Sector Collaborative on Energy Efficiency Accomplishments and Next Steps

A RESOURCE OF THE NATIONAL ACTION PLAN FOR ENERGY EFFICIENCY

JULY 2008

About This Document

This report, *Sector Collaborative on Energy Efficiency Accomplishments and Next Steps,* presents the major findings of an important year two activity of the National Action Plan for Energy Efficiency. The Report is designed to help gas and electric utilities, utility regulators, and energy users identify and act on cost-effective opportunities for expanding energy efficiency resources in five commercial sectors—hospitality, retail, commercial real estate, grocery, and municipal.

The Report describes the barriers to cost-effective energy efficiency, documents how energy savings are valuable investments for participating sectors, identifies tools needed for implementation and evaluation of cost-effective energy efficiency measures, and highlights new commitments and partnerships to increase investment in energy efficiency in the participating sectors. The Report also presents key findings of the Sector Collaborative that suggest specific next steps for the participating sectors as well as for utilities and other stakeholders.

The primary intended audiences for this report are property owners and managers in the hospitality, retail, commercial real estate, grocery, and municipal sectors; gas and electric utilities; and utility regulators.

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The Leadership Group of the National Action Plan for Energy Efficiency is committed to taking action to increase investment in cost-effective energy efficiency. *Sector Collaborative on Energy Efficiency Accomplishments and Next Steps* was developed under the guidance of and with input from the Leadership Group. The document does not necessarily represent a consensus view and does not represent an endorsement by the organizations of Leadership Group members.

Sector Collaborative on Energy Efficiency Accomplishments and Next Steps is a product of the National Action Plan for Energy Efficiency's Sector Collaborative on Energy Efficiency and does not reflect the views, policies, or otherwise of the federal government. The role of the U.S. Department of Energy and U.S. Environmental Protection Agency is limited to facilitation of the Action Plan.

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List of Abbreviations and Acronyms

BOMA	Building Owners and Managers Association
EEI	Edison Electric Institute
EIA	Energy Information Administration
EPA	U.S. Environmental Protection Agency
ft^2	square foot
kBtu	thousand British thermal units
kW	kilowatt
kWh	kilowatt-hour
HVAC	heating, ventilation, and air conditioning
NASEO	National Association of State Energy Officials
O&M	operations and maintenance

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Executive Summary

This document presents the major outcomes from the first phase of the Sector Collaborative on Energy Efficiency (Sector Collaborative) of the National Action Plan for Energy Efficiency, including the workshop held in Washington, D.C., on June 27–28, 2007. These outcomes include the identification of key barriers to energy efficiency experienced by Sector Collaborative participants, documentation of significant energy savings from a series of energy efficiency measures, and a number of recommendations and actionable commitments derived from discussions among participating sectors.

Improving energy efficiency in our homes, businesses, schools, governments, and industries—which collectively consume more than 70 percent of the natural gas and electricity used in the country—is one of the most constructive, cost-effective ways to address the challenges of high energy prices, energy security and independence, air pollution, and global climate change. Despite these benefits and the success of energy efficiency programs in some regions of the country, energy efficiency remains critically underutilized in the nation's energy portfolio. It is time to take advantage of more than two decades of experience with successful energy efficiency programs, broaden and expand these efforts, and capture the savings that energy efficiency offers. The Sector Collaborative's work to help utilities, regulators, and energy users identify and act on cost-effective energy efficiency opportunities is key to capturing these benefits.

The Sector Collaborative was launched in 2007 as an important year two activity of the National Action Plan for Energy Efficiency (Action Plan). The Sector Collaborative brings utilities and energy-using organizations together around the following objectives:

- Exploring the barriers to cost-effective energy efficiency.
- Documenting how energy savings are valuable investments for participating sectors.
- Identifying tools needed for implementation and evaluation of cost-effective energy efficiency measures.
- Providing peer exchange opportunities to share approaches to effective energy efficiency programs.
- Identifying and pursuing new commitments and partnerships to increase investment in energy efficiency.

The U.S. Environmental Protection Agency, U.S. Department of Energy, Edison Electric Institute, and American Gas Association provide support for the Sector Collaborative. The first phase of the Sector

Figure ES-1. Organizations Represented in the Sector Collaborative Design Team

Alliance to Save Energy	National Conference of Mayors
American Council for an Energy-Efficient Economy	New Jersey Natural Gas
American Gas Association	Pacific Gas and Electric
City of Austin, Texas	Seattle City Light
Cushman & Wakefield	Staples, Inc.
Duke Energy	Target Corporation
Edison Electric Institute	Transwestern
Food Lion, LLC	USAA Realty
Great Plains Energy	Wal-Mart Stores
Hilton	Whole Foods Market
Marriott Corporation	
National Association of Regulatory Utility Commissioners	

Collaborative focused on five key energy-using sectors: hospitality, retail, commercial real estate, grocery, and municipality. A Design Team representing more than 20 diverse organizations (see Figure ES-1) chose the initial set of objectives and participating sectors. An important milestone of the first phase was the Sector Collaborative's first workshop, held on June 27–28, 2007, in Washington, D.C., and attended by more than 100 sector and utility representatives.

This document summarizes the progress to date in meeting the Sector Collaborative objectives, including important findings that have emerged from the workshop and other Sector Collaborative activities.

Exploring Barriers to Cost-Effective Energy Efficiency

The Sector Collaborative developed a comprehensive list of barriers to cost-effective energy efficiency faced by the participating sectors. These barriers follow four main themes:

- Lack of management commitment.
- Lack of information.
- Lack of comprehensive measurement tools and methodologies.
- Financial barriers.

Sector Collaborative participants also identified a number of sector-specific barriers to energy efficiency, such as complex ownership structures for commercial real estate, lack of capital for the municipal sector, and primacy of customer and guest comfort for the hospitality, retail, and grocery sectors.

Documenting Energy Savings

The Sector Collaborative seeks to document how energy savings are valuable investments for participating sectors. By clearly demonstrating this value, Sector Collaborative members gain information critical to helping them overcome the identified barriers. Toward this end, the Sector Collaborative has developed energy use and savings profiles that document the potential in each of the participating sectors. The profiles will help building owner/operators and utilities identify the most promising energy efficiency measures for buildings in each sector.

The Sector Collaborative developed each profile based on an average-sized building in each sector. Savings were analyzed for a series of upgrade strategies consisting of conventional energy efficiency measures, with a focus on measures that reduce energy consumption during the peak summer months. The energy profiles demonstrate substantial energy savings potential for buildings in each of the sectors, including significant savings from low-cost measures such as improved operations and maintenance (O&M). Table ES-1 summarizes the key findings, which include the following:

- O&M measures alone result in overall cost-effective energy savings of 9 to 24 percent and peak demand savings of 3 to 10 percent.
- For a 250,000-square-foot office building, dollar savings from O&M measures alone can amount to well over $100,000.
- When comprehensive energy efficiency measures are implemented, overall energy savings range from 15 percent for supermarkets to 30 percent for retail stores and office buildings, with peak demand savings ranging from 21 to 42 percent.
- Implementation of comprehensive energy efficiency measures increases the buildings' EPA energy performance ratings by 17 to 46 points.[1]
- Proper sequencing of energy efficiency measures reduces a building's required cooling capacity by 3 to 20 percent, helping to lower HVAC equipment and installation costs while increasing savings.

Sector Collaborative participants found these results to be realistic and achievable based on their own experience.

Table ES-1. Summary of Savings by Building Type and Efficiency Measures

	Upgrade Measures	Electricity Savings (%)	Gas Savings (%)	Energy Savings (%)	Peak Demand Savings (%)	Energy Cost ($)	Energy Savings ($)	EPA Energy Rating
Office (250,000 ft²)	Baseline	—	—	—	—	$598,049	—	59
	O&M only	16%	25%	20%	8%	$490,035	$108,014	74
	Lighting only	10%	-3%	4%	8%	$559,788	$38,261	65
	HVAC only	21%	-5%	9%	27%	$515,895	$82,154	72
	All measures	41%	17%	30%	36%	$392,768	$205,281	88
Hotel (180,000 ft²)	Baseline	—	—	—	—	$351,957	—	44
	O&M only	10%	10%	10%	6%	$316,249	$35,708	59
	Lighting only	21%	-12%	3%	19%	$317,787	$34,170	61
	HVAC only	23%	-1%	9%	23%	$300,991	$50,966	68
	All measures	45%	4%	22%	42%	$243,256	$108,701	90
Supermarket (45,000 ft²)	Baseline	—	—	—	—	$342,750	—	66
	O&M only	4%	40%	9%	3%	$322,211	$20,538	71
	Lighting only	7%	-30%	2%	11%	$327,279	$15,471	71
	HVAC only	1%	0%	1%	4%	$340,042	$2,707	67
	All measures	16%	10%	15%	21%	$288,215	$54,535	83
Retail (30,000 ft²)	Baseline	—	—	—	—	$55,261	—	41
	O&M only	14%	32%	24%	10%	$44,479	$10,782	57
	Lighting only	28%	-27%	5%	25%	$46,861	$8,399	57
	HVAC only	4%	0%	2%	12%	$53,770	$1,491	43
	All measures	42%	14%	30%	41%	$35,729	$19,532	75

Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool.

Progress on Other Objectives

Activities are underway to advance the other key objectives of the Sector Collaborative. In terms of tool development, participants have focused on the need for better ways to bring energy data and benchmarking systems together. As a result, the Sector Collaborative is developing best practices for the provision of utility data. The June workshop provided peer exchange opportunities, with much of the discussion devoted to the development of effective energy efficiency programs. Following on the workshop, several organizations partnered to create sector-based commitments. These commitments provide a forum for further peer exchange, as well as a basis for action to increase investment in cost-effective energy efficiency.

Key Findings and Commitments

Several important findings emerged from the first phase of the Sector Collaborative. These include:

- Opportunities for substantial cost-effective energy savings exist across the sectors represented in the Sector Collaborative: hospitality, retail, commercial real estate, grocery, and municipalities.

- A focus on whole-building energy consumption is critical to benchmarking, allowing building owners and operators to identify efficiency opportunities and measure progress.
- Lack of readily available, consistent utility data hinders benchmarking and other energy management efforts.
- Focusing on O&M can be a cost-effective first step to achieving efficiency improvements and saving energy.
- There is a need for sector-based forums to facilitate the sharing of best practices.
- Guidelines for procurement and bulk purchasing of energy-efficient products and services would help both public and private organizations carry out efficiency programs.

Based on these findings, a number of Sector Collaborative participants and interested parties have developed and are adopting sector-based commitments to increase investment in energy efficiency. Seventeen organizations have already made commitments (see Figure ES-2), among them several cities and counties, large nationwide retail companies, and state and private-sector associations, representing billions of square feet of building space across the country. The commitments include one or more of the following action steps:

- Reduce energy consumption substantially over the coming years (goals range from 10 to 30 percent).
- Conduct energy benchmarking for all properties above 5,000 square feet.
- Implement all cost-effective strategies to improve energy efficiency.
- Create and/or increase energy efficiency education and awareness within and outside each organization.
- Pursue bulk purchasing of energy-efficient products and services.
- Support expanded efficiency program offerings across states and utilities.

Figure ES-2. Organizations Adopting Sector-Based Commitments to Energy Efficiency

Advantage IQ

Arlington County, Virginia

City of Aurora, Colorado

Building Owners and Managers Association (BOMA) International

Costco Wholesale

City of Denver, Colorado

Food Lion, LLC

City of Indianapolis, Indiana

King County, Washington

Louisville Metro Government, Kentucky

City of Medford, Massachusetts

National Association of State Energy Officials (NASEO)

San Miguel County, Colorado

City of Somerville, Massachusetts

Stop and Shop/Giant Foods

Town of Mountain Village, Colorado

Whole Foods Market

- Support development of standardized electronic utility billing data access by large customers for benchmarking.
- Explore energy efficiency programs offered by federal, state, and local agencies and sector-based associations.

The Sector Collaborative plans to support the sectors in fulfilling these commitments. The full sector-based commitments are included in Appendix C.

Next Steps

The accomplishments from the first phase of the Sector Collaborative demonstrate the value of this National Action Plan initiative. Several additional actions could increase the Sector Collaborative's value in achieving the Action Plan goal of creating a sustainable, aggressive national commitment to energy efficiency. These include:

- Engaging additional organizations within the initial five sectors.

- Creating working groups, developing materials, and undertaking other actions to help the existing organizations succeed.
- Exploring new sectors that could benefit from the Sector Collaborative.
- Continuing dialogue between end-users and utilities on programs to advance cost-effective energy efficiency.

Notes

1. EPA energy performance ratings range from 1 to 100 based on the EPA Portfolio Manager benchmarking tool. See <www.energystar.gov/benchmark>.

1: Introduction

Improving the energy efficiency of homes, businesses, schools, governments, and industries—which collectively consume more than 70 percent of the natural gas and electricity used in the United States—is one of the most constructive, cost-effective ways to address the challenges of high energy prices, energy security and independence, air pollution, and global climate change. Mining this efficiency could help us meet on the order of 50 percent or more of the expected growth in U.S. consumption of electricity and natural gas in the coming decades, yielding many billions of dollars in saved energy bills and avoiding significant emissions of greenhouse gases and other air pollutants.[1]

Recognizing this large untapped opportunity, more than 60 leading organizations representing diverse stakeholders from across the country joined together to develop the National Action Plan for Energy Efficiency.[2] The Action Plan identifies many of the key barriers contributing to under-investment in energy efficiency and outlines five key policy recommendations for achieving all cost-effective energy efficiency, focusing largely on state-level energy efficiency policies and programs (Figure 1-1). As of January 2008, over 120 organizations have endorsed the Action Plan recommendations and made public commitments to implement them in their areas. The Sector Collaborative's work to help utilities, regulators, and energy users identify and act on cost-effective opportunities for expanding energy efficiency resources is key to making the Action Plan a reality.

1.1 Objectives of the Sector Collaborative

The Sector Collaborative on Energy Efficiency, launched in 2007, helps put the Action Plan recommendations into practice. The Sector Collaborative brings utilities and end-using organizations together around the following objectives:

- Exploring the barriers to cost-effective energy efficiency.
- Documenting how energy savings are valuable investments for participating sectors.
- Identifying tools needed for implementation and evaluation of cost-effective energy efficiency measures.
- Providing peer exchange opportunities to share approaches to effective energy efficiency programs.

Figure 1-1. National Action Plan for Energy Efficiency Recommendations

- **Recognize energy efficiency as a high-priority energy resource.**
- **Make a strong, long-term commitment to implement cost-effective energy efficiency as a resource.**
- **Broadly communicate the benefits of and opportunities for energy efficiency.**
- **Promote sufficient, timely, and stable program funding to deliver energy efficiency where cost-effective.**
- **Modify policies to align utility incentives with the delivery of cost-effective energy efficiency and modify ratemaking practices to promote energy efficiency investments.**

- Identifying and pursuing new commitments and partnerships to increase investment in energy efficiency.

The first phase of the Sector Collaborative focused on five key energy-using sectors: hospitality, retail, commercial real estate, grocery, and municipality. These sectors offer tremendous opportunity for cost-effective energy efficiency. Over 100 sector and utility participants attended the first meeting of the Sector Collaborative, held on June 27–28, 2007, in Washington, D.C.

1.2 Structure of the Sector Collaborative

A Design Team representing more than 20 diverse organizations, listed in Figure 1-2, chose the initial set of objectives and participating sectors.

In preparation for the June Sector Collaborative workshop, the Design Team helped develop a number of background resources and meeting materials. These resources served as the basis for breakout group discussions during the workshop, and can be viewed online at <http://www.epa.gov/cleanenergy/energy-programs/napee/meetings/sector.html>. The workshop agenda is included in Appendix A.

The U.S. Environmental Protection Agency, U.S. Department of Energy, Edison Electric Institute, and American Gas Association provide support for the Sector Collaborative.

Figure 1-2. Organizations Represented in the Sector Collaborative Design Team

Alliance to Save Energy	National Conference of Mayors
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City of Austin, Texas	Seattle City Light
Cushman & Wakefield	Staples, Inc.
Duke Energy	Target Corporation
Edison Electric Institute	Transwestern
Food Lion, LLC	USAA Realty
Great Plains Energy	Wal-Mart Stores
Hilton	Whole Foods Market
Marriott Corporation	
National Association of Regulatory Utility Commissioners	

1.3 This Document

Sector Collaborative accomplishments and next steps are presented as follows:

- **Chapter 2: Barriers to Energy Efficiency.** This chapter presents the general and sector-specific barriers to energy efficiency, as identified and agreed on by the Design Team and the participants at the June 2007 Sector Collaborative workshop.
- **Chapter 3: Energy Use and Savings Profiles.** This chapter discusses the outcomes of the four energy use profiles that were developed for the June 2007 workshop and discussed during the breakout sessions at that meeting. These profiles not only discuss the general energy consumption trends experienced within the participating sectors, but also illustrate the significant potential for energy savings from multiple energy efficiency upgrade strategies.
- **Chapter 4: Key Findings.** This chapter presents important findings from the June 2007 workshop and other Sector Collaborative activities.
- **Chapter 5: Sector Commitments.** This chapter presents the sector-based commitments that emerged from discussions of the Design Team and Sector Collaborative participants, and lists the organizations that have already taken on specific initiatives to advance the Sector Collaborative's objectives.
- **Chapter 6: Summary and Next Steps.** This chapter describes how the outcomes of the first phase of the Sector Collaborative correspond to the overarching goals of the initiative, and lists possible next steps for consideration.

1.4 Notes

1. See the National Action Plan for Energy Efficiency (2006), available at <www.epa.gov/cleanenergy/actionplan/report.htm>.

2. See <www.epa.gov/eeactionplan>.

2: Barriers to Energy Efficiency

Identifying, analyzing, and eliminating barriers to energy efficiency are important goals of the Action Plan. The Sector Collaborative has developed a comprehensive list of the barriers to cost-effective energy efficiency that participating sectors face. Table 2-1 provides an overview of the barriers common to all sectors, organized by four main themes: lack of management commitment, lack of information, lack of comprehensive measurement tools and methodologies, and financial barriers. Table 2-2 lists the barriers specific to each participating sector.

The lack of consistent, easily obtainable utility billing data was the single most important barrier acknowledged across all sectors. Workshop participants were unanimous in recognizing the importance of energy use benchmarking as a first step in energy management. This practice continues to be hindered, however, by the absence of a common, generally accepted protocol for the provision of the billing data needed for benchmarking and tracking.

Table 2-1. Barriers to Energy Efficiency Common to All Sectors

Lack of Corporate Commitment	• Typically, energy management is not considered a core business concern, and the cost of energy is not perceived as being large enough (relative to other costs) to address strategically. • The organization believes that energy costs are not controllable. • There is no champion at the CEO or CFO level to drive energy efficiency initiatives. • Responsibility is diffused among a number of players: those paying the bills, those operating the equipment, and those making investment decisions. • The energy manager has too many responsibilities and not enough time, resources, or staff.
Lack of Information	• The energy efficiency options available in the marketplace are insufficiently understood. There is a lack of: – Subject matter expertise and implementation experience. – Case studies and other types of information sharing to demonstrate the potential from successful implementation of best practices. • The organization believes that energy efficiency requires—or can be guaranteed by—significant capital investment and installation of new technologies. More specifically, the organization: – Believes that "our building is already energy-efficient" because of recent renovation or installation of new equipment. – Is unaware that significant improvements can be achieved through low- and no-cost improvements in operations and maintenance. – Is unaware that system design issues, installation issues, and system integration issues can significantly affect the actual savings from many efficient technologies. • Difficulty obtaining consistent and easy analyzable utility billing data within and across regions serves as an impediment to energy consumption benchmarking and tracking.

Table 2-1. Barriers to Energy Efficiency Common to All Sectors, continued

Lack of Comprehensive Measurement Tools and Methodologies	• Lack of a generally accepted, widely used, standardized method for benchmarking building energy efficiency results in a lack of awareness of how buildings perform relative to one another and therefore what opportunities they may have to improve. • There is a lack of readily available, user-friendly tools that can account for the interaction of complex building systems and technologies; therefore, equipment tends to be addressed in isolation, leading to missed opportunities for efficiency and higher costs. • There is a lack of tools and techniques to reflect the secondary (non-energy) benefits of energy efficiency, such as reduced climate impact and enhanced corporate reputation.
Financial Barriers	• Incentives are split (e.g., tenant-landlord relationships and other contractual arrangements separate the party responsible for funding and/or implementing efficiency improvements and the party that reaps the benefits of efficiency improvements). • "First cost" considerations dominate. • Short holding periods for investment properties lead to the belief that there is not enough time to recoup savings from energy investments.

Table 2-2. Sector-Specific Barriers to Energy Efficiency

Commercial Real Estate	• Split incentives are inherent in the tenant-landlord relationship. If energy costs are paid directly by the tenant (e.g., triple-net leasing), the owner will not be motivated to make energy efficiency investments that cannot be recouped. • The complex investment/ownership/management structure requires coordination, education, and communication to get all players moving in the same direction.
Retail	• Customer comfort and shopping experience take precedence over energy performance. • There is a tendency toward overlighting based on outdated assumptions of what is necessary to make a property and shopping experience attractive.
Grocers	• Thin profit margins lead to strict thresholds for the simple payback period. • Customer comfort and shopping experience take precedence over energy performance. • Constraints on refrigerant use and emissions must be considered because of interaction with efficiency.

Table 2-2. Sector-Specific Barriers to Energy Efficiency, continued

Hospitality	• Primary importance is placed on guest experience—i.e., comfort and aesthetics. It is believed that energy efficiency implies cutting corners and detracting from the amenities that guests have come to expect. • Complex ownership and contractual structures (involving owners, managers, and franchisees) make it difficult to determine which parties are in the best position to drive energy efficiency initiatives. This complexity also raises the possibility of split or misaligned incentives. • Capital investment priorities for owners include bringing newly acquired properties up to brand standards; capital is not always available to address energy efficiency improvements.
Cities/Municipalities	• Politics, policy, and other considerations beyond "typical" market forces have a strong influence—especially as they relate to state and local budgets and funding cuts. • Decisions are often subject to consensus, so there is more lead time before changes are implemented. • Accessing and obtaining capital is more difficult than in other commercial sectors; also, there is a lack of familiarity with/understanding of creative financing structures and mechanisms such as performance contracting.

3: Energy Use and Savings Profiles

The Sector Collaborative seeks to document how energy savings are valuable investments for participating sectors. Toward this end, the Sector Collaborative has developed energy use profiles that illustrate the savings potential in each of the participating sectors. The profiles were designed to help building owner/operators and utilities identify the most promising energy efficiency measures for buildings in each sector. They can assist Sector Collaborative participants in understanding how building systems combine to affect whole-building energy performance, and can help end-users and utilities alike to identify strategies and best practices for overcoming the barriers to cost-effective energy efficiency improvements.

The energy use profiles for each sector demonstrate substantial energy savings potential through conventional energy efficiency measures, including significant savings from low-cost measures such as improved operations and maintenance (O&M). Key findings include:

- O&M measures alone result in overall cost-effective energy savings of 9 to 24 percent and peak demand savings of 3 to 10 percent.
- For a 250,000-square-foot office building, dollar savings from O&M measures alone can amount to well over $100,000.
- When comprehensive energy efficiency measures are implemented, overall energy savings range from 15 percent for supermarkets to 30 percent for retail stores and office buildings, with peak demand savings ranging from 21 to 42 percent.
- Implementing comprehensive energy efficiency measures increases these buildings' EPA energy performance ratings by 17 to 46 points.
- Proper sequencing of energy efficiency measures reduces a building's required cooling capacity by 3 to 20 percent, helping to lower HVAC equipment and installation costs while increasing savings.

3.1 Potential for Cost-Effective Energy and Cost Savings

The energy use profiles, included in full as Appendix B, provide an overview of the average annual energy consumption and cost within each sector, as well as a sector-specific breakdown of energy end-uses. For each sector, the contractor for the Sector Collaborative, ICF International, ran a representative building through a variety of simulations using eQUEST, a DOE-2–based software tool. To demonstrate the effect of energy efficiency measures on peak load, the buildings were modeled on a typical summer day in Chicago. For each building, a baseline case was modeled first and a load profile was developed to show the relative contributions of lighting, HVAC, and other systems to the total energy consumption and peak daily loads. Figure 3-1 shows a sample baseline load profile for an office building.

With the baseline established, ICF International modeled each building further to demonstrate the impact of four separate energy efficiency upgrade strategies:

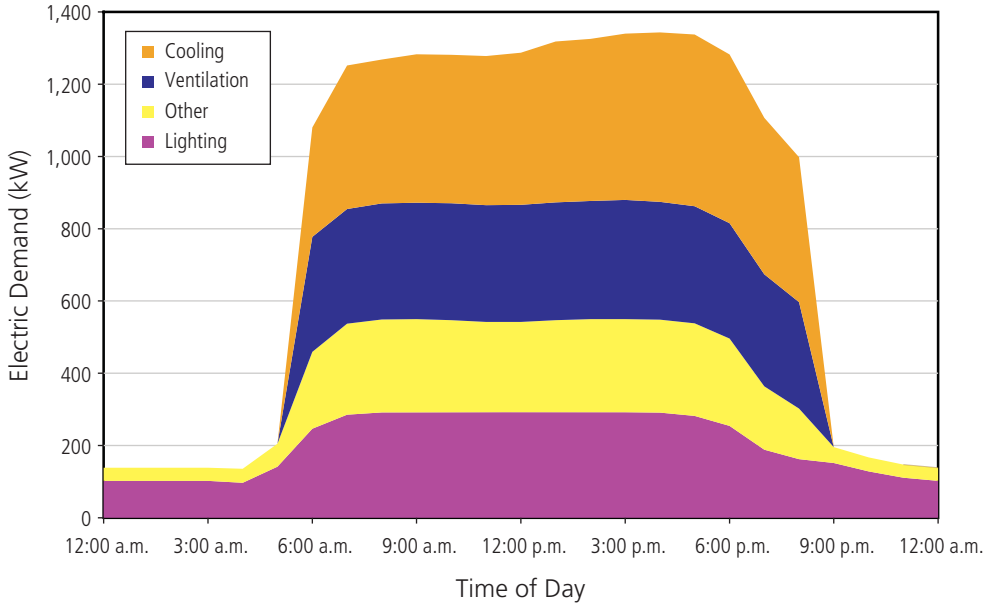
1. O&M and re-commissioning (representing the low- and no-cost energy efficiency opportunities). Cost-effective lighting upgrade measures.
2. Comprehensive HVAC system improvements.
3. A full suite of upgrade measures, including O&M, lighting, and HVAC.

Figure 3-2 shows a sample load profile for the same office building, following a full suite of upgrade measures.

Figure 3-1. Typical Office Building: Load Profile, Baseline Scenario

Assumptions

- High-rise office building
- 250,000 square feet
- Centrifugal chiller/gas-fired hot water boiler
- 7:00 a.m.–7:00 p.m., Mon–Fri; 8:00 a.m.–2:00 p.m., Sat
- Chicago, Illinois
- Typical summer day

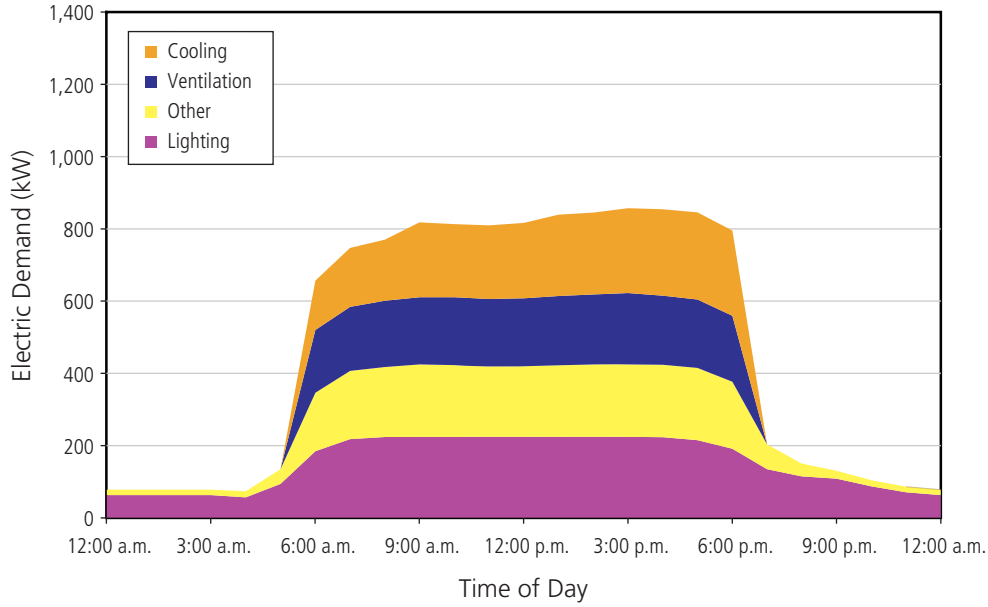


Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool.

Figure 3-2. Typical Office Building: Load Profile with All Measures

Measure List

- O&M/re-commissioning measures: optimize temperature setpoints, HVAC scheduling, ventilation, etc.
- Lighting measures: high-performance T8s/T5s, compact fluorescents, occupancy sensors, perimeter daylighting controls, etc.
- HVAC measures: high-efficiency chillers, variable-speed pumps and fans, premium efficiency motors, etc.



Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool.

Implementing the full set of efficiency measures reduced total energy use by 30 percent and reduced peak demand by an even greater percentage.

For each sector, the individual efficiency measures that made up the various upgrade strategies were specific to the space type being modeled (e.g., occupancy-based guest room HVAC controls for hotels versus evaporator fan controls for walk-in coolers in supermarkets), with a focus on reducing consumption during the peak summer months. In addition to the eQUEST modeling, each sample building was entered into EPA's Portfolio Manager benchmarking tool in order to track the relative improvement in the 1 to 100 energy performance rating that would result from the various upgrade strategies.[1]

Table 3-1 shows the results for each type of building; for a complete description of the modeling results for each sector, refer to Appendix B.

Across all property types, applying the full suite of efficiency measures significantly reduced electricity consumption, gas consumption, and peak demand compared to the baseline. The modeling revealed that no- and low-cost O&M measures alone can account for a sizable portion of a property's overall savings and demand reduction. O&M measures also account for a significant part of the jump in each building's EPA energy performance rating, which grew 17 to 46 points over the baseline ratings. Importantly, the EPA rating reflects savings expected over 12 months for the whole

Table 3-1. Summary of Energy Savings by Building Type and Upgrade Measures

	Upgrade Measures	Electricity Savings (%)	Gas Savings (%)	Energy Savings (%)	Peak Demand Savings (%)	Energy Cost ($)	Energy Savings ($)	EPA Energy Rating
Office (250,000 ft²)	Baseline	—	—	—	—	$598,049	—	59
	O&M only	16%	25%	20%	8%	$490,035	$108,014	74
	Lighting only	10%	-3%	4%	8%	$559,788	$38,261	65
	HVAC only	21%	-5%	9%	27%	$515,895	$82,154	72
	All measures	41%	17%	30%	36%	$392,768	$205,281	88
Hotel (180,000 ft²)	Baseline	—	—	—	—	$351,957	—	44
	O&M only	10%	10%	10%	6%	$316,249	$35,708	59
	Lighting only	21%	-12%	3%	19%	$317,787	$34,170	61
	HVAC only	23%	-1%	9%	23%	$300,991	$50,966	68
	All measures	45%	4%	22%	42%	$243,256	$108,701	90
Supermarket (45,000 ft²)	Baseline	—	—	—	—	$342,750	—	66
	O&M only	4%	40%	9%	3%	$322,211	$20,538	71
	Lighting only	7%	-30%	2%	11%	$327,279	$15,471	71
	HVAC only	1%	0%	1%	4%	$340,042	$2,707	67
	All measures	16%	10%	15%	21%	$288,215	$54,535	83
Retail (30,000 ft²)	Baseline	—	—	—	—	$55,261	—	41
	O&M only	14%	32%	24%	10%	$44,479	$10,782	57
	Lighting only	28%	-27%	5%	25%	$46,861	$8,399	57
	HVAC only	4%	0%	2%	12%	$53,770	$1,491	43
	All measures	42%	14%	30%	41%	$35,729	$19,532	75

Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool.

building, taking into account the interaction among building systems. For example, while lighting retrofits can result in large electricity savings, the simultaneous reduction in internal heating loads may require greater consumption of natural gas for heating during the winter months. The increased energy performance ratings account for this interaction and demonstrate that the net result is nevertheless substantial savings in energy and cost.

3.2 Value of Proper Sequencing

The order in which energy efficiency measures are implemented affects overall savings. In the "Good" upgrade sequence in Table 3-2 below, the building operator replaces HVAC equipment before completing other improvements. This sequence was titled "Good" because it includes comprehensive improvements at the facility. A "Better" sequence consists of implementing O&M upgrades before HVAC equipment replacement, and the "Best" sequence includes O&M and lighting upgrades before changing out HVAC equipment.

Modeling results demonstrate that a building's required cooling capacity can be reduced by 1 to 11 percent due to O&M measures alone, and by 3 to 20 percent when cost-effective lighting measures follow O&M but precede HVAC upgrades. In other words, if a building owner or manager is interested in upgrading HVAC equipment as part of a comprehensive energy efficiency overhaul, it is wise to begin with O&M and lighting upgrades. The resulting reduction in cooling load can decrease the size of the HVAC equipment needed and therefore the installation costs. The cost savings associated with reduced equipment capacity are highly variable, depending on factors such as equipment type, equipment efficiency, and the building's geographic location. However, it is reasonable to expect savings of about $350 to $650 for every ton of cooling avoided. Using these assumptions, the "Best" scenario described above can result in first cost savings ranging from $3,500 to $24,700. If a facility replaces HVAC equipment before implementing O&M and lighting measures, however, it will not realize this right-sizing opportunity.

Table 3-2. The Impact of Sequencing on Energy Efficiency Upgrades

	Sequence of Upgrade Measures	1st Upgrade	2nd Upgrade	3rd Upgrade	Cooling Capacity (Tons)	Reduction in Cooling Capacity (%)
Office (250,000 ft²)	Good:	HVAC	O&M	Lighting	760	0%
	Better:	O&M	HVAC	Lighting	752	1%
	Best:	O&M	Lighting	HVAC	722	5%
Hotel (180,000 ft²)	Good:	HVAC	O&M	Lighting	457	0%
	Better:	O&M	HVAC	Lighting	450	2%
	Best:	O&M	Lighting	HVAC	445	3%
Supermarket (45,000 ft²)	Good:	HVAC	O&M	Lighting	95	0%
	Better:	O&M	HVAC	Lighting	92	3%
	Best:	O&M	Lightinwg	HVAC	85	11%
Retail (30,000 ft²)	Good:	HVAC	O&M	Lighting	70	0%
	Better:	O&M	HVAC	Lighting	62	11%
	Best:	O&M	Lighting	HVAC	56	20%

Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool.

In addition to the first cost reductions derived from right-sizing HVAC equipment, proper sequencing is also likely to result in whole-building energy consumption savings. HVAC systems operate most efficiently when their cooling capacity matches the cooling load of the building. In situations where the cooling equipment is oversized, a building will operate with a lower efficiency than expected. Part-load efficiency is determined by the particular HVAC equipment being used, with energy savings from right-sizing expected to be greater for packaged rooftop units than for central chillers. Savings are difficult to predict with energy modeling, and actual savings from right-sizing have not been widely documented. The Consortium for Energy Efficiency document Guidelines for Energy-Efficient Commercial Unitary HVAC Systems claims that the efficiency of oversized packaged rooftop units "can drop by up to 50 percent due to part-load operation and excessive short cycling."[2] For chiller systems, a case study by CRC Construction Innovation found whole-building energy savings up to 4.3 percent resulting from right-sizing.[3]

3.3 Notes

1. Those facilities that achieve a score of 75 or higher in EPA's Portfolio Manager are eligible for the ENERGY STAR label, indicating that they are among the top 25 percent of facilities in the country for energy performance. See <www.energystar.gov/benchmark>.

2. Consortium for Energy Efficiency (2001). Guidelines for Energy-Efficient Commercial Unitary HVAC Systems. p. 4.

3. Thomas, P.C., and S. Moller (2007). HVAC System Size: Getting It Right—Ri*ght-Sizing HVAC Systems in Commercial Systems*. Cooperative Research Centre for Construction Innovation. p. 11.

4: Key Findings

Several important findings emerged from the June workshop and other activities during the first phase of the Sector Collaborative. These findings are discussed below.

- **Opportunities for substantial cost-effective energy savings exist across the sectors represented in the Sector Collaborative: hospitality, retail, commercial real estate, grocery, and municipalities.**

  The energy use and savings profiles document the potential for buildings in each of these sectors. Discussions among the Design Team members and during the June workshop confirm that building owners and operators recognize this potential and many have found ways to cost-effectively tap it.

- **A focus on whole-building energy consumption is critical to benchmarking, allowing building owners and operators to identify efficiency opportunities and measure progress.**

  A whole-building approach accounts for interaction among various building systems and across fuel types, allowing for the tracking of actual building performance over time and providing the clearest indication of a property's environmental impact.

  Sector Collaborative participants suggested that utility programs will need to progress beyond their traditional focus on specific technologies in order to embrace a whole-building approach to energy efficiency. By providing incentives for technology-focused energy efficiency projects, utility programs as currently structured may lead end-users to overlook the complex interaction of building systems.

- **Lack of readily available, consistent utility data hinders benchmarking and other energy management efforts.**

  Sector Collaborative participants pinpointed utility data availability and consistency as a major determinant of energy efficiency program success. They recognize the value of continuously benchmarking and tracking their buildings' energy performance improvements. To achieve this, they need access to utility data on a timely, ongoing, and consistent basis, in a standardized electronic format. This issue is especially important for utility customers with properties spread across a variety of utility territories, as well as for customers with multiple properties in a single service territory.

- **Focusing on operations and maintenance is a cost-effective first step to achieving efficiency improvements and saving energy.**

  Building owner/operators—and utilities—often overlook the savings potential from O&M and re-commissioning, due in part to the widespread misconception that improved energy efficiency requires substantial capital investment. As demonstrated through the energy use and savings profiles, however, and as recognized by Sector Collaborative participants, O&M measures can deliver significant "early wins" at low cost. By leveraging and communicating these early achievements, building operators also increase the likelihood of gaining the upper-level corporate commitment that is crucial to the continued success of an energy efficiency program.

- **There is a need for sector-based forums to facilitate the sharing of best practices.**

  Sector Collaborative participants valued the forum that the June workshop provided to share their experiences and learn from others, and would like more opportunity for this type of information exchange.

- **Guidelines for procurement and bulk purchasing of energy-efficient products and services would help both public and private organizations carry out efficiency programs.**

  In some cases, organizations do not have access to reliable information about the relative efficiency of products or the value of energy efficiency services; in addition, efficient products and services may have high up-front costs when purchased in small quantities. Guidelines on how best to procure efficient products and services would help organizations achieve greater efficiency at lower cost. The lack of guidelines or standards is particularly acute for grocers seeking to purchase refrigerated cases, as there is no standardized measure of efficiency for these products.

5: Sector Commitments

During the June Sector Collaborative workshop and in the months following, the participating end-user sectors and utilities drew upon the discussion of barriers to energy efficiency as well as the energy savings profiles to formulate a series of actionable commitments and next steps for advancing the goals of the Action Plan. Each of the organizations signing on to a sector commitment agrees to undertake one or more of the initiatives listed below.

- Reduce energy consumption substantially over the coming years (goals range from 10 to 30 percent).
- Conduct energy benchmarking for all properties above 5,000 square feet.
- Implement all cost-effective strategies to improve energy efficiency.
- Create and/or increase energy efficiency education and awareness within and outside each organization.
- Pursue bulk purchasing of energy-efficient products and services.
- Support expanded efficiency program offerings across states and utilities.
- Support development of standardized electronic utility billing data access by large customers for benchmarking.
- Explore energy efficiency programs offered by federal, state, and local agencies and sector-based associations.

To date, several organizations have made sector commitments, including:

- Advantage IQ
- Arlington County, Virginia
- City of Aurora, Colorado
- Building Owners and Managers Association (BOMA) International
- Costco Wholesale
- City of Denver, Colorado
- Food Lion, LLC
- City of Indianapolis, Indiana
- King County, Washington
- Louisville Metro Government, Kentucky
- City of Medford, Massachusetts
- National Association of State Energy Officials (NASEO)
- San Miguel County, Colorado
- City of Somerville, Massachusetts
- Stop and Shop/Giant Foods
- Town of Mountain Village, Colorado
- Whole Foods Market

Moving forward, the U.S. Environmental Protection Agency, U.S. Department of Energy, Edison Electric Institute, and American Gas Association will bring together expertise across existing programs to support the implementation of these recommendations.

The sector-based commitment documents are included in full in Appendix C.

A complete list of all public statements of support and commitments to the Action Plan can be viewed online at <www.epa.gov/eeactionplan>.

6: Summary and Next Steps

The accomplishments from the first phase of the Sector Collaborative demonstrate the value of this National Action Plan initiative. The introduction to this paper laid out the five objectives of the Sector Collaborative:

- Explore the barriers to cost-effective energy efficiency.
- Document how energy savings are valuable investments for participating sectors.
- Identify tools needed for implementation and evaluation of cost-effective energy efficiency measures.
- Provide peer exchange opportunities to share approaches to effective energy efficiency programs.
- Identify and pursue new commitments and partnerships to increase investment in energy efficiency.

The results of the first phase of the Sector Collaborative address these objectives as follows:

- The comprehensive list of barriers to energy efficiency reflected the consensus of end-use sectors, forming the basis of a productive and ongoing discussion between these end-users and their utility providers.
- Sector Collaborative participants recognized the value of energy use benchmarking as an indispensable first step to improving efficiency, and acknowledged a clear need for consistency in the provision of utility billing data in order to ensure the widespread uptake of benchmarking.
- The sector-based energy profiles demonstrated to end-users and utilities the peak demand and consumption savings potential of a comprehensive approach to energy efficiency upgrades. By examining the impacts of various system upgrades, these profiles also illustrated the interdependence of building systems and highlighted the need for building owners and operators to take a whole-building approach to energy efficiency. Furthermore, the importance of a staged approach to efficiency upgrades—including an initial focus on O&M—helped to dispel the myth that technology alone guarantees energy performance.
- The Sector Collaborative meeting provided a forum where participants could exchange lessons learned and best practices within and across sectors. As a direct output of this networking opportunity, the participants have already agreed on a number of actionable commitments.

Several other activities could increase the Sector Collaborative's value in achieving the Action Plan goal of creating a sustainable, aggressive national commitment to energy efficiency. These include:

- Engaging additional organizations within the initial five sectors.
- Creating working groups, developing materials, and undertaking other actions to help the existing organizations achieve success.
- Exploring new sectors that could benefit from the Sector Collaborative.
- Continuing dialogue between end-users and utilities on programs to advance cost-effective energy efficiency.

The Design Team and supporting organizations will consider these next steps in the coming months, and bring forward a proposal to the Action Plan Leadership Group for review. In the near term, the Sector Collaborative will build on the results and findings to date, and continue to work with participants and interested parties to drive investment in cost-effective energy efficiency.

Appendix A: Final Agenda from the June 27–28, 2007, Sector Collaborative Workshop

Sector Collaborative on Energy Efficiency Summer Workshop

June 27–28, 2007

Edison Electric Institute
701 Pennsylvania Avenue, NW
Washington, DC

Agenda

Background

Recognizing the large untapped environmental, economic, and energy security benefits of energy efficiency, more than 50 leading organizations from across the country joined together in 2006 to develop the National Action Plan for Energy Efficiency. The Action Plan provides five key recommendations for capturing all cost-effective energy efficiency in the country over the coming years. The Sector Collaborative, a new initiative under the Action Plan, is designed to engage a broader set of stakeholders in this critical effort and help them find new opportunities for leadership in energy efficiency. The Sector Collaborative is coordinated by the American Gas Association, the Edison Electric Institute, the U.S. Environmental Protection Agency, and the U.S. Department of Energy.

The Sector Collaborative workshop will explore the extent of savings available through cost-effective energy efficiency and approaches to effective energy efficiency programs. It will offer the opportunity for organizations to make new commitments to increase investment in energy efficiency and be recognized nationally for leadership. To learn more about the Action Plan and Sector Collaborative, and to find out who has already made an energy efficiency commitment, visit <www.epa.gov/cleanenergy/actionplan>.

Who Should Attend:

- Executives and energy managers in the commercial real estate, grocery, hospitality, retail, and municipal sectors
- Electric and gas utility program managers
- Others who can play a key role in advancing energy efficiency in the sectors listed above

Workshop Purpose:

- Identify the tools and resources participants need to overcome barriers to increased use of energy efficiency in their organizations
- Feature innovative energy efficiency technologies, financing, products, services, programs, and best practices
- Promote peer exchange on energy efficiency
- Encourage voluntary development of efficiency commitments
- Discuss future national recognition opportunities available to Collaborative participants
- Learn how to communicate your success

DAY 1: June 27, 2007

12:00 pm	**Registration**	
1:00–1:20	**I. Opening Remarks** – Overview of Sector Collaborative and how it relates to Year Two of the Action Plan, EEI's National Accounts Program, other initiatives, and nationwide energy needs – Acknowledgement of participants' commitment to energy efficiency – Discussion of benefits of energy efficiency for commercial sector and municipalities	**Speakers:** **Kathleen Hogan,** Director, Climate Protection Partnerships Division, EPA **Diane Munns,** Executive Director, Retail Services Group, Edison Electric Institute
1:20–1:35	**II. Introductions & Meeting Purpose** – Participant introductions – Review meeting purpose & agenda	**Abby Arnold,** RESOLVE
1:35–1:50	**III. Introduction to the Sector Collaborative & Design Team Activities** – Who/what is the Design Team – Overview of identified barriers to energy efficiency – Outlines for proposed case studies on best practices – Overview of sector energy use profiles	**Cindy Jacobs,** EPA
1:50–3:15	**IV. Energy Efficiency IS in Your Budget** *(Panel and Facilitated Discussion)* – Green buildings that don't break the budget/design solutions to increasing energy efficiency – Can you finance energy efficiency improvements? What options exist and will they work for you? *Q & A with Workshop Participants* – What innovative financing mechanisms have you used for energy efficiency projects? – What is needed to help you accomplish your efficiency goals? What is really challenging you? – In an ideal world, what elements of a financial model would you like to see?	**Kara Strong,** AIA, LEED AP, Senior Project Manager, Sustainable Design Consulting **Leslie Hoffman,** Executive Director, Earth Pledge **Joseph McGee,** Vice President, Public Policy and Programs, Business Council of Fairfield County, CT

3:15–3:30	**V. Overview of Sector Breakout Sessions** – Purpose and goals for sector breakout sessions	**Abby Arnold,** RESOLVE
3:30–3:45	**Break and Move to Breakout Sessions** (Three concurrent breakout sessions will run with the following sector groupings: **grocery/ retail, commercial real estate/ hospitality, and municipality.**)	
3:45–5:00	**VI. Sector Breakout Group Discussions** (See Sector Breakout Outline handout for agenda)	
5:00–5:15	**Break and Return to Plenary**	
5:15–6:00	**VII. How Buildings Measure Up: Benchmarking Energy Use** (Presentation and Facilitated Discussion) – Value of benchmarking to building owners and managers and opportunities to enable increased benchmarking – Overview of proposed Sector Collaborative activities on benchmarking, including proposed pilot projects to address barriers – Proposal for recommended best practices for utilities for providing a set of standard energy use data to customers – Facilitated Discussion with Workshop Participants – Have we identified the primary challenges to increasing benchmarking? – Do you have any comments on the recommended set of best practices for providing standard energy use data to utility customers? – Are you interested in participating in any of these pilot projects?	**Tracy Narel,** EPA **Gina Rye,** Energy Manager, Food Lion
6:00–7:30	**Reception and Networking at EEI**	

DAY 2: June 28, 2007

8:00–8:30	**Breakfast**	
8:30–8:35	**VIII. Overview of Day** (Plenary)	**Abby Arnold,** RESOLVE
8:35–10:00	**IX. Emerging Energy Efficiency Technologies** (Presentation and Discussion) – Examples of key technologies that could benefit energy efficiency efforts ▪ What is the state of the shelf technologies that can help you meet energy efficiency goals? ▪ Advances in modeling that help you understand your energy use and how changes will help you save dollars—before any decisions are made ▪ Cutting-edge emerging technologies that will available soon or in the near future to further advance energy savings ▪ Overview of the latest in smart grid technology, along with a discussion of the technologies and applications Pepco is currently exploring – Facilitated Discussion: An opportunity for Design Team members to discuss new technology applications and participants to better understand various applications.	**Dr. Chuck Eastman,** Professor, Colleges of Architecture and Computing; Director, College of Architecture Ph.D. Program, Georgia Institute of Technology **Drury B. Crawley,** Acting Team Leader, Commercial Buildings R&D, U.S. DOE **Jeff Harris,** Vice President for Programs, Alliance to Save Energy **George Potts,** Vice President for Business Transformation, Pepco
10:00–10:15	**X. Review of Day Two Sector Breakout Session Agenda and Goals**	**Abby Arnold,** RESOLVE
10:15–10:30	**Break and Move to Breakout Sessions**	
10:30–12:00	**XI. Sector Breakout Group Discussions** Continued from Day 1 (See Sector Breakout Outline handout for agenda)	
12:00–1:00	**Break for Lunch**	

1:00–2:15	**XII. Results from Breakout Sessions—Return to Plenary** (Reports from each Sector Breakout Discussion) – Identification of barriers and how sectors have identified opportunities for overcoming them to make specific energy efficiency commitments. – Is there interest in pursuing bulk purchasing and ensuring methods of information sharing on emerging technologies? – You have heard presentations on specific case studies—which ones will help the most and should be developed further? – What else do your organizations need to make commitments? What is the timeline for making commitments?	
2:15–2:45	**XIII. Closing Speaker Observations/Reflections and Q&A**	**Roger Cooper,** Executive Vice President, Policy & Planning, American Gas Association **David Rodgers,** Deputy Assistant Secretary for Energy Efficiency, U.S. DOE
2:45–3:00	**XIV. Final Remarks, Next Steps, Thank You**	**Abby Arnold,** RESOLVE
3:00	**Adjourn**	

Appendix B: Energy Use Profiles

B.1 Office Building Energy Use Profile

It has been estimated that as much as 30 percent of the energy consumed in office buildings is wasted. This suggests a significant opportunity for energy use reduction, cost savings, and the mitigation of greenhouse gas emissions through cost-effective energy efficiency opportunities. To help identify the best opportunities, both from the perspective of the building owner and the utility, it is important to examine how, where, and when energy is used and the savings are likely to occur.

This profile first provides high-level energy consumption and cost metrics for the office building sector. Next, it presents representative daily load shapes for a typical office building; one of these load shapes reflects a baseline building scenario, while the others represent the same building following the implementation of a package of cost-effective energy efficiency measures. Finally, these building scenarios are benchmarked with EPA's energy performance rating system in order to demonstrate the relationship between energy use and the 1-to-100 rating.

Average Energy Consumption, Cost, and End-Use Figures

Across the United States, the average annual energy intensity for office buildings is 79.8 kBtu per square foot and the average cost is $1.65 per square foot. Of the total energy consumption, 66 percent is for electricity and 34 percent is for natural gas and other fuels (see Figure B-1). This translates to 15.5 kWh per square foot of electricity and 0.27 therms per square foot of natural gas (see Table B-1).

As shown in Figure B-2, space conditioning and lighting together account for 70 percent of all energy consumed in a typical office building, with an additional 20 percent of energy consumption used to power office equipment. The remaining energy is consumed by water heating, cooking, and refrigeration systems, as well as other miscellaneous uses.

Daily Load Shape

Load Shape—Baseline Scenario: Figure B-3 represents a baseline scenario for daily operations at a typical office building on a summer weekday. This load profile illustrates the contributions of lighting, cooling, ventilation,

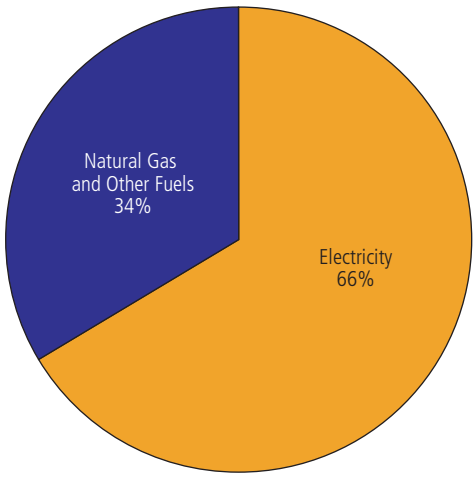
Table B-1. Typical Office Building: Annual Energy Consumption per Square Foot

	Consumption per Square Foot (Billing Units)	Energy Use Intensity ($kBtu/ft^2$)
Electricity	15.5 kWh/ft^2	53.0
Natural gas	0.27 $therms/ft^2$	26.8
Total		79.8

Source: Based on EPA analysis of data from the Energy Information Administration's 2003 Commercial Building Energy Consumption Survey.

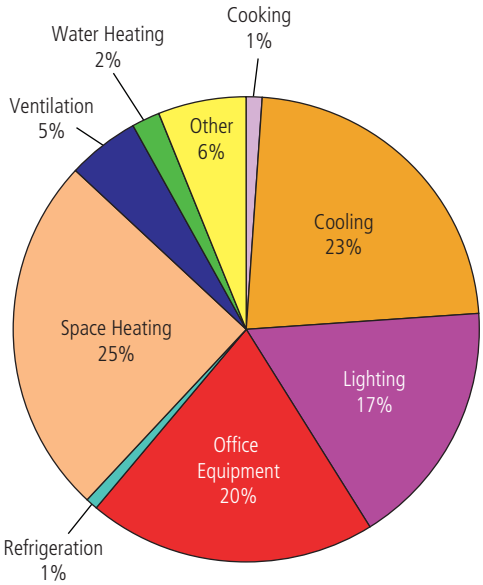
Note: For the purposes of illustration, all non-electric energy consumption has been converted to the equivalent consumption of natural gas. Other fuels may include oil, steam, and propane.

Figure B-1. Typical Office Building: Energy Consumption by Fuel Type



Source: Based on EPA analysis of data from the Energy Information Administration's 2003 Commercial Building Energy Consumption Survey.

Figure B-2. Typical Office Building: Total Energy Consumption by End Use

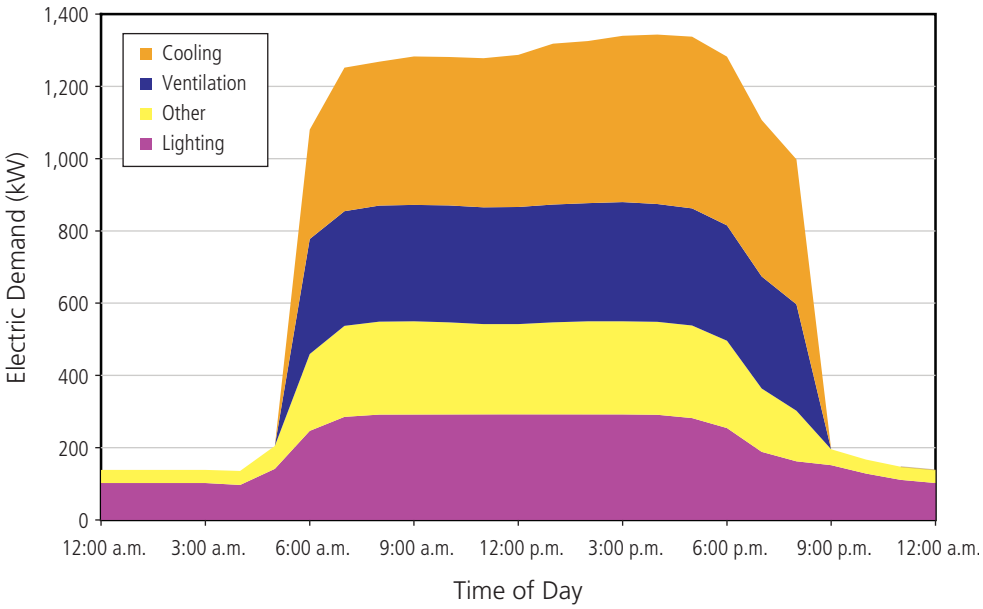


Source: Adapted from E Source (2006). Commercial Energy Advisor. Online at <http://www.esource.com/BEA/hosted/PDF/CEA_offices.pdf>.

Figure B-3. Typical Office Building: Load Profile, Baseline Scenario

Assumptions

- High-rise office building
- 250,000 square feet
- Centrifugal chiller/gas-fired hot water boiler
- 7:00 a.m.–7:00 p.m., Mon–Fri; 8:00 a.m.–2:00 p.m., Sat
- Chicago, Illinois
- Typical summer day



Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool.

and other loads throughout the day. Total building energy consumption in offices ramps up quickly in the morning as building systems are brought online to prepare the property for occupancy. Once systems are online, demand is relatively steady throughout the day. As the working day draws to a close, building systems are taken offline and the resulting electricity load drops accordingly.

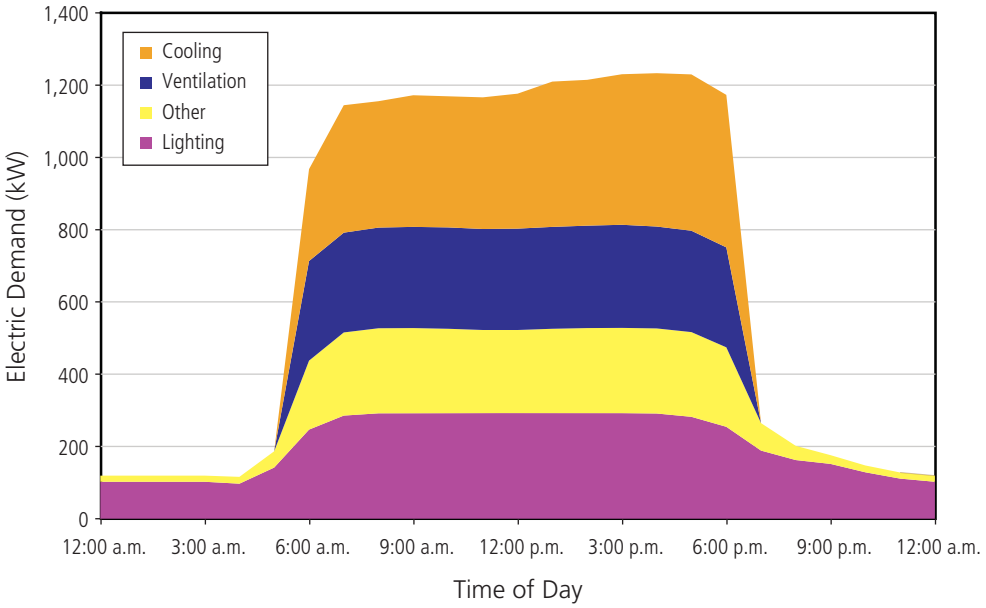
With Efficiency Measures: Figures B-4 through B-7 illustrate the typical office building after the implementation of four different energy efficiency upgrade scenarios: enhanced operations and maintenance (O&M)/re-commissioning, lighting upgrades, HVAC upgrades, and a "full package" of all three improvement categories. The upgrade scenarios consist of conventional energy efficiency measures, with a focus on measures that reduce energy consumption during the peak summer months. O&M or re-commissioning measures generally represent low- or no-cost opportunities that should be a first step in energy management efforts. Lighting measures require capital investment, but have a relatively low simple payback. The HVAC measures include more comprehensive equipment upgrades.

The load profile after the implementation of O&M measures (Figure B-4) shows the greatest savings at the beginning and end of the work day due to the shortening of HVAC schedules. It also shows a reduction in peak demand from temperature setpoint changes, and a reduction in overnight energy consumption from turning off unnecessary lights and equipment. The lighting measures result in savings during the work day as a result of more efficient lighting technologies, and savings overnight from lighting controls (Figure B-5). The HVAC measures reduce peak cooling demand as a result of high-efficiency chillers and variable-speed drives (Figure B-6). When all measures are taken together, the total reduction in peak demand for this building on a typical summer day is 487 kW, or 36 percent of the baseline (Figure B-7).

Figure B-4. Typical Office Building: Load Profile with Operations and Maintenance/Re-commissioning Measures

Measure List

- Optimize temperature setpoints
- Optimize HVAC scheduling
- Optimize ventilation to minimum required for code
- Implement chilled water reset controls
- Implement janitorial best practices
- Enable power management for PCs, printers, and copiers
- Turn off plug loads at night
- Specify ENERGY STAR® equipment—office equipment, vending machines

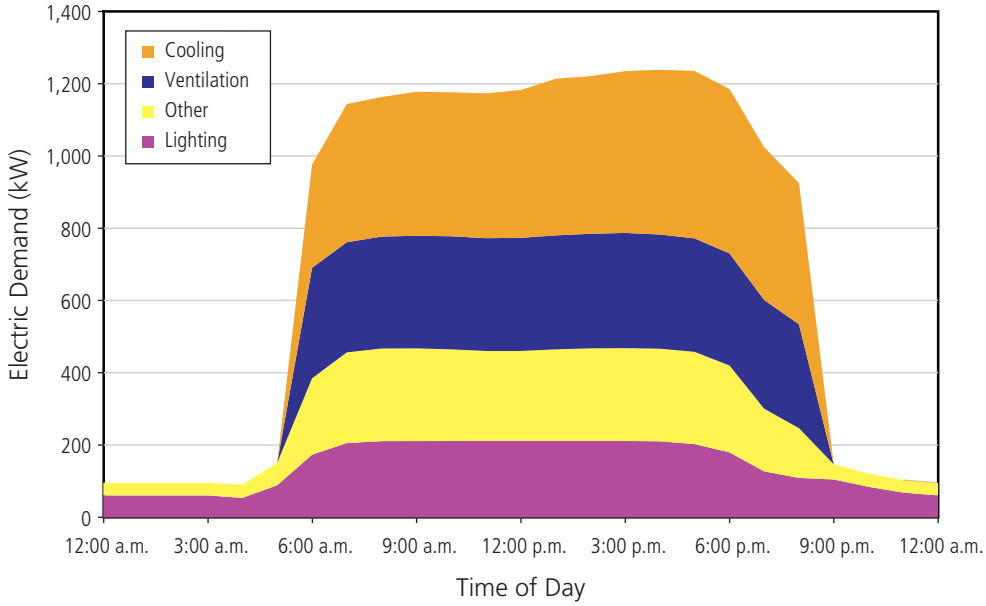


Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool.

Figure B-5. Typical Office Building: Load Profile with Lighting Measures

Measure List

- Efficient lighting (high-performance T8s/T5s, compact fluorescents, LED exit signs)
- Occupancy sensors
- Perimeter daylighting controls

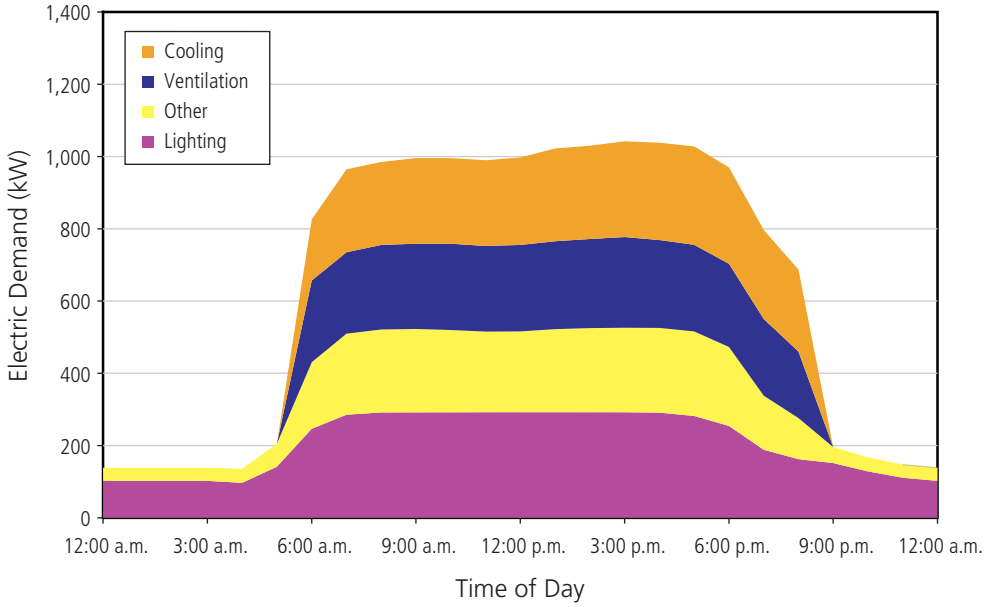


Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool.

Figure B-6. Typical Office Building: Load Profile with HVAC Measures

Measure List

- High-efficiency chillers
- Variable-speed pumps and fans
- Premium efficiency motors

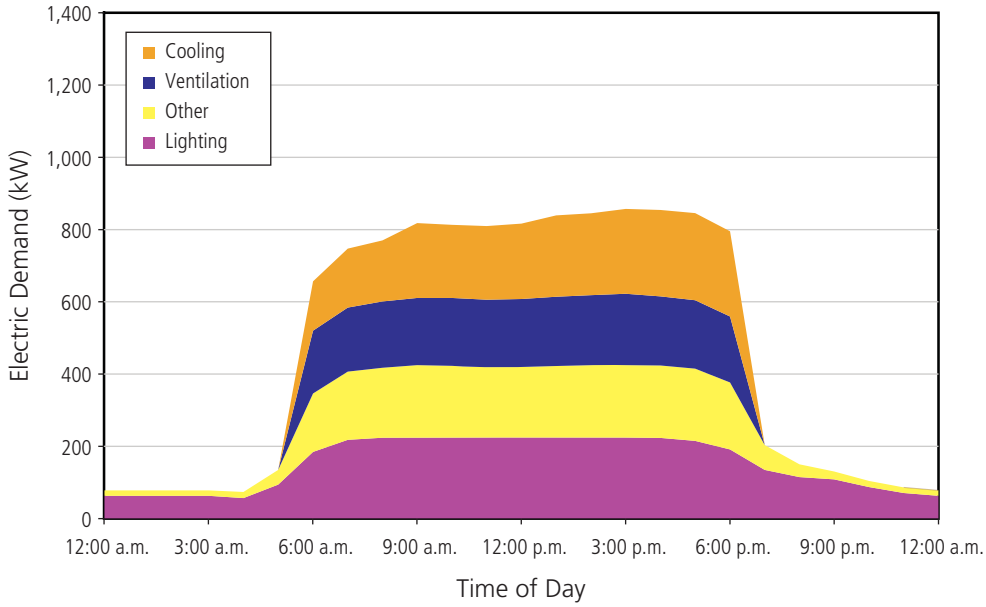


Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool.

Figure B-7. Typical Office Building: Load Profile with All Measures

Measure List

- Includes all O&M/ re-commissioning measures
- Includes all lighting measures
- Includes all HVAC measures



Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool.

On an annual basis, the savings from the full package of measures results in a reduction in energy intensity of 35 kBtu per square foot, or 30 percent of the baseline. This translates to $205,281 per year at national average utility rates of $0.094 per kWh and $1.16 per therm.[1]

Impact of Sequencing: When undertaking comprehensive energy efficiency improvements, implementing measures in the proper sequence can reduce the required capacity of the HVAC equipment. Table B-2 illustrates the necessary size of the HVAC equipment when installed at different points in a comprehensive upgrade process. In the first scenario, the building operator replaces HVAC equipment before completing other improvements. This scenario is called "Good" because the operator is undertaking comprehensive improvements at the facility. A "Better" scenario consists of implementing O&M upgrades before HVAC equipment replacement, and the "Best" scenario includes upgrading O&M and lighting before changing out HVAC equipment. Results demonstrate that an office building's required cooling capacity can be reduced by up to 5 percent when the operator implements HVAC measures after all other upgrades. Additional energy savings can often be achieved as well, due to more efficient operation of right-sized equipment.

Energy Performance Rating

The energy performance of each of these building scenarios can be benchmarked using EPA's energy performance rating system. This tool allows building owners and operators to enter building attributes and consumption data and obtain a 1-to-100 rating, normalized for weather and occupancy, which compares a given building to its peer group. In the baseline scenario, the property received a rating of 59. Factoring in the hypothetical energy efficiency measures that were applied to this building, the energy performance rating increased to 88.

Annual electric and natural gas savings, energy intensity savings, peak demand reductions, cost savings, and energy performance ratings for each of the energy efficiency measure scenarios are included in Table B-3.

Table B-2. Typical Office Building: Analysis of Sequencing Effects

Sequence of Upgrade Measures	1st Upgrade	2nd Upgrade	3rd Upgrade	Cooling Capacity (Tons)	Reduction in Cooling Capacity (%)
Good	HVAC	O&M	Lighting	760	0%
Better	O&M	HVAC	Lighting	752	1%
Best	O&M	Lighting	HVAC	722	5%

Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool.

Table B-3. Typical Office Building: Energy Savings Summary

Scenario	Electricity Use (kWh)	Electricity Savings (kWh)	Electricity Savings (%)	Natural Gas Use (Therms)	Natural Gas Savings (Therms)	Natural Gas Savings (%)	Annual Energy Intensity (kBtu/ft^2)	Energy Intensity Reduction (%)
Baseline	4,577,800	—	—	144,600	—	—	120	—
O&M	3,866,800	711,000	16%	109,100	35,500	25%	96	**20%**
Lighting	4,114,000	463,800	10%	149,200	-4,600	-3%	116	**4%**
HVAC	3,616,200	961,600	21%	151,700	-7,100	-5%	110	**9%**
All measures	2,700,000	1,877,800	41%	119,800	24,800	17%	85	**30%**

Scenario	Peak Demand (kW)	Demand Reduction (kW)	Demand Reduction (%)	Energy Cost ($)	Energy Savings ($)	EPA Energy Rating
Baseline	1,343	—	—	$598,049	—	**59**
O&M	1,233	110	**8%**	$490,035	**$108,014**	**74**
Lighting	1,239	105	**8%**	$559,788	**$38,261**	**65**
HVAC	983	360	**27%**	$515,895	**$82,154**	**72**
All measures	857	487	**36%**	$392,768	**$205,281**	**88**

Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool. EPA Energy Ratings calculated using EPA's Portfolio Manager tool.

Note: When calculating the EPA energy rating, assumptions entered into Portfolio Manager included 250,000 square feet, 625 occupants, 703 personal computers, and 66 hours of operation per week.

B.2 Hotel Energy Use Profile

Utility expenditures represent the fastest-growing operating cost for hoteliers (increasing by an average of 12 percent per year from 2004 to 2006)[2] and one of the largest controllable costs. There is a significant opportunity for energy use reduction, cost savings, and the mitigation of greenhouse gas emissions through cost-effective energy efficiency opportunities. To help identify the best opportunities, both from the perspective of the building owner and the utility, it is important to examine how, where, and when energy is used and the savings are likely to occur.

This profile first provides high-level energy consumption and cost metrics for the lodging sector. Next, it presents representative daily load shapes for a typical lodging property building; one of these load shapes reflects a baseline building scenario, while the others will represent the same building following the implementation of a package of cost-effective energy efficiency measures. Finally, these building scenarios are benchmarked with EPA's energy performance rating system in order to demonstrate the relationship between energy use and the 1-to-100 rating.

Average Energy Consumption, Cost, and End-Use Figures

Across the United States, the average annual energy intensity for hotels and motels is 87 kBtu per square foot and the average cost is $1.42 per square foot. Of the total energy consumption, 61 percent is for electricity and 39 percent is for natural gas and other fuels (see Figure B-8). This translates to 15.6 kWh per square foot of electricity and 0.34 therms per square foot of natural gas (see Table B-4).

As shown in Figure B-9, space conditioning, water heating, and lighting together account for almost 80 percent of all energy consumed in a typical lodging property. The remaining energy is consumed by cooking, office equipment, refrigeration, and other miscellaneous uses.

Breaking energy end-use down one step further shows that the major energy end-uses in hotels differ according to fuel type (see Figures B-10 and B-11). Of course, any individual building may have a different end-use breakdown than the typical building; for example, an all-electric building would have no natural gas consumption, and would have a breakdown of electricity use that would look similar to the total energy end-use breakdown in Figure B-9.

Daily Load Shape

Load Shape—Baseline Scenario: Figure B-12 represents a baseline scenario for daily operations at a typical hotel on a summer weekday. This load profile illustrates the contributions of lighting, cooling, ventilation, and other loads throughout the day. Total building energy consumption in hotels is highest in the evening, when most guests are in their rooms. Energy consumption

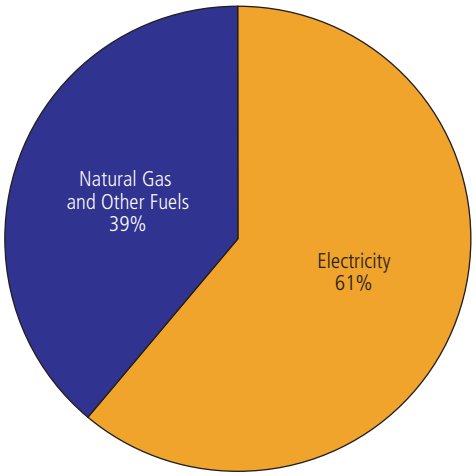
Table B-4. Typical Hotel: Annual Energy Consumption per Square Foot

	Consumption per Square Foot (Billing Units)	Energy Use Intensity (kBtu/ft^2)
Electricity	15.6 kWh/ft^2	53.2
Natural gas	0.34 therms/ft^2	33.8
Total		87.0

Source: Based on EPA analysis of data from the Energy Information Administration's 2003 Commercial Building Energy Consumption Survey.

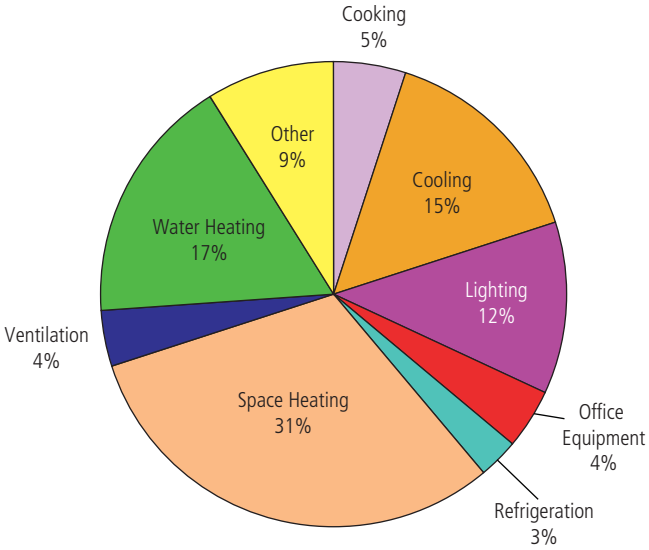
Note: For the purposes of illustration, all non-electric energy consumption has been converted to the equivalent consumption of natural gas. Other fuels may include oil, steam, and propane.

Figure B-8. Typical Hotel: Energy Consumption by Fuel Type



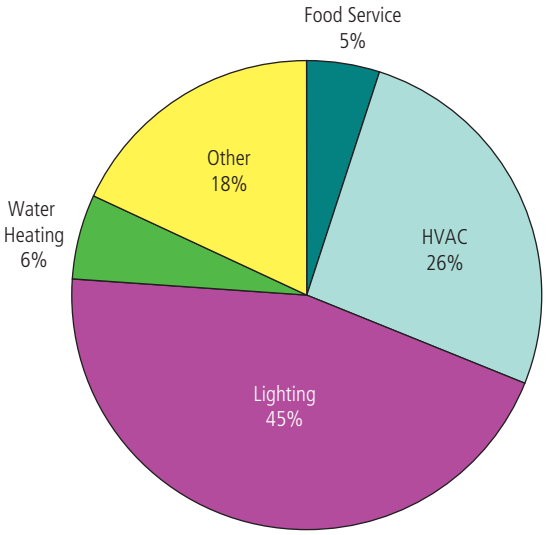
Source: Based on EPA analysis of data from the Energy Information Administration's 2003 Commercial Building Energy Consumption Survey.

Figure B-9. Typical Hotel: Total Energy Consumption by End Use



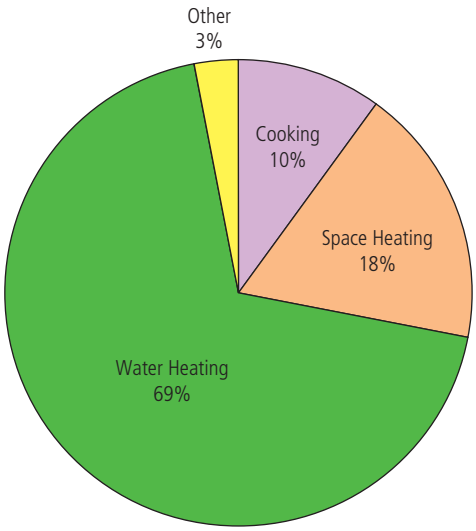
Source: Adapted from E Source (2006). Commercial Energy Advisor. Online at <http://www.esource.com/BEA/hosted/PDF/CEA_motels.pdf>.

Figure B-10. Typical Hotel: Electric Consumption by End Use



Source: Adapted from Edison Electric Institute (2001). *Managing Energy in Your Hotel.*

Figure B-11. Typical Hotel: Natural Gas Consumption by End Use



Source: Adapted from Edison Electric Institute (2001). *Managing Energy in Your Hotel.*

dips down overnight, when guests are sleeping, and during the day, when guests check out.

With Efficiency Measures: Figures B-13 through B-16 illustrate the typical hotel after the implementation of four different energy efficiency upgrade scenarios: enhanced O&M/re-commissioning, lighting upgrades, HVAC upgrades, and a "full package" of all three improvement categories. The upgrade scenarios consist of conventional energy efficiency measures, with a focus on measures that reduce energy consumption during the peak summer months. O&M or re-commissioning measures generally represent low- or no-cost opportunities that should be a first step in energy management efforts. Lighting measures require capital investment, but have a relatively low simple payback. The HVAC measures include more comprehensive equipment upgrades.

The load profile after the implementation of O&M measures (Figure B-13) shows savings for all end-uses throughout the day, due to a combination of controls adjustments and the specification of ENERGY STAR equipment. The lighting measures cause savings throughout the day as a result of more efficient lighting technologies, including many in areas of 24-hour operation, and savings during mid-day and overnight from lighting controls (Figure B-14). The HVAC measures reduce peak cooling demand as a result of high-efficiency chillers, variable-speed drives, and guest room controls (Figure B-15). When all measures are taken together, the total reduction in peak demand for this building on a typical summer day is 188 kW, or 42 percent of the baseline (Figure B-16).

On an annual basis, the savings from the full package of measures results in a reduction in energy intensity of 23 kBtu per square foot, or 22 percent of the baseline. This translates to $108,701 per year at national average utility rates of $0.094 per kWh and $1.16 per therm.[3]

Impact of Sequencing: When undertaking comprehensive energy efficiency improvements, implementing measures in the proper sequence can reduce the required capacity of the HVAC equipment. Table B-5 illustrates the necessary size of the HVAC equipment when installed at different points in a comprehensive upgrade process. In the first scenario, the building operator replaces HVAC equipment before completing other improvements. This scenario is called "Good" because the operator is undertaking comprehensive improvements at the facility. A "Better" scenario consists of implementing O&M upgrades before HVAC equipment replacement, and the "Best" scenario includes upgrading O&M and lighting before changing out HVAC equipment. Results demonstrate that a hotel's required cooling capacity can be reduced by up to 3 percent when the operator implements HVAC measures after all other upgrades. Additional energy savings can often be achieved as well, due to more efficient operation of right-sized equipment.

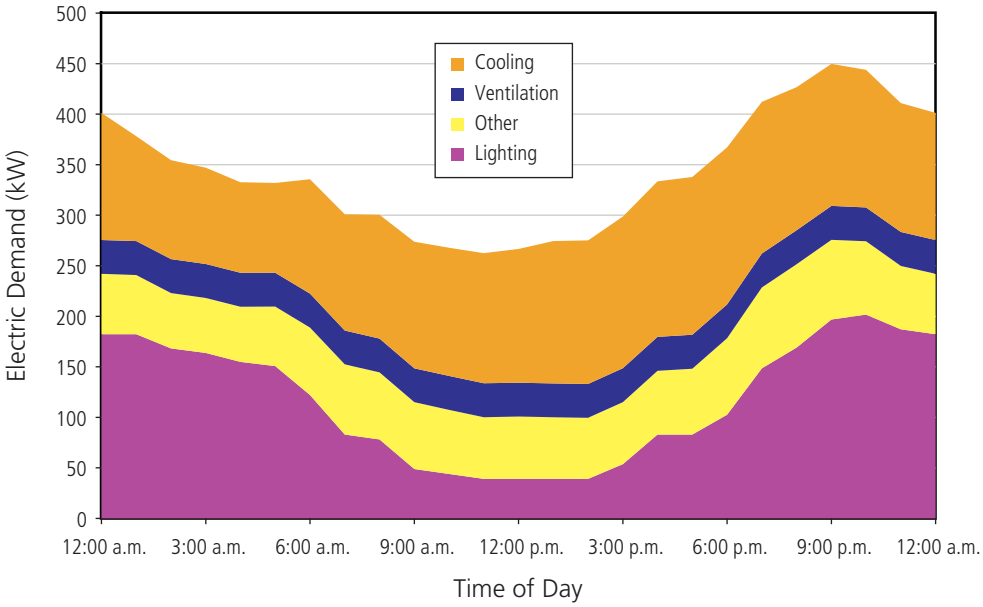
Energy Performance Rating

The energy performance of each of these building scenarios can be benchmarked using EPA's energy performance rating system. This tool allows building owners and operators to enter building attributes and consumption data and obtain a 1-to-100 rating, normalized for weather and occupancy, which compares a given building to its peer

Figure B-12. Typical Hotel: Load Profile, Baseline Scenario

Assumptions

- High-rise hotel
- 180,000 square feet
- Centrifugal chiller/ four-pipe fan coils with hot water heating
- Chicago, Illinois
- Typical summer day

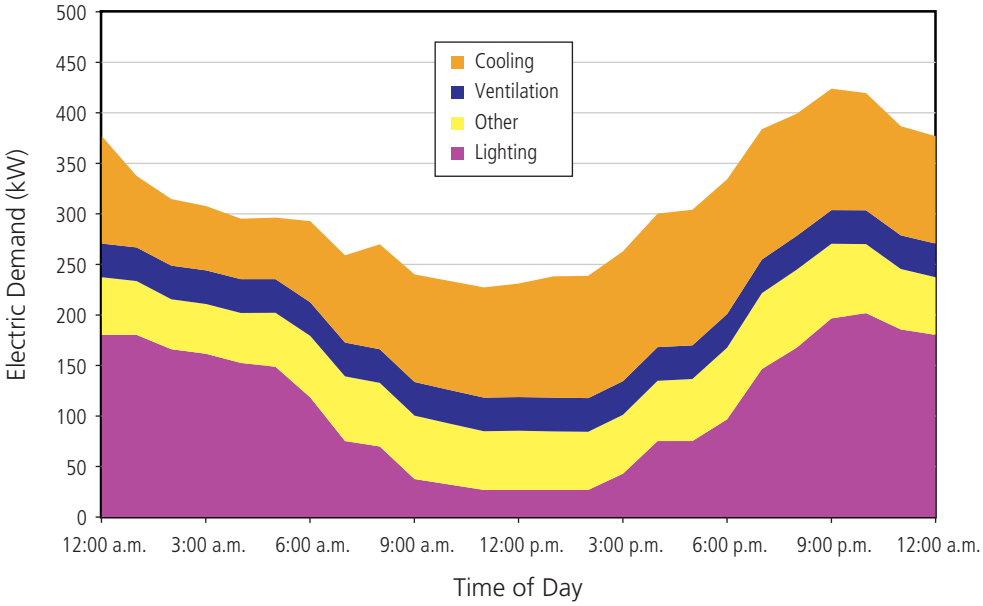


Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool.

Figure B-13. Typical Hotel: Load Profile with Operations and Maintenance/ Re-commissioning Measures

Measure List

- Optimize temperature setpoints in common areas
- Optimize HVAC scheduling in common areas
- Implement demand-controlled ventilation in common areas
- Enable power management for PCs, printers, and copiers
- Turn off plug loads at night
- Establish towel and linen re-use programs
- Specify ENERGY STAR equipment—vending, refrigerators, TVs, commercial food service equipment

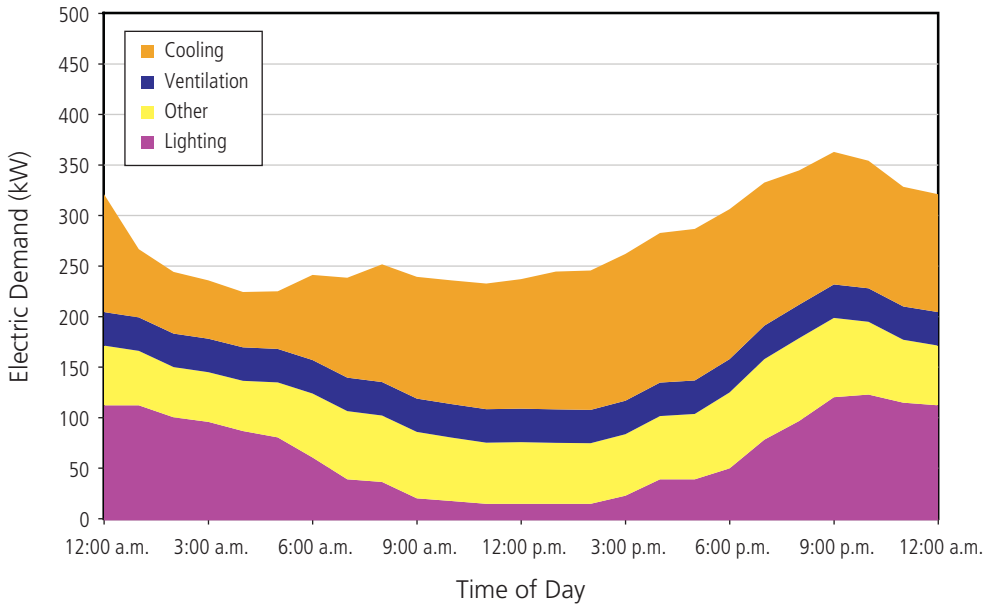


Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool.

Figure B-14. Typical Hotel: Load Profile with Lighting Measures

Measure List

- Efficient lighting (compact fluorescents, high-performance T8s, LED exit signs)
- Occupancy sensors (back rooms)
- Night lights in guest rooms

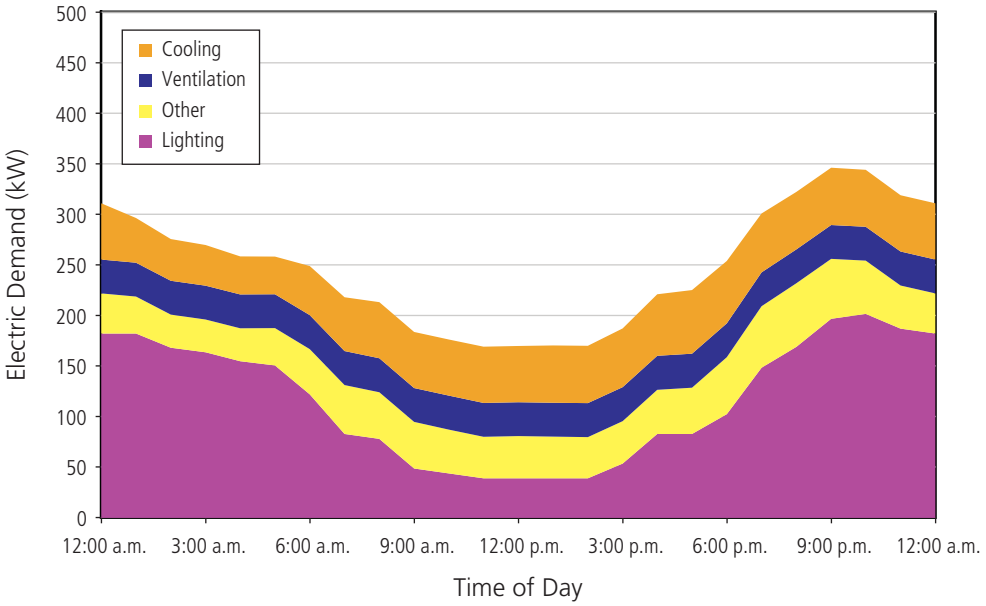


Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool.

Figure B-15. Typical Hotel: Load Profile with HVAC Measures

Measure List

- High-efficiency chillers
- Variable-speed pumps and fans
- Premium efficiency motors
- Occupancy-based guest room HVAC and lighting controls

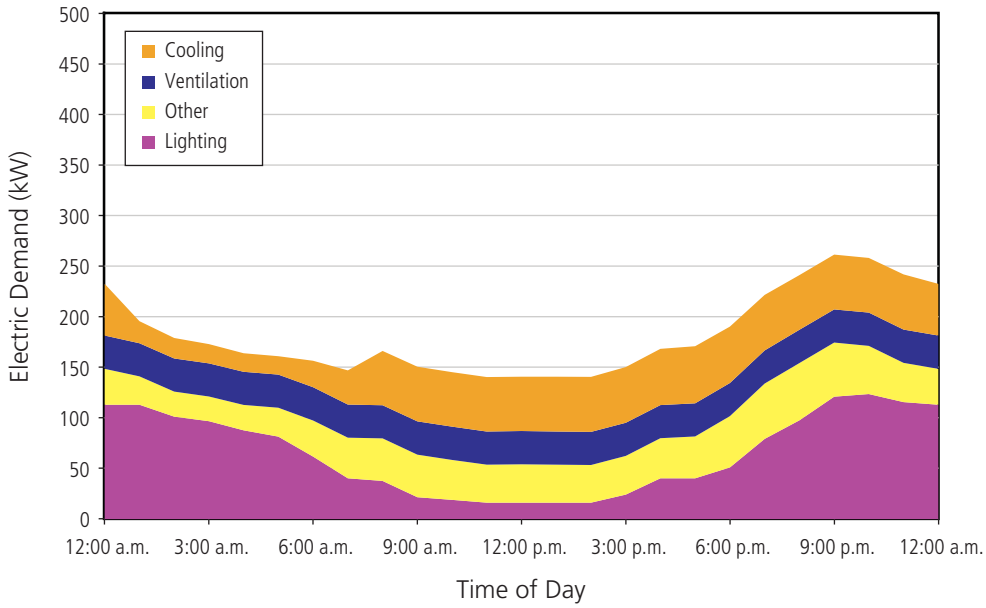


Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool.

Figure B-16. Typical Hotel: Load Profile with All Measures

Measure List

- Includes all O&M/ re-commissioning measures
- Includes all lighting measures
- Includes all HVAC measures



Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool.

group. In the baseline scenario, the property received a rating of 44. Factoring in the hypothetical energy efficiency measures that were applied to this building, the energy performance rating increased to 90.

Annual electric and natural gas savings, energy intensity savings, peak demand reductions, cost savings, and energy performance ratings for each of the energy efficiency measure scenarios are included in Table B-6.

Table B-5. Typical Hotel: Analysis of Sequencing Effects

Sequence of Upgrade Measures	1st Upgrade	2nd Upgrade	3rd Upgrade	Cooling Capacity (Tons)	Reduction in Cooling Capacity (%)
Good	HVAC	O&M	Lighting	457	0%
Better	O&M	HVAC	Lighting	450	2%
Best	O&M	Lighting	HVAC	445	3%

Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool.

Table B-6. Typical Hotel: Energy Savings Summary

Scenario	Electricity Use (kWh)	Electricity Savings (kWh)	Electricity Savings (%)	Natural Gas Use (Therms)	Natural Gas Savings (Therms)	Natural Gas Savings (%)	Annual Energy Intensity (kBtu/ft^2)	Energy Intensity Reduction (%)
Baseline	2,481,800	—	—	102,300	—	—	104	—
O&M	2,224,100	257,700	10%	92,400	9,900	10%	93	**10%**
Lighting	1,966,500	515,300	21%	114,600	-12,300	-12%	101	**3%**
HVAC	1,921,100	560,700	23%	103,800	-1,500	-1%	94	**9%**
All measures	1,376,000	1,105,800	45%	98,200	4,100	4%	81	**22%**

Scenario	Peak Demand (kW)	Demand Reduction (kW)	Demand Reduction (%)	Energy Cost ($)	Energy Savings ($)	EPA Energy Rating
Baseline	450	—	—	$351,957	—	**44**
O&M	424	26	**6%**	$316,249	**$35,708**	**59**
Lighting	362	88	**19%**	$317,787	**$34,170**	**61**
HVAC	346	104	**23%**	$300,991	**$50,966**	**68**
All measures	262	188	**42%**	$243,256	**$108,701**	**90**

Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool. EPA Energy Ratings calculated using EPA's Portfolio Manager tool.

Note: When calculating the EPA energy rating, assumptions entered into Portfolio Manager included a space type of upscale hotel with 180,000 square feet, 200 guest rooms, and the presence of a food preparation facility.

B.3 Supermarket Energy Use Profile

It has been calculated that a 10 percent reduction in energy costs for the average supermarket is equivalent to increasing net profit margins by 16 percent. These financial results are well within reach, as there are significant opportunities for energy use reduction, cost savings, and the mitigation of greenhouse gas emissions through cost-effective energy efficiency measures. To help identify the best opportunities, both from the perspective of the building owner and the utility, it is important to examine how, where, and when energy is used and the savings are likely to occur.

This profile first provides high-level energy consumption and cost metrics for the grocery sector. Next, it presents representative daily load shapes for a typical supermarket; one of these load shapes reflects a baseline building scenario, while the others represent the same building following the implementation of a package of cost-effective energy efficiency measures. Finally, these building scenarios are benchmarked with EPA's energy performance rating system in order to demonstrate the relationship between energy use and the 1-to-100 rating.

Average Energy Consumption, Cost, and End-Use Figures

Across the United States, the average annual energy intensity for grocery stores is 213.1 kBtu per square foot and the average cost is $4.84 per square foot. Of the total energy consumption, 82 percent is for electricity and 18 percent is for natural gas and other fuels (see Figure B-17). This translates to 51.3 kWh per square foot of electricity and 0.38 therms per square foot of natural gas (see Table B-7).

As shown in Figure B-18, refrigeration alone accounts for over 35 percent of the energy consumed in a typical grocery store. Just over 50 percent is used for space conditioning, lighting, and office equipment. The remainder is consumed by cooking, water heating, and other miscellaneous uses.

Breaking energy end-use down one step further shows that the major energy end-uses in grocery stores differ according to fuel type (see Figures B-19 and B-20). Of course, any individual building may have a different end-use breakdown than the typical building; for example, an all-electric building would have no natural gas consumption, and would have a breakdown of electricity use that would look similar to the total energy end-use breakdown in Figure B-18.

Daily Load Shape

Load Shape—Baseline Scenario: Figure B-21 represents a baseline scenario for daily operations at a typical supermarket on a summer weekday. This load profile illustrates the contributions of refrigeration, lighting, cooling, ventilation, and other loads throughout the day. Total building energy consumption in supermarkets

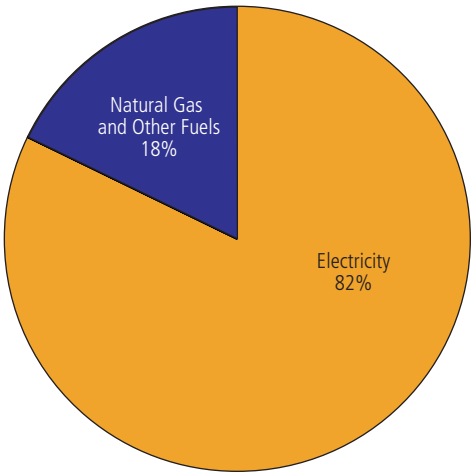
Table B-7. Typical Supermarket: Annual Energy Consumption per Square Foot

	Consumption per Square Foot (Billing Units)	Energy Use Intensity (kBtu/ft^2)
Electricity	51.3 kWh/ft^2	175.0
Natural gas	0.38 therms/ft^2	38.1
Total		213.1

Source: Based on EPA analysis of data from the Energy Information Administration's 2003 Commercial Building Energy Consumption Survey.

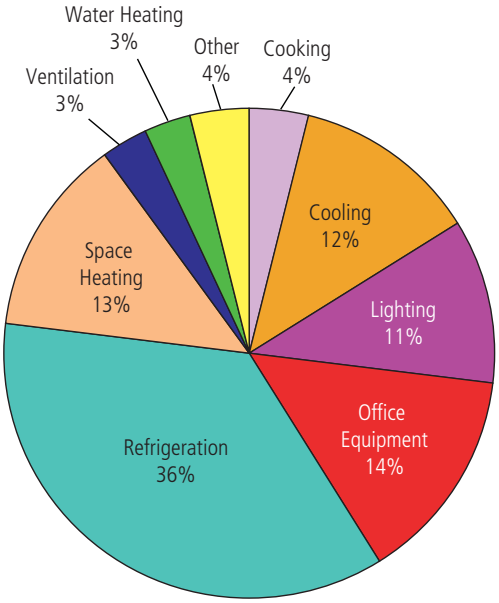
Note: For the purposes of illustration, all non-electric energy consumption has been converted to the equivalent consumption of natural gas. Other fuels may include oil, steam, and propane.

Figure B-17. Typical Supermarket: Energy Consumption by Fuel Type



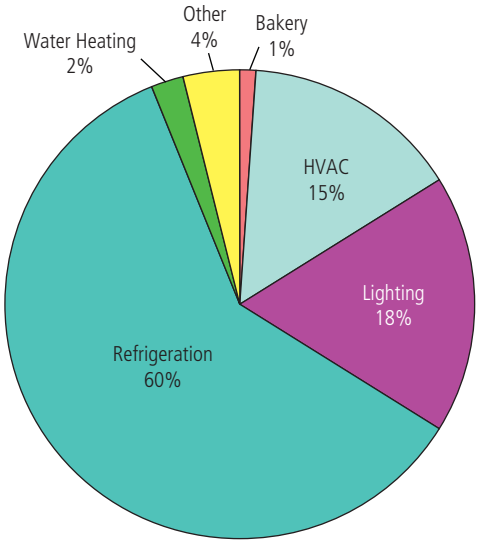
Source: Based on EPA analysis of data from the Energy Information Administration's 2003 Commercial Building Energy Consumption Survey.

Figure B-18. Typical Supermarket: Total Energy Consumption by End Use



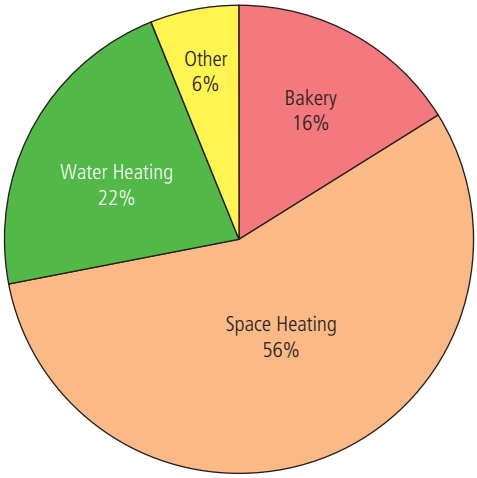
Source: Adapted from E Source (2006). Commercial Energy Advisor. Online at <http://www.esource.com/BEA/hosted/PDF/CEA_groceries.pdf>.

Figure B-19. Typical Supermarket: Electric Consumption by End Use



Source: Adapted from Edison Electric Institute (2001). *Managing Energy in Your Supermarket*.

Figure B-20. Typical Supermarket: Natural Gas Consumption by End Use

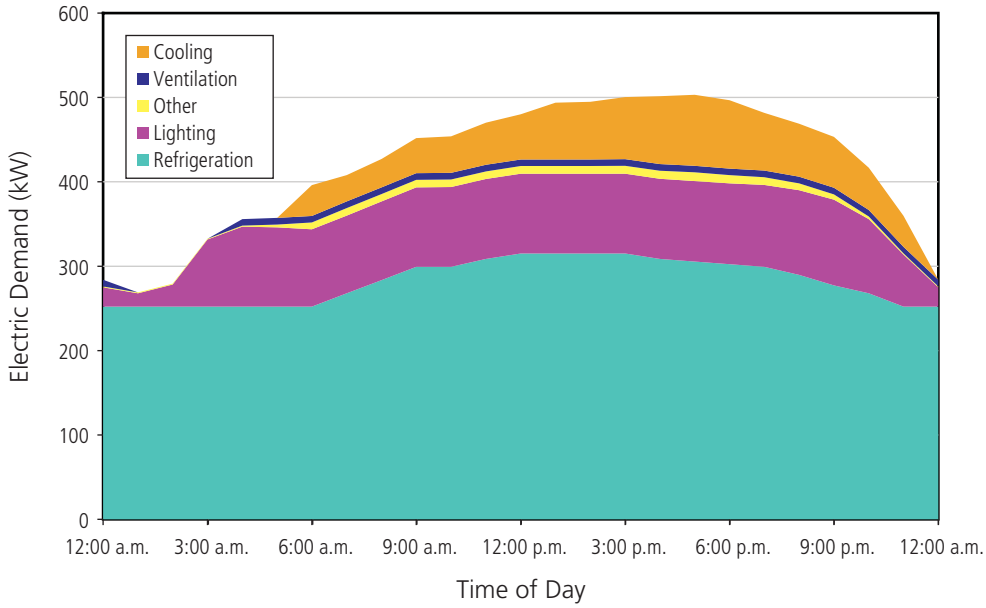


Source: Adapted from Edison Electric Institute (2001). *Managing Energy in Your Supermarket*.

Figure B-21. Typical Supermarket: Load Profile, Baseline Scenario

Assumptions

- 45,000-square-foot supermarket
- Packaged rooftop direct exchange unit with gas furnace
- 7:00 a.m.–11:00 p.m., Mon–Sat
- 7:00 a.m.–9:00 p.m., Sun
- Chicago, Illinois
- Typical summer day



Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool.

increases early in the morning, when employees come in to prepare for store opening, and decreases after the store closes at night. Supermarkets have a high base load at night due to the large amount of refrigeration equipment.

With Efficiency Measures: Figures B-22 through B-25 illustrate the typical supermarket after the implementation of four different energy efficiency upgrade scenarios: enhanced O&M/re-commissioning, lighting upgrades, HVAC upgrades, and a "full package" of all three improvement categories. The upgrade scenarios consist of conventional energy efficiency measures, with a focus on measures that reduce energy consumption during the peak summer months. O&M or re-commissioning measures generally represent low- or no-cost opportunities that should be a first step in energy management efforts. Lighting measures require capital investment, but have a relatively low simple payback. The HVAC measures include more comprehensive equipment upgrades.

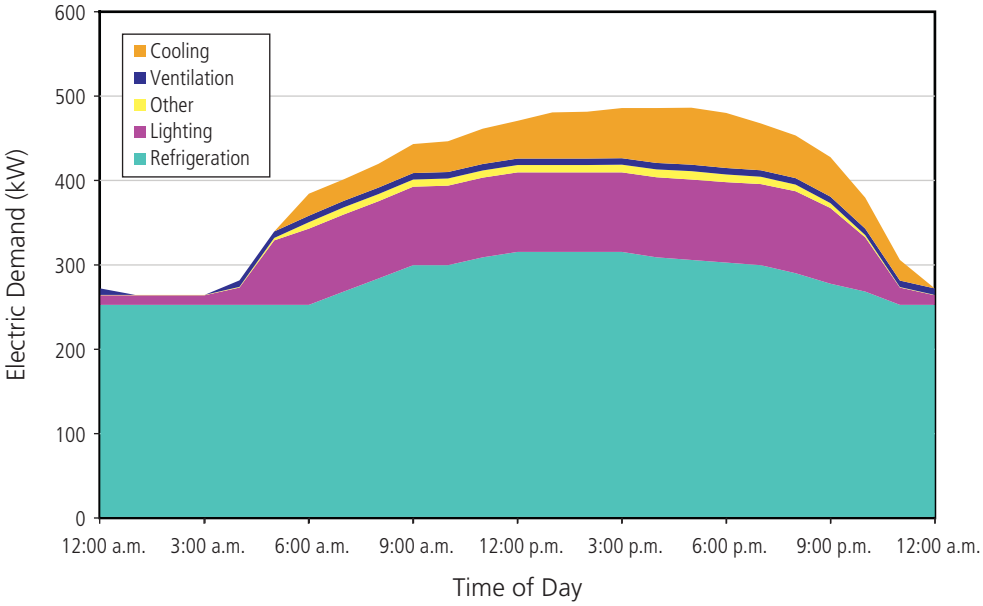
The load profile after the implementation of O&M measures (Figure B-22) shows the greatest savings at the beginning and end of the work day due to the shortening of HVAC and lighting schedules. It also shows a reduction in peak demand from temperature setpoint changes, and a reduction in overnight energy consumption from turning off unnecessary lights and equipment. The lighting measures reduce peak demand, partially because of the more efficient technology, but the greater impact is from the use of daylighting (Figure B-23). The HVAC measures reduce peak cooling demand as a result of high-efficiency rooftop units and a reduction in refrigeration energy from efficient motors and controls (Figure B-24). When all measures are taken together, the total reduction in peak demand for this building on a typical summer day is 104 kW, or 21 percent of the baseline (Figure B-25).

On an annual basis, the savings from the full package of measures results in a reduction in energy intensity of 47 kBtu per square foot, or 15 percent of the baseline. This translates to $54,535 per year at national average utility rates of $0.094 per kWh and $1.16 per therm.[4]

Figure B-22. Typical Supermarket: Load Profile with Operations and Maintenance/Re-commissioning Measures

Measure List

- Optimize temperature setpoints
- Optimize lighting and HVAC scheduling
- Implement demand-controlled ventilation
- Operate economizer
- Enable power management for PCs, printers, and copiers
- Turn off registers and other plug loads at night
- Specify ENERGY STAR equipment—office equipment, vending machines

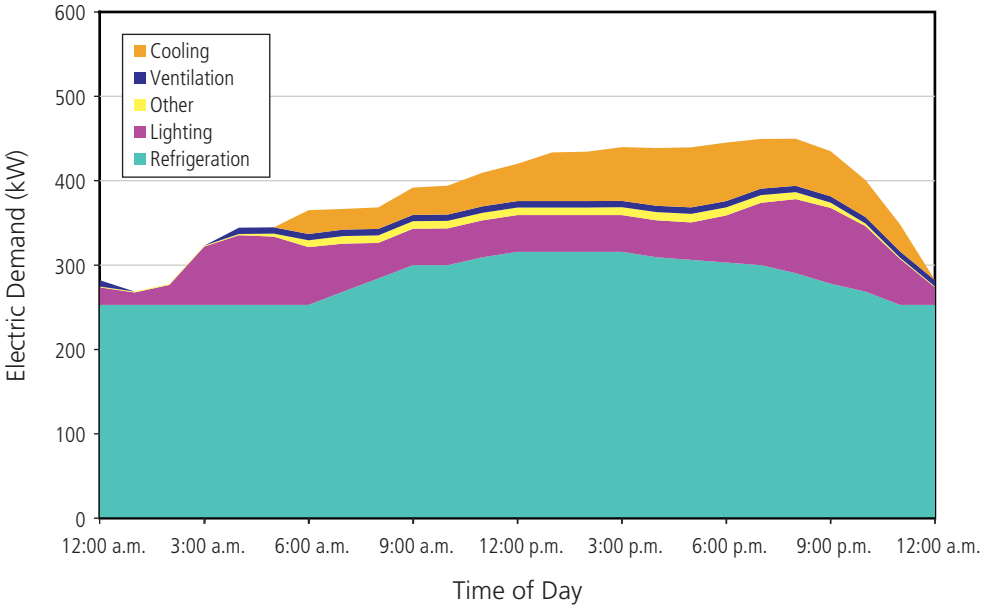


Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool.

Figure B-23. Typical Supermarket: Load Profile with Lighting Measures

Measure List

- Efficient lighting (high-performance T8s/T5s, compact fluorescents, ceramic metal halide, LED exit signs)
- Occupancy sensors (back rooms)
- Daylighting with skylights

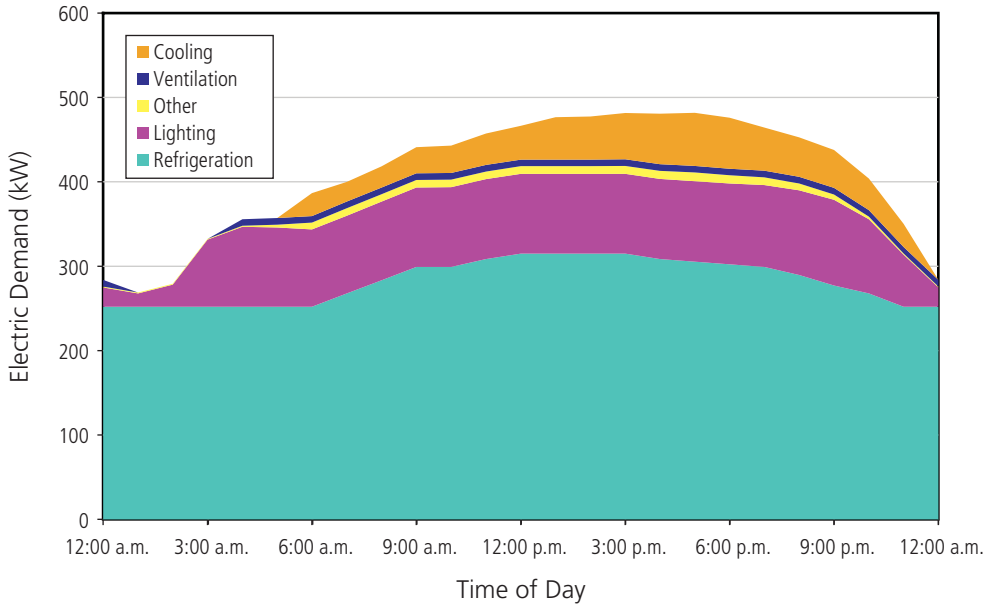


Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool.

Figure B-24. Typical Supermarket: Load Profile with HVAC Measures

Measure List

- High-efficiency rooftop units
- Antisweat heater controls
- ECM motors for display cases and walk-ins
- Evaporator fan controls for walk-in coolers

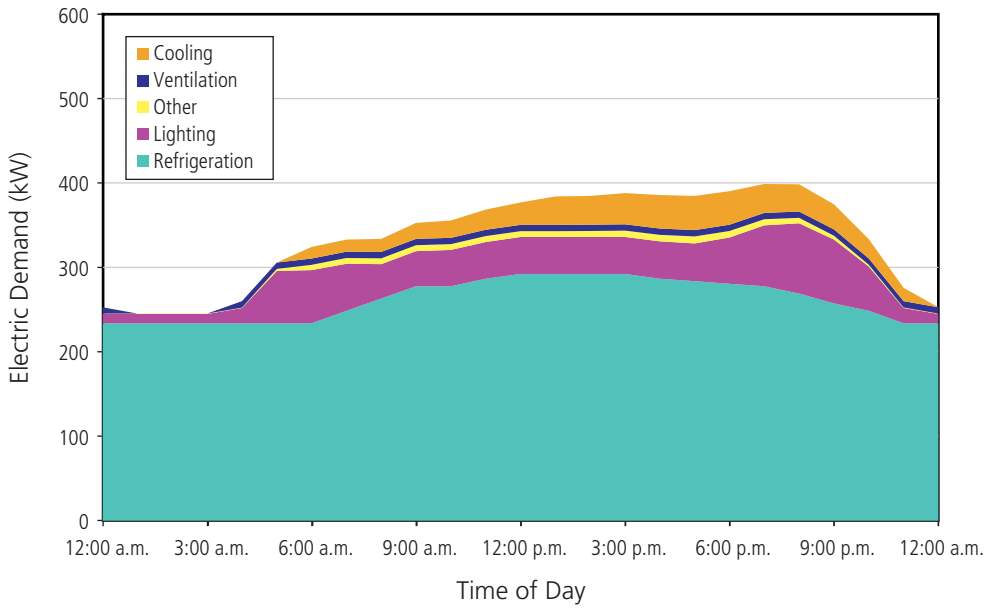


Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool.

Figure B-25. Typical Supermarket: Load Profile with All Measures

Measure List

- Includes all O&M/ re-commissioning measures
- Includes all lighting measures
- Includes all HVAC measures



Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool.

Impact of Sequencing: When undertaking comprehensive energy efficiency improvements, implementing measures in the proper sequence can reduce the required capacity of the HVAC equipment. Table B-8 illustrates the necessary size of the HVAC equipment when installed at different points in a comprehensive upgrade process. In the first scenario, the building operator replaces HVAC equipment before completing other improvements. This scenario is called "Good" because the operator is undertaking comprehensive improvements at the facility. A "Better" scenario consists of implementing O&M upgrades before HVAC equipment replacement, and the "Best" scenario includes upgrading O&M and lighting before changing out HVAC equipment. Results demonstrate that a supermarket's required cooling capacity can be reduced by up to 11 percent when the operator implements HVAC measures after all other upgrades. Additional energy savings can often be achieved as well, due to more efficient operation of right-sized equipment.

Energy Performance Rating

The energy performance of each of these building scenarios can be benchmarked using EPA's energy performance rating system. This tool allows building owners and operators to enter building attributes and consumption data and obtain a 1-to-100 rating, normalized for weather and occupancy, which compares a given building to its peer group. In the baseline scenario, the property received a rating of 66. Factoring in the hypothetical energy efficiency measures that were applied to this building, the energy performance rating increased to 83.

Annual electric and natural gas savings, energy intensity savings, peak demand reductions, cost savings, and energy performance ratings for each of the energy efficiency measure scenarios are included in Table B-9.

Table B-8. Typical Supermarket: Analysis of Sequencing Effects

Sequence of Upgrade Measures	1st Upgrade	2nd Upgrade	3rd Upgrade	Cooling Capacity (Tons)	Reduction in Cooling Capacity (%)
Good	HVAC	O&M	Lighting	95	0%
Better	O&M	HVAC	Lighting	92	3%
Best	O&M	Lighting	HVAC	85	11%

Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool.

Table B-9. Typical Supermarket: Energy Savings Summary

Scenario	Electricity Use (kWh)	Electricity Savings (kWh)	Electricity Savings (%)	Natural Gas Use (Therms)	Natural Gas Savings (Therms)	Natural Gas Savings (%)	Annual Energy Intensity (kBtu/ft^2)	Energy Intensity Reduc-tion (%)
Baseline	3,423,800	—	—	18,028	—	—	300	—
O&M	3,293,900	129,900	4%	10,849	7,179	40%	274	**9%**
Lighting	3,191,600	232,200	7%	23,507	-5,479	-30%	294	**2%**
HVAC	3,395,000	28,800	1%	18,028	0	0%	297	**1%**
All measures	2,866,200	557,600	16%	16,200	1,828	10%	253	**15%**

Scenario	Peak Demand (kW)	Demand Reduc-tion (kW)	Demand Reduc-tion (%)	Energy Cost ($)	Energy Savings ($)	EPA Energy Rating
Baseline	503	—	—	$342,750	—	**66**
O&M	487	17	**3%**	$322,211	**$20,538**	**71**
Lighting	449	54	**11%**	$327,279	**$15,471**	**71**
HVAC	482	21	**4%**	$340,042	**$2,707**	**67**
All measures	399	104	**21%**	$288,215	**$54,535**	**83**

Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool. EPA Energy Ratings calculated using EPA's Portfolio Manager tool.

Note: When calculating the EPA energy rating, assumptions entered into Portfolio Manager included 45,000 square feet, main shift staffing of 45 people, 110 operating hours per week, the presence of a food preparation facility, 16 registers or personal computers, 55 refrigerated and freezer cases, and five walk-in coolers and freezers.

B.4 Retail Store Energy Use Profile

According to the Edison Electric Institute, the cost of energy accounts for anywhere from 3 to 8 percent of a retailer's total operating expense. There are significant opportunities for energy use reduction, cost savings, and the mitigation of greenhouse gas emissions through cost-effective energy efficiency opportunities. To help identify the best opportunities, both from the perspective of the building owner and the utility, it is important to examine how, where, and when energy is used and the savings are likely to occur.

This profile first provides high-level energy consumption and cost metrics for the retail sector. Next, it presents representative daily load shapes for a typical retail store; one of these load shapes reflects a baseline building scenario, while the others represent the same building following the implementation of a package of cost-effective energy efficiency measures. Finally, these building scenarios are benchmarked with the EPA's energy performance rating system (under development for retail buildings) in order to demonstrate the relationship between energy use and the 1-to-100 rating.

Average Energy Consumption, Cost, and End-Use Figures

Across the United States, the average annual energy intensity for retail properties is 81.5 kBtu per square foot and the average cost is $1.57 per square foot. Of the total energy consumption, 67 percent is for electricity and 33 percent is for natural gas and other fuels (see Figure B-26). This translates to 16.1 kWh per square foot of electricity and 0.27 therms per square foot of natural gas (see Table B-10).

As shown in Figure B-27, space conditioning, lighting, and office equipment together account for 80 percent of all energy consumed in a typical retail property. The remaining energy is consumed by refrigeration, water heating, cooking, and other miscellaneous uses.

Breaking energy end-use down one step further shows that the major energy end-uses in retail properties differ according to fuel type (see Figures B-28 and B-29). Of course, any individual building may have a different end-use breakdown than the typical building; for example, an all-electric building would have no natural gas consumption, and would have a breakdown of electricity use that would look similar to the total energy end-use breakdown in Figure B-27.

Daily Load Shape

Load Shape—Baseline Scenario: Figure B-30 represents a baseline scenario for daily operations at a typical retail store on a summer weekday. This load profile illustrates the contributions of lighting, cooling, ventilation, and other loads throughout the day. Total building energy consumption in retail stores ramps up quickly in the morning before the store opens, and down again after the store closes at night.

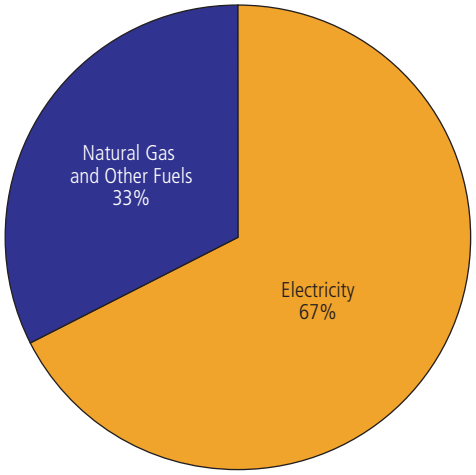
Table B-10. Typical Retail Store: Annual Energy Consumption per Square Foot

	Consumption per Square Foot (Billing Units)	Energy Use Intensity ($kBtu/ft^2$)
Electricity	16.1 kWh/ft^2	54.9
Natural gas	0.27 $therms/ft^2$	26.6
Total		81.5

Source: Based on EPA analysis of data from the Energy Information Administration's 2003 Commercial Building Energy Consumption Survey.

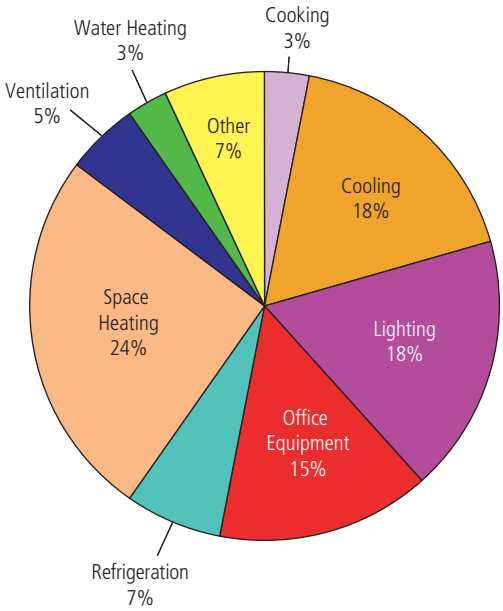
Note: For the purposes of illustration, all non-electric energy consumption has been converted to the equivalent consumption of natural gas. Other fuels may include oil, steam, and propane.

Figure B-26. Typical Retail Store: Energy Consumption by Fuel Type



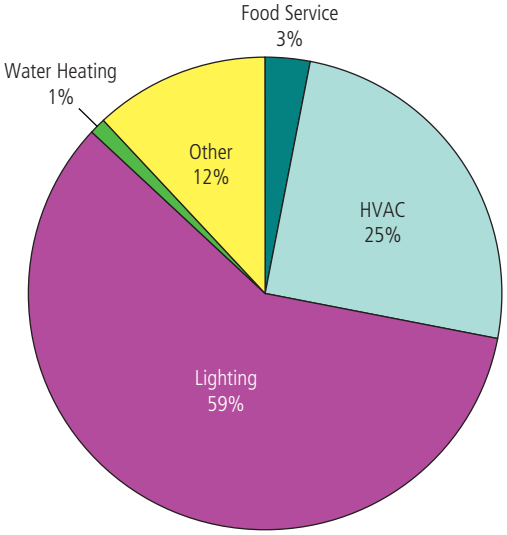
Source: Based on EPA analysis of data from the Energy Information Administration's 2003 Commercial Building Energy Consumption Survey.

Figure B-27. Typical Retail Store: Total Energy Consumption by End Use



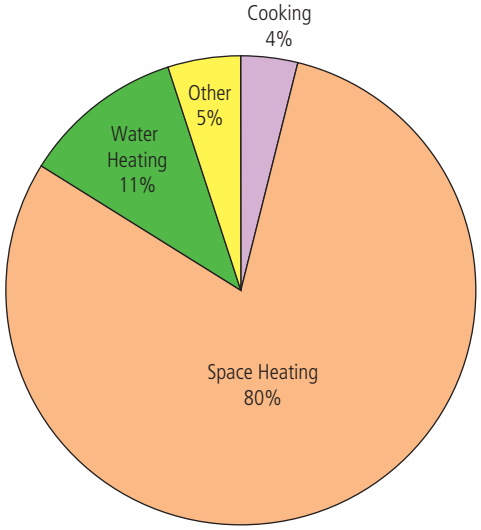
Source: Adapted from E Source (2006). Commercial Energy Advisor. Online at <http://www.esource.com/BEA/hosted/PDF/CEA_retail.pdf>.

Figure B-28. Typical Retail Store: Electric Consumption by End Use



Source: Adapted from Edison Electric Institute (2001). *Managing Energy in Your Retail Store*.

Figure B-29. Typical Retail Store: Natural Gas Consumption by End Use

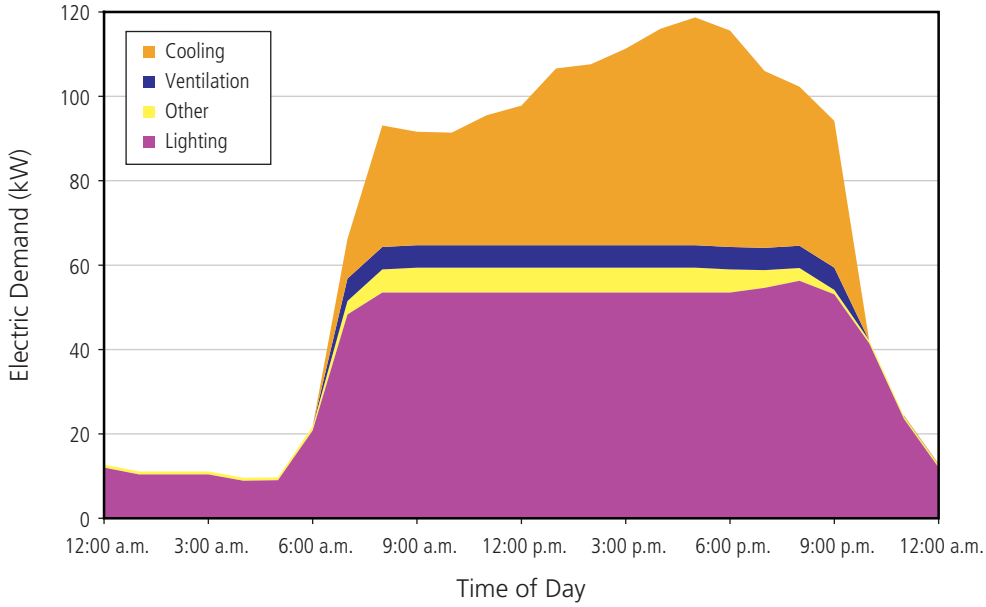


Source: Adapted from Edison Electric Institute (2001). *Managing Energy in Your Retail Store*.

Figure B-30. Typical Retail Store: Load Profile, Baseline Scenario

Assumptions

- 30,000-square-foot retail store
- Packaged rooftop direct exchange unit with gas furnace
- 9:00 a.m.–9:00 p.m., Mon–Sat
- 10:00 a.m.–7:00 p.m., Sun
- Chicago, Illinois
- Typical summer day



Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool.

With Efficiency Measures: Figures B-31 through B-34 illustrate the typical retail store after the implementation of four different energy efficiency upgrade scenarios: enhanced O&M/re-commissioning; lighting upgrades; HVAC upgrades; and a "full package" of all three improvement categories. The upgrade scenarios consist of conventional energy efficiency measures, with a focus on measures that reduce energy consumption during the peak summer months. O&M or re-commissioning measures generally represent low- or no-cost opportunities that should be a first step in energy management efforts. Lighting measures require capital investment, but have a relatively low simple payback. The HVAC measures include more comprehensive equipment upgrades.

The load profile after the implementation of O&M measures (Figure B-31) shows savings at the beginning and end of the work day due to the shortening of HVAC and lighting schedules. It also shows a reduction in peak demand from temperature setpoint changes and demand-controlled ventilation, and a reduction in overnight energy consumption from turning off unnecessary lights and equipment. The lighting measures reduce peak demand, partially because of the more efficient technology, but the greater impact is from the use of daylighting (Figure B-32). The HVAC measures reduce peak cooling demand as a result of high-efficiency packaged rooftop units (Figure B-33). When all measures are taken together, the total reduction in peak demand for this building on a typical summer day is 49 kW, or 41 percent of the baseline (Figure B-34).

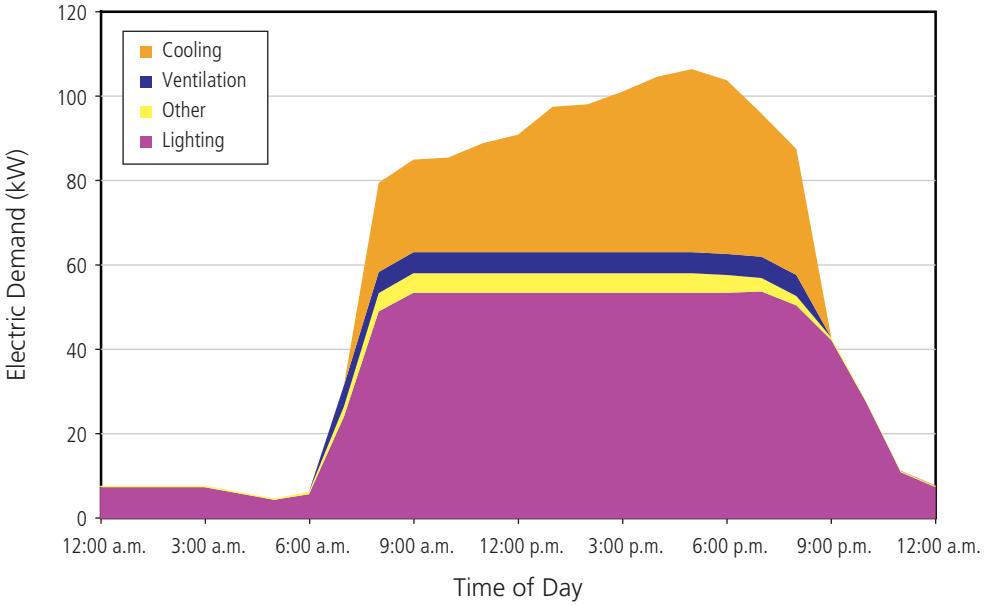
On an annual basis, the savings from the full package of measures results in a reduction in energy intensity of 27 kBtu per square foot, or 30 percent of the baseline. This translates to $19,532 per year at national average utility rates of $0.094 per kWh and $1.16 per therm.[5]

Impact of Sequencing: When undertaking comprehensive energy efficiency improvements, implementing measures in the proper sequence can reduce the required capacity of the HVAC equipment. Table B-11 illustrates the necessary size of the HVAC equipment

Figure B-31. Typical Retail Store: Load Profile with Operations and Maintenance/Re-commissioning Measures

Measure List

- Optimize temperature setpoints
- Optimize lighting and HVAC scheduling
- Implement demand-controlled ventilation
- Operate economizer
- Enable power management for PCs, printers, and copiers
- Turn off registers and other plug loads at night
- Specify ENERGY STAR equipment—office equipment, vending machines

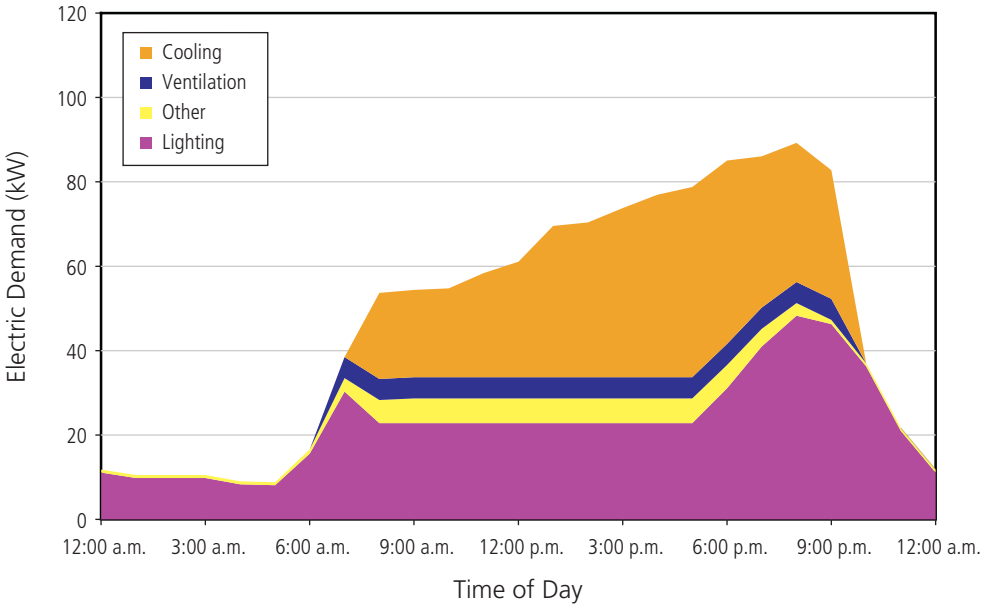


Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool.

Figure B-32. Typical Retail Store: Load Profile with Lighting Measures

Measure List

- Efficient lighting (high-performance T8s/T5s, compact fluorescents, LED exit signs)
- Occupancy sensors (back rooms)
- Daylighting with skylights

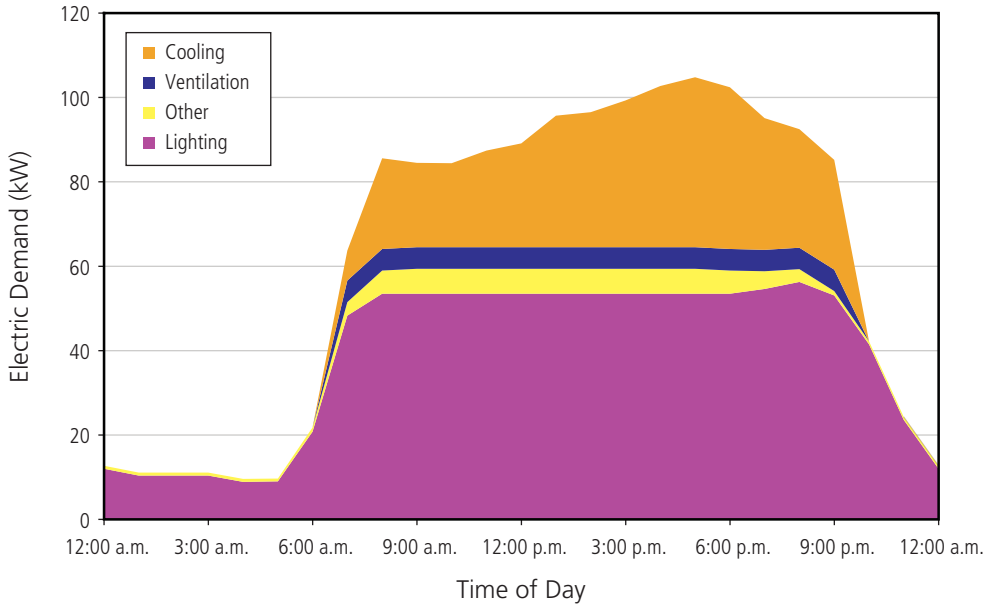


Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool.

Figure B-33. Typical Retail Store: Load Profile with HVAC Measures

Measure List

- High-efficiency packaged rooftop units

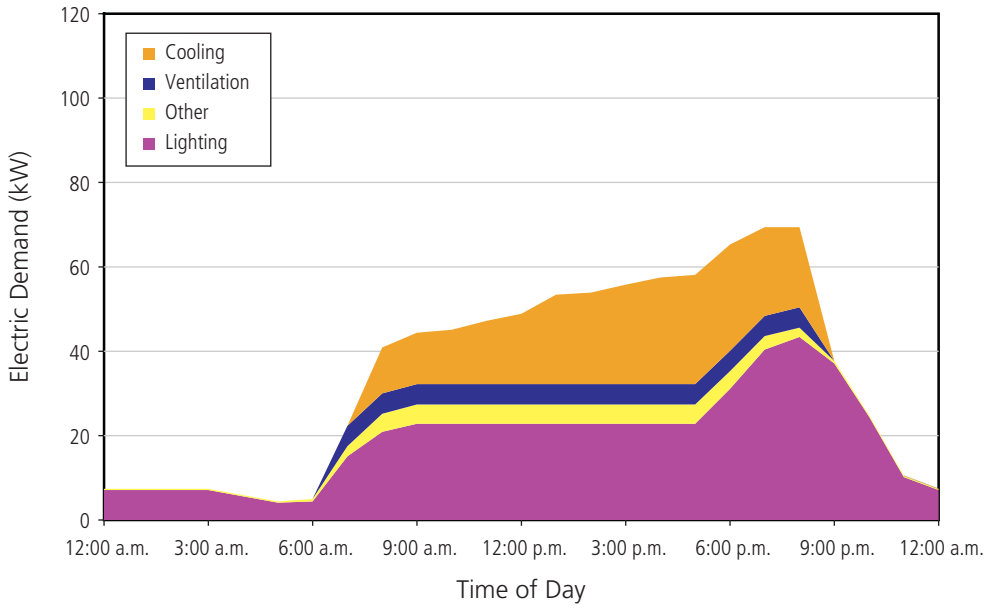


Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool.

Figure B-34. Typical Retail Store: Load Profile with All Measures

Measure List

- Includes all O&M/ re-commissioning measures
- Includes all lighting measures
- Includes all HVAC measures



Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool.

Table B-11. Typical Retail Store: Analysis of Sequencing Effects

Sequence of Upgrade Measures	1st Upgrade	2nd Upgrade	3rd Upgrade	Cooling Capacity (Tons)	Reduction in Cooling Capacity (%)
Good	HVAC	O&M	Lighting	70	0%
Better	O&M	HVAC	Lighting	62	11%
Best	O&M	Lighting	HVAC	56	20%

Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool.

when installed at different points in a comprehensive upgrade process. In the first scenario, the building operator replaces HVAC equipment before completing other improvements. This scenario is called "Good" because the operator is undertaking comprehensive improvements at the facility. A "Better" scenario consists of implementing O&M upgrades before HVAC equipment replacement, and the "Best" scenario includes upgrading O&M and lighting before changing out HVAC equipment. Results demonstrate that a retail property's required cooling capacity can be reduced by up to 20 percent when the operator implements HVAC measures after all other upgrades. Additional energy savings can often be achieved as well, due to more efficient operation of right-sized equipment.

Energy Performance Rating

The energy performance of each of these building scenarios can be benchmarked using EPA's energy performance rating system. This tool allows building owners and operators to enter building attributes and consumption data and obtain a 1-to-100 rating, normalized for weather and occupancy, which compares a given building to its peer group. In the baseline scenario, the property received a rating of 41. Factoring in the hypothetical energy efficiency measures that were applied to this building, the energy performance rating increased to 75.

Annual electric and natural gas savings, energy intensity savings, peak demand reductions, cost savings, and energy performance ratings for each of the energy efficiency measure scenarios are included in Table B-12.

Table B-12. Typical Retail Store: Energy Savings Summary

Scenario	Electricity Use (kWh)	Electricity Savings (kWh)	Electricity Savings (%)	Natural Gas Use (Therms)	Natural Gas Savings (Therms)	Natural Gas Savings (%)	Annual Energy Intensity (kBtu/ft^2)	Energy Intensity Reduc-tion (%)
Baseline	454,750	—	—	10,788	—	—	88	—
O&M	389,690	65,060	14%	6,766	4,023	37%	67	**24%**
Lighting	329,240	125,510	28%	13,718	-2,930	-27%	83	**5%**
HVAC	438,690	16,060	4%	10,804	-16	0%	86	**2%**
All measures	265,570	189,180	42%	9,280	1,508	14%	61	**30%**

Scenario	Peak Demand (kW)	Demand Reduc-tion (kW)	Demand Reduc-tion (%)	Energy Cost ($)	Energy Savings ($)	EPA Energy Rating
Baseline	119	—	—	$55,261	—	**41**
O&M	107	12	**10%**	$44,479	**$10,782**	**57**
Lighting	89	29	**25%**	$46,861	**$8,399**	**57**
HVAC	105	14	**12%**	$53,770	**$1,491**	**43**
All measures	69	49	**41%**	$35,729	**$19,532**	**75**

Source: Based on modeling performed by ICF International using eQUEST, a DOE-2 based software tool. EPA Energy Ratings calculated using EPA's Portfolio Manager tool.

Note: When calculating the EPA energy rating, assumptions entered into Portfolio Manager included 30,000 square feet, main shift staffing of 12 people, 81 operating hours per week, eight registers, and three personal computers.

B.5 Notes

1. Based on Energy Information Administration data for 2006.
2. From PKF Consulting's Hospitality Research Group and personal communications.
3. Based on Energy Information Administration data for 2006.
4. Based on Energy Information Administration data for 2006.
5. Based on Energy Information Administration data for 2006.

Appendix C: Energy Efficiency Commitments from Sector Collaborative Participants

Municipality Sector Commitment to Energy Efficiency

Today we are announcing our endorsement of the recommendations of the National Action Plan for Energy Efficiency and our commitment to a new Sector Collaborative. The overall goal of the Sector Collaborative is to reduce energy consumption substantially (or by 10 percent or more) over the coming years. To achieve this goal, each of the undersigned organizations agrees to pursue one or more of the initiatives listed below. These initiatives were identified by a team of industry leaders and through a Sector Collaborative workshop as best practices for overcoming the barriers limiting improvements in energy efficiency.

As participants in this Sector Collaborative, we are leaders among our peers in the municipality sector. We are stepping up to the challenge today of increasing energy efficiency as representatives of this sector and as leaders in the industry. Buildings today represent approximately 40 percent of energy use in the country. By stepping out as leaders, we are helping to reduce costs and our impact on the environment. We proudly agree to take on the following commitments that will lead to wise use of energy for our planet.

Participants in the Sector Collaborative effort will undertake one or more of the following initiatives:

- Conduct energy benchmarking for all properties above 5,000 square feet.
- Implement all cost-effective strategies to improve energy efficiency.
- Create and/or increase energy efficiency education and awareness within and outside each organization.
- Pursue bulk purchasing of energy-efficient products and services.
- Support expanded efficiency program offerings across states and utilities.
- Support development of standardized electronic utility billing data access by large customers for benchmarking.
- Explore energy efficiency programs offered by federal, state, and local agencies and sector-based associations.

As with all National Action Plan commitments, these sector commitments will be tracked on an annual basis.

Grocery and Retail Sector Commitment to Energy Efficiency

Today we are announcing our endorsement of the recommendations of the National Action Plan for Energy Efficiency and our commitment to a new Sector Collaborative. The overall goal of the Sector Collaborative is to improve energy efficiency substantially (e.g. by 10 percent or more) over the coming years. To achieve this goal, each of the undersigned organizations agrees to pursue one or more of the initiatives listed below. These initiatives were identified by a team of industry leaders and through a Sector Collaborative workshop as best practices for overcoming the barriers limiting improvements in energy efficiency.

As participants in this Sector Collaborative, we are leaders among our peers in the grocery and retail sectors. We are stepping up to the challenge today of increasing energy efficiency as representatives of these sectors and as leaders in the industry. Buildings today represent approximately 40 percent of energy use in the country. By stepping out as leaders, we are helping to reduce

costs and our impact on the environment. We proudly agree to take on the following commitments that will lead to wise use of energy for our planet.

Participants in the Sector Collaborative effort will undertake one or more of the following initiatives:

- Explore energy efficiency programs offered by federal, state, and local agencies and sector-based associations.
- Conduct energy benchmarking for all properties.
- Implement all low-cost strategies to improve energy efficiency.
- Create and/or increase energy efficiency education and awareness within and outside each organization.
- Pursue guidelines for procurement and bulk purchasing of energy-efficient products and services, including refrigeration cases.
- Work with utility company leaders to increase consistency in both data reporting and program offerings, and help prove the benefits to encourage more utility companies to offer consistent data and programs.

As with all National Action Plan commitments, these sector commitments will be tracked on an annual basis.

BOMA International Commitment to Energy Efficiency

We are today announcing our support of the goals of the National Action Plan for Energy Efficiency and our commitment to a new Sector Collaborative. The overall goal is to help our members improve energy efficiency by 30 percent or more over the coming years. The initiatives below represent best practices for overcoming the barriers limiting improvements in energy efficiency, as concluded during discussions under the National Action Plan.

The Building Owners and Managers Association (BOMA) International has consistently demonstrated our commitment to energy efficiency, most recently in the announcement of our Market Transformation Strategy, also known as the 7-Point Energy Challenge. In support of the 7-Point Energy Challenge and the National Action Plan for Energy Efficiency, we call on our members to:

1. Continue to work towards a goal to decrease energy consumption by 30 percent across their portfolios by 2012—as measured against an "average building" measuring a 50 on the ENERGY STAR benchmarking tool in 2007;
2. At least once a year, benchmark energy performance and water usage through EPA's ENERGY STAR benchmarking tool and share the results with BOMA;
3. Provide education to managers, engineers, and others involved in building operations, to ensure that equipment is properly installed, commissioned, maintained, and utilized;
4. Perform an energy audit and/or retro-commissioning of their building(s), and implement low-risk, low-cost, and cost-effective strategies to improve energy efficiency with high returns;
5. Extend equipment life by improving the operations and maintenance of building systems and ensure equipment is operating as designed;
6. Through leadership, positively impact the community and planet by helping to reduce the real estate industry's role in global warming; and
7. Position their company and the industry as leaders and solution providers to owners and tenants seeking environmental and operational excellence.

NASEO Commitment to Energy Efficiency

NASEO is today renewing its endorsement of the broad recommendations of the National Action Plan for Energy Efficiency and announcing its commitment to a new state energy office collaborative. The overall goal

is to improve energy efficiency across the country by 10 percent or more over the coming years. To achieve this goal, NASEO will continue to work with all of its member states, territories and the District of Columbia to pursue one or more of the initiatives listed below. These initiatives are among some of the best practices State energy offices employ to overcome the barriers limiting improvements in energy efficiency.

In support of the National Action Plan on Energy Efficiency, NASEO will work with its member State energy offices to:

- Strive to benchmark the energy efficiency of all properties.
- Work to implement all low-cost strategies to improve energy efficiency in all properties.
- Increase energy efficiency education and awareness in the states.
- Continue to pursue bulk purchasing of energy-efficient products and services.
- Work with utility company leaders and regulators to increase consistency in both data reporting and program offerings, and help prove the benefits of these programs, projects, and policies to encourage more utility companies to offer critical energy efficiency programs.
- Encourage businesses and other organizations in the states to pursue each of these initiatives.
- Take all practical steps to encourage energy efficiency in all sectors of the economy.

Funding and printing for this report was provided by the U.S. Department of Energy and U.S. Environmental Protection Agency in their capacity as co-sponsors for the National Action Plan for Energy Efficiency.

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