.5% per year while the AEO projection maintains a 1.4% annual growth rate. This difference likely derives from the institutional perspectives of both NERC and EIA, as well as the inclusion of interactive effects between regions.

To reconcile this difference, the study developed the peak demand forecast to maintain consistency with the AEO projections of electricity consumption, while preserving the capacity- and reliability-based definitions of peak demand embodied in the NERC forecast. This was accomplished by adjusting the AEO forecast upward to correspond to the present-day peak demand figures as reported by NERC. The growth in the AEO forecast was then applied, resulting in a hybrid between the two forecasts.

Once a high-level forecast for peak demand was established, the projected values were broken out along the same dimensions employed in the energy forecast through the following series of steps:

Split the forecast of peak demand by sector through the application of characteristic utility load shapes for each of the regions. Because of the large variation in customer attributes within relatively large geographical boundaries, this required significant averaging and qualitative judgment about which figures were typical for a given region.

Map peak demand forecast from the 13 regions at which the AEO modeling is performed (under the Electricity Market Module) to the four census regions analyzed in this study. This was performed by applying transformation matrices provided by EIA.

Apply the same percentages for existing energy efficiency as in the energy baseline to account for the impacts of programs already embedded in the forecast.

Follow the procedure utilized in energy baseline development to break out peak demand by end use and technology.

Estimation of Energy Efficiency Impacts

The general approach for estimating the potential savings from energy efficiency involves two steps:

- Developing a list of efficient measures along with unit impacts and pertinent market data for each measure
- Developing forecast of electricity use under alternative definitions of potential. This involves phasing the energy-efficiency measures into general use, in accordance with the definitions of efficiency potential described below

Each of these steps is described below.

Energy Efficiency Measures List

The first step toward estimating savings through energy efficiency is to identify specific efficient technologies and measures (collectively referred to here as “measures”) for consideration. While the selection of energy-efficient measures should be as inclusive as possible in order to reflect the full potential for savings, the wide scope of this study required that measures be broadly applicable and not overly detailed.

The task of assembling a robust, comprehensive list of available efficiency measures began with first combining the lists of several previous energy efficiency potential studies. Because most of those studies were performed at the individual utility level, it was necessary to aggregate and generalize the measures to obtain the appropriate level of applicability. These measures were then compared against the proprietary Database for Energy Efficiency Measures (DEEM) maintained by Global Energy Partners to yield a more comprehensive list of measures and their associated energy impact and pertinent cost information. Next, the list was updated by examining literature on emerging energy efficiency technologies, leveraging EPRI research in many of these technologies, as well as numerous other studies performed by national labs, universities, and industry.

The resulting comprehensive list of energy efficiency measures was then benchmarked against those applied in recent potential studies, resources such as California's Database for Energy Efficient Resources (DEER), and those developed by energy efficiency organizations such as the American Council for an Energy-Efficient Economy (ACEEE). Finally, an internal review refined the list of measures and reconciled them to the latest EPRI research in order to ensure a sample representative of the energy efficiency measures available today.

The definition of energy efficiency measures and specific efficiency levels is an area of considerable debate within the industry. The perspectives on this issue can be characterized as follows:

1. One approach is to restrict the set of measures and efficiency options to what is known at the time of the study. That is, the study includes only those technology options that are commercially available at the time and it does not include any forecasts of future technology commercialization or breakthroughs. This approach can apply to the list of energy efficiency measures included in the study, as well as the building codes and equipment/appliance standards that are embedded in the baseline forecast.

At the other extreme, the study embodies forecasts of technology innovation and commercialization beyond what is known at the time of the study. This may take the form of identifying specific technologies that become commercially available or cost effective during the forecast horizon. Alternatively, the new, more efficient technologies can be modeled as a trend in existing equipment. For example, it could be assumed that more efficient refrigerators come online in the future at a rate of improvement that reflects recent history. This approach can also apply to the codes and standards that are embedded in the baseline forecast. That is, it could be assumed that future refrigerator standards will be developed at the same rate as standards were implemented in the past.

Of course, between these two bookends it is possible to construct various middle grounds or hybrids. This study utilized the first approach, for the most part, which results in relatively conservative estimates of efficiency savings, as compared to the second approach. There is one exception, however. For a few technologies, EPRI identified options that are available elsewhere in the world that it expects to become commercial available in the U.S. in the next three to seven years. An example is variable refrigerant flow air conditioners, which are assumed to become commercially available and cost effective in 2010 (see Table 2-4). It is underscored here that this study assumes compliance with existing codes as standards in the baseline forecast, which is the same assumption used by the EIA in developing the Annual Energy Outlook.

Appendix F presents a description of each measure along with technology information regarding efficiency levels, year available, annual energy savings, summer peak demand savings, and the benefit/cost ratio by region. Table 2-4 presents an example of this measure detail for residential central air conditioners for the Northeast and Midwest census regions.

Table 2-4
Energy Efficiency Measure Data Example – Residential Central Air Conditioning

Technology	Year	Northeast			Midwest		
		Energy Savings	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**
SEER 13	2008	0.0%	0.0%	1.11	0.0%	0.0%	1.19
SEER 14	2008	8.3%	9.7%	1.02	8.3%	7.5%	1.04
SEER 15	2008	11.6%	9.7%	0.67	11.5%	7.5%	0.44
SEER 16	2008	14.4%	9.7%	0.63	14.1%	7.5%	0.39
SEER 18	2008	18.7%	9.7%	0.60	18.4%	10.0%	0.33
SEER 20	2008	22.0%	11.0%	0.58	21.8%	10.9%	0.28
Ductless VRF	2010	30.0%	15.0%	0.56	30.0%	15.0%	0.24
		2010	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	79%	80%	25%	76%	76%
Program Implementation Factor		24%	47%	70%	20%	45%	70%

Table 2-5 summaries the categories of energy efficiency measures included in this study.

Table 2-5
Categories of Energy Efficiency Measures Included in this Study

Residential Sector Measures	Commercial Sector Measures
Efficient air conditioning (central, room, heat pump)	Efficient cooling equipment (chillers, central AC)
Efficient space heating (heat pumps)	Efficient space heating equipment (heat pumps)
Efficient water heating (e.g. heat pump water heaters & solar water heating)	Efficient water heating equipment (heat pumps)
Efficient appliances (refrigerators, freezers, dishwashers, clothes washers, clothes dryers)	Efficient refrigeration equipment & controls (e.g. efficient compressors, floating head pressure controls, anti-sweat heater controls, etc.)
Efficient lighting (CFL, LED, linear fluorescent)	Efficient lighting (interior and exterior; LED exit signs, task lighting)
Efficient power supplies for Information Technology and consumer electronic appliances	Lighting controls (occupancy sensors, daylighting, etc.)
Air conditioning maintenance	Efficient power supplies for Information Technology and electronic office equipment
Heat pump maintenance	Water temperature reset
Duct repair and insulation	Efficient ventilation (air handling and pumps; variable air volume)
Infiltration control	Economizers and energy management systems (EMS)
Whole-house and ceiling fans	Programmable thermostats
Reflective roof, storm doors, external shades	Duct insulation
Roof, wall and foundation insulation	Retro-commissioning
High-efficiency windows	**Industrial Sector Measures**
Faucet aerators and low-flow showerheads	Efficient process heating
Pipe insulation	High-efficiency motors and drives
Programmable thermostats	High-efficiency Heating, Ventilation and Air Conditioning (HVAC)
In-home energy displays	Efficient lighting

Modeling Approach

For the residential and commercial sectors, a bottom-up end-use forecasting approach was applied to estimate potential, which requires detailed microeconomic modeling at the segment, end-use and technology levels. To this end, the LoadMAP model, developed by Global Energy Partners, was used. The LoadMAP model begins with a characterization of the customer base and end-use equipment in the base year (2008 for this study).

LoadMAP is a stock accounting-based model that develops forecasts of annual energy use and peak demand for each end use within a given region and sector. The LoadMAP model tracks the number of end-use devices by vintage and average efficiency level for each year in the forecast period. The model replaces equipment after its useful life according to the average lifetime for the equipment. For the oldest equipment a decay rate is applied. The annual energy use is calculated as the product of the number of end-use devices and the average annual energy contribution per device. The number of devices is the product of the number of households and the device saturation, where the device saturation is defined as the average number of devices per household.

The LoadMAP model was used to replicate the AEO 2008 reference forecast (after adjusting for embedded energy efficiency impacts). For calibration purposes, minor adjustments in the distribution of vintages and efficiency levels were made until the annual energy use matched the baseline forecast within a 5% margin. The calibrated baseline provides the reference point for determining the savings implied by the four potentials forecasts. The analytical framework for the LoadMAP modeling is depicted in Figure 2-8 and explained in some detail below.

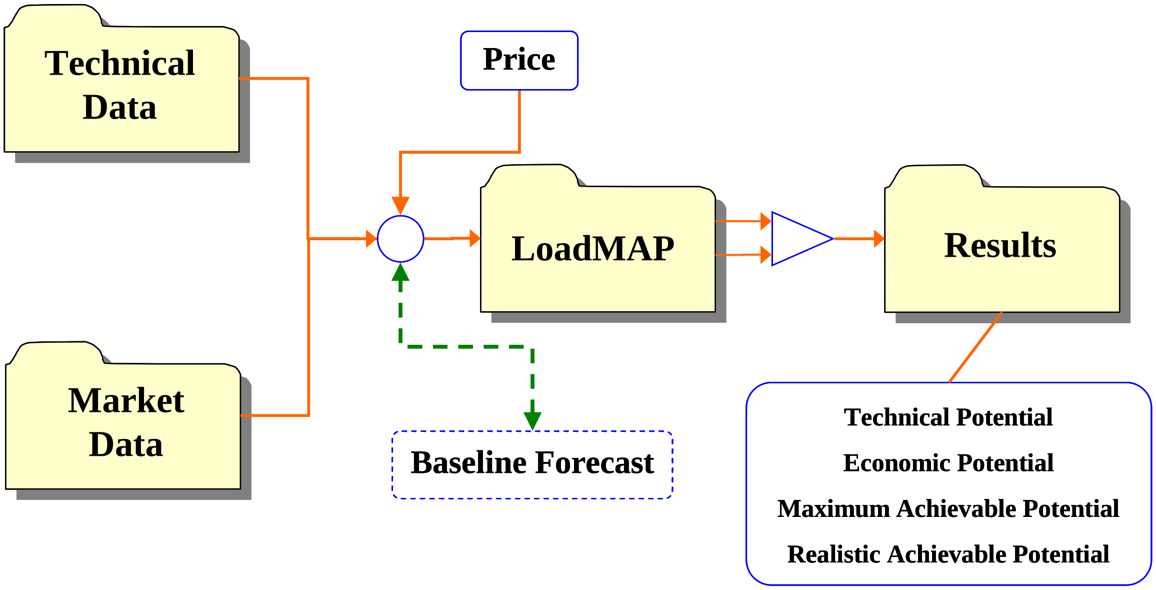


Figure 2-8
Schematic of Modeling Approach

Equipment Model

The first task executed by LoadMAP is a “bottom up” estimate of energy use based on market and technical data such as vintage and efficiency of existing stock, relative efficiency levels of current shipments, and unit energy consumption. This level of resolution was possible within the residential and commercial sectors. Within this stock accounting framework, a set of efficiency measures is introduced and phased into general use as equipment turns over, with customer choice depending on the case being considered. A model baseline is developed by aggregating the energy use by each technology and end use within a given sector and region. Once calibrated, this model baseline is altered at the consumer-choice level to produce potential estimates under the definitions described above.

Controls and Shell Model

While the phasing-in of energy-consuming equipment according to the appropriate efficiency levels represents part of the potential savings, many energy efficiency measures can not be treated through this approach. For example, consider the installation of an energy management system (EMS) in a large commercial office building. Because the power requirements of such a system are negligible in comparison to those of the entire building, a stock accounting model tracking such installations would reveal almost no potential for energy savings. However, because the EMS controls the HVAC systems for the entire building, it is likely to deliver significant electricity savings and a large peak demand reduction. Instead of accounting for the EMS through stock accounting, therefore, its associated energy savings potential is assessed through application of a savings fraction to the applicable load based on engineering calculations and empirical data. In this case, an EMS is assumed capable of a 17-19% reduction in cooling load and a 4-6% reduction in electrical heating, depending on climate zone, based on the best available supporting data. Savings from devices and controls are estimated after the equipment modeling to capture interactive effects and prevent savings from being overstated.

Industrial Model

The residential and commercial sectors have been the primary focus of detailed electricity forecasts and energy efficiency market research and potential studies for many years. This level of data resolution allowed a bottom-up modeling approach for these two sectors. By contrast, the industrial sector provides much less data resolution, due largely to the diverse array of highly specialized processes that take place in today’s industrial facilities. Because of its unique character, the industrial sector was modeled using a “top-down” analysis of the data available through AEO 2008 and other sources. With a smaller list of efficiency measures, each with a more general and inclusive definition, the industrial model applies technical savings values based on a survey of the literature and engineering judgment, benchmarked against available studies on industrial energy efficiency.

Developing Forecasts of Energy Efficiency Potential

The primary focus of this study was to develop a range of **achievable** energy efficiency and demand response potentials. The approach for deriving *achievable potential* is predicated on first establishing the theoretical constructs of *technical potential* and *economic potential* and then discounting them to reflect market and institutional constraints. This study applies the condition that new equipment does not replace existing equipment instantaneously or prematurely, but rather is "phased-in" over time as existing equipment reaches the end of its useful life. All categories of potentials in this study conform to this condition, and may be termed "phase-in" potentials.[14]

Each type of energy efficiency potential is defined below and explained through the modeling treatment example of residential central air conditioning (AC) (see Table 2-4).

Technical Potential

Technical potential represents the energy and peak demand savings due to energy efficiency and demand response programs that would result if all homes and businesses adopted the most efficient, commercially available technologies and measures, regardless of cost. Technical potential provides the broadest and largest definition of savings since it quantifies the savings that would result if all current equipment, processes, and practices in all sectors of the market were replaced at the end of their useful lives by the most efficient available options. Technical potential does not take into account the cost-effectiveness of the measures or the rate of market acceptance of those measures (i.e. 100% customer acceptance assumed).

Using the example of residential central air conditioning with reference to Table 2-4, technical potential assumes that in 2008 and 2009 every new home equipped with central AC and every existing home with a central AC unit that has reached the end of its useful life will purchase and install a SEER 20 unit. For the years 2010 through 2030, the technical potential assumes the purchase and installation of Ductless Variable Refrigerant Flow (VRF) units. In addition, devices and controls such as programmable thermostats are applied to all eligible existing homes that don't already have the measure and to new homes in 2008. These devices are assumed to remain in place for the duration of the forecast.

Economic Potential

Economic potential represents the savings due to programs that would result if all homes and business adopted the most efficient "cost-effective" technologies, ignoring market and programmatic barriers. It is a subset of the Technical Potential and is quantified only over those measures that pass a widely recognized economic cost-effectiveness screen. The cost-effectiveness screen applied in this study is a simplified variation of the Participant Test, which compares the incremental cost to a consumer of an efficient technology relative to its baseline option, and the bill savings expected from that technology over its useful life. Only those technologies for which the net present value of benefits exceeds its incremental cost to

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[14] For the purposes of this study, no "mid-life" replacements of existing equipment for more efficient equipment are assumed, even though in some instances such replacements may be economically justifiable. Consumers or firms that initiate such replacements could be considered predisposed to efficiency or conservation, and their actions may be grouped in the category or market-driven or "naturally-occurring" savings if they would occur independent of an energy efficiency program.

consumers pass the test. Economic potential does not take into account the rate of market acceptance of those technologies or measures that are deemed cost-effective, i.e. 100% customer acceptance assumed.

To perform the net present value calculations required of the Participant Test, the EIA forecast of retail electricity prices by sector and region is applied to the calculated electricity savings associated with an energy efficiency measure over its assumed operational life, to yield stream of economic benefits to the participating consumer. A 5% discount rate is applied to convert this stream of life-cycle benefits into present day dollars, which is directly comparable to the incremental cost of the energy efficiency measure. When the benefit-to-cost ratio is greater than or equal to one, the measure passes the economic screen.

As an example, consider the application of the economic screen to the cost-effectiveness calculation for a SEER 14 central air conditioner for a single family home in the Midwest region. The baseline unit is a central air conditioner with the minimum efficiency required by law, SEER 13. They key inputs to the calculation, based on the best available data, are:

- SEER 14 unit costs about $182 more than the SEER 13
- Labor costs of installation and ongoing maintenance are assumed to be equal for both units; i.e. zero incremental cost for labor and O&M
- Operation lifetime of 18 years for a residential central AC (whether SEER 13 or 14)

As indicated in Table 2-4, a SEER 14 unit in the Midwest reduces electricity use by 8.3% compared to a SEER 13, based on engineering calculations and the best available data. This results in an annual electricity savings of 205 kWh over the unit's lifetime. When applied to the EIA forecast of residential electricity prices in the Midwest, and discounted back at a rate of 5%, the equates to a present value benefit of $190. Because its present value benefit is greater than its incremental cost ($182), SEER 14 passes the Participant Test in the Midwest with a benefit-to-cost ratio of 1.04 (i.e. $190/$182), as indicated in Table 2-4.

Continuing with the example of residential central air conditioning with reference to Table 2-4, SEER 14 air conditioners have a benefit-cost (B/C) ratio greater than 1.0 in the Northeast region, while SEER 15 units have a B/C ratio less than 1.0. For the economic potential forecast, it is assumed that SEER 14 units are installed in existing homes when the central air conditioning equipment fails, as well as in new homes. B/C ratios are also calculated for each device and control type. Using again the example of programmable thermostats, their B/C ratio is 5.4 in the Northeast region, so these are also applied in economic potential forecast.

Maximum Achievable Potential

Maximum achievable potential (MAP) is defined as the fraction of the economic potential (i.e. cost-effective savings) that could be achieved after consideration of market acceptance. MAP takes into account market, societal, and attitudinal barriers that limit customer participation in energy efficiency programs – despite the positive net present value that the promoted technologies would provide to program participants. These barriers could reflect customers' resistance to doing more than the absolute minimum required or a dislike of the technology option.

For example, some customers might choose not to buy compact fluorescent lamps (CFLs) because they don't like the color of the light or don't believe they work as well as incandescent lamps. Others may be resistant to installing or using a programmable thermostat because of perceived hassle or compromise in comfort. When considering the purchase of major appliances, many customers consider price, aesthetics, and functional attributes before turning to energy efficiency and operational costs.

Such barriers exist even under ideal conditions conducive to program participation, including perfect information and sufficient funding for effective program marketing and administration and attractive financial incentives to consumers (representing up to 100% of the incremental cost of energy efficient measures above baseline measures). Even though a financial incentive such as a rebate afforded by a program would bring the up-front cost of an energy-efficient product at parity with a standard product, some segment of customers are not be willing to go through the perceived hassle of a rebate application.

These barriers are introduced in the LoadMAP model by applying a set of Market Acceptance Ratios (MARs) to the economic potential savings from each measure. Based on current market data where available, such as ENERGY STAR® sales figures, and augmented through an expert review process, the MARs applied in this study are free of regional variation and generally increase through the forecast horizon. This increase reflects the growing acceptance of energy efficiency in modern society, a trend that is assumed under achievable potential conditions to continue throughout the next 22 years. MAR values applied in this study are presented in Tables 2-6, 2-7, and 2-8 for the residential, commercial, and industrial sectors, respectively.

Using our example of residential central AC, the market acceptance rates in the first line of Table 2-6 are applied in the corresponding years. That is, in 2010, only 25% of the homes eligible for equipment replacement and in new construction install SEER 14 AC units. The remaining homes install SEER 13 units. By 2020, 75% of the homes undergoing equipment replacement or being built install the higher-efficiency unit. Similarly, only 33% of the homes eligible for programmable thermostats install them in 2010. By 2025, 100% of homes install them and the MAP equals economic potential in that year.

Table 2-6
Market Acceptance Ratios for Residential Efficiency Measures by End Use

Measure	2010	2015	2020	2025	2030
Central AC	25%	50%	75%	75%	75%
Room AC	50%	75%	90%	90%	90%
Space Heat - Heat Pumps	25%	50%	75%	75%	75%
Lighting (CFL)	50%	63%	75%	75%	75%
Lighting (Linear Fluorescent)	100%	100%	100%	100%	100%
Refrigerators	100%	100%	100%	100%	100%
Freezers	100%	100%	100%	100%	100%
Water Heating	33%	66%	80%	80%	80%
Clothes Washers	25%	35%	45%	50%	50%
Clothes Dryers	50%	75%	90%	90%	90%
Dishwashers	50%	75%	90%	90%	90%
Color TVs	50%	63%	75%	75%	75%
PCs	50%	63%	75%	75%	75%
Ceiling Fan	25%	50%	75%	75%	75%
Whole-House Fan	25%	50%	75%	75%	75%
Duct Insulation	25%	33%	50%	65%	75%
Programmable Thermostat	33%	50%	75%	100%	100%
Storm Doors	25%	33%	50%	65%	75%
External Shades	25%	33%	50%	65%	75%
Ceiling Insulation	33%	50%	70%	80%	90%
Foundation Insulation	33%	50%	70%	80%	90%
Wall Insulation	33%	50%	70%	80%	90%
Reflective Roof	33%	50%	70%	80%	90%
Windows	25%	33%	50%	65%	75%
Faucet Aerators	50%	75%	75%	75%	75%
Pipe Insulation	50%	75%	75%	75%	75%
Low-Flow Showerheads	50%	75%	75%	75%	75%
AC Maintenance	25%	33%	50%	65%	75%
HP Maintenance	25%	33%	50%	65%	75%
Duct Repair	25%	33%	50%	65%	75%
Infiltration Control	25%	33%	50%	65%	75%

Table 2-7
Market Acceptance Ratios for Commercial Efficiency Measures by End Use

Measure	2010	2015	2020	2025	2030
Cooling - Central AC	25%	50%	75%	75%	75%
Cooling - Chiller	30%	60%	85%	85%	85%
Cooling – Chiller Water Temperature Reset	30%	60%	85%	85%	85%
Cooling – Chiller VSD on Pump	25%	50%	75%	75%	75%
Cooling – Economizer	25%	50%	75%	75%	75%
Cooling – Central, Duct Insulation	30%	60%	85%	85%	85%
Cooling – Energy Management System	25%	50%	75%	75%	75%
Cooling – Programmable Thermostat	25%	50%	75%	75%	75%
Cooling – Fans, Energy-Efficient Motors	25%	50%	75%	75%	75%
Cooling – Fans, Variable Speed Control	25%	50%	75%	75%	75%
Cooling – Chiller: Duct Testing and Sealing	30%	60%	85%	85%	85%
Cooling – Cool Roof	30%	60%	85%	85%	85%
Cooling – Roof Insulation	30%	60%	85%	85%	85%
Cooling – Efficient Windows	30%	60%	85%	85%	85%
Cooling – HVAC Retrocommissioning	30%	60%	85%	85%	85%
Heating – Heat Pump	25%	50%	75%	75%	75%
Heating – Economizer	25%	50%	75%	75%	75%
Heating – Heat Pump, Duct Insulation	30%	60%	85%	85%	85%
Heating – Energy Management System	25%	50%	75%	75%	75%
Heating – Programmable Thermostat	25%	50%	75%	75%	75%
Heating – Roof Insulation	30%	60%	85%	85%	85%
Heating – Efficient Windows	30%	60%	85%	85%	85%
Heating –HVAC Retrocommissioning	30%	60%	85%	85%	85%
Ventilation – Variable Air Volume System	25%	50%	75%	75%	75%
Ventilation – Fans, Energy-Efficient Motors	25%	50%	75%	75%	75%
Ventilation – Fans, Variable Speed Control	25%	50%	75%	75%	75%
Lighting	50%	70%	85%	85%	85%
Lighting – LED Exit Lighting	50%	75%	95%	95%	95%
Lighting – Occupancy Sensors	50%	65%	75%	75%	75%
Lighting – Task Lighting	50%	65%	75%	75%	75%
Lighting – Outdoor	30%	65%	75%	75%	75%
Lighting – Daylighting Controls, Outdoors	50%	65%	75%	75%	75%
Lighting Retrocommissioning	30%	60%	85%	85%	85%
Water Heater	25%	55%	80%	80%	80%
Refrigeration – Compressor, High-Efficiency	30%	60%	85%	85%	85%
Refrigeration – Controls, Anti-Sweat Heater	30%	60%	85%	85%	85%
Refrigeration – Controls, Floating Head Pressure	30%	60%	85%	85%	85%
Refrigeration – Glass Doors, Installation	30%	65%	75%	75%	75%
Refrigeration – Icemakers	30%	60%	85%	85%	85%
Refrigeration – Reach-in Coolers and Freezers	30%	60%	85%	85%	85%
Personal Computers	50%	70%	85%	85%	85%
Servers	50%	70%	85%	85%	85%
Monitors	50%	70%	85%	85%	85%
Copiers, Printers and Other Electronics	50%	70%	85%	85%	85%
Vending Machine, High Efficiency	25%	50%	75%	75%	75%

Table 2-8
Market Acceptance Ratios for Industrial Efficiency Measures by End Use

Measure	2010	2015	2020	2025	2030
Process Heating – Electric resistance	25%	35%	50%	50%	50%
Process Heating – Radio Frequency	25%	35%	50%	50%	50%
1-5 hp motors	50%	75%	95%	95%	95%
5-20 hp motors	50%	75%	95%	95%	95%
20-50 hp motors	50%	75%	95%	95%	95%
50-100 hp motors	50%	75%	95%	95%	95%
100-200 hp motors	50%	75%	95%	95%	95%
200-500 hp motors	50%	75%	95%	95%	95%
500-1,000 hp motors	50%	75%	95%	95%	95%
1,000-2,500 hp motors	50%	75%	95%	95%	95%
>2,500 hp motors	50%	75%	95%	95%	95%
HVAC	30%	60%	85%	85%	85%
Lighting – Fluorescent	50%	65%	85%	85%	85%
Lighting – HID	50%	65%	85%	85%	85%
Other	25%	35%	50%	50%	50%

Realistic Achievable Potential

Realistic Achievable Potential (RAP) further refines the Maximum Achievable Potential by accounting for barriers of a programmatic nature that are likely to further limit program participation. For example, utilities do not have unlimited budgets for energy efficiency and demand response programs, and as such may not be able to provide funding for program marketing or incentives sufficient to induce participation. Moreover, utilities and other program implementers have varying levels of experience implementing programs; as such, best practices in program implementation are not universally applied, which further reduces achievable potential savings. In addition, political barriers often reflect differences in regional attitudes toward energy efficiency and its value as a resource. RAP also takes into account recent utility experience and reported savings.

As in the case of MAP, RAP is developed through the application of factors that represent these programmatic barriers. These are termed Program Implementation Factors (PIFs), and are tied in the near term to the existing climate for energy efficiency and demand response programs. In the long run, however, the PIFs contain no regional variation and differ across measures only in the sense that the implementation avenues are inconsistent. For instance, the maximum value for measures targeting efficient central air conditioners is limited to 70%, while those pertaining to CFL lighting programs reach 100%. This difference can be attributed to the split incentive problem, through which the contractors responsible for efficiency decisions will not recognize the benefits.

PIF values applied in this study are presented in Tables 2-9, 2-10, and 2-11 for the residential, commercial, and industrial sectors, respectively. Referring to our residential central AC example from above and the first line in Table 2-9, the MAP estimate in 2010 is multiplied by 30% to reflect programmatic barriers. By 2020, these barriers are reduced and the multiplier is 60%. Similarly, the MAP estimate for programmable thermostats is multiplied by 20% in 2010 and 48% in 2020.

Table 2-9
Program Implementation Factors for Residential Measures by End Use

Measure	2010	2015	2020	2025	2030
Cooling – Central AC	30%	40%	50%	60%	70%
Cooling –Room AC	50%	60%	70%	80%	90%
Space Heat – Heat Pumps	30%	40%	50%	60%	70%
Lighting (CFL)	60%	70%	80%	90%	100%
Lighting (LF)	45%	55%	65%	75%	85%
Refrigerators	50%	60%	70%	80%	90%
Freezers	30%	38%	45%	53%	60%
Water Heating	30%	35%	40%	45%	50%
Clothes Washers	50%	60%	70%	80%	90%
Clothes Dryers	30%	35%	40%	45%	50%
Dishwashers	50%	60%	70%	80%	90%
Cooking	20%	26%	32%	39%	45%
Color TV	25%	36%	48%	59%	70%
Personal Computers	25%	39%	52%	66%	80%
Furnace Fans	25%	31%	38%	44%	50%
Miscellaneous	0%	0%	0%	0%	0%
Ceiling Fan	10%	18%	25%	33%	40%
Whole-House Fan	20%	28%	35%	43%	50%
Duct Insulation	5%	11%	18%	24%	30%
Programmable Thermostat	20%	34%	48%	61%	75%
Storm Doors	5%	10%	15%	20%	25%
External Shades	5%	11%	18%	24%	30%
Ceiling Insulation	5%	11%	18%	24%	30%
Foundation Insulation	5%	11%	18%	24%	30%
Wall Insulation	5%	11%	18%	24%	30%
Reflective Roof	10%	20%	30%	40%	50%
Windows	15%	26%	38%	49%	60%
Faucet Aerators	5%	11%	18%	24%	30%
Pipe Insulation	5%	11%	18%	24%	30%
Low-Flow Showerheads	5%	11%	18%	24%	30%
AC Maintenance	5%	9%	13%	16%	20%
HP Maintenance	5%	9%	13%	16%	20%
Duct Repair	5%	11%	18%	24%	30%
Infiltration Control	5%	11%	18%	24%	30%
Dehumidifier	1%	2%	3%	4%	5%
Combined Washer/Dryer	1%	4%	8%	12%	15%
Reduce Standby Wattage	15%	27%	40%	52%	65%
In-home Feedback Monitor	2%	16%	31%	45%	60%

Table 2-10
Program Implementation Factors for Commercial Measures by End Use

Measure	2010	2015	2020	2025	2030
Cooling					
Central AC	30%	41%	52%	64%	75%
Chiller	25%	34%	42%	51%	60%
Chiller Water Temperature Reset	20%	30%	40%	50%	60%
Chiller, VSD on Pump	20%	30%	40%	50%	60%
Economizer	15%	24%	33%	41%	50%
EMS	20%	28%	35%	43%	50%
Programmable Thermostat	20%	28%	35%	43%	50%
Fans, Variable Speed Control	25%	38%	50%	63%	75%
Fans, Energy-Efficient Motors	25%	38%	50%	63%	75%
Duct Testing and Sealing	15%	21%	27%	34%	40%
Cool Roof	10%	18%	25%	33%	40%
Roof Insulation	15%	21%	27%	34%	40%
HVAC Retrocommissioning	10%	20%	30%	40%	50%
Efficient Windows	15%	21%	27%	34%	40%
Heating					
Heat pump	30%	41%	52%	64%	75%
Economizer	15%	24%	33%	41%	50%
Duct Insulation	15%	21%	27%	34%	40%
EMS	20%	28%	35%	43%	50%
Programmable Thermostat	20%	28%	35%	43%	50%
Roof Insulation	15%	21%	27%	34%	40%
Efficient Windows	15%	21%	27%	34%	40%
HVAC Retrocommissioning	10%	20%	30%	40%	50%
Ventilation					
Fans	10%	26%	42%	59%	75%
Variable Air Volume System	10%	18%	25%	33%	40%
Fans, Energy-Efficient Motors	25%	38%	50%	63%	75%
Fans, Variable Speed Control	25%	38%	50%	63%	75%

Table 2-10 (continued)
Program Implementation Factors for Commercial Measures by End Use

Measure	**2010**	**2015**	**2020**	**2025**	**2030**
Lighting					
Lighting	50%	63%	75%	88%	100%
Daylighting Controls, Outdoors	5%	11%	18%	24%	30%
LED Exit Lighting	50%	63%	75%	88%	100%
Occupancy Sensors	20%	28%	35%	43%	50%
Task Lighting	5%	11%	18%	24%	30%
Outdoor Lighting	25%	38%	50%	63%	75%
Lighting Retrocommissioning	10%	20%	30%	40%	50%
Water Heater	40%	52%	65%	77%	90%
Refrigeration					
Refrigeration, High-Efficiency	25%	31%	38%	44%	50%
Compressor, High-Efficiency	15%	21%	27%	34%	40%
Controls, Anti-Sweat Heater	15%	21%	27%	34%	40%
Controls, Floating Head Pressure	15%	21%	27%	34%	40%
Glass Doors, Installation	15%	21%	27%	34%	40%
Icemakers	5%	16%	27%	39%	50%
Reach-in Coolers and Freezers	10%	20%	30%	40%	50%
Electronics and Other					
Personal Computers	25%	38%	50%	63%	75%
Servers	25%	38%	50%	63%	75%
Monitors	20%	34%	48%	61%	75%
Copiers Printers	20%	34%	48%	61%	75%
Other Electronics	20%	34%	48%	61%	75%
Vending Machine, High Efficiency	15%	21%	27%	34%	40%

Table 2-11
Program Implementation Factors for Industrial Measures by End Use

Measure	2010	2015	2020	2025	2030
Electric resistance	2%	6%	11%	15%	20%
Radio frequency	2%	6%	11%	15%	20%
1-5 hp motors	15%	21%	27%	34%	40%
5-20 hp motors	15%	21%	27%	34%	40%
20-50 hp motors	10%	18%	25%	33%	40%
50-100 hp motors	10%	18%	25%	33%	40%
100-200 hp motors	10%	18%	25%	33%	40%
200-500 hp motors	10%	18%	25%	33%	40%
500-1,000 hp motors	10%	18%	25%	33%	40%
1,000-2,500 hp motors	10%	18%	25%	33%	40%
>2,500 hp motors	10%	18%	25%	33%	40%
HVAC	10%	20%	30%	40%	50%
Lighting – Fluorescent	20%	30%	40%	50%	60%
Lighting – HID	20%	30%	40%	50%	60%
Other	2%	6%	11%	15%	20%

Estimation of Demand Response Impacts

In addition to estimating the impacts of energy efficiency measures on both energy consumption and summer peak demand, this study examined the potential for additional summer peak demand reduction through demand response. Because energy efficiency measures are typically technology-centric, whereas demand response options are generally more dependent on customer behavior, it was necessary to adopt a distinct approach to this estimate. While this methodology is self-consistent and represents a reasonable estimate of peak demand reduction attainable through demand response, it should be noted that the resulting potentials are not developed at the level of detail associated with individual programs. Rather, this analysis considers demand response offerings at an aggregate level and estimates the likelihood of participation by a representative customer, taking into account market and administrative barriers.

The modeling of demand response potential was based on existing demand response programs in North America, broadly categorized in terms of the approach to shifting load. Programmatic specifics such as incentive structure, allowed load shed strategies, and penalties were not considered. For example, rather than distinguishing between an interruptible tariff offered by a utility to industrial customers and an ancillary services program administered by the regional transmission operator, these programs are grouped together with other forms of event-based load shifting. Demand response programs considered in the analysis are grouped by sector and applicable end use, and include:

- Residential sector: direct load control for air conditioning, direct load control for water heating, and dynamic pricing programs (time-of-use, critical-peak pricing, real-time pricing, and peak time rebates)
- Commercial sector: direct control load management for cooling, lighting, and other uses; interruptible demand (e.g., interruptible, demand bidding, emergency, ancillary services); and dynamic pricing programs (TOU, CPP, RTP)
- Industrial sector: direct control load management for process; interruptible demand (e.g., interruptible, demand bidding, emergency, ancillary services); and dynamic pricing programs (TOU, CPP, RTP)

These program types fall into three primary categories – direct load control, event-based voluntary shed, and response to price signals. While each of these categories can be divided along numerous dimensions – i.e. enabling technology, timescale of notification, resource reliability – they are mutually exclusive and collectively exhaustive, in the sense that most existing demand response programs can be placed into one of these three categories. Further, this simplification allows for a consistent treatment of interactions between program options, a modeling challenge faced by many studies estimating demand response potential.

Definitions of Potentials

As in the case of energy efficiency, various types of potential savings were estimated for the demand response options. These programs range from technical to realistic achievable potential, but differ from the energy efficiency model in that there is no economic potential reported. Instead, the programs included in the analysis are assumed to be cost-effective for both the implementer and participant, and the predicted acceptance is encompassed in the maximum achievable potential. The potentials estimated for demand response are defined as follows:

- Technical Potential – Complete penetration of DR programs among eligible customers, assuming load shed comparable to highest performing customers under existing programs. Because of several examples of 100% load drop in interruptible programs, a technical potential is meaningless in this category and therefore not reported.
- Maximum Achievable Potential – Technical potential adjusted to include market penetration, accounting for perceived market barriers.
- Realistic Achievable Potential – Maximum achievable potential adjusted to reflect regulatory and administrative barriers.

Because demand response is not tied directly to the installation of efficient technologies, the potential modeling does not include a stock accounting approach. Instead, program participation rates are modeled as percentages of total eligible load, with increasing saturation as demand response offerings expand and enabling technology becomes more widely available. The analysis is built on two key assumptions about relative priority between DR and energy efficiency and among DR program types. These “loading orders” prevent the double-counting of savings impacts that would occur if each program type were considered in vacuum.

1. Energy efficiency is considered before demand response. This ordering implies a lower, efficient peak demand baseline from which to deduct the impacts of demand response, resulting in a possible bias toward efficiency when the results of each form of demand-side activities are assessed together.

2. Demand Response program types are considered in the following order:
   - Direct Load Control
   - Pricing Options
   - Interruptible Programs

3

THE BASELINE FORECAST

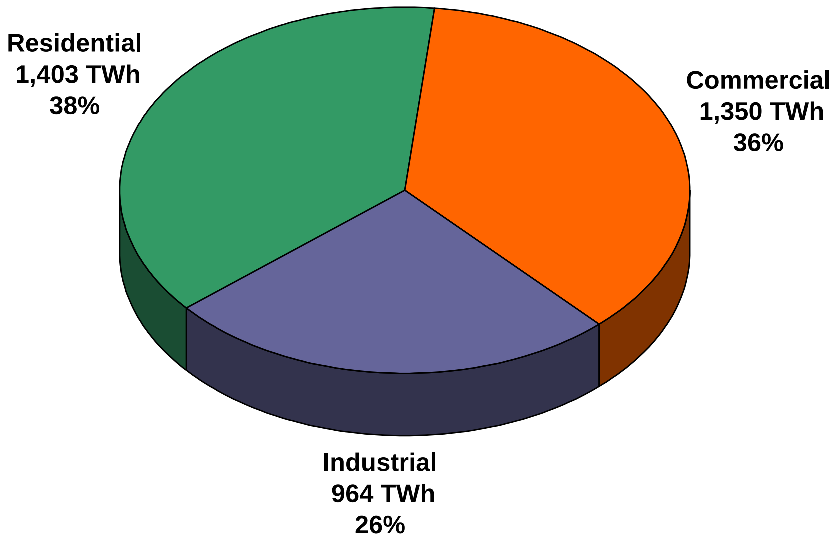
Before the analysis of energy savings can begin, it is critical to understand how customers use energy today and to forecast how much they are likely to use in the future in the absence of any new energy efficiency programs. This section presents electricity profiles for the U.S. in the base year of 2008, and establishes a baseline forecast of electricity use and summer peak demand by sector and end use.

2008 Electricity Use and Summer Peak Demand

This study characterizes two dimensions of electricity use: annual consumption and non-coincident summer peak demand for 2008.

2008 Annual Electricity Use

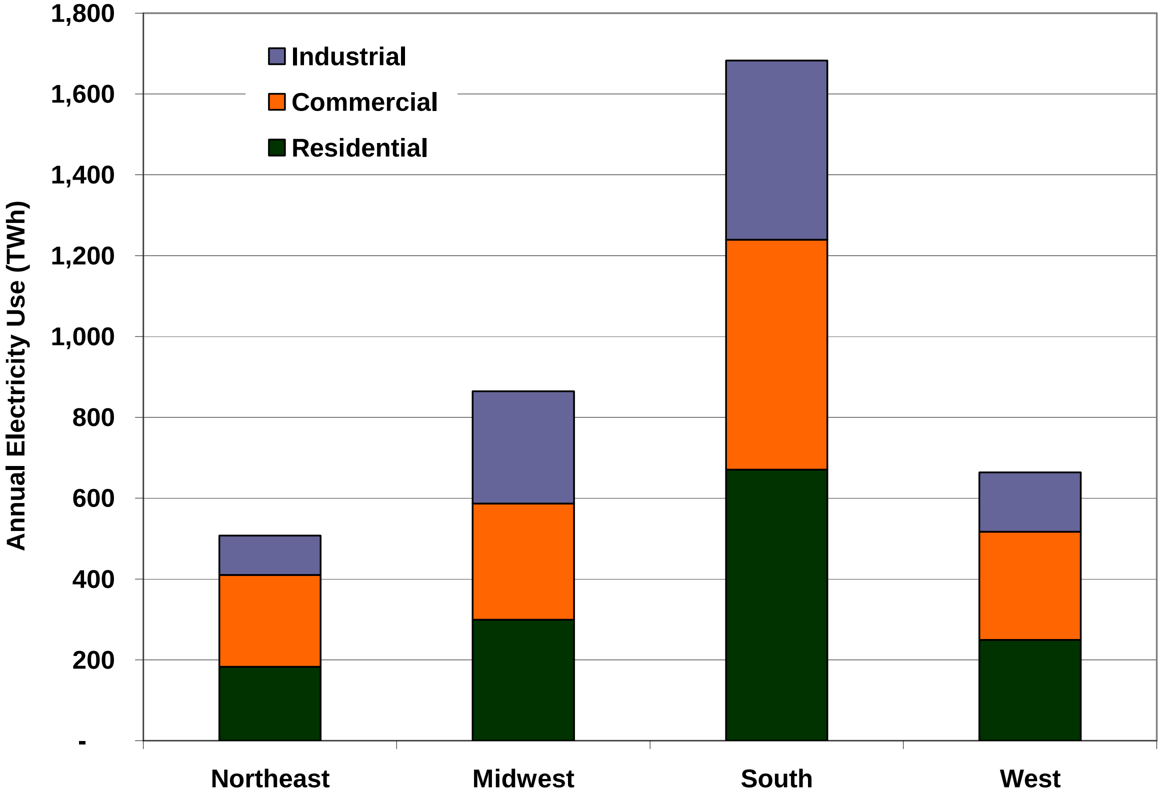
Based on the 2008 Annual Energy Outlook Reference Case, annual electricity use for the U.S. is estimated at 3,717 TWh. This represents 12.3 MWh per capita and 0.32 kWh per dollar of Gross Domestic Product in 2008. The allocation of U.S. electricity use across sectors is fairly even. As shown in Figure 3-1, the residential sector accounts for 38%, the commercial sector accounts for 36%, and the industrial sector uses 26%.



Source: 2008 Annual Energy Outlook Reference Case

Figure 3-1
U.S. Annual Electricity Use by Sector in 2008 (3,717 TWh)

Figure 3-2 presents 2008 electricity use by region and sector. The South is the largest region with 45% of the total. The Northeast is smallest with 14%, followed by the West with 18%.



Source: 2008 Annual Energy Outlook Reference Case

Figure 3-2
2008 Annual Electricity Use by Sector and Region (TWh)

Table 3-1 shows the allocation of electricity use by sector within each region. The commercial sector is the largest in all regions except the Midwest and South. The industrial sector has the smallest share across all regions. In the Midwest, the sectors have almost equal shares, while the other regions show greater variation among sector splits.

Table 3-1
2008 Electricity Use by Sector and Region (TWh)

	Northeast	**Midwest**	**South**	**West**	**U.S.**
2008 TWh					
Residential	183	299	671	250	**1,403**
Commercial	227	287	568	268	**1,350**
Industrial	97	278	443	146	**964**
Total	**507**	**864**	**1,682**	**664**	**3,717**
% of U.S. Total	13.7%	23.2%	45.3%	17.9%	100.0%
Sector Share of Region					
Residential	36.1%	34.6%	39.9%	37.6%	37.7%
Commercial	44.8%	33.2%	33.8%	40.3%	36.3%
Industrial	19.1%	32.2%	26.3%	22.1%	25.9%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

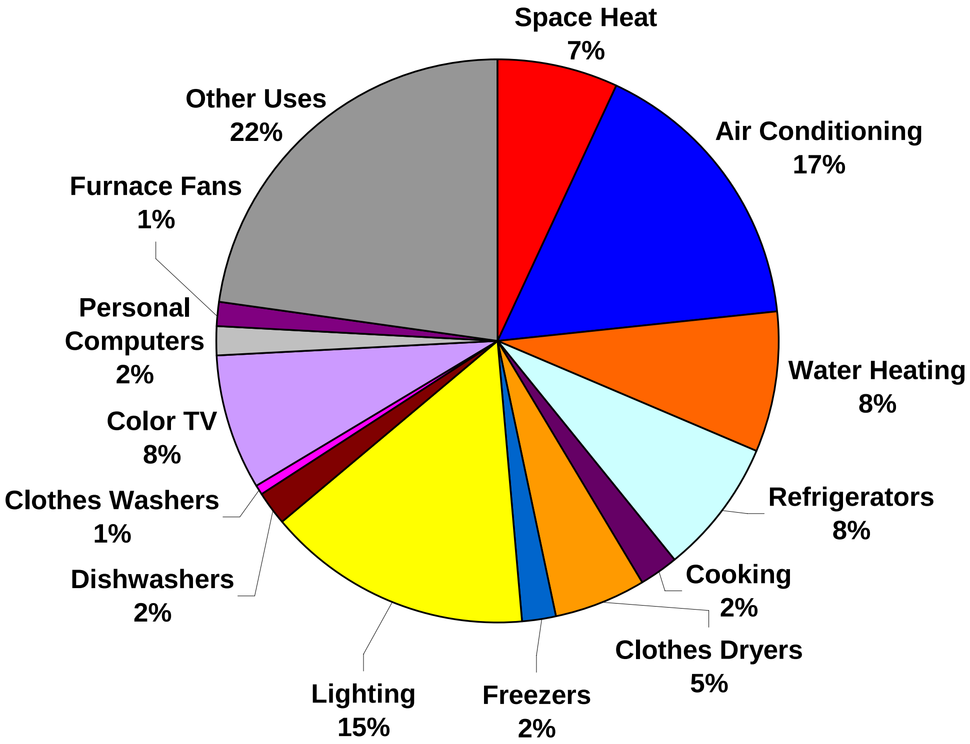
Source: 2008 Annual Energy Outlook Reference Case

Residential Sector

In 2008, annual electricity use in the residential sector is 1,403 TWh or 37% of the total across sectors. Figure 3-3 shows the breakout by end use for the U.S. as a whole.

- The largest identifiable electric end use is air conditioning (251 TWh), accounting for 17% of total annual use.
- Lighting is the second highest with 211 TWh. It accounts for 15% of total annual use.
- Water heating, refrigeration, and color TVs (and associated electronics) each account for 8%, while electric space heating accounts for 7%.
- Other uses, which include everything from coffee makers to hair dryers to pool pumps, account for almost one-fourth (23%) of total residential use.

For all the isolated end uses, it is possible to identify specific energy-efficiency measures and quantify savings as described in Chapter 2. For the other uses, this study does not project energy-efficiency savings through utility programs due to the lack of granularity. This leaves an area of untapped energy-efficiency potential for utility programs.



Source: 2008 Annual Energy Outlook Reference Case

Figure 3-3
2008 U.S. Residential Electricity Use by End Use

In 2008, the average residential home used 12,407 kWh per year. Table 3-2 and Figure 3-4 present the residential electric intensity in kWh per household by region and end use. The end-use intensities in these exhibits are share-weighted and represent average use across all households in the region. Stated differently, the intensities are the product of the end-use penetration (or fuel share) and the unit energy consumption (UEC) per household.

The South Region

Electricity use per household is highest in the South. With annual use of 16,101 kWh per household per year, it is one third higher than the national average. This difference is attributed to:

- Average use per household for cooling is more than twice as high as the next highest region (the Midwest). Hot and humid weather for most of the year results in a high saturation of air conditioning units in homes, as well as high usage.
- Space heating and water heating are also higher than the other regions in spite of mild weather. This results from a high saturation of electric heating equipment. All other regions rely more heavily on natural gas for space heating and water heating.

- The South uses lighting, electronics and appliances to the same degree as the other regions, with the exception of electric clothes dryers. They, too, have a higher penetration in the South than gas clothes dryers.

The Northeast Region

The Northeast has the lowest electricity use per household in 2008, at 8,793 kWh. This is one third less than the U.S. average and reflects:

- Low air conditioning use as a result of a shorter cooling season and a lower saturation of air conditioners.
- Lowest per household use of space heating and water heating, reflecting lower electricity fuel shares relative to the other regions. In addition to natural gas for space heating and water heating, the Northeast also uses fuel oil for space heating.
- Lighting is the largest end use in the Northeast even though use per household is less than in other regions.

The West Region

The West region has the greatest diversity in terms of climate. This region includes the hot arid cities of Phoenix and Las Vegas, as well as the Pacific Northwest with its wet, cool winters and mild summers. The West also includes California, the most energy-efficient state in the Union.

The West uses only slightly more electricity per year per household (9,454 kWh) than the Northeast and is still well below the national average. Lighting is the dominant end use, followed by air conditioning. Air conditioning use varies widely within the West region due to the diversity of the region. Air conditioner saturations are relatively low in the Pacific Northwest, California, and the mountain states, but they are high in the desert regions. Overall, the weather is milder in West compared to other regions. In spite of mild weather, however, the West region utilizes natural gas for space and water heating more extensively than in the South. Even the Pacific Northwest is experiencing increased penetration of natural gas for heating uses.

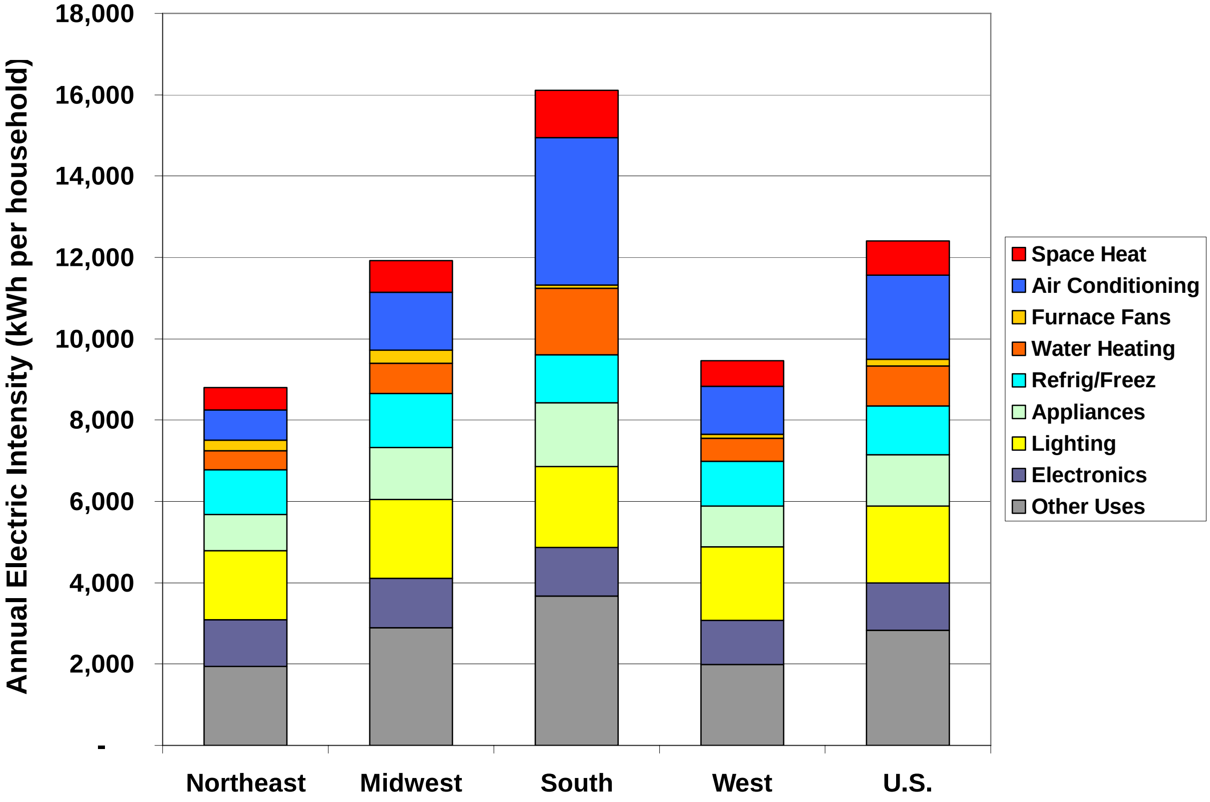
The Midwest Region

The Midwest region lies between the West and the South in terms of annual household electricity use. Lighting is largest single end use. Cooling is used intensively in the Midwest, due to hot and humid weather during the summer, but the cooling season is shorter than in the South. Natural gas is the dominant source for space heating and water heating. Furnace-fan use is highest in the Midwest, which reflects the long heating season.

Table 3-2
2008 U.S. Residential Use per Household by Region (kWh per household)

	Northeast	Midwest	South	West	U.S.
Space Heat	538	784	1,163	616	845
Air Conditioning	753	1,425	3,617	1,184	2,064
Furnace Fans	251	316	84	97	170
Water Heating	476	743	1,631	574	988
Refrigerators	960	1,055	961	908	977
Freezers	138	279	221	181	211
Dishwashers	205	245	257	237	243
Cooking	180	260	365	209	274
Clothes Washers	79	95	92	81	88
Clothes Dryers	424	674	858	488	658
Lighting	1,708	1,936	1,980	1,802	1,895
Personal Computers	202	210	206	191	204
Color TV	932	1,003	990	888	966
Other Uses	1,947	2,902	3,677	1,997	2,823
Total	**8,793**	**11,927**	**16,101**	**9,454**	**12,407**

Source: 2008 Annual Energy Outlook Reference Case



Source: 2008 Annual Energy Outlook Reference Case

Figure 3-4
2008 U.S. Residential Use per Household by Region

Commercial Sector

In 2008, annual electricity use in the commercial sector is estimated at 1,350 TWh or 36% of the total across sectors. Figure 3-5 shows the breakout of commercial sector electricity consumption by end use. The commercial sector represents a wide variety of business and building types, including office buildings, restaurants, retail, supermarkets, warehouses, schools, hospitals, hotels, churches, theaters, and more[15].

Electricity use for lighting is 333 TWh. In most segments within the commercial sector, the floorspace is often lit continuously during operating hours. With operating hours typically ranging between nine and twelve hours per day, at least five days per week, it is the largest single use in the commercial sector. Moreover, some portion of lighting equipment is often left on at night for security reasons.

The second largest use at the national level is office equipment at 220 TWh. Office equipment includes all types of computing, IT, and other office equipment from PCs and monitors, to

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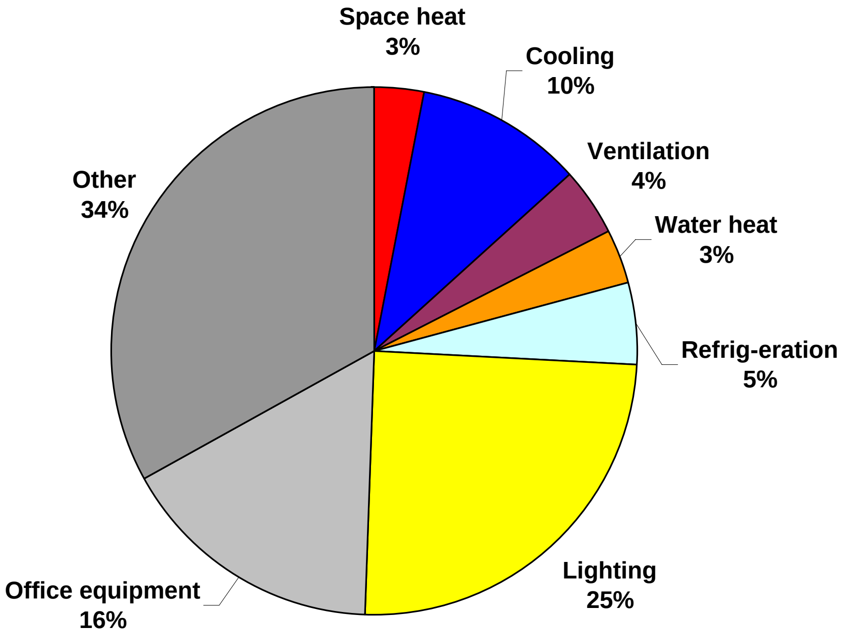
[15] For more information about how commercial segments use electricity, see "Commercial Building Energy Efficiency and Efficient Technologies Guidebook," EPRI TR-1016112, April 2008.

servers and copiers. Like lighting, computing equipment has become ubiquitous and typically runs continuously during normal operating hours. Often the equipment also runs at night, although newer equipment with automatic "sleep" modes is reducing consumption during non-active periods.

Cooling is the third-largest use across the U.S. as a whole at 137 TWh. Cooling use varies considerably across segments, with very high use in hospitals, large offices, and large retail, particularly in the warm regions. But it has low use in warehouses, education and small establishments, particularly in milder climates.

Cooking and refrigeration use is a relatively small fraction of total electricity use. However, cooking has a high share of electricity use in restaurants, even when natural gas is the primary cooking fuel. Refrigeration use is roughly half of total electricity use in the food-sales segment and is also relatively high in restaurants.

The "other" category includes miscellaneous uses, such as medical equipment, coffee makers, and laundry equipment. In AEO, it also includes commercial cooking, which is often isolated as its own end use in utility studies. Finally, "other" also includes "non-specified" uses, which consists of non-building uses of electricity. As with the residential category "other uses," the other category in the commercial sector is excluded from the analysis of energy-efficiency potential through utility programs, which leaves an untapped area for future research into the composition of the end use and the possible savings.



Source: 2008 Annual Energy Outlook Reference Case

Figure 3-5
2008 U.S. Commercial Electricity Use by End Use

In 2008, the commercial sector used an average of 17.3 kWh per square foot averaged across all commercial-sector floor space. Table 3-3 and Figure 3-6 present the commercial electric intensity (in kWh/ft.^{2}) by region and end use. These intensities are share weighted and are the product of the end-use penetration (or fuel share) and the energy-use intensity (EUI) across floor space with the end use present.

The variation in overall electric intensity across regions in the commercial sector is much smaller than it is for the residential sector. This reflects the smaller impact that weather plays on energy use in this sector. While smaller buildings, with more surface area exposed to the elements, are more affected by weather, larger buildings are dominated by "internal loads" caused by people and equipment. Further, business operations are increasingly homogeneous across regions, as witnessed by the proliferation of shopping "strip" malls and chain retail stores. Nevertheless, some variation across regions is evident.

The South Region

As in the residential sector, the commercial sector in the South has highest overall intensity. At 19.5 kWh per square foot, it is about 13% higher than the national average.

- Compared to the other regions, cooling is highest in the South. This reflects the combination of hot weather, a long cooling season, and a high saturation of cooling equipment.
- Lighting is the largest end use, and accounts for 25% of total electricity use in the South.
- Water heating and space heating are highest in the South compared to other regions, which reflects both milder weather and a higher saturation of electric equipment.
- Ventilation and refrigeration are both higher in the South than other regions because of the long, warm-weather season.

The West Region

The commercial sector in the West has the second highest intensity. At 19.2 kWh per square foot, it is only slightly less than the South. However, the end-use breakdown is different.

- Lighting is the highest use in the West region at 4.9 kWh per square foot. We speculate that this reflects newer well-lit building stock comprised largely of retail and office space, relative to the other regions of the country.
- Cooling is second highest of the regions. In spite of relatively mild weather, the newer buildings in the region have a high saturation of cooling equipment.

The Midwest and Northeast Region

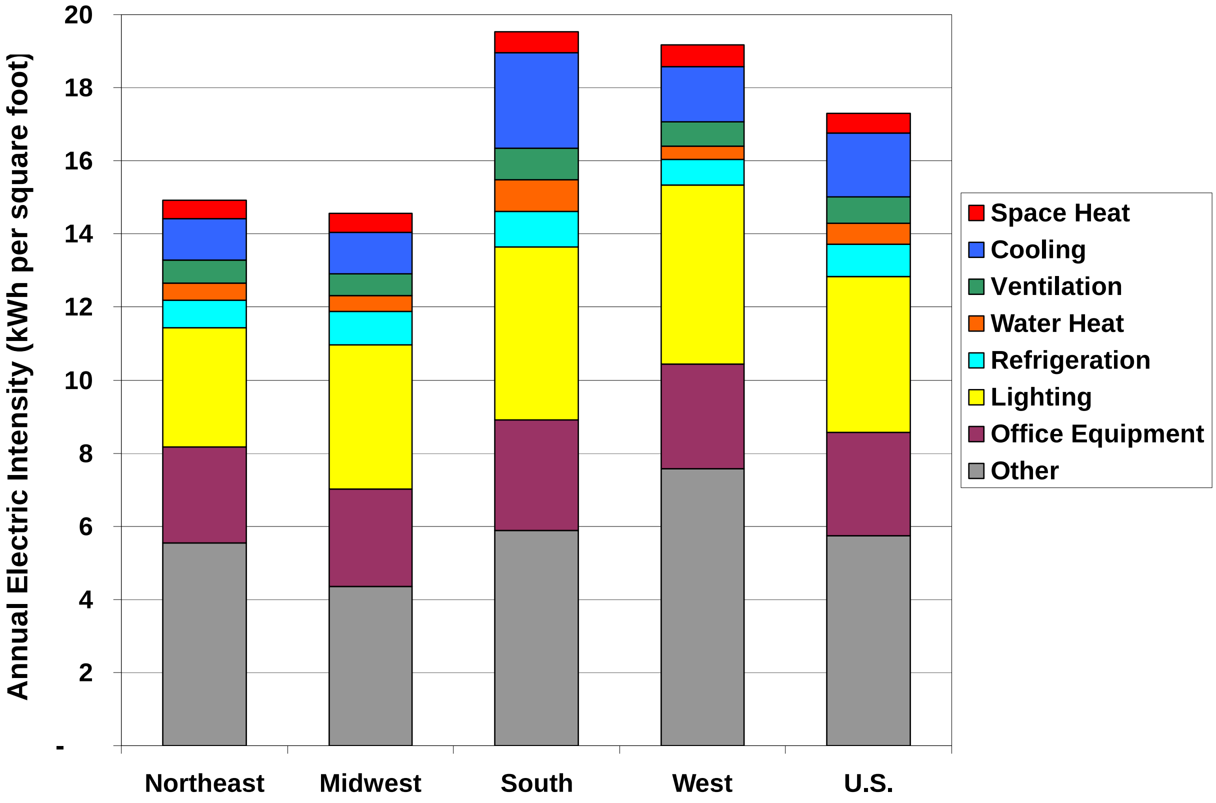
The Midwest and the Northeast have the lowest overall intensity at 14.6 and 14.9 kWh per square foot, respectively, about 12 to 15% less than the national average. The end-use breakdown for these two regions is roughly the same:

- Lighting is the dominant end use at 4 kWh per square foot and over one-fourth of total electricity use.
- Office equipment is the second-highest use, although the intensity of use in these two regions is roughly the same as in the West and the South.
- Cooling is lower than in the West and South, reflecting milder weather and lower cooling saturation in older and smaller buildings.

Table 3-3
2008 U.S. Commercial Intensity by Region and End Use (kWh/ft.^{2})

	Northeast	Midwest	South	West	U.S.
Space Heat	0.5	0.5	0.6	0.6	0.5
Cooling	1.1	1.1	2.6	1.5	1.8
Ventilation	0.6	0.6	0.9	0.7	0.7
Water Heat	0.5	0.4	0.9	0.4	0.6
Refrigeration	0.8	0.9	1.0	0.7	0.9
Lighting	3.2	4.0	4.7	4.9	4.3
Office Equipment	2.6	2.7	3.0	2.9	2.8
Other	5.6	4.4	5.9	7.6	5.7
Total	**14.9**	**14.6**	**19.5**	**19.2**	**17.3**

Source: 2008 Annual Energy Outlook Reference Case



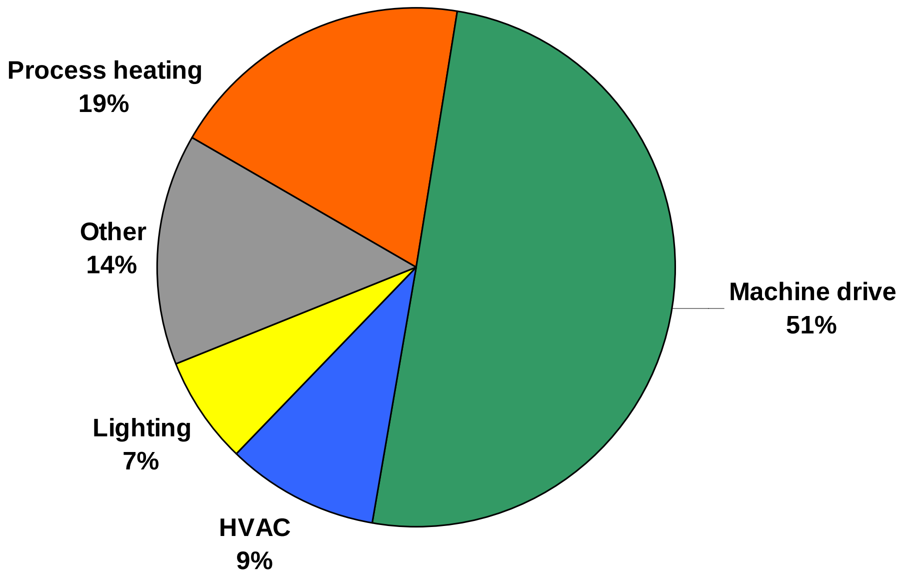
Source: 2008 Annual Energy Outlook Reference Case

Figure 3-6
2008 U.S. Commercial Intensity by Region

Industrial Sector

Annual electricity use in 2008 in the industrial sector is 964 TWh or 26% of the total across sectors. Figure 3-7 shows the breakout by end use.

- The largest industrial end use is machine drives, which consists of motors and air compressors. It accounts for 485 TWh, or 51% of total industrial use.
- Process heating is second largest at 185 TWh.
- Space heating, ventilation, and air conditioning together account for 89 TWh, or 9% of total use, while lighting accounts for 66 TWh (7%).



Source: 2008 Annual Energy Outlook Reference Case

Figure 3-7
2008 U.S. Industrial Electricity Use by End Use

Table 3-4 and Figure 3-8 present industrial electricity use by region and end use. The South is highest, with 444 TWh or almost half of the U.S. total. The variation in end-use shares of total use across regions does not vary significantly. Machine drives is the largest end use across regions and lighting is the smallest.

Table 3-4
2008 U.S. Industrial Electricity Use by Region and End Use (TWh)

	Northeast	Midwest	South	West	U.S.
2008 TWh					
Process Heating	19	58	85	23	**185**
Machine Drive	45	139	228	74	**485**
HVAC	11	24	39	15	**89**
Lighting	9	21	26	10	**66**
Other	13	35	65	25	**138**
Total	**97**	**278**	**444**	**146**	**964**
% of U.S. Total	10%	29%	46%	15%	100%
End Use Share of Region					
Process Heating	20%	21%	19%	16%	19%
Machine Drive	46%	50%	51%	50%	50%
HVAC	12%	9%	9%	10%	9%
Lighting	9%	8%	6%	7%	7%
Other	14%	13%	15%	17%	14%
Total	100%	100%	100%	100%	100%

Source: 2008 Annual Energy Outlook Reference Case

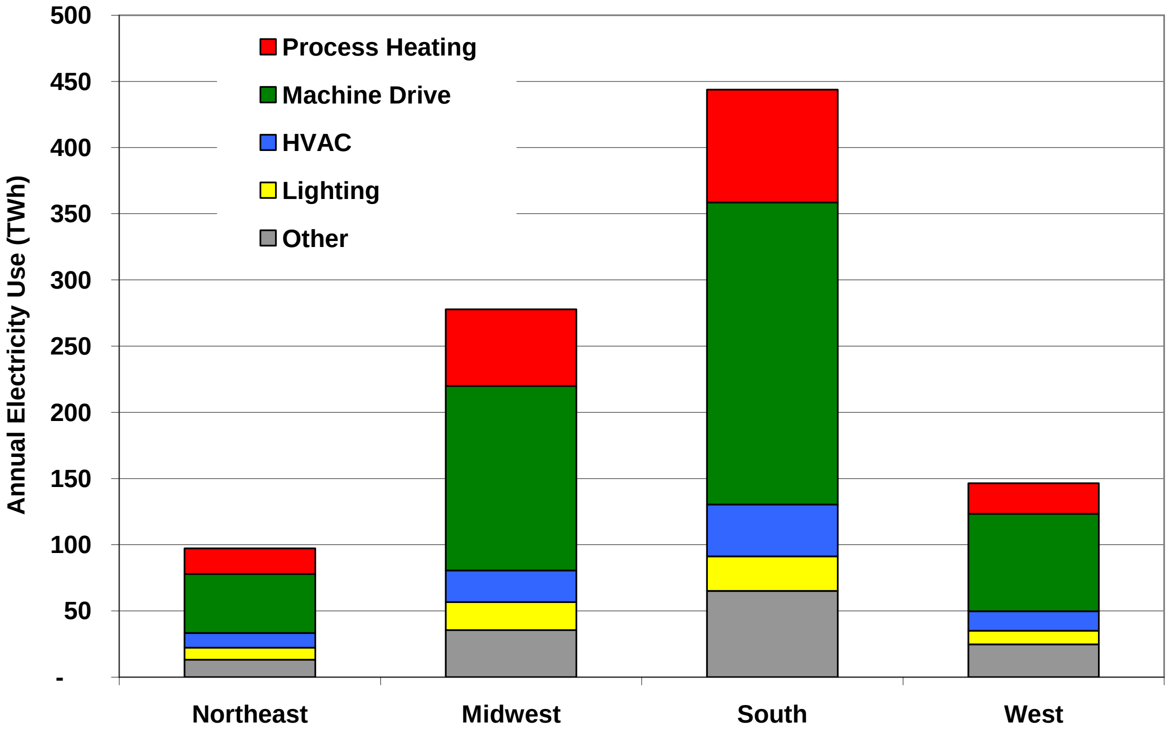


Figure 3-8
2008 U.S. Industrial Electricity Use by Region (TWh)

2008 Non-Coincident Summer Peak Demand

Non-coincident summer peak demand in the U.S. in 2008 is 801 GW. The pattern by region follows the allocation of annual energy (see Figure 3-9). The South is highest at 365 GW and the other regions are considerably lower, ranging between 109 GW and 187 GW.

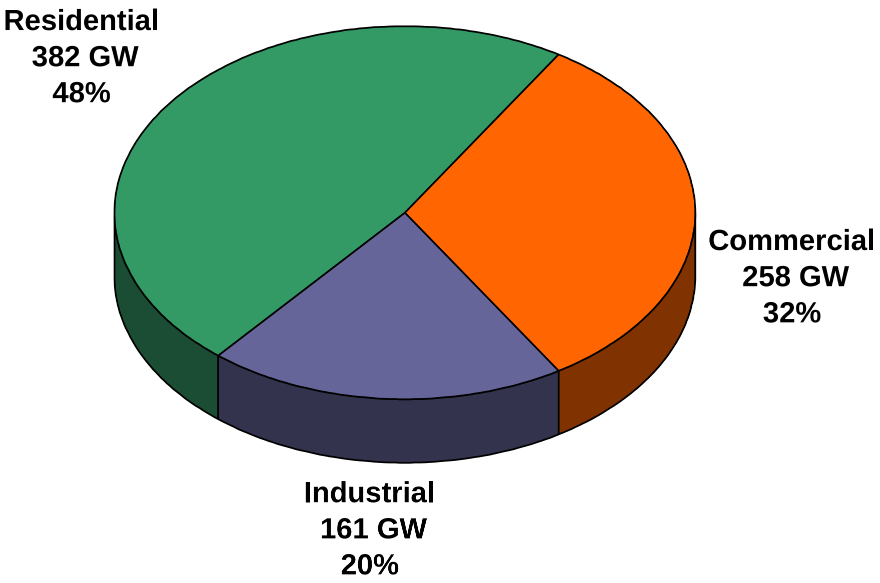


Figure 3-9
2008 Summer Peak Demand (GW)

Summer peak demand and load factors by region and sector are presented in Table 3-5. As expected, the residential sector has the lowest load factor across all regions. The industrial sector has the highest load factor in the South and the Midwest, while the commercial has the highest in the West and Northeast.

The breakdown by end use within sector for the U.S as a whole is shown in Figure 3-10. As expected, cooling is the largest single use in the residential and commercial sectors. In the residential sector, it accounts for more than half the summer peak. In the commercial sector, it accounts for 41%. In the commercial sector, lighting is the second highest peak use. In the industrial sector, machine drives have highest share of peak use. Additional discussion by sector is presented in the following sections.

Table 3-5
2008 Summer Peak Demand by Sector and Region (GW)

	Northeast	Midwest	South	West	U.S.
Peak Demand					
Residential	52	89	174	67	**382**
Commercial	35	62	116	45	**258**
Industrial	22	37	73	28	**161**
Total	**109**	**187**	**364**	**141**	**801**
Load Factors					
Residential	40%	38%	44%	42%	**42%**
Commercial	74%	53%	56%	67%	**60%**
Industrial	49%	87%	69%	59%	**68%**
Total	**53%**	**53%**	**53%**	**54%**	**53%**

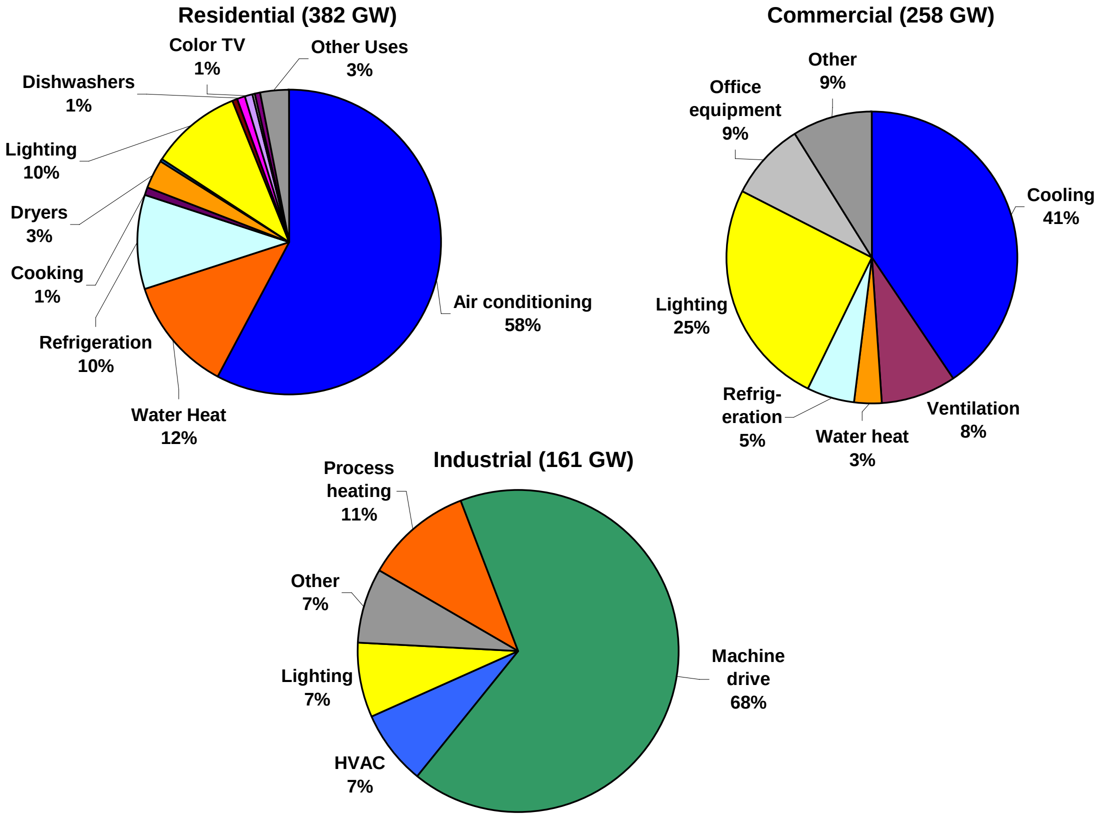


Figure 3-10
2008 Summer Peak Demand by Sector and End Use

The Residential Sector

For the residential sector, Table 3-6 and Figure 3-11 show the summer peak intensity in kW per household by end use and region. The peak intensity is highest in the South region at 4.19 kW per household. It is lowest in the Northeast and West regions.

- Across all regions, cooling is the dominant use during the summer peak, accounting for about 60% of the total.
- Water heating, while a small share of annual electricity use, commands a significant share of peak at 12% of the total.
- Lighting and refrigerators tie for third place, at about 10% of the total.
- Home electronics and other uses, although a substantial part of annual electricity use, contribute negligibly to the summer peak.

With the large contributions that air conditioning and water heating make to the summer peak, it is little wonder that these two end uses are the primary targets for direct load control programs.

Table 3-6
2008 Residential Summer Peak Demand by Region and End Use (kW/household)

	Northeast	Midwest	South	West	U.S.
Space Heat	0.00	0.00	0.00	0.00	0.00
Air Conditioning	1.43	2.04	2.42	1.47	1.95
Furnace Fans	0.01	0.02	0.03	0.02	0.02
Water Heating	0.31	0.44	0.52	0.32	0.42
Refrigerators	0.24	0.35	0.41	0.25	0.33
Freezers	0.01	0.01	0.01	0.01	0.01
Dishwashers	0.02	0.03	0.04	0.02	0.03
Cooking	0.03	0.04	0.04	0.03	0.03
Clothes Washers	0.01	0.01	0.02	0.01	0.01
Clothes Dryers	0.07	0.10	0.12	0.07	0.10
Lighting	0.25	0.35	0.42	0.25	0.34
Personal Computers	0.01	0.01	0.01	0.01	0.01
Color TV	0.02	0.03	0.04	0.02	0.03
Other Uses	0.07	0.11	0.13	0.08	0.10
Total	**2.48**	**3.54**	**4.19**	**2.54**	**3.38**

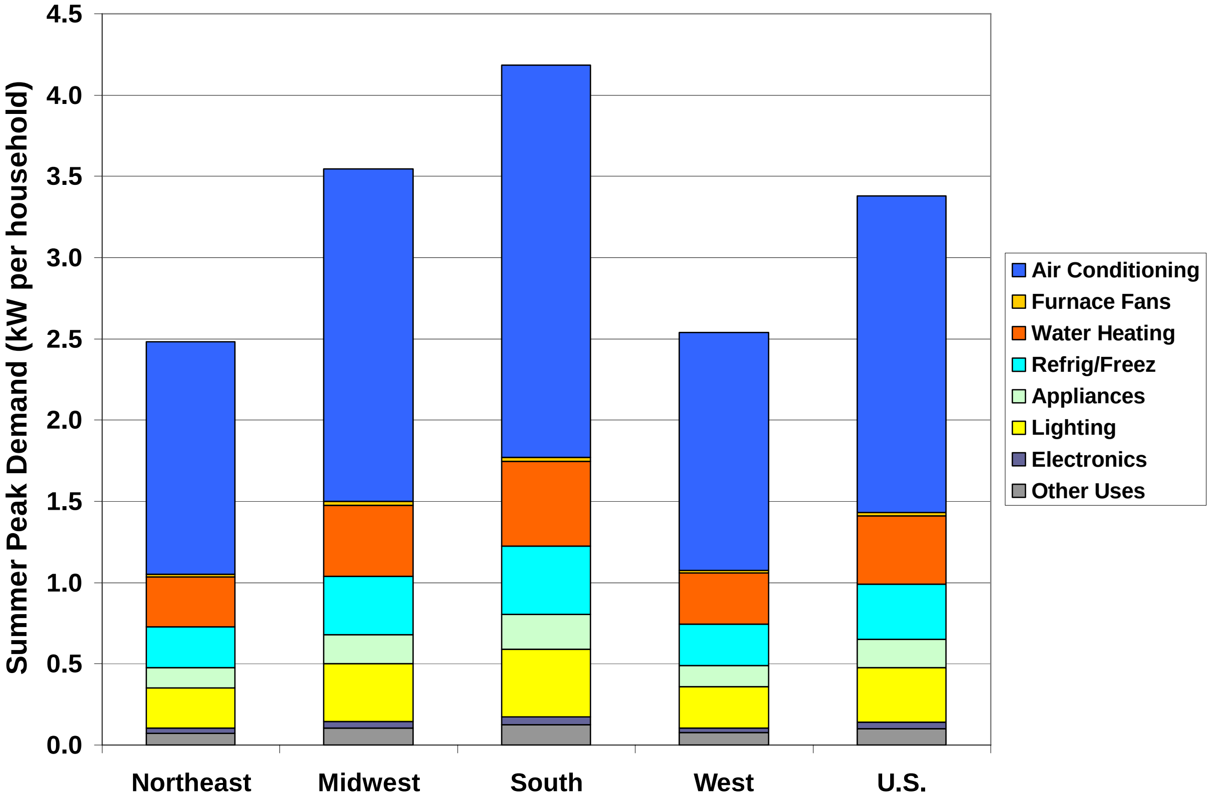


Figure 3-11
2008 Residential Summer Peak Demand per Household by Region

The Commercial Sector

Across all commercial segments for the U.S. as a whole, the commercial summer peak is 3.3 Watts per square foot (averaged across all commercial floor space)

Table 3-7 and Figure 3-12 show commercial summer peak demand by region and end use. Summer peak in the South is higher than all other regions at nearly 4 Watts per square foot. Cooling accounts for most of the difference. The summer peak is lowest in the Northeast at only 2.3 Watts per square foot.

As with the residential sector, cooling is the dominant contributor to the summer peak across all regions, accounting for 40% of the total. Lighting is the second largest, with one fourth of the total summer peak. The remaining end uses contribute less than 10% each to the summer peak.

Table 3-7
2008 Commercial Summer Peak Demand Intensity by Region and End Use (Watts/ft.^{2})

	Northeast	Midwest	South	West	U.S.
Space Heat	0.00	0.00	0.00	0.00	0.00
Cooling	0.93	1.27	1.62	1.32	1.34
Ventilation	0.19	0.26	0.33	0.27	0.28
Water Heat	0.07	0.10	0.12	0.10	0.10
Refrigeration	0.11	0.16	0.20	0.16	0.17
Lighting	0.58	0.79	1.01	0.83	0.84
Office Equipment	0.20	0.27	0.35	0.28	0.29
Other	0.20	0.27	0.35	0.28	0.29
Total	**2.29**	**3.13**	**3.98**	**3.25**	**3.30**

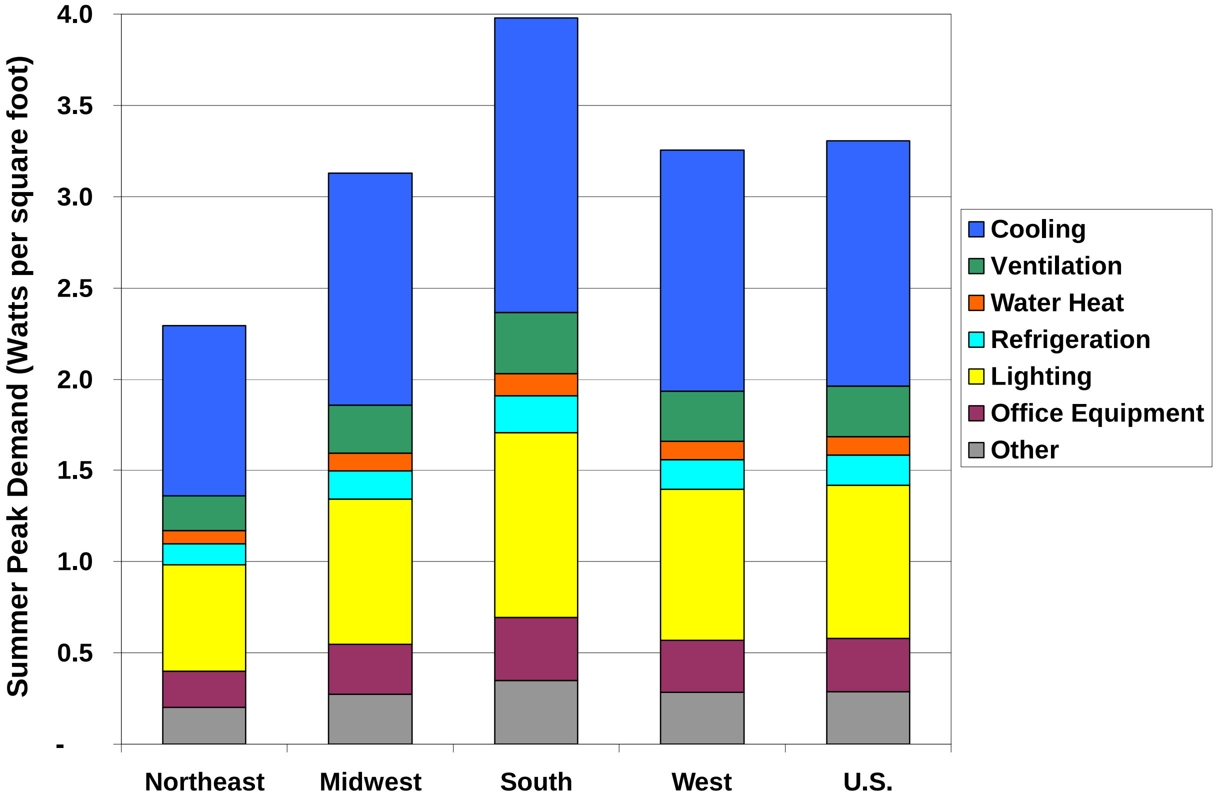


Figure 3-12
2008 Commercial Summer Peak Demand Intensity by Region

The Industrial Sector

Table 3-8 and Figure 3-13 show industrial summer peak demand by region and end use. As with annual electricity use, machine drives (motors) contribute most to the summer peak across all regions. HVAC, predominantly cooling during the summer peak, contributes the smallest amount.

Table 3-8
2008 Industrial Summer Peak Demand by Region and End Use (MW)

	Northeast	Midwest	South	West	U.S.
Process Heating	2,405	3,921	7,872	3,049	17,246
Machine Drive	14,987	24,434	49,054	18,998	107,473
HVAC	1,675	2,731	5,483	2,123	12,012
Lighting	1,675	2,731	5,483	2,123	12,012
Other	1,675	2,731	5,483	2,123	12,012
Total	**22,417**	**36,548**	**73,374**	**28,416**	**160,755**

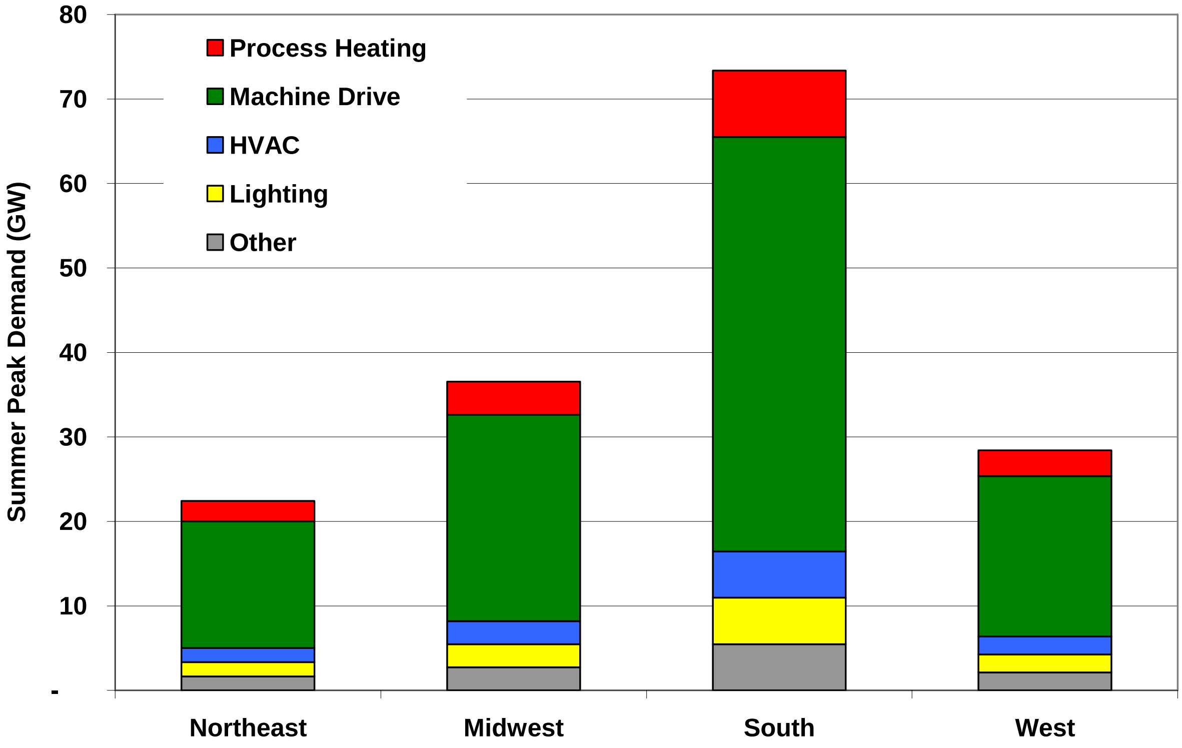


Figure 3-13
2008 Industrial Summer Peak Demand by Region (GW)

The Baseline Forecast

As with base-year electricity use, the baseline forecast has two components: the annual electricity load forecast and the summer peak demand forecast. This section presents the forecast results.

Forecast of Annual Electricity Use

In the baseline load forecast, electricity use increases from 3,717 TWh in 2008 to 4,858 TWh, an increase of 1,141 TWh or 31% over the 2008 level. The average growth rate for the forecast period is 1.2%, which is considerably lower than in the pre oil-embargo (pre-1973) rate of 7.8% and the post oil-embargo time periods of 2.3%. The baseline forecast is shown in the context of historical use in Figure 3-14.

The baseline forecast incorporates market-driven efficiency improvements and the impacts of all current federal appliance standards and building codes (such as those specified in the Energy Independence and Security Act of 2007) and rulemaking procedures. The baseline electricity fore cast represents the 2008 Annual Energy Outlook adjusted to reflect an estimate of embedded energy-efficiency savings from utility programs beyond 2008.

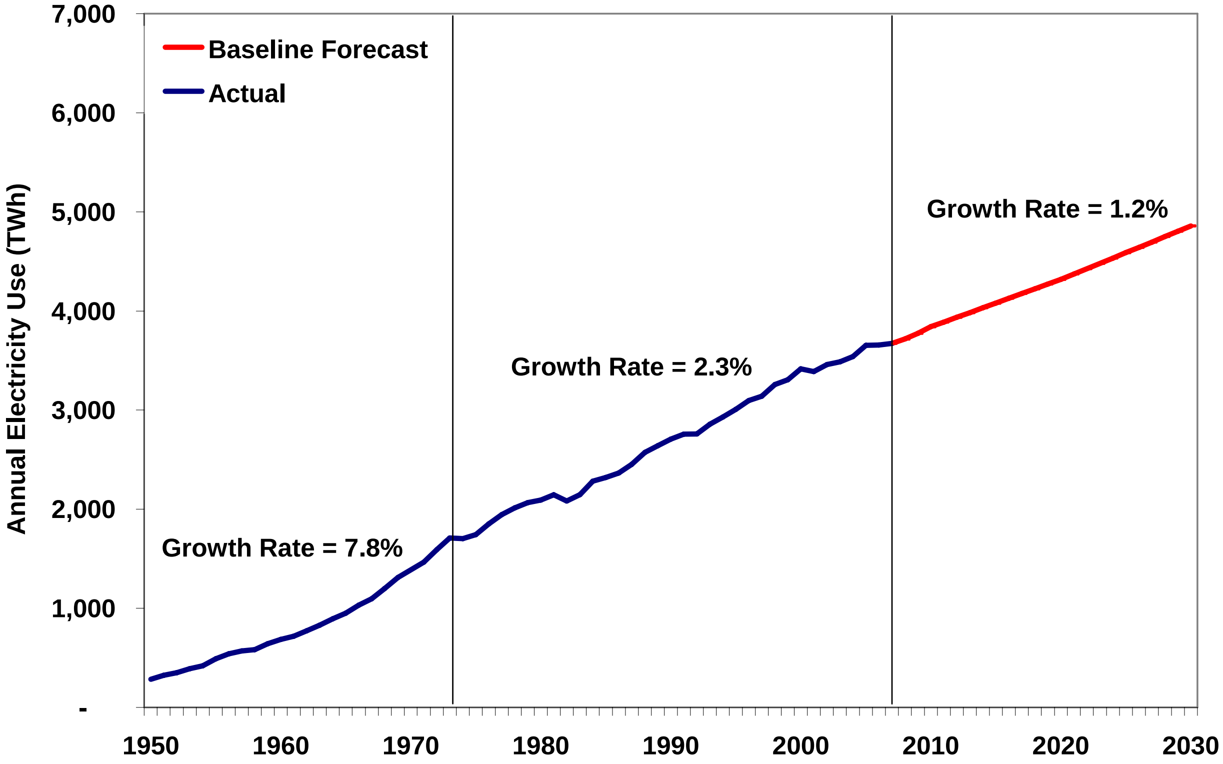


Figure 3-14
U.S. Electricity History and Forecast (TWh)

The four regions grow at different rates, as shown in Table 3-9and Figure 3-15. The West and South, the "sunbelt" regions, grow at the fastest rate, an average rate of 1.5% per year. The Midwest and Northeast grow the slowest.

Table 3-9
U.S. Electricity Forecast by Region (TWh)

	2008	2010	2020	2030	% Increase (2030/2008)	Average Growth Rate
Northeast	507	514	550	591	17%	0.7%
Midwest	864	885	943	1,010	17%	0.7%
South	1,683	1,747	2,027	2,336	39%	1.5%
West	664	694	798	921	39%	1.5%
Total	**3,719**	**3,841**	**4,319**	**4,858**	**31%**	**1.2%**

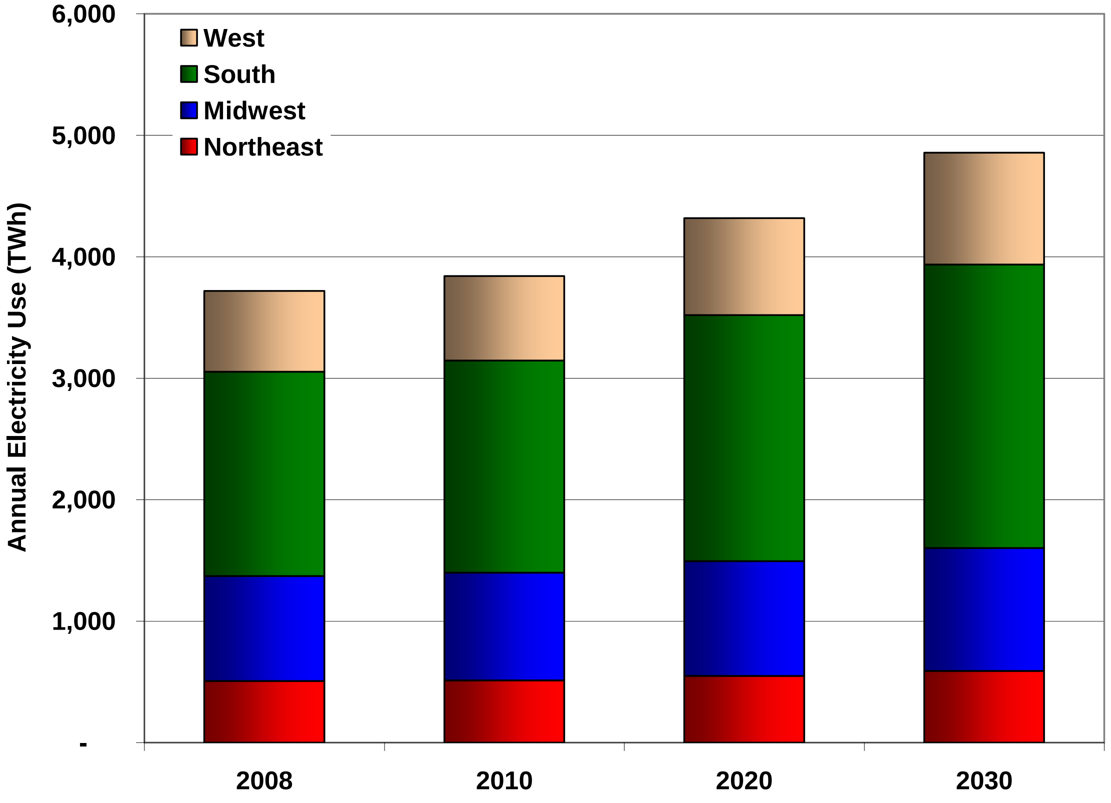


Figure 3-15
U.S. Electricity Forecast by Region (TWh)

Table 3-10 and Figure 3-16 summarize the U.S. electricity forecast for each sector. The commercial sector is the fastest growing. Annual electricity use increases from 1,350, to 2,033 TWh, an increase of 51%. The residential sector grows at an average annual rate of 1.1%, slightly less than the total forecast rate of 1.2. Additional discussion by sector is provided in the following sections.

Table 3-10
U.S. Electricity Forecast by Sector (TWh)

	2008	2010	2020	2030	% Increase (2030/2008)	Average Growth Rate
Residential	1,403	1,454	1,574	1,787	27%	1.1%
Commercial	1,350	1,395	1,710	2,033	51%	1.9%
Industrial	964	992	1,035	1,038	8%	0.3%
Total	**3,717**	**3,841**	**4,319**	**4,858**	**31%**	**1.2%**

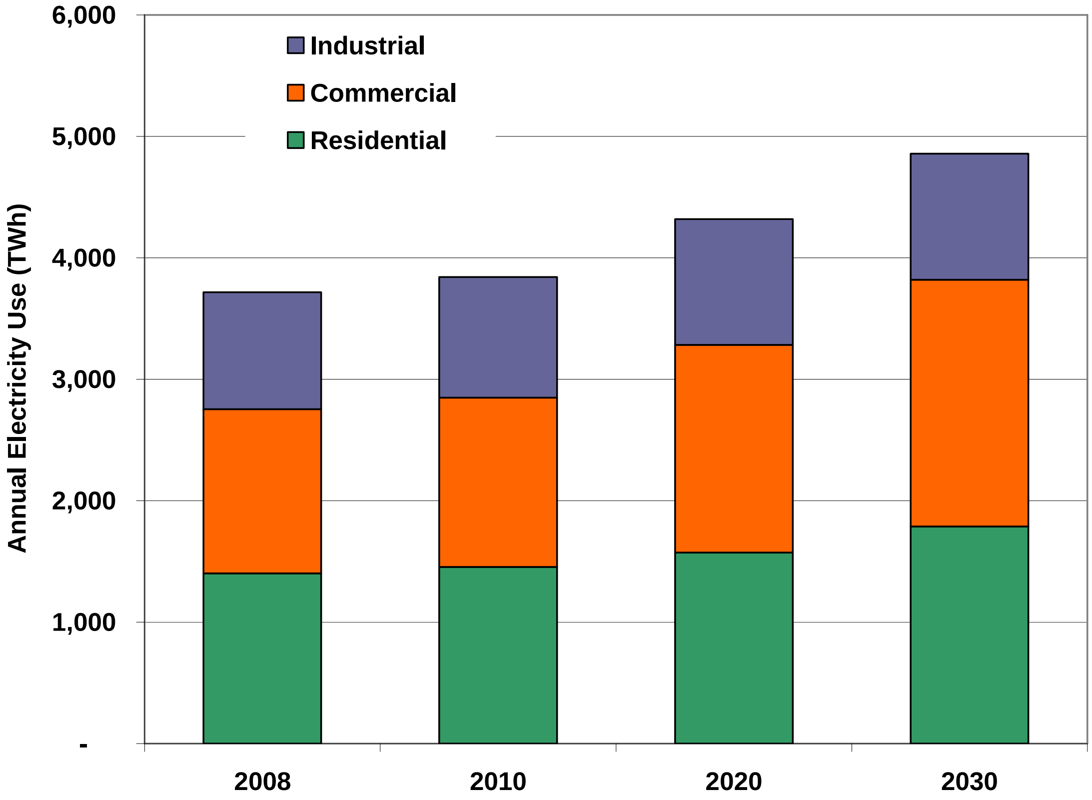


Figure 3-16
U.S. Electricity Forecast by Sector (TWh)

The Residential Sector

Residential electricity use increases by 384 TWh, or 27%, between 2008 and 2010. The annual growth rate of 1.1% is slightly larger than the rate of population growth (0.8%).

Figure 3-17 and Table 3-11 present the forecast by end use.

- In absolute terms, other uses increase the most, by 181 TWh, which is slightly less than cooling or lighting use in 2008. This represents a 57% increase over 2008.
- Air conditioning use increases by 107 TWh, a 46% increase over 2008. This reflects increasing saturation of air conditioners and home size despite the offsetting impacts of appliance standards.
- Growth in personal computing is fastest at 3.3% per year, which leads to a doubling of use between 2030 and 2008.
- Lighting use decreases by 31% over the forecast period, reflecting impact of the EISA legislation.

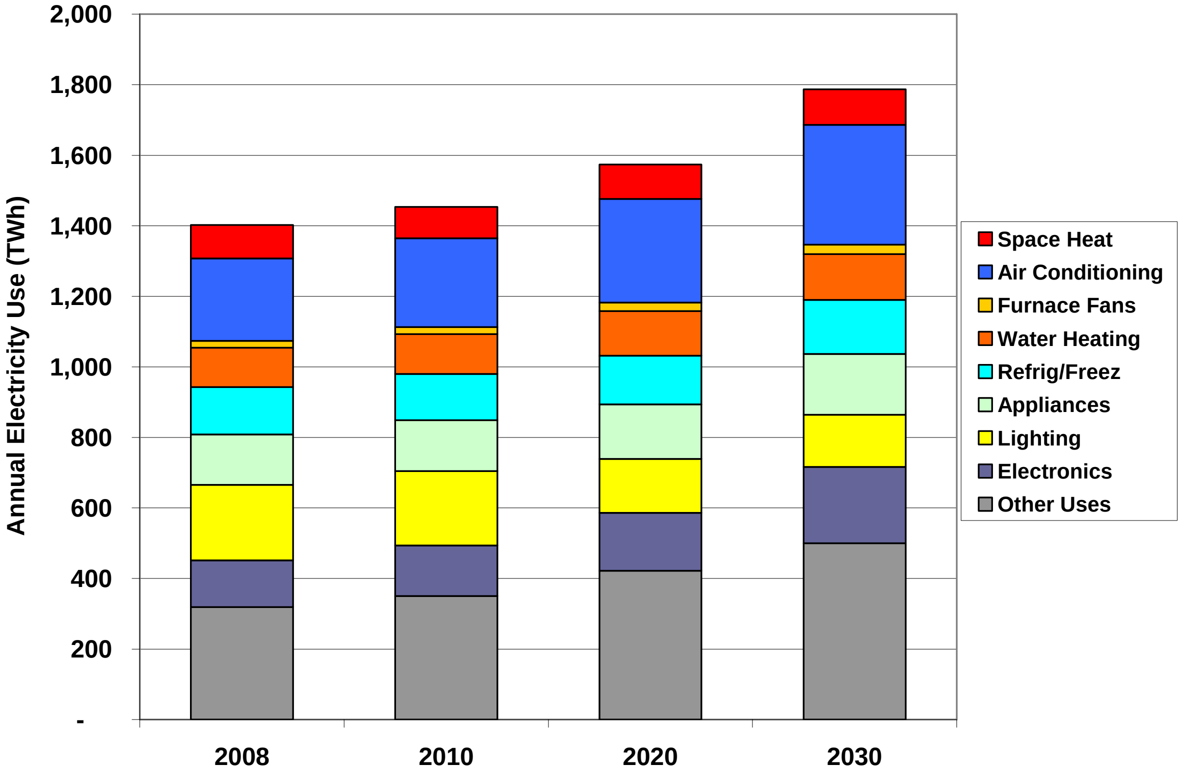


Figure 3-17
U.S. Residential Electricity Forecast (TWh)

Table 3-11
U.S. Residential Electricity Forecast by End Use (GWh)

	2008	2010	2020	2030	% Increase (2030/2008)	Average Growth Rate
Space Heat	95,586	89,212	97,007	100,599	5%	0.2%
Air Conditioning	233,372	251,357	294,732	340,326	46%	1.7%
Furnace Fans	19,219	20,304	23,679	26,203	36%	1.4%
Water Heating	111,661	112,721	126,625	130,450	17%	0.7%
Refrigerators	110,451	107,936	110,056	118,955	8%	0.3%
Freezers	23,827	23,766	27,485	33,988	43%	1.6%
Dishwashers	27,428	27,183	28,699	32,286	18%	0.7%
Cooking	31,017	31,820	37,408	42,212	36%	1.4%
Clothes Washers	9,994	9,645	8,036	8,306	-17%	-0.8%
Clothes Dryers	74,337	74,702	81,024	89,726	21%	0.9%
Lighting	214,205	211,220	152,381	147,992	-31%	-1.7%
Personal Computers	23,094	27,989	36,404	47,816	107%	3.3%
Color TV	109,238	115,247	128,111	168,074	54%	2.0%
Other Uses	319,205	350,581	421,978	500,294	57%	2.0%
Total	**1,402,634**	**1,453,685**	**1,573,622**	**1,787,225**	**27%**	**1.1%**

Residential Electric Intensity

Over the forecast horizon, electricity use per household does not change significantly. Figure 3-18 and Table 3-12 present use per household by end use for the forecast period. These exhibits present share-weighted usage estimates across all residential dwellings, which are the product of appliance saturation (and electric fuel share) and unit energy consumption (UEC).

- Personal computers, color TVs, and other uses grow at the fastest rate. This is driven by an increase in the number of units per household, as well as a trend of increased performance requirement (i.e. higher-powered processors and larger displays).
- Air conditioning use per household increases by 17%. This reflects the continuing increase in air conditioner saturation across all housing stock and average home size, driven by the trend toward larger homes in new construction. Offsetting these two factors that drive up air conditioning use is the increasing efficiency of air conditioning equipment, both central systems and room air conditioners, which are subject to Federal appliance standards.

- Lighting use per household declines slightly between 2008 and 2010 and then drops dramatically between 2010 and 2020 to almost half the use in 2008. The increase in home size, which results in higher lighting usage (just as with air conditioning), is more than offset by Federal standards resulting from EISA that require higher efficacy (lumens per Watt) for residential lighting systems.
- Use per household decreases for space heating, refrigerators, and clothes washers, reflecting efficiency gains from appliance standards.

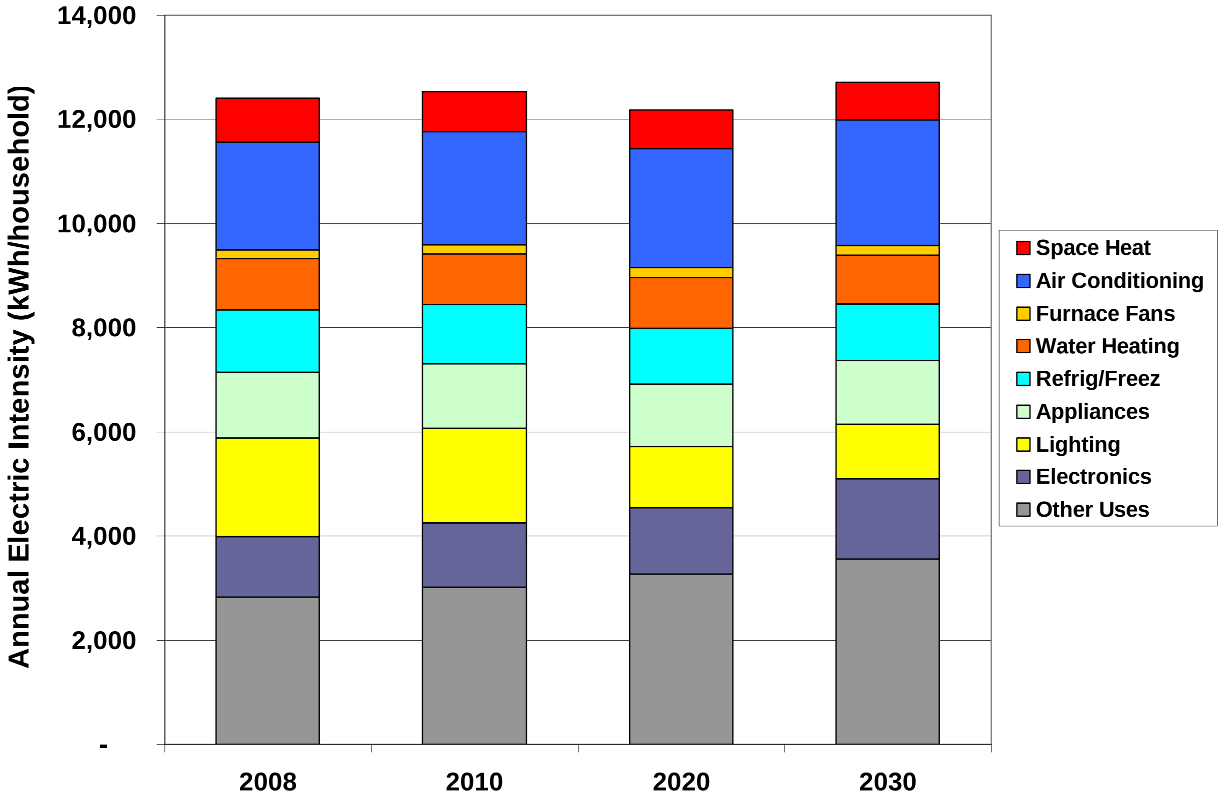


Figure 3-18
Forecast of U.S. Residential Electricity Use per Household

Table 3-12
U.S. Residential Electric Intensity Forecast by End Use (kWh/household)

	2008	2010	2020	2030	% Increase (2030/2008)	Average Growth Rate
Space Heat	845	769	751	716	-15%	-0.8%
Air Conditioning	2,064	2,167	2,282	2,421	17%	0.7%
Furnace Fans	170	175	183	186	10%	0.4%
Water Heating	988	972	980	928	-6%	-0.3%
Refrigerators	977	930	852	846	-13%	-0.7%
Freezers	211	205	213	242	15%	0.6%
Dishwashers	243	234	222	230	-5%	-0.2%
Cooking	274	274	290	300	9%	0.4%
Clothes Washers	88	83	62	59	-33%	-1.8%
Clothes Dryers	658	644	627	638	-3%	-0.1%
Lighting	1,895	1,821	1,180	1,053	-44%	-2.7%
Personal Computers	204	241	282	340	67%	2.3%
Color TV	966	993	992	1,196	24%	1.0%
Other Uses	2,823	3,022	3,267	3,559	26%	1.1%
Total	**12,407**	**12,531**	**12,184**	**12,713**	**2%**	**0.1%**

The Commercial Sector

Annual electricity use in the commercial sector increases from 1,350 TWh in 2008 to 2,033 TWh in 2030. This 51% increase implies an average growth rate of 1.9%. This exceeds the growth in employment (0.9% per year) and commercial floor stock (1.2% per year) over the forecast horizon.

Table 3-13 and Figure 3-19 present the commercial sector forecast by end use.

- Office equipment and other end use grow the fastest, almost doubling over the forecast horizon.
- The other end use increases by 371 TWh, which is more than the lighting use in 2008.
- Cooling, ventilation, refrigeration and lighting all increase substantially in absolute terms.

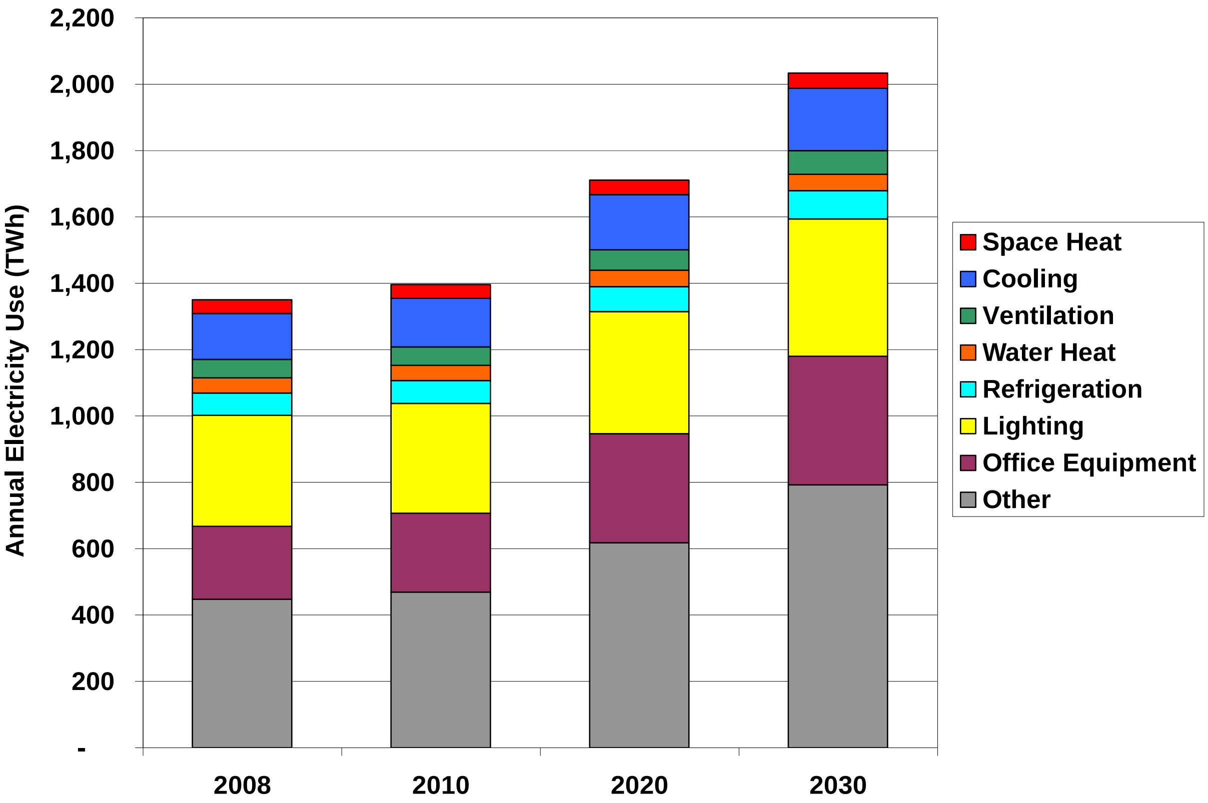


Figure 3-19
U.S. Commercial Sector Electricity Forecast (TWh)

Table 3-13
U.S. Commercial Sector Electricity Forecast by End Use (GWh)

	2008	2010	2020	2030	% Increase (2030/2008)	Average Growth Rate
Space Heat	42,451	40,671	43,203	45,528	7%	0.3%
Cooling	137,182	146,578	165,069	187,822	37%	1.4%
Ventilation	55,426	55,992	63,071	70,981	28%	1.1%
Water Heat	45,725	45,201	48,352	49,677	9%	0.4%
Refrigeration	68,086	68,965	76,176	85,823	26%	1.1%
Lighting	333,500	330,590	367,265	412,710	24%	1.0%
Office Equipment	220,305	237,646	329,328	389,320	77%	2.6%
Other	447,709	469,759	617,659	791,100	77%	2.6%
Total	**1,350,385**	**1,395,401**	**1,710,122**	**2,032,961**	**51%**	**1.9%**

Commercial Electric Intensity

Figure 3-20 and Table 3-14 present the intensity forecast by end use. These exhibits present share-weighted usage estimates across all commercial segments and floor space, which are the product of end-use saturation (and electric fuel share) and energy-use intensity (EUI).

Electricity intensity in kWh per square foot also increases over the forecast horizon, but only by 9% between 2008 and 2030. This implies an average growth rate of 0.4%. During the forecast period, there is considerable variation in end-use growth:

- Office equipment and "other" intensity each increase by 28%.
- Space heating and water heating intensity each fall by more than 20%, primarily reflecting increased equipment efficiency over the forecast horizon.
- Lighting use decreases by 11%, reflecting the equipment standards resulting from EISA.
- Cooling use holds steady at about 1.8 kWh per square foot per year. This reflects the offsetting trends in increased cooling saturation and improvements in equipment efficiency and building shell.

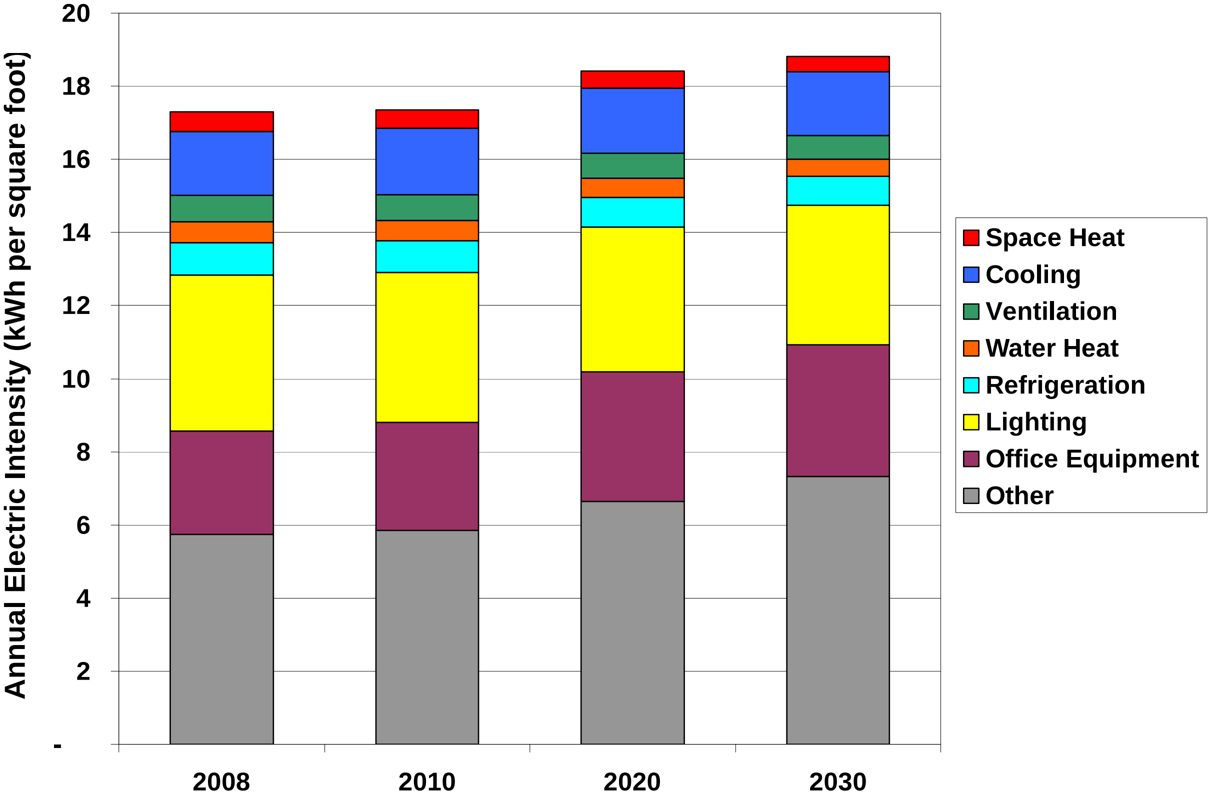


Figure 3-20
Forecast of U.S. Commercial Sector Electric Intensity

Table 3-14
Forecast of U.S. Commercial Sector Electric Intensity (kWh per square foot)

	2008	2010	2020	2030	% Increase (2030/2008)	Average Growth Rate
Space Heat	0.5	0.5	0.5	0.4	-23%	-1.2%
Cooling	1.8	1.8	1.8	1.7	-1%	-0.1%
Ventilation	0.7	0.7	0.7	0.7	-8%	-0.4%
Water Heat	0.6	0.6	0.5	0.5	-22%	-1.1%
Refrigeration	0.9	0.9	0.8	0.8	-9%	-0.4%
Lighting	4.3	4.1	4.0	3.8	-11%	-0.5%
Office Equipment	2.8	3.0	3.5	3.6	28%	1.1%
Other	5.7	5.8	6.6	7.3	28%	1.1%
Total	**17.3**	**17.4**	**18.4**	**18.8**	**9%**	**0.4%**

Industrial Sector

Electricity use in the industrial sector increases modestly between 2008 and 2030; the 8% increase of 74 TWh represents an average growth rate of 0.3%. The increase by industrial end use, shown in Table 3-15 and Figure 3-21, is fairly consistent and ranges between 6% and 9%.

Table 3-15
U.S. Industrial Sector Electricity Forecast by End Use (GWh)

	2008	2010	2020	2030	% Increase (2030/2008)	Average Growth Rate
Process Heating	185,139	190,376	198,226	198,229	7%	0.3%
Machine Drive	485,302	499,350	521,709	523,702	8%	0.3%
HVAC	89,056	91,610	95,578	95,792	8%	0.3%
Lighting	66,201	68,036	70,632	70,390	6%	0.3%
Other	138,330	142,402	149,147	150,130	9%	0.4%
Total	**964,028**	**991,774**	**1,035,292**	**1,038,243**	**8%**	**0.3%**

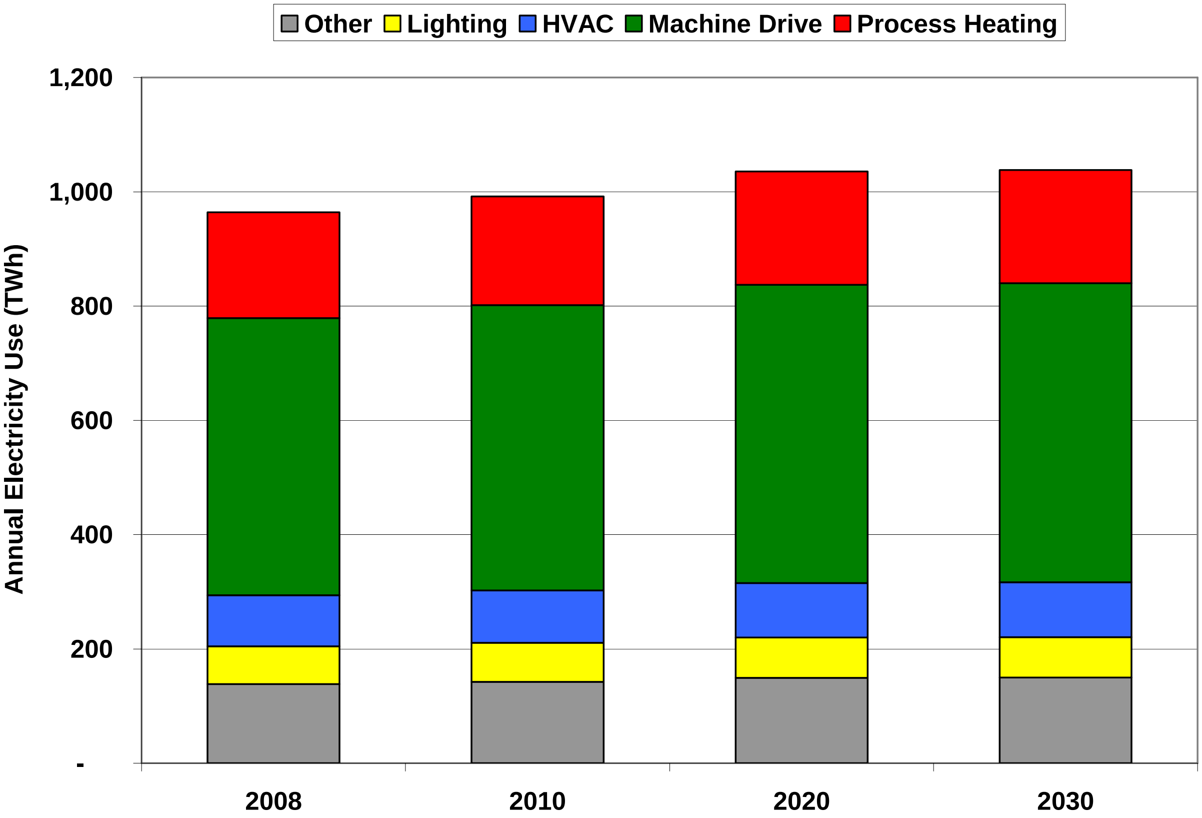


Figure 3-21
U.S. Industrial Sector Electricity Forecast (TWh)

Non-Coincident Summer Peak Demand Forecast

U.S. summer peak demand is projected to grow from 801 GW in 2008 to 1,117 GW in 2030, as illustrated in Figure 3-22, which represents an increase of 316 GW, or 39%. The growth rate in the forecast period is 1.5%, which is considerably lower than the forecast over the previous 20-year period.

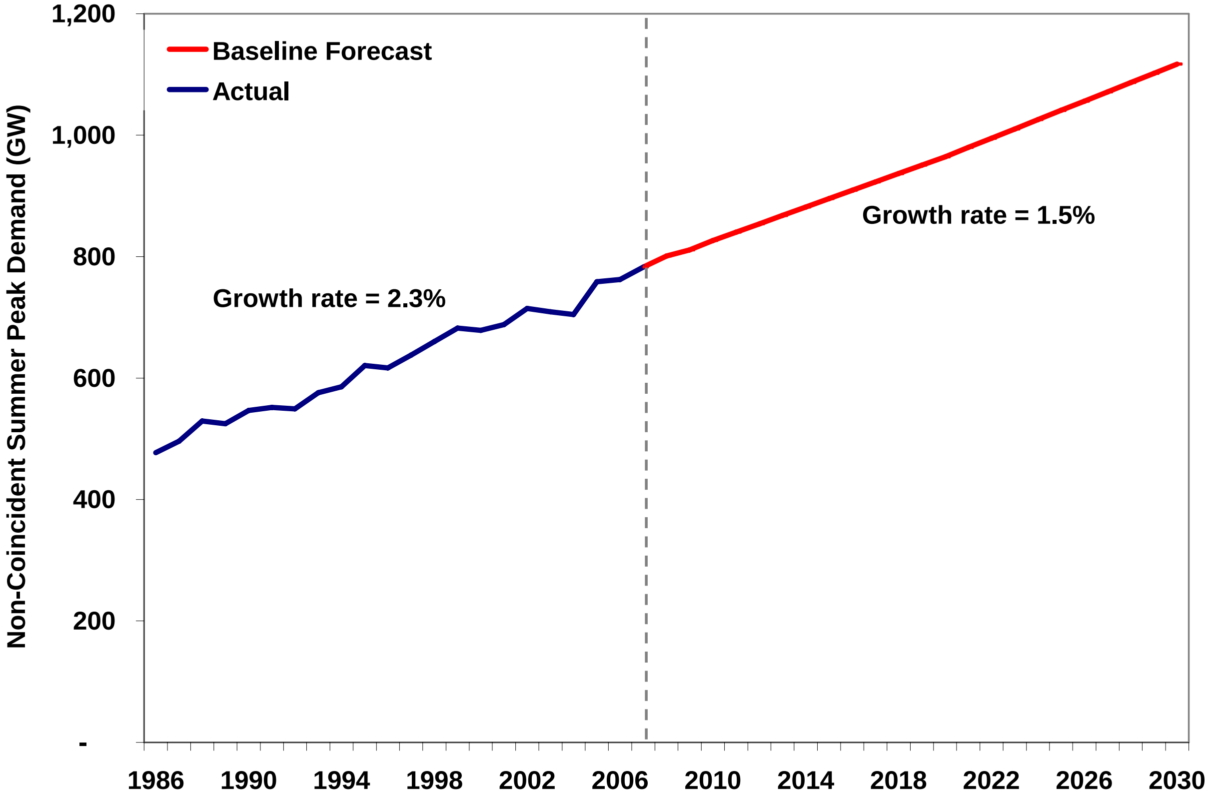


Figure 3-22
U.S. Summer Peak Demand History and Forecast (GW)

The U.S. summer peak demand forecast by region is shown in Table 3-16 and Figure 3-23. The summer peak demand in the West increases the most, by 52% between 2008 and 2030. The growth in summer peak demand is slowest for the Midwest, at an annual rate of 1.16 over the forecast horizon. The system load factor decreases during the forecast period across all sectors (see Table 3-16) as a result of increasing air conditioning penetration.

Table 3-16
Forecast of U.S. Summer Peak Demand by Region (GW)

	2008	2010	2020	2030	% Increase (2030/2008)	Average Growth Rate
Peak Demand (GW)						
Northeast	109	113	128	143	31%	1.22%
Midwest	187	192	216	242	29%	1.16%
South	364	374	442	519	43%	1.62%
West	141	146	178	214	52%	1.90%
Total	**801**	**826**	**964**	**1,117**	**39%**	**1.51%**
Load Factors						
Northeast	53%	52%	49%	47%		
Midwest	53%	53%	50%	48%		
South	53%	53%	52%	51%		
West	54%	54%	51%	49%		
Total	**53%**	**53%**	**51%**	**50%**		

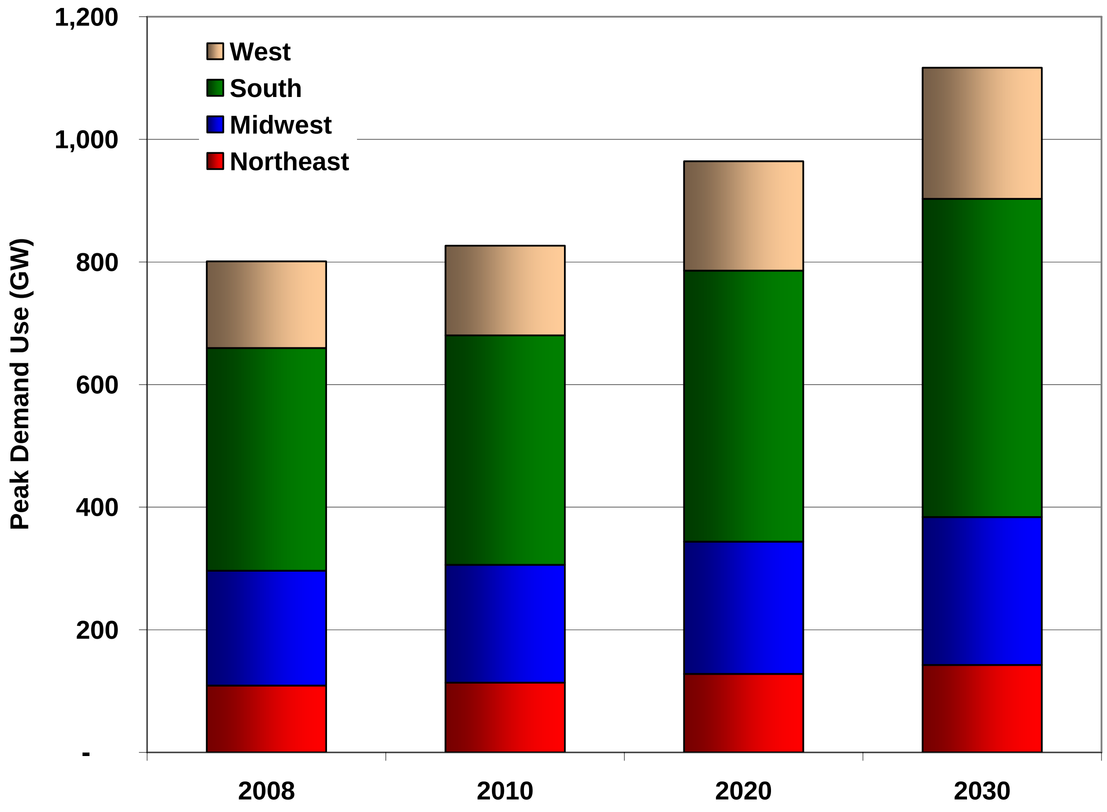


Figure 3-23
Forecast of U.S. Summer Peak Demand by Region (GW)

The U.S. summer peak demand forecast grows at roughly the same rate across sectors (see Table 3-17 and Figure 3-24). In absolute terms, the residential sector peak increases the most, by 154 GW, reflecting increases in air conditioner saturation and average home size. The commercial sector summer peak increases by 101 GW, also reflecting the increase in cooling saturation. The 38% increase in the industrial sector summer peak is only 61 GW.

Table 3-17
U.S. Summer Peak Demand Forecast (GW)

	2008	2010	2020	2030	% Increase (2030/2008)	Average Growth Rate
Residential	382	394	462	536	40%	1.54%
Commercial	258	266	310	359	39%	1.50%
Industrial	161	166	192	222	38%	1.48%
Total	**801**	**826**	**964**	**1,117**	**39%**	**1.51%**

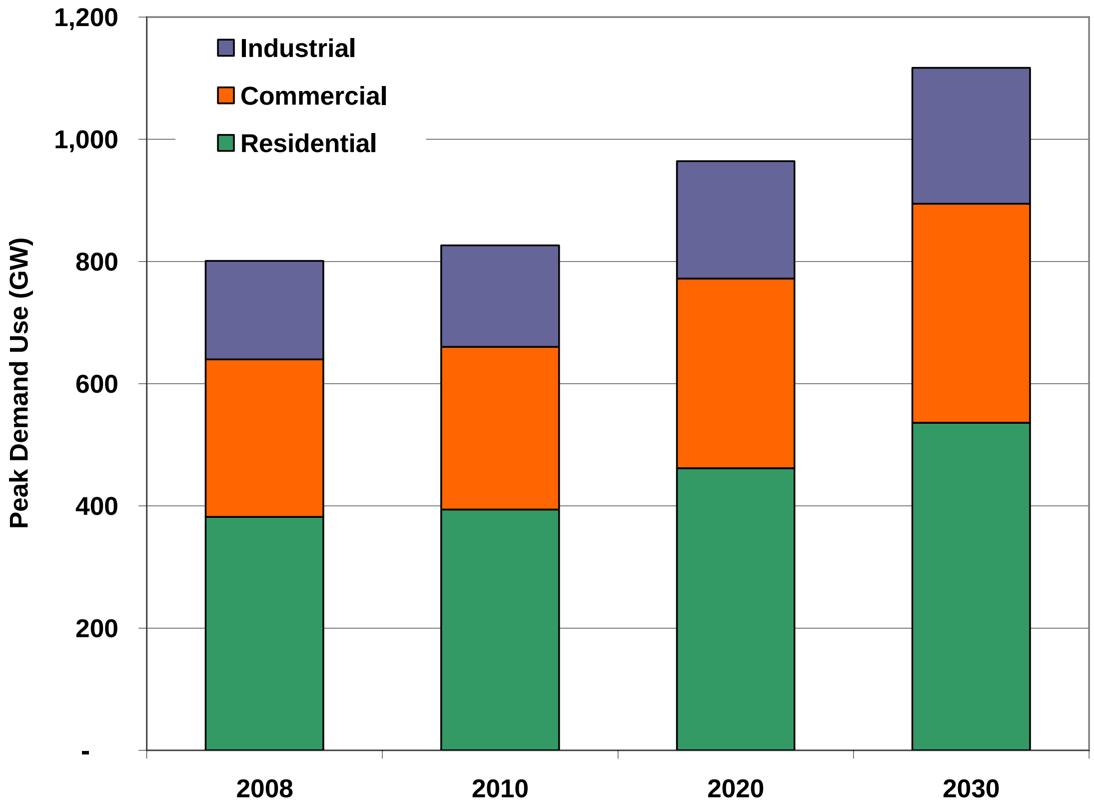


Figure 3-24
Forecast of U.S. Summer Peak Demand by Sector (GW)

Residential Summer Peak Demand Forecast

The residential summer peak demand forecast grows by 40%, a 154 GW increase from 382 GW in 2008 to 536 GW in 2030. Air conditioning accounts for 89 GW of the increase, or almost 60%. All other end uses grow proportionately to the summer peak in 2008. Figure 3-25 and Table 3-18 show the residential summer peak forecast by end use.

Table 3-18
Forecast of U.S. Residential Summer Peak Demand by End Use (MW)

	2008	2010	2020	2030
Space Heat	0	0	0	0
Air Conditioning	220,528	227,393	266,398	309,285
Furnace Fans	2,307	2,379	2,787	3,235
Water Heating	47,381	48,856	57,237	66,451
Refrigerators	37,437	38,602	45,224	52,505
Freezers	1,073	1,107	1,296	1,505
Dishwashers	3,363	3,468	4,062	4,717
Cooking	3,937	4,059	4,756	5,521
Clothes Washers	1,396	1,439	1,686	1,958
Clothes Dryers	10,812	11,149	13,061	15,164
Lighting	38,022	39,206	45,931	53,325
Personal Computers	866	893	1,046	1,214
Color TV	3,565	3,675	4,306	4,999
Other Uses	11,484	11,841	13,872	16,106
Total	**382,170**	**394,067**	**461,662**	**535,985**

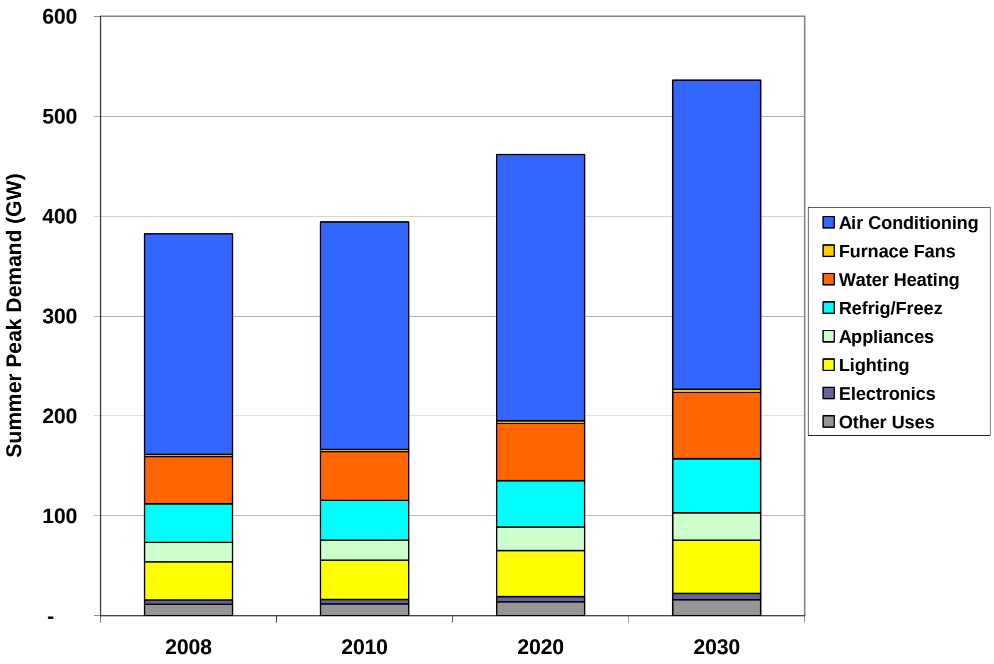


Figure 3-25
Forecast of Residential Sector Summer Peak Demand by End Use (GW)

Commercial Sector Summer Peak Demand Forecast

In the commercial sector, cooling accounts for the largest share of the growth in the summer peak as well. Cooling increases by 41 GW, or 41%, of the 99 GW increase in the commercial summer peak. Lighting accounts for 26 GW of the total increase. Figure 3-26 and Table 3-19 show the summer peak demand forecast for the commercial sector.

Table 3-19
Forecast of U.S. Commercial Summer Peak Demand by End Use (MW)

	2008	2010	2020	2030
Space Heat	0	0	0	0
Cooling	104,678	108,113	125,991	145,573
Ventilation	21,671	22,382	26,084	30,138
Water Heat	7,953	8,214	9,572	11,060
Refrigeration	12,923	13,347	15,554	17,972
Lighting	65,511	67,660	78,849	91,104
Office Equipment	22,566	23,306	27,161	31,382
Other	22,566	23,306	27,161	31,382
Total	**257,867**	**266,329**	**310,372**	**358,609**

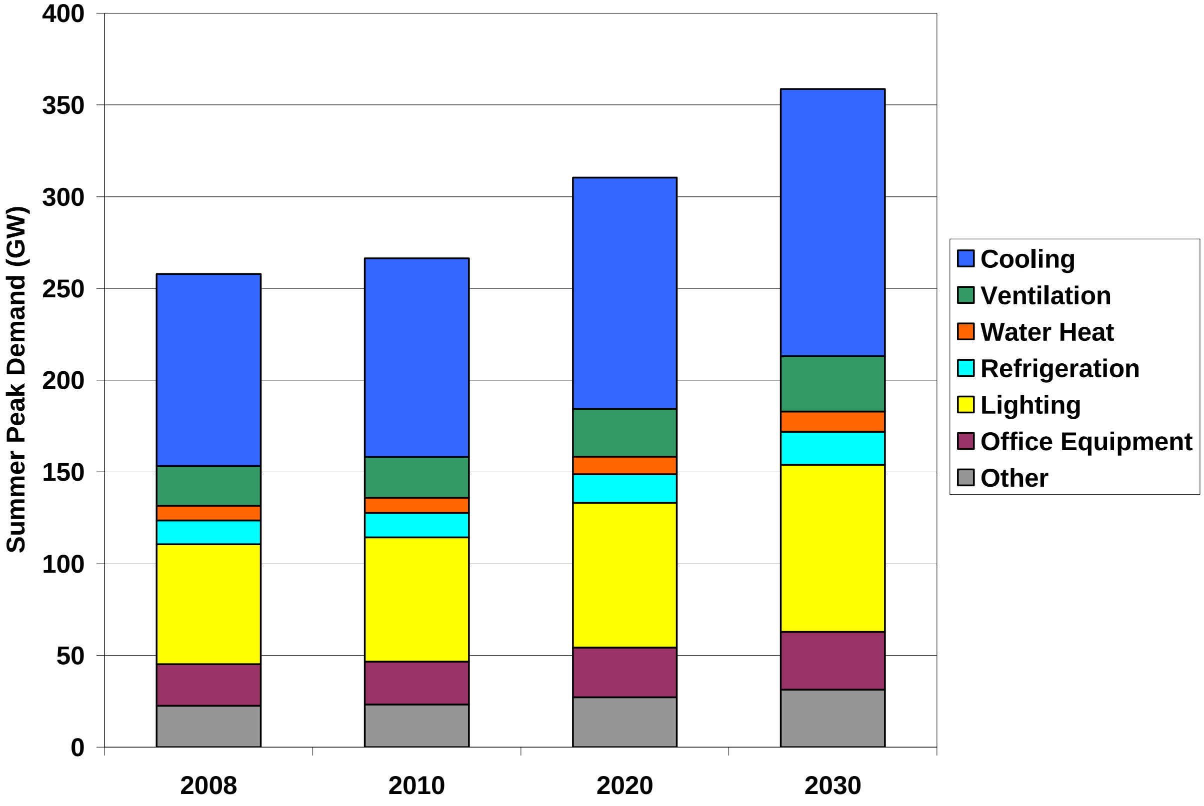


Figure 3-26
Forecast of Commercial Sector Summer Peak Demand by End Use (GW)

Industrial Sector Summer Peak Demand Forecast

In the industrial sector, machine drive is the end use that contributes most to peak demand, and this end use increases the most in absolute terms during the forecast period. The end use whose contribution to summer peak demand grows most rapidly during the forecast period is process heating. Table 3-20 and Figure 3-27 show the summer peak demand forecast for the industrial sector.

Table 3-20
Forecast of U.S. Industrial Summer Peak Demand by End Use (MW)

	2008	2010	2020	2030
Process Heating	17,246	17,819	20,630	23,866
Machine Drive	107,473	111,038	128,559	148,722
HVAC	12,012	12,410	14,369	16,622
Lighting	12,012	12,410	14,369	16,622
Other	12,012	12,410	14,369	16,622
Total	**160,755**	**166,087**	**192,296**	**222,455**

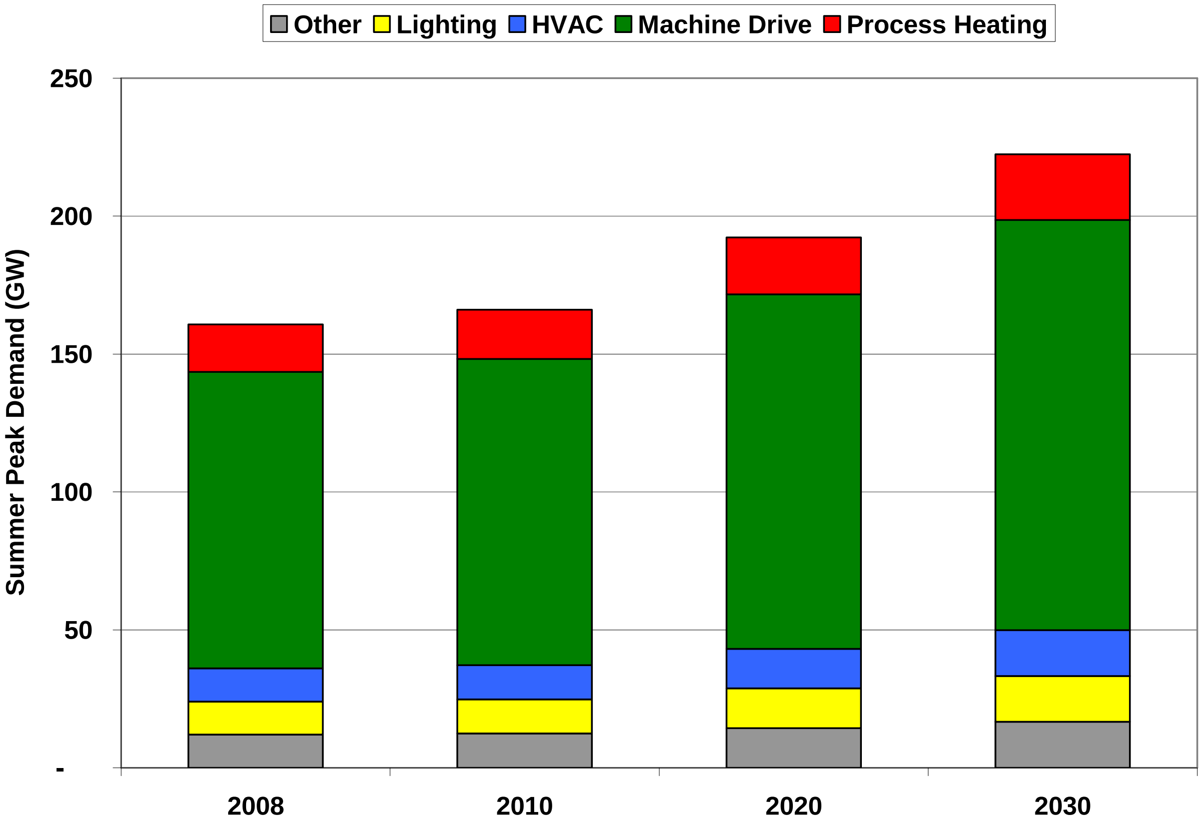


Figure 3-27
Forecast of Industrial Sector Summer Peak Demand by End Use (GW)

4

ENERGY EFFICIENCY POTENTIAL

The baseline development process and energy use modeling described above results in a set of energy efficiency and demand response potential estimates. These impacts are obtained in the form of technical, economic, maximum achievable, and realistic achievable potentials, each embodying a set of assumptions about the implementation and acceptance of energy efficiency and other demand-side activities. This chapter first presents the potential savings for energy efficiency for the U.S., followed by a discussion of each of the primary customer sectors. This chapter also includes estimates of potential savings for the four U.S. census regions.

Summary of National Results

The energy savings potentials associated with energy efficiency are displayed in Figure 4-1, each expressed as a percentage of the baseline electricity consumption for that year. As expected, the savings values increase over time as efficient technologies are phased in through equipment turnover. In addition, the savings values are largest for technical potential and progressively reduced through the refinements applied to estimate the other potentials. The realistic achievable potential reaches 8.2% of the baseline by 2030.

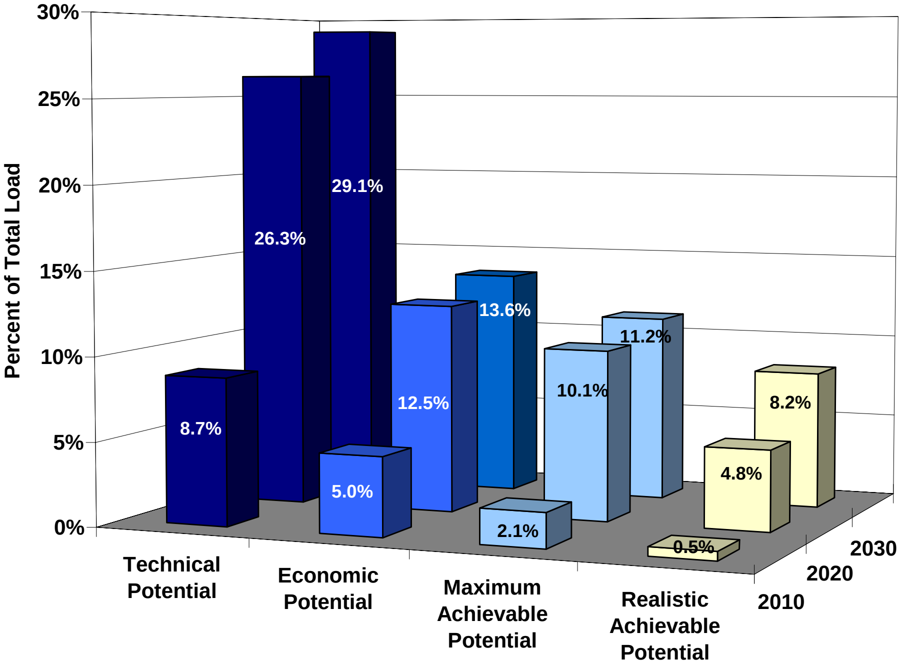


Figure 4-1
Energy Efficiency Potential Estimates as Percentages of Load

These savings potentials represent the combined effects of energy efficiency efforts in the three primary market segments – residential, commercial, and industrial. While the specific measures vary between sectors, the overall impacts are comparable. The realistic achievable potential for each sector is displayed in absolute terms (GWh) in

Table 4-1. The same potential is illustrated as a percentage of each sector's baseline over time in Figure 4-2. While the estimates for the residential and commercial sectors are roughly equal on a percentage basis, the projected growth in commercial energy use results in a realistic achievable potential 29% greater than that of the residential sector. In absolute energy savings, the industrial estimate is less than half that of the commercial sector, and lags behind the other sectors in percentage terms as well.

Table 4-1
Realistic Achievable Potential by Sector (GWh)

Sector	2010	2020	2030
Residential	12,127	64,374	139,637
Commercial	6,455	96,878	179,632
Industrial	2,027	45,696	78,736
Total	**20,609**	**206,947**	**398,005**

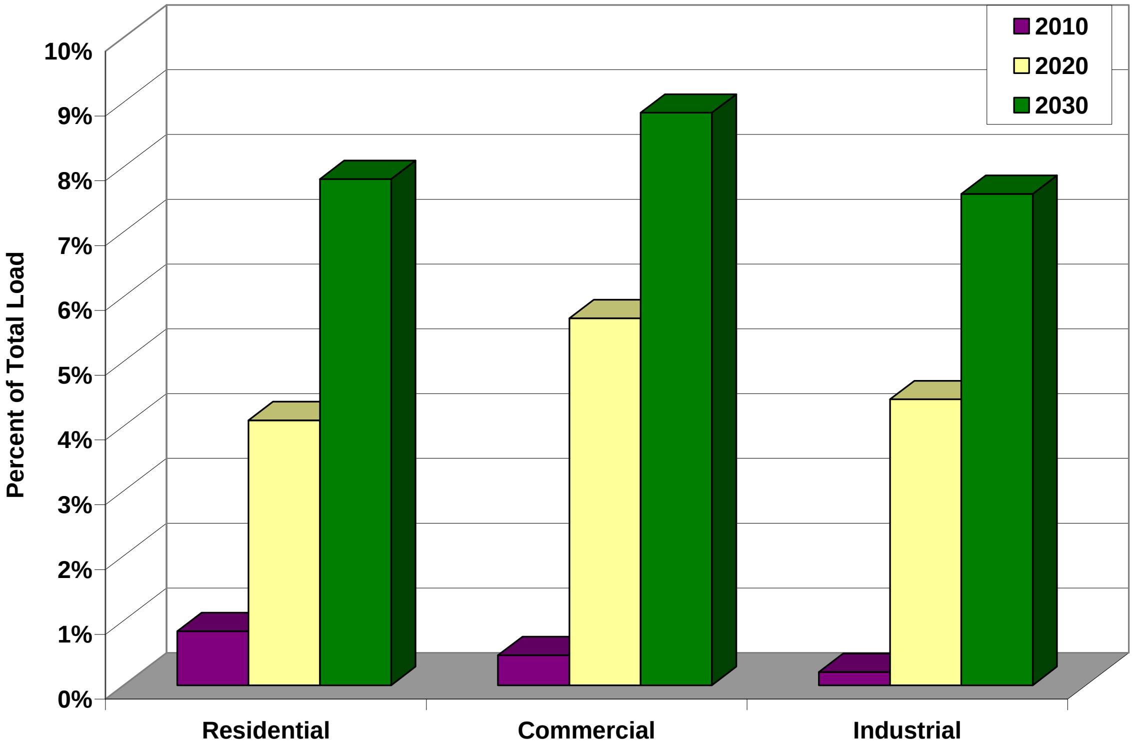


Figure 4-2
Realistic Achievable Potential as Percentage of Energy Baseline by Sector

It is useful to view these potential estimates in the context of historical electricity consumption and the baseline forecast. Figure 4-3 displays the energy use associated with each of the four potential estimates over time, highlighting the main forecast years (2010, 2020, and 2030). In contrast to the baseline, which embodies a continuation of recent growth, the technical potential shows a gradual reduction in annual consumption as the most efficient available technologies are phased into the marketplace. While the projections under the other potential estimates continue to rise, they do so at a reduced rate compared to the baseline forecast. For instance, implementing the realistic achievable potential for energy efficiency programs would slow the projected annual baseline growth of 1.2% to an annual rate of 0.83%.

As the efficient technologies approach market saturation, a change of slope occurs in the trends of maximum achievable, economic, and technical potential. Because most measure lifetimes are less than 15 years, this change occurs approximately midway through the forecast horizon, at which point the forecasted growth in population, employment, and other macroeconomic indicators take over as the primary drivers. This phenomenon is indicative of an inherent bias toward existing technologies applied in this study. The results should not be interpreted as a limitation on future efficiency efforts; rather, they results from extrapolating present-day technologies over a long forecast horizon rather than speculating about new technologies.

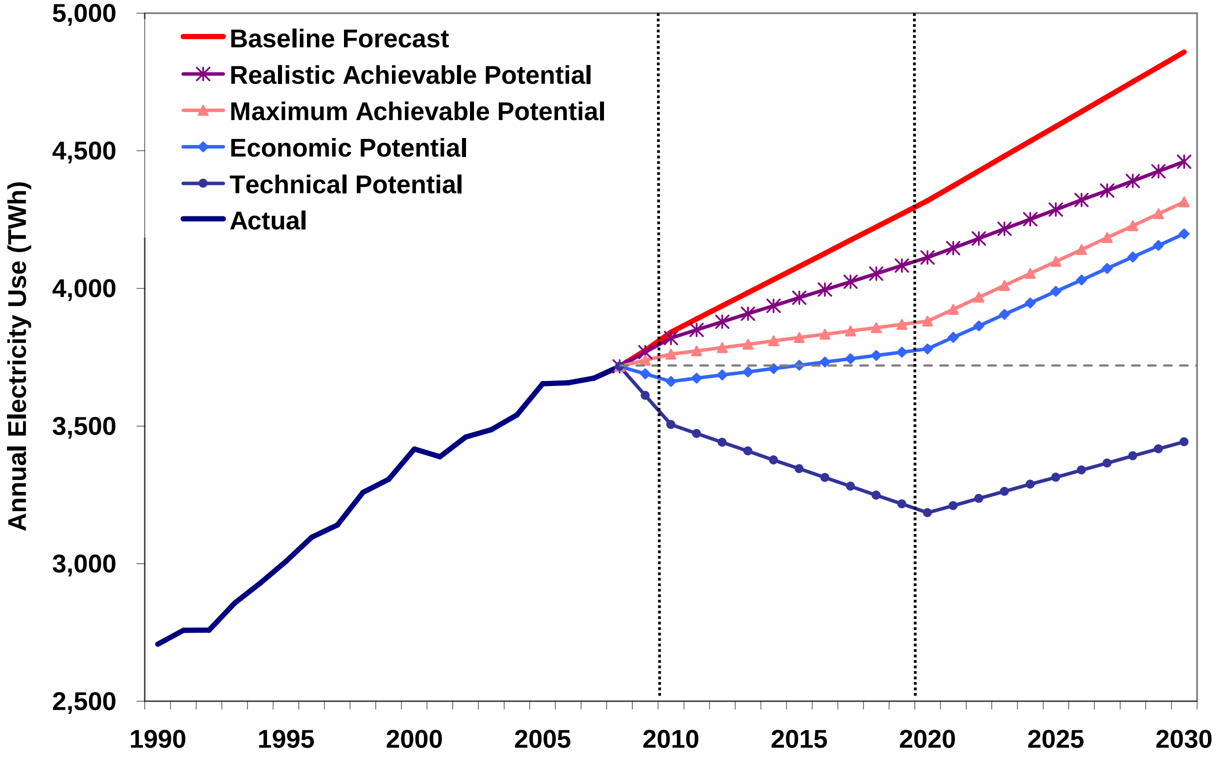


Figure 4-3
Energy Efficiency Potentials in Context of Baseline Forecast

Also apparent in Figure 4-3 is the approximate leveling effect possible under the economic potential estimate. Although the electricity use continues to rise, the implementation of all cost-effective energy efficiency measures would lead to electricity consumption in 2020 just slightly greater than that of the present.

Comparing the baseline forecast in Figure 4-3 with the realistic achievable potential indicates that energy-efficiency efforts can realistically expect to offset 35% of load growth between 2008 and 2030.

Residential Sector

The residential sector has long been a target for, and source of, significant energy savings. Over the past two decades, a comprehensive set of codes and standards has affected energy use, in addition to utility programs. The combined effect of natural market forces with codes and standards is embodied in the baseline forecast between 2008 and 2030, shown in the first two bars in Figure 4-4. In addition, this figure shows maximum achievable and realistic achievable potential cases for the year 2030. As noted in Chapter 3, there is a decrease in baseline lighting usage and an increase in electronics over the course of the forecast.

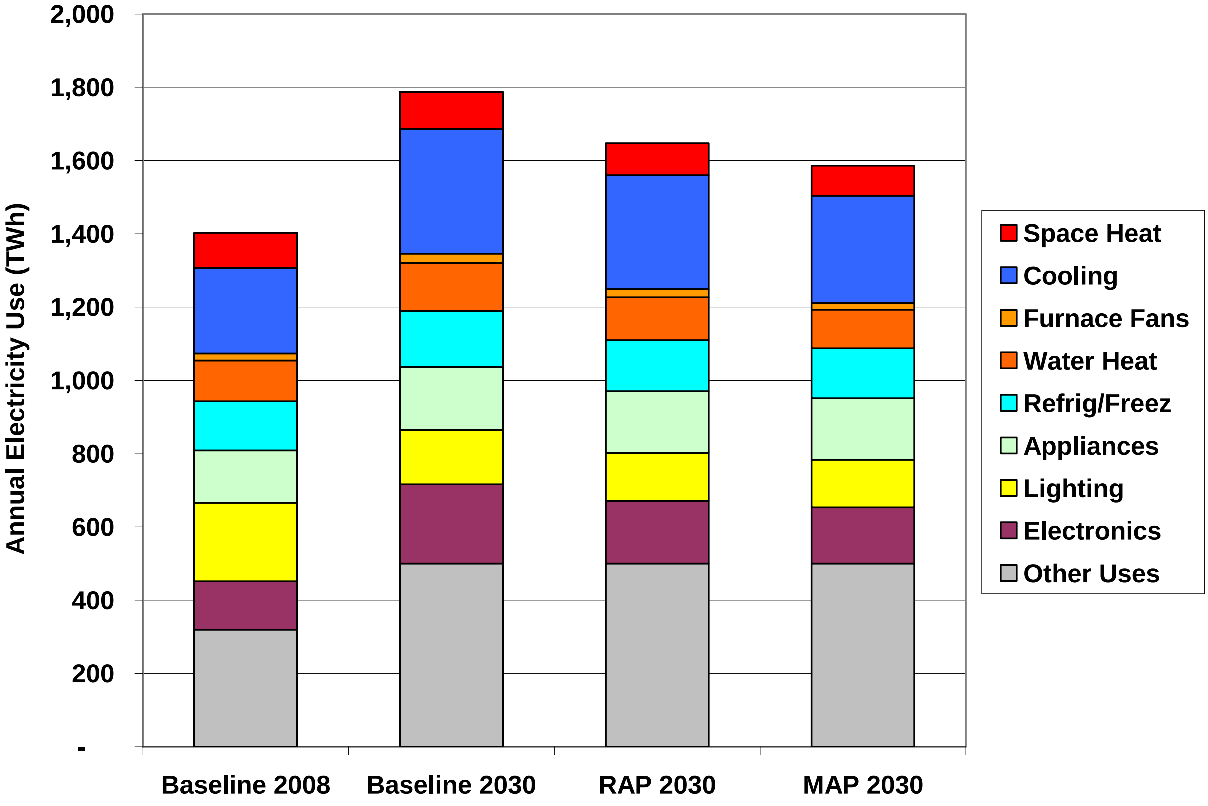


Figure 4-4
Residential Sector Energy Baseline and Achievable Potentials by End Use

Residential Savings in Terms of Use Per Household

Because the forecast embodies economic growth and other drivers, it is useful to examine the energy intensity associated with the baseline and potential cases. Intensity is expressed in use per household, averaged across all households. The baseline intensity for 2008 and 2030, along with maximum and realistic achievable potential for 2030, are presented in Figure 4-5.

An average U.S. household in 2008 consumes approximately 12,500 kWh of electricity. As discussed in Chapter 3, the dominant uses are "other" and cooling. While currently unclassified, it is likely that myriad future energy efficiency developments will emerge from the "other" category. Just as lighting and, more recently, color televisions were once included in "other," the energy consumption profiles of the miscellaneous set of small appliances, device chargers, and assorted plug loads in this category are not well understood at present. However, research efforts are already beginning to focus on these end uses. In contrast, cooling has been studied for decades, resulting in rapid technological advances, increased penetration of efficient technologies, and adoptions of federal appliance standards. However, factors such as geographic shifts in population from coastal to inland areas and increasing levels of thermal load due to additional electronic devices have contributed to a rising demand for cooling as an electrical end use. Both the "other" and cooling categories are likely to contain energy savings potential beyond those explicitly modeled in this study.

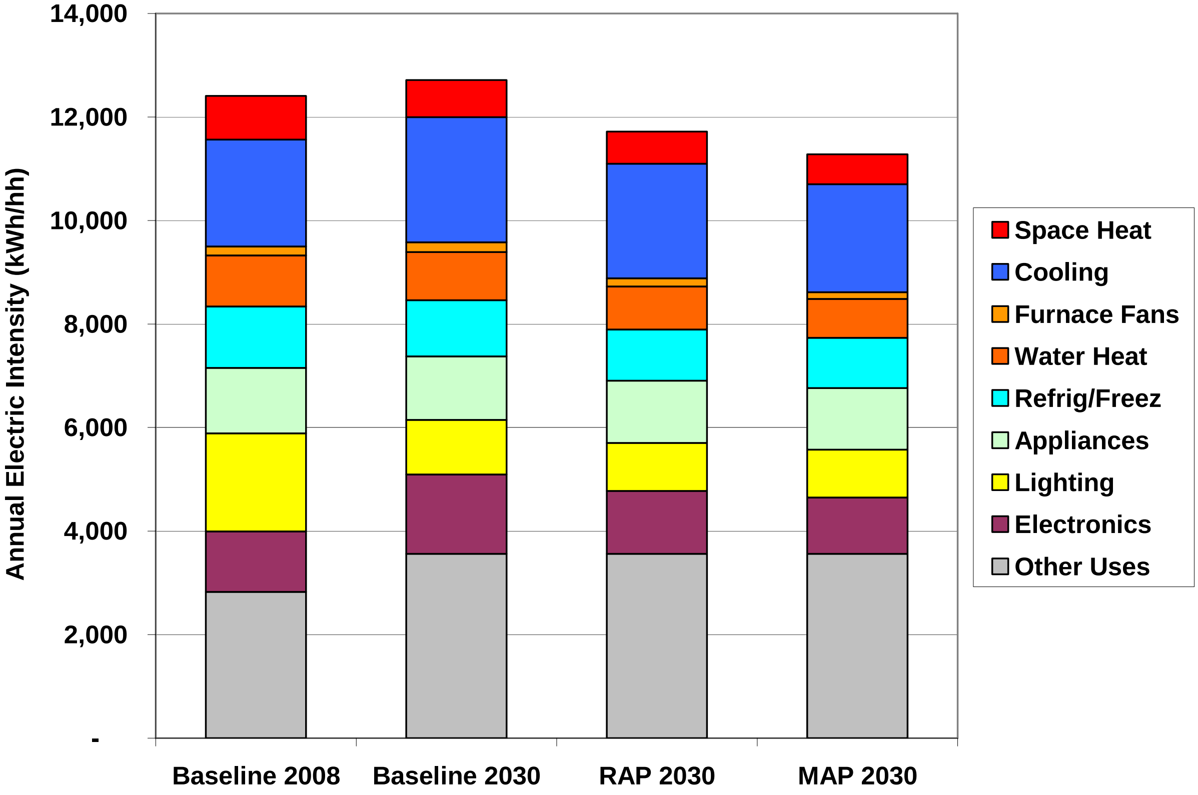


Figure 4-5
Residential Electricity Intensity by End Use

Residential Savings Potential by End Use

The realistic achievable potential electricity savings in the residential sector are presented by end use in Figure 4-6. The highest savings potential is found in the electronics category, where increasing numbers of devices with rising power demands create a large opportunity for efficiency gains. Cooling, appliances and lighting also contribute in roughly equal shares. Each of these end uses is discussed in detail below.

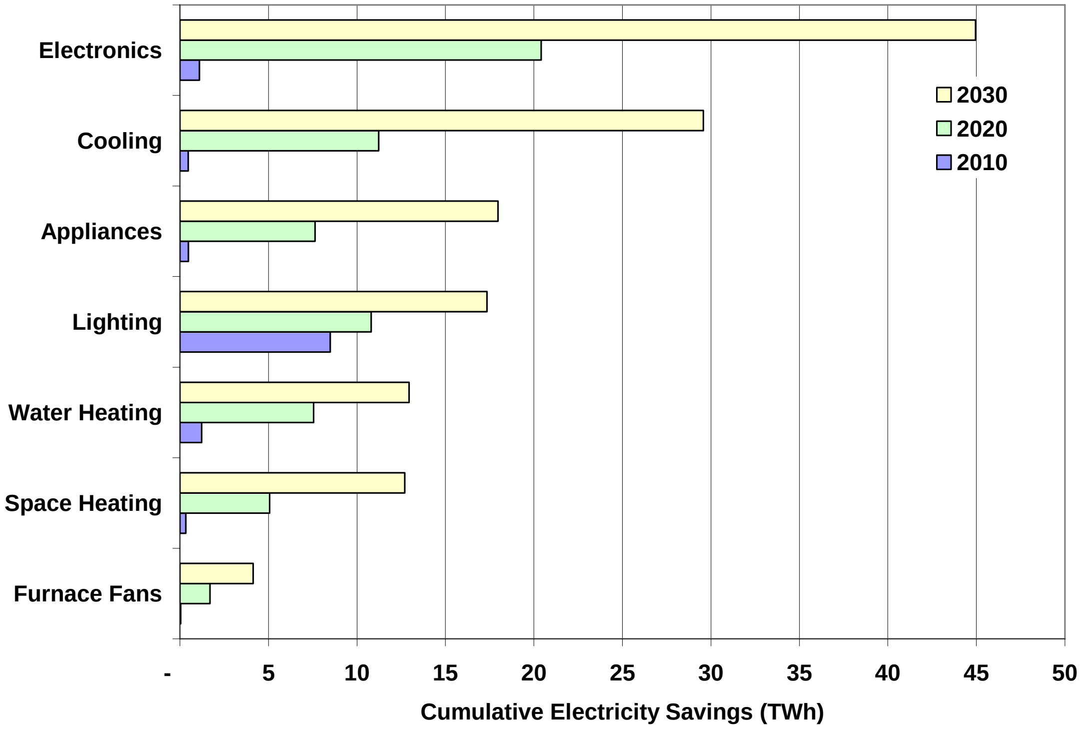


Figure 4-6
Residential Realistic Achievable Potential Energy Savings by End Use

Residential Electronics

In absence of utility programs, the baseline forecast shows substantial growth in the electronics end uses, comprised of personal computers, color TVs and other uses. Figure 4-7 displays this rising baseline along with the economic and achievable potentials over the forecast horizon. Although the savings in the near-term are minimal, electronics becomes the end use with the largest potential by 2030. A number of factors contribute to these estimates:

- Low marginal cost of efficiency – design choices by manufacturers such as standby power requirements can be incorporated into mainstream products at minimal cost to the consumer
- Spillover from other technologies – advances in power management for battery-powered applications can often be transferred directly to “plug-in” devices
- Increasing emphasis in efficiency community – ENERGY STAR® labeling for electronics, as well as ongoing research (EPRI, national labs, etc.)

- Collaboration with private industry – voluntary coalitions are indicative of a wholesale alignment of different interests toward the goal of efficient electronic devices

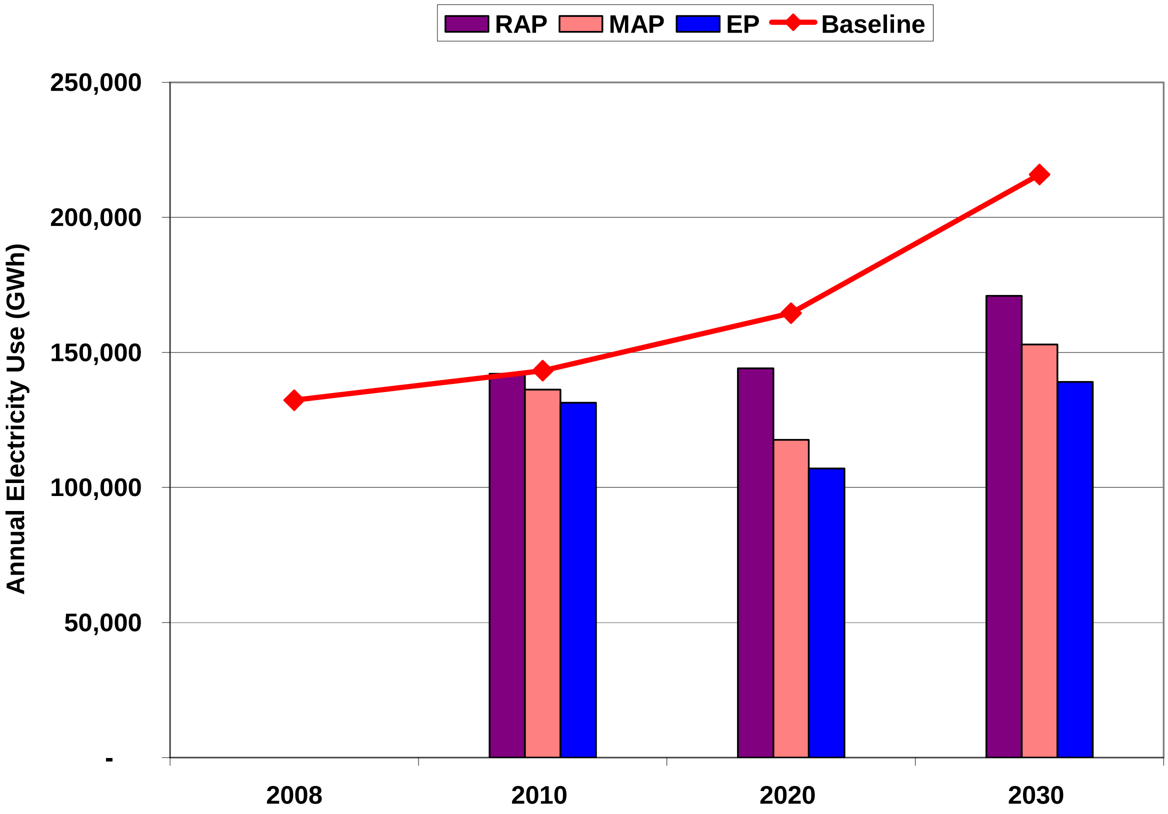


Figure 4-7
Residential Electronics Potential Estimates

The limited historical data in the category of efficient electronics suggests a path to market that differs from traditional energy efficiency. For example, while the purchaser of a refrigerator often understands its relative energy use and sometimes receives a rebate from the utility for selecting an efficient product, the choice of a personal computer involves so many variables and features as to render power consumption all but meaningless. Although both models are reinforced through the ENERGY STAR® rating system, the fundamental differences in product make it unlikely that programs comparable to those addressing refrigerators will emerge for PCs. Further, the consumer likely will not see a difference in retail price between an ENERGY STAR® labeled computer and a less efficient model.

Instead of traditional rebates and incentives, efficiency in residential electronics could be achieved through a close collaboration between advocates and researchers and the designers and manufacturers of the equipment. Examples of such voluntary interplay have arisen in recent years; as this type of cooperation progresses, the results will be a widespread improvement in power management for electronic devices, resulting in large maximum and realistic achievable potential savings, such as those shown in Figure 4-8.

While all of the existing efficiency measures for electronic devices are found to be cost-effective, the expected market penetration of the measures listed in Figure 4-8 will be influenced by present-day efforts, such as:

- ENERGY STAR® 3.0 for color televisions effective November 2008
- Ongoing research into standby power at Lawrence Berkeley National Laboratory informing the federal rulemaking process
- ENERGY STAR® personal computers as an extension of programs being undertaken and sponsored by government and private firms, such as the 80Plus program for efficient power supplies in desktop PCs and the ClimateSavers Initiative for efficient power supplies in servers

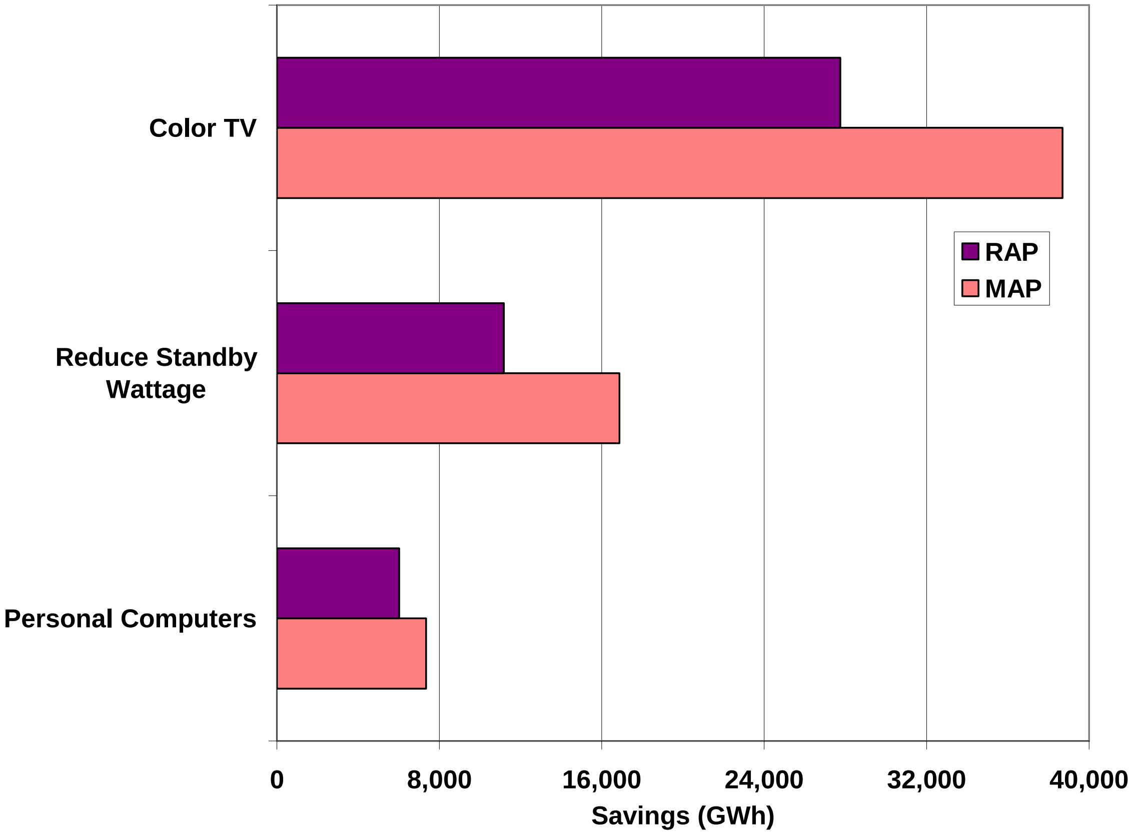


Figure 4-8
Residential Electronics Energy Savings by Measure in 2030

Residential Cooling

Figure 4-9 illustrates the potential impacts on residential cooling through energy efficiency. As previously mentioned, the baseline demonstrates a gradual climb between 2008 and 2030, consistent with the trends of nation-wide penetration of central air conditioning systems and increasing conditioned floor space, but also reflecting the trend toward more efficient equipment and the recently-implemented standard that sets the floor for central systems at SEER 13.

Relative to other uses, the efficiency potential for cooling is relatively small. This is due, in large part, to the fact that the SEER 13 standard is new (at the time of this study). While units with SEER ratings above 20 are commercially available today, the incremental cost is very high. This, together with a relatively flat electricity price forecast results in the adoption of a mix of SEER 14 and 15 units in the economic and achievable potential forecasts. These savings are further reduced when split incentive barriers are considered under realistic achievable potential, representing the programmatic difficulty of marketing efficiency to HVAC contractors for whom energy savings may not be a top priority.

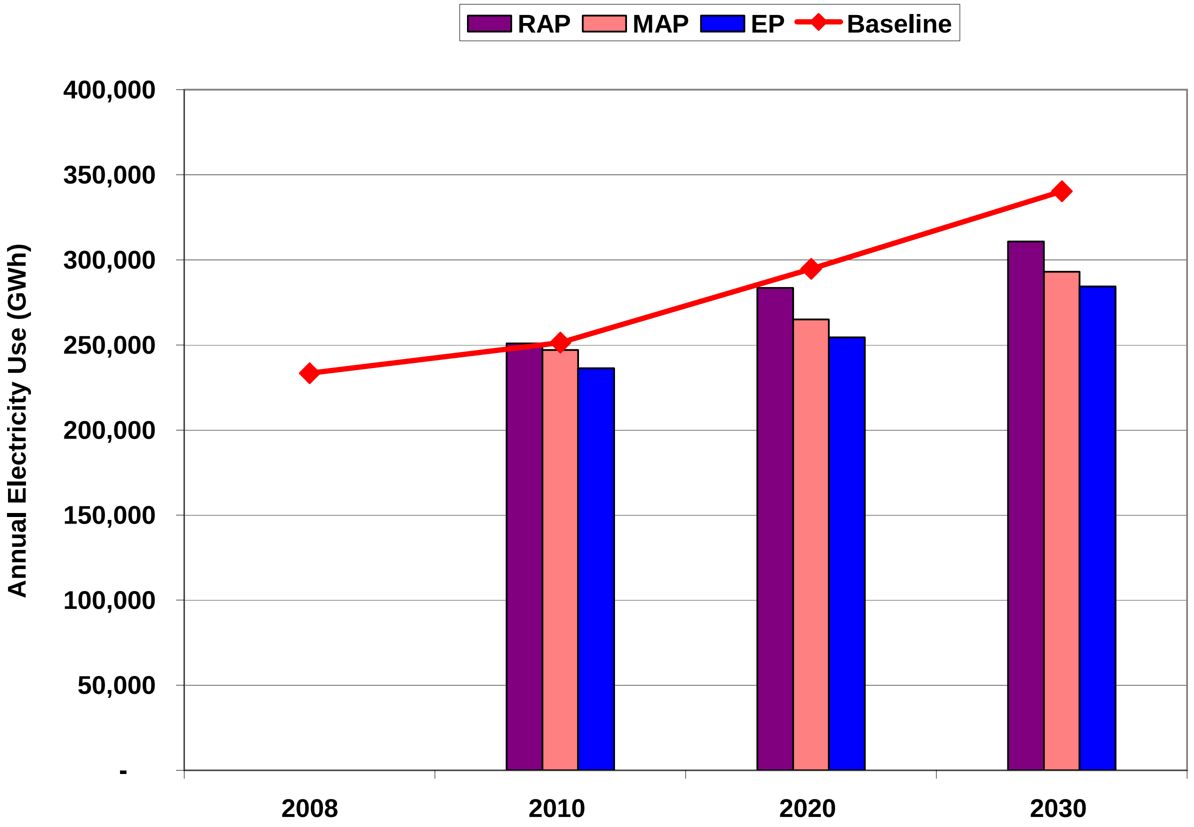


Figure 4-9
Residential Cooling Potential Estimates

The achievable potential savings are broken out into specific efficiency measures in Figure 4-10. Programmable thermostats and efficient central air conditioners are the two measures with the largest potential for energy savings. While the savings are comparable in magnitude, the paths to implementation differ between these two measures. For central air conditioners, savings result from the installation of a new unit, requiring a large capital expenditure and the involvement of at least one contractor. Savings are typically limited to circumstances of equipment burnout, major renovation and new construction. Programmable thermostats, on the other hand, are relatively inexpensive and deliver the majority of their savings in retrofit applications.

This distinction is evident in a categorization of the measures presented here into three basic types:

1. Efficient Equipment – These measures correspond directly to electricity consumption, obtaining savings by more efficiently converting electric energy to the delivered energy form (e.g. Btu of cooling).
2. Controls and Shell – These measures do not correlate directly with baseline usage, but rather influence the system in which the electricity-consuming equipment is operating. These measures do not require a unit to fail before replacement, but can instead be modeled as increasingly penetrating the applicable market segment.
3. Shell Measures – Like controls, these measures do not correlate to energy usage and are modeled in the same manner. Most shell improvements are confined to major renovations and new construction, and therefore follow a slower diffusion path across all homes than do controls.

It is important to recognize the role of interactions between measures in these savings values. For instance, installing a programmable thermostat typically saves 6-12% of annual cooling use, depending on climate zone and dwelling size. In a house with an efficient central air conditioner, the potential savings from the thermostat are less than in a comparable house with a less efficient unit. Throughout this study, efficient equipment is first applied, followed by controls and shell measures.

Also apparent in Figure 4-10 is the large disparity between maximum and realistic achievable potential for several shell-related measures, such as efficient windows, in the year 2030. In these cases, a combination of barriers such as imperfect information and high capital cost of installation pose a challenge to programmatic efforts to promulgate these measures, although recent advances in consumer awareness and program innovations have demonstrated the possibility for large success in these areas.

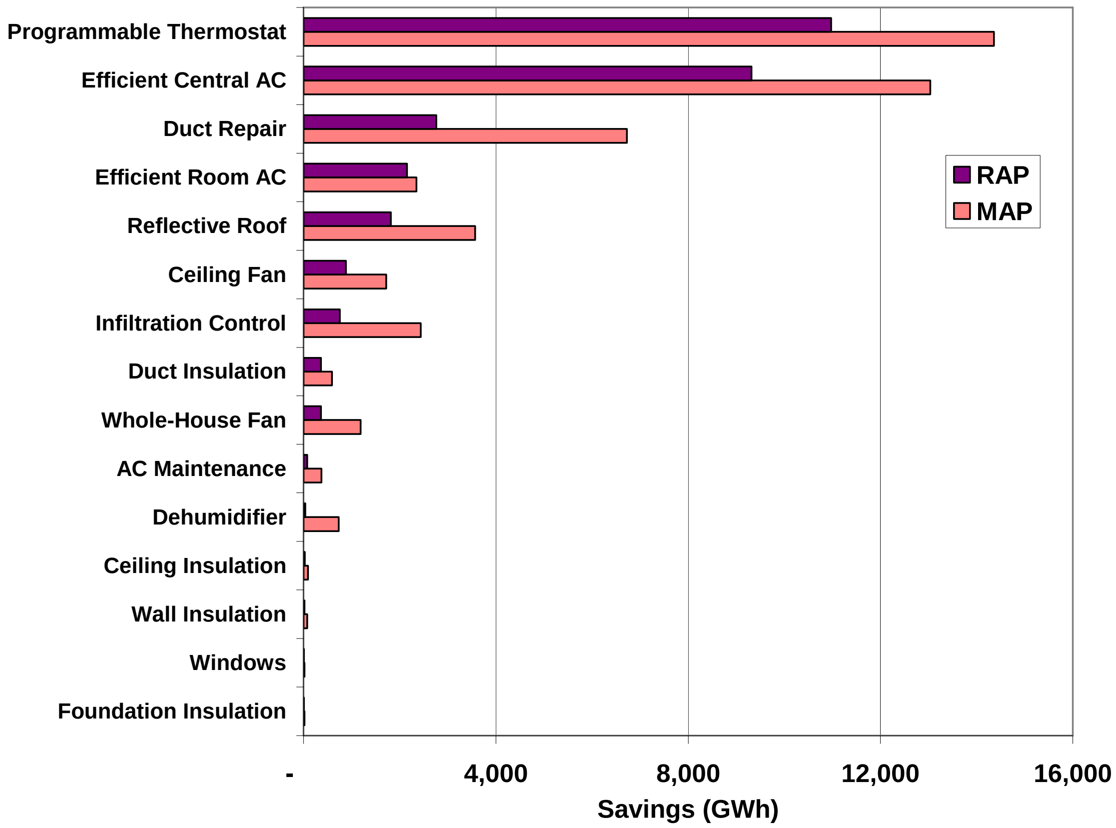


Figure 4-10
Residential Cooling Energy Savings by Measure in 2030

Residential Appliances

Appliances present a relatively straightforward opportunity for energy savings. Each unit installation can be relied on to deliver a known annual energy reduction for two reasons. First, typical manufacturer specifications include unit energy consumption, providing transparent information based on rigorous testing. Second, Energy Star labels have been designated for most of the main appliances, requiring manufacturers to document a pre-specified energy savings as a percentage of a comparable unit complying with federal standards. In addition to standardizing the savings calculations, the Energy Star brand has gained traction among manufacturers as a legitimate marketing tool. Information about energy consumption is now commonplace in the appliance displays at retail locations.

This simplicity from a programmatic perspective has led to widespread efforts by utility demand-side management (DSM) planners to target residential appliances.[16] A survey of existing programs in 2008 would likely reveal hundreds of rebate-per-appliance programs, often basing the requirements on Energy Star qualified appliances.

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[16] The term Demand Side Management (DSM) is used in this study to refer collectively to energy efficiency, demand response, and other load management activities undertaken by utilities and related entities.

These factors continue to play a role in the potentials estimated in this study, presented by appliance type in Figure 4-11. Most of the appliances shown here are familiar from an energy efficiency perspective. Refrigerators, for example, continue to provide the largest savings potential when both equipment upgrades and removal of old units are considered. Remarkable gains in efficiency achieved over the previous decades in Energy Star-rated appliances such as clothes washers and dishwashers have brought these units close to full market saturation. This results in smaller savings in absolute terms among these appliances.

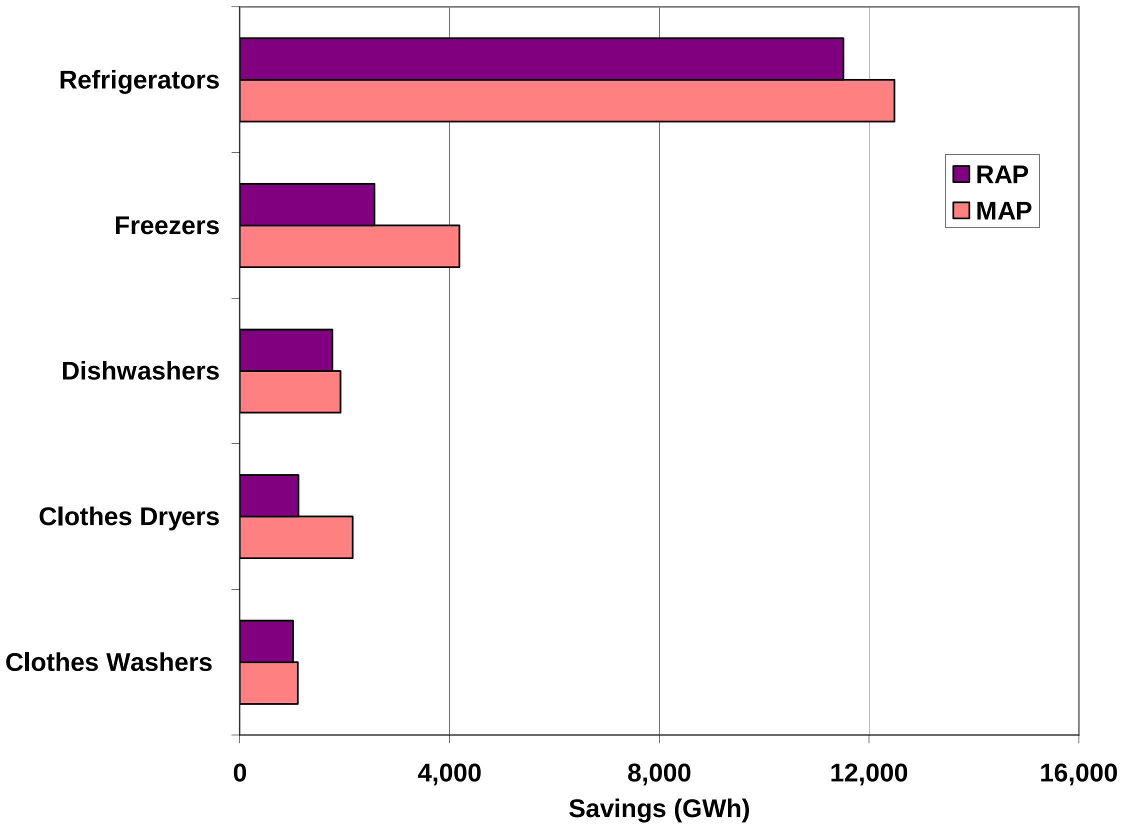

Figure 4-11
Residential Energy Savings by Appliance Type in 2030

The potential for energy savings in residential refrigerators is displayed in Figure 4-12. The relatively long history of efforts targeting this appliance with efficiency standards has nearly checked growth in consumption, appearing in the form of a flat baseline. Even with significant energy efficiency already assumed into this baseline, Figure 4-12 reveals the potential for still greater savings, derived primarily from the adoption of Energy Star certified units and replacement of "second" refrigerators. Successful examples of such programs are abundant today, suggesting low barriers to implementation and increasing consumer awareness. These programmatic goals have been attained by building on a track record of close collaboration with the manufacturing community.

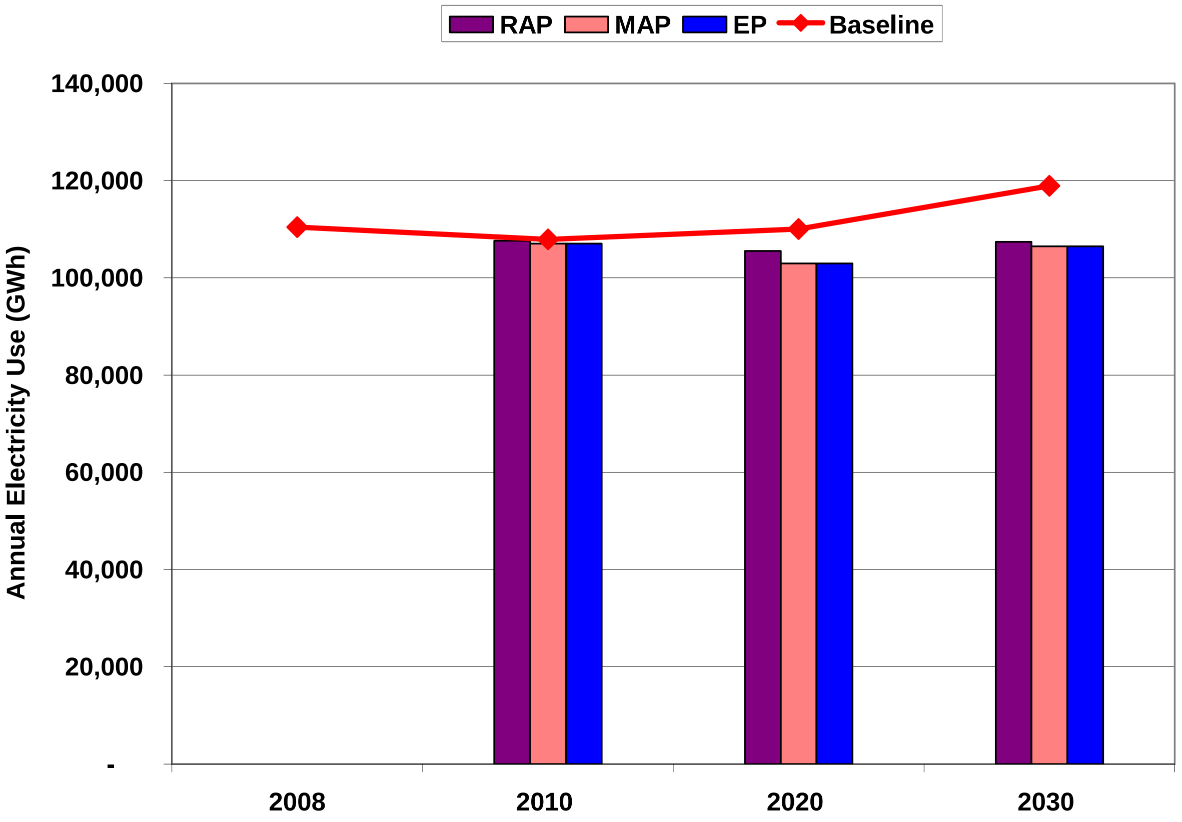

Figure 4-12
Residential Refrigerators Potential Estimates

Residential Lighting

Figure 4-13 displays the baseline forecast for residential lighting along with the economic, maximum achievable, and realistic achievable potentials. This end use is unique in that the baseline forecast displays a significant decline over the forecast horizon. This change is tied largely to the passage of the Energy Independence and Security Act (EISA) in 2007 mandating higher efficacies for lighting technologies.

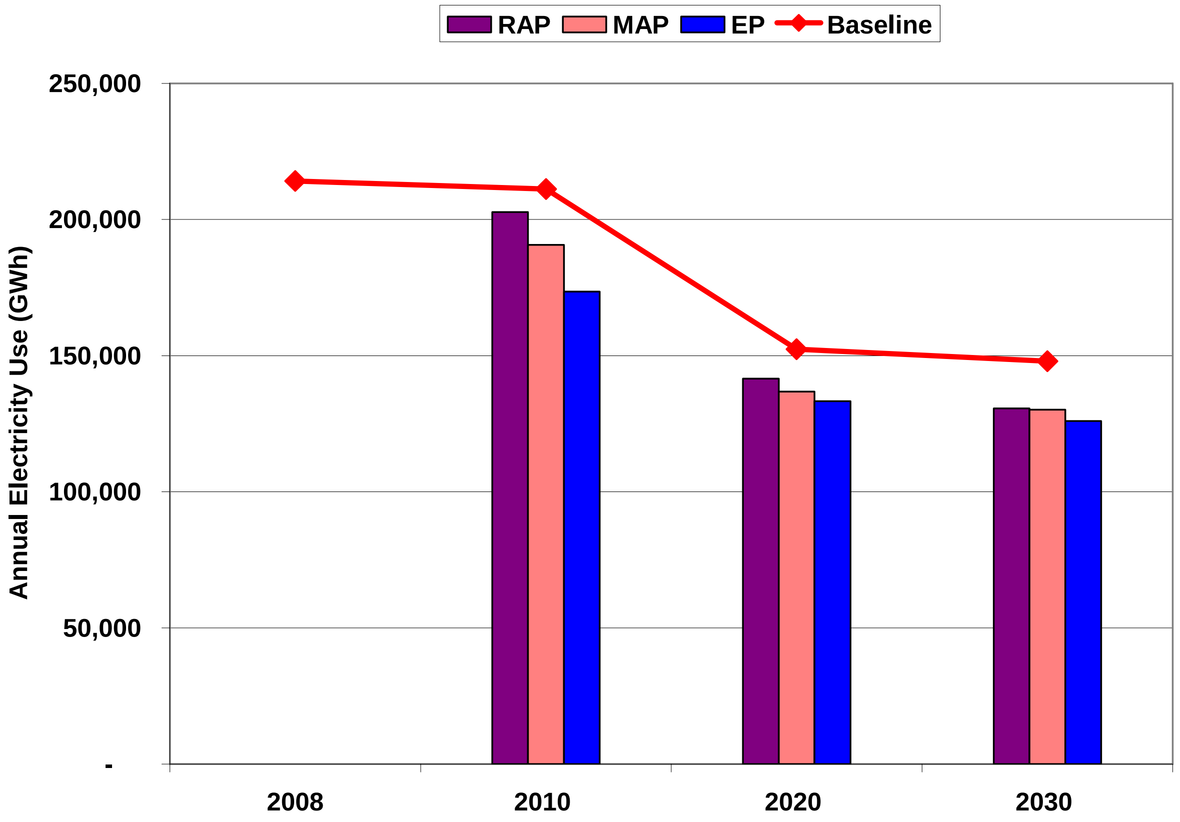

Figure 4-13
Residential Lighting Potential Estimates

The bulk of the lighting service embodied in the achievable potential cases is produced by compact fluorescent lamps (CFL). With a lumen per Watt efficacy of approximately four times greater than traditional incandescent lamps, CFLs represent a large savings opportunity on a per unit basis, especially in applications with substantial operating hours per year.

While significant advances have been made in solid-state general service lighting (e.g., white LED's), and this technology is widely viewed as the primary residential light source of the future, it appears only in the technical potential estimate. The other potentials do not include white LED's, which are filtered in the economic screening process under assumptions of current equipment costs and a conservative electricity price forecast.

Although not appearing in this analysis, solid state lighting is likely to play a large role in future energy efficiency efforts in the residential sector. Current investments by both private and public organizations focused on research and development of this technology, leading to higher performance at lower cost, as well as possible increases in electricity prices, combine to create a future scenario under which white LED's are a significant player in general service lighting. While these effects do not appear in Figure 4-13, they could be imagined as a further reduction in the potential estimates for 2030, allowing for a large increase in energy savings over the latter forecast years.

Residential Water Heating

In contrast to the other end uses in the residential sector, efficiency efforts in water heating are driven not only by an objective to reduce electricity consumption, but also by a growing need to optimize water usage in the United States. For example, a low-flow showerhead is both a water-saving and an energy-saving measure because it reduces the heating load on the water heater. This nexus between energy and water allows for greater savings in the short run through water-conscious appliances and fittings. In the long run, the dual drivers of energy and water could lead to the widespread adoption of advanced technologies such as combined washer-dryer units.

In addition to measures that save both energy and water, a variety of efficient electric water heating technologies were considered, including solar water heaters and air-source and geothermal heat pump water heaters. Figure 4-14 displays the potential savings in residential water heating over the forecast timeframe, while Figure 4-15 breaks down these savings by measure. Note the large role of clothes washers and dishwashers in the potential estimates. These appliances are capable of large savings in the water heating load, while preserving the simplicity of an appliance program, where consumers are marketed directly (as opposed to through a contractor as in the case of water heaters). This approach benefits from a long history of successful appliance rebate programs.

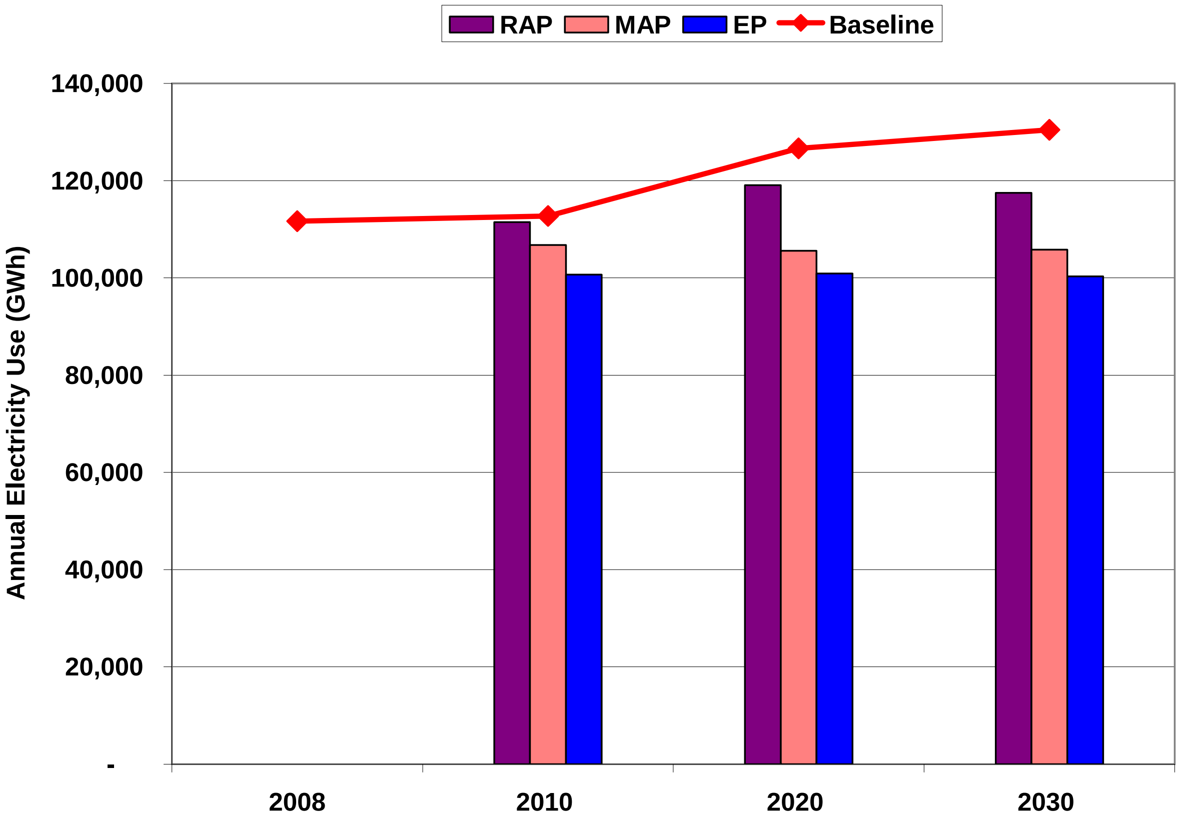

Figure 4-14
Residential Water Heating Potential Estimates

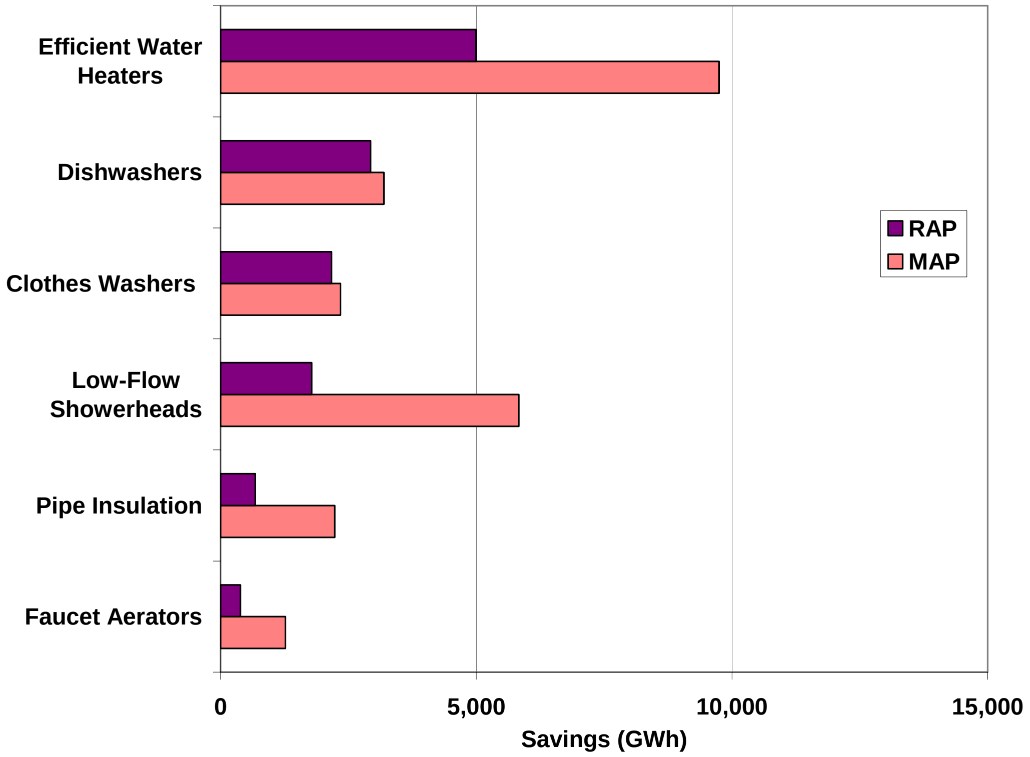

Figure 4-15
Residential Water Heating Energy Savings by Measure in 2030

Residential Space Heating

The baseline forecast and potential estimates for space heating in the residential sector are displayed in Figure 4-16. In contrast to the steady rise in energy used for cooling, the baseline for space heating remains relatively flat. The primary reason for this trend is an assumed movement away from electric resistance heating systems such as baseboard heaters. While some of these systems will be replaced by more efficient heat pumps, others will convert to a gas-fired furnace or boiler, reducing the electricity forecast for heating.

Evident in Figure 4-16 are the relatively long measure lifetimes associated with heating technologies and the slow diffusion of relevant shell measures. For instance, a standard efficient air source heat pump has an expected lifetime of 15 years, meaning the opportunity to replace a unit purchased just before the forecast begins will not have the opportunity for upgrade until 2023. For this reason, the savings potentials for residential space heating reach a significantly higher level by 2030 than during the intermediate forecast years.

Figure 4-17 shows the achievable potential savings in residential space heating associated with each measure. As in the case of cooling, programmable thermostats have the largest magnitude. This impact is amplified by the fact that many of older buildings with inefficient electric heating are capable of reducing consumption considerably by changing set-points just a few degrees.

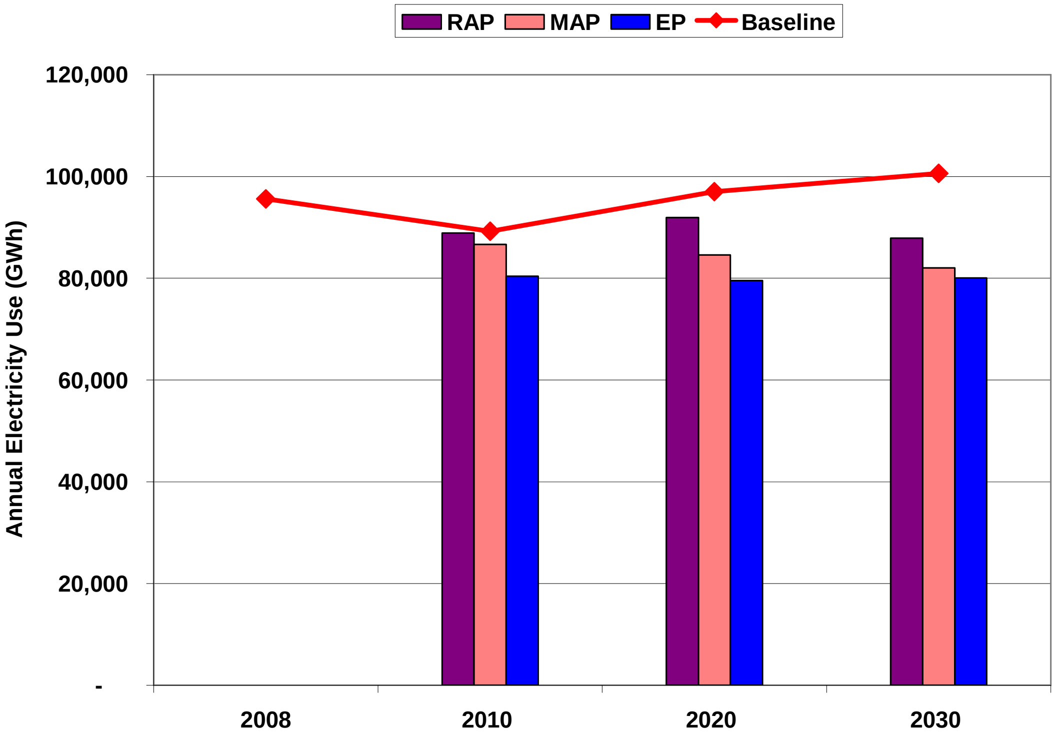

Figure 4-16
Residential Space Heating Potential Estimates

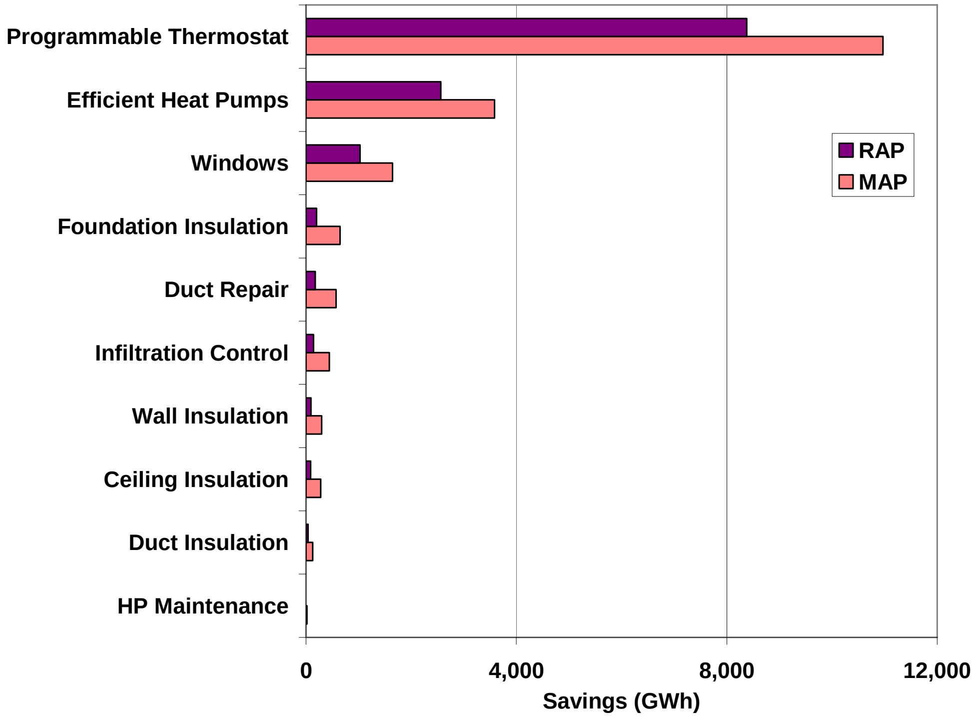

Figure 4-17
Residential Space Heating Energy Savings by Measure in 2030

Commercial Sector

Energy efficiency efforts targeting the commercial sector have gathered momentum in recent years. As one example of this enthusiasm, there have been several analogies drawn between large office buildings and conventional power plants, emphasizing the resource-like nature of demand-side management. Widespread energy efficiency programs range from lighting and HVAC retrofits to the commissioning of new and existing buildings. While these efforts adopt many different strategies to obtain savings in the commercial sector, they can be viewed together as evidence of a growing consensus that commercial energy efficiency represents a large potential savings.

As displayed in Figure 4-18, changes in commercial electricity usage between 2008 and 2030 lead to significant savings opportunities. Figure 4-19 presents electricity consumption normalized by square footage, the analog to the energy-per-household intensity reported for the residential sector. In both of these charts, two of the largest drivers of commercial electricity consumption are lighting and office equipment, suggesting the dominant role of office buildings in this sector. In addition to these end uses, almost 40% of commercial baseline use in 2030 is projected to fall into the "other" category, limiting the savings potential to non-specific and non-building measures. As in the residential sector, additional savings are likely by isolating specific end uses within this "other" category, suggesting the importance of research focused on this issue.

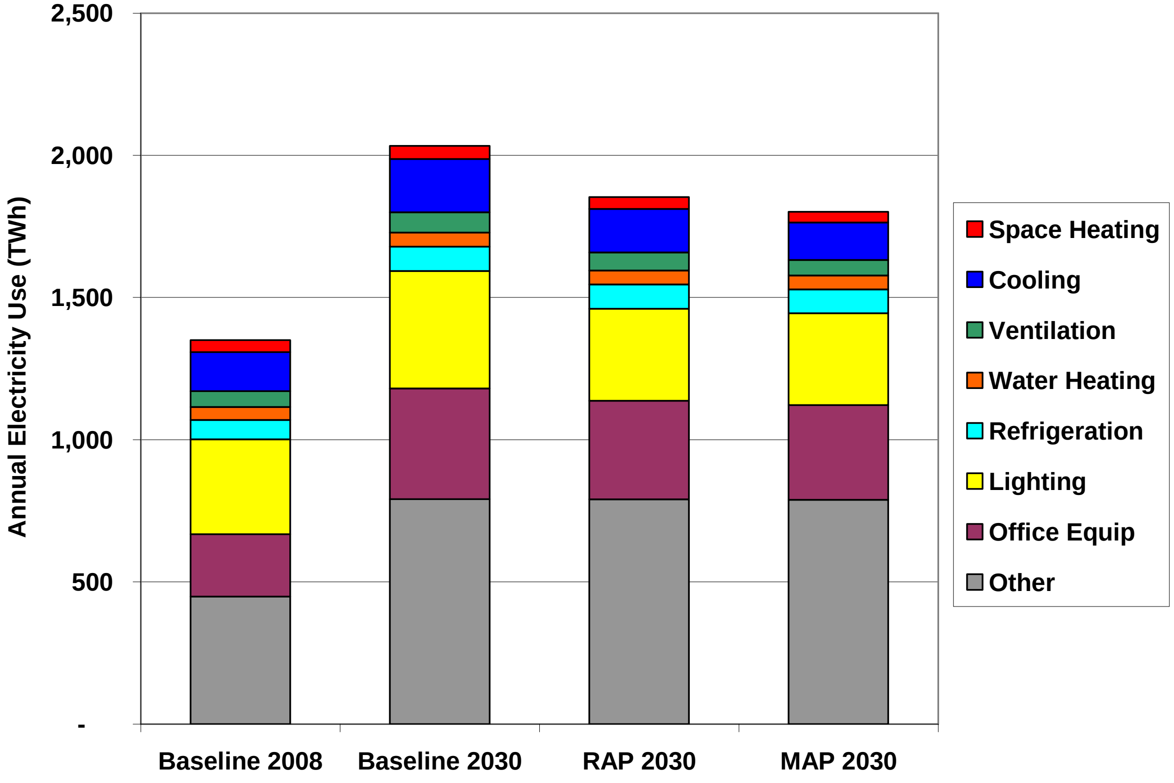

Figure 4-18
Commercial Sector Energy Baseline and Potential Savings by End Use

Commercial Savings in Terms of Electric Intensity

As discussed in Chapter 3 and shown in Figure 4-19, the baseline forecast of electric intensity reveals a substantial decrease in lighting, from 4.3 kWh/square-foot in 2008 to 3.8 kWh/square-foot in 2030. Advances in lighting technology, the passage of EISA, and a long history of implementing lighting efficiency programs results in an overall decline in electricity use for lighting per square foot.

In contrast, the energy used for commercial office equipment grows in both absolute and per-square footage terms, from 2.8 kWh/square-foot in 2008 to 3.6 kWh/square-foot in 2030, suggesting a large potential for energy efficiency. As a midpoint between lighting and electronics, energy consumed by commercial cooling is expected to stay roughly constant on a per-square footage basis, with an achievable potential reduction of 6-10%.

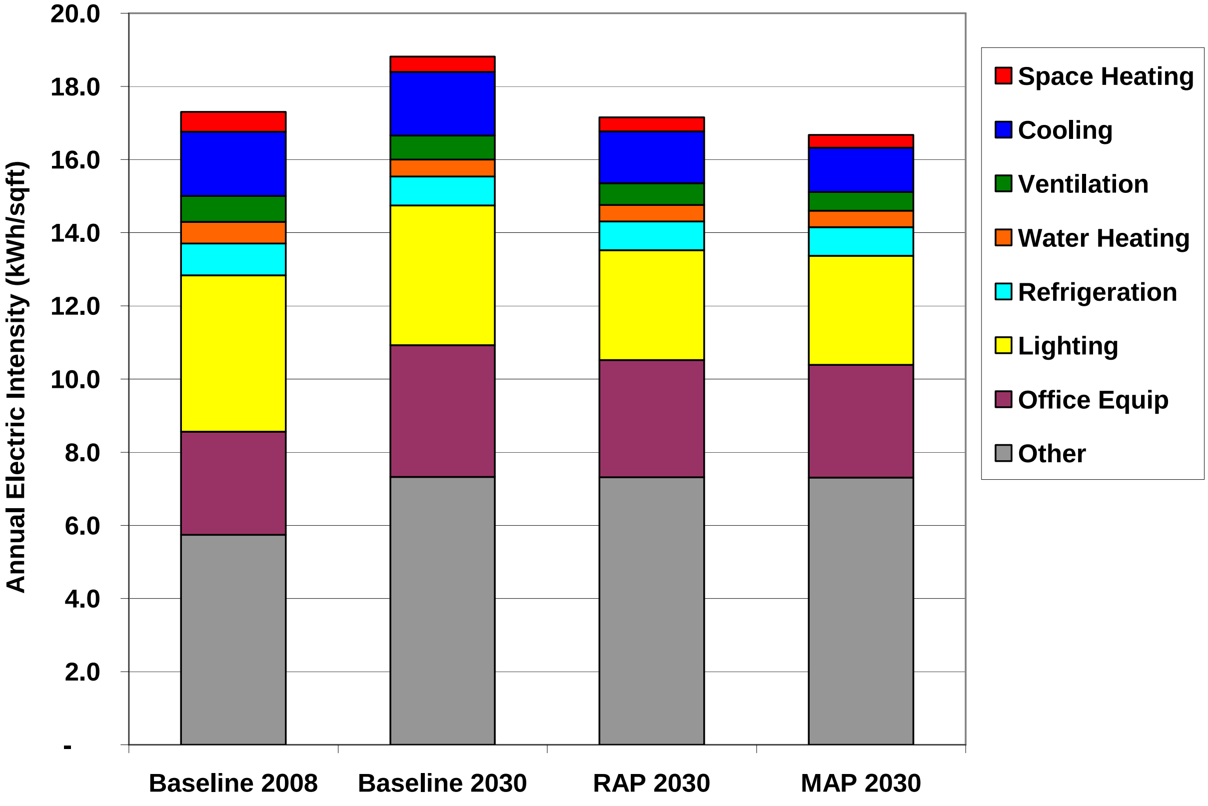

Figure 4-19
Commercial Energy Intensity by End Use

Commercial Sector Savings Potential by End Use

The realistic achievable potential for each of the end uses in the commercial sector are displayed in Figure 4-20. As expected, the end uses with the largest savings potential are lighting, other (including office equipment), and cooling. Each of these is discussed in detail below.

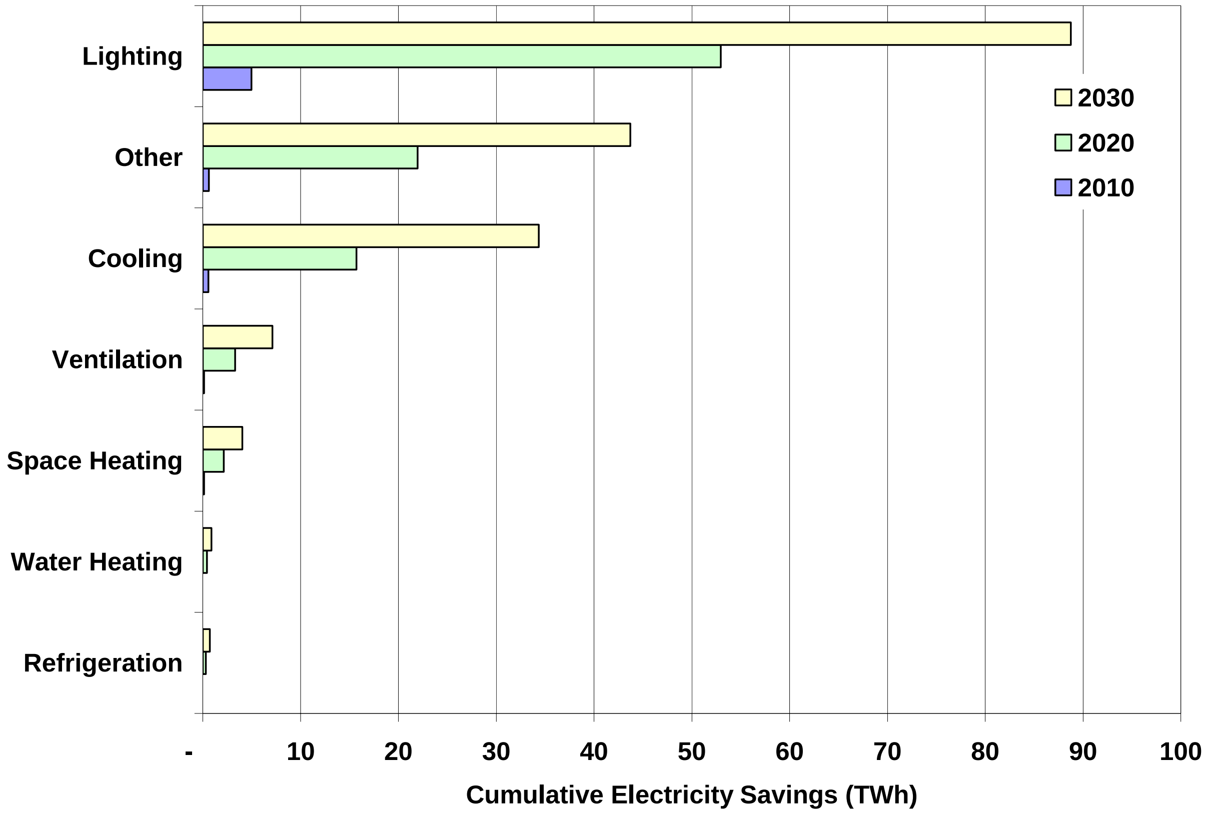

Figure 4-20
Commercial Realistic Achievable Potential by End Use

Commercial Lighting

Although similar in composition to the residential sector, commercial lighting faces a unique set of circumstances that contribute to its large savings potential. First, the recent changes in lighting standards such as EISA 2007 have less of an impact on commercial applications because of the lower use of incandescent lamps across all commercial segments (although incandescent lamps are still widely used in the lodging segment). Over 70% of baseline consumption in commercial lighting is produced by linear fluorescent technologies (i.e., T12, T8, T5. etc). Second, older building vintages provide a sizeable retrofit potential for replacement of inefficient technologies with efficient ones. For example, many large office buildings continue to rely on T12 lamps with magnetic ballasts. Replacement of these lamps with electronic ballasts and T8 lamps provides savings of nearly 30%, a short economic payback period, and a straightforward opportunity for a utility rebate program. These factors combine to yield a large potential for energy savings in commercial lighting, displayed in the context of the baseline in Figure 4-21.

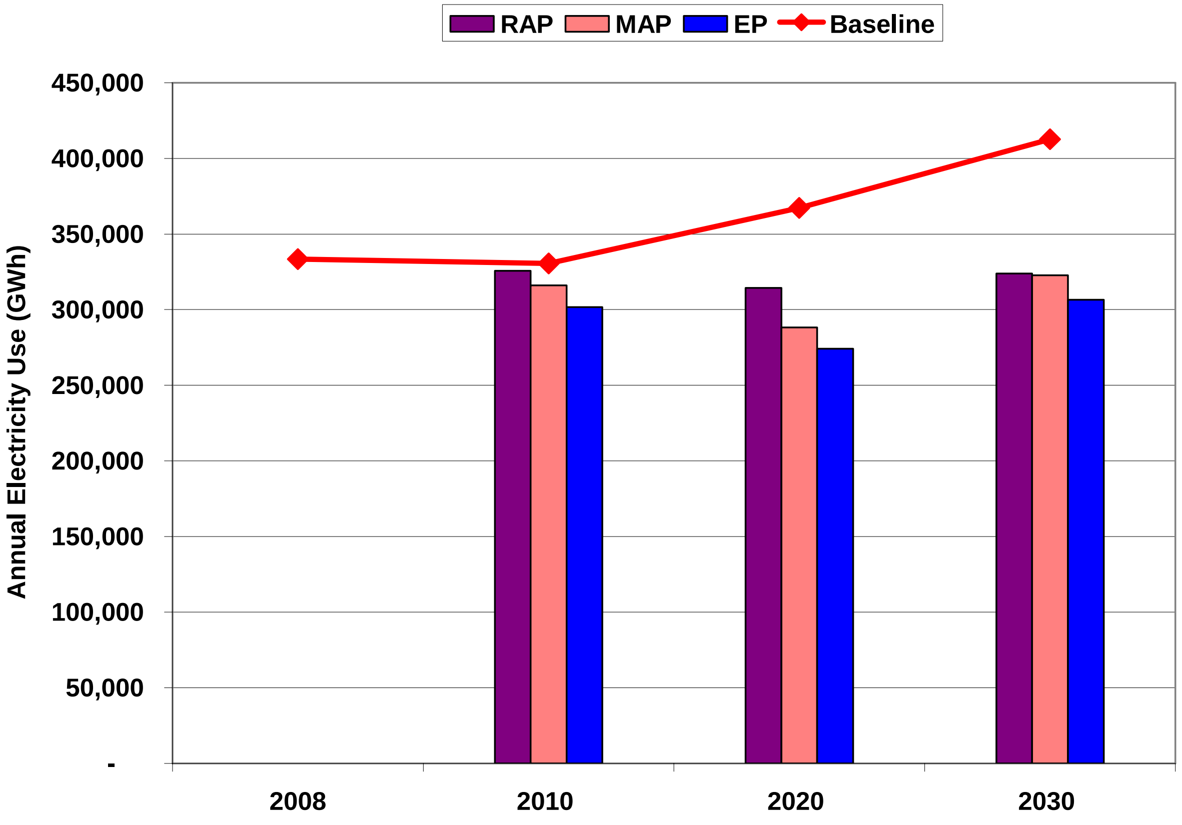

Figure 4-21
Commercial Lighting Potential Estimates

Commercial Cooling

Figure 4-22 shows the potential savings for commercial cooling over the forecast horizon. Although the baseline forecast entails growth of approximately 35% between 2008 and 2030, this can be mitigated to 10% under realistic achievable potential and reversed for a 6% reduction in energy usage under maximum achievable potential. As in the aggregate figures discussed above, the achievable potential savings slow down during the 2020-2030 period as existing measures approach saturation. With a changing economic landscape and an extension of recent technological innovation, it is conceivable that realistic savings in commercial cooling could exceed those displayed in Figure 4-22.

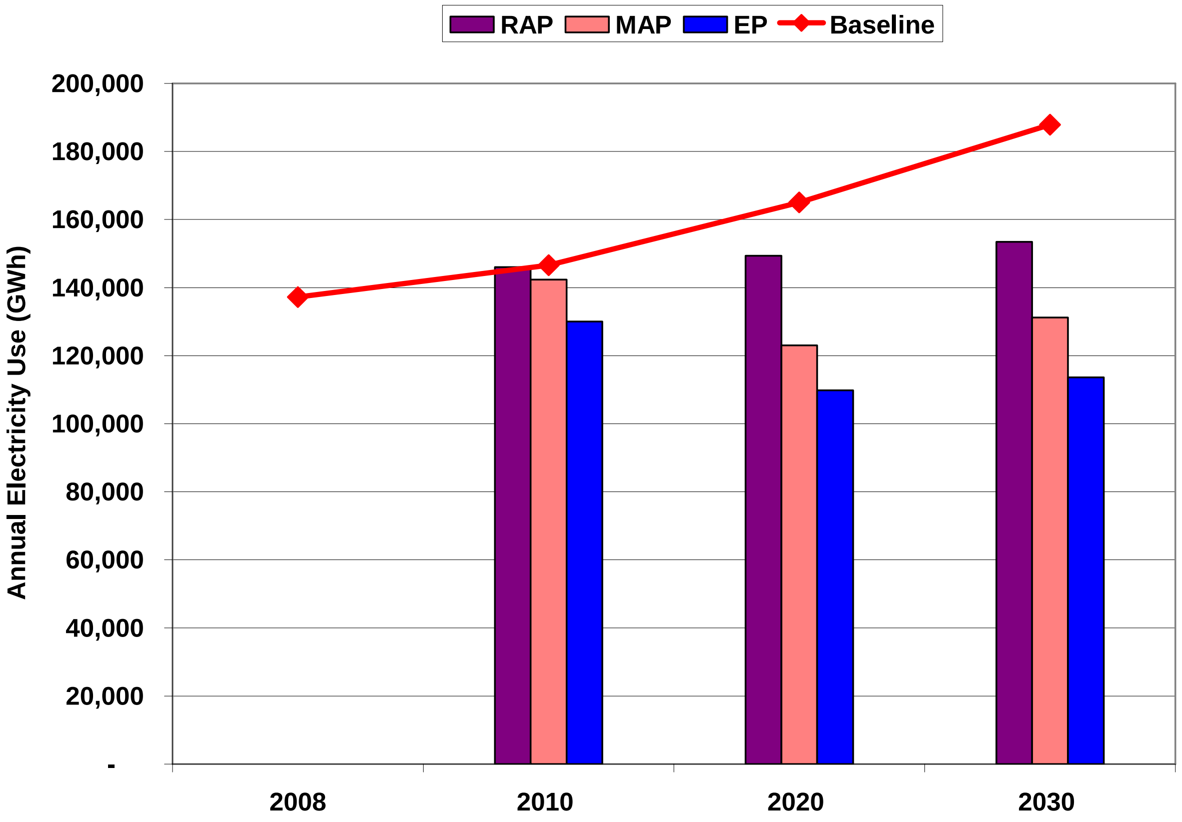

Figure 4-22
Commercial Cooling Potential Estimates

The savings in commercial cooling are expressed by efficiency measure in Figure 4-23, indicating the same division as in the case of residential cooling, between equipment upgrades, improved controls, and shell measures. By 2030, most of the savings come from phasing in efficient equipment. In large office buildings, chiller efficiencies increase from a range of 1.2-1.4 kW/ton to about 1.1 kW/ton under achievable potential. For smaller offices and retail buildings with packaged systems, the average EER is improved from a baseline value of 8.5-10 to more than 11 under the achievable potential case.

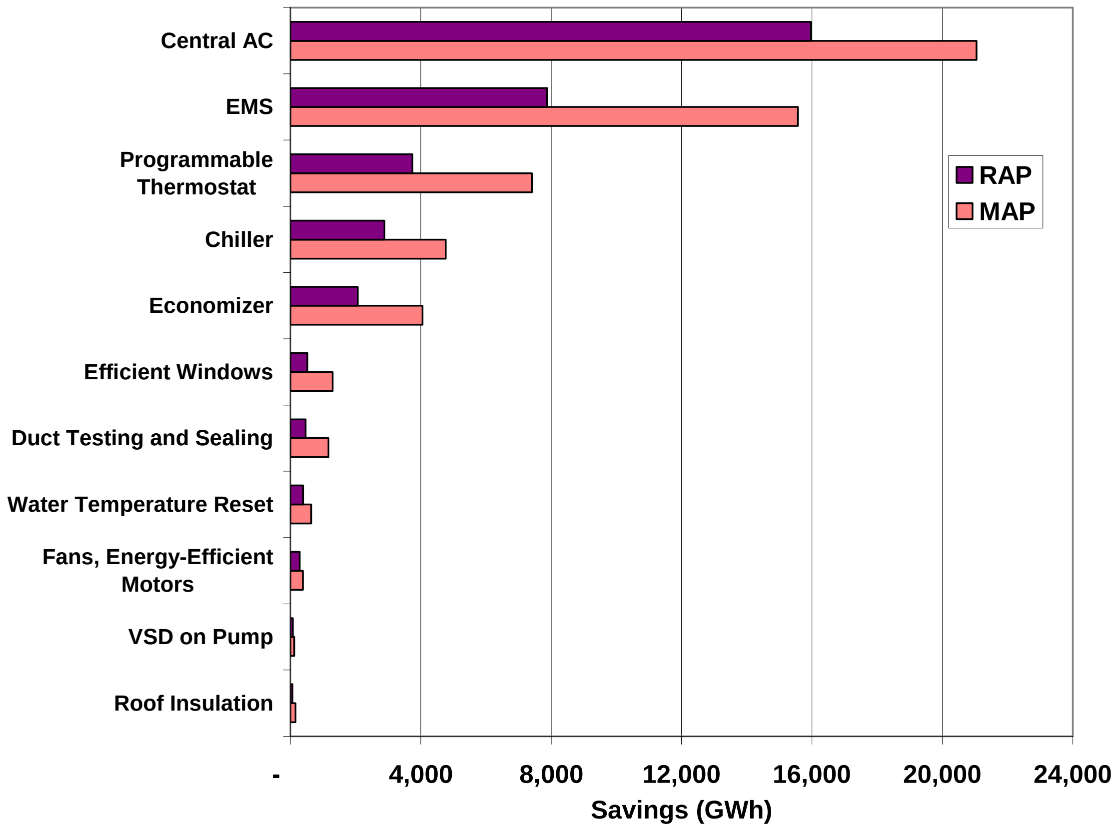

Figure 4-23
Commercial Cooling Energy Savings by Measure in 2030

It is illustrative to examine the change over time in the nature of the cooling measures, displayed as percentages of the total realistic savings in Figure 4-24. While the equipment measures provide the greatest savings by the end of the forecast, the time required to phase in these technologies limits their role in the near term. In the early forecast years, between 2008 and 2020, retrofits of existing commercial HVAC systems with controls such as Energy Management Systems and Programmable Thermostats provide the bulk of the energy savings.

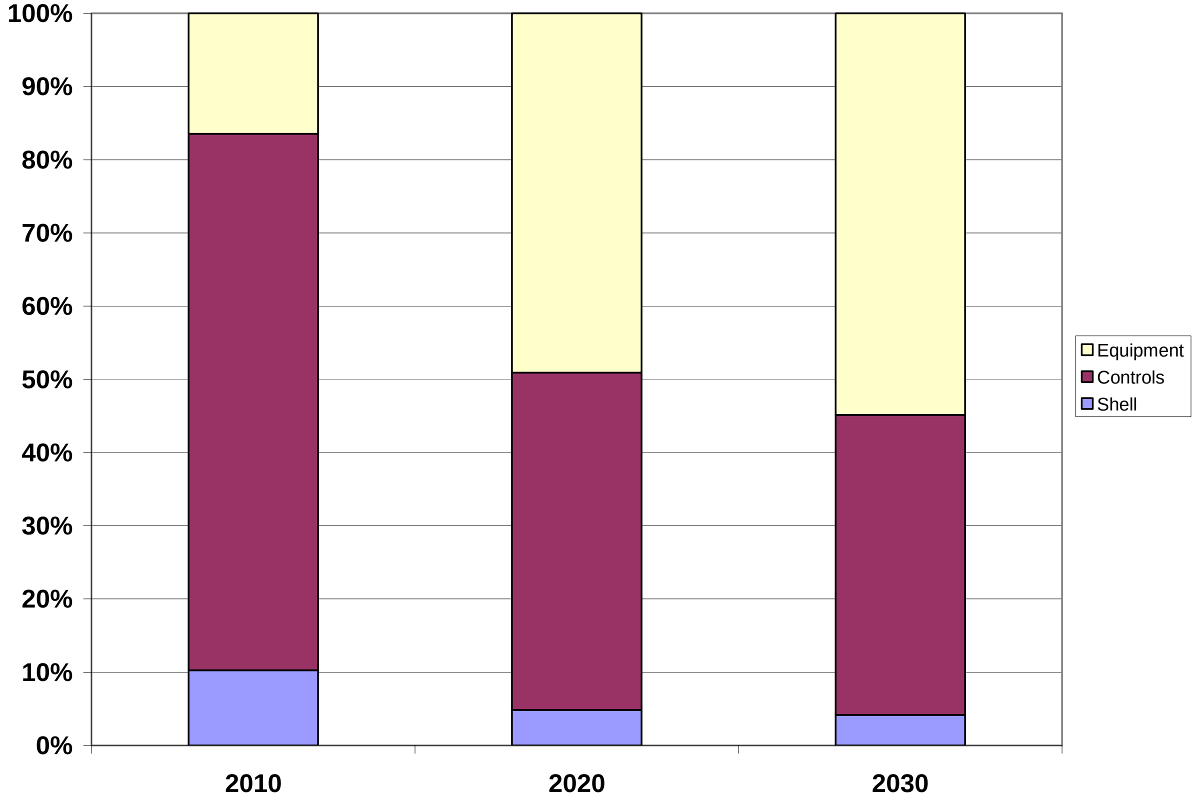

Figure 4-24
Commercial Cooling Realistic Achievable Potential by Measure Type

Commercial Office Equipment

Similar to the market for residential electronics, commercial office equipment is expected to account for a growing portion of electricity consumption over the next 22 years. This trend is amplified by several factors:

- Shift toward service-based economy
- Increased digitalization
- Rapid technological development
- Expanding performance demands

Along with this growth comes a large potential for energy efficiency, represented in Figure 4-25 by the widening gap between the baseline and the achievable potentials over time. The potential savings for commercial office equipment are enabled, as in the case of residential electronics, by a low marginal cost of efficiency and a market mechanism that involves initiatives by designers and manufacturers of technologies. This trend gains momentum in the commercial sector, where large entities purchasing high volumes of office equipment represent a strong market power which can be used to call for efficiency improvements. An example of this phenomenon is the ClimateSavers Initiative, where over 200 organizations have committed to purchase energy efficient computers and servers and apply power management practices, with the stated goal of reducing power consumption in these end uses by 50% in 2010.

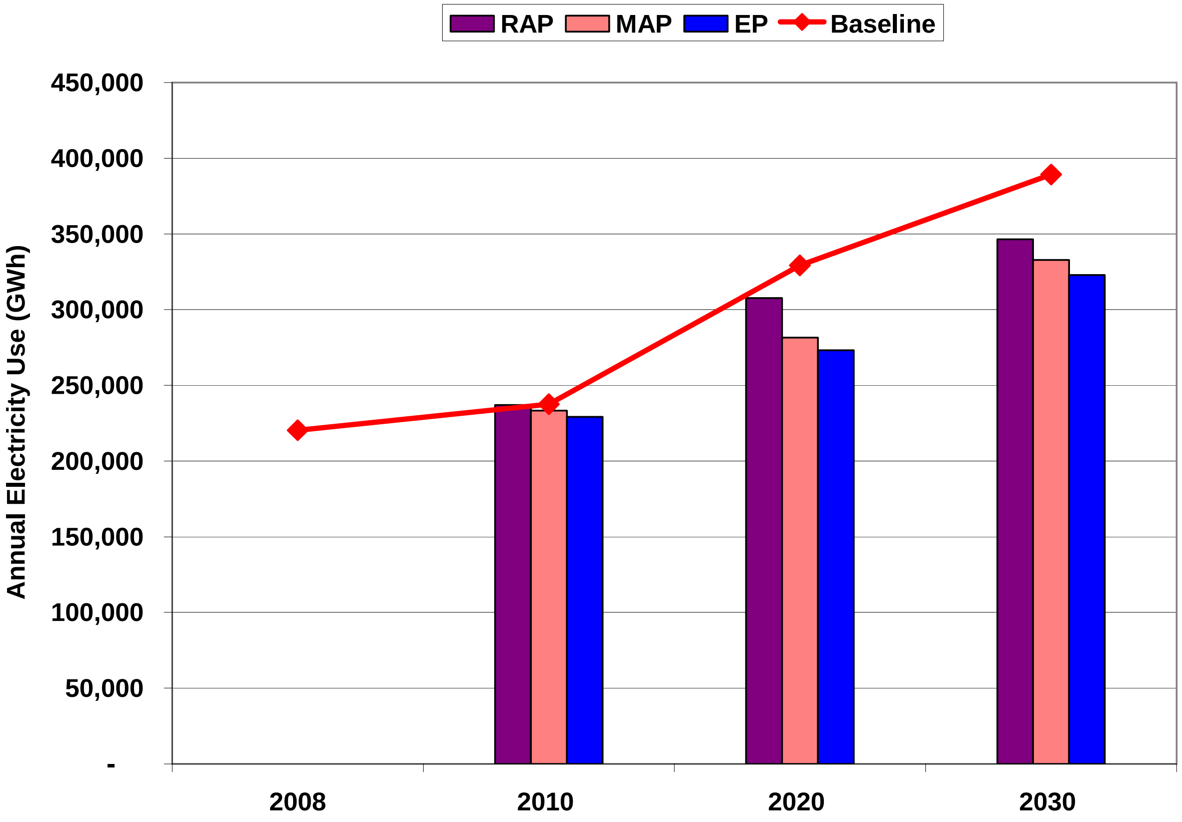

Figure 4-25
Commercial Office Equipment Potential Estimates

While the measures displayed in Figure 4-26 vary in the delivered service to the user, they have in common the central role of power management. Because the conversion of electricity from the AC line in conventional buildings to the low-voltage DC power necessary for electronic circuits is ubiquitous across all plug-in office equipment, it is reasonable to expect a spillover between these measures. While this effect is likely to be most pronounced in the collaborative approaches to engineering solutions on the part of equipment designers and manufacturers, it could also reasonably be extended to the realm of efficiency advocacy, policy-making, and marketing. Thus, the commercial office equipment measures have an advantage in the sense that they are bundled together. As an example, consider an individual responsible for the purchase of office equipment for a large building. As this person comes to understand the benefits of efficiency and builds connections with the vendors supplying efficient equipment, he/she is likely to acquire not only efficient PC’s, but also monitors, servers, copiers, and other powered office equipment.

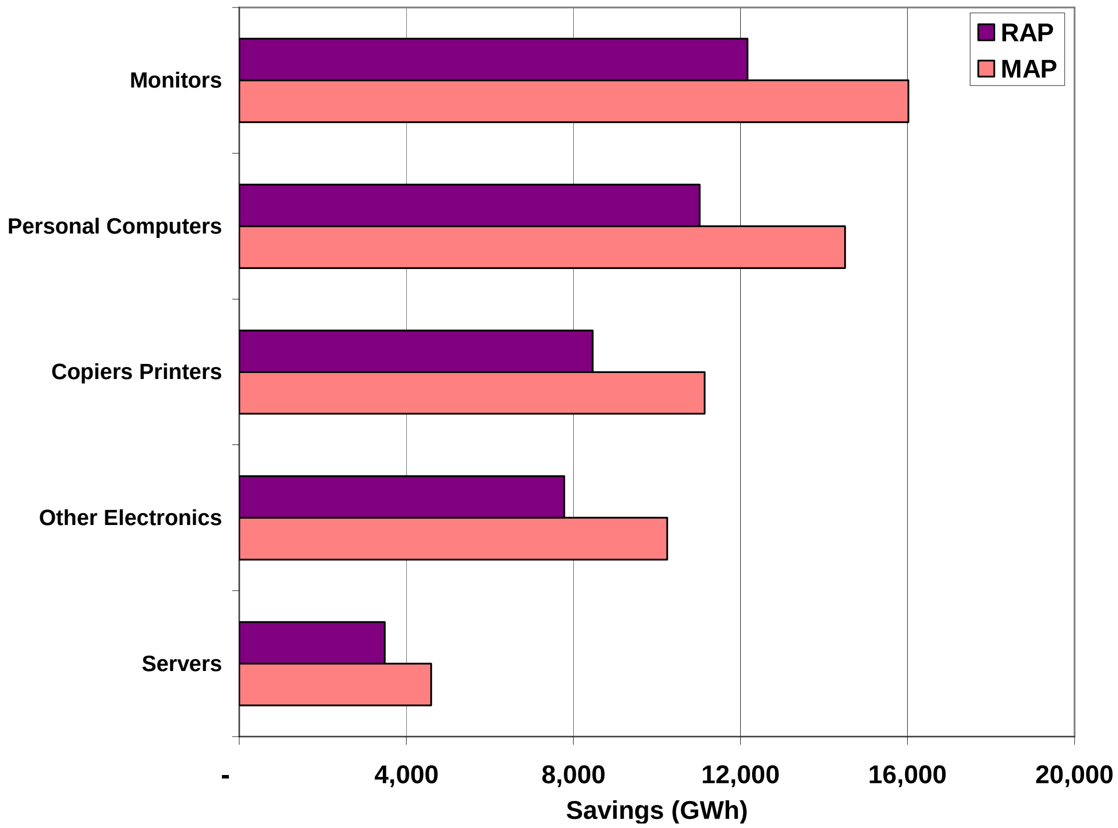

Figure 4-26
Commercial Office Equipment Energy Savings by Measure in 2030

Industrial Sector

While the residential and commercial sectors have been studied in detail and targeted through a range of DSM efforts over the past several decades, demand-side analysis of the industrial sector has traditionally maintained a more general approach. This is largely due to the highly specialized, complex and widely diverse energy-consuming systems and processes employed at industrial facilities, ranging from chemical production to metal reprocessing to production of specialized aerospace technologies. Without the detailed, almost site-specific data that extend beyond the scope of this study, it is necessary to analyze energy use in industrial applications at a generalized level, following the approach applied in most comparable forecasts.

The baseline electricity consumption, as evident in Figure 4-27, is dominated by motors and drives as well as process heating applications. Both energy use and potential savings associated with lighting and HVAC are minor in comparison.

Examination of the achievable potential savings by end use suggests a need for a change in the approach to industrial energy efficiency efforts. In an informal survey of DSM programs listed on the DSIRE database maintained by North Carolina State University, approximately 480 programs were listed as applying to the commercial *or* industrial sector. Of these programs, 53 define the eligible sector as commercial *and* industrial grouped together, often restricting participation by requiring a certain level of annual consumption or peak demand. To efficiently administer the programs and savings, an itemized approach is common, under which traditional and well-understood measures such as chiller compressor retrofits or High Intensity Discharge (HID) lamp replacements are rebated on a per-install basis with an assumed, "deemed" savings value. Such programs, though useful and proven effective, are inherently biased toward the end uses with the smallest impact on industrial energy consumption. They are incapable of obtaining savings through comprehensive, customized projects such as a redesigned process heat system or a novel pumping technology. Programs that target these types of "custom" efficiency measures, though capable of delivering significant savings, are much less common in existing DSM portfolios. For example, only three of the 480 programs surveyed are described as targeting *only* the industrial sector – Idaho Power and Light, the Ohio Department of Development, and Tillamook County PUD. While there are certainly more examples existing programs targeting the industrial sector and pursuing customized efficiency opportunities (e.g. California IOU's), there is significant potential for increased savings through this avenue.

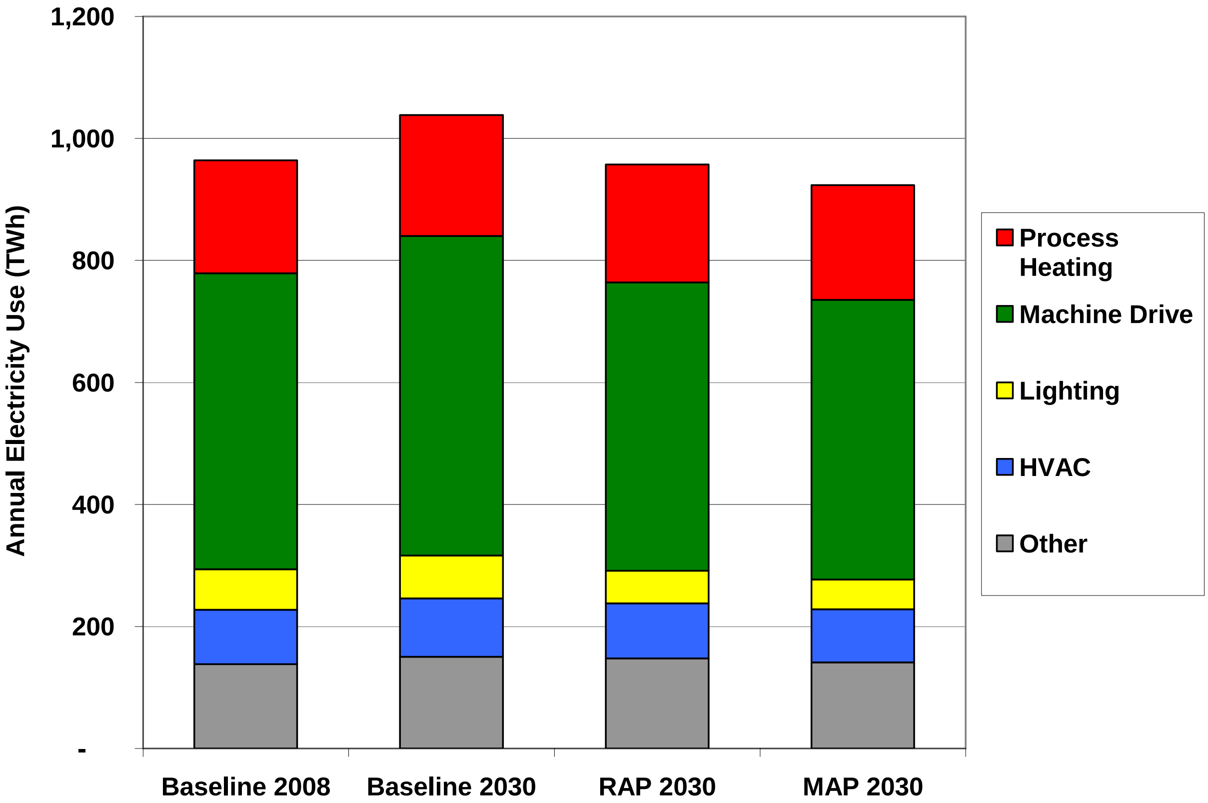

Figure 4-27
Industrial Sector Baseline and Potential by End Use

Industrial Sector Savings in Terms of Electric Intensity

Figure 4-28 displays the energy intensity for the various industrial end uses, calculated as annual electricity consumed per employee. Here it should be noted that the energy intensity is expected to decline between 2008 and 2030. The industrial sector is the only sector to follow this trend, despite lagging behind the residential and commercial sectors in terms of historical energy efficiency efforts. This decline in energy intensity is indicative of a mounting pressure on domestic industry in the form of both environmental and economic constraints. However, the industrial sector is capable of delivering even more savings.

Changing circumstances could represent a tremendous opportunity for growth in industrial energy efficiency, possibly leveraging other drivers such as climate change and high costs to encourage greater performance in the industrial sector. Emphasis on energy efficiency programs in the industrial sector could lead to a further reduction in energy intensity, as shown in the realistic and maximum achievable potential values in Figure 4-28.

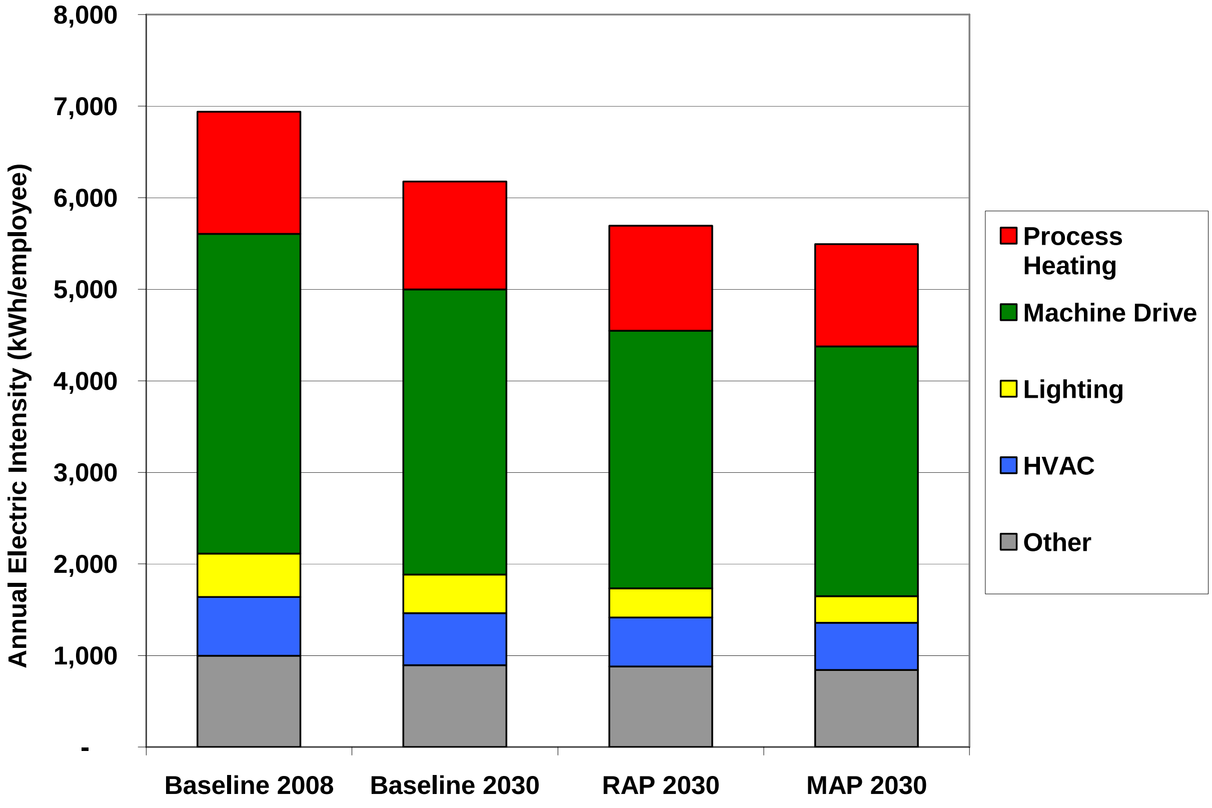

Figure 4-28
Industrial Energy Intensity by End Use

Industrial Sector Savings Potential by End Use

The potential savings are dominated by efficient motors and drives, as evident in Figure 4-29. While nearly 50 TWh of electricity savings by 2030 are substantial – comparable in magnitude to residential electronics and commercial office equipment – this value could be enhanced through the widespread adoption of a customized approach to industrial energy efficiency. In addition to machine drive, lighting upgrades in industrial facilities are capable of 18 TWh savings in 2030. This potential builds on the extension of existing "Large C&I" program efforts targeting both linear fluorescent and high-intensity discharge technologies.

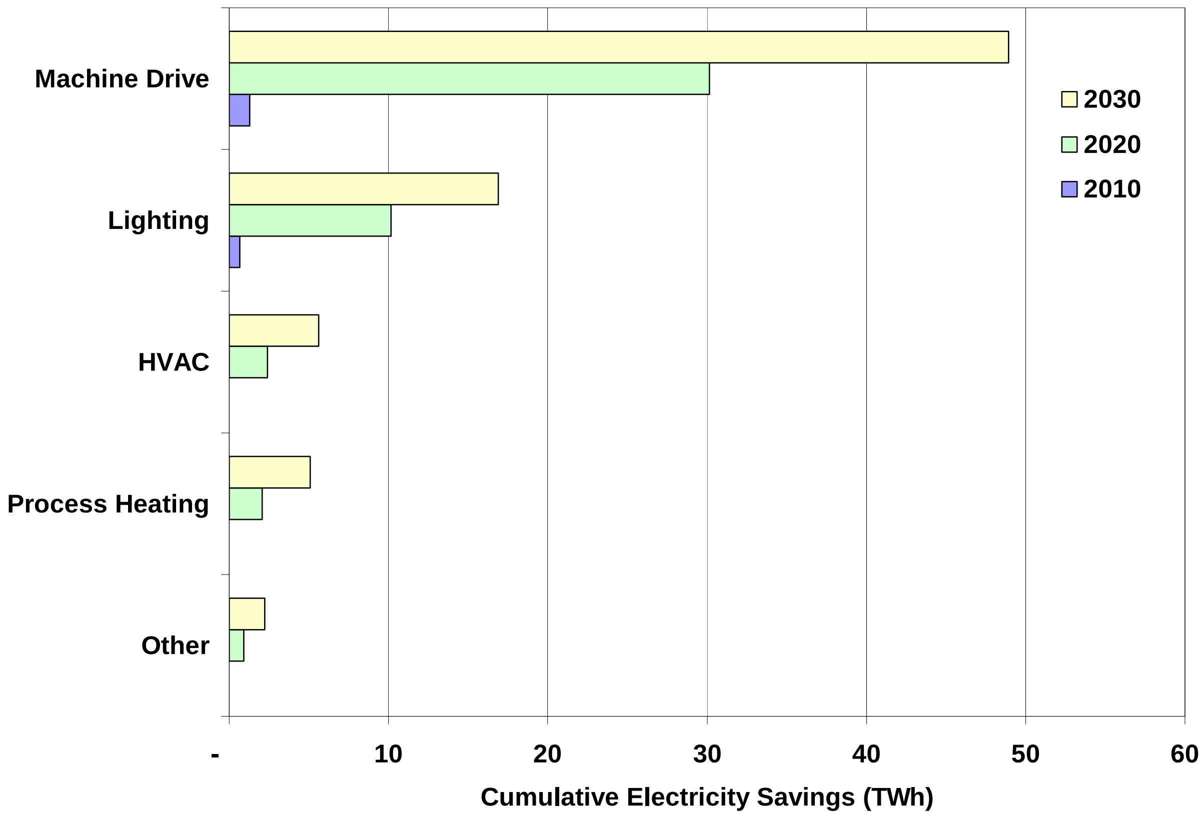

Figure 4-29
Industrial Realistic Achievable Potential by End Use

Industrial Motors and Drives

Representing the bulk of the electricity consumption in the industrial sector, motors and drives also present the greatest opportunity for achievable potential savings, displayed in Figure 4-30 in the context of the baseline forecast. Note the large disparity between maximum and realistic achievable potential in 2020, which closes by 2030 as barriers to implementing programs among industrial facilities are reduced through experience and collaboration.

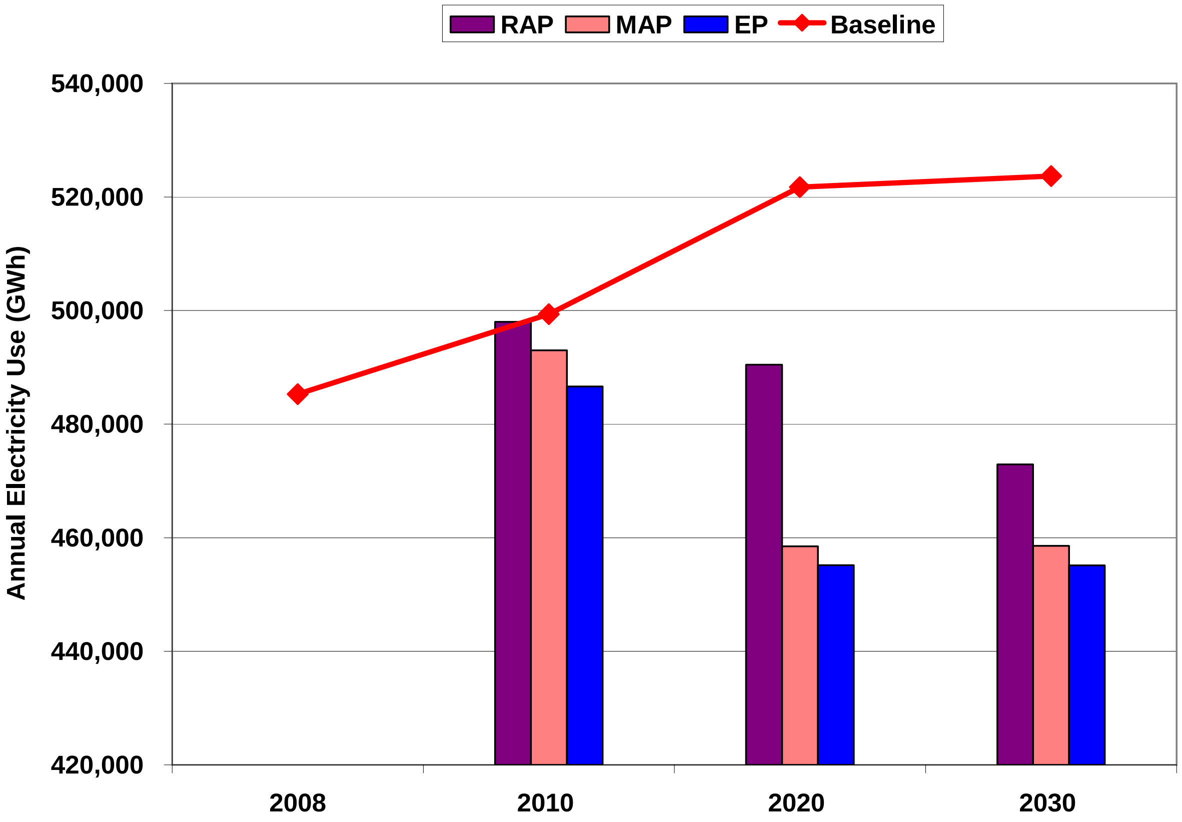

Figure 4-30
Industrial Motors and Drives Potential Estimates

Industrial Process Heating

As previously discussed, industrial process heating is highly specialized to the application, suggesting that the majority of the savings must be attained through custom projects. Several potential models could be applied:

- Utility-driven – collaboration between utility account representative and program managers lead to specific projects that provide energy savings and acceptable economic payback, often involving financial incentives
- Third-party contractors – utility hires industrial specialists to administer customized projects and deliver savings
- Price-based – industrial customers are offered more aggressive tariffs that provide opportunities for financial rewards for efficiency and load management

The potential for energy savings in process heating applications is presented in Figure 4-31. The inherent barriers to successfully executing customized efficiency projects are apparent in both the customer acceptance process (economic to maximum achievable potential) and the program implementation process (maximum to realistic achievable potential), leaving a realistic savings potential of only 26% of economic potential in 2030.

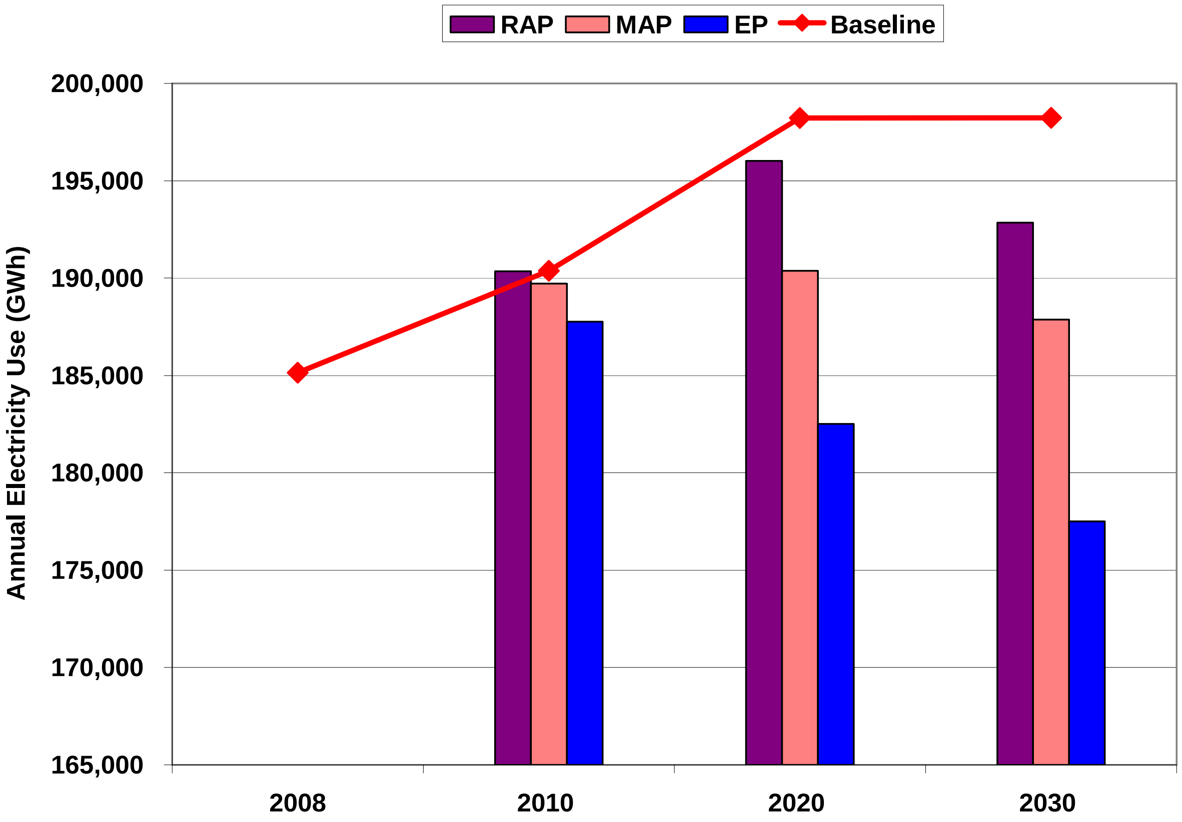

Figure 4-31
Industrial Process Heating Potential Estimates

Regional Analysis

While many of the trends in the baseline energy use and potential savings are evident at the national level, it is also useful to analyze the regional results. This provides a better understanding of the various components of the aggregate U.S. results reported in this section, in addition to providing greater insight to a reader interested in a specific geographic area. To aid this investigation, complete analyses for each of the four census divisions are included in Appendices A through D. The present section discusses the regional results comparatively and at a high level, rather than repeating the analysis by sector, end use and measure.

Figure 4-32 illustrates the realistic achievable potential in 2030 by region. The South makes up nearly half of the total savings, followed by the Midwest, West and Northeast. While the values vary greatly in absolute terms, it is illustrative to consider each savings estimate in the context of the relevant baseline forecast. These values are displayed as percentages of baseline in Figure 4-33. Here, the Northeast holds slightly more potential than the other regions, with the values for all four regions remaining close to the national average of 8.2%.

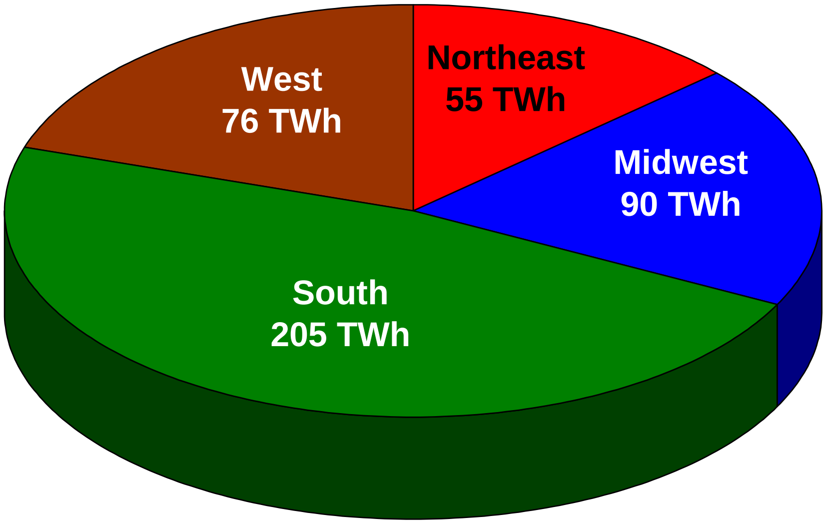

Figure 4-32
Realistic Achievable Potential in 2030 by Region

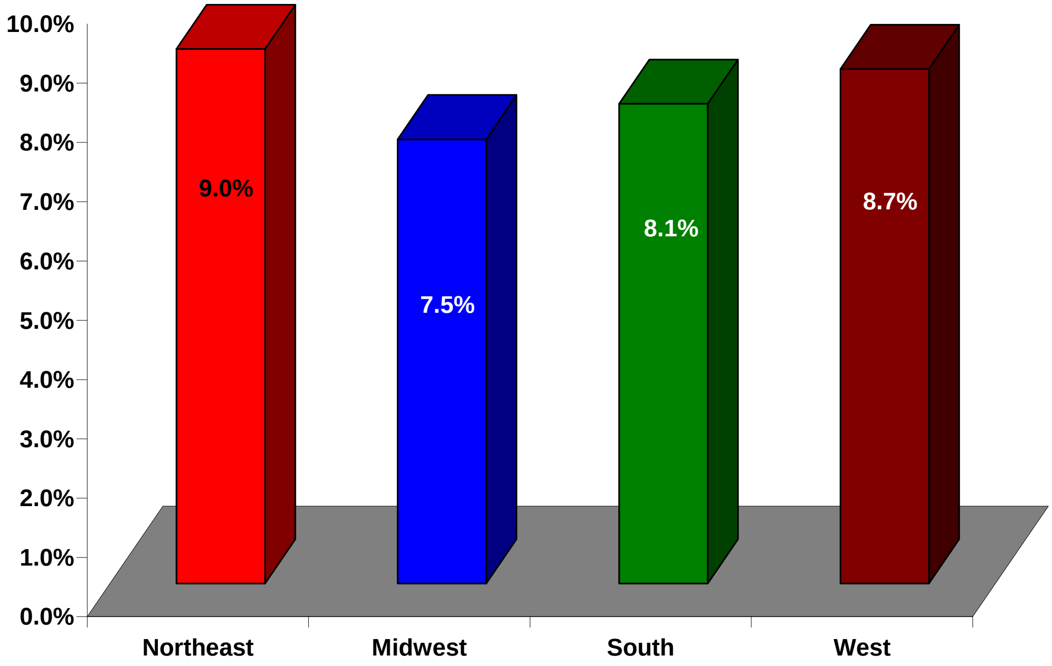

Figure 4-33
Realistic Achievable Potential in 2030 as Percentage of Regional Baseline

In addition to the overall savings magnitudes varying by region, there are also variations in the source of the savings. Figure 4-34 displays the absolute energy savings associated with the top five measures in each region. While commercial lighting dominates each region, the remaining spots are held by a combination of industrial motors and drives, residential and commercial cooling, commercial "other" (primarily office equipment) and residential electronics. The primary source of this variation is the composition of the regional baselines. For example, the share of the Northeast baseline forecast attributable to the industrial sector is small in comparison to that of the South or Midwest, leaving relatively fewer opportunities for energy savings in the motors and drives category.

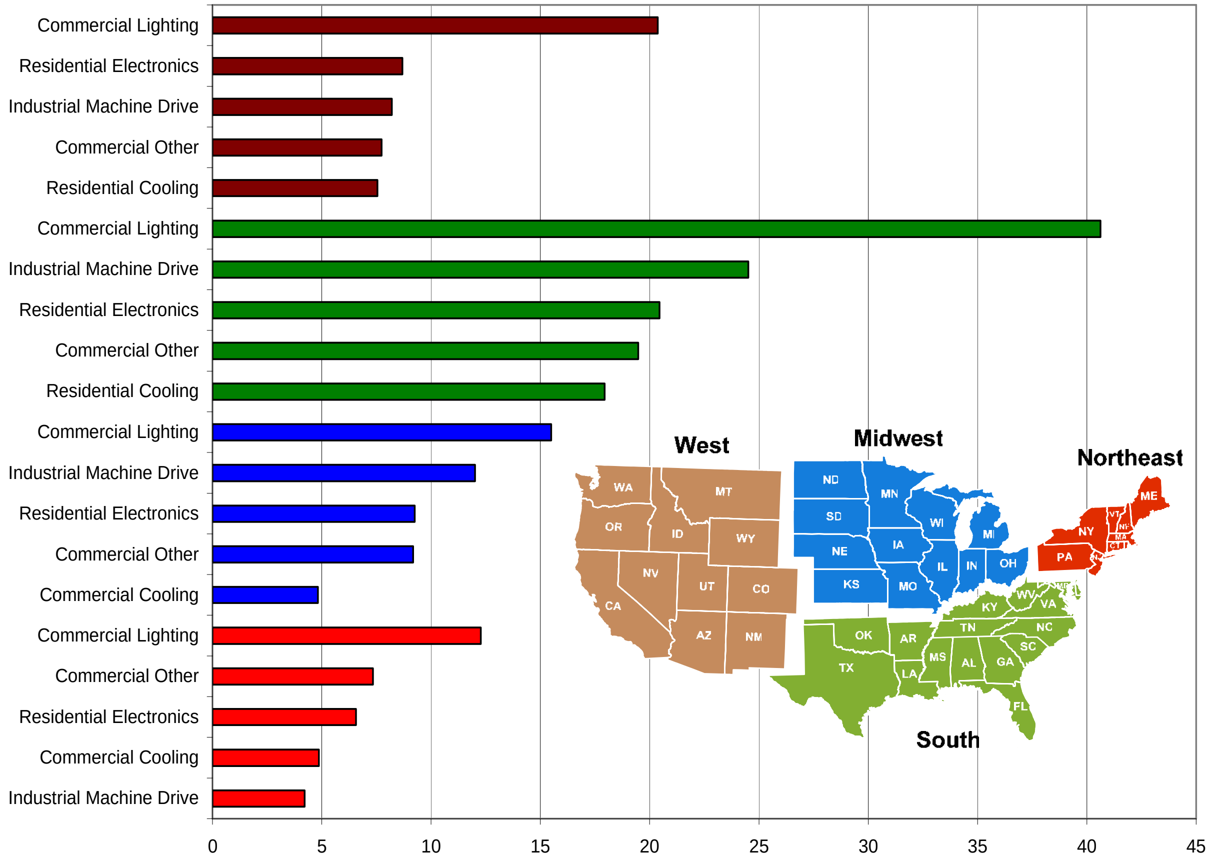

Figure 4-34
Realistic Achievable Potential in 2030 by Region and End Use

5

PEAK DEMAND REDUCTION POTENTIAL

Although closely tied to electricity consumption and based on the same end uses, peak demand is in many ways an independent quantity with its own unique set of conditions. For example, while electricity consumption is reported in total kilowatt hours used in a month or year, much the same way a conventional electric meter measures usage, peak demand is concerned with *which* kilowatt hours are used. The result is a distribution of crucial end uses and technologies that varies significantly from that of annual electricity consumption. Further, the drivers and motivating factors for peak demand reductions are often grounded in concerns over electric grid reliability and the economics of constructing new capacity. Because of this unique perspective, a different set of energy efficiency measures are emphasized and demand response programs are considered extremely valuable. This section discusses the results of the potential modeling for both energy efficiency measures and demand response on peak demand in the United States.

Summary of Peak Demand Results

The combined effects of energy efficiency and demand response on the potential for peak demand reduction for the United States as a whole are presented in Table 5-1. Figure 5-1 shows savings expressed as a percentage of the baseline forecast in the corresponding year. Similar to energy-efficiency savings, the peak demand savings also decrease as we moved from technical to achievable potential. It is interesting to note the magnitude of the technical potential estimate, which approaches 43% of the peak demand in 2030. This value does not include the savings associated with interruptible demand response programs, which could be assumed to accomplish 100% load shed when economic factors are not considered and therefore not applicable for technical potential. Although not typically thought useful as a practical guide, technical potential for peak demand reveals at a theoretical level the possibility of an extremely flexible electric load. Such flexibility is capable of not only reducing the need for new generation capacity, but also compensating for grid reliability problems under transmission-constrained scenarios or inconsistent generation output from a growing renewable power sector.

Table 5-1
Summer Peak Demand Savings from Energy Efficiency and Demand Response (GW)

	2010	2020	2030
Technical Potential			
Energy Efficiency	67	222	304
Demand Response	170	163	175
Total	237	385	479
Maximum Achievable Potential			
Energy Efficiency	11	82	117
Demand Response	30	66	101
Total	41	148	218
Realistic Achievable Potential			
Energy Efficiency	2	35	78
Demand Response	17	44	78
Total	18	79	157

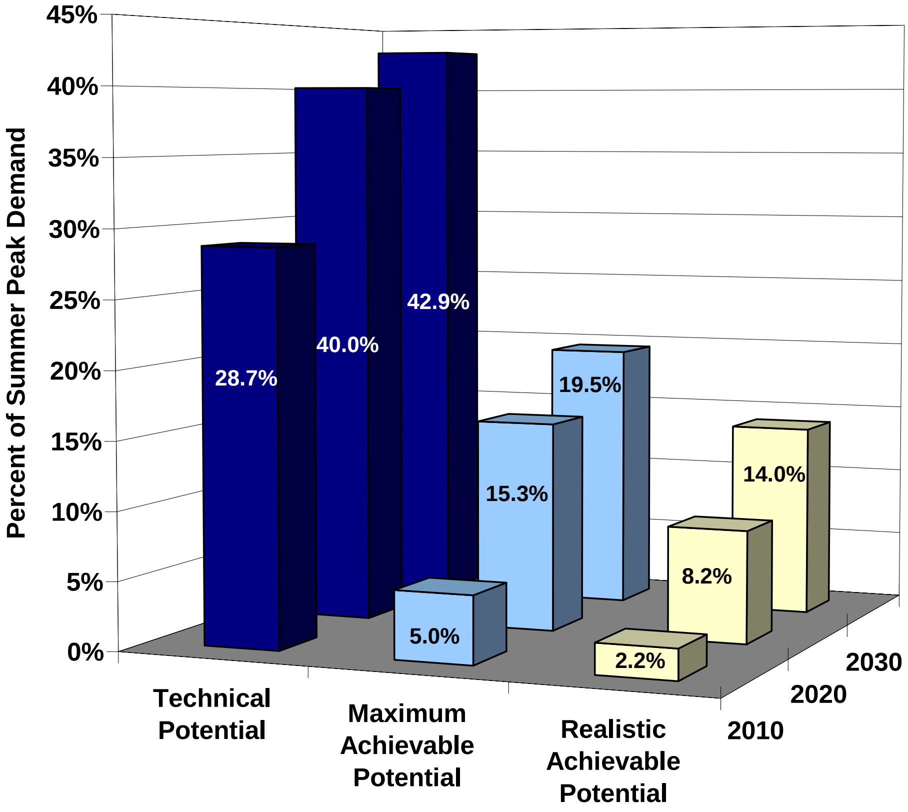

Figure 5-1
Summer Peak Demand Savings from Energy Efficiency and Demand Response

From a more practical perspective, the combined impacts of energy efficiency and demand response are realistically expected to reduce peak demand by 14.7% in 2030. These savings, approximately 164 GW at the national level, represent an offset of 52% of baseline load growth during the forecast timeframe. The effective result is a reduction of the average annual growth rate from 1.5% to 0.8%, as illustrated in Figure 5-2. As the attention of utility planners and system operators continues to look to efficiency and demand response as the most cost-effective approach to meeting capacity requirements, these savings will play an increasingly important role in the electric power industry of the future.

Also apparent in Figure 5-2 is the makeup of the savings when compared to energy efficiency. While several measures considered in this study, such as personal electronics and refrigerators, derive large energy savings by a small reduction in power intake over many hours, others are more directly coupled to peak demand. Measures reducing the electric consumption involved in cooling buildings, for example, provide maximum savings during summer peak hours, corresponding to relatively high peak demand reductions. In addition, demand response options are defined by their performance during periods of peak demand. Each of these contributions is assessed below.

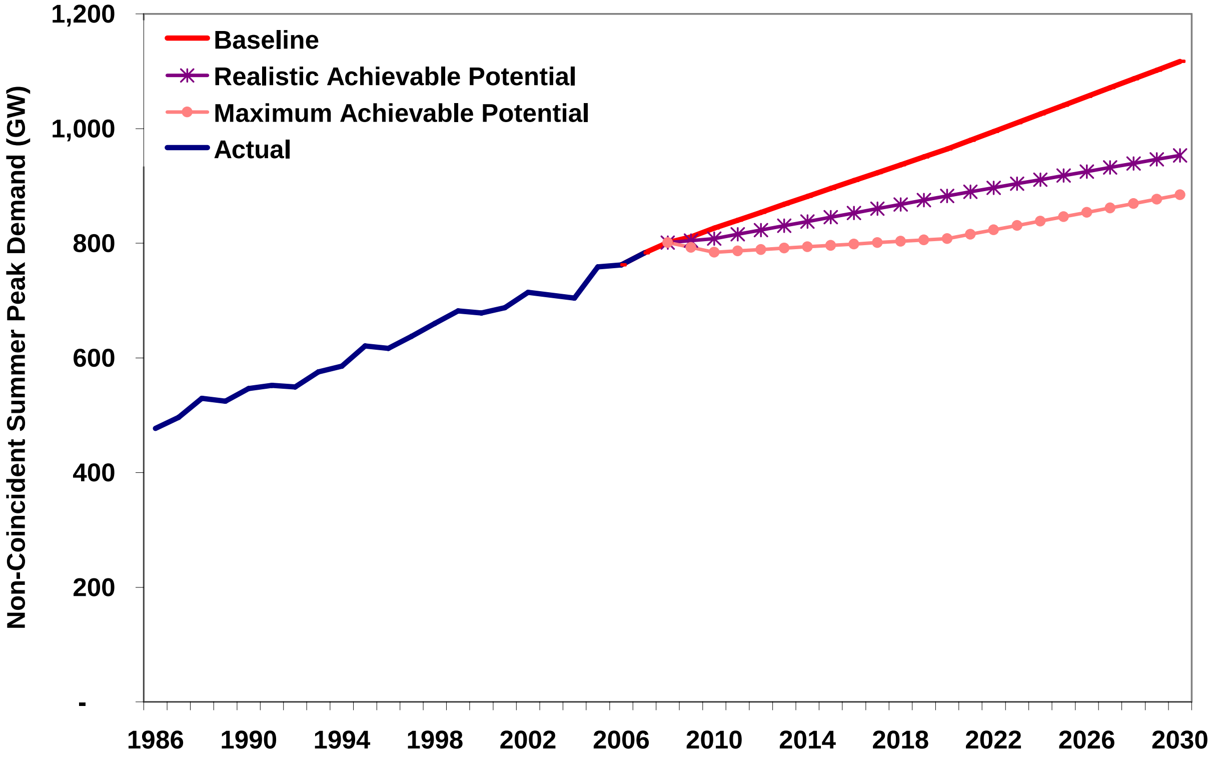

Figure 5-2
Peak Demand Potential Reductions in Context of Baseline Forecast

Peak Demand Savings Resulting from Energy Efficiency Programs

Utilizing the same measures, economic screening process, and end-use modeling approach, the peak demand impacts from energy efficiency are expected to resemble the energy savings, at least qualitatively. This parallel is evident in Figure 5-3, which displays technical, maximum achievable, and realistic achievable potential peak demand reductions through energy efficiency. A realistic achievable potential of 7.7% is estimated for 2030, compared to 8.6% in the case of energy savings. This difference results from the level of coincidence with the summer peak inherent in each measure, as well as the relative capability by advocates to market and implement energy efficiency measures with a high load factor.

Also apparent in Figure 5-3 is the flattening of the potential estimates after 2020, again reflecting a bias toward technologies currently available and deployed commercially. As in the case of energy consumption, an extrapolation of innovation and technological research throughout the forecast horizon could result in peak demand reductions significantly greater than those estimated here.

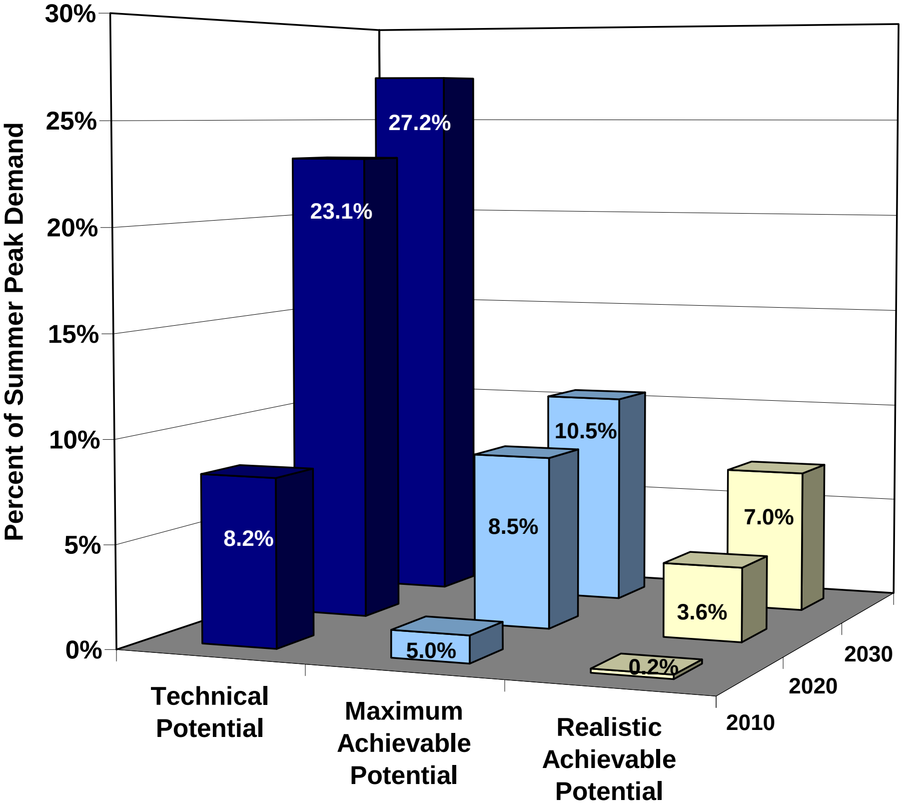

Figure 5-3
Peak Demand Reduction from Energy Efficiency

The makeup of the potential peak demand reductions through efficiency is displayed in Figure 5-4 and Table 5-2, which reports realistic achievable potential by sector and end use. The difference between peak demand and energy can be seen in the dominance of cooling in both the residential and commercial sectors. Driving an increasing fraction of summer peak demand, cooling has become a primary target for energy efficiency programs in areas where peak capacity shortfall is an issue. As discussed in the previous section, cooling measures in the modeling are heavily constrained by economics; among residential central air conditioners, only units with SEER 14 and 15 pass the economic screen and are included in the economic potential estimate. With additional research, development, and demonstration of efficient cooling technologies, many of which are technically available today, the incremental costs are expected to fall, opening the door for a large impact on both energy and peak demand from savings in cooling.

In addition to cooling, industrial machine drive is a significant contributor to realistic achievable potential. In many cases, motors and other electromechanical systems operate continuously, resulting in a full load during peak hours. In addition, the timing of peak hours during the afternoon of summer days generally coincides with operational schedules constrained by labor availability and production deadlines. For these reasons, efficiency measures targeting motors and drives deliver substantial peak demand reductions in addition to energy savings.

Table 5-2
Summer Peak Demand Savings from Energy-Efficiency Measures

	2010	2020	2030
Residential			
Cooling	276	7,691	20,972
Appliances	52	1,856	5,321
Water Heating	178	1,653	3,502
Furnace Fans	7	478	1,267
Lighting	236	575	1,050
Electronics	14	332	667
Space Heating	-	-	-
Total	764	12,585	32,779
Commercial			
Cooling	159	6,859	16,205
Lighting	192	2,454	4,251
Other	59	1,795	3,494
Ventilation	27	680	1,484
Refrigeration	2	66	148
Water Heating	0	16	38
Space Heating	-	-	-
Total	440	11,870	25,620
Industrial			
Machine Drive	297	7,525	13,984
Lighting	131	2,197	4,242
HVAC	4	341	976
Process Heating	3	205	617
Other	1	81	247
Total	437	10,350	20,065

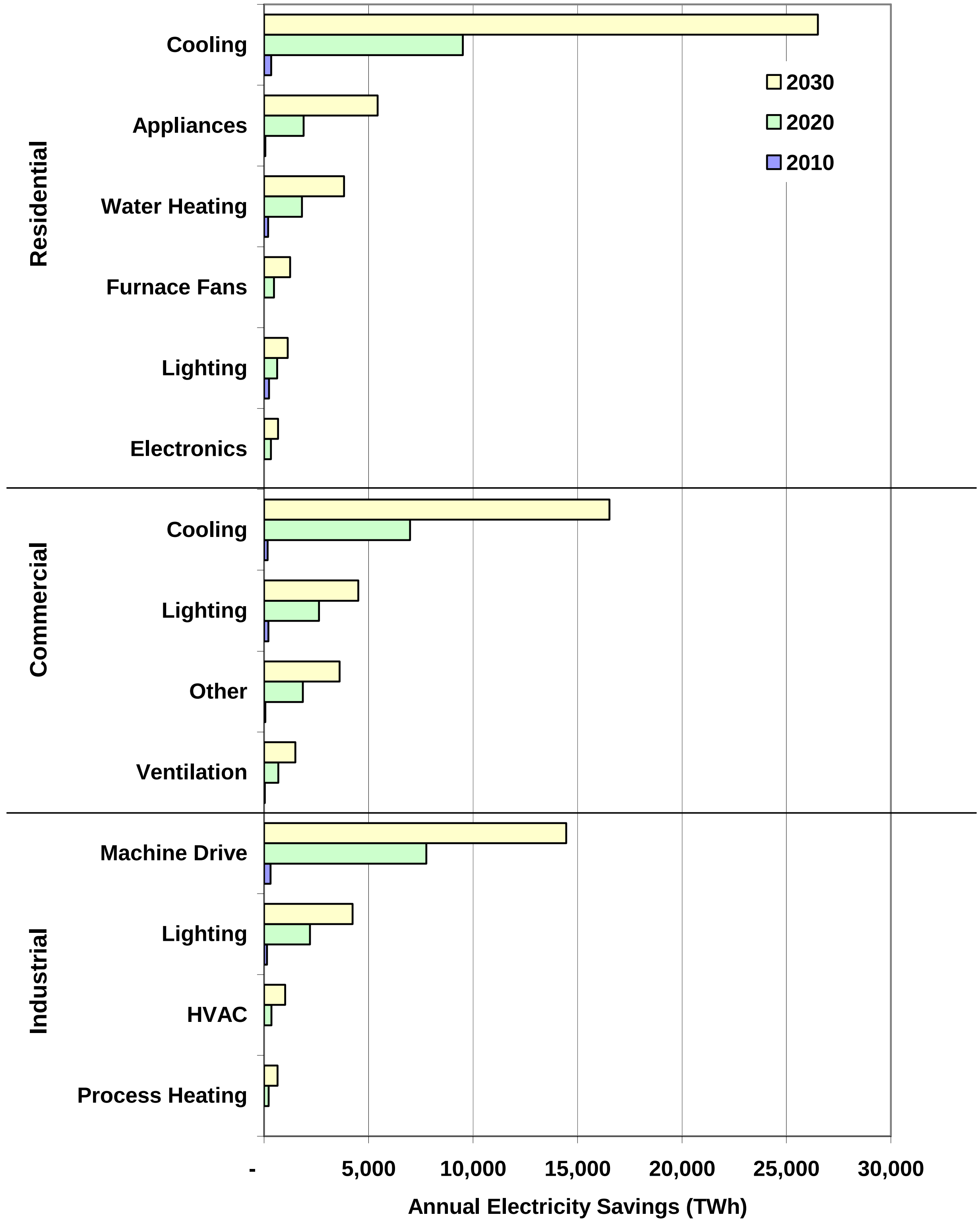

Figure 5-4
Realistic Achievable Peak Demand Reductions through Energy Efficiency Measures

Demand Response Impacts

Figure 5-5 illustrates the potential reductions in peak demand estimated to result from demand response efforts during the forecast horizon. While this study does not represent an attempt at rigorous modeling of demand response as a stand-alone concept, it is important that both efficiency and demand response are considered together in order to estimate the potential for peak demand reduction.[17]

The decreasing technical potential values over time in Figure 5-5 are a result of the interaction between the two different avenues of peak reduction considered – energy efficiency and demand response. When technical potential due to energy efficiency is still reasonably small in the early forecast years, the baseline peak demand available for demand response participation is high. In 2020 and 2030, when the technical potential of energy efficiency reaches nearly 30% of baseline demand, the portion available for demand response diminishes, reflected as a decreasing percentage in technical potential. Because market acceptance constraints and programmatic barriers mitigate the peak demand impacts on achievable potential through energy efficiency, this trend is reversed under the maximum and realistic achievable potential estimates for demand response.

Another distinction between the evolution of the potential estimates due to energy efficiency and demand response is the time required for impacts to take effect. While efficiency measures are tied to the installation of specific equipment and requires a phase-in approach limited by turnover, demand response could be adopted much more quickly. For instance, an ancillary services program administered by an independent system operator could be launched "on paper" and nearly instantaneously, creating the opportunity for proactive industrial energy managers to profit from demand reductions and for third-party aggregators to recruit customers and amass responsive load. This trend is evident in the large savings impacts in 2010 and 2020 displayed in Figure 5-5.

Under the achievable potential estimates, market acceptance and barriers to program implementation refine the technical potential to values in closer agreement with the experience of existing demand response programs. As general consumer awareness increases over time, along with the progression of demand response implementation through a "learning curve" relating to programmatic barriers, potential estimates can be expected to approach the technical and economic limits. By 2030, the achievable savings attainable through existing demand response mechanisms range from 7 to 9%.

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[17] For a more detailed treatment of the potential for demand response in the U.S., the reader is referred to a study on the subject commissioned by FERC, expected in June 2009.

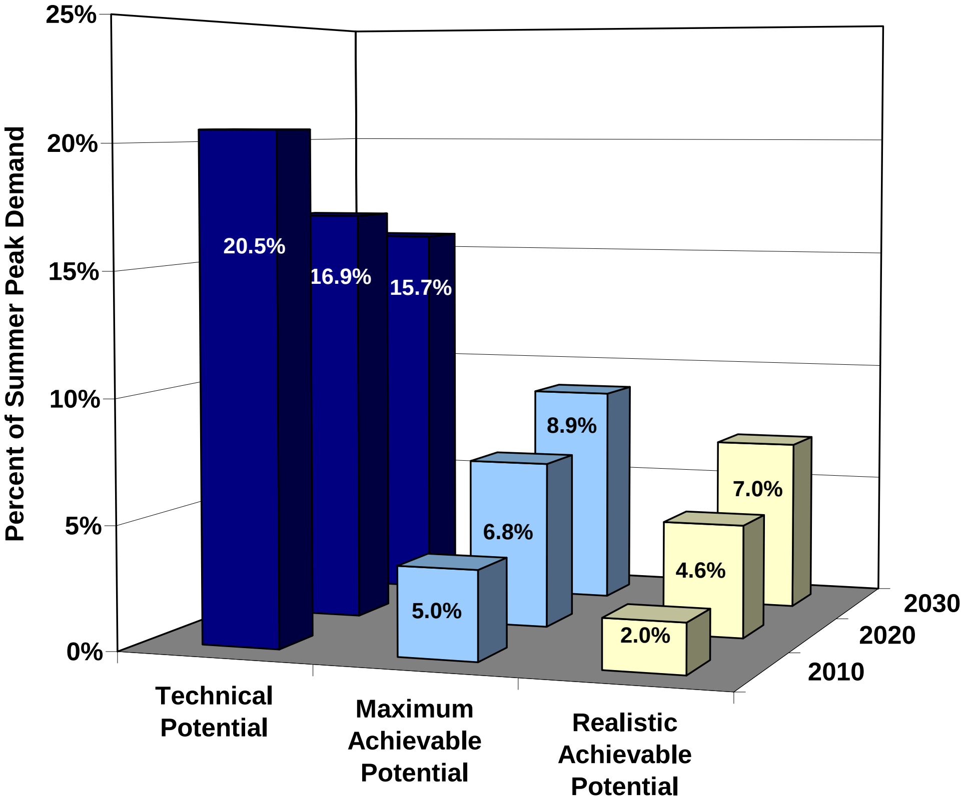

Figure 5-5
Peak Demand Reduction from Demand Response

In addition to analyzing the demand response potential as a whole, it is useful to examine the contributions of the various sectors and program types. This resolution is provided in Figure 5-6, which lists each of the demand response options considered in the study along with its realistic achievable potential.

As outlined above in the discussion on modeling approach, the order in which these program options were treated introduces a bias into the results shown here. For instance, direct load control, often applicable to only a few distinct end uses, was first calculated and the impacts subtracted from the remaining available peak demand. At this point, the potential attributable to pricing options was estimated, based in part on the total peak demand after accounting for the impacts of first energy efficiency and then direct load control. This process was then repeated for interruptible programs. Thus, the demand response program types are prioritized as follows:

1. Direct load control
2. Price-response
3. Interruptible programs

Although this bias complicates the relative distribution between program types in the potential estimates, it is necessary to adopt a loading order to avoid double counting program impacts.

It should be noted that despite the bias toward direct load control, price-based and interruptible programs (including demand bidding and emergency load response) are estimated to deliver significant peak demand reductions, especially in the commercial and industrial sectors. In contrast to direct load control, in which the implementer must understand power requirements at an end use level and manage load accordingly, the price-response and interruptible programs assign responsibility for decision-making to the end-use customers themselves, typically allowing for a more comprehensive approach to peak demand reductions.

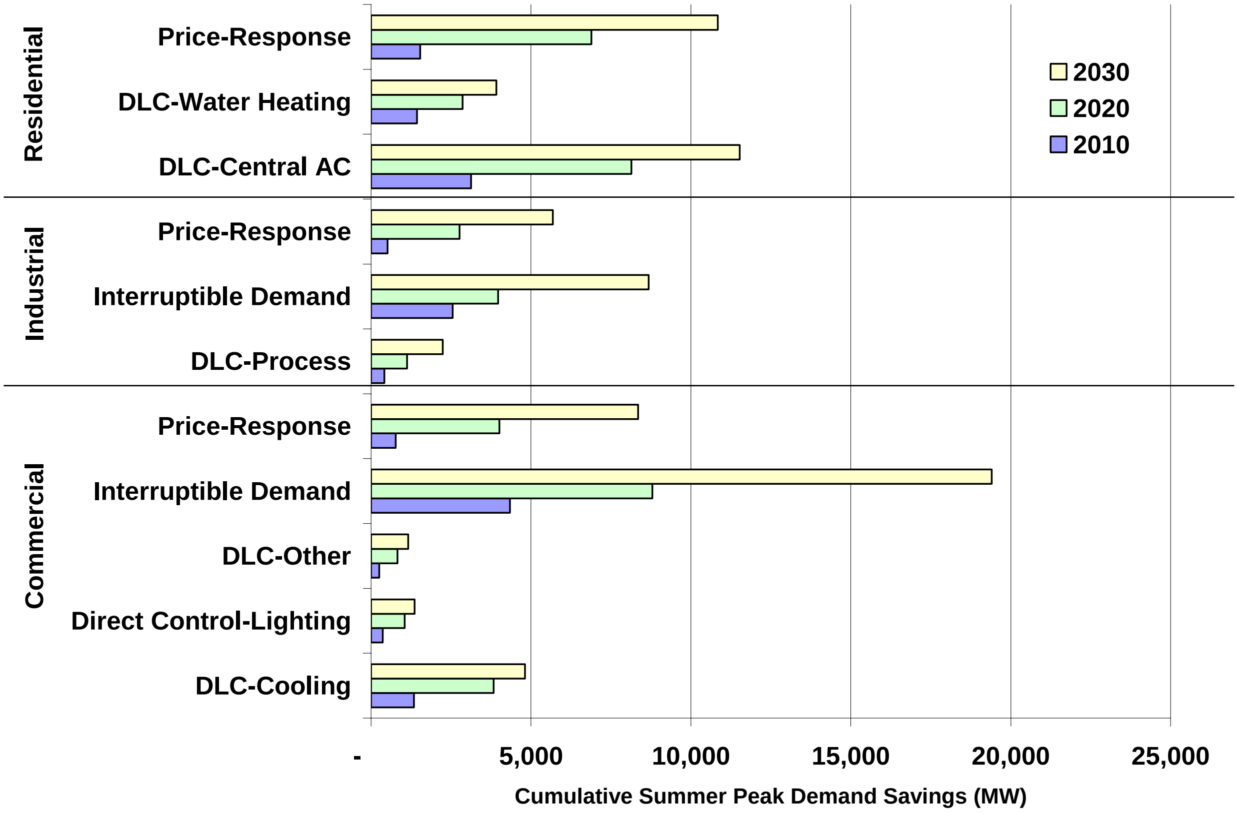

Figure 5-6
Realistic Achievable Peak Demand Reduction through Demand Response Programs

6

THE COST OF ACHIEVABLE POTENTIAL

A natural question that arises from any discussion of energy efficiency potential is "how much will it cost?" This chapter provides estimates of the costs associated with the implementation – promotion and delivery – of energy efficiency and demand response programs throughout the U.S. over the time horizon of this study to realize the achievable savings potential.

Our analysis covers the derivation of representative unit costs per kWh and kW saved, a comparison of these types of cost figures relative to the various studies reviewed as part of this study, and the total projected cost correlated with the projected savings.

Unit Cost Estimates

Our analysis was initiated by drawing upon measure-level cost data that was used to support a November 2006 Electricity Journal article on electricity end-use energy efficiency potential (Gellings, et. al.)[18]. In that assessment, equipment, installation and enablement costs were represented for a wide variety of energy efficiency and demand response measures. These costs were used to construct energy efficiency and demand response supply curves.

Our analysis weight-averaged the measure-specific costs within each of the sectors (residential, commercial, and industrial) using the total potential savings associated with each measure as a basis for the weight within the sector. A similar approach was then taken to represent the average cost across all sectors. These costs then were represented as the one-time equipment, installation and enablement costs. The cost for program administration was added to the one-time equipment cost to represent the full implementation costs. The administration adder was assumed to be 15%.[19] To normalize those costs over the lifetime of the measures, a lifecycle cost analysis (with a 10% discount rate) was performed. The assumed program lifetime for the analysis was 10 years.[20] The cost figures are represented in Table 6-1 below. It should be noted that for demand response measures, the costs do not include the incentive costs associated with the various price response tariffs. Demand response however do account for the costs of smart meters and the

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[18] Gellings, Clark, Greg Wikler, Debyani Ghosh. "Assessment of U.S. Electric End-Use Energy Efficiency." The Electricity Journal. Vol. 19, Issue 9. November 2006.

[19] Program administration costs as a percentage of total measure costs range from 5-20%, depending on the size of the energy efficiency program, the region of the country and the experience of the implementation entity. We assumed 15% as a representation of the composite program administration cost adder.

[20] Measure lifetimes range from 5 to 20 years, depending on the sector (residential, commercial or industrial) and type of measures that are promoted in the program. We assume 10 years as a representation of the composite measure life.

associated data management systems that would be required to track and monitor demand response events in a timely manner.

Table 6-1
Unit Cost of Energy Efficiency and Demand Response Measures

Year	Levelized Cost for Energy Efficiency Measures ($/kWh)	Levelized Cost for Demand Response Measures ($/kW-year)
2010	$0.0217	$50.70
2020	$0.0264	$61.81
2030	$0.0322	$75.34

Comparison of Cost Estimates

We compared the cost estimates reflected in Table 6-1 relative to the benchmark studies of energy efficiency potential discussed in Chapter 9. We also compared our estimates to planned energy efficiency implementation efforts by the investor-owned electric utilities in California – Pacific Gas & Electric, Southern California Edison, and San Diego Gas & Electric. From the energy efficiency studies that we reviewed only two points of reference for cost were identified.

- The first was from a study conducted by the Midwest Energy Efficiency Alliance (MEEA)[21]. Tables 5-6 and 5-11 in the MEEA study reports on the distributions of residential sector energy efficiency potentials by cost category. We calculated an average levelized cost of energy efficiency from this study of $0.10/kWh.
- A second study, conducted by ACEEE on energy efficiency potential in Florida, indicates a levelized cost of electricity saved for residential energy efficiency programs in that state of $0.035/kWh.[22]
- Finally, we conducted a review of the planned expenditures by the California investor-owned utilities during the 2009-11 energy efficiency program cycle. Projected expenditures of approximately $1.2 billion per year are expected to yield annual savings of 2,465 TWh.[23] We calculated an average levelized cost of $0.07/kWh.

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[21] Midwest Energy Efficiency Alliance. “Midwest Residential Market Assessment and DSM Potential Study”. Sponsored by Xcel Energy. March 2006.

[22] American Council for an Energy-Efficient Economy. “Potential for Energy Efficiency and Renewable Energy to Meet Florida’s Growing Energy Demands.” Report Number E072. June 2007.

[23] Cost projections based on reviews of PG&E and SCE program plans for 2009-11; SDG&E amounts estimated based on historical trends. Energy savings for 2010 based on CPUC Proposed Decision dated 7/1/08 (Docket # R.06-04-010), Table 3.

Total Projected Cost

The projected cost of the energy efficiency and demand response maximum achievable potential was calculated based on the results of the various analyses described above. No ranges for demand response measures are provided due to limited available benchmark data on DR program costs. Table 6-2 reports the range of total implementation costs for the maximum achievable potential case, and Table 6-3 reports the corresponding costs for the realistic achievable potential case.

Table 6-2
Estimated Cost Range for Energy Efficiency and Demand Response Program Portfolio Maximum Achievable Potential

Year	Energy Efficiency Measures (Billion $)	Demand Response Measures (Billion $)	Total Cost (Billion $)
2010	$1.73 to $5.49	$1.51	$3.24 to $7.00
2020	$11.57 to $33.67	$4.07	$15.64 to $40.74
2030	$17.52 to $55.51	$7.62	$25.13 to $63.13

The projected implementation cost for energy efficiency and demand response efforts to realize the maximum achievable potential ranges from a low of $3 billion and a high of $7 billion in 2010. By 2020, those costs are projected to increase to a low of $16 billion and a high of nearly $41 billion. By 2030, the cost grows further to a low of $25 billion and a high of over $63 billion.

Table 6-3
Estimated Cost Range for Energy Efficiency and Demand Response Program Portfolio Realistic Achievable Potential

Year	Energy Efficiency Measures (Billion $)	Demand Response Measures (Billion $)	Total Cost (Billion $)
2010	$0.46 to $1.44	$0.84	$1.30 to $2.29
2020	$5.47 to $17.33	$2.74	$8.21 to $20.07
2030	$12.81 to $40.61	$5.91	$18.72 to $46.52

The estimated cost ranges for both the Maximum Achievable Potential and Realistic Achievable Potential are depicted graphically in Figure 6-1.

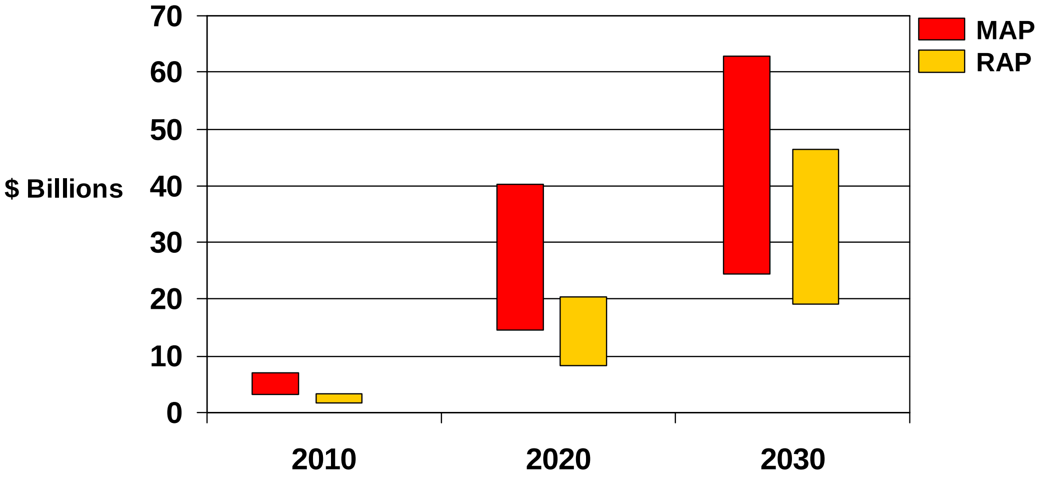

Figure 6-1
Estimated Cost Ranges for Maximum- and Realistic- Achievable Potentials

7

COMPARISON WITH OTHER STUDIES

For several decades, utilities, and states, and regional entities have commissioned studies of energy efficiency potential in their respective territories. This body of literature encompasses a wealth of empirical data on energy efficiency technologies and programs, as well as expositions of various approaches to conducting such potential studies. Organizations and professional services firms have developed great proficiency in conducting such studies over the years, and the lessons learned from prior studies serve to assist future endeavors. Indeed, as a document prepared for the public domain, this study is intended to contribute to the industry's knowledge base and assist future studies of electric end-use efficiency potential studies. To provide context for this study, the chapter discusses several recent noteworthy potential studies and compares and contrasts their methodologies and results with those herein.

Energy-Efficiency Estimates

Two dozen prominent energy efficiency potential studies from the past seven years were assembled and screened to provide a basis of comparison to the present study. Out of these studies, the following seven were selected for detailed review and comparison, based on their scope, reputation, currency, and diversity of approaches and geographical coverage areas:

1. Energy Efficiency's Role in a Carbon Cap-and-Trade System: Modeling Results from the Regional Greenhouse Gas Initiative. American Council of Energy Efficient Economy, Report Number E064, May 2006.
2. CEC, 2007. *Statewide Energy Efficiency Potential Estimates and Targets for California Utilities*. Draft Staff Report. CEC-200-2007-019-SD, August 2007.
3. *Midwest Residential Market Assessment and DSM Potential Study*. Commissioned by the Midwest Energy Efficiency Alliance. March 2006.
4. *Energy Efficiency Task Force Report by the Western Governor's Association – Clean and Diversified Energy Initiative*. January 2006
5. *Potential for Energy Efficiency and Renewable Energy to meet Florida's Growing Energy Demands*. ACEEE Report No. E072, June 2007.
6. *Role of Energy Efficiency and Onsite Renewables in Meeting Energy and Environmental Needs in the Dallas/Fort Worth and Houston/Galveston Metro Areas*. American Council of Energy Efficient Economy, Report Number E078, September 2007.
7. *Reducing U.S. Greenhouse Gas Emission: How Much at What Cost?* McKinsey & Company, U.S. Greenhouse Gas Abatement Mapping Initiative Executive Report, December 2007.

The selection of these studies was based on the following criteria:

- **Geographical coverage**. The seven studies represent a wide geographical coverage of the nation. Figure 7-1 shows the areas covered by the seven different studies we reviewed. Aside from the McKinsey study which was national in scope, the other studies did not represent some of the southern states along with Pennsylvania.
- **Robust methodology**. Each of the seven studies had a detailed and robust methodology to arrive at their potential estimates.
- **Timing of the study**. Each of the seven studies the latest available studies on potential estimates for the different regions.

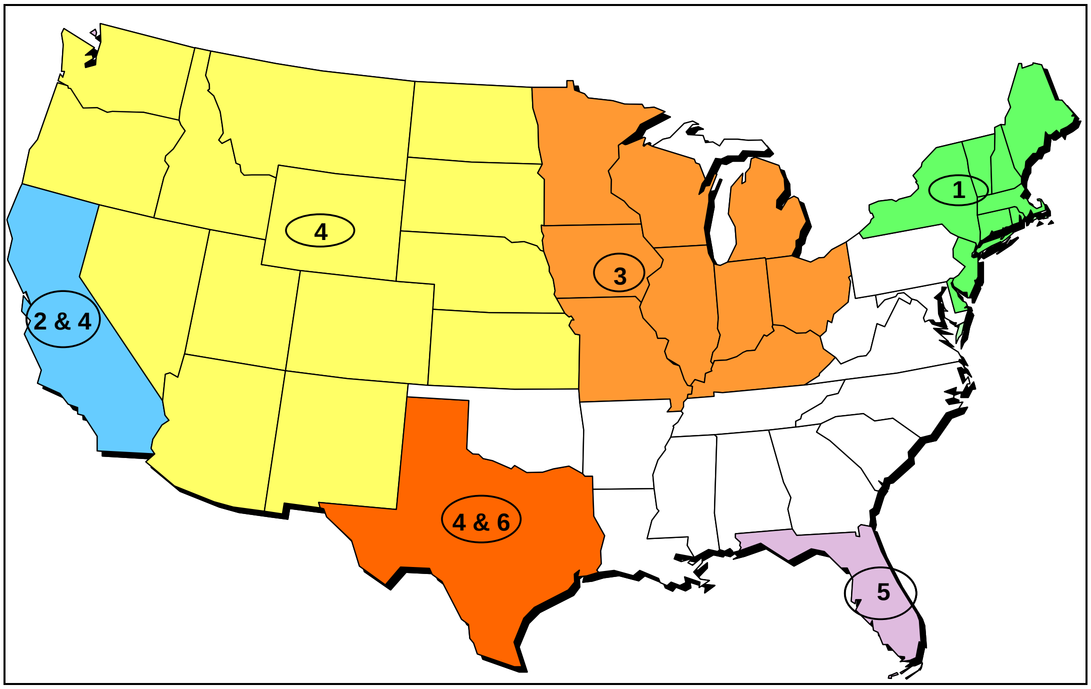

Figure 7-1
Geographic Coverage of the Seven Energy Efficiency Potential Studies[24]

We describe each of the six studies briefly below.

- Study 1- *Energy Efficiency's Role in a Carbon Cap-and-Trade System: Modeling Results from the Regional Greenhouse Gas Initiative*. American Council of Energy Efficient Economy, Report Number E064, May 2006.

  This study estimates the economic and achievable potential for a number of northeastern states over the period 2005 to 2025. The states covered include Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New Jersey, New York and Delaware. The economic potential estimates range between 26-31% for the entire time period covered

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[24] Note that the seventh study (i.e., the McKinsey study) addresses all states in the U.S.

in the study for the entire region. The achievable potential is estimated at two-thirds of the economic potential.

- Study 2- *Statewide Energy Efficiency Potential Estimates and Targets for California Utilities*. Draft Staff Report. CEC-200-2007-019-SD, August 2007.

  The California Energy Commission (CEC) staff report provides estimates of the technical, economic, and achievable potentials for the state of California in the year 2016. These savings estimates are aggregated from individual utility data from all utilities in the state. Results from this study indicate that the technical potential is 23%, economic potential is at 18% and the achievable potential is at 9%.

- Study 3- *Midwest Residential Market Assessment and DSM Potential Study*. Commissioned by the Midwest Energy Efficiency Alliance. March 2006.

  This study, sponsored by the Midwest Energy Efficiency Alliance (MEEA) estimates both technical and achievable potential for the residential sector only in the Midwest region. The states covered in this study are Indiana, Kentucky, Michigan, Minnesota, Missouri, Illinois, Wisconsin, Iowa and Ohio. The potential estimates are provided for a single year, which is 2025. The technical potential for the residential sector is estimated at close to 24%, while the achievable potential estimate is close to 10%.

- Study 4- *Energy Efficiency Task Force Report by the Western Governor's Association (WGA) - Clean and Diversified Energy Initiative*. January 2006

  This study provides estimates of the energy savings potential for 18 western states that belong to the WGA. These states include Alaska, Arizona, California, Colorado, Hawaii, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming. The study estimates achievable potential for the three years- 2010, 2015 and 2020 at 7%, 14%, and 20%, respectively.

- Study 5- *Potential for Energy Efficiency and Renewable Energy to meet Florida's Growing Energy Demands.* ACEEE Report No. E072, June 2007.

  This study, conducted for the state of Florida alone, provides estimates of the achievable potential in the state for the years 2013 and 2023. Based on the electricity sales forecast and the electricity savings projections in the study, the achievable potential is estimated to be 6.6% for 2013 and 20% for 2023.[25]

- Study 6- *Role of Energy Efficiency and Onsite Renewables in Meeting Energy and Environmental Needs in the Dallas/Fort Worth and Houston/Galveston Metro Areas.* American Council of Energy Efficient Economy, Report Number E078, September 2007.

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[25] Note that ACEEE is currently in the process of modifying the results of this study. These modifications may result in changes to the reduction estimates represented here. Unfortunately, the revised report was not available at the time that this report was finalized.

Similar to the Florida study, this one conducted for two regions in Texas, provides estimates of the achievable potential in the state for the years 2013 and 2023. Based on the electricity sales forecast and the electricity savings projections in the study, the average achievable potential for Texas is estimated to be 8% for 2013 and 18% for 2023.

- Study 7- *Reducing U.S. Greenhouse Gas Emission: How Much at What Cost?* McKinsey & Company, U.S. Greenhouse Gas Abatement Mapping Initiative Executive Report, December 2007.

  The purpose of this study was to estimate at a national level the costs and potentials of different options to reduce or prevent greenhouse gas emissions within the U.S. over a 25-year period. The study team evaluated over 250 options, encompassing efficiency gains, shifts to lower-car bon energy sources, and expanded carbon sinks. Among the various options, the team concluded that energy efficiency programs and policies directed at factories, commercial buildings, and homes could contribute up to 15% of reduced carbon emissions by 2030. While not specified, we assume these reductions would be most comparable to our estimates of achievable potential (rather than technical or economic).

  More specifically, the study anticipates a variety of abatement options, some of which are directly related to the same energy efficiency measures that are identified in our study. In particular, McKinsey estimates that by improving energy efficiency in buildings and appliances (e.g., lighting retrofits, improved heating, ventilation, air conditioning systems, building envelopes, building control systems, home and office electronics and appliances), a total of 710 to 870 million tons of CO_2 could be avoided by 2030. Another 620-770 million tons of avoided CO_2 could result from energy efficiency options for the industrial sector (e.g., equipment upgrades, process changes, and motor efficiency) by 2030.

  Our study team further assessed these reduction estimates to represent the portion of avoided CO_2 in terms of electricity savings resulting from the same types of energy efficiency programs and initiatives that are presumed in our study. Our analysis yielded savings estimates ranging from 488 TWh to 602 TWh. When compared with the EIA baseline forecast for 2030 (4,858 TWh[26]), this amounts to achievable potential savings ranging from 10-12%.

Figure 7-2 shows a plot of the potential estimates from the six studies we reviewed.[27] It plots all three potential estimates – technical, economic, and achievable – for the individual years represented by each study over the period 2005-2025. The achievable potential estimate has the maximum number of data points, as all studies reviewed provided estimates of the achievable potential. The achievable potential estimate ranges between 7-21% for the time period being considered.

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[26] See Table 3-9.

[27] Note that it was not possible to include the plot points for the seventh study (i.e., the McKinsey study) since, unlike the other six studies, comparable percentage figures were not directly cited in the study.

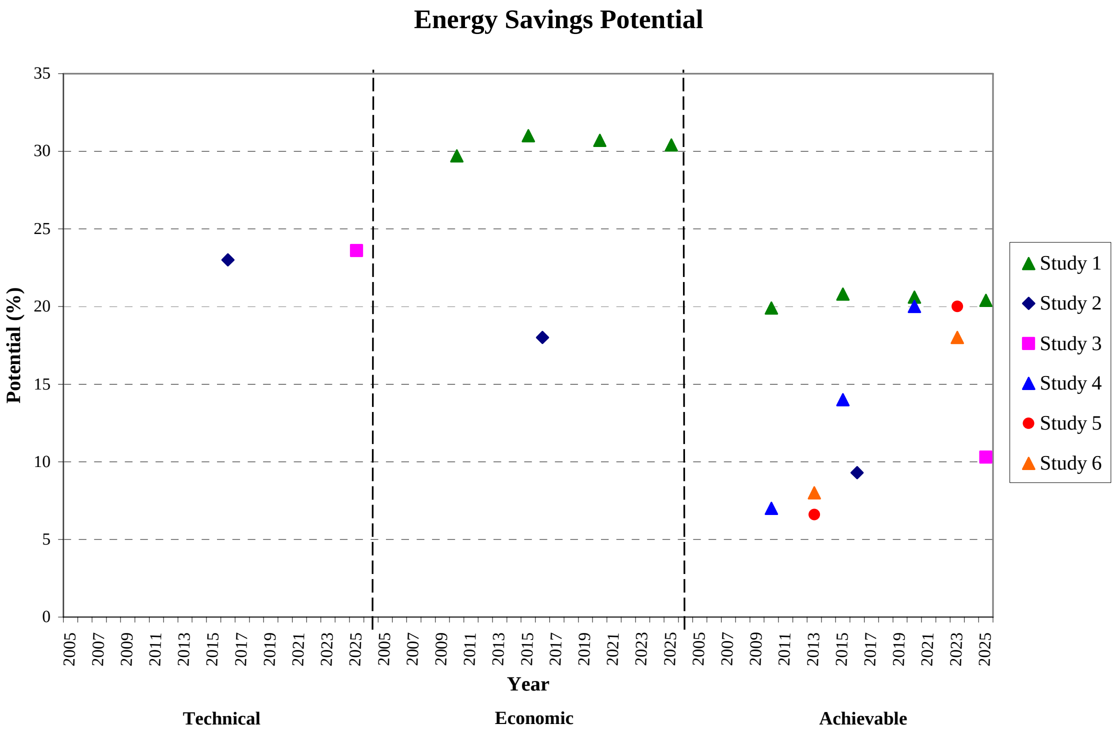

Figure 7-2
Energy Efficiency Potential Estimates from Six Studies

Estimates of Peak Demand Savings from Energy Efficiency

Three of the six studies of energy efficiency potential we reviewed also provided estimates of the peak demand savings from energy efficiency. These were:

- Study 2- CEC, 2007. *Statewide Energy Efficiency Potential Estimates and Targets for California Utilities*. Draft Staff Report. CEC-200-2007-019-SD, August 2007.

  This study estimated the technical, economic, and achievable demand savings potential from energy efforts for California in 2016. The demand savings potential estimates are- 24%, 16%, and 8% corresponding to technical, economic and achievable potential.

- Study 5- *Potential for Energy Efficiency and Renewable Energy to meet Florida's Growing Energy Demands*. ACEEE Report No. E072, June 2007.

  This study estimates the achievable demand savings potential due to energy efficiency efforts for the state of Florida in the years 2013 and 2023. These are estimated at 7% and 22% for 2013 and 2023 respectively.

- Study 6- *Role of Energy Efficiency and Onsite Renewables in Meeting Energy and Environmental Needs in the Dallas/Fort Worth and Houston/Galveston Metro Areas*. American Council of Energy Efficient Economy, Report Number E078, September 2007.

  Similar to the Florida study, this one estimates the achievable demand savings potential due to energy efficiency efforts for Texas in the years 2013 and 2023. These are estimated at 6% and 10% for 2013 and 2023 respectively.

Similar to the energy savings potential chart, Figure 7-3 shows a plot of the potential estimates from the three studies reviewed. It plots all three potential estimates -- technical, economic, and achievable -- for the individual years represented by each study over the period 2005-2025. The achievable potential estimate has the maximum number of data points, and ranges between 6-22% for the time period being considered.

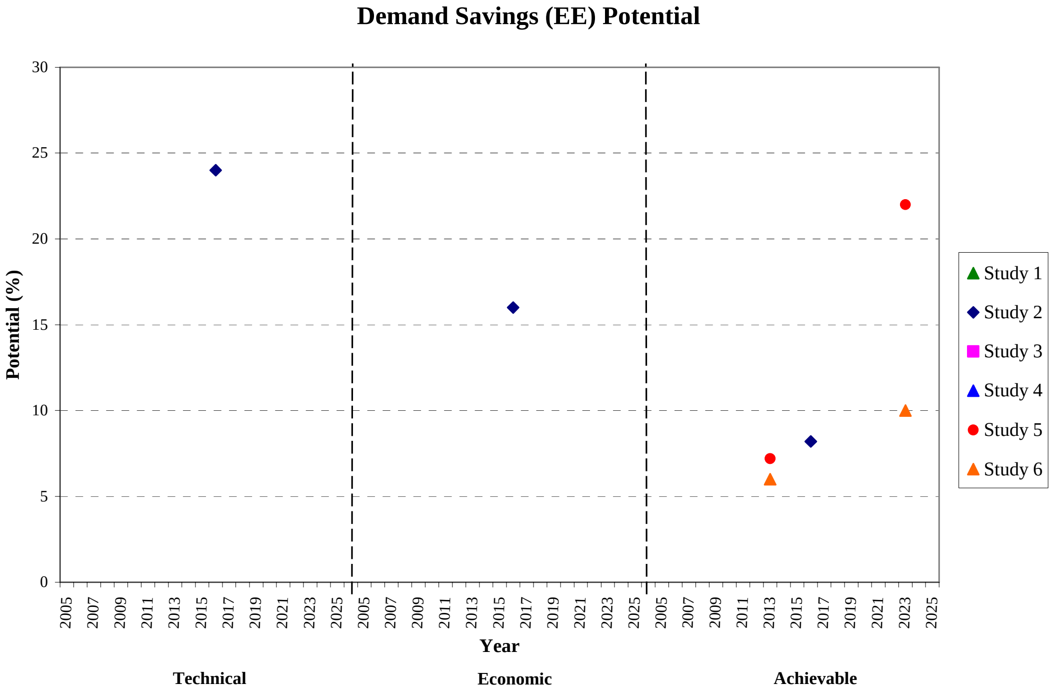

Figure 7-3
Preliminary Estimates of Maximum Achievable Potential

Estimates of Demand Response Potential

We reviewed four studies of demand response potential. These studies are described below.

- Study 1- *California's Next Generation of Load Management Standards. California Energy Commission.* The Brattle Group, Draft Consultant Report by Ahmad Faruqui and Ryan Hledik, May 2007.

  This report summarizes Demand Response (DR) potential in California and offers proposals for further promotion of DR in the region. Importantly, it quantifies the potential impact of DR using technical, economic, and market potential measures. The report estimates the technical potential to be around 25%, the economic potential to be around 12% and finally the market potential to be around 5%.

- Study 2- *Potential for Energy Efficiency and Renewable Energy to Meet Florida's Growing Energy Demands*. ACEEE Report No. E072, June 2007.

  This study covers the state of Florida and estimates the achievable potentials for energy efficiency (EE) and DR. Potential DR savings as a percentage of projected peak demand is estimated to be 9% in 2013 and 15% in year 2023.

- Study 3- *Role of Energy Efficiency and Onsite Renewables in Meeting Energy and Environmental Needs in the Dallas/Fort Worth and Houston/Galveston Metro Areas*. American Council for an Energy-Efficient Economy, Report Number E078, September 2007.

  This study covers the state of Texas and estimates the achievable potentials for energy efficiency (EE) and DR. Potential DR savings as a percentage of projected peak demand is estimated to be 5% in 2013 and 12% in year 2023.

- Study 4- *Assessment of Demand Response and Advanced Metering*. FERC Staff Report, Docket AD06-2-000, August 2006.

  FERC Staff Report harvests the findings of a comprehensive national survey, FERC Demand Response and Advanced Metering Survey (FERC Survey). This survey compiles information from the participants on the existing demand response programs and the uses of advanced metering. It covers the North American Electric Reliability Corporation (NERC) regions (ERCOT, FRCC, MRO, NPCC, RFC, SERC, SPP, and WECC). DR resource potentials are presented by NERC regions in Table 7-1.

Table 7-1
Demand Response Resource Potential by NERC Region

Region	Achievable Peak Reduction (MW)	Summer 2006 Peak Demand	Achievable Peak Reduction (%)
ERCOT	1,862	63,033	3.0%
FRCC	2,624	40,529	6.5%
MRO	4,878	30,955	15.8%
NPCC	3,301	57,783	5.7%
RFC	7,165	209,750	3.4%
SERC	4,887	156,400	3.1%
SPP	1,003	41,025	2.4%
WECC	3,847	129,675	3.0%
Other	88	#N/A	#N/A

Source: Reproduced from FERC Staff Report, pg. I-8 Figure V-5.
Notes: Other reliability region includes Alaska and Hawaii.

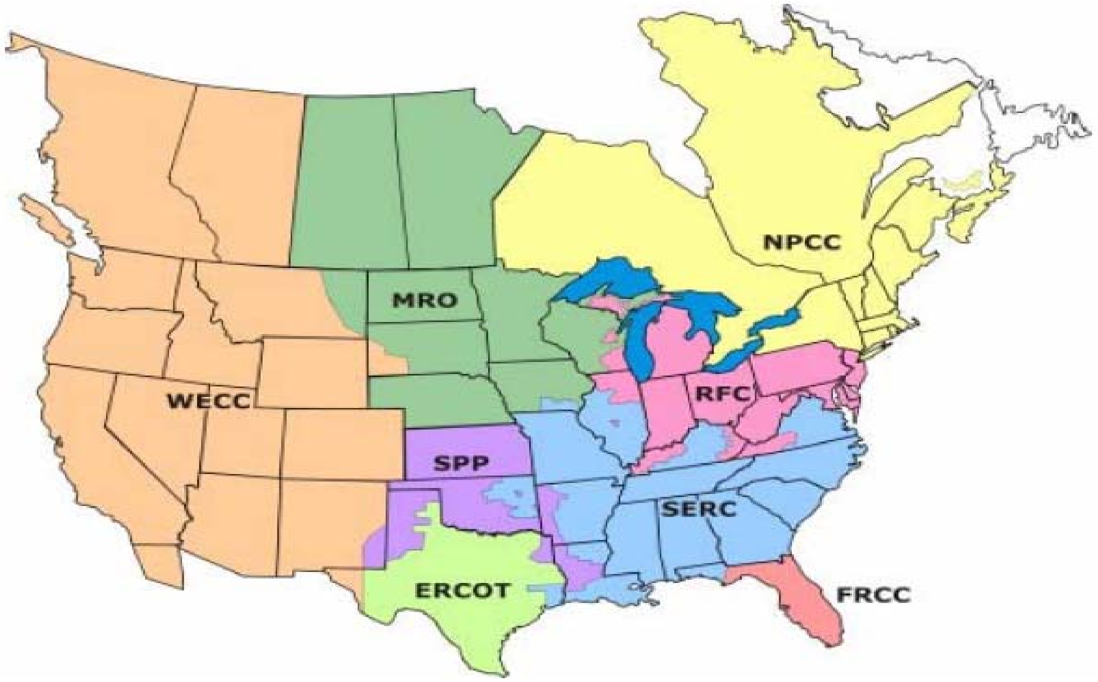

Figure 7-4
Map of NERC Regions

Source: Assessment of Demand Response and Advanced Metering, FERC Staff report, Docket Number: AD-06-2-000, page 4.

Selection of the studies above allowed us to represent each region in the country in terms of their DR savings potential. Moreover, we were able to introduce time dimension to our recommended DR potential numbers with the assessment of studies that present dynamic estimates.

After reviewing these studies, we compiled DR potential estimates from each study and plotted them in Figure 7-5. Point estimates denoted by Study 4_1 through Study 4_8 are taken from the Study 4 and represent the estimates associated with NERC regions in the same order they are introduced in Table 7-1. Examination of Figure 7-5 reveals that the DR savings potentials gather around two foci in year 2006 after excluding the Study 4_3 point which is apparently an outlier.

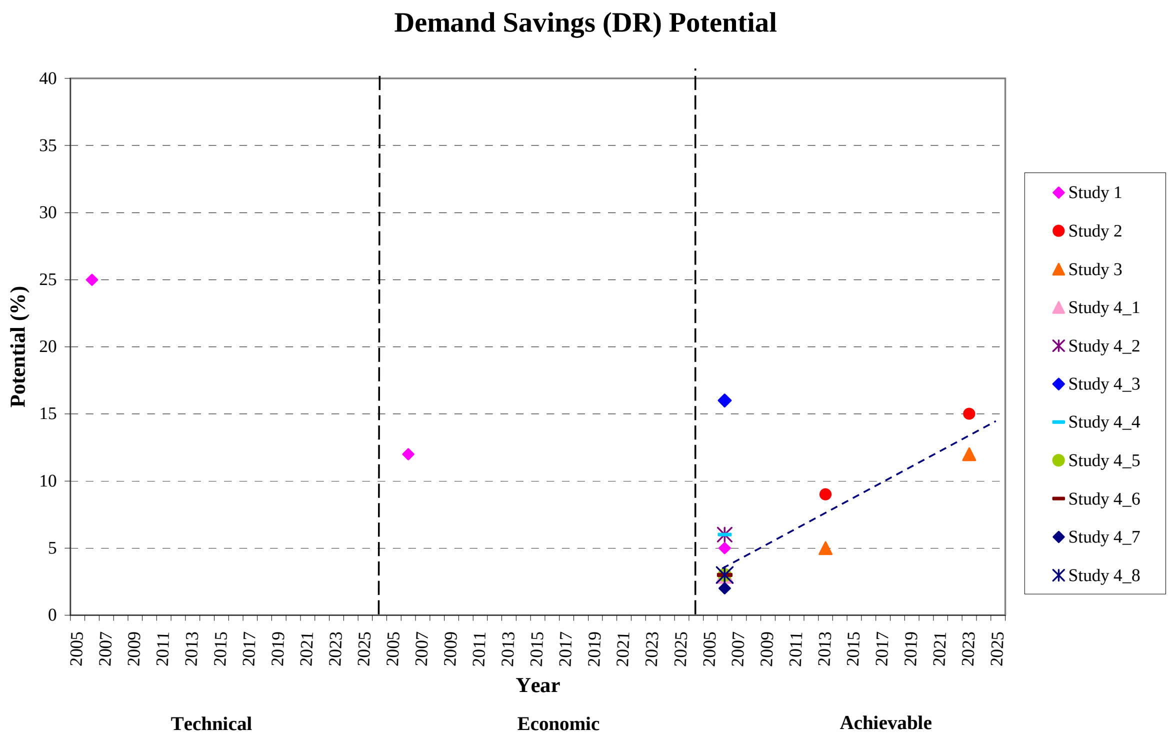

Figure 7-5
Demand Response Savings Potential Estimates from Selected Studies

8
CONCLUSIONS

The potential for electricity and summer peak demand savings from energy-efficiency and demand-response programs is significant. Across the U.S., these programs have the potential to reduce the annual growth rate of electricity consumption from a historical 1.7% growth rate per year from 1996 to 2006 to a realistically achievable 0.83% growth rate per year from 2009 to 2030.

These programs also have the potential to reduce the annual growth rate of summer peak demand from a historical 2.1% growth rate per year from 1996 to 2006 to a realistically achievable 0.83% growth rate per year from 2009 to 2030.

Achieving these savings in electricity consumption and peak demand will require significant industry investment in energy efficiency and demand response programs. The estimated cost to realize the realistic achievable potential is $1 to $2 billion in 2010, growing to $8 to $20 billion in 2020, and finally to $19 to $46 billion in 2030. The estimated cost to realize the maximum achievable potential is $3 to $7 billion in 2010, growing to $16 to $41 billion in 2020, and finally to $25 to $63 billion in 2030.

Comparison with Actual Program Results

Over the period 2008 to 2030, the achievable potential of energy efficiency programs identified in this study equates to an annual incremental reduction in electricity consumption of 0.37% to 0.51%.per year.[28] Our analysis of energy efficiency potential is based on the turnover of currently installed energy-consuming devices (as well new construction) to efficient technologies commercially available today, and since most devices have a useful life of less than fifteen years, it is instructive to examine the results for the year 2020, by which time the existing stock of most energy-consuming devices has turned over. Over the twelve year period of 2008 through 2020, the achievable potential of energy efficiency programs identified in this study equates to an annual incremental reduction in electricity consumption of 0.40% to 0.85%.per year.

How do these estimates compare with recent program results for the nation? A recent study released by ACEEE has determined that energy efficiency programs operated in 2006 reduced electricity consumption in the U.S. by an average of 0.24% in 2006.[29] This finding underscores

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[28] Computed by dividing the realistic- and maximum- achievable percentage savings in 2030 over the 22 year period spanning 2008 through 2030.

[29] American Council for an Energy-Efficient Economy. "The 2008 State Energy Efficiency Scorecard." ACEEE Report Number E086. October 2008.

that, for the nation as a whole, current energy efficiency program efforts will need to expand by 40% to capture the moderate case (i.e. realistic achievable potential) for savings identified in this study. By the same token, according to the ACEEE study, in 2006 eighteen states attained annual electricity savings from programs within the range of the national achievable potential (i.e. above 0.40%). Of these eighteen states, in fact, three states – Rhode Island, Vermont, and Connecticut – implemented programs in 2006 that reduced electricity consumption that year by more than 1%.

For another perspective, the study analyzed data compiled by the EIA through utility Form 861 filings[30], which suggests that U.S. utilities achieved cumulative savings of 74 TWh between 1995 and 2006. More than half these savings come from the West Census region, primarily from California. A comparable time frame for this study is 2008 to 2020, which has a realistic achievable potential estimate of about 207 TWh. The disparity between historically-achieved and realistically-projected savings is clarified by the regional distinctions illustrated in Figure 8-1.

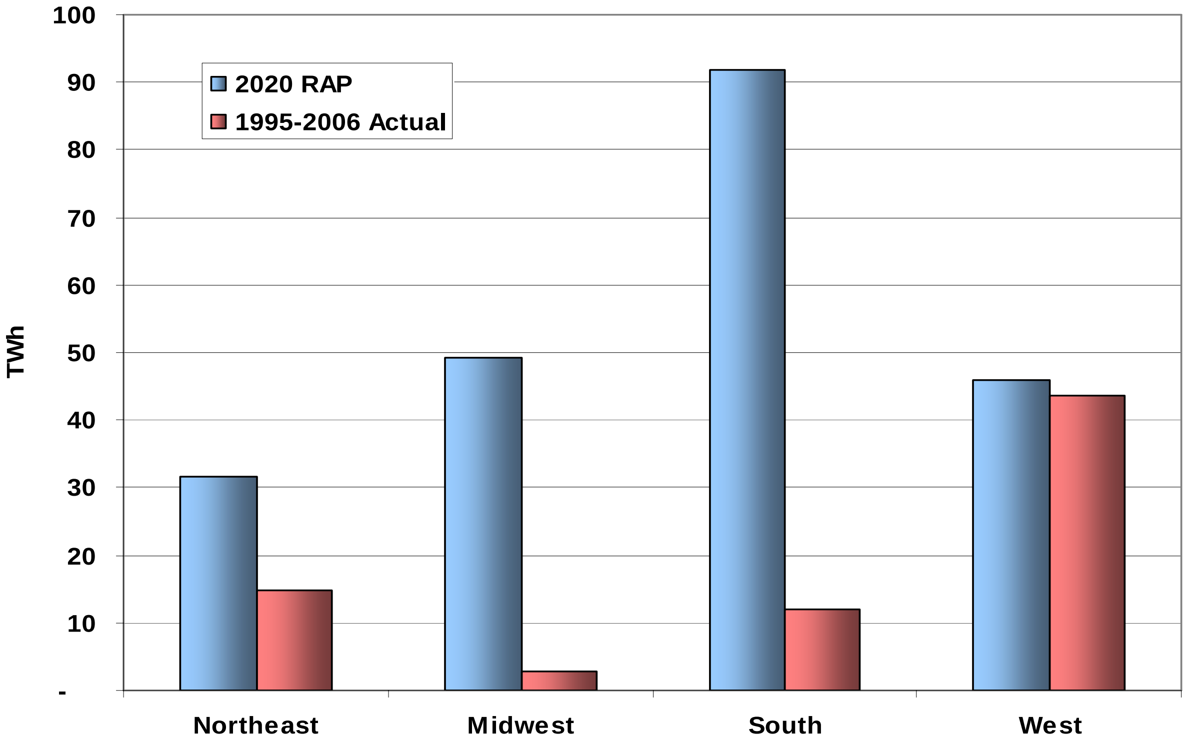

Figure 8-1
Realistic Achievable Potential by Region in 2020 – Historical Context

The expected realistic savings exceed the savings that utilities reported between 1996 and 2006 in the Northeast and especially in the Midwest and South. By contrast, in the West the historical and projected savings are closely comparable, owing to the significant experience with energy efficiency programs in the region, particularly in California and the Pacific Northwest.

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[30] Form EIA-861 collects information from U.S. electric power companies on a variety of operational metrics, including the impact of energy efficiency and load management (demand-side management) activities.

It is important to note that between 1995 and the early 2000s there were significant funding reductions in energy efficiency programs due largely to electric industry restructuring, a fact that may help explain the disparity between past and projected savings. While the electricity industry is different today, and it is reasonable to project higher expected energy efficiency savings, it should be recognized by all stakeholders that significant investment in energy-efficiency program infrastructure, consumer education, and enabling technology beyond current levels are needed to realize the achievable energy efficiency potential.

Applying the Results

This potential study represents a bottom-up study based on equipment stock turnover and adoption of energy-efficiency measures at the technology and end-use levels within sectors for four Census regions. Using a bottom-up, technology-based approach is consistent with the type of potential studies usually conducted by utilities or states. However, it is unique in its application to the U.S. as a whole. As such, it differs from most national studies of energy efficiency potential which employ macro “top-down” approaches. Top-down approaches are useful, but the results are typically highly sensitive to variations in a few key *qualitative* assumptions.

By contrast, the bottom-up approach is more *quantitative*, grounded in actual technology efficiencies and costs. This approach includes assumptions about customer adoption predicated on experience and observation of the range of results realized by program implementers. The bottom-up approach facilitates detailed segmentation of savings potential by region, sector, end use and technology, which provides insightful, actionable results.

It is worth emphasizing that while other studies co-mingle the effects of existing and anticipated codes and standards (i.e., those not yet legislated) with programmatic effects, this study isolates the impact of programs. As such, any new codes and standards or other externalities would contribute to greater levels of overall efficiency.

This study was undertaken to provide an independent, analytically-rigorous estimate of the electricity savings potential of energy efficiency and demand response programs to inform utilities, policymakers, regulators, and other stakeholder groups. The regional results in particular can serve as useful calibration points to compare against state or utility potential studies. Where variances may be observed, a detailed breakdown of potential by sector and end-use may be useful to identify areas of over- or under-stated potential.

Utilities can examine the major areas of energy efficiency potential specific to their region with their own allocation of resources. For example, an examination of the magnitude of commercial lighting potential – which is the largest area of potential energy savings in every region – should prompt questions such as:

- How much resource are we allocating to savings in this area?
- What programs do we have addressing this market? What results have been achieved?
- What state or local codes and standards exist for this market beyond federal levels?

Follow-on Research

The analysis of potential savings from energy efficiency and demand response programs detailed in this report is predicated on the identical set of macro-economic assumptions used by the EIA in its AEO 2008 reference case projections of electricity consumption and peak demand. This includes, for example, a relatively flat electricity price forecast in real dollars between 2008 and 2030. In addition, the study does not presume the future enactment of more stringent building codes, equipment standards, or other policies beyond what is currently mandatory. Moreover, the future enactment carbon legislation, which could create greater incentives for energy efficiency programs, was not considered.

EPRI plans to conduct follow-on analysis on the sensitivities of electricity use and savings potentials to alternate scenarios of electricity price levels, the establishment of national carbon legislation such as a cap and trade market, the expectation of new codes and standards, new utility regulatory incentives for energy efficiency, and greater investment in end-use technology innovation. Such externalities bear significantly on the future savings potential from energy efficiency programs.

In addition, while this study focuses exclusively on electricity *end-use* savings, there are also opportunities to reduce electricity consumption upstream of end-use. For example, making power plants more energy efficient and reducing line losses in the transmission and distribution of electricity can yield sizeable net electricity savings. Utility experience indicates that savings from such pursuits, through investment in technology, can be attained cost-effectively and at a lower cost per kWh saved than some end-use programs. Follow-on research at EPRI could therefore also explore the national and regional savings potential from *end-to-end* electric efficiency, inclusive of the generation, transmission, distribution, and end-use of electricity

A

APPENDIX: NORTHEAST CENSUS REGION RESULTS

The Northeast is the smallest of the four Census regions in terms of geographic size and electricity use. In 2008, total electricity use is 507 TWh. Figure A-1 shows the breakdown by sector. The largest sector is commercial with 45% of the total. Residential accounts for 36%.

By 2030, total use is expected to be 591 TWh, a 15% increase over 2008 and implying a modest growth rate of 0.7% per year. The commercial sector grows the fastest during the forecast period at a rate of 1.3%, while the residential sector grows at 0.4% per year and the industrial sector declines at a rate of -0.3% per year.

Total achievable potential in 2030 for electricity savings through energy-efficiency programs ranges from 53 to 73 TWh, which equates to 9-12% of total load in that year as shown in Figure A-2. Figure A-3 shows the realistic achievable potential savings by sector. In terms of the share of total load that can be saved by 2030, the three sectors are roughly equal. In the short term, the residential sector has the greatest opportunity.

Figure A-4 presents the residential baseline and achievable potential forecasts by end use. In the baseline forecast, the fastest growing end uses are electronics and other, while lighting declines as a result of the EISA legislation. Growth in the remaining end uses is fairly flat. Energy efficiency savings in this sector will come from actions across several end uses: home electronics, air conditioning, appliances, lighting, space heating and water heating.

The commercial sector, in contrast, grows more rapidly and the potential for savings is concentrated in a few end uses. Figure A-5 presents the commercial-sector baseline and achievable potential forecasts by end use. Baseline growth is driven largely by growth in office equipment and "other" uses. Achievable energy-efficiency savings are dominated by opportunities in lighting, office equipment and cooling, which together account for 30 TWh savings in 2030.

The industrial sector is in decline, yet continues to have considerable opportunity for energy-efficiency savings in the machine drive end use. Figure A-6 presents the industrial-sector baseline and achievable potential forecasts by end use.

To put the end-use and sector-level savings potential in perspective, Figure A-7 presents the Top 10 End Uses in the Northeast's maximum achievable potential. These results parallel the findings for the U.S. as a whole. Finally, Figure A-8 presents the potential for summer peak demand savings from demand response. For the Northeast, the achievable range is 8-10% in 2030, slightly more than the 7-9% range for the U.S. as a whole.

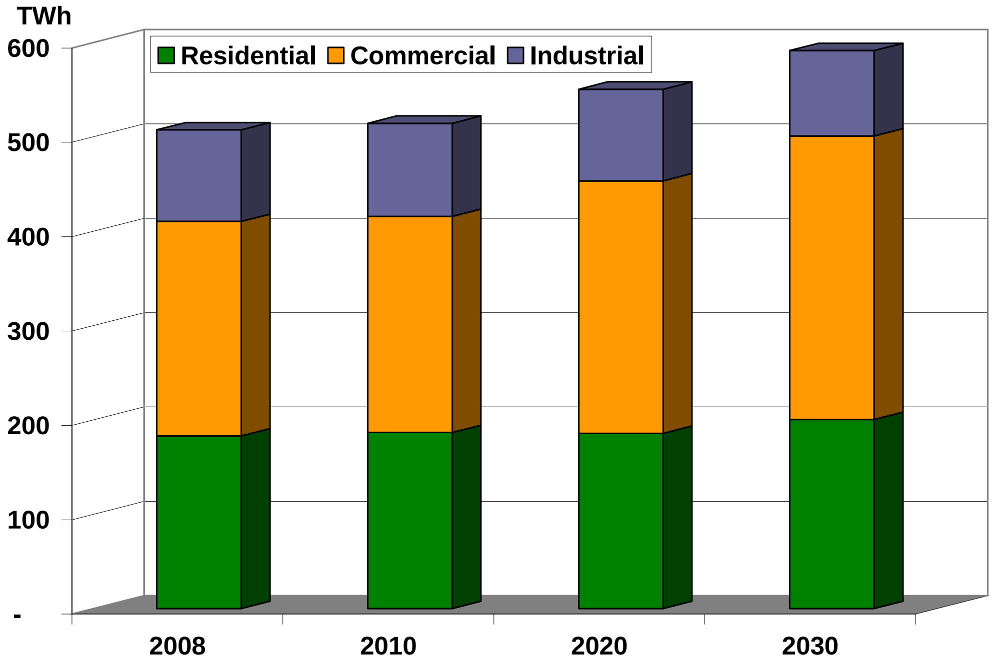


Figure A-1
Electricity Forecast by Sector – Northeast Region

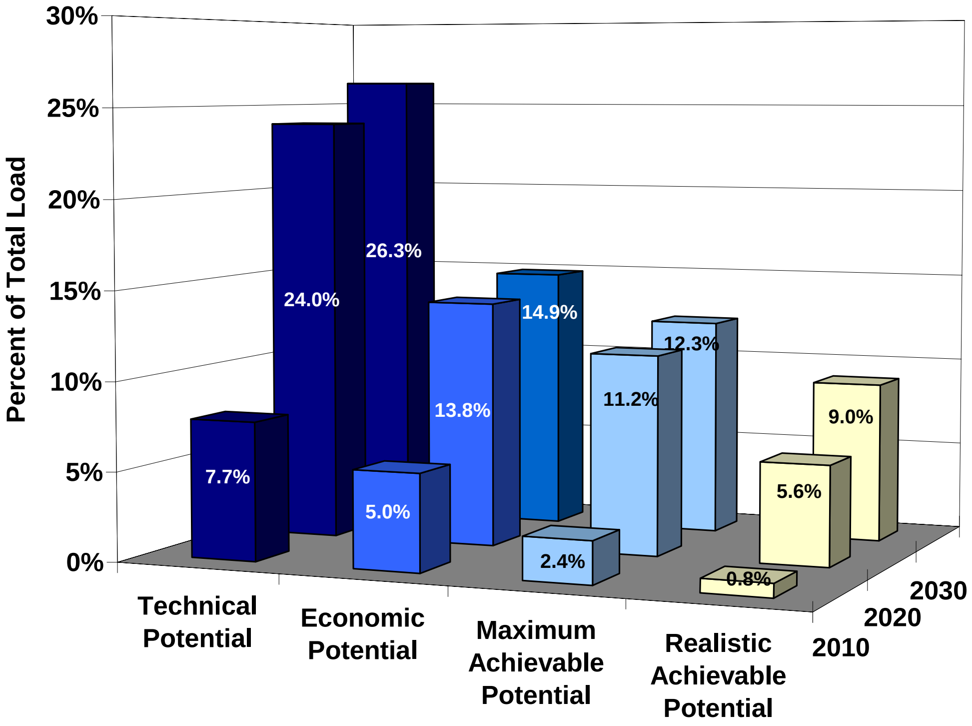


Figure A-2
Energy Efficiency Potential – Northeast Region

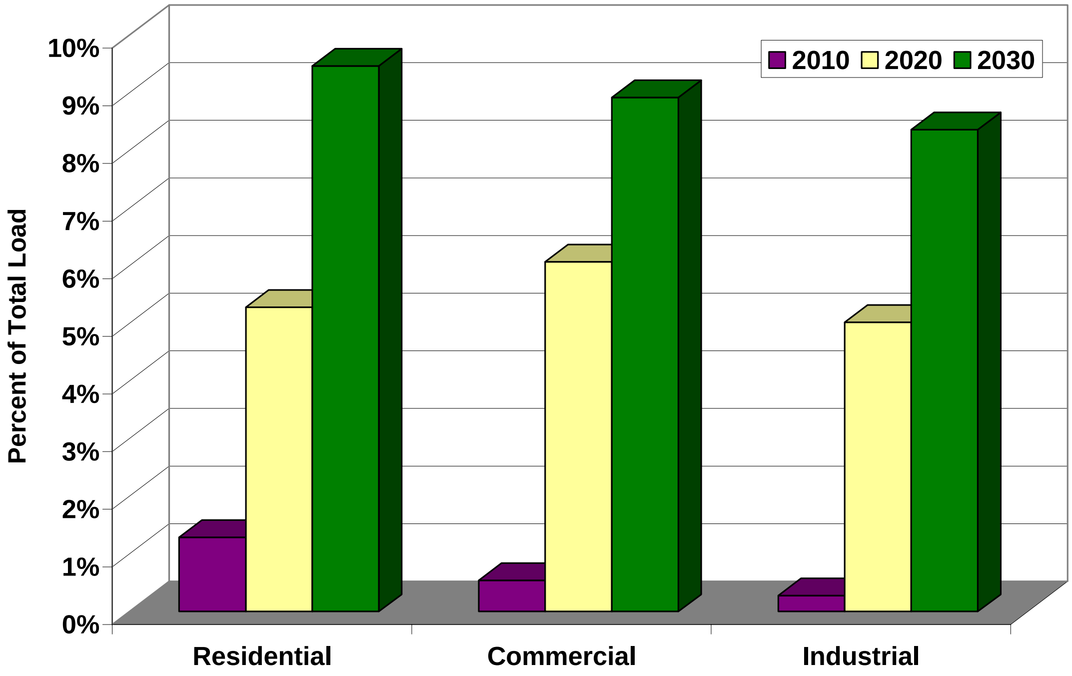


Figure A-3
Realistic Achievable Potential by Sector – Northeast Region

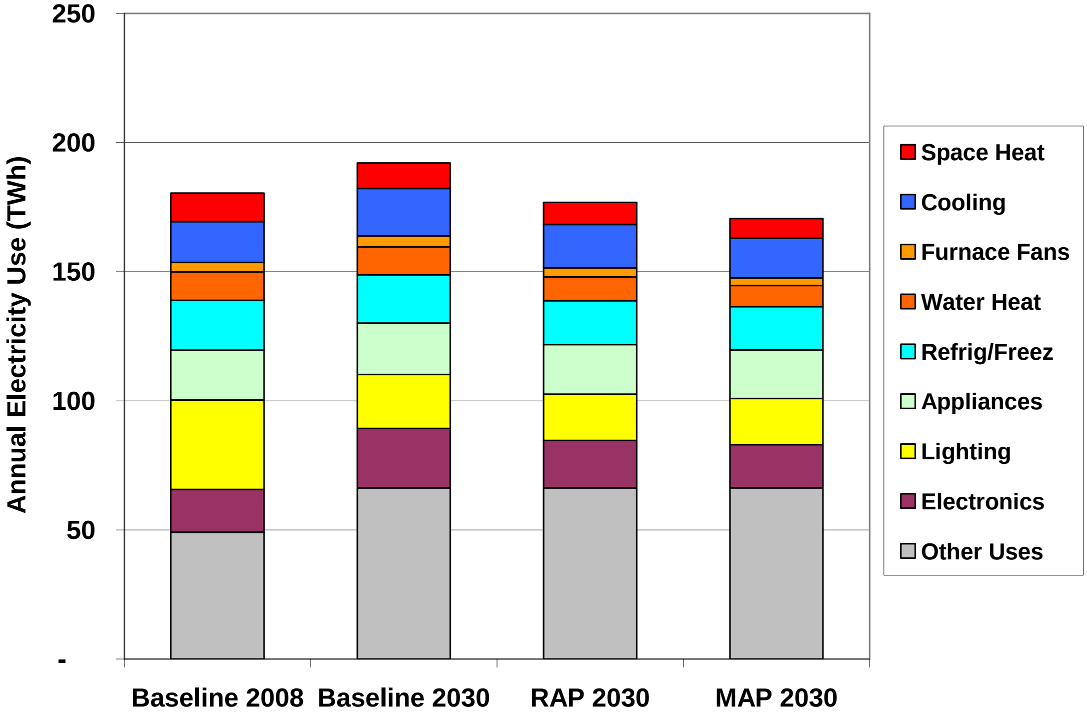


Figure A-4
Residential Baseline and Achievable Potentials by End Use – Northeast

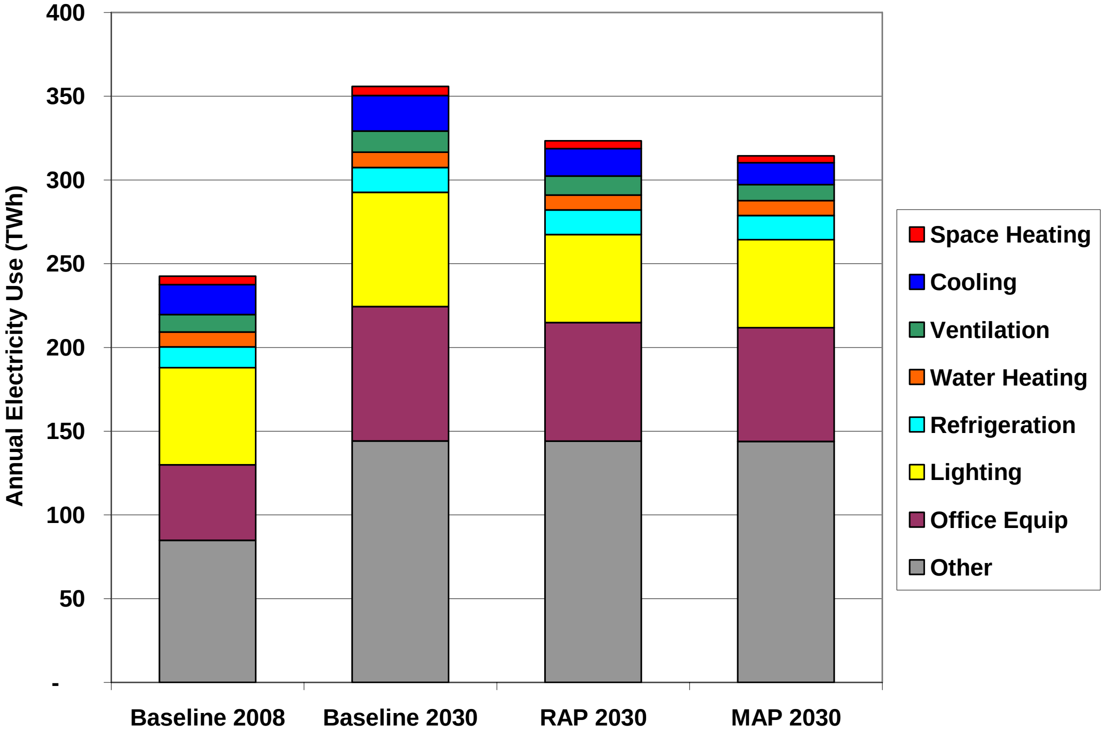


Figure A-5
Commercial Sector Baseline and Achievable Potentials by End Use – Northeast

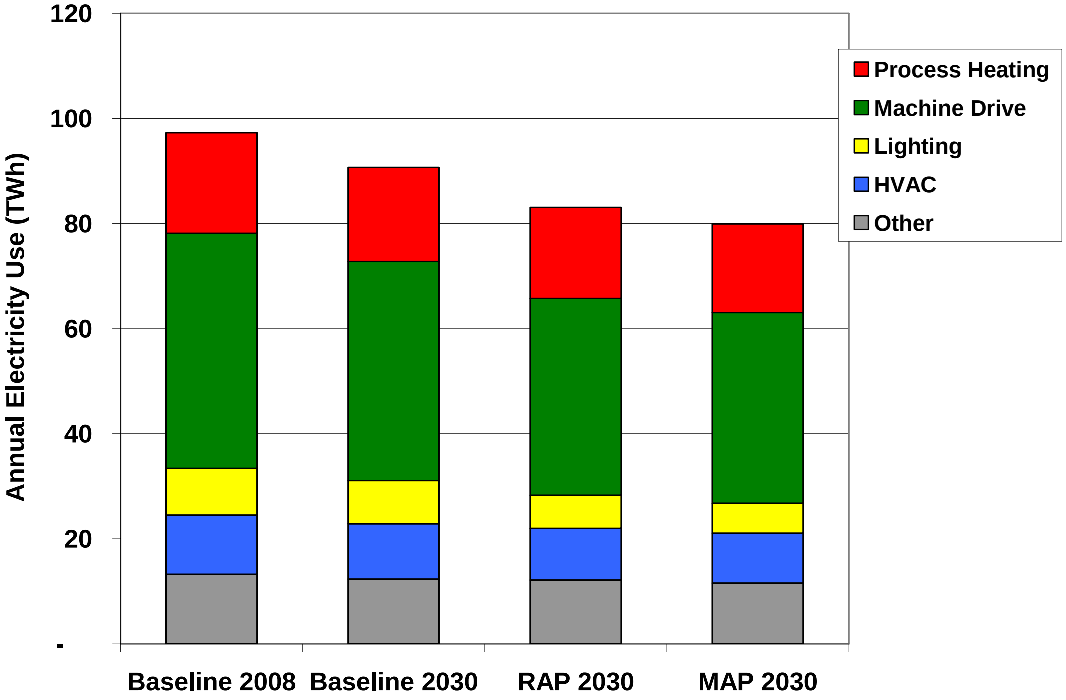


Figure A-6
Industrial Sector Baseline and Achievable Potentials by End Use – Northeast

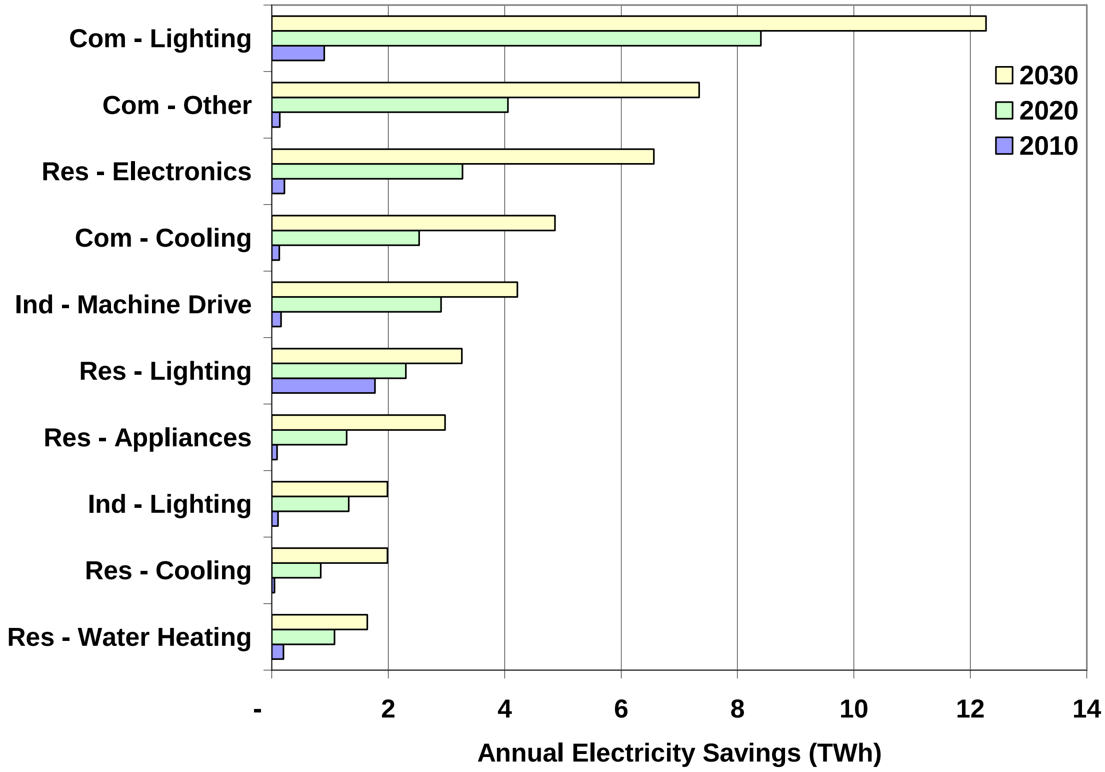


Figure A-7
Realistic Achievable Potential, Top 10 End Uses – Northeast

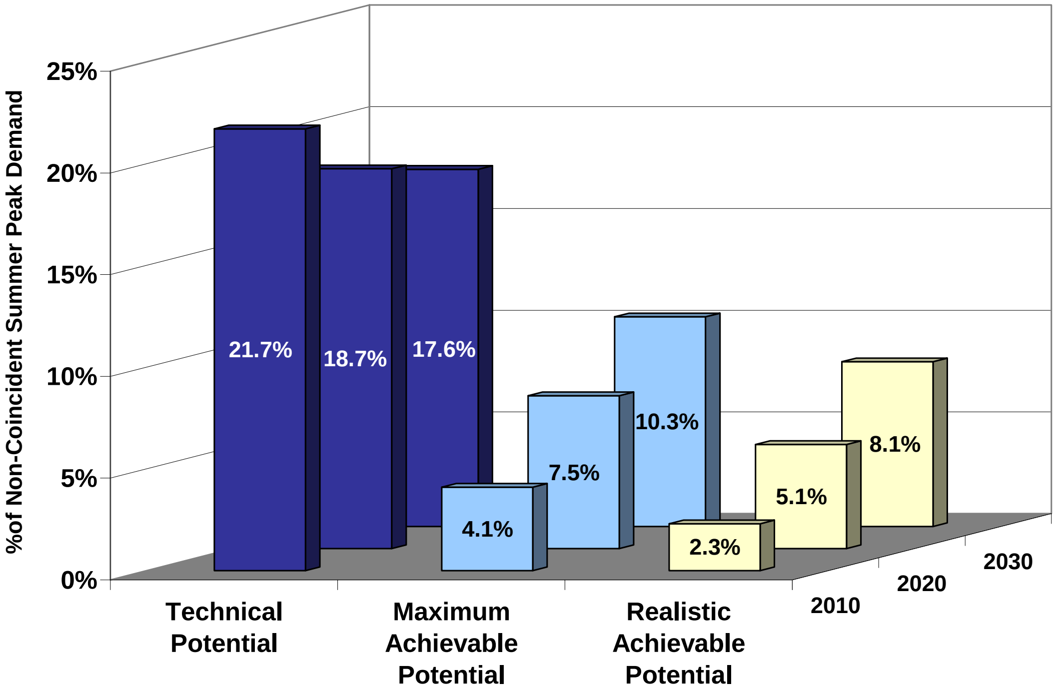


Figure A-8
Demand Response Potential – Northeast

B

APPENDIX: MIDWEST CENSUS REGION RESULTS

The Midwest is the second largest of the four Census regions in terms of electricity use. In 2008, total electricity use is 864 TWh. Figure B-1 shows the breakdown by sector. The three sectors each account for roughly one third of electricity use.

By 2030, total use is expected to be 1.010 TWh, a 14% increase over 2008 and implying a modest growth rate of 0.7% per year. The commercial sector grows the fastest during the forecast period at a rate of 1.6%, while the residential sector grows at 0.5% per year and the industrial sector declines at a rate of -0.3% per year.

Total achievable potential in 2030 for electricity savings through energy-efficiency programs ranges from 76 to 102 TWh, which equates to 8-10% of total load in that year as shown in Figure B-2. Figure B-3 shows the maximum achievable potential savings by sector. In terms of the share of total load that can be saved by 2030, the three sectors are roughly equal. In the short term, the residential sector has the greatest opportunity.

Figure B-4 presents the residential baseline and achievable potential forecasts by end use. In the baseline forecast, the fastest growing end uses are electronics, other and air conditioning, while lighting declines as a result of the EISA legislation. Growth in the remaining end uses varies. Energy efficiency savings in this sector will come from actions across several end uses: home electronics, air conditioning and lighting.

Figure B-5 presents the commercial-sector baseline and achievable potential forecasts by end use. Baseline growth is driven largely by growth in office equipment and “other” uses. Achievable energy-efficiency savings are dominated by opportunities in lighting, office equipment and cooling, which together account for 38 TWh savings in 2030.

The industrial sector is in decline, yet continues to have considerable opportunity for energy-efficiency savings in the machine drive end use. Figure B-6 presents the industrial-sector baseline and achievable potential forecasts by end use.

To put the end-use and sector-level savings potential in perspective, Figure B-7 presents the top 10 end uses in the Midwest’s realistic achievable potential. These results parallel the findings for the U.S. as a whole.

Finally, Figure B-8 presents the potential for summer peak demand savings from demand response. For the Northeast, the achievable range is 7-9% in 2030, which is consistent with the results for the U.S. as a whole.

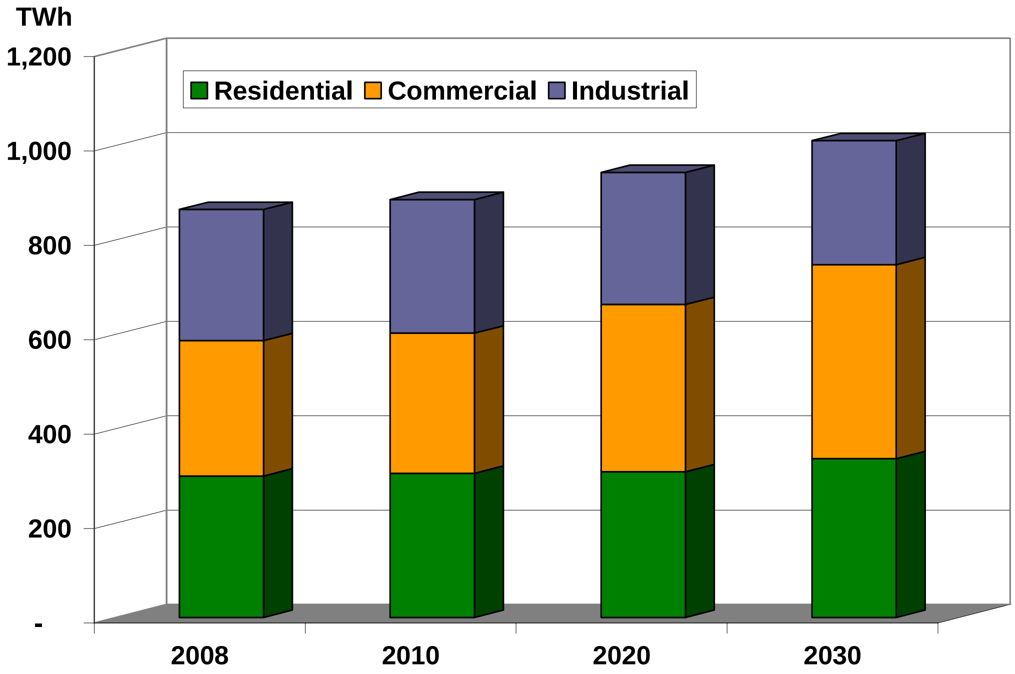


Figure B-1
Electricity Forecast by Sector – Midwest Region

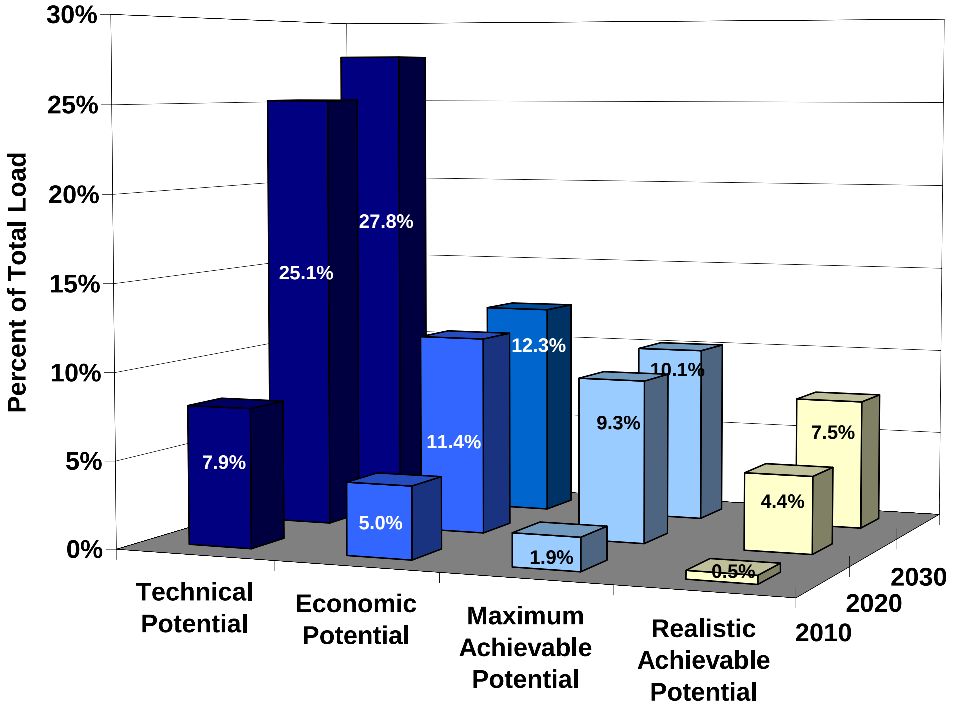


Figure B-2
Energy Efficiency Potential – Midwest Region

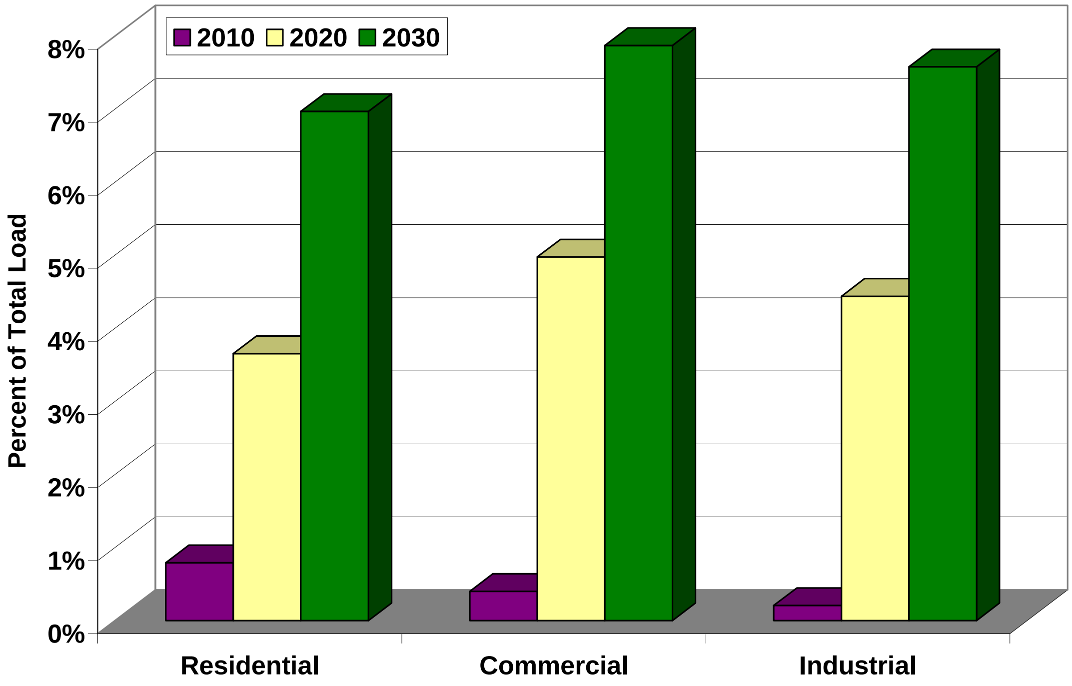


Figure B-3
Realistic Achievable Potential by Sector – Midwest Region

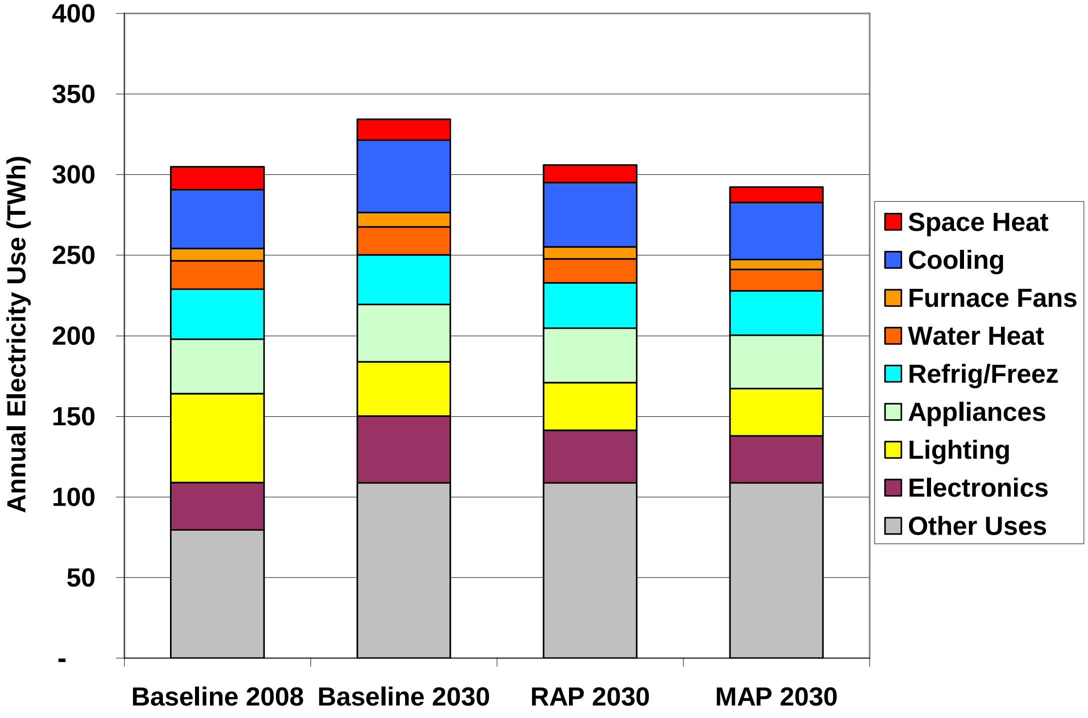


Figure B-4
Residential Baseline and Achievable Potentials by End Use – Midwest

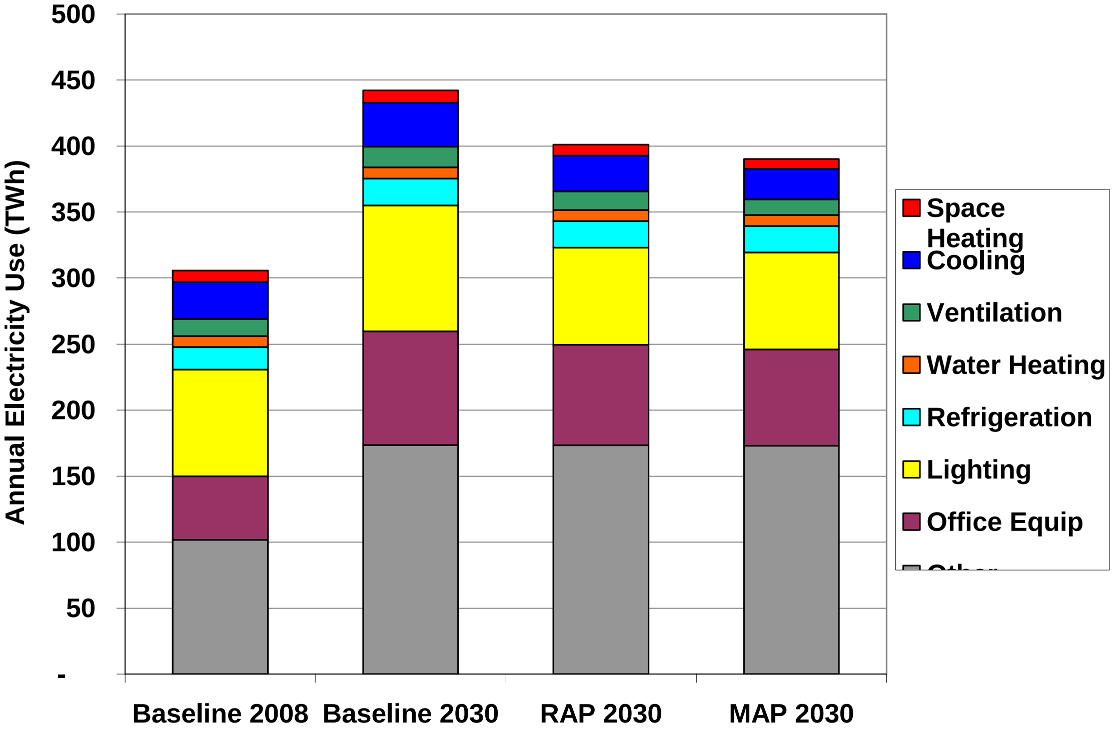


Figure B-5
Commercial Sector Baseline and Achievable Potentials by End Use – Midwest

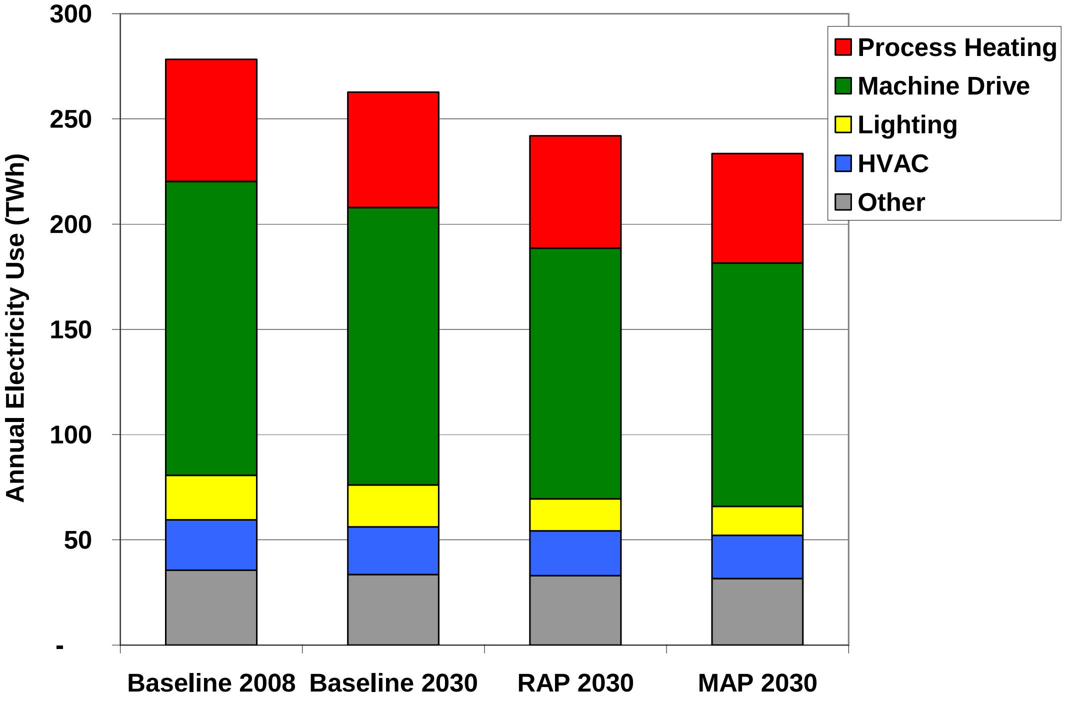


Figure B-6
Industrial Sector Baseline and Achievable Potentials by End Use – Midwest

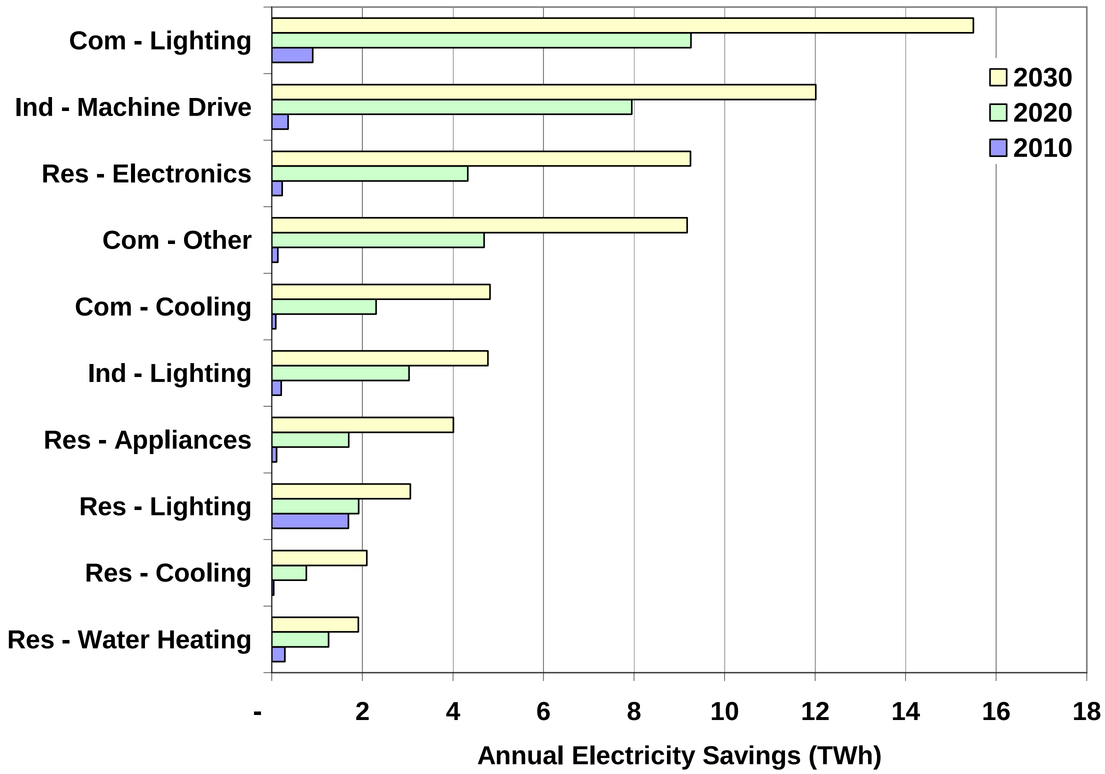


Figure B-7
Realistic Achievable Potential, Top 10 End Uses – Midwest

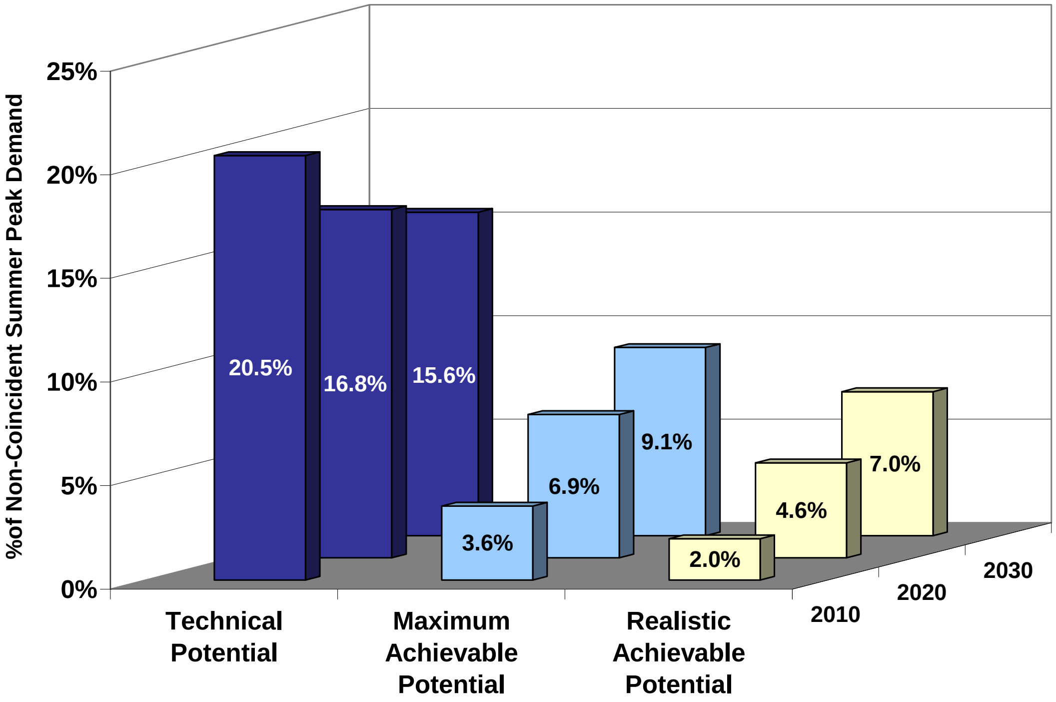


Figure B-8
Demand Response Potential – Midwest

C

APPENDIX: SOUTH CENSUS REGION RESULTS

The South is the largest region in terms of electricity use. In 2008, total electricity use is estimated as 1,683 TWh. Figure C-1 shows the breakdown by sector. The largest sector is residential with 40% of the total. The commercial sector accounts for 36% and the industrial sector for 26%.

By 2030, total use is expected to be 2,336 TWh, a 34% increase over 2008, implying a growth rate of 1.5% per year. The commercial sector grows the fastest during the forecast period at a rate of 2.1%, while the residential sector grows at 1.5% per year and the industrial sector grows at 0.7% per year.

Total achievable potential in 2030 for electricity savings through energy-efficiency programs ranges from 189 to 259 TWh, which equates to 8-11% of total load in that year as shown in Figure C-2. Figure C-3 shows the realistic achievable potential savings by sector. In terms of the share of total load that can be saved by 2030, the commercial sector is the largest and the residential and industrial sectors are roughly equal. In the short term, the residential sector has the greatest opportunity.

Figure C-4 presents the residential baseline and achievable potential forecasts by end use. In the baseline forecast, the fastest growing end uses are electronics and other. Air conditioning increases by almost 50%, while lighting declines as a result of the EISA legislation. Energy efficiency savings in this sector will come from actions across several end uses: home electronics, air conditioning, water heating and lighting.

Figure C-5 presents the commercial-sector baseline and achievable potential forecasts by end use. Baseline growth is driven largely by growth in office equipment and “other” uses. Achievable energy-efficiency savings are dominated by opportunities in lighting, office equipment and cooling, which together account for 78 TWh savings in 2030.

The industrial sector grows at a steady pace and has considerable opportunity for energy-efficiency savings in the machine drive end use. Savings are 26 TWh in 2030, 65% of the industrial-sector realistic achievable potential. Figure C-6 presents the industrial-sector baseline and achievable potential forecasts by end use.

To put the end-use and sector-level savings potential in perspective, Figure C-7 presents the top 10 end uses in the South’s realistic achievable potential. As expected, residential and commercial cooling represent more opportunity than in the other regions. Finally, Figure C-8 presents the potential for summer peak demand savings from demand response. For the Northeast, the achievable range is 7-9% in 2030, which is consistent with the results for the U.S. as a whole.

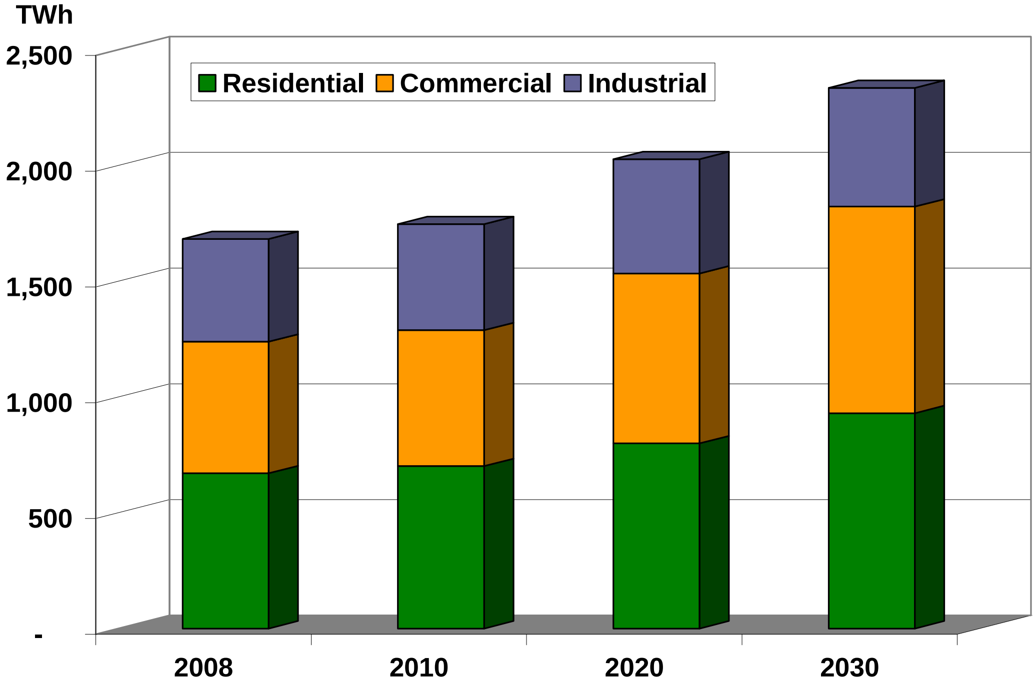


Figure C-1
Electricity Forecast by Sector – South Region

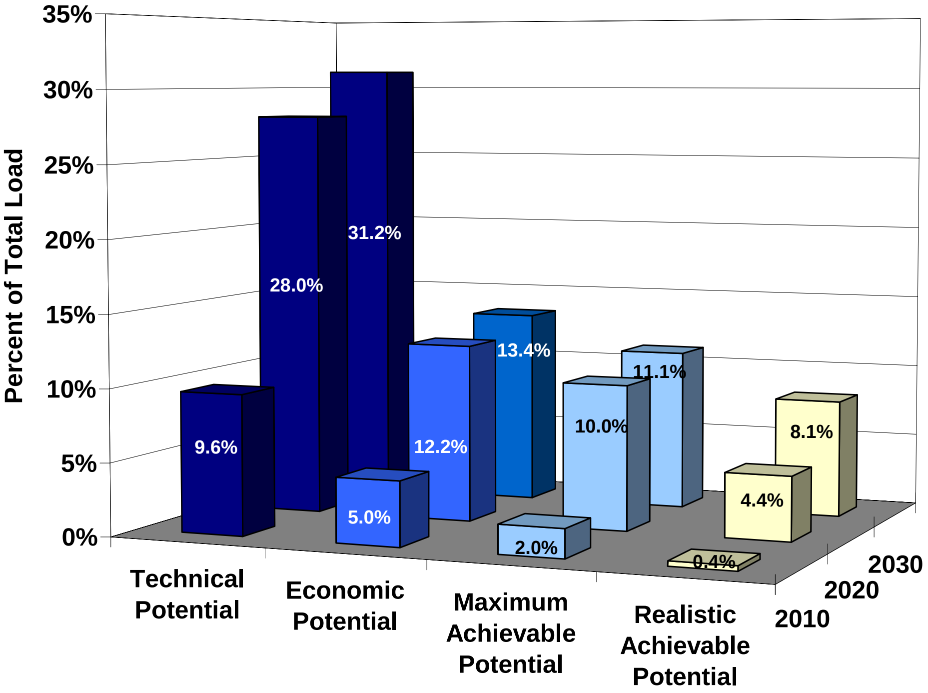


Figure C-2
Energy Efficiency Potential – South Region

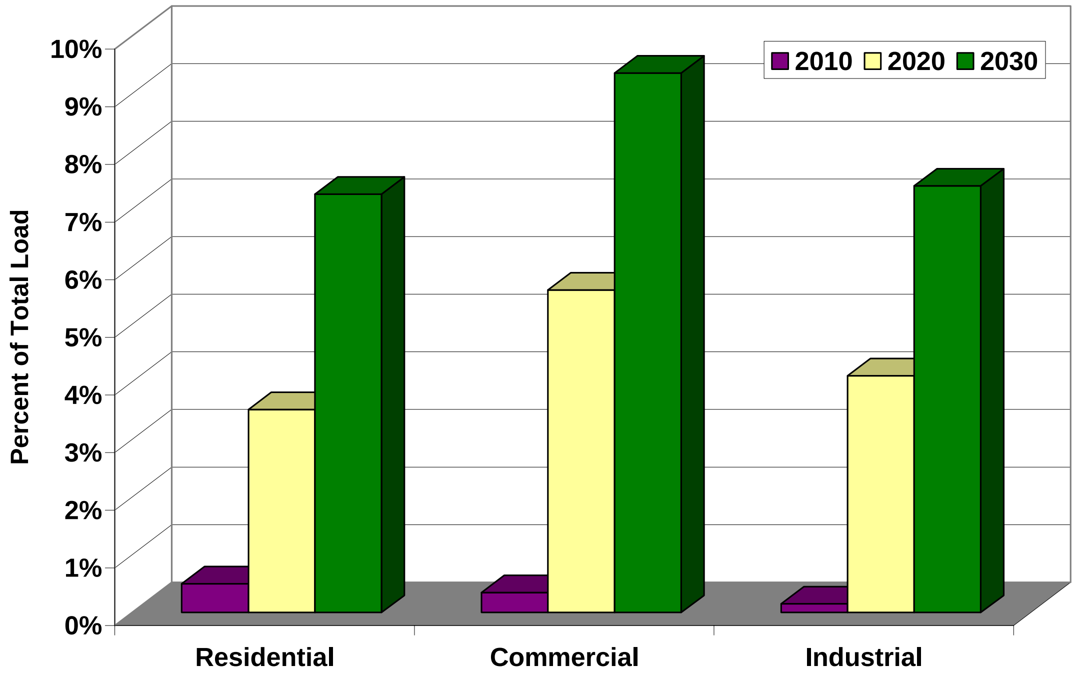


Figure C-3
Realistic Achievable Potential by Sector – South Region

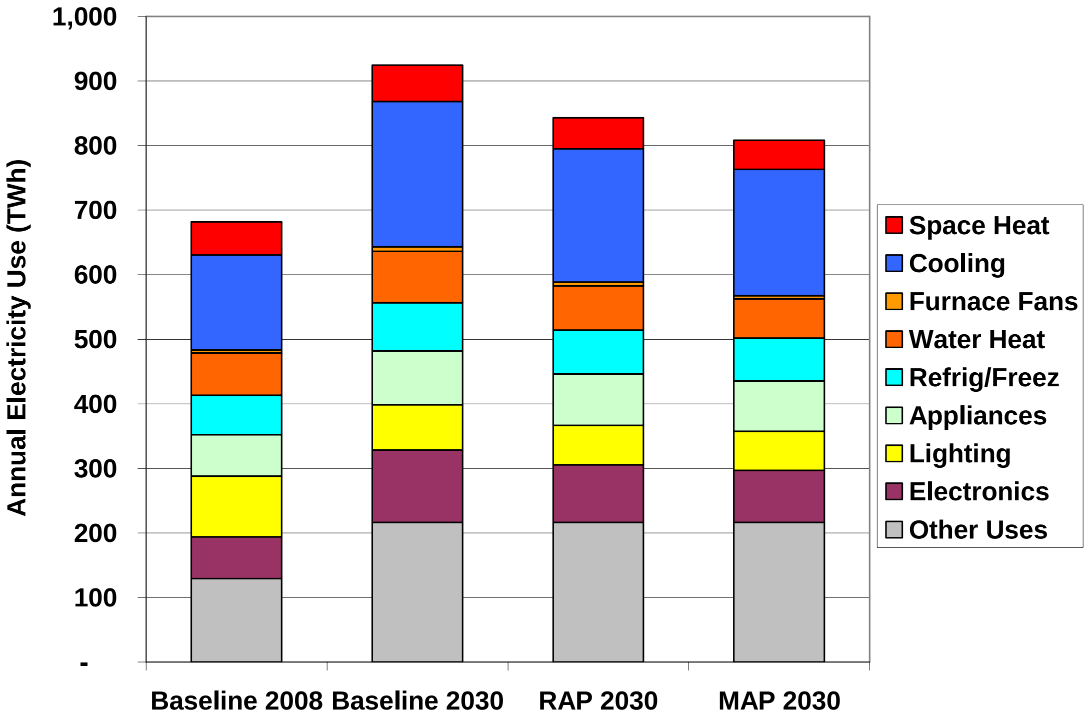


Figure C-4
Residential Baseline and Achievable Potentials by End Use – South

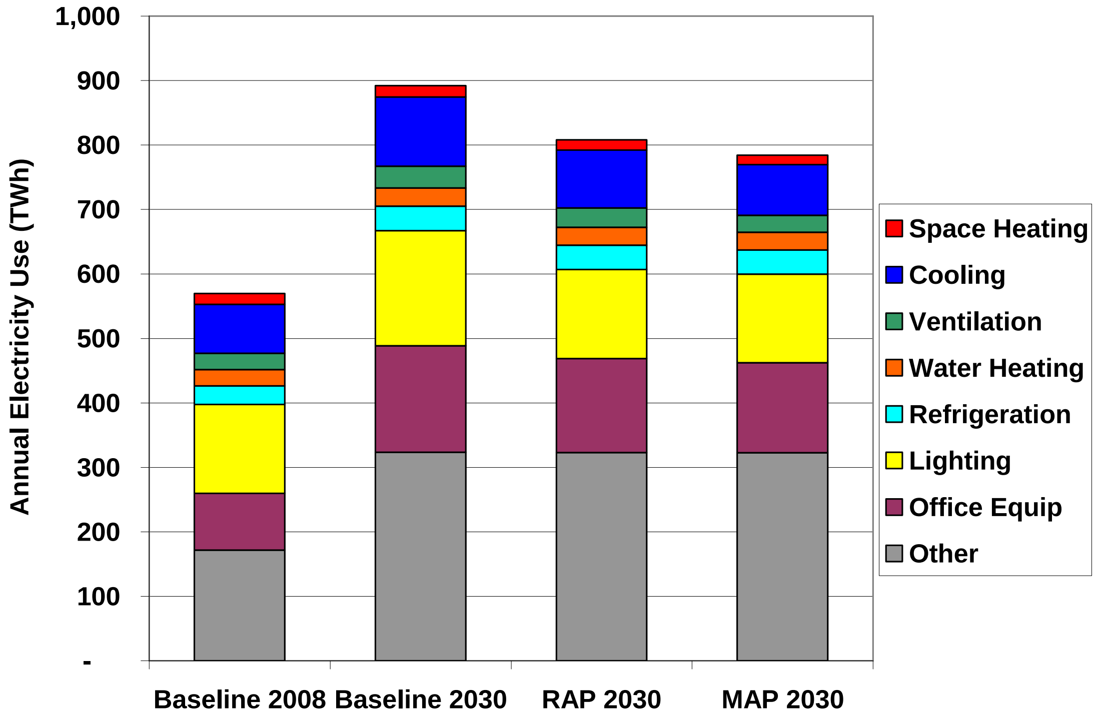


Figure C-5
Commercial Sector Baseline and Achievable Potentials by End Use – South

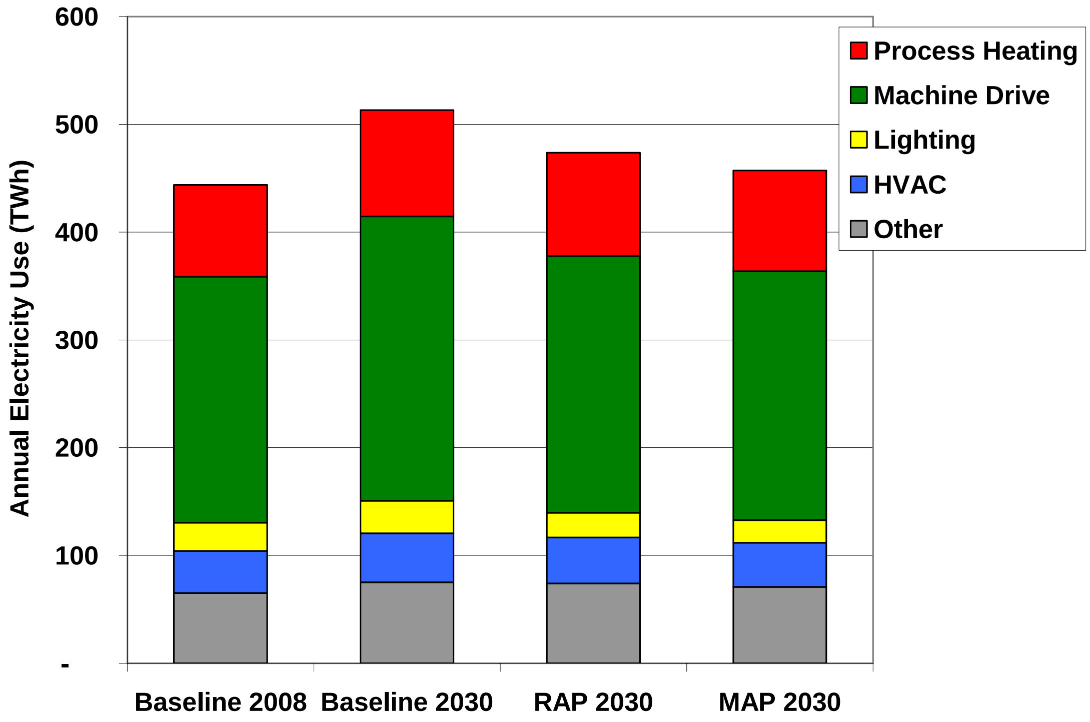


Figure C-6
Industrial Sector Baseline and Achievable Potentials by End Use – South

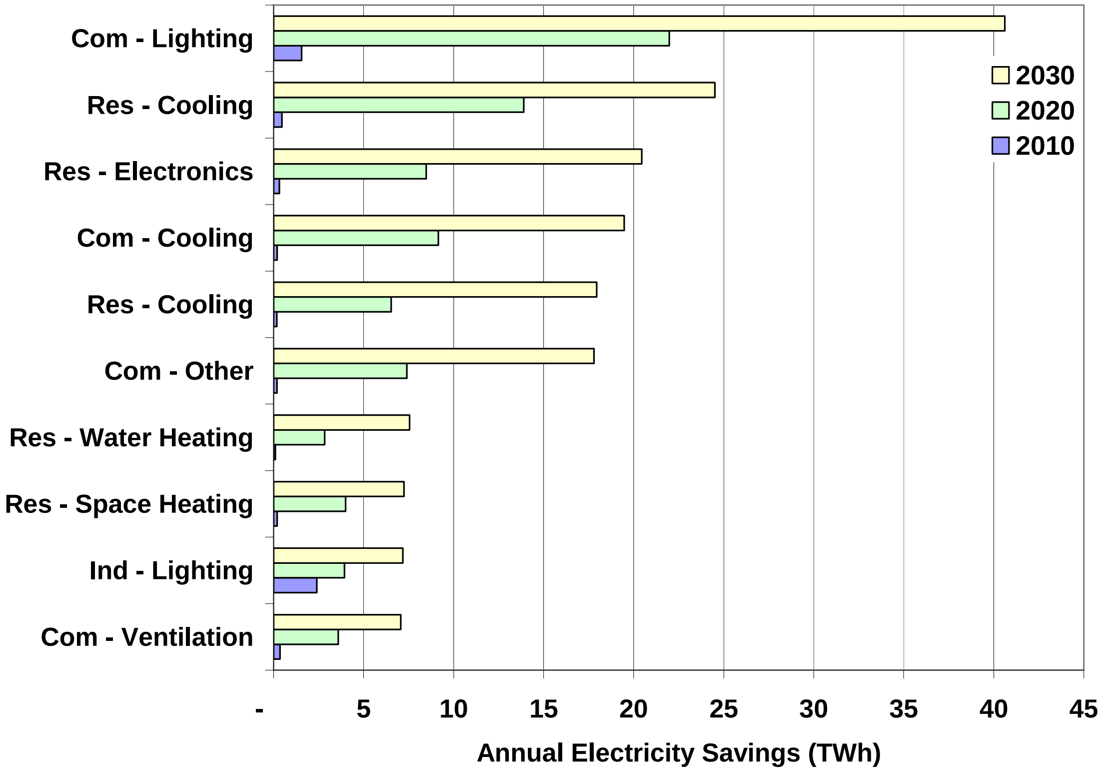


Figure C-7
Realistic Achievable Potential, Top 10 End Uses – South

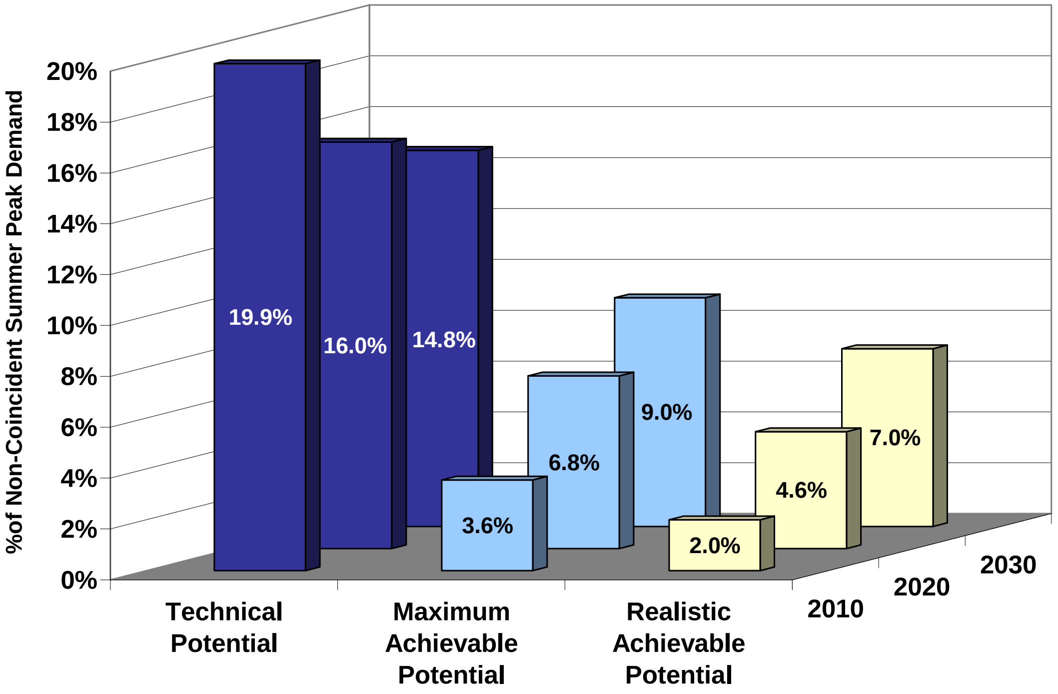


Figure C-8
Demand Response Potential – South

D

APPENDIX: WEST CENSUS REGION RESULTS

The West is the second smallest of the four Census regions in terms of electricity use. In 2008, total electricity use is 664 TWh. Figure D-1 shows the breakdown by sector. The largest sector is commercial with 40% of the total. Residential accounts for 38% and the industrial for 22%.

By 2030, total use is expected to be 921 TWh, a 33% increase over 2008 and a growth rate of 1.5% per year, the highest of all four regions. The commercial sector grows the fastest during the forecast period at a rate of 2.2%, while the residential sector grows at 1.1% per year and the industrial sector at a rate of 0.7% per year.

Total achievable potential in 2030 for electricity savings through energy-efficiency programs ranges from 80 to 110 TWh, which equates to 9-12% of total load in that year as shown in Figure D-2. Figure D-3 shows the realistic achievable potential savings by sector. In terms of the share of total load that can be saved by 2030, the three sectors are roughly equal. In the short term, the residential sector has the greatest opportunity.

Figure D-4 presents the residential baseline and achievable potential forecasts by end use. In the baseline forecast, the fastest growing end uses are electronics and air conditioning, while lighting declines as a result of the EISA legislation. Growth in the remaining end uses varies. Energy efficiency savings in this sector will come from actions across several end uses: home electronics, air conditioning, space heating and water heating.

Figure D-5 presents the commercial-sector baseline and achievable potential forecasts by end use. Baseline growth is driven largely by growth in office equipment, cooling and space heating. Achievable energy-efficiency savings are dominated by opportunities in lighting, cooling and office equipment, which together account for 35 TWh savings in 2030.

The industrial sector grows at a modest rate, but has considerable opportunity for energy-efficiency savings in the machine drive end use. Figure D-6 presents the industrial-sector baseline and achievable potential forecasts by end use.

To put the end-use and sector-level savings potential in perspective, Figure D-7 presents the Top 10 end uses in the west region’s realistic achievable potential. These results parallel the findings for the U.S. as a whole.

Finally, Figure D-8 presents the potential for summer peak demand savings from demand response. For the West, the achievable range is 6.4 to 8.3% in 2030, slightly less than the 7-9% range for the U.S. as a whole.

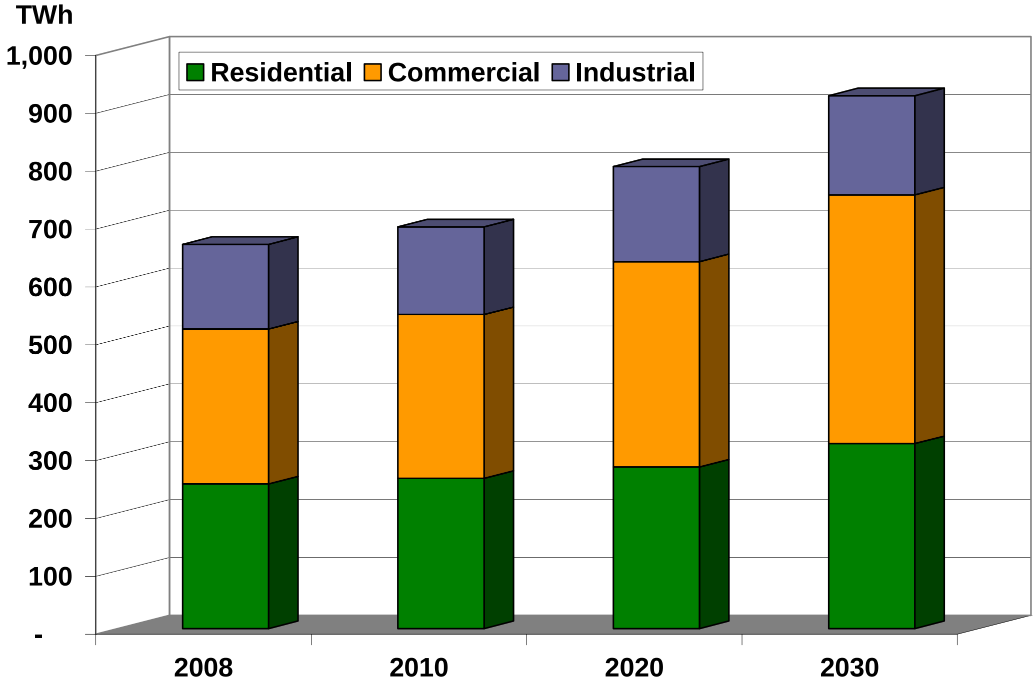


Figure D-1
Electricity Forecast by Sector – West Region

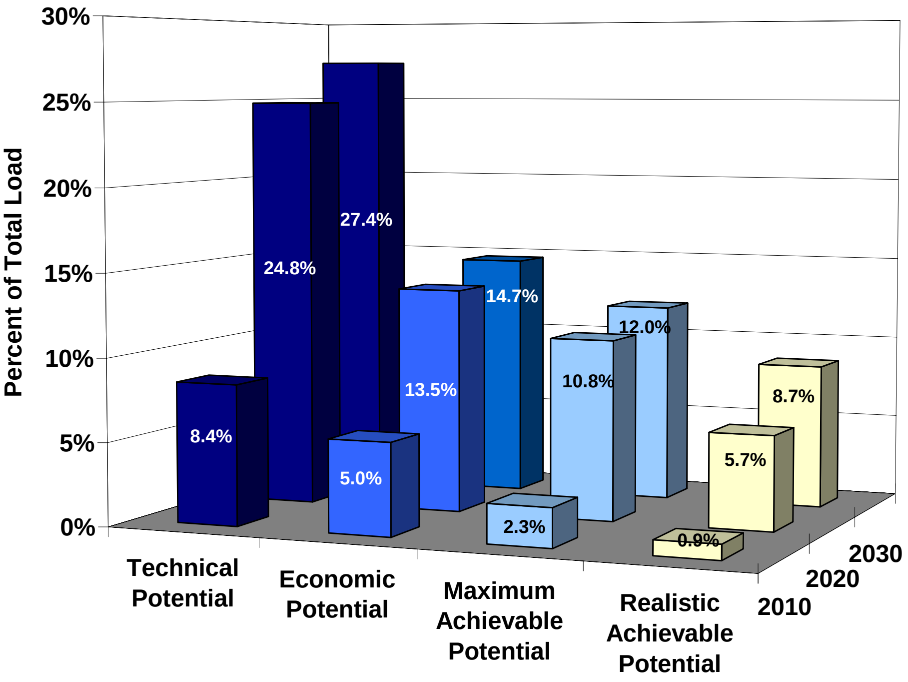


Figure D-2
Energy Efficiency Potential – West Region

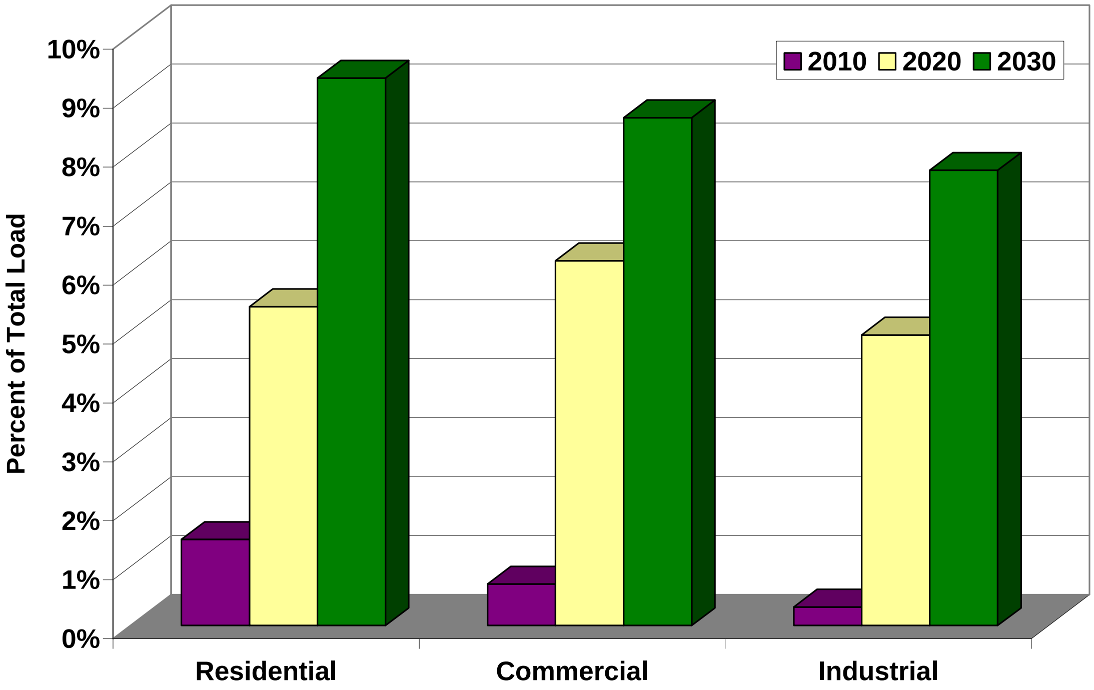


Figure D-3
Realistic Achievable Potential by Sector – West Region

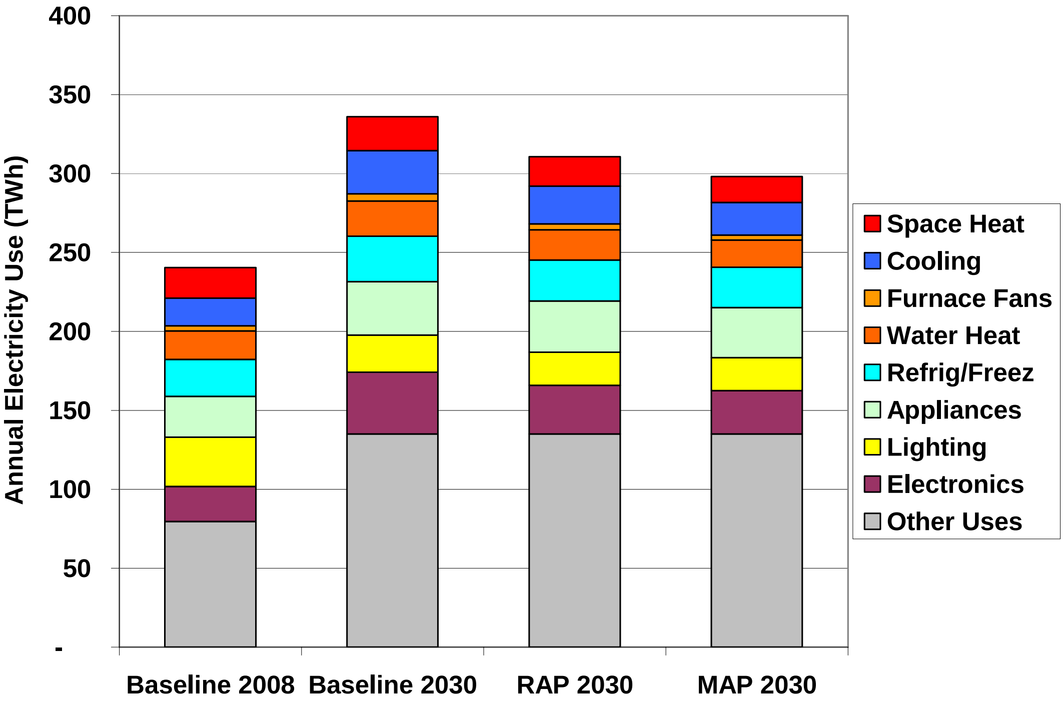


Figure D-4
Residential Baseline and Achievable Potentials by End Use – West

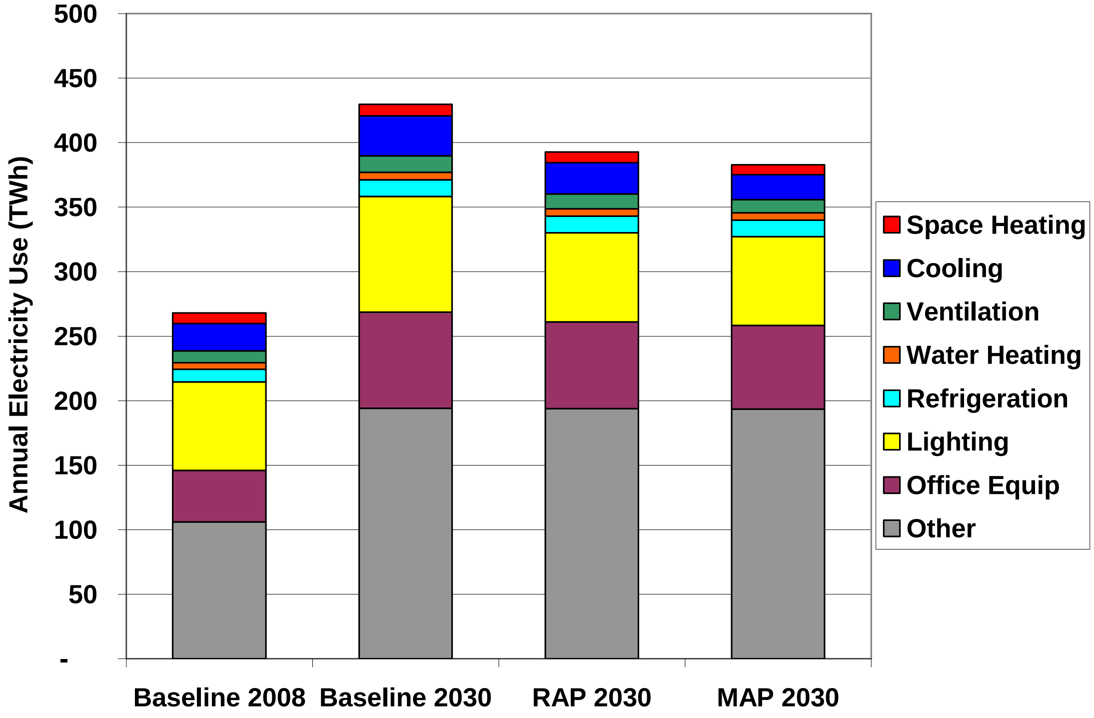


Figure D-5
Commercial Sector Baseline and Achievable Potentials by End Use – West

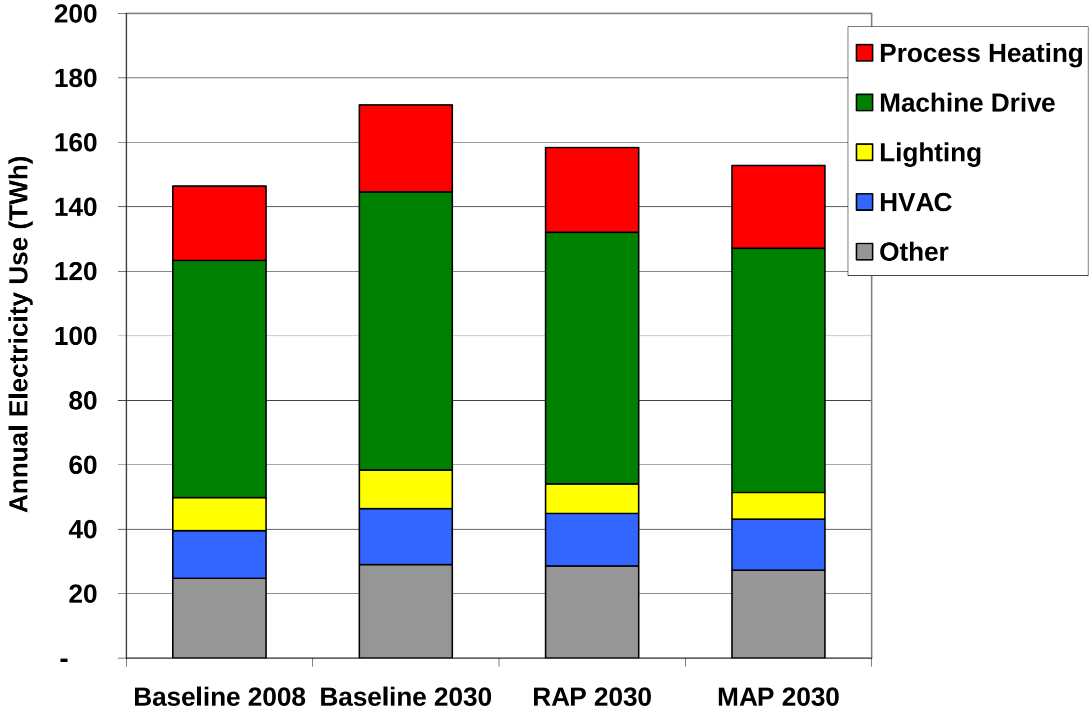


Figure D-6
Industrial Sector Baseline and Achievable Potentials by End Use – West

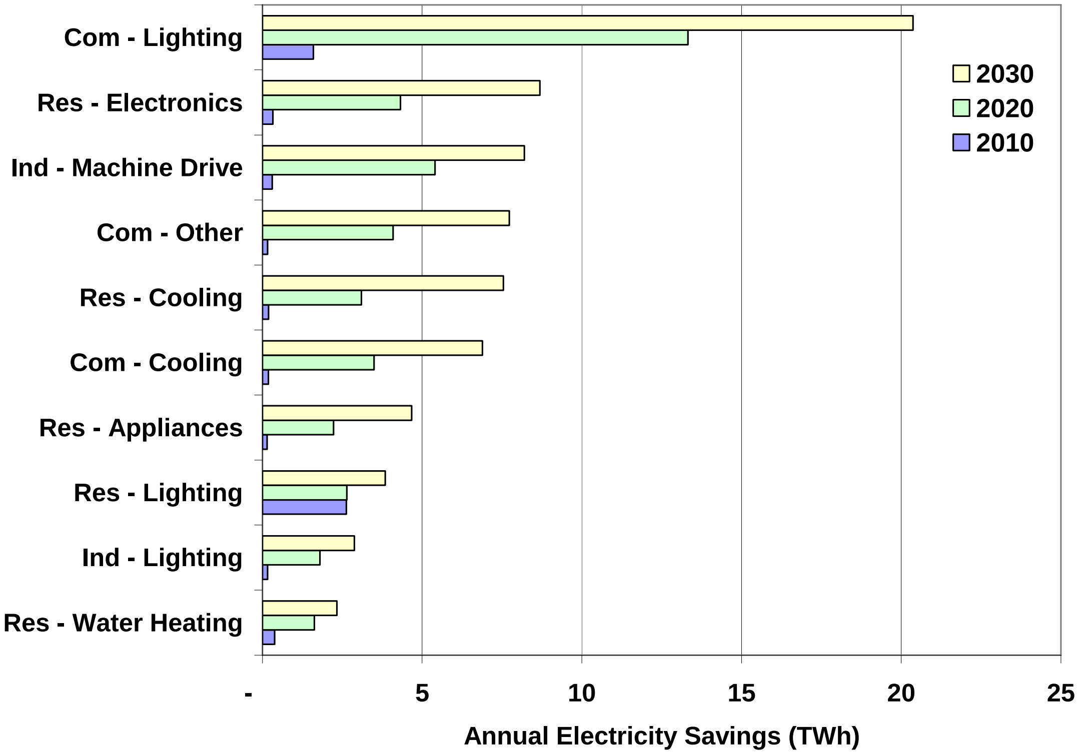


Figure D-7
Realistic Achievable Potential, Top 10 End Uses – West

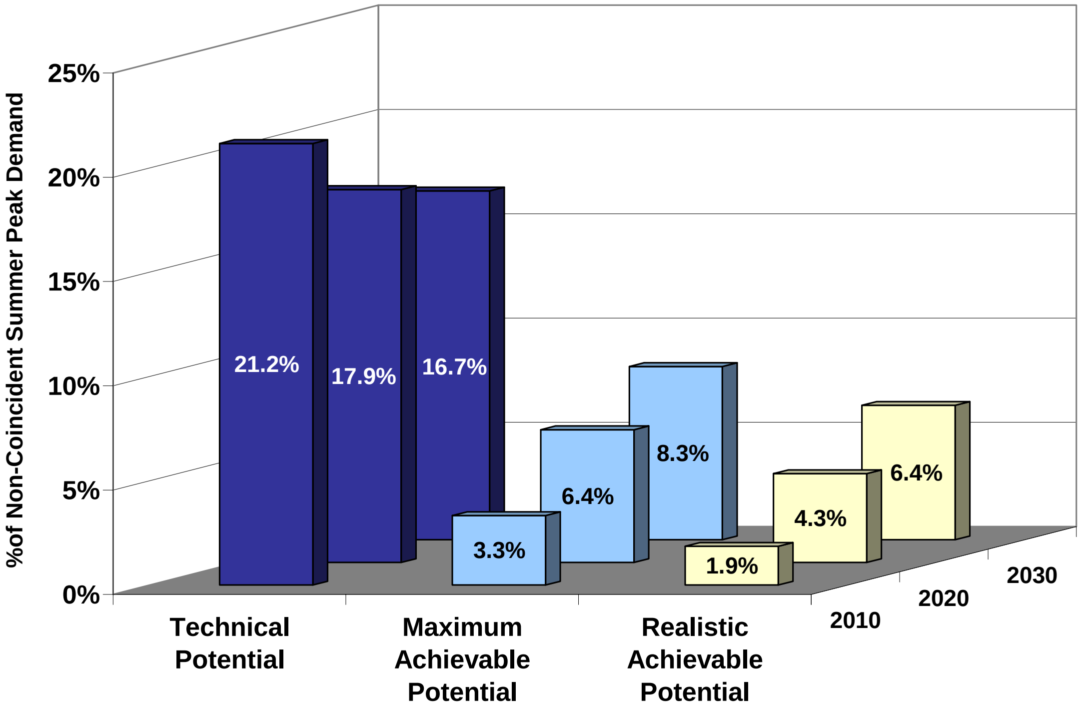


Figure D-8
Demand Response Potential – West

E

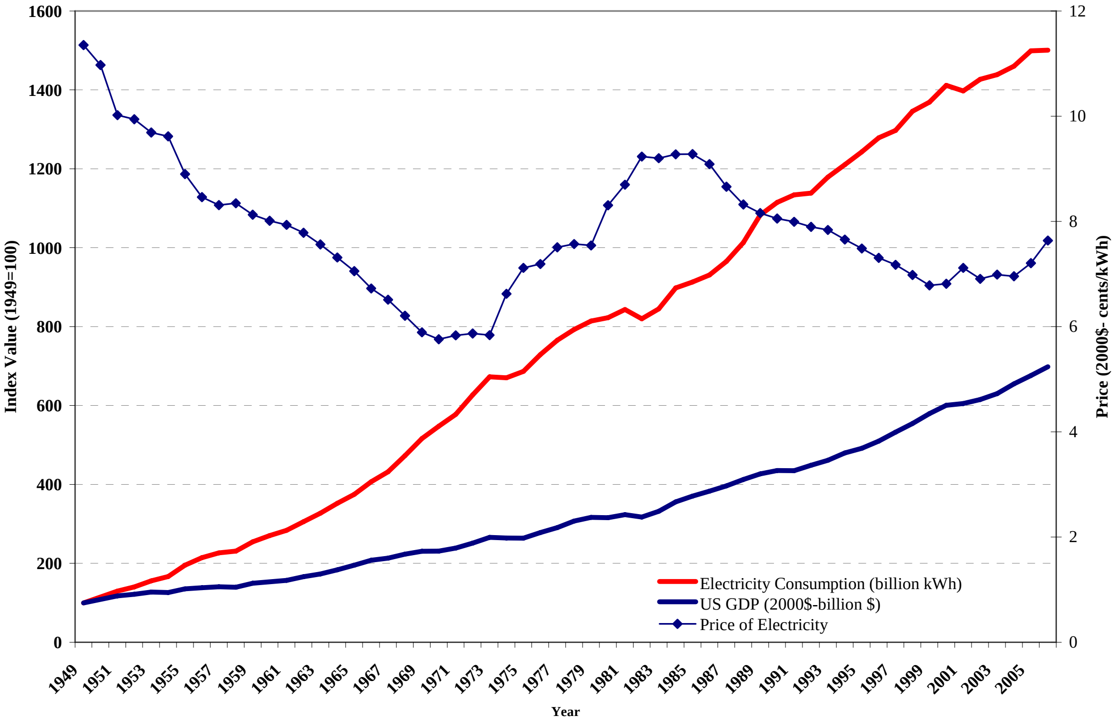
APPENDIX: HISTORICAL GAINS IN ENERGY EFFICIENCY

In the aftermath of the 1973 oil embargo, the United States took several actions to reduce its dependence on foreign oil supply. The first major step towards this goal was the issuance of the Energy Policy and Conservation Act of 1975 (EPCA) which promoted electricity generation from nuclear resources and natural gas rather than from oil. Many utilities initiated demand-side management (DSM) programs, inclusive of both energy efficiency and peak load management, to conserve energy in their service territories with support from federal and state authorities. Supportive of these initiatives, national energy codes and standards emerged as cost-effective options to reduce energy consumption by buildings and appliances. In some cases, such as in California, these were reinforced by even more stringent state standards.

As these structural reforms took hold, energy consumption began to slow down. But it was furthered slowed down by several other market forces such as a slowing down in the growth of the economy, a steady shift away from manufacturing to services. A countervailing factor was the continued electrification of the economy, brought on by continued market penetration of electricity consuming devices in the energy sector.

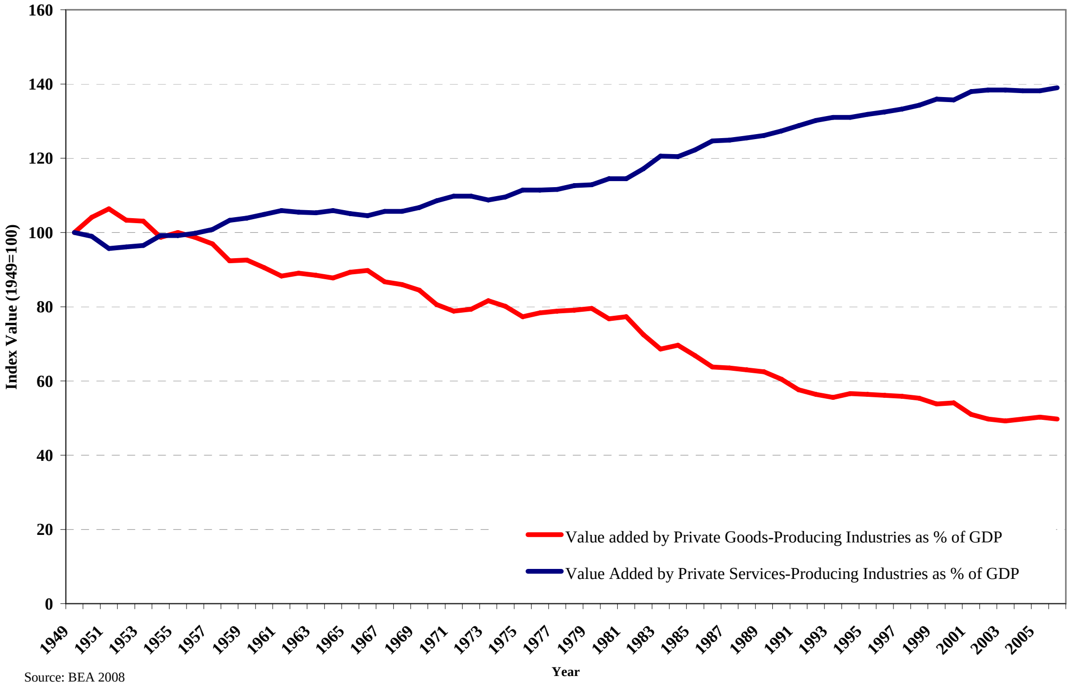
Figure E-1 shows that both U.S. GDP and electricity consumption have grown over the 1949-2006 period, however electricity consumption has grown at a higher pace than the GDP. Figure E-2 shows the gradual decline in value added from private-goods producing industries as percent of total U.S GDP over the 1949- 2006 period. This is matched by increase in the share of private-services producing industries over the same time period. These observations imply that the growth in economy has required increasingly more electricity consumption.

The price of electricity is an important market force that directly affects the consumption of electricity. Figure E-1 plots real (in constant 2000 dollars) electricity prices over the 1949-2006 period. A decreasing trend in electricity prices in the pre-embargo period was reversed by the oil embargo and a rising trend was sustained through the mid-1980s. After 1985, electricity prices started to fall once again and this downward trend continued until 2002. These changes in electricity prices brought about increases and decreases in electricity consumption over the 1949-2006 period as consumers adjusted their consumption to changes in prices.



Source: Electricity consumption and US GDP from Annual Energy Review 2007
Price of electricity from EEI

Figure E-1
U.S. GDP, Electricity Consumption, and Electricity Price (1949-2006)



Source: BEA 2008
1- Private goods-producing industries consist of agriculture, forestry, fishing, and hunting; mining; construction; and manufacturing.
2- Private services-producing industries consist of utilities; wholesale trade; retail trade; transportation and warehousing; information; finance, insurance, real estate, rental, and leasing; professional and business services; educational services, health care, and social assistance.

Figure E-2
Value Added from Goods and Services Industries as Percent of U.S. GDP (1949-2006)

This section zooms in on the changes in the rate of growth of U.S. electricity consumption during the 1975-2006 period relative to the historical period that preceded the oil embargo. We first present a brief literature review of the studies that looked into the question of how the consumption of electricity, or more generally energy, changed after 1975. We then present our analysis that compares actual post-embargo consumption with the consumption that would have occurred if the drivers of consumption kept growing at their historical growth rates. Our analysis constructs a "wedge" of unobserved consumption and makes an effort to identify the drivers of this wedge such as the slowing of economic growth, the changing mix of the economy, energy prices, codes and standards, and utility DSM programs using the evidence from the literature.

Literature Review

"Energy Efficiency Policies: A Retrospective Examination"- 2006

In their descriptive survey[31] of demand-side energy efficiency policies, Gillingham, Newell, and Palmer focus on the adoption of energy efficient equipment and building practices. They classify these measures into four broad categories: appliance standards, financial incentive programs for energy-efficient investments, information programs and management of government energy use. Their survey excludes building codes, professional codes, and transportation policies including CAFÉ standards.

They report that the total energy savings from all utility-based DSM projects was 53,936 gigawatt-hours (GWh) in 2001; 50,265 GWh in 2003; and 54,710 GWh in 2004 according to an EIA study of the utility DSM programs. These estimates imply that the utility DSM programs saved 1.6 percent of total U.S. electricity consumption under the assumption that all energy savings from these projects were due to reduced electricity usage. York and Kushler (2005)[32] find that total savings reach to more than 67,000 GWh in 2003 when savings from state-run public benefits programs are also accounted for in addition to the utility based DSM programs. Gillingham et al. also report that several ENERGY STAR® activities saved more than 80,000 GWh and avoided the use of 10 GWs of peak generating capacity in 2001 according to Environmental Protection Agency (EPA) estimates.

Gillingham et al. acknowledge the limitations of existing information and program data incompatibility. Nevertheless, they make an effort to estimate annual energy savings for 2000 or a proximate year. They identify energy savings up to 4 quads[33] resulting from appliance standards and utility DSM programs. Components of these savings are reproduced in Table E-1.

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[31] Gillingham, K., R. Newell, and K. Palmer, "Energy Efficiency Policies: A Retrospective Examination," Annual Review of Environment and Resources, Vol. 31:161–92.

[32] York D., M. Kushler, "ACEEE's Third National Scorecard on Utility and Public Benefits Energy Efficiency Programs: A National Review and Update of State-level Activity," 2005, ACEEE Rep. U054,Washington, DC.

[33] 1 quad is equal to 293 TWh. This translates into 1,172 TWh of electricity savings if we assume that all savings originate from electricity consumption. Including other energy efficiency programs, such as building codes and new research and development, would increase this estimate further.

Table E-1
Energy Savings from Appliance Savings and Utility DSM Programs

	Energy Savings (in Quads)	% of Total
Appliance Standards	1.2	29%
Financial Incentives	0.62	15%
Information and Voluntary Programs	2.27	55%
Management of Government Energy Use	0.07	2%
Total	**4.16**	**100%**

Source: Reproduced based on Gillingham et al., Table 2, page 183.

"Assessing U.S. Energy Policy" - 2006

In this study[34], Brown, Sovacool, and Hirsh compare U.S. energy consumption in 2004 to that in 1970 and discuss the factors that lead to changes in nation's energy consumption pattern. They report that the U.S. electricity consumption is 167 percent larger in 2004 than it was in 1970. In the same period, electricity grew from representing 25 percent of nation's total energy use to representing 40 percent in 2004. Authors find that before the 1973 oil embargo, U.S. energy consumption grew in unison with the U.S. GDP which meant that energy intensity of the nation remained relatively constant. However, this trend changed after the oil embargo. While the real GDP grew by 148 percent from 1973 to 2004, total U.S energy consumption grew from 76 quads to 100 quads, only by 32 percent. In other words, the energy intensity of the economy dropped substantially and this is largely attributed to gains in energy productivity. Authors conclude that if the U.S. energy intensity remained the same today as it was in 1970, U.S. energy consumption would be twice as much of its value in 2004. This implies that energy savings in U.S economy was 100 quads in 2004.

"The American Energy Efficiency Investment Market" - A White Paper Prepared for the Energy Efficiency Finance Forum (ACEEE) – 2007

This ACEEE study[35] finds that U.S. energy consumption grew from 68 to 100 quadrillion BTU between 1970 and 2006. Energy efficiency is reported to have met three-fourths of all new demand for energy services since 1970 by outperforming conventional energy supplies. According to the paper, total U.S. energy consumption in 2006 would reach to 200 quadrillion Btu without the efficiency improvements implying 100 quadrillion Btu energy savings in 2006[36].

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[34] Brown, M., B. Sovacool, R. Hirsh, "Assessing U.S. Energy Policy," American Academy of Arts and Sciences, June 2006.

[35] Leitner, J., K. Ehrhardt-Martinez, W. Prindle, "The American Energy Efficiency Investment Market," A White Paper prepared for the Energy Efficiency Finance Forum, April 2007.

[36] The U.S. Annual Energy Outlook 2008 reports that 40 percent of total energy consumption in 2006 can be attributed to electricity consumption. If we take authors estimate of 100 quadrillion BTU savings in 2006 and

“Energy Efficiency Resource Standards: Experience and Recommendations”- 2006

This study[37] reports that if U.S. economy had used the same amount of energy per unit of GDP as it did in 1973, U.S. energy use would have been 90 percent higher in 2004. In other words, efficiency and other energy-intensity improvements saved 90 quads in 2004 and this is reported to be more than U.S. energy supplied annually from domestic coal, natural gas, and oil sources. The study references another study by Geller et al. (2006)[38] which finds that one-third of this improvement is due to structural changes in the economy (i.e., relative decline in the production of energy-intensive industries), while the remaining two-thirds is due to improvements in energy efficiency.

“Information and Communication Technologies: The Power of Productivity”- 2008

According to this study[39], the U.S. dramatically reduced the amount of energy required to support economic activity since 1970. Today, it is possible to produce a dollar worth of economic output using half the energy used in 1970 to produce the same output. U.S. energy intensity (energy consumption per dollar of economic output) declined to 9,000 BTUs in 2008 from 18,000 BTU in 1970. Energy efficiency improvements reportedly provided 75 percent of the new demand in the economy.

“California Energy Demand 2008- 2018- Staff Revised Forecast”- 2007

In this report[40], California Energy Commission (CEC) staff developed estimates of conservation impacts for each utility planning area. Their methodology is based on introducing program savings in the reverse order of introduction. For example impacts of the 2005 building standards are determined through comparing the forecasts when those standards are in effect to the forecasts when only the 1998 building standards are in effect. Through a series of model runs and iterative process, all program impacts are estimated. When all building and appliance standards are removed from the forecasts, only the market and the price effects remain. Finally prices are held constant to produce a baseline demand forecast with no price or standard impacts. The impacts from many utility and government programs are also accounted for in the forecasts.

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assume that 40 percent of total energy savings is due to reduced energy consumption, we find that 11,720 TWh of electricity consumption has been saved in 2006 due to energy efficiency measures.

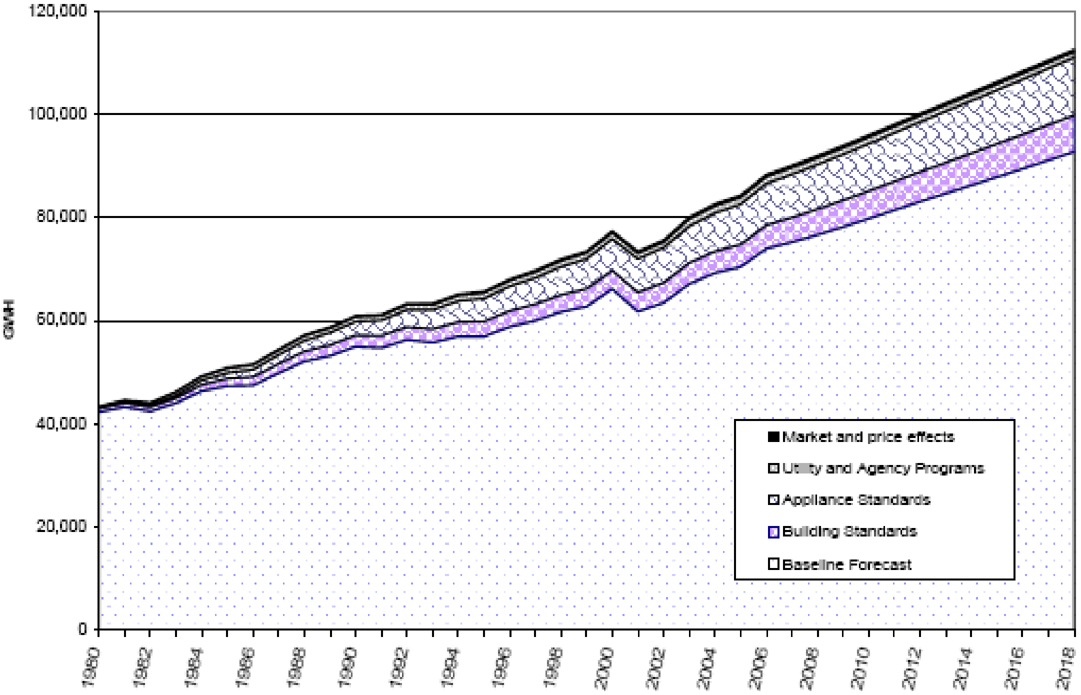
[37] Nadel, S., “Energy Efficiency and Resource Standards: Experience and Recommendations,” ACEEE Report E063, 2006.

[38] Geller, H., P. Harrington, A. Rosenfeld, S. Tanishima, and F. Unander, *Policies for Increasing Energy Efficiency: Thirty Years of Experience in OECD Countries,* Boulder, Colo: Southwest Energy Efficiency Project, 2006.

[39] Laitner, J., K. Ehrhardt-Martinez, “Information and Communication Technologies: The Power of Productivity,” February 2008.

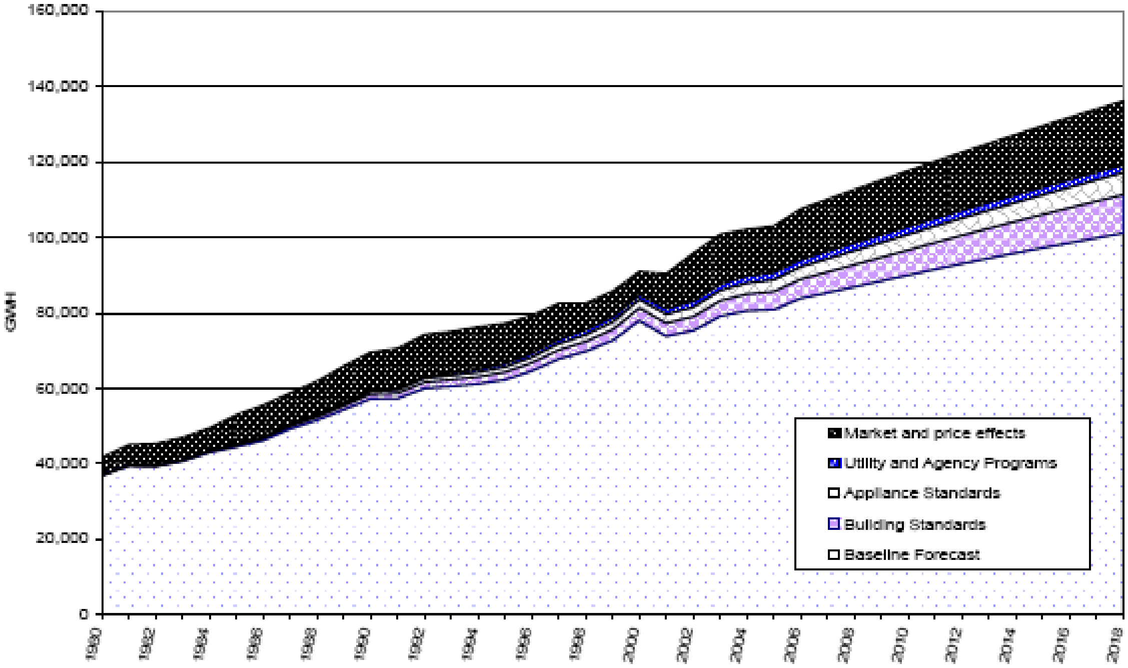
[40] California Energy Commission, “California Energy Demand 2008-2018, Staff Revised Forecast,” Staff Final Report, November 2007.

These savings are directly obtained from the utilities and public agencies. The following figures present the commercial and residential results for three California IOUs combined.



Source: CEC, 2007

Figure E-3
Estimated IOU Residential Consumption and Conservation Impacts (GWh)



Source: CEC, 2007

Figure E-4
Estimated IOU Commercial Consumption and Conservation Impacts (GWh)

According to Table E-2, building and appliance standards and utility and public agency programs together represent 66 percent of the total conservation impacts in 2008 for three California IOUs' residential and commercial customers. Market and price impacts are responsible for 34 percent of the total savings. CEC report states that residential and commercial sectors represent two thirds of total consumption and that commission's industrial, agricultural and other sector forecasts do not model conservation explicitly. It is also reported that industrial sector has shown large decreases in energy intensity for many industries largely exceeding utility estimates of program savings for those sectors

Table E-2
Percentage Breakdown of the Savings for Residential and Commercial Classes Combined

Year	Building & Appliance Standards	Utility and Public Agency Programs	Market and Price Effects	Total
1990	37%	6%	56%	100%
2000	62%	9%	29%	100%
2005	58%	8%	34%	100%
2008	59%	7%	34%	100%
2013	62%	6%	32%	100%
2018	65%	5%	30%	100%

Source: Reproduced based on CEC, 2007- Table 6, pg.28

Methodology

As stated previously, our goal is to quantify the efficiency improvement that has taken place historically. Graphically, this can be conceived of as a wedge between a line that traces out actual consumption in the post-embargo period and a line that plots out the consumption that would have occurred had pre-embargo trends continued in the post-embargo period. Conceptually, the wedge can be said to be comprised of to two main forces: market forces and government codes and standards coupled with utility DSM programs. The first group, "market forces," includes the impacts from a slower growth in GDP and rising electricity prices. The second group comprises the impacts associated with government codes and standards and utility DSM programs. In our analysis, we quantify the size of the wedge through econometric modeling. We then use the evidence from the literature surveyed earlier to bracket the size of the determinants of the wedge. Our methodology involves three main steps:

1. We first estimate an econometric model of US electricity consumption during the pre-embargo (1949-1974) period
2. Using the estimated parameters from the electricity consumption model, we predict the electricity consumption in the post-embargo period that would have occurred had GDP and price grown at their historical (1949-1974) rates.
3. We quantify the wedge by comparing the counterfactual series predicted in step 2 with the series representing actual electricity consumption over the same period.

These steps are described below.

Step1: Estimation of Electricity Consumption Model

We estimate the electricity consumption model given in Step 1 using the 1949- 1974 period data on electricity consumption, first lag of electricity consumption, total number of customers, electricity prices, and U.S. GDP. $\ln(Y)$ is the logarithm of the national electricity consumption, $L.\ln(Y)$ is the first lag of $\ln(Y)$ while ln (GDP) and ln (PRICE) are respectively logarithms of U.S. GDP and electricity price. Regression results are provided in Table E-3.

$$\ln(Y)_t = \beta_0 + \beta_1 L.\ln(Y)_t + \beta_2 \ln(PRICE)_t + \beta_3 \ln(GDP)_t + u_t \qquad \textbf{(1)}$$

Table E-3
Electricity Consumption Model, 1949-1974

Dependent Variable: In (Consumption)	
Lag of In (Consumption)	0.727 (15.12)**
In (Price)	-0.27 (2.85)***
In (GDP)	0.297 (3.19)**
Constant	0.057 -0.08
Observations	25
R-Squared	0.99
Durbin-Watson	1.85
Absolute value of t statistic in parentheses * significant at 5%; ** significant at 1%	

As can be seen from Table E-3, all parameter estimates are statistically significant and have the expected signs. The short run price elasticity is equal to -0.27 and the short run GDP elasticity is equal to 0.297. Both elasticities are statistically significant. The long run price elasticity is equal to the ratio ${}^{\beta_2}\!/_{1-\beta_1}$ and can be calculated using the parameter estimates from equation (1). Plugging in the coefficients, we find that long-run price elasticity is -1. The R-squared is 0.99 indicating that the model explains 99 percent of the variation in the dependent variable. The Durbin-Watson statistic of 1.85 reveals that the model specification does not contain serially correlated errors and thus the standard errors of the parameter estimates are unbiased.

Step 2: Predicting "But-for" Electricity Consumption

In this step, we infer the size of the wedge using the parameters of the model estimated in Step 1. We predict electricity consumption by using price and GDP series simulated through the post-embargo (1975-2006) period using their pre-embargo growth rates. By using historical growth rates to project electricity price and GDP and predicting consumption using these projected values, we allow market forces to drive electricity consumption the way they were driving it in the pre-1975 period. This prediction represents the continuation of the market trends in the pre-1975 period. We denote this series by $\hat{Y}(Historic)$. The average GDP growth rate is 3.8 percent between 1949 and 1974 while the average price growth rate is -2.1 percent during the same time period. We use these growth rates to project GDP and price series that will be used in the prediction of $\hat{Y}(Historic)$.

Actual and projected series for price and GDP are presented respectively in Figure E-5 and Figure E-6.

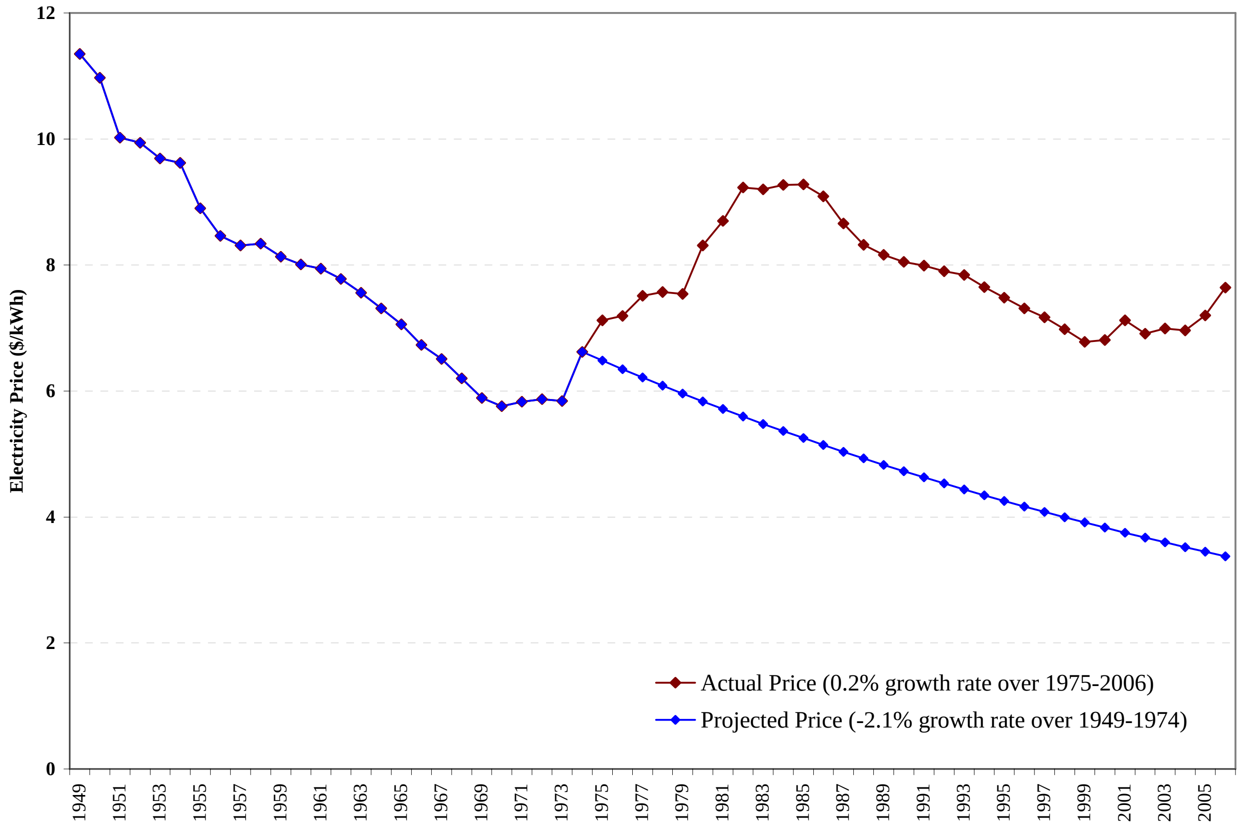


Figure E-5
Comparison of Actual and Projected Price Series

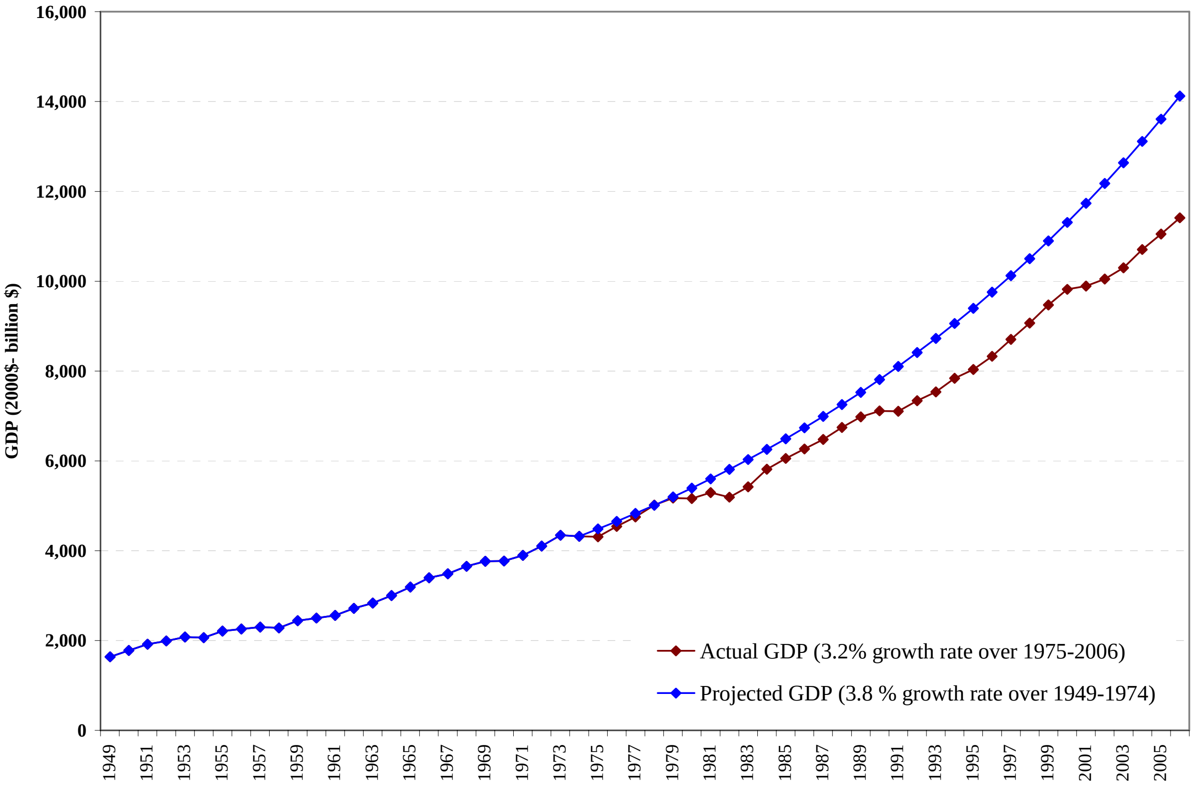


Figure E-6
Comparison of Actual and Projected GDP Series

Step 3: Quantifying the Wedge

In this step, we compare $\hat{Y}(Historic)$ to actual electricity consumption ($Y(Actual)$) in the 1975-2006 period. The average GDP growth rate is 3.2 percent between 1975 and 2006, indicating a drop of 0.6 percent compared to the pre-embargo period, while the average price growth rate is 0.2 percent, indicating a rise of 2.3 percent.

When we take the difference between the actual and predicted series, the differential can be attributed to the deviation of post-1975 driving forces from those of pre-1975. This difference represents the change in electricity consumption brought about by the change in the market forces and government codes and standards coupled with utility DSM programs in the post-1975 period.

$$Wedge = \hat{Y}(Historic) - Y(Actual)$$

In 2006, total actual electricity consumption has reached 3,820 TWh. If the market forces had remained the same as they were in the pre-1975 period and there had been no structural changes in the way electricity was consumed in the economy, electricity consumption would have reached to 10,423 TWh in 2006. Our analysis shows that in 2006, 6,603 TWh more electricity would have been consumed if codes and standards and utility DSM programs had not been implemented; GDP and electricity price changes had not modified the consumption patterns in the post-1975 period. Figure E-7 shows historical efficiency savings in the post-1975 period.

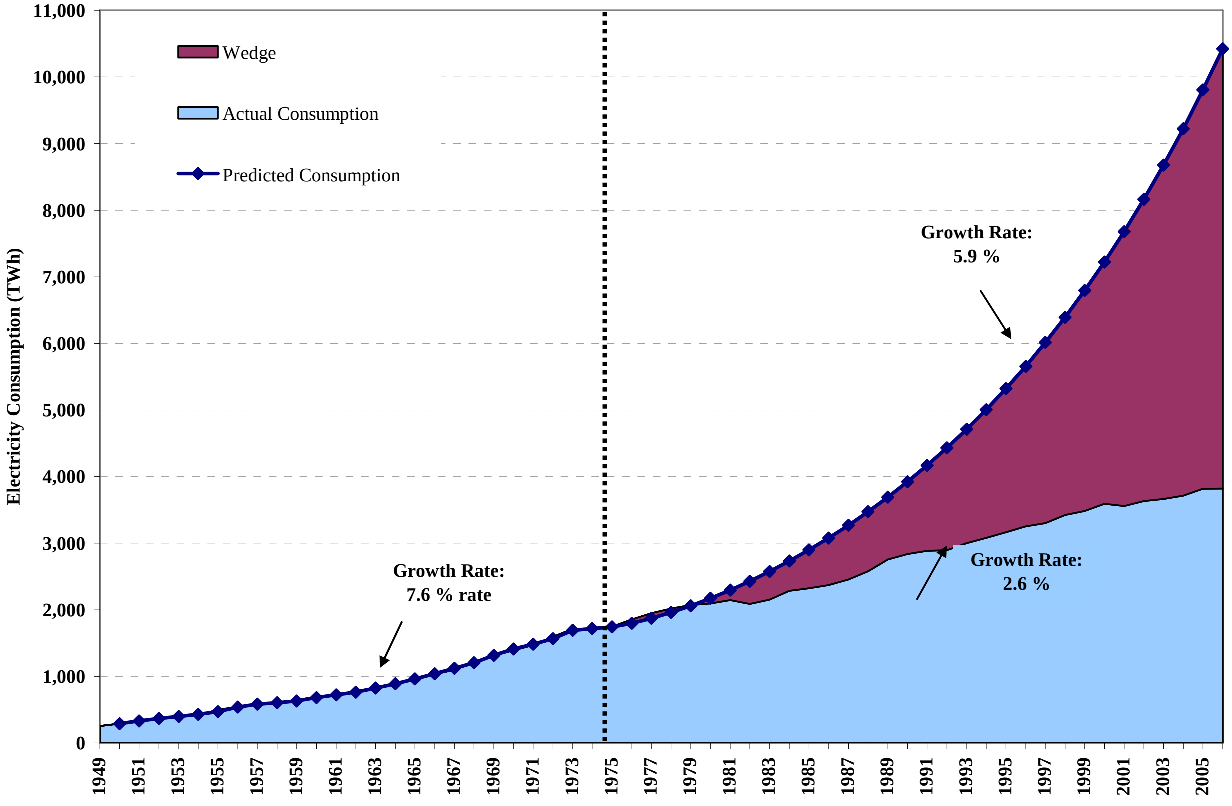


Figure E-7
Historical Efficiency Gains

Having quantified the size of the wedge, we can use the evidence from the literature to attribute the savings to market forces and government codes and standards coupled with utility DSM programs. The CEC staff report finds that 66 percent of electricity consumption savings in California are due to codes and standards and utility and public agency programs while the remaining 34 percent is due to market forces. The Geller et al. (2006) study finds that one third of the total energy savings is due to market forces while the remaining two thirds is due to improvement in energy efficiency. According to Laitner et al. (2008), energy efficiency improvements reportedly provided 75 percent of the new demand in the economy. Geller et al. (2006) and Laitner et al. (2008) focus on energy savings from all resources while the CEC staff report (2007) only focuses on savings in electricity consumption.

California being the most aggressive state in the nation in terms of the utility DSM programs and codes and standards, it is reasonable to assert that the 66 percent savings estimated by the CEC represents the upper bound on the national electricity savings due to government codes and standards coupled with utility DSM programs. This corresponds to 4,358 TWh savings in electricity consumption due to government codes and standards coupled with utility DSM programs, in comparison to 2,245 TWh savings due to market forces at the national level. Once again, savings due to DSM programs and codes and standards represent the upper bound at the national level, and the decomposition of the wedge requires further research.

F

APPENDIX: ENERGY EFFICIENCY MEASURE DATA

This appendix provides two types of information:

- A description of the energy-efficiency measures considered in this study
- Tables of modeling assumptions for each measure.

Each of these two sections is organized by sector: residential, commercial and industrial.

Table F-1
Energy Efficiency Measure Descriptions – Residential

End-Use	Energy Efficiency Measure	Description
Cooling	Air Conditioner - Central, Energy Star or better	Central air conditioners consist of a refrigeration system using a direct expansion cycle. Equipment includes a compressor, an air-cooled condenser (located outdoors), an expansion valve, and an evaporator coil. A supply fan is located near the evaporator coil in order to distribute supply air through air ducts to many rooms inside the building. Cooling efficiencies vary based on the quality of the materials used, the size of equipment, the condenser type and the configuration of the system. Central air conditioners may be of the unitary variety (all components housed in a factory-built assembly) or a split system (an outdoor condenser section and an indoor evaporator section connected by refrigerant lines and with the compressor at either the outdoor or indoor location). The EPA Energy Star Program rates the energy efficiency of central air conditioners according to the size of the unit. A metric of efficiency performance is the Seasonal Energy Efficiency Rating (SEER), which ranges from a baseline value of 13 to a 20 or more. Systems with Variable Refrigerant Flow further improve the operating efficiency.
Cooling	Air Conditioner - Room, Energy Star or better	Room air conditioners are designed to cool a single room or space. This type of unit incorporates a complete air-cooled refrigeration and air-handling system in an individual package. Cooled air is discharged in response to thermostatic controls to meet room requirements. Each unit has a self-contained, air-cooled direct expansion (DX) cooling system and associated controls. Room air conditioners come in several forms, including window, split-type, and packaged terminal units. The EPA Energy Star Program rates the energy efficiency of room air conditioners according to the size of the unit. Energy Star labeled room air conditioners must exceed minimum federal standards for energy consumption by at least 10 percent, with Energy Efficiency Ratings (EER) typically greater than 10.
Heating / Cooling	Heat Pump - Central, High Efficiency	A central heat pump consists of components similar to a central air conditioner. In fact, oftentimes a unit is capable of functioning both as a heat pump and an air conditioner. It consists of a refrigeration system using a direct expansion (DX) cycle. Equipment includes a compressor, an air-cooled condenser (located outdoors), an expansion valve, and an evaporator coil (located in the supply air duct near the supply fan) and a reversing valve to change the DX cycle from cooling to heating when required. The cooling and heating efficiencies vary based on the quality of the materials used, the size of equipment, the condenser type and the configuration of the system. Heat pumps may be of the unitary variety (all components housed in a factory-built assembly) or be a split system (an outdoor condenser section and an indoor evaporator section connected by refrigerant lines and with the compressor at either the outdoor or indoor location). Air-source heat pumps are only appropriate for use in climates where there are mild winter temperatures.

Table F-1 (continued)
Energy Efficiency Measure Descriptions – Residential

End-Use	Energy Efficiency Measure	Description
Heating / Cooling	Heat Pump, Geothermal or Water Source	Geothermal heat pumps are similar to ordinary air conditioners and heat pumps, but use the ground or groundwater instead of outside air to provide heating, cooling, and, in most cases, hot water. A geothermal heat pump system generally consists of three major subsystems or parts: a geothermal heat pump to move heat between the building and the fluid in the earth connection, an earth connection for transferring heat between its fluid and the earth, and a distribution subsystem for delivering heating or cooling to the building. Each system may also have a desuperheater to supplement the building's water heater, or a full-demand water heater to meet all of the building's hot water needs. In heating mode, heat is extracted from the fluid in the earth connection by the geothermal heat pump and distributed to the home or building -- typically through a system of air ducts. In cooling mode, the cycle is reversed and the earth serves as a heat sink where the heat pump rejects heat transferred from the building.
Lighting	Compact Fluorescent Lamps	Compact fluorescent lamps can consist of either electronic or magnetic ballast and a twin tube or quad tube lamp. They are designed to be a replacement for standard incandescent lamps and use about 25% of the energy used by incandescent lamps to produce the same lumen output. Integral compact fluorescent lamps have the ballast integrated into the base of the lamp and have a standard screw-in base and a spiral design which permits installation into existing incandescent fixtures.
Lighting	Fluorescent, T8 Lamps and Electronic Ballasts	T8 fluorescent lamps are smaller in diameter than standard T12 lamps, which result in greater light output per watt input (more efficient lighting). T8 lamps also operate at a lower current and wattage, which also increases the efficiency of the ballast but requires the lamps to be compatible with the ballast. Fluorescent lamp fixtures can include a reflector that increases the light output from the fixture, and thus making it possible to use a fewer number of lamps in each fixture. T5 lamps further increase efficiency by reducing the lamp diameter to 5/8"".
Lighting	Solid State Lighting	LED lighting has seen recent penetration in specific applications such as traffic lights and exit signs. With the potential for extremely high conversion efficiency, LED’s show promise to provide general use white lighting for interior spaces. Current models commercially available have efficacies comparable to CFLs. However, theoretical efficiencies are significantly higher. White LED models under development are expected to provide efficacies greater than 80 lumens per watt.
Lighting	Outdoor Lighting – Photosensor Control	Photosensors controls for exterior lighting determine the need for lighting by measuring the ambient lighting levels. When it becomes dark outside, the controls turn on exterior lights and turns them off again when ambient light levels increase. This eliminates the operation of exterior lighting during daylight hours.

Table F-1 (continued)
Energy Efficiency Measure Descriptions – Residential

End-Use	Energy Efficiency Measure	Description
Lighting	Outdoor Lighting – Photovoltaic, Installation	Outdoor photovoltaic (PV) lighting systems use PV panels (or modules), which convert sunlight to electricity. The electricity is stored in batteries for use at night. They can be cost effective relative to installing power cables and/or step down transformers for relatively small lighting loads. The "nightly run time" listings on most "off-the-shelf" products are based on specific sunlight conditions. Systems located in places that receive less sunlight than the system is designed for will operate for fewer hours per night than expected. Nightly run times may also vary depending on how clear the sky is on any given day. Shading of the PV panel by landscape features (vegetation, buildings, etc.) will also have a large impact on battery charging and performance.
Appliance	Refrigerator/Freezer, Energy Star or better	An energy-efficient refrigerator/freezer is designed by improving the various components of the cabinet and refrigeration system. These components improvements include cabinet insulation, compressor efficiency, evaporator fan efficiency, defrost controls, mullion heaters, oversized condenser coils, and improved door seals. The Energy Star Program has a system for labeling refrigerator/freezer units that are energy efficient. In this analysis, a NAECA-standard refrigerator is assumed to consume 60 kWh per year less than a standard refrigerator. An Energy Star refrigerator is assumed to consume 15% (approximately 156 kWh per year) less than a standard refrigerator. Further efficiency increases can be obtained by reducing the volume of refrigerated space, or adding multiple compartments to reduce losses from opening doors.
Water Heating	Water Heater - Electric, High Efficiency	For electric residential hot water heating, common heaters include automatic storage heaters and instantaneous heaters. Automatic storage heaters incorporate the electric heating element, storage tank, outer jacket, insulation, and controls in a single unit and are normally installed without dependence on other hot water storage equipment. Efficient residential electric water heaters are characterized by a high recovery or thermal efficiency and low standby losses (the ratio of heat lost per hour to the content of the stored water).
Water Heating	Water Heater, Heat Pump	An electric heat pump water heater uses a vapor-compression thermodynamic cycle similar to that found in an air-conditioner or refrigerator. The electrical work input to the process allows a heat pump water heater to extract heat from an available source (e.g., air) and reject that heat to a higher temperature sink, in this case, the water in the water heater. Because the heat pump makes use of available ambient heat rather than generating all of the heat required to heat the water, the coefficient of performance is greater than one—typically in the range of 2 to 3. By utilizing the earth as a thermal reservoir, ground source heat pump water heaters can reach even higher levels of efficiency. The heat pump can be integrated with a traditional water storage tank or installed remote to the storage tank.

Table F-1 (continued)
Energy Efficiency Measure Descriptions – Residential

End-Use	Energy Efficiency Measure	Description
Water Heating	Water Heating, Solar	Solar water heating is a renewable energy technology that is well proven and readily available and has considerable potential for application. Solar water-heating systems can be used effectively in residential buildings that have an appropriate near-south-facing roof or nearby unshaded grounds for installation of a collector. Although there are a large number of different types of solar water-heating systems, the basic technology is very simple. Sunlight strikes and heats an "absorber" surface within a "solar collector" or an actual storage tank. Either a heat-transfer fluid or the actual potable water to be used flows through tubes attached to the absorber and picks up the heat from it. (Systems with a separate heat-transfer-fluid loop include a heat exchanger that then heats the potable water.) The heated water is stored in a separate preheat tank or a conventional water heater tank until needed. If additional heat is needed, it is provided by electricity or fossil-fuel energy by the conventional water-heating system.
Appliance	Dishwasher, Energy Star or better	Energy Star labeled dishwashers save by using both improved technology for the primary wash cycle, and by using less hot water to clean. Construction includes more effective washing action, energy-efficient motors, and other advanced technology such as sensors that determine the length of the wash cycle and the temperature of the water necessary to clean the dishes.
Appliance	Clothes Washer, Energy Star or better	Energy Star labeled clothes washers use superior designs that require less water to get clothes thoroughly clean. These machines use sensors to match the hot water needs to the load, preventing energy waste. There are two designs: top-loading and front-loading. The front-loading is a horizontal axis machine and utilizes significantly less water than the standard vertical axis machines. A horizontal axis clothes washer utilizes a cylinder that rotates horizontally to wash, rinse, and spin the clothes. Further energy and water savings can be achieved through advanced technologies such as inverter-drive or combination washer-dryer units.
Appliance	Clothes Dryer – Electric, High Efficiency	An energy-efficient clothes dryer has a moisture-sensing device to terminate the drying cycle rather than using a timer, and an energy-efficient motor is used for spinning the dryer tub. Application of a heat pump cycle for extracting the moisture from clothes leads to additional energy savings.
Appliance	Range and Oven – Electric, High Efficiency	These products have additional insulation in the oven compartment and tighter-fitting oven door gaskets and hinges to save energy. Conventional ovens must first heat up about 35 pounds of steel and a large amount of air before they heat up the food. Tests indicate that only 6% of the energy output of a typical oven is actually absorbed by the food. In this analysis, high-efficiency range and oven are assumed to consume 20% less energy than a standard range and oven.

Table F-1 (continued)
Energy Efficiency Measure Descriptions – Residential

End-Use	Energy Efficiency Measure	Description
Electronics	TVs and Home Electronics, Energy Star or better	In the average home, 90% of the energy used to power electronic products is consumed when the products are turned off - energy used to maintain features like clock, remote control, and channel/station memory. Energy Star labeled consumer electronics can drastically reduce consumption during standby mode, in addition to increasing operation through advanced power management during normal use.
Electronics	Personal Computers, Energy Star or better	Computers are responsible for an increasing share of power consumption as the penetration of PC's grows and the performance requirements rise. Power supplies for specialty gaming systems, for example, draw as much as 750 W of power, resulting in 6570 kWh per year if the unit runs continuously. Improved power management can significantly reduce the annual consumption of a Personal Computer, in both standby and normal operation.
Electronics	Home Electronics, Reduce Standby Wattage	Representing a growing portion of home electricity consumption, plug-in electronics such as set-top boxes, DVD players, digital video recorders and even battery chargers for mobile phones and laptop computers are often designed to supply a set voltage. When the units are not in use, this voltage could be dropped significantly (~1 W) and thereby generate a significant energy savings, assumed for this analysis to be between 4-5% on average. These savings are in excess of the measures already discussed for computers and televisions.
Other	Furnace Fans, Electronically Commutating Motor	In homes heated by a gas-fired furnace, there is still substantial energy use by the fan responsible for moving the hot air throughout the ductwork. Application of an Electronically Commutating Motor (ECM) ensures that motor speed matches the heating requirements of the system and saves energy when compares to a continuously operating standard motor.
Cooling	Ceiling Fan, Installation	Ceiling fans can reduce the need for air conditioning. However, the house occupants must also select a ceiling fan with a high-efficiency motor and setup the thermostat temperature of the air conditioning system in order to realize the potential energy savings. Some ceiling fans also come with lamps. In this analysis, it is assumed that there are no lamps, and installing a ceiling fan will allow occupants to increase the thermostat cooling set point up by 2 degrees (F).
Cooling	Dehumidifier, Installation	Ceiling fans can reduce the need for air conditioning by reducing the latent heat in the air. Effective in humid climates during moderate days, the installation of a dehumidifier is assumed to reduce the number of days of operation of central or room AC units.

Table F-1 (continued)
Energy Efficiency Measure Descriptions – Residential

End-Use	Energy Efficiency Measure	Description
Cooling	Whole-House Fan, Installation	Whole house fans can reduce the need for air conditioning on moderate-weather days or on cool evenings. The fan facilitates a quick air change throughout the entire house. Several windows must be open to achieve the best results. The fan is mounted on the top floor of the house, usually in a hallway ceiling.
Cooling	Attic Fan, Installation	Attic fans can reduce the need for air conditioning by reducing the heat transfer from the attic through the ceiling of the house. A well-ventilated attic reaches temperatures several degrees lower than in comparable, unventilated space.
HVAC - Other	Ducting, Insulation	Furnace and air conditioning ducts that are outside the conditioned space (e.g. in basement or attic) can be insulated to reduce heating or cooling losses. Best results can be achieved by covering the entire surface area with insulation. Several types of ducts and duct insulation are available, including flexible duct, pre-insulated duct, duct board, duct wrap, tacked, or glued rigid insulation, and waterproof hard shell materials for exterior ducts. This analysis assumes that installing duct insulation can reduce the temperature drop/gain in ducts by 50%.
HVAC – Other	Thermostat, Clock / Programmable	A clock thermostat can be added to most heating/cooling systems. They are typically used during winter to lower temperatures at night and in summer to increase temperatures during the afternoon. There are two-setting models, and well as models that allow separate programming for each day of the week. The energy savings from this type of thermostat are identical to those of a "setback" strategy with standard thermostats, but the convenience of a clock thermostat makes it a much more attractive option. In this analysis, the baseline is assumed to have no thermostat setback.
Building Envelope	Doors, Storm and Thermal	In addition to their obvious function of providing entry and egress to or from the home, doors also function as part of the thermal envelope or shell of the home. Like other components of the shell, doors are subject to several types of heat loss: conduction, infiltration, and radiant losses. Like a storm window, a storm door works by creating an insulating air space between the storm and primary doors. A tight fitting storm door can also help reduce air leakage or infiltration. Thermal doors have exceptional thermal insulation properties and also are provided with weather-stripping on the doorframe to reduce air leakage.
Building Envelope	External Shades or Overhangs/Fins	Physical features on the exterior of buildings that provide additional shade for windows and/or wall areas. This reduces the heat gain of the building from direct sunlight, which reduces the cooling load, thus saving cooling energy.

Table F-1 (continued)
Energy Efficiency Measure Descriptions – Residential

End-Use	Energy Efficiency Measure	Description
Building Envelope	Insulation, Ceiling	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation can conserve energy by reducing the heat loss or gain of a building. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose; loose-fill (blown) fiberglass; and rigid polystyrene.
Building Envelope	Insulation, Foundation	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation can conserve energy by reducing the heat loss or gain of a building. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose; loose-fill (blown) fiberglass; and rigid polystyrene.
Building Envelope	Insulation, Wall Cavity	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation can conserve energy by reducing the heat loss or gain of a building. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose; loose-fill (blown) fiberglass; and rigid polystyrene.
Building Envelope	Roofs, High Reflectivity	The color and material of a building structure surface will determine the amount of solar radiation absorbed by that surface and subsequently transferred into a building. This is called solar absorptance. By using a material or painting the roof with a light color (and a lower solar absorptance), the roof will absorb less solar radiation and consequently reduce the cooling load. This analysis assumes that implementing high reflectivity roofs will decrease the roof's absorptance of solar radiation by 45%.
Building Envelope	Windows, High Efficiency/Energy Star	High-efficiency windows, such as those labeled under the Energy Star Program, are designed to reduce a building's energy bill while increasing comfort for the occupants at the same time. High-efficiency windows have reducing properties that reduce the amount of heat transfer through the glazing surface. For example, some windows have a low-E coating, which is a thin film of metallic oxide coating on the glass surface that allows passage of short-wave solar energy through glass and prevents long-wave energy from escaping. Another example is double-pane glass that reduces conductive and convective heat transfer. There are also double-pane glasses that are gas-filled (usually argon) to further increase the insulating properties of the window.

Table F-1 (continued)
Energy Efficiency Measure Descriptions – Residential

End-Use	Energy Efficiency Measure	Description
Water Heating	Faucet Aerators	Water faucet aerators are threaded screens that attach to existing faucets. They reduce the volume of water coming out of faucets while introducing air into the water stream. This measure provides both water conservation through reduced water flow for both hot and cold water and energy conservation through the reduction in hot water use. In this analysis, it is assumed that faucet aerators reduce hot water consumption by 4%.
Water Heating	Pipe - Hot Water, Insulation	Insulation material inhibits the transfer of heat through the hot water pipe. In residential applications, usually the first five feet of pipe closest to the domestic water heater are insulated. Small pipes are insulated with cylindrical half-sections of insulation with factory applied jackets that form a hinge-and-lap or with flexible closed cell material. This measure is modeled by increasing the energy factor of the building's water heater by 6%.
Water Heating	Showerheads, Low-Flow	Similar to faucet aerators, low-flow showerheads reduce the consumption of hot water, which results in decreasing the energy used for creating hot water. For this analysis, this measure assumes a replacement of two standard showerheads with low-flow showerheads, which results in a reduction of 10,000 gallons of hot water use per year.
Cooling	Air Conditioner - Central, Maintenance	An air conditioner's filters, coils, and fins require regular cleaning and maintenance for the unit to function effectively and efficiently throughout its years of service. Neglecting necessary maintenance will lead to a steady decline in air conditioning performance while energy use steadily increases. This analysis assumes that maintenance will increase the efficiency of poorly performing equipment by 10%.
Heating / Cooling	Heat Pump - Central, Maintenance	A heat pump's filters, coils, and fins require regular cleaning and maintenance for the unit to function effectively and efficiently throughout its years of service. Neglecting necessary maintenance ensures a steady decline in heating performance while energy use steadily increases. This analysis assumes that maintenance will increase the efficiency of poorly performing heat pump equipment by 10%.

Table F-1 (continued)
Energy Efficiency Measure Descriptions – Residential

End-Use	Energy Efficiency Measure	Description
HVAC – Other	Ducting, Repair and Sealing	An ideal duct system would be free of leaks. Leakage in unsealed ducts varies considerably with the fabricating machinery used, the methods for assembly, installation workmanship, and age of the ductwork. Air leaks from the system to the outdoors result in a direct loss proportional to the amount of leakage and the difference in enthalpy between the outdoor air and the conditioned air. To seal ducts, a wide variety of sealing methods and products exist. Each has a relatively short shelf life, and no documented research has identified the aging characteristics of sealant applications. This analysis assumes that the baseline air loss from ducts has doubled, and conducting repair and sealing of the ducts will restore leakage from ducts to the original baseline level (10% air loss from ducts).
Building Envelope	Infiltration Control (caulk, weather strip, etc.)	Significant energy savings can be obtained by lowering the infiltration rate through caulking small leaks and weather-stripping around window frames, doorframes, power outlets, plumbing and wall corners. Weather-stripping doors and windows will create a tight seal and further reduce air infiltration. This analysis assumes that conducting infiltration control will reduce the overall infiltration by 25%.
Compre-hensive	In-home Feedback Monitor	By providing customers with accurate and timely information about their electricity consumption, in-home displays typically lead to energy savings through a combination of behavioral modifications and equipment choices. Under existing electricity rate structures, this analysis assumes an overall reduction of 2.6% in annual energy consumption.

Table F-2
Energy Efficiency Measure Descriptions – Commercial

End-Use	Energy Efficiency Measure	Description
Cooling	Air Conditioner - Packaged, High-Efficiency	Packaged cooling systems are the simplest and probably the most commonly used in small commercial buildings. Applications range from a single supply system with air intake filters, supply fan, and cooling coil, or can become more complex with the addition of a return air duct, return air fan, and various controls to optimize performance. For this analysis, units with Energy Efficiency Ratios (EER) of 8.5 and higher were considered, as well as ductless or “mini-split” systems with variable refrigerant flow.
Cooling	Air Conditioner - Packaged, Maintenance	Poor maintenance is a primary reason for many air conditioning failures. Regular maintenance on condenser coils, evaporators, air filters, etc. can improve the efficiency of the equipment, thus leading to energy savings and longer equipment lifetimes. This analysis assumes that maintenance will increase the efficiency of poorly performing equipment by 10%.
Cooling	Chilled Water, Reset	Chilled water reset controls save energy by improving chiller performance through increasing the supply chilled water temperature, which allows increased suction pressure during low load periods. Raising the chilled water temperature also reduces chilled water piping losses. However, the primary savings from the chilled water reset measure results from chiller efficiency improvement. This is due partly to the smaller temperature difference between chilled water and ambient air, and partly due to the sensitivity of chiller performance to suction temperature.
Cooling	Chilled Water, Variable-Flow System	The part-load efficiency of chilled water loop pumps can be improved substantially by varying the speed of the motor drive according to the building demand for cooling. There is also a reduction in piping losses associated with this measure that has a major impact on the energy use for a building. However, pump speeds can generally only be reduced to a minimum specified rate, because chillers and the control valves may require a minimum flow rate to operate. There are two major types of variable speed drives: mechanical and electronic. An additional benefit of variable-speed drives is the ability to start and stop the motor gradually, thus extending the life of the motor and associated machinery. This analysis assumes that electronic variable speed drives are installed.
Cooling	Chiller - Air-Cooled, High-Efficiency	Air-cooled chiller systems are usually used in buildings that have cooling requirements less than 200 tons, and eliminate the need for a cooling tower and its associated water pumps, piping, and fans, reducing installation and maintenance costs. Air-cooled chillers are usually limited to the reciprocating and screw chiller types. For this analysis, several assumptions were made in order to model efficient chilled water systems. The metric containing these assumptions is the kW/ton rating for the system. Lower kW/ton values assume more efficient cooling towers as well as chillers.

Table F-2 (continued)
Energy Efficiency Measure Descriptions – Commercial

End-Use	Energy Efficiency Measure	Description
Cooling	Chiller - Water-Cooled, High-Efficiency	Water-cooled chillers reject heat through cooling towers via a condenser water loop. Water-cooled chiller systems are usually used in multi-zone buildings that have cooling requirements greater than 200 tons.
Cooling	Chiller, VSD Centrifugal	Centrifugal chillers are driven by electric motors. Motor speed can be controlled by installing a variable speed drive (VSD). This use of a VSD is additional to inlet vanes traditionally used for chiller capacity control and load matching. VSDs can be used for capacity control over a fairly small band near the chiller's full load capacity.
Cooling	Condenser Water, Temperature Reset	The cooling tower fan for an open, water-cooled condenser is controlled based on the part-load ratio of the chiller (load-reset), instead of on leaving condenser water temperature. This allows the leaving condenser water temperature to float based on outdoor wet-bulb temperature and cooling load. This strategy attempts to minimize the total compressor plus tower fan energy use.
Cooling	Cooling Tower, High-Efficiency Fan	Cooling towers typically use banks of fans to draw ambient air into the tower, which in turn cools the condenser water. The fans move outside air through a spray of water, allowing heat to dissipate from the water. A high efficiency motor can improve operating efficiency and reduce energy consumption. Specific fan designs will also make a difference on the overall efficiency performance of the cooling tower. In this analysis, it is assumed that installing high-efficiency fans will increase the cooling tower's efficiency by 5%.
Cooling	Cooling Tower, Variable Speed Fan	The part-load efficiency of cooling tower fans can be improved substantially by varying the speed of the motor drive. There are two major types of variable speed drives: mechanical and electronic. An additional benefit of variable-speed drives is the ability to start and stop the motor gradually, thus extending the life of the motor and associated machinery. This analysis assumes the installation of electronic variable speed drives.
Cooling	Economizer, Installation	Economizers allow outside air (when it is cool and dry enough) to be brought into the building space to meet cooling loads instead of using mechanically cooled interior air. An economizer consists of indoor and outdoor temperature and humidity sensors, dampers, motors, and motor controls. Economizers are most applicable to temperate climates and savings will be smaller in extremely hot or humid areas.

Table F-2 (continued)
Energy Efficiency Measure Descriptions – Commercial

End-Use	Energy Efficiency Measure	Description
Heating	Hot Water, Variable-Flow System	The part-load efficiency of hot water loop pumps can be improved substantially by adjusting the speed of the motor drive according to the building demand for heating or cooling. There is also a reduction in piping losses associated with this measure that has a major impact on the heating loads and energy use for a building. However, pump speeds can generally only be reduced to a minimum specified rate, because boilers and the control valves may require a minimum flow rate to operate. There are two major types of variable speed drives: mechanical and electronic. An additional benefit of variable-speed drives is the ability to start and stop the motor gradually, thus extending the life of the motor and associated machinery. This analysis assumes that electronic variable-speed drives are installed.
Heating / Cooling	Heat Pump - Air-Source, High-Efficiency	Air-source heat pumps heat and cool spaces by moving heat from one place to another. In the summer, they transfer heat from indoor air to air outside the conditioned space. In the winter, they extract heat from outdoor air and deliver it inside. Packaged-thermal heat pumps can be designed to serve a room or multiple zones. Most air-source heat pumps that are installed in commercial buildings are unitary, which means they are pre-engineered and factory- assembled in one or two modules. Air-source heat pumps are only appropriate for use in climates where there are mild winter temperatures.
Heating / Cooling	Heat Pump - Air-Source, Maintenance	Regular service and maintenance is necessary for optimum operation of any heat pump system. In addition to the maintenance issues associated with air conditioning systems, regular maintenance on valves, defrost timers and heat strips are necessary for proper operation of heat pumps. This analysis assumes that maintaining the heat pump will increase its efficiency by 10%.
Heating / Cooling	Heat Pump - Room, High Efficiency	Window (or wall) mounted room heat pumps are designed to cool or heat a single room or space. This type of unit incorporates a complete air-cooled refrigeration and air-handling system in an individual package. Cool or warm air is discharged in response to thermostatic control to meet room requirements. Each unit has a self-contained, air-cooled direct expansion (DX) cooling system, a heat pump heating system and associated controls. The energy saving decreases with each incremental increase in efficiency. Air-source heat pumps are only appropriate for use in climates where there are mild winter temperatures.

Table F-2 (continued)
Energy Efficiency Measure Descriptions – Commercial

End-Use	Energy Efficiency Measure	Description
Heating / Cooling	Heat Pump, Geothermal or Water Source	Geothermal heat pumps are similar to ordinary air conditioners and heat pumps, but use the ground or groundwater instead of outside air to provide heating, cooling, and, in most cases, hot water. A geothermal heat pump system generally consists of three major subsystems or parts: a geothermal heat pump to move heat between the building and the fluid in the earth connection, an earth connection for transferring heat between its fluid and the earth, and a distribution subsystem for delivering heating or cooling to the building. Each system may also have a desuperheater to supplement the building's water heater, or a full-demand water heater to meet all of the building's hot water needs. In heating mode, heat is extracted from the fluid in the earth connection by the geothermal heat pump and distributed to the home or building -- typically through a system of air ducts. In cooling mode, the cycle is reversed and the earth serves as a heat sink where the heat pump rejects heat transferred from the building.
HVAC-Other	Air-Handler VAV Systems	In a forced-air HVAC system, variable air-volume systems respond to changes in heating and cooling loads by reducing the amount of conditioned air flowing to the space (rather than by keeping the airflow constant and varying the temperature of the supply air as with constant-volume air systems). This measure saves electricity by reducing airflow rates during the entire year.
HVAC-Other	Ducting, Insulation	Air distribution ducts can be insulated to reduce heating or cooling losses. Best results can be achieved by covering the entire surface area with insulation. Insulation material inhibits the transfer of heat through the air-supply duct. Several types of ducts and duct insulation are available, including flexible duct, pre-insulated duct, duct board, duct wrap, tacked, or glued rigid insulation, and waterproof hard shell materials for exterior ducts. This analysis assumes that installing duct insulation can reduce the temperature drop/gain in ducts by 50%.
HVAC-Other	Ducting, Repair and Sealing	An ideal duct system would be free of leaks. Leakage in unsealed ducts varies considerably with the fabricating machinery used, the methods for assembly, installation workmanship, and age of the ductwork. Air leaks from the system to the outdoors result in a direct loss proportional to the amount of leakage and the difference in enthalpy between the outdoor air and the conditioned air. To seal ducts, a wide variety of sealing methods and products exist. Each has a relatively short shelf life, and no documented research has identified the aging characteristics of sealant applications. This analysis assumes that conducted repair and sealing of ducts will reduce leakage from ducts by 50%.

Table F-2 (continued)
Energy Efficiency Measure Descriptions – Commercial

End-Use	Energy Efficiency Measure	Description
HVAC-Other	Energy Management System	An energy management system (EMS) will allow managers/owners to monitor and control the major energy-consuming systems within a commercial building. At the minimum, the EMS can be used to monitor and record energy consumption of the different end-uses in a building, and can control operation schedules of the HVAC and lighting systems. The monitoring function helps building managers/owners to identify systems that are operating inefficiently so that actions can be taken to correct the problem. The EMS can also provide preventive maintenance scheduling that will reduce the cost of operations and maintenance in the long run. The control functionality of the EMS allows the building manager/owner to operate building systems from one central location. The operation schedules set via the EMS help to prevent building systems from operating during unwanted or unoccupied periods. This analysis assumes that this measure is limited to buildings with a central HVAC system.
HVAC-Other	Thermostat, Clock/ Programmable	A clock thermostat can be added to most heating/cooling systems. They are typically used during winter to lower temperatures at night and in summer to increase temperatures during the afternoon. There are two-setting models, and well as models that allow separate programming for each day of the week. The energy savings from this type of thermostat are identical to those of a "setback" strategy with standard thermostats, but the convenience of a clock thermostat makes it a much more attractive option. In this analysis, the baseline is assumed to have no thermostat setback.
HVAC-Other	Fans, Energy-Efficient Motors	High-efficiency motors are essentially interchangeable with standard motors, but differences in construction make them more efficient. Energy-efficient motors achieve their improved efficiency by reducing the losses that occur in the conversion of electrical energy to mechanical energy. This analysis assumes that the efficiency of supply fans is increased by 5% due to installing energy-efficient motors.
HVAC-Other	Fans, Variable Speed Control	The part-load efficiency of ventilation fans can be improved substantially by varying the speed of the motor drive. There are two major types of variable speed controls: mechanical and electronic. An additional benefit of variable-speed controls is the ability to start and stop the motor gradually, thus extending the life of the motor and associated machinery. This analysis assumes that electronic variable speed controls are installed.

Table F-2 (continued)
Energy Efficiency Measure Descriptions – Commercial

End-Use	Energy Efficiency Measure	Description
HVAC-Other	Pumps, Variable Speed Control	The part-load efficiency of chilled and hot water loop pumps can be improved substantially by varying the speed of the motor drive according to the building demand for heating or cooling. There is also a reduction in piping losses associated with this measure that has a major impact on the heating loads and energy use for a building. However, pump speeds can generally only be reduced to a minimum specified rate, because chillers, boilers, and the control valves may require a minimum flow rate to operate. There are two major types of variable speed controls: mechanical and electronic. An additional benefit of variable-speed drives is the ability to start and stop the motor gradually, thus extending the life of the motor and associated machinery. This analysis assumes that electronic variable speed controls are installed.
Building Envelope	Insulation, Ceiling	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation can conserve energy by reducing the heat loss or gain of a building. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose; loose-fill (blown) fiberglass; and rigid polystyrene.
Building Envelope	Insulation, Wall Cavity	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation can conserve energy by reducing the heat loss or gain of a building. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose; loose-fill (blown) fiberglass; and rigid polystyrene.
Building Envelope	Cool Roof	For smaller commercial buildings, heat gain through the roof is an important issue, particularly in sunny and hot climates. By using a reflective material or painting the roof with a light color (and a lower solar absorptance), the roof will absorb less solar radiation and consequently reduce the cooling load.
Building Envelope	Windows, High Efficiency	High-efficiency windows, such as those labeled under the Energy Star Program, are designed to reduce a building's energy bill while increasing comfort for the occupants at the same time. High-efficiency windows have reducing properties that reduce the amount of heat transfer through the glazing surface. For example, some windows have a low-E coating, which is a thin film of metallic oxide coating on the glass surface that allows passage of short-wave solar energy through glass and prevents long-wave energy from escaping. Another example is double-pane glass that reduces conductive and convective heat transfer. There are also double-pane glasses that are gas-filled (usually argon) to further increase the insulating properties of the window.

Table F-2 (continued)
Energy Efficiency Measure Descriptions – Commercial

End-Use	Energy Efficiency Measure	Description
Lighting	Compact Fluorescent Fixtures	Compact fluorescent lamps consist of either electronic or magnetic ballast and a twin tube or quad tube lamp. They are designed to be a replacement for standard incandescent lamps and use 25% to 30% of the energy used by incandescent lamps to produce the same lumen output. Non-integral compact fluorescent lamps do not have the ballast integrated into the base of the lamp, and thus must be hard-wired into specific fixtures that allow the lamp to operate with a ballast. Non-integral compact fluorescent lamps cannot be retrofitted into existing incandescent fixtures. This analysis assumes that 25% of all of the building's incandescent lamps can be replaced by compact fluorescent fixtures.
Lighting	Compact Fluorescent Lamps	Compact fluorescent lamps consist of either electronic or magnetic ballast and a twin tube or quad tube lamp. They are designed to be a replacement for standard incandescent lamps and use 25% to 30% of the energy used by incandescent lamps to produce the same lumen output. Integral compact fluorescent lamps have the ballast integrated into the base of the lamp and have a standard screw-in base, which permits installation into existing incandescent fixtures. This analysis assumes that 25% of all of the building's incandescent lamps can be replaced by compact fluorescent lamps.
Lighting	Daylighting Controls	Daylighting controls usually come in the form of a photocell sensor that automatically turns off lamps in response to natural daylight levels.
Lighting	Fluorescent, T5 Lamps and Fixtures	T5 lamps are smaller in size (length and width) which makes T5's well suited for the low-profile, elegant fixtures that are especially popular for upscale retail, hospitality and commercial spaces like display cases or wall-washing. Its smaller scale allows for sleeker fluorescent direct/indirect surface mounted and pendant fixtures. They are designed to peak in their lumen ratings at 95°, compared to 77° for T12 and T8 lamps. This thermal characteristic provides higher light output in confined applications where there is little or no air circulation, and it provides more usable lumens per watt in indirect fixtures. Fixtures for T5 can offer more uniform distribution (less "hot spots"), wider on-center spacing, and shorter drop lengths for pendant-mounted fixtures. T5/HO fixtures can use fewer lamps to deliver light levels similar to other fluorescent technologies. This analysis assumes that 10% of all of the building's fluorescent fixtures can be replaced by T5 2-foot lamp fixtures, while 20% can be replaced by T5 4-foot lamp fixtures.

Table F-2 (continued)
Energy Efficiency Measure Descriptions – Commercial

End-Use	Energy Efficiency Measure	Description
Lighting	Fluorescent, T8 Lamps and Electronic Ballasts	T8 fluorescent lamps are smaller in diameter than standard T12 lamps, which result in greater light output per watt input (more efficient lighting). T8 lamps also operate at a lower current and wattage, which also increases the efficiency of the ballast but requires the lamps to be compatible with the ballast. Fluorescent lamp fixtures can include a reflector that increases the light output from the fixture, and thus making it possible to use a fewer number of lamps in each fixture. This analysis assumes that 3% of all of the building's fluorescent fixtures can be replaced by T8 2-foot 2-lamp fixtures, while 4% can be replaced by T8 2-foot 4-lamp fixtures, 15% can be replaced by T8 4-foot 2-lamp fixtures, 25% can be replaced by T8 4-foot 3-lamp fixtures, 50% can be replaced by T8 4-foot 4-lamp fixtures, and 3% can be replaced by T8 8-foot lamp fixtures.
Lighting	Fluorescent, Super T8 Lamps and Fixtures	"Super" T8 lamps are physically identical to standard T8 fluorescent lamps. However, super T8 lamps have a 9% greater light output than their standard counterparts while consuming the same wattage. Thus, there would be negligible energy savings in retrofit situations. The purpose of using super T8 lamps is to produce the most light per lamp, and thus be able to use a fewer number of lamps. Energy savings can be realized in new construction situations where super T8 lamps are integrated into the general lighting design of commercial buildings.
Lighting	High-Pressure Sodium Lamps	High-pressure sodium lamps (HPS) have been used outdoors to replace mercury vapor flood lamps. Their high luminous efficacy has also led to their use in commercial buildings ranging from warehouses to office buildings. However, their poor color rendition is often cited as a constraint on their use in retail establishments. HPS is commonly used to light roadways, parking lots, and pathways, and for security, industrial and warehouse lighting applications. Since they operate well in cold temperatures, they can be good as retrofits for exterior incandescent and mercury vapor lighting. This analysis assumes that 5% of all of the building's HID fixtures can be replaced 50W high-pressure sodium lamps, 5% by 70W high-pressure sodium lamps, and 10% by 100W high-pressure sodium lamps.
Lighting	LED Exit Lighting	The lamps inside exit signs represent a significant energy end-use, since they usually operate 24 hours per day. Many old exit signs use incandescent lamps, which consume approximately 40 watts per sign. The incandescent lamps can be replaced with LED lamps that are specially designed for this specific purpose. In comparison, the LED lamps consume approximately 2-5 watts.

Table F-2 (continued)
Energy Efficiency Measure Descriptions – Commercial

End-Use	Energy Efficiency Measure	Description
Lighting	Metal Halide Lighting with Pulse Start	Metal halide lamps are similar in construction and appearance to mercury vapor lamps. The addition of metal halide gases to mercury gas within the lamp results in higher light output, more lumens per watt, and better color rendition than from mercury gas alone. Pulse-start metal halide lighting systems typically consume 20 percent less energy than standard metal halide systems. This new technology produces the same intensity at a lower wattage. This analysis assumes that 100% of all of the building's HID fixtures can be replaced by pulse-start metal halide lamps.
Lighting	Occupancy Sensors	The installation of occupancy sensors allows lights to be turned off during periods when a space is unoccupied. Such systems are appropriate for areas with intermittent use, such as conference rooms or bathrooms. There are several types of occupancy sensors in the market. For this analysis, it a wall-switch type of sensor is assumed to control 2 four-lamp T-12 fluorescent fixtures (172W each) that operate 9 hours for 250 days per year. Installing the occupancy sensor will reduce operation by 10%.
Lighting	Outdoor Lighting - PV, Installation (parking lots)	Outdoor photovoltaic (PV) lighting systems use PV panels (or modules), which convert sunlight to electricity. The electricity is stored in batteries for use at night. They can be cost effective relative to installing power cables and/or step down transformers for relatively small lighting loads. The "nightly run time" listings on most "off-the-shelf" products are based on specific sunlight conditions. Systems located in places that receive less sunlight than the system is designed for will operate for fewer hours per night than expected. Nightly run times may also vary depending on how clear the sky is on any given day. Shading of the PV panel by landscape features (vegetation, buildings, etc.) will also have a large impact on battery charging and performance. Open areas with no shading, such as parking lots, are ideal places where PV lighting systems can be used.
Lighting	Task Lighting	In commercial facilities, individual work areas can use task lighting instead of brightly lighting the entire area. Significant energy savings can be realized by focusing light directly where it is needed and lowering the general lighting level. An example of task lighting is the common desk lamp. A 25W desk lamp can be installed in place of a typical lamp in a fixture.
Water Heating	Faucet Aerators	Water faucet aerators are threaded screens that attach to existing faucets. They reduce the volume of water coming out of faucets while introducing air into the water stream. This measure provides both water conservation through reduced water flow for both hot and cold water and energy conservation through the reduction in hot water use. In this analysis, it is assumed that faucet aerators reduce hot water consumption by 4%.

Table F-2 (continued)
Energy Efficiency Measure Descriptions – Commercial

End-Use	Energy Efficiency Measure	Description
Water Heating	Pipe - Hot Water (DHW), Insulation	Insulation material inhibits heat loss through the hot water pipe. This measure is simulated by increasing the energy factor of the building's water heater by 6%.
Water Heating	Water Heater - Electric, High-Efficiency	Efficient residential electric water heaters are characterized by a high recovery or thermal efficiency (percentage of heat from combustion of gas which is transferred to the water) and low standby losses (the ratio of heat lost per hour to the content of the stored water). Included in the savings associated with high-efficiency electric water heaters are timers that allow temperature set-points to change with hot water demand patterns. For example, the heating element could be shut off throughout the night, increasing the overall energy factor of the unit.
Water Heating	Water Heater, Heat Pump	Unlike conventional water heaters that use either gas burners (and sometimes other fuels) or electric resistance heating coils to heat the water, the heat pump water heater takes heat from the surrounding air and transfers it to the water in the tank. This is the same principle as refrigerators, freezers, and room air conditioners but in reverse. Much less energy is required to "move" the heat than to actually heat the water unless the surrounding air temperature is very low. Most heat pump water heaters have back up heating elements to heat the water during very low temperature periods. A further increase in energy factor can be obtained through ground source heat pump water heaters.
Water Heating	Water Heater, Thermostat Setback	Timers are used to turn off the water heater or reduce the thermostat setting on the water heater during non-use periods. These measures are relatively low-cost and easy to operate with very unpredictable savings due to the variation in usage. This measure is simulated by increasing the energy factor of the building's water heater by 15%.
Water Heating	Water Heater, Solar	Solar water heating is a renewable energy technology that is well proven and readily available and has considerable potential for application at federal facilities. Solar water-heating systems can be used effectively in buildings that have an appropriate near-south-facing roof or nearby unshaded grounds for installation of a collector. Although there are a large number of different types of solar water-heating systems, the basic technology is very simple. Sunlight strikes and heats an "absorber" surface within a "solar collector" or an actual storage tank. Either a heat-transfer fluid or the actual potable water to be used flows through tubes attached to the absorber and picks up the heat from it. (Systems with a separate heat-transfer-fluid loop include a heat exchanger that then heats the potable water.) The heated water is stored in a separate preheat tank or a conventional water heater tank until needed. If additional heat is needed, it is provided by electricity or fossil-fuel energy by the conventional water-heating system.

Table F-2 (continued)
Energy Efficiency Measure Descriptions – Commercial

End-Use	Energy Efficiency Measure	Description
Office Equip.	Office Equipment – Computers, Energy Star or Better	Energy Star labeled office equipment saves energy by powering down and "going to sleep" when not in use. ENERGY STAR labeled computers automatically power down to 15 watts or less when not in use and may actually last longer than conventional products because they spend a large portion of time in a low-power sleep mode. ENERGY STAR labeled computers also generate less heat than conventional models.
Office Equip.	Office Equipment – Copiers, Energy Star or Better	Energy Star labeled office equipment saves energy by powering down and "going to sleep" when not in use. ENERGY STAR labeled copiers are equipped with a feature that allows them to automatically turn off after a period of inactivity, reducing a copier's annual electricity costs by over 60%. High-speed copiers that include a duplexing unit that is set to automatically make double-sided copies can reduce paper costs by $60 a month and help to save trees.
Office Equip.	Office Equipment – Fax, Energy Star or Better	Energy Star labeled office equipment saves energy by powering down and "going to sleep" when not in use. The medium-speed ENERGY STAR labeled fax machine uses 25% less energy in sleep mode than in standby mode when it is immediately ready to send or receive faxes. ENERGY STAR labeled fax machines can also scan double-sided pages. This will reduce both the copying and the paper costs.
Office Equip.	Office Equipment – Monitors, Energy Star or Better	Energy Star labeled office equipment saves energy by powering down and "going to sleep" when not in use. ENERGY STAR labeled monitors automatically power down to 15 watts or less when not in use.
Office Equip.	Office Equipment – Printers, Energy Star or Better	Energy Star labeled office equipment saves energy by powering down and "going to sleep" when not in use. ENERGY STAR labeled printers automatically power down to less than 10 to 100 watts, depending on the number of pages per minute produced and printer type. This analysis assumes a laser printer. This automatic "power-down" feature cuts the printer's electricity use.
Office Equip.	Office Equipment – Scanners, Energy Star or Better	Energy Star labeled office equipment saves energy by powering down and "going to sleep" when not in use. Home offices and businesses save approximately $20 per year per scanner by using ENERGY STAR labeled scanners and these scanners do not cost more money than standard scanners. By going to sleep during its idle periods, the ENERGY STAR labeled scanner will undergo less wear and tear, and the light source may last significantly longer.

Table F-2 (continued)
Energy Efficiency Measure Descriptions – Commercial

End-Use	Energy Efficiency Measure	Description
Other	Vending Machine, High Efficiency	Cold beverage vending machines usually operate 24 hours a day regardless of whether the surrounding area is occupied or not. The result is that the vending machine consumes energy unnecessarily, because it will operate all night to keep the beverage cold even when there would be no customer until the next morning. There is a product called the Vending Miser that can reduce energy consumption by 47% without compromising the temperature of the vended product. The Vending Miser uses an infrared sensor to monitor the surrounding area's occupancy and will power down the vending machine when the area is unoccupied. It will also monitor the room's temperature and will re -power the machine at one to three hour intervals independent of occupancy to ensure that the product stays cold. In this analysis, it is assumed that a vending machine normally consumes 3,500 kWh per year, and installing a Vending Miser will reduce the annual electricity consumption by 47%.
Other	Icemaker, High Efficiency	In certain building types (restaurant, hotel), the production of ice is a significant usage of electricity. By optimizing the timing of ice production and the type of output to the specific application, icemakers are assumed to deliver a 15% electricity savings.
Refriger-ation	Compressor, High Efficiency	Standard compressors typically operate at approximately 65% efficiency. High-efficiency models are available that can improve compressor efficiency by 15%.
Refriger-ation	Controls, Anti-Sweat Heater	Anti-sweat heaters are used in virtually all low-temperature display cases and many medium-temperature cases to control humidity and prevent the condensation of water vapor on the sides and doors and on the products contained in the cases. Typically, these heaters stay on all the time, even though they only need to be on about half the time. Anti-sweat heater controls can come in the form of humidity sensors or time clocks.
Refriger-ation	Controls, Floating Head Pressure	Floating head pressure control allows the pressure in the condenser to "float" with ambient temperatures. This method reduces refrigeration compression ratios, improves system efficiency and extends the compressor life. The greatest savings with a floating head pressure approach occurs when the ambient temperatures are low, such as in the winter season. Floating head pressure control is most practical for new installations. However, retrofits installation can be completed with some existing refrigeration systems. Installing floating head pressure control increases the capacity of the compressor when temperatures are low, which may lead to short cycling.

Table F-2 (continued)
Energy Efficiency Measure Descriptions – Commercial

End-Use	Energy Efficiency Measure	Description
Refrigeration	Glass Doors, Installation	Glass doors can be used to enclose multi-deck display cases for refrigerated items in supermarkets. In the past, stores were reluctant to close refrigerated cases because they feared that any obstruction would impede customers from reaching (and buying) refrigerated products.
Refrigeration	Reach-in Coolers and Freezers, High Efficiency	Although cold storage typically comes to mind for the commercial sector, reach-in refrigerators and freezers account for a substantial portion of the commercial refrigeration load. Analogous to those measures discussed in the residential sector, reach-in refrigerators and freezers can be built to Energy Star standards or better for significant savings.

Table F-3
Energy Efficiency Measure Descriptions – Industrial

End-Use	Energy Efficiency Measure	Description
Industrial Process Equip.	Efficient Process Heating	Because of the customized nature of industrial heating applications, a variety of opportunities are summarized in a general improvement of process heating, focusing on electric resistance heating and the injection of RF waves as two electrotechnologies.
Industrial Process Equip.	Motors, Premium Efficiency	Premium efficiency motors reduce the amount of lost energy going into heat rather than power. Since less heat is generated, less energy is needed to cool the motor with a fan. Therefore, the initial cost of energy efficient motors is generally higher than for standard motors. However their life-cycle costs can make them far more economical because of savings they generate in operating expense. Premium efficiency motors can provide savings of 0.5% to 3% over standard motors. The savings results from the fact that energy efficient motors run cooler than their standard counterparts, resulting in an increase in the life of the motor insulation and bearing. In general, an efficient motor is a more reliable motor because there are fewer winding failures, longer periods between needed maintenance, and fewer forced outages. For example, using copper instead of aluminum in the windings, and increasing conductor cross-sectional area, lowers a motor’s I^2R losses. This analysis assumes 75% loading factor (for peak efficiency) for 1800 rpm motor. Hours of operation vary depending on horsepower size. In addition, improved drives and controls are assumed to be implemented along with the motors, resulting in savings as high as 10% of annual energy consumption
HVAC	General HVAC Improvements	While small in comparison to process usage, HVAC systems at industrial facilities account for a significant amount of energy consumption. Improvements such as those identified in the residential and commercial sectors are assumed to provide a savings of between 9-20% of the typical industrial HVAC energy usage.
Lighting	Efficient Lighting Technologies	Because industrial sites differ from the other sectors and vary widely in terms of facility layout, usage patterns and application, lighting improvements are estimated at a general level to provide savings between 28% (replacing T12 with T8) and 76% (replacing incandescent with CFL).

EE Measure Assumptions

The tables in this section present the following information for equipment and devices/controls

Equipment Data

Equipment data are provided separately for each region. Regional weather variation, equipment costs, and electricity prices factor in to the annual energy savings, peak demand savings and benefit/cost (B/C) ratio. Equipment data tables include the following:

- **Technology name** is the left-most item on the table. The first option on this left is always the "standard" default option and represents the minimum efficiency level available in the marketplace. Additional options are labeled in a descriptive manner.
- **Year** indicates the year the technology is commercially available for purchase.
- **Energy** indicates the annual energy savings expressed as a percentage.
- **Demand** indicates the summer peak demand savings in expressed as a percentage.
- **B/C** indicates the benefit/cost ratio. Ratios greater than 1.0 imply cost effectiveness and pass the economic screen for installation under economic potential.
- **Market Acceptance Ratio** (MAR) is applied to economic potential to calculate maximum achievable potential.
- **Program Implementation Factor (PIF)** is applied to maximum achievable potential to calculate realistic achievable potential.

Devices and Controls Data

These data are also provided separately for each region. Regional weather variation, equipment costs, and electricity prices factor in to the annual energy savings, peak demand savings and benefit/cost (B/C) ratio. These data tables include the following:

- **Technology** is the left-most item on the table. Often, there is only one option for devices and controls. When there is more than one option, the first option on this left is always the "standard" default option and represents the minimum efficiency level available in the marketplace. Additional options are labeled in a descriptive manner.
- **Year** indicates the year the technology is commercially available for purchase.
- **Energy** indicates the annual energy savings expressed as a percentage.
- **Demand** indicates the summer peak demand savings expressed as a percentage.
- **B/C** indicates the benefit/cost ratio. Ratios greater than 1.0 imply cost effectiveness. These measures are installed under economic potential.
- **Market Acceptance Ratio** (MAR) is applied to economic potential to calculate maximum achievable potential.

- **Program Implementation Factor (PIF)** is applied to maximum achievable potential to calculate realistic achievable potential.
- **Saturation** indicates the fraction of homes/floor space that have the measure in the base year (2008).
- **Applicability** identifies the fraction of homes/floor space eligible for the measures. For example, programmable thermostats are applicable to homes with central heating and/or cooling.
- **Feasibility** identifies the fraction of units that can be replaced from an engineering perspective.

Saturation, applicability and feasibility factors will typically by retrofit application in existing homes/buildings and new construction.

Residential Equipment Data

Table F-4
Residential Room Air Conditioning

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
EER 9.8	2008	0.0%	0.0%	2.68	0.0%	0.0%	3.68	0.0%	0.0%	7.11	0.0%	0.0%	3.81
EER 10.2	2008	3.9%	6.1%	0.83	3.9%	3.3%	1.00	3.9%	2.2%	1.80	3.9%	4.3%	1.11
EER 10.8	2008	9.3%	9.1%	0.77	9.2%	10.0%	0.92	9.3%	8.7%	1.62	9.2%	10.6%	1.03
EER 11	2008	10.9%	12.1%	0.73	10.9%	10.0%	0.85	10.9%	10.9%	1.50	10.9%	10.6%	0.96
EER 11.5	2008	14.8%	15.2%	0.70	14.8%	13.3%	0.81	14.8%	13.0%	1.42	14.8%	14.9%	0.92
Advanced Tech	2015	30.0%	30.0%	0.45	30.0%	30.0%	0.45	30.0%	30.0%	0.45	30.0%	30.0%	0.45
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		53%	95%	95%	51%	91%	91%	51%	91%	91%	51%	92%	92%
Program Implementation Factor		40%	65%	90%	33%	61%	90%	25%	58%	90%	50%	70%	90%

Table F-5
Residential Central Air Conditioning

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**
SEER 13	2008	0.0%	0.0%	1.11	0.0%	0.0%	1.19	0.0%	0.0%	1.96	0.0%	0.0%	1.15
SEER 14	2008	8.3%	9.7%	1.02	8.3%	7.5%	1.04	8.3%	9.4%	1.68	8.3%	9.3%	1.02
SEER 15	2008	11.6%	9.7%	0.67	11.5%	7.5%	0.44	11.0%	9.4%	0.60	11.4%	9.3%	0.59
SEER 16	2008	14.4%	9.7%	0.63	14.1%	7.5%	0.39	13.3%	9.4%	0.52	13.9%	9.3%	0.54
SEER 18	2008	18.7%	9.7%	0.60	18.4%	10.0%	0.33	17.0%	9.4%	0.42	18.0%	9.3%	0.49
SEER 20	2008	22.0%	11.0%	0.58	21.8%	10.9%	0.28	20.0%	10.0%	0.33	21.2%	10.6%	0.45
Ductless VRF	2010	30.0%	15.0%	0.56	30.0%	15.0%	0.24	30.0%	15.0%	0.25	30.0%	15.0%	0.42
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	79%	80%	25%	76%	76%	25%	76%	76%	26%	77%	77%
Program Implementation Factor		24%	47%	70%	20%	45%	70%	15%	42%	70%	30%	50%	70%

Table F-6
Residential Heat Pumps

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Resistance Heat	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
HSPF=7.7; SEER=13	2008	45.0%	0.0%	4.10	45.0%	0.0%	4.00	45.0%	0.0%	1.14	45.0%	0.0%	5.80
HSPF=9.3; SEER=14	2008	51.5%	0.0%	2.76	51.5%	0.0%	2.87	51.5%	0.0%	0.55	51.5%	0.0%	3.73
HSPF=12.0; SEER=18	2008	58.0%	0.0%	1.30	58.0%	0.0%	1.53	58.0%	0.0%	0.45	58.0%	0.0%	2.07
Advanced Tech	2015	67.0%	0.0%	0.41	67.0%	0.0%	0.41	67.0%	0.0%	0.35	67.0%	0.0%	0.41
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	79%	80%	25%	76%	76%	25%	76%	76%	26%	77%	77%
Program Implementation Factor		24%	47%	70%	20%	45%	70%	15%	42%	70%	30%	50%	70%

Table F-7
Residential Lighting – Linear Fluorescent

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
T12	2008	0.0%	0.0%	1.80	0.0%	0.0%	1.80	0.0%	0.0%	1.80	0.0%	0.0%	1.80
T8	2008	8.9%	2.2%	1.40	9.2%	2.3%	1.40	13.3%	3.3%	1.40	7.5%	1.9%	1.40
T5	2008	18.6%	4.6%	0.60	19.3%	4.8%	0.60	27.8%	7.0%	0.60	15.7%	3.9%	0.60
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Program Implementation Factor		36%	60%	85%	29%	57%	85%	23%	54%	85%	45%	65%	85%

Table F-8
Residential Lighting – Standard Lamps

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Incandescent	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Old Halogen	2008	3.3%	0.8%	3.00	3.3%	0.8%	3.00	3.3%	0.8%	3.00	3.3%	0.8%	3.00
New Halogen	2008	27.5%	6.9%	2.00	27.5%	6.9%	2.00	27.5%	6.9%	2.00	27.5%	6.9%	2.00
LED	2008	67.8%	17.0%	1.50	67.8%	17.0%	1.50	67.8%	17.0%	1.50	67.8%	17.0%	1.50
CFL	2008	75.8%	19.0%	1.20	75.8%	19.0%	1.20	75.8%	19.0%	1.20	75.8%	19.0%	1.20
HID	2008	81.9%	20.5%	2.00	81.9%	20.5%	2.00	81.9%	20.5%	2.00	81.9%	20.5%	2.00
White LED	2012	86.0%	21.5%	0.40	86.0%	21.5%	0.40	86.0%	21.5%	0.40	86.0%	21.5%	0.40
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		53%	79%	80%	51%	76%	76%	51%	76%	76%	51%	77%	77%
Program Implementation Factor		48%	74%	100%	39%	70%	100%	30%	65%	100%	60%	80%	100%

Table F-9
Residential Water Heating

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
EF=0.83	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
EF=0.86	2008	3.5%	0.9%	2.44	3.5%	0.9%	2.35	3.5%	0.9%	3.09	3.5%	0.9%	2.35
EF=0.90	2008	7.8%	1.9%	1.55	7.8%	1.9%	1.49	7.8%	1.9%	1.35	7.8%	1.9%	1.53
EF=0.93	2008	9.8%	2.4%	1.10	9.8%	2.4%	1.06	9.8%	2.4%	1.14	9.8%	2.4%	1.12
HP COP=2	2008	20.0%	5.0%	1.09	20.0%	5.0%	1.08	20.0%	5.0%	0.96	20.0%	5.0%	1.05
Solar	2008	50.0%	12.5%	0.58	50.0%	12.5%	0.59	50.0%	12.5%	0.92	50.0%	12.5%	0.65
HP COP=3	2008	66.0%	16.5%	0.41	66.0%	16.5%	0.41	66.0%	16.5%	0.43	66.0%	16.5%	0.42
GSHP COP=4	2008	75.0%	18.8%	0.27	75.0%	18.8%	0.27	75.0%	18.8%	0.27	75.0%	18.8%	0.33
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		35%	85%	85%	33%	81%	81%	34%	81%	81%	34%	82%	82%
Program Implementation Factor		24%	37%	50%	20%	35%	50%	15%	33%	50%	30%	40%	50%

Table F-10
Residential Dishwashers

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Standard	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	25.0%	10.0%	1.17	25.0%	10.0%	1.17	25.0%	10.0%	1.17	25.0%	10.0%	1.17
Energy Star	2008	35.0%	15.0%	1.09	35.0%	15.0%	1.09	35.0%	15.0%	1.09	35.0%	15.0%	1.09
Advanced Tech	2015	50.0%	20.0%	0.41	50.0%	20.0%	0.41	50.0%	20.0%	0.41	50.0%	20.0%	0.41
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		53%	95%	95%	51%	91%	91%	51%	91%	91%	51%	92%	92%
Program Implementation Factor		40%	65%	90%	33%	61%	90%	25%	58%	90%	50%	70%	90%

Table F-11
Residential Dishwashers (Domestic Hot Water)

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Standard	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	2.7%	1.1%	1.17	2.7%	1.1%	1.17	2.7%	1.1%	1.17	2.7%	1.1%	1.17
Energy Star	2008	3.6%	1.4%	1.09	3.6%	1.4%	1.09	3.6%	1.4%	1.09	3.6%	1.4%	1.09
Advanced Tech	2015	5.0%	2.0%	0.41	5.0%	2.0%	0.41	5.0%	2.0%	0.41	5.0%	2.0%	0.41
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		53%	95%	95%	51%	91%	91%	51%	91%	91%	51%	92%	92%
Program Implementation Factor		40%	65%	90%	33%	61%	90%	25%	58%	90%	50%	70%	90%

Table F-12
Residential Clothes Washers

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Standard	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Horizontal Axis	2008	2.7%	4.5%	1.41	45.0%	4.5%	1.36	45.0%	4.5%	1.00	45.0%	4.5%	1.21
Inverter-drive	2008	3.6%	5.5%	0.45	55.0%	5.5%	0.45	55.0%	5.5%	0.45	55.0%	5.5%	0.45
Combo	2008	5.0%	6.0%	0.30	60.0%	6.0%	0.30	60.0%	6.0%	0.30	60.0%	6.0%	0.30
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		53%	95%	95%	51%	91%	91%	51%	91%	91%	51%	92%	92%
Program Implementation Factor		40%	65%	90%	33%	61%	90%	25%	58%	90%	50%	70%	90%

Table F-13
Residential Clothes Washers (Domestic Hot Water)

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Standard	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Horizontal Axis	2008	11.9%	1.2%	1.41	11.9%	1.2%	1.36	11.9%	1.2%	1.00	11.9%	1.2%	1.21
Inverter-drive	2008	14.5%	1.5%	0.45	14.5%	1.5%	0.45	14.5%	1.5%	0.45	14.5%	1.5%	0.45
Combo	2008	20.0%	2.0%	0.30	20.0%	2.0%	0.30	20.0%	2.0%	0.30	20.0%	2.0%	0.30
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		53%	95%	95%	51%	91%	91%	51%	91%	91%	51%	92%	92%
Program Implementation Factor		40%	65%	90%	33%	61%	90%	25%	58%	90%	50%	70%	90%

Table F-14
Residential Clothes Dryers

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Standard	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Moisture Sensor	2008	10.0%	1.0%	1.03	10.0%	1.0%	1.03	10.0%	1.0%	1.03	10.0%	1.0%	1.03
Efficient	2008	15.0%	1.5%	0.67	15.0%	1.5%	0.67	15.0%	1.5%	0.67	15.0%	1.5%	0.67
Heat Pump	2008	50.0%	5.0%	0.44	50.0%	5.0%	0.44	50.0%	5.0%	0.44	50.0%	5.0%	0.44
Combo	2008	55.0%	5.5%	0.35	55.0%	5.5%	0.35	55.0%	5.5%	0.35	55.0%	5.5%	0.35
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		53%	95%	95%	51%	91%	91%	51%	91%	91%	51%	92%	92%
Program Implementation Factor		24%	37%	50%	20%	35%	50%	15%	33%	50%	30%	40%	50%

Table F-15
Residential Refrigerators

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Standard	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient 1	2008	7.0%	7.0%	1.80	7.0%	7.0%	1.80	7.0%	7.0%	1.80	7.0%	7.0%	1.80
Energy Star	2008	15.0%	15.0%	1.14	15.0%	15.0%	1.14	15.0%	15.0%	1.14	15.0%	15.0%	1.14
Efficient 2	2008	20.0%	20.0%	0.49	20.0%	20.0%	0.49	20.0%	20.0%	0.49	20.0%	20.0%	0.49
Inverter-Driven w/Multiple Drawers	2008	30.0%	30.0%	0.41	30.0%	30.0%	0.41	30.0%	30.0%	0.41	30.0%	30.0%	0.41
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Program Implementation Factor		40%	65%	90%	33%	61%	90%	25%	58%	90%	50%	70%	90%

Table F-16
Residential Freezers

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Standard	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	10.0%	10.0%	1.80	10.0%	10.0%	1.80	10.0%	10.0%	1.80	10.0%	10.0%	1.80
Energy Star	2008	15.0%	15.0%	1.14	15.0%	15.0%	1.14	15.0%	15.0%	1.14	15.0%	15.0%	1.14
Compact	2008	20.0%	20.0%	0.49	20.0%	20.0%	0.49	20.0%	20.0%	0.49	20.0%	20.0%	0.49
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Program Implementation Factor		24%	42%	60%	20%	40%	60%	15%	38%	60%	30%	45%	60%

Table F-17
Residential Cooking

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Standard	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	20.0%	5.0%	0.76	20.0%	5.0%	0.77	20.0%	5.0%	0.85	20.0%	5.0%	0.75
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Program Implementation Factor		16%	31%	45%	13%	29%	45%	10%	27%	45%	20%	32%	45%

Table F-18
Residential Color TV

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Standard	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Energy Star	2008	30.0%	15.0%	1.07	30.0%	15.0%	1.07	30.0%	15.0%	1.07	30.0%	15.0%	1.07
Advanced Tech	2012	60.0%	25.0%	0.41	60.0%	25.0%	0.41	60.0%	25.0%	0.41	60.0%	25.0%	0.41
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		53%	79%	80%	51%	76%	76%	51%	76%	76%	51%	77%	77%
Program Implementation Factor		20%	45%	70%	16%	43%	70%	13%	41%	70%	25%	48%	70%

Table F-19
Residential Personal Computers

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Standard	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Energy Star	2008	20.0%	10.0%	1.07	20.0%	10.0%	1.07	20.0%	10.0%	1.07	20.0%	10.0%	1.07
Advanced Tech	2012	60.0%	25.0%	0.41	60.0%	25.0%	0.41	60.0%	25.0%	0.41	60.0%	25.0%	0.41
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		53%	79%	80%	51%	76%	76%	51%	76%	76%	51%	77%	77%
Program Implementation Factor		20%	50%	80%	16%	48%	80%	13%	46%	80%	25%	52%	80%

Table F-20
Residential Furnace Fans

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Standard	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
ECM	2008	40.0%	0.0%	1.03	40.0%	0.0%	1.34	40.0%	0.0%	1.52	40.0%	0.0%	1.22
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	79%	80%	25%	76%	76%	25%	76%	76%	26%	77%	77%
Program Implementation Factor		20%	35%	50%	16%	33%	50%	13%	31%	50%	25%	38%	50%

Table F-21
Residential Attic Fan

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	0.0%	0.0%	0.85	0.0%	0.0%	0.76	0.0%	0.0%	0.65	14.0%	7.1%	1.02
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Program Implementation Factor		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Residential Devices and Controls Data

Table F-22
Residential Ceiling Fan

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	15.8%	0.0%	1.32	0.0%	0.0%	1.92	0.6%	0.0%	2.41	26.3%	8.9%	1.44
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
New Construction		48%	76%	100%	73%	88%	100%	77%	75%	100%	51%	94%	100%
Existing Construction		48%	28%	100%	73%	70%	100%	77%	59%	100%	51%	52%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	79%	80%	25%	76%	76%	25%	76%	76%	26%	77%	77%
Program Implementation Factor		8%	24%	40%	7%	23%	40%	5%	23%	40%	10%	25%	40%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-23
Residential Whole House Fan

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	20.0%	0.0%	1.03	0.0%	0.0%	1.34	1.0%	0.0%	1.52	31.3%	8.9%	1.22
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
New Construction		4%	76%	29%	4%	88%	21%	4%	75%	100%	4%	94%	9%
Existing Construction		3%	28%	29%	3%	70%	21%	3%	59%	100%	3%	52%	9%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	79%	80%	25%	76%	76%	25%	76%	76%	26%	77%	77%
Program Implementation Factor		16%	33%	50%	13%	31%	50%	10%	30%	50%	20%	35%	50%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-24
Residential Duct Insulation

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	2.1%	4.3%	2.73	2.0%	3.3%	2.62	2.7%	4.2%	1.01	3.8%	3.8%	3.64
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
New Construction		14%	95%	100%	10%	88%	100%	7%	100%	100%	16%	76%	100%
Existing Construction		50%	35%	100%	50%	70%	100%	50%	78%	100%	50%	42%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	53%	80%	25%	51%	76%	25%	51%	76%	26%	51%	77%
Program Implementation Factor		4%	17%	30%	3%	17%	30%	3%	16%	30%	5%	18%	30%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-25
Residential Duct Insulation (Heating)

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	5.4%	0.0%	2.73	4.6%	0.0%	2.62	3.8%	0.0%	1.01	5.5%	0.0%	3.64
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
New Construction		14%	95%	100%	10%	88%	100%	7%	100%	100%	16%	76%	100%
Existing Construction		50%	35%	100%	50%	70%	100%	50%	78%	100%	50%	42%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	53%	80%	25%	51%	76%	25%	51%	76%	26%	51%	77%
Program Implementation Factor		4%	17%	30%	3%	17%	30%	3%	16%	30%	5%	18%	30%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-26
Residential Programmable Thermostat

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	12.0%	6.1%	5.37	8.7%	6.2%	6.07	5.7%	1.4%	2.54	10.8%	7.1%	7.29
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
New Construction		25%	76%	100%	29%	88%	100%	18%	100%	100%	26%	76%	100%
Existing Construction		25%	28%	100%	29%	70%	100%	18%	78%	100%	26%	42%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		35%	79%	100%	33%	76%	100%	34%	76%	100%	34%	77%	100%
Program Implementation Factor		16%	45%	75%	13%	44%	75%	10%	42%	75%	20%	48%	75%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-27
Residential Programmable Thermostat (Heating)

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	8.8%	0.0%	5.37	9.2%	0.0%	6.07	20.1%	0.0%	2.54	11.4%	0.0%	7.29
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
New Construction		25%	76%	100%	29%	88%	100%	18%	100%	100%	26%	76%	100%
Existing Construction		25%	28%	100%	29%	70%	100%	18%	78%	100%	26%	42%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		35%	79%	100%	33%	76%	100%	34%	76%	100%	34%	77%	100%
Program Implementation Factor		16%	45%	75%	13%	44%	75%	10%	42%	75%	20%	48%	75%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-28
Storm Doors

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	0.7%	2.1%	0.73	0.3%	1.6%	0.79	0.6%	1.4%	0.89	1.0%	1.9%	0.70
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
New Construction		50%	95%	100%	50%	88%	100%	50%	100%	100%	50%	57%	100%
Existing Construction		50%	35%	100%	50%	70%	100%	50%	78%	100%	50%	31%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	53%	80%	25%	51%	76%	25%	51%	76%	26%	51%	77%
Program Implementation Factor		4%	15%	25%	3%	14%	25%	3%	14%	25%	5%	15%	25%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-29
Storm Doors (Heating)

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	1.4%	0.0%	0.73	1.1%	0.0%	0.79	2.3%	0.0%	0.89	0.9%	0.0%	0.70
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
New Construction		50%	95%	100%	50%	88%	100%	50%	100%	100%	50%	57%	100%
Existing Construction		50%	35%	100%	50%	70%	100%	50%	78%	100%	50%	31%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	53%	80%	25%	51%	76%	25%	51%	76%	26%	51%	77%
Program Implementation Factor		4%	15%	25%	3%	14%	25%	3%	14%	25%	5%	15%	25%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-30
External Shades

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	14.2%	11.5%	0.94	10.3%	9.0%	0.91	8.0%	9.0%	0.78	15.6%	10.3%	0.95
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
New Construction		10%	76%	100%	10%	88%	100%	10%	100%	100%	10%	94%	100%
Existing Construction		10%	4%	100%	10%	11%	100%	10%	12%	100%	10%	8%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	53%	80%	25%	51%	76%	25%	51%	76%	26%	51%	77%
Program Implementation Factor		4%	17%	30%	3%	17%	30%	3%	16%	30%	5%	18%	30%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-31
Ceiling Insulation

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
R25	2008	0.0%	0.0%	1.83	0.0%	0.0%	1.46	0.0%	0.0%	0.85	0.0%	0.0%	1.36
R35	2008	1.3%	0.0%	1.36	1.1%	1.6%	1.02	1.6%	1.4%	0.67	1.5%	0.0%	1.02
R46	2008	2.1%	2.2%	1.03	1.9%	1.6%	0.74	2.6%	1.4%	0.55	2.5%	1.9%	0.76
R49	2008	2.4%	2.2%	0.82	2.0%	1.6%	0.54	2.8%	1.4%	0.44	2.7%	1.9%	0.57
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
New		14%	95%	100%	10%	88%	100%	7%	100%	100%	16%	76%	100%
Existing		14%	5%	100%	10%	11%	100%	7%	12%	100%	16%	6%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		35%	74%	95%	33%	71%	91%	34%	71%	91%	34%	71%	92%
Program Implementation Factor		4%	17%	30%	3%	17%	30%	3%	16%	30%	5%	18%	30%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-32
Ceiling Insulation (Heating)

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**
R25	2008	0.0%	0.0%	1.83	0.0%	0.0%	1.46	0.0%	0.0%	0.85	0.0%	0.0%	1.36
R35	2008	2.5%	0.0%	1.36	1.8%	0.0%	1.02	4.1%	0.0%	0.67	2.2%	0.0%	1.02
R46	2008	4.1%	0.0%	1.03	2.9%	0.0%	0.74	6.8%	0.0%	0.55	3.7%	0.0%	0.76
R49	2008	4.4%	0.0%	0.82	3.1%	0.0%	0.54	7.4%	0.0%	0.44	4.0%	0.0%	0.57
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
New		14%	95%	100%	10%	88%	100%	7%	100%	100%	16%	76%	100%
Existing		14%	5%	100%	10%	11%	100%	7%	12%	100%	16%	6%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		35%	74%	95%	33%	71%	91%	34%	71%	91%	34%	71%	92%
Program Implementation Factor		4%	17%	30%	3%	17%	30%	3%	16%	30%	5%	18%	30%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-33
Foundation Insulation

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	1.0%	0.0%	2.57	1.2%	1.8%	2.18	0.7%	0.0%	0.52	1.0%	2.0%	1.84
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
New Construction		14%	95%	100%	10%	88%	100%	7%	100%	100%	16%	76%	100%
Existing Construction		14%	5%	100%	10%	11%	100%	7%	12%	100%	16%	6%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		35%	74%	95%	33%	71%	91%	34%	71%	91%	34%	71%	92%
Program Implementation Factor		4%	17%	30%	3%	17%	30%	3%	16%	30%	5%	18%	30%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-34
Foundation Insulation (Heating)

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	4.5%	0.0%	2.57	4.2%	0.0%	2.18	1.6%	0.0%	0.52	4.4%	0.0%	1.84
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
New Construction		14%	95%	100%	10%	88%	100%	7%	100%	100%	16%	76%	100%
Existing Construction		14%	5%	100%	10%	11%	100%	7%	12%	100%	16%	6%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		35%	74%	95%	33%	71%	91%	34%	71%	91%	34%	71%	92%
Program Implementation Factor		4%	17%	30%	3%	17%	30%	3%	16%	30%	5%	18%	30%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-35
Wall Insulation

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
R11	2008	0.0%	0.0%	1.49	0.0%	0.0%	1.01	0.0%	0.0%	0.76	0.0%	0.0%	1.06
R15	2008	1.2%	2.1%	1.05	1.0%	1.6%	0.98	0.8%	1.4%	0.72	0.5%	0.0%	0.99
R21	2008	2.3%	2.1%	0.84	1.6%	1.6%	0.83	1.4%	2.8%	0.61	1.3%	1.9%	0.88
R25	2008	2.9%	4.3%	0.49	1.7%	3.3%	0.54	1.7%	4.2%	0.50	1.9%	1.9%	0.52
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
New		14%	95%	100%	10%	88%	100%	7%	100%	100%	16%	76%	100%
Existing		14%	5%	100%	10%	11%	100%	7%	12%	100%	16%	6%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		35%	74%	95%	33%	71%	91%	34%	71%	91%	34%	71%	92%
Program Implementation Factor		4%	17%	30%	3%	17%	30%	3%	16%	30%	5%	18%	30%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-36
Wall Insulation (Heating)

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
R11	2008	0.0%	0.0%	1.49	0.0%	0.0%	1.01	0.0%	0.0%	0.76	0.0%	0.0%	1.06
R15	2008	3.7%	0.0%	1.05	3.1%	0.0%	0.98	7.1%	0.0%	0.72	3.2%	0.0%	0.99
R21	2008	6.6%	0.0%	0.84	5.8%	0.0%	0.83	13.1%	0.0%	0.61	5.8%	0.0%	0.88
R25	2008	8.1%	0.0%	0.49	6.9%	0.0%	0.54	15.4%	0.0%	0.50	7.0%	0.0%	0.52
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
New		14%	95%	100%	10%	88%	100%	7%	100%	100%	16%	76%	100%
Existing		14%	5%	100%	10%	11%	100%	7%	12%	100%	16%	6%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		35%	74%	95%	33%	71%	91%	34%	71%	91%	34%	71%	92%
Program Implementation Factor		4%	17%	30%	3%	17%	30%	3%	16%	30%	5%	18%	30%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-37
Reflective Roof

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	21.0%	22.8%	0.92	14.3%	18.1%	0.49	15.0%	21.3%	4.16	18.5%	19.4%	0.86
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
New Construction		10%	76%	100%	10%	88%	100%	10%	100%	100%	10%	94%	100%
Existing Construction		10%	4%	100%	10%	11%	100%	10%	12%	100%	10%	8%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		35%	74%	95%	33%	71%	91%	34%	71%	91%	34%	71%	92%
Program Implementation Factor		8%	29%	50%	7%	28%	50%	5%	27%	50%	10%	30%	50%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-38
Windows

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Double-Pane	2008	13.6%	13.2%	1.20	9.2%	10.3%	0.91	8.2%	13.4%	0.87	13.4%	13.3%	1.15
Energy Star	2008	17.2%	18.9%	0.48	11.9%	16.2%	0.59	11.5%	19.5%	0.67	16.7%	18.3%	0.57
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
New		94%	76%	100%	94%	88%	100%	94%	100%	100%	94%	94%	100%
Existing		94%	4%	100%	94%	11%	100%	94%	12%	100%	94%	8%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	53%	80%	25%	51%	76%	25%	51%	76%	26%	51%	77%
Program Implementation Factor		12%	36%	60%	10%	35%	60%	8%	34%	60%	15%	38%	60%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-39
Windows (Heating)

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Double-Pane	2008	25.3%	0.0%	1.20	20.6%	0.0%	0.91	33.9%	0.0%	0.87	23.2%	0.0%	1.15
Energy Star	2008	37.3%	0.0%	0.48	30.4%	0.0%	0.59	50.6%	0.0%	0.67	34.2%	0.0%	0.57
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
New		94%	76%	100%	94%	88%	100%	94%	100%	100%	94%	94%	100%
Existing		94%	4%	100%	94%	11%	100%	94%	12%	100%	94%	8%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	53%	80%	25%	51%	76%	25%	51%	76%	26%	51%	77%
Program Implementation Factor		12%	36%	60%	10%	35%	60%	8%	34%	60%	15%	38%	60%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-40
Faucet Aerators

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	3.2%	0.0%	69.8	3.2%	0.0%	67.1	3.2%	0.0%	96.4	3.2%	0.0%	60.0
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
New Construction		15%	25%	100%	14%	23%	100%	38%	62%	100%	6%	10%	100%
Existing Construction		15%	23%	100%	14%	21%	100%	38%	58%	100%	10%	15%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		53%	79%	80%	51%	76%	76%	51%	76%	76%	51%	77%	77%
Program Implementation Factor		4%	17%	30%	3%	17%	30%	3%	16%	30%	5%	18%	30%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-41
Pipe Insulators

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	5.7%	0.0%	7.83	5.7%	0.0%	8.01	5.6%	0.0%	11.9	5.7%	0.0%	7.33
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
New Construction		18%	25%	100%	16%	23%	100%	45%	62%	100%	7%	10%	100%
Existing Construction		10%	23%	100%	9%	21%	100%	26%	58%	100%	7%	15%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		53%	79%	80%	51%	76%	76%	51%	76%	76%	51%	77%	77%
Program Implementation Factor		4%	17%	30%	3%	17%	30%	3%	16%	30%	5%	18%	30%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-42
Low Flow Shower Heads

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	14.6%	0.0%	173.3	14.6%	0.0%	166.8	14.6%	50.0%	67.0	14.6%	0.0%	148.6
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
New Construction		19%	25%	100%	18%	23%	100%	48%	62%	100%	8%	10%	100%
Existing Construction		19%	23%	100%	18%	21%	100%	48%	58%	100%	12%	15%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		53%	79%	80%	51%	76%	76%	51%	76%	76%	51%	77%	77%
Program Implementation Factor		4%	17%	30%	3%	17%	30%	3%	16%	30%	5%	18%	30%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-43
Air Conditioning Maintenance

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	9.9%	10.2%	0.84	10.0%	9.2%	0.84	10.0%	10.1%	0.84	9.9%	9.4%	0.84
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
Existing Construction		50%	26%	100%	50%	68%	100%	50%	57%	100%	50%	35%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	53%	80%	25%	51%	76%	25%	51%	76%	26%	51%	77%
Program Implementation Factor		4%	12%	20%	3%	12%	20%	3%	11%	20%	5%	13%	20%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-44
Heat Pump Maintenance

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	8.5%	0.0%	1.04	9.2%	0.0%	1.04	9.9%	0.0%	1.04	9.2%	0.0%	1.04
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
Existing Construction		50%	2%	100%	50%	2%	100%	50%	21%	100%	50%	4%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	53%	80%	25%	51%	76%	25%	51%	76%	26%	51%	77%
Program Implementation Factor		4%	12%	20%	3%	12%	20%	3%	11%	20%	5%	13%	20%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-45
Duct Repair

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	14.9%	15.9%	1.05	16.9%	20.7%	1.07	19.4%	23.9%	0.60	11.2%	13.3%	1.04
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
Existing Construction		50%	28%	100%	50%	70%	100%	50%	78%	100%	50%	42%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	53%	80%	25%	51%	76%	25%	51%	76%	26%	51%	77%
Program Implementation Factor		4%	17%	30%	3%	17%	30%	3%	16%	30%	5%	18%	30%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-46
Duct Repair (Heating)

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	26.5%	0.0%	1.05	27.5%	0.0%	1.07	20.3%	0.0%	0.60	31.9%	0.0%	1.04
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
Existing Construction		50%	28%	100%	50%	70%	100%	50%	78%	100%	50%	42%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	53%	80%	25%	51%	76%	25%	51%	76%	26%	51%	77%
Program Implementation Factor		4%	17%	30%	3%	17%	30%	3%	16%	30%	5%	18%	30%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-47
Infiltration Control

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	0.5%	0.0%	1.05	2.1%	3.4%	1.07	2.3%	1.1%	0.60	0.0%	1.7%	1.04
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
New Construction		14%	76%	100%	10%	88%	100%	7%	100%	100%	16%	76%	100%
Existing Construction		50%	28%	100%	50%	70%	100%	50%	78%	100%	50%	42%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	53%	80%	25%	51%	76%	25%	51%	76%	26%	51%	77%
Program Implementation Factor		4%	17%	30%	3%	17%	30%	3%	16%	30%	5%	18%	30%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-48
Infiltration Control (Heating)

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	6.2%	0.0%	1.05	5.4%	0.0%	1.07	5.8%	0.0%	0.60	3.5%	0.0%	1.04
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
New Construction		14%	76%	100%	10%	88%	100%	7%	100%	100%	16%	76%	100%
Existing Construction		50%	28%	100%	50%	70%	100%	50%	78%	100%	50%	42%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	53%	80%	25%	51%	76%	25%	51%	76%	26%	51%	77%
Program Implementation Factor		4%	17%	30%	3%	17%	30%	3%	16%	30%	5%	18%	30%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-49
Combined Washer/Dryer

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	40.0%	4.0%	0.60	40.0%	4.0%	0.60	40.0%	4.0%	0.60	40.0%	4.0%	0.60
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
New Construction		1%	72%	100%	1%	81%	100%	1%	84%	100%	1%	73%	100%
Existing Construction		1%	72%	100%	1%	84%	100%	1%	81%	100%	1%	73%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		53%	95%	95%	51%	91%	91%	51%	91%	91%	51%	92%	92%
Program Implementation Factor		1%	8%	15%	1%	8%	15%	1%	8%	15%	1%	8%	15%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-50
In-Home Feedback Monitor

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	2.6%	1.3%	0.60	2.6%	1.3%	0.60	2.6%	1.3%	0.60	2.6%	1.3%	0.60
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
New Construction		5%	76%	100%	5%	88%	100%	5%	100%	100%	5%	76%	100%
Existing Construction		5%	28%	100%	5%	70%	100%	5%	78%	100%	5%	42%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	79%	80%	25%	76%	76%	25%	76%	76%	26%	77%	77%
Program Implementation Factor		2%	31%	60%	1%	31%	60%	1%	31%	60%	2%	31%	60%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-51
Dehumidifier

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	0.6%	0.6%	1.03	0.6%	0.6%	0.91	0.6%	0.6%	1.52	0.6%	0.6%	0.82
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
New Construction		18%	76%	100%	25%	88%	100%	5%	100%	100%	1%	57%	100%
Existing Construction		18%	28%	100%	25%	70%	100%	5%	78%	100%	1%	31%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	79%	80%	25%	76%	76%	25%	76%	76%	26%	77%	77%
Program Implementation Factor		1%	3%	5%	1%	3%	5%	1%	3%	5%	1%	3%	5%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-52
Reduce Standby Wattage

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Efficient	2008	4.5%	2.3%	5.37	4.5%	2.3%	6.07	4.5%	2.3%	2.54	4.5%	2.3%	7.29
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
New Construction		1%	76%	100%	1%	88%	100%	1%	100%	100%	1%	76%	100%
Existing Construction		1%	28%	100%	1%	70%	100%	1%	78%	100%	1%	42%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Program Implementation Factor		12%	38%	65%	10%	37%	65%	8%	36%	65%	15%	40%	65%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Commercial Equipment Data

Table F-53
Commercial Heat Pumps

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
EER=8.5; COP=2.8	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
EER=8.9; COP=3.0	2008	3.0%	0.0%	1.93	3.0%	0.0%	1.93	4.4%	0.0%	2.27	2.5%	0.0%	2.02
EER=9.5; COP=3.2	2008	5.5%	0.0%	1.63	5.4%	0.0%	1.69	8.3%	0.0%	1.69	4.7%	0.0%	1.67
EER=10.7; COP=3.6	2008	9.6%	0.0%	1.02	9.5%	0.0%	1.05	14.9%	0.0%	1.05	8.2%	0.0%	1.04
EER=15	2012	25.0%	0.0%	0.41	25.0%	0.0%	0.41	25.0%	0.0%	0.41	25.0%	0.0%	0.41
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	77%	78%	25%	75%	76%	25%	76%	76%	25%	76%	76%
Program Implementation Factor		24%	49%	75%	20%	47%	75%	15%	45%	75%	30%	52%	75%

Table F-54
Commercial Central Air Conditioning

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
EER < 8.5	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
EER = 8.9	2008	4.8%	5.0%	3.66	4.8%	4.3%	4.70	4.8%	4.9%	7.61	4.8%	4.1%	3.71
EER = 10.1	2008	17.0%	17.1%	2.62	17.0%	15.4%	3.37	17.0%	17.1%	5.45	16.9%	15.2%	2.65
EER = 11.0	2008	24.3%	24.6%	1.52	24.4%	21.8%	1.89	24.4%	24.6%	2.93	24.3%	21.6%	1.53
Ductless VRF	2010	35.0%	35.0%	0.41	35.0%	35.0%	0.41	35.0%	35.0%	0.41	35.0%	35.0%	0.41
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	77%	78%	25%	75%	76%	25%	76%	76%	25%	76%	76%
Program Implementation Factor		24%	49%	75%	20%	47%	75%	15%	45%	75%	30%	52%	75%

Table F-55
Commercial Chiller

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
>1.41 kW/ton	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
1.30 kW/ton	2008	7.8%	5.4%	2.07	7.8%	5.5%	1.97	7.8%	5.4%	3.42	7.8%	5.5%	2.11
1.23 kW/ton	2008	12.8%	8.9%	1.70	12.8%	8.9%	1.66	12.8%	8.9%	2.18	12.8%	8.9%	1.69
1.11 kW/ton	2008	21.3%	14.9%	1.06	21.3%	14.8%	1.03	21.3%	14.9%	1.30	21.3%	14.9%	1.05
Ductless VRF	2008	40.0%	30.0%	0.41	40.0%	30.0%	0.41	40.0%	30.0%	0.41	40.0%	30.0%	0.41
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		31%	88%	88%	30%	86%	86%	30%	86%	86%	30%	86%	86%
Program Implementation Factor		20%	40%	60%	16%	38%	60%	13%	36%	60%	25%	42%	60%

Table F-56
Commercial Water Heater

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
EF < 0.96	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
EF = 0.98	2008	2.0%	3.0%	1.26	2.0%	0.8%	1.40	2.0%	0.9%	1.51	2.0%	0.0%	1.54
EF = 1.00	2008	4.0%	3.0%	1.08	4.0%	1.4%	1.11	4.0%	0.9%	1.09	4.0%	0.6%	1.12
HP COP = 3	2008	66.0%	33.0%	0.41	66.0%	33.0%	0.41	66.0%	33.0%	0.41	66.0%	33.0%	0.41
GSHP COP=4	2008	75.0%	38.0%	0.34	75.0%	38.0%	0.34	75.0%	38.0%	0.34	75.0%	38.0%	0.34
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	82%	83%	25%	80%	81%	25%	81%	81%	25%	81%	81%
Program Implementation Factor		32%	61%	90%	26%	58%	90%	20%	55%	90%	40%	65%	90%

Table F-57
Commercial Lighting

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Incandescent	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Halogen	2008	1.4%	0.7%	3.00	1.4%	0.7%	3.00	1.4%	0.7%	3.00	1.4%	0.7%	3.00
Reflector	2008	3.3%	1.7%	2.80	3.3%	1.7%	2.80	3.3%	1.7%	2.80	3.3%	1.7%	2.80
LED	2008	66.3%	33.1%	1.40	66.3%	33.1%	1.40	66.3%	33.1%	1.40	66.3%	33.1%	1.40
T12	2008	71.0%	35.5%	1.80	71.0%	35.5%	1.80	71.0%	35.5%	1.80	71.0%	35.5%	1.80
CFL	2008	75.8%	37.9%	1.20	75.8%	37.9%	1.20	75.8%	37.9%	1.20	75.8%	37.9%	1.20
T8	2008	79.3%	39.6%	1.40	79.3%	39.6%	1.40	79.3%	39.6%	1.40	79.3%	39.6%	1.40
HID	2008	81.9%	40.9%	1.50	81.9%	40.9%	1.50	81.9%	40.9%	1.50	81.9%	40.9%	1.50
T5	2008	85.5%	42.8%	0.60	85.5%	42.8%	0.60	85.5%	42.8%	0.60	85.5%	42.8%	0.60
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		52%	88%	88%	50%	86%	86%	51%	86%	86%	51%	86%	86%
Program Implementation Factor		40%	70%	100%	33%	66%	100%	25%	63%	100%	50%	75%	100%

Table F-58
Commercial Personal Computers

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Energy Star	2008	20.0%	20.0%	5.08	20.0%	20.0%	5.20	20.0%	20.0%	4.91	20.0%	20.0%	4.42
Climate Savers	2008	30.0%	30.0%	1.01	30.0%	30.0%	1.05	30.0%	30.0%	1.21	30.0%	30.0%	1.06
Supersavers	2012	50.0%	50.0%	0.43	50.0%	50.0%	0.44	50.0%	50.0%	0.51	50.0%	50.0%	0.45
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		52%	88%	88%	50%	86%	86%	51%	86%	86%	51%	86%	86%
Program Implementation Factor		20%	48%	75%	16%	46%	75%	13%	44%	75%	25%	50%	75%

Table F-59
Commercial Servers

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Energy Star	2008	15.0%	15.0%	5.08	15.0%	15.0%	5.20	15.0%	15.0%	4.91	15.0%	15.0%	4.42
Supersavers	2012	40.0%	40.0%	0.43	40.0%	40.0%	0.44	40.0%	40.0%	0.51	40.0%	40.0%	0.45
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		52%	88%	88%	50%	86%	86%	51%	86%	86%	51%	86%	86%
Program Implementation Factor		20%	48%	75%	16%	46%	75%	13%	44%	75%	25%	50%	75%

Table F-60
Commercial Monitors

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Energy Star	2008	25.0%	25.0%	5.08	25.0%	25.0%	5.20	25.0%	25.0%	4.91	25.0%	25.0%	4.42
Supersavers	2012	50.0%	50.0%	0.43	50.0%	50.0%	0.44	50.0%	50.0%	0.51	50.0%	50.0%	0.45
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		52%	88%	88%	50%	86%	86%	51%	86%	86%	51%	86%	86%
Program Implementation Factor		16%	45%	75%	13%	44%	75%	10%	42%	75%	20%	48%	75%

Table F-61
Commercial Copiers and Printers

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Energy Star	2008	25.0%	25.0%	5.08	25.0%	25.0%	5.20	25.0%	25.0%	4.91	25.0%	25.0%	4.42
Supersavers	2012	50.0%	50.0%	0.43	50.0%	50.0%	0.44	50.0%	50.0%	0.51	50.0%	50.0%	0.45
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		52%	88%	88%	50%	86%	86%	51%	86%	86%	51%	86%	86%
Program Implementation Factor		16%	45%	75%	13%	44%	75%	10%	42%	75%	20%	48%	75%

Table F-62
Commercial Other Electronics

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Base	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
Energy Star	2008	13.0%	13.0%	5.08	13.0%	13.0%	5.20	13.0%	13.0%	4.91	13.0%	13.0%	4.42
Supersavers	2012	30.0%	30.0%	0.43	30.0%	30.0%	0.44	30.0%	30.0%	0.51	30.0%	30.0%	0.45
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		52%	88%	88%	50%	86%	86%	51%	86%	86%	51%	86%	86%
Program Implementation Factor		16%	45%	75%	13%	44%	75%	10%	42%	75%	20%	48%	75%

Commercial Devices and Controls Data

Table F-63
Commercial Building Water Temperature Reset

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	15.2%	8.6%	1.64	13.7%	5.7%	1.14	10.8%	4.1%	3.39	24.3%	10.3%	6.12
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		5.0%	18.0%	100%	5.0%	18.0%	100%	5.0%	18.0%	100%	5.0%	18.0%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		31%	88%	88%	30%	86%	86%	30%	86%	86%	30%	86%	86%
Program Implementation Factor		16%	38%	60%	13%	37%	60%	10%	35%	60%	20%	40%	60%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-64
Commercial VSD on Pump

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	4.8%	1.7%	1.06	3.5%	0.9%	1.06	1.9%	0.9%	1.45	6.0%	2.0%	1.11
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		5.0%	18.0%	100%	5.0%	18.0%	100%	5.0%	18.0%	100%	5.0%	18.0%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	77%	78%	25%	75%	76%	25%	76%	76%	25%	76%	76%
Program Implementation Factor		16%	38%	60%	13%	37%	60%	10%	35%	60%	20%	40%	60%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-65
Commercial HVAC Economizer

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	18.0%	0.0%	1.19	14.5%	0.0%	1.11	7.4%	0.0%	1.08	19.3%	0.0%	2.44
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		32.6%	76.6%	90%	32.6%	76.6%	90%	32.6%	76.6%	90%	32.6%	76.6%	90%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	77%	78%	25%	75%	76%	25%	76%	76%	25%	76%	76%
Program Implementation Factor		12%	31%	50%	10%	30%	50%	8%	29%	50%	15%	33%	50%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-66
Commercial HVAC Economizer (Heating)

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	0.0%	0.0%	1.19	0.0%	0.0%	1.11	0.0%	0.0%	1.08	-1.4%	0.0%	2.44
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		32.6%	76.6%	90%	32.6%	76.6%	90%	32.6%	76.6%	90%	32.6%	76.6%	90%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	77%	78%	25%	75%	76%	25%	76%	76%	25%	76%	76%
Program Implementation Factor		12%	31%	50%	10%	30%	50%	8%	29%	50%	15%	33%	50%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-67
Duct Insulation

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	1.8%	2.3%	0.39	1.7%	2.0%	0.39	1.3%	2.3%	0.49	-0.5%	-1.5%	0.38
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		25.0%	76.6%	90%	25.0%	76.6%	90%	25.0%	76.6%	90%	25.0%	76.6%	90%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		31%	88%	88%	30%	86%	86%	30%	86%	86%	30%	86%	86%
Program Implementation Factor		12%	26%	40%	10%	25%	40%	8%	24%	40%	15%	27%	40%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-68
Duct Insulation (Heating)

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	0.0%	5.9%	0.39	0.0%	7.5%	0.39	0.0%	23.1%	0.49	-4.3%	-7.6%	0.38
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		25.0%	76.6%	90%	25.0%	76.6%	90%	25.0%	76.6%	90%	25.0%	76.6%	90%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		31%	88%	88%	30%	86%	86%	30%	86%	86%	30%	86%	86%
Program Implementation Factor		12%	26%	40%	10%	25%	40%	8%	24%	40%	15%	27%	40%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-69
Energy Management System (EMS)

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	20.8%	8.6%	1.55	19.6%	6.7%	1.64	17.4%	5.8%	1.72	30.7%	8.5%	1.44
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		24.1%	76.6%	90%	24.1%	76.6%	90%	24.1%	76.6%	90%	24.1%	76.6%	90%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	77%	78%	25%	75%	76%	25%	76%	76%	25%	76%	76%
Program Implementation Factor		16%	33%	50%	13%	31%	50%	10%	30%	50%	20%	35%	50%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-70
Energy Management System (EMS), Heating

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	20.8%	8.6%	1.55	19.6%	6.7%	1.64	17.4%	5.8%	1.72	30.7%	8.5%	1.44
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		24.1%	76.6%	90%	24.1%	76.6%	90%	24.1%	76.6%	90%	24.1%	76.6%	90%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	77%	78%	25%	75%	76%	25%	76%	76%	25%	76%	76%
Program Implementation Factor		16%	33%	50%	13%	31%	50%	10%	30%	50%	20%	35%	50%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-71
Variable Air Volume System

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	33.7%	18.2%	3.30	32.7%	12.9%	3.03	31.1%	10.8%	2.55	26.0%	7.3%	3.15
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		30.3%	100%	90%	30.3%	100%	90%	30.3%	100%	90%	30.3%	100%	90%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	77%	78%	25%	75%	76%	25%	76%	76%	25%	76%	76%
Program Implementation Factor		8%	24%	40%	7%	23%	40%	5%	23%	40%	10%	25%	40%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-72
Programmable Thermostat

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	7.9%	0.0%	3.35	10.4%	0.0%	3.13	9.2%	0.0%	1.29	6.1%	-5.6%	1.41
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		25.0%	76.6%	100%	25.0%	76.6%	100%	25.0%	76.6%	100%	25.0%	76.6%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	77%	78%	25%	75%	76%	25%	76%	76%	25%	76%	76%
Program Implementation Factor		16%	33%	50%	13%	31%	50%	10%	30%	50%	20%	35%	50%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-73
Programmable Thermostat (Heating)

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	20.2%	0.0%	3.35	18.9%	0.0%	3.13	16.5%	0.0%	1.29	19.6%	-0.2%	1.41
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		25.0%	76.6%	100%	25.0%	76.6%	100%	25.0%	76.6%	100%	25.0%	76.6%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	77%	78%	25%	75%	76%	25%	76%	76%	25%	76%	76%
Program Implementation Factor		16%	33%	50%	13%	31%	50%	10%	30%	50%	20%	35%	50%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-74
Fans, Energy-Efficient Motors

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	0.5%	0.4%	3.12	0.5%	0.4%	4.74	0.4%	0.3%	10.4	0.7%	0.4%	7.77
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		25.0%	76.6%	100%	25.0%	76.6%	100%	25.0%	76.6%	100%	25.0%	76.6%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	77%	78%	25%	75%	76%	25%	76%	76%	25%	76%	76%
Program Implementation Factor		20%	48%	75%	16%	46%	75%	13%	44%	75%	25%	50%	75%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-75
Fans, Energy-Efficient Motors (Ventilation)

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	4.9%	4.9%	3.12	4.9%	4.7%	4.74	4.9%	5.0%	10.4	4.9%	5.0%	7.77
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		25.0%	76.6%	100%	25.0%	76.6%	100%	25.0%	76.6%	100%	25.0%	76.6%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	77%	78%	25%	75%	76%	25%	76%	76%	25%	76%	76%
Program Implementation Factor		20%	48%	75%	16%	46%	75%	13%	44%	75%	25%	50%	75%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-76
Fans, Variable Speed Control

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	2.9%	1.3%	0.95	2.6%	0.8%	0.68	2.3%	0.8%	1.02	2.3%	0.6%	0.48
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		25.0%	76.6%	100%	25.0%	76.6%	100%	25.0%	76.6%	100%	25.0%	76.6%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	77%	78%	25%	75%	76%	25%	76%	76%	25%	76%	76%
Program Implementation Factor		20%	48%	75%	16%	46%	75%	13%	44%	75%	25%	50%	75%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-77
Fans, Variable Speed Control (Ventilation)

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	26.5%	17.6%	0.95	26.5%	13.0%	0.68	28.2%	12.2%	1.02	23.7%	8.0%	0.48
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		25.0%	76.6%	100%	25.0%	76.6%	100%	25.0%	76.6%	100%	25.0%	76.6%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	77%	78%	25%	75%	76%	25%	76%	76%	25%	76%	76%
Program Implementation Factor		20%	48%	75%	16%	46%	75%	13%	44%	75%	25%	50%	75%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-78
Daylighting Controls, Outdoors

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	8.7%	0.0%	0.71	8.7%	0.0%	0.68	8.7%	0.0%	0.54	8.7%	0.0%	0.71
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		42%	78%	80%	42%	78%	80%	42%	78%	80%	42%	78%	80%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		52%	77%	78%	50%	75%	76%	51%	76%	76%	51%	76%	76%
Program Implementation Factor		4%	17%	30%	3%	17%	30%	3%	16%	30%	5%	18%	30%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-79
LED Exit Lighting

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	9.0%	0.0%	12.2	9.0%	0.0%	12.3	9.0%	0.0%	12.0	9.0%	0.0%	11.4
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		50%	5%	100%	50%	5%	100%	50%	5%	100%	50%	5%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		52%	98%	98%	50%	96%	96%	51%	96%	96%	51%	96%	96%
Program Implementation Factor		40%	70%	100%	33%	66%	100%	25%	63%	100%	50%	75%	100%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-80
Occupancy Sensors

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	9.0%	0.0%	161	9.0%	0.0%	170	9.0%	0.0%	212	9.0%	0.0%	161
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		5%	25%	50%	5%	25%	50%	5%	25%	50%	5%	25%	50%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		52%	77%	78%	50%	75%	76%	51%	76%	76%	51%	76%	76%
Program Implementation Factor		16%	33%	50%	13%	31%	50%	10%	30%	50%	20%	35%	50%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-81
Task Lighting

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	8.7%	8.8%	0.93	8.7%	9.1%	0.92	8.7%	8.8%	0.85	8.7%	8.7%	0.92
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		5%	25%	100%	5%	25%	100%	5%	25%	100%	5%	25%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		52%	77%	78%	50%	75%	76%	51%	76%	76%	51%	76%	76%
Program Implementation Factor		4%	17%	30%	3%	17%	30%	3%	16%	30%	5%	18%	30%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-82
Outdoor Lighting, Photovoltaic Installation (Parking Lots)

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	9.0%	0.0%	0.67	9.0%	0.0%	0.69	9.0%	0.0%	0.71	9.0%	0.0%	0.64
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		2%	10%	50%	2%	10%	50%	2%	10%	50%	2%	10%	50%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		31%	77%	78%	30%	75%	76%	30%	76%	76%	30%	76%	76%
Program Implementation Factor		20%	48%	75%	16%	46%	75%	13%	44%	75%	25%	50%	75%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-83
Commercial Refrigeration: Compressor, High Efficiency

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	8.0%	8.0%	6.87	8.0%	8.0%	6.87	8.0%	8.0%	6.87	8.0%	8.0%	6.87
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		25%	4.5%	100%	25%	4.5%	100%	25%	4.5%	100%	25%	4.5%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		31%	88%	88%	30%	86%	86%	30%	86%	86%	30%	86%	86%
Program Implementation Factor		12%	26%	40%	10%	25%	40%	8%	24%	40%	15%	27%	40%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-84
Commercial Refrigeration: Controls, Anti-Sweat Heater

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	6.0%	6.0%	1.77	6.0%	6.0%	1.85	6.0%	6.0%	2.21	6.0%	6.0%	1.75
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		25%	4.5%	100%	25%	4.5%	100%	25%	4.5%	100%	25%	4.5%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		31%	88%	88%	30%	86%	86%	30%	86%	86%	30%	86%	86%
Program Implementation Factor		12%	26%	40%	10%	25%	40%	8%	24%	40%	15%	27%	40%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-85
Commercial Refrigeration: Controls, Floating Head Pressure

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	10.0%	10.0%	14.5	10.0%	10.0%	14.8	10.0%	10.0%	14.9	10.0%	10.0%	13.8
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		25%	4.5%	100%	25%	4.5%	100%	25%	4.5%	100%	25%	4.5%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		31%	88%	88%	30%	86%	86%	30%	86%	86%	30%	86%	86%
Program Implementation Factor		12%	26%	40%	10%	25%	40%	8%	24%	40%	15%	27%	40%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-86
Commercial Refrigeration: Glass Doors, Installation

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	5.0%	5.0%	0.47	5.0%	5.0%	0.48	5.0%	5.0%	0.49	5.0%	5.0%	0.44
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		25%	4.5%	100%	25%	4.5%	100%	25%	4.5%	100%	25%	4.5%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		31%	77%	78%	30%	75%	76%	30%	76%	76%	30%	76%	76%
Program Implementation Factor		12%	26%	40%	10%	25%	40%	8%	24%	40%	15%	27%	40%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-87
Vending Machine, High Efficiency

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	3.5%	3.7%	4.30	3.5%	3.7%	4.37	3.5%	3.7%	4.29	3.5%	3.7%	4.06
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		2%	10%	100%	2%	10%	100%	2%	10%	100%	2%	10%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		26%	77%	78%	25%	75%	76%	25%	76%	76%	25%	76%	76%
Program Implementation Factor		12%	26%	40%	10%	25%	40%	8%	24%	40%	15%	27%	40%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-88
Icemakers, High Efficiency

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	10.0%	10.0%	1.77	10.0%	10.0%	1.85	10.0%	10.0%	2.21	10.0%	10.0%	1.75
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		15%	4.5%	100%	15%	4.5%	100%	15%	4.5%	100%	15%	4.5%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		31%	88%	88%	30%	86%	86%	30%	86%	86%	30%	86%	86%
Program Implementation Factor		4%	27%	50%	3%	27%	50%	3%	26%	50%	5%	27%	50%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-89
Reach-in Coolers and Freezers, High Efficiency

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	15.0%	15.0%	6.87	15.0%	15.0%	6.87	15.0%	15.0%	6.87	15.0%	15.0%	6.87
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		15%	4.5%	100%	15%	4.5%	100%	15%	4.5%	100%	15%	4.5%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		31%	88%	88%	30%	86%	86%	30%	86%	86%	30%	86%	86%
Program Implementation Factor		8%	29%	50%	7%	28%	50%	5%	27%	50%	10%	30%	50%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-90
Duct Testing and Sealing

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	8.0%	4.0%	1.64	8.0%	4.0%	1.14	8.0%	4.0%	3.39	8.0%	4.0%	6.12
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		25%	18%	100%	25%	18%	100%	25%	18%	100%	25%	18%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		31%	88%	88%	30%	86%	86%	30%	86%	86%	30%	86%	86%
Program Implementation Factor		12%	26%	40%	10%	25%	40%	8%	24%	40%	15%	27%	40%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-91
Cool Roof

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	2.0%	1.0%	0.70	2.0%	1.0%	0.79	2.0%	1.0%	0.75	2.0%	1.0%	0.75
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		10%	15%	100%	10%	15%	100%	10%	15%	100%	10%	15%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		31%	88%	88%	30%	86%	86%	30%	86%	86%	30%	86%	86%
Program Implementation Factor		8%	24%	40%	7%	23%	40%	5%	23%	40%	10%	25%	40%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-92
Roof Insulation

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	1.5%	0.8%	1.04	1.5%	0.8%	0.90	1.5%	0.8%	0.53	1.5%	0.8%	1.03
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		12.5%	76.6%	100%	12.5%	76.6%	100%	12.5%	76.6%	100%	12.5%	76.6%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		31%	88%	88%	30%	86%	86%	30%	86%	86%	30%	86%	86%
Program Implementation Factor		12%	26%	40%	10%	25%	40%	8%	24%	40%	15%	27%	40%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-93
Roof Insulation (Heating)

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**	**Energy Savings**	**Peak Demand Savings**	**B/C**
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	3.0%	0.0%	1.04	3.0%	0.0%	0.90	3.0%	0.0%	0.53	3.0%	0.0%	1.03
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		12.5%	76.6%	100%	12.5%	76.6%	100%	12.5%	76.6%	100%	12.5%	76.6%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		31%	88%	88%	30%	86%	86%	30%	86%	86%	30%	86%	86%
Program Implementation Factor		12%	26%	40%	10%	25%	40%	8%	24%	40%	15%	27%	40%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-94
Efficient Windows

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	5.0%	2.5%	1.63	5.0%	2.5%	1.42	5.0%	2.5%	0.39	5.0%	2.5%	1.07
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		60%	76.6%	100%	60%	76.6%	100%	60%	76.6%	100%	60%	76.6%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		31%	88%	88%	30%	86%	86%	30%	86%	86%	30%	86%	86%
Program Implementation Factor		12%	26%	40%	10%	25%	40%	8%	24%	40%	15%	27%	40%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-95
Efficient Windows (Heating)

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	10.0%	0.0%	1.63	10.0%	0.0%	1.42	10.0%	0.0%	0.39	10.0%	0.0%	1.07
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		60%	76.6%	100%	60%	76.6%	100%	60%	76.6%	100%	60%	76.6%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		31%	88%	88%	30%	86%	86%	30%	86%	86%	30%	86%	86%
Program Implementation Factor		12%	26%	40%	10%	25%	40%	8%	24%	40%	15%	27%	40%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-96
HVAC Retrocommissioning

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	10.0%	10.0%	1.0	10.0%	10.0%	1.0	10.0%	10.0%	1.0	10.0%	10.0%	1.0
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		16.6%	76.6%	100%	16.6%	76.6%	100%	16.6%	76.6%	100%	16.6%	76.6%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		31%	88%	88%	30%	86%	86%	30%	86%	86%	30%	86%	86%
Program Implementation Factor		8%	29%	50%	7%	28%	50%	5%	27%	50%	10%	30%	50%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-97
HVAC Retrocommissioning (Heating)

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	10.0%	0.0%	1.0	10.0%	0.0%	1.0	10.0%	0.0%	1.0	10.0%	0.0%	1.0
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		16.6%	76.6%	100%	16.6%	76.6%	100%	16.6%	76.6%	100%	16.6%	76.6%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		31%	88%	88%	30%	86%	86%	30%	86%	86%	30%	86%	86%
Program Implementation Factor		8%	29%	50%	7%	28%	50%	5%	27%	50%	10%	30%	50%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Table F-98
Lighting Retrocommissioning

Technology	Year	Northeast			Midwest			South			West		
		Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C	Energy Savings	Peak Demand Savings	B/C
Without	2008	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00	0.0%	0.0%	0.00
With	2008	10.0%	10.0%	1.0	10.0%	10.0%	1.0	10.0%	10.0%	1.0	10.0%	10.0%	1.0
		Sat.	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**	**Sat.**	**App.**	**Fea.**
All Construction		7.4%	78.0%	100%	7.4%	78.0%	100%	7.4%	78.0%	100%	7.4%	78.0%	100%
		2010	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**	**2010**	**2020**	**2030**
Market Acceptance Ratio		31%	88%	88%	30%	86%	86%	30%	86%	86%	30%	86%	86%
Program Implementation Factor		8%	29%	50%	7%	28%	50%	5%	27%	50%	10%	30%	50%

Sat. = Saturation; App. = Applicability; Fea. = Feasibility

Industrial Equipment

Table F-99
Industrial Equipment

Measure	Energy Savings Range		Market Acceptance Ratio			Program Implementation Factor		
	Low	High	2010	2020	2030	2010	2020	2030
Process Heating	8.5%	25%	25%	50%	50%	5%	29%	52%
Efficient Motors and Drives (1-20 hp)	10%	30%	50%	95%	95%	26%	52%	78%
Efficient Motors and Drives (20-1,000 hp)	0.5%	10%	50%	95%	95%	21%	49%	78%
Efficient Motors and Drives (>1,000 hp)	0.1%	15%	50%	95%	95%	21%	49%	78%
HVAC Improvements	9.5%	20%	30%	85%	85%	10%	38%	65%
Retrofit with Efficient Lighting Technologies	28.0%	76%	50%	85%	85%	21%	49%	78%
Process Heating	8.5%	25%	25%	50%	50%	5%	29%	52%

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