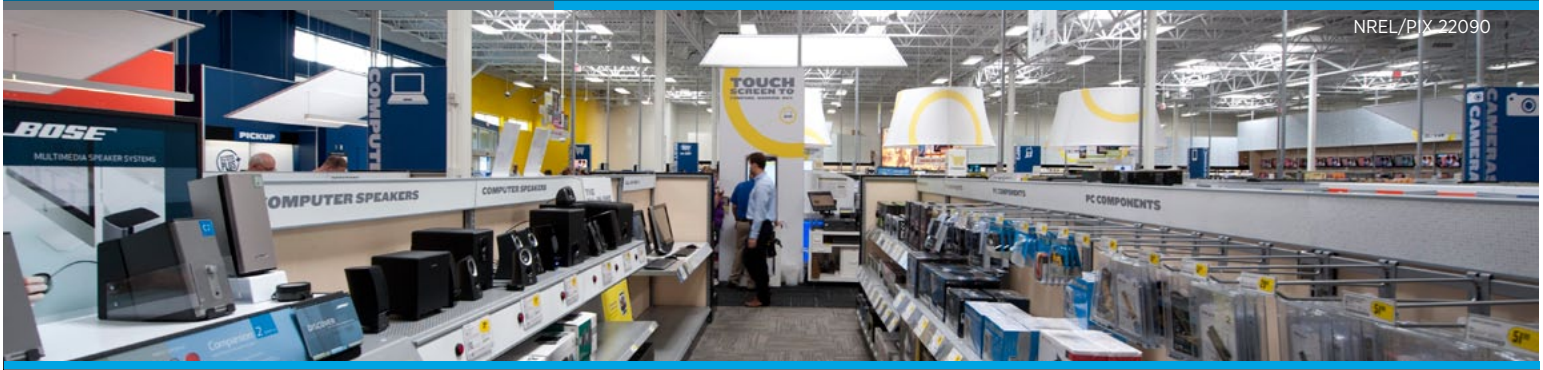

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General Merchandise

Introduction

According to the U.S. Department of Energy (DOE), non-mall mercantile stores typically spend roughly $2/ft²/yr on energy.[1] This sector represented 6% of commercial building floor space and 5% of the nation's total commercial building energy consumption[2] as of 2003, equivalent to approximately 870 trillion Btu/yr.[3]

The Commercial Building Partnership (CBP), a DOE-sponsored public/private, cost-shared program, paired selected commercial building owners and operators with representatives of DOE, its national laboratories, and private-sector technical experts. These teams explored energy efficiency measures (EEMs) across building systems—including some considered too costly or technologically challenging—and used advanced energy modeling to achieve peak whole-building performance. Modeling results were then included in new construction and retrofit designs to achieve significant energy reductions.

CBP aimed to achieve 50% energy savings compared to ANSI/ASHRAE/IES Energy Standard 90.1-2004[4] for new construction; retrofits were designed to consume at least 30% less energy than either ASHRAE 90.1-2004 or pre-retrofit consumption. After construction and commissioning of the project, laboratory staff continued to work with partners to collect and analyze data to verify the energy reduction.

CBP projects represented diverse building types in commercial real estate, including lodging, grocery, retail, higher education, office, and warehouse/storage facilities. Partners also committed to replicating low-energy technologies and strategies from their CBP projects throughout their building portfolios. This commitment represented a potential to impact almost 2 billion ft² of commercial real estate.

[1] DOE Buildings Energy Data Book table 3.3.9 (http://buildingsdatabook.eren.doe.gov/TableView.aspx?table=3.3.9)
[2] DOE Biuldings Energy Data Book table 3.2.2 (http://buildingsdatabook.eren.doe.gov/TableView.aspx?table=3.2.2)
[3] Based on an assumed total commercial consumption of 17.33 quadrillion Btu/yr from http://buildingsdatabook.eren.doe.gov/TableView.aspx?table=3.1.1
[4] Projects selected after 2009 used a baseline of ANSI/ASHRAE/IES Standard 90.1-2007 rather than ANSI/ASHRAE/IES Standard 90.1-2004.

As a result of CBP projects, five sector overviews (General Merchandise, Higher Education, Lodging, Offices, and Retail Food Sales) were created to capture successful strategies and recommended EEMs that could be broadly applied across these sectors. These overviews were supplemented with individual case studies providing specific details of the decision criteria, modeling results, and lessons learned for each project. Sector overviews and CBP case studies will be updated to reflect verified data and replication strategies as they become available.

Several market drivers are currently pushing the general merchandise sector toward more efficient use of energy, including improved shopping experience for customers, increased worker productivity, lower equipment lifecycle costs, and the value that customers place on actions taken by companies to reduce their environmental impact.

Projects at a Glance

Six organizations are featured (see "Projects at a Glance" table): Best Buy, Home Depot, J.C. Penney, Kohl's, Target, and Walmart. They are all nationwide companies with large building portfolios, topped by Walmart with 4,300 stores and 950 million ft² in the United States. The total floor area of the projects included in the 10 case studies was 1 million ft²; individual stores ranged from 40,000 ft² to 200,000 ft². The Target and Walmart projects were "combination big box" stores and were featured in both general merchandise and retail food sales sectors. The Kohl's new construction project was still being designed at the time of publication.

The total floor area of the company portfolios was 1.7 billion ft² at the time of publication. As part of CBP, DOE helped companies analyze the nationwide savings potential of the EEMs implemented in CBP pilot projects. EEMs that performed as expected in the CBP pilot projects were incorporated into companies' new construction specifications and standard retrofit packages. While the companies did not commit to a certain level of CBP pilot project replication in terms of square footage, they all maintain a regular cycle of store renovation, providing continual opportunities for saving energy based on CBP

General Merchandise Sector: Projects at a Glance

Company Name	Best Buy*	Home Depot	J.C. Penney	J.C. Penney	Kohl's*	Kohl's*	Target	Target	Walmart	Walmart	Total
Project Type	New	New	Retrofit	New	Retrofit	New	Retrofit	New	Retrofit	New	—
Climate Zone	5B cool-dry	3B warm-dry	4A mixed-humid	3A warm-humid	5A cool-humid	2A hot-humid	5B cool-dry	6A cold-humid	5B cool-dry	4A mixed-humid	—
Ownership	Leased	Owner-occupied	Owner-occupied	Owner-occupied	Owner-occupied	Owner-occupied	Owner-occupied	Owner-occupied	Owner-occupied	Owner-occupied	—
Square Footage	30,500 ft^2	103,500 ft^2	107,200 ft^2	103,500 ft^2	87,000 ft^2	55,000 ft^2	173,000 ft^2	133,000 ft^2	190,000 ft^2	200,000 ft^2	1 million ft^2
Portfolio Floor Area	38 million ft^2	237 million ft^2	105 million ft^2		104 million ft^2		250 million ft^2		950 million ft^2		1.7 billion ft^2
Expected Energy Reductions (Versus Pre-Retrofit or current prototype)	not modeled	40%	45%	31%	26%	TBD	28%	5%	33%	Not modeled	—
Expected Energy Reductions (Versus Code Baseline)	25%	60%	Not Modeled	52%	36%	TBD	35%	50%	41%	51%	—
Expected Electricity Reductions (Versus Code Baseline)	0.25 million kWh/yr	0.9 millionkWh/yr	1 million kWh/yr	1.1 million kWh/yr	0.7 million kWh/yr	TBD	2.0 million kWh/yr	1.3 million kWh/yr	2.8 million kWh/yr	3.4 million kWh/yr	13.5 million kWh/yr
Expected Natural Gas Reductions (Versus Code Baseline)	(500) therms/yr	(1,360) therms/yr	1,800 therms/yr	(464) therms/yr	(130) therms/yr	TBD	3,300 therms/yr	32,200 therms/yr	61,000 therms/yr	(18,000) therms/yr	78,000 therms/yr
Expected Cost Savings	$9,800/yr	$116,000/yr	$102,000/yr	$118,000/yr	Not available	TBD	Not Available	Not Available	$253,000/yr	$245,000/yr	$844,000/yr
Simple Payback Period	<5 Years	<5 Years	7.5 years	12.4 years	<5 years	TBD	<5 years	<5 years	4.8 Years	3.9 Years	—

*DOE Better Buildings Challenge Participant: see http://www4.eere.energy.gov/challenge/

successes. Lessons learned during CBP were also available for DOE Better Building Challenge participants such as Best Buy and Kohl's that had committed to 20% company-wide energy savings by 2020.

Some of the stores described below occupied buildings owned by the company; others were in leased spaces. In general, occupying leased spaces did not represent a barrier to saving energy for these companies. Because they paid the entire utility bill (net lease), they were able to negotiate lease terms that allowed them to specify the design of a store and its equipment.

Energy for heating was expected to increase in many of the projects in cold climates compared to baseline (shown by the the quantities in parentheses in the "Projects at a Glance" table) because EEMs that reduced lighting and plug load energy use also cut down on the heating provided by those end uses. In general, this increase in heating energy offset only a small portion of the overall savings caused by the EEMs.

Lastly, each company had its own process in place for improving energy efficiency and propagating design changes throughout its building portfolio. Some companies maintained an internal engineering department that continually searched for additional incremental savings; others depended on outside consultants. All the companies profiled here maintained one or more "prototypical" store designs that were replicated and adapted for regional conditions. Some companies tracked energy use and controlled store operations from a central location; others had decentralized tracking and control.

Successful Strategies

Companies that value energy efficiency and use it to their advantage have developed a number of strategies to ensure their energy reduction efforts are successful. Each strategy helps to take advantage of market drivers or overcome barriers that have slowed down or kept companies from achieving their energy savings and sustainability goals. CBP participants used these strategies to successfully invest in energy efficiency:

- **Make saving energy part of the company brand.** Corporate management at many companies recognizes that publicizing sustainability practices can garner customer interest and build loyalty. Successful companies use energy efficiency and other environmentally responsible practices to illustrate their corporate values and differentiate themselves in the marketplace.
- **Focus on corporate commitment.** Companies establish clear lines of authority and responsibility for managing and implementing energy efficiency initiatives. They reward individuals or teams for actions they take to improve energy efficiency.
- **Set quantitative whole-building energy goals.** Having a target to shoot for enables and motivates effective action. Energy modeling has been used by several companies in the design process to identify how far energy consumption can be reduced cost effectively in different parts of the country. Companies use this information to craft company-wide action plans for saving energy.
- **Get operations, branding, and marketing buy-in.** Companies need to protect their brands and ensure positive customer experiences. To succeed, they make saving energy part of these functions and give all company stakeholders a voice in design and acquisition decisions around energy efficiency. Without aligned goals, different parts of a company can end up working at cross-purposes with unwanted results.
- **Invest in resources and analysis.** To achieve energy savings, companies train their internal staff and contract with outside specialists to help make informed decisions based on analysis of the best technologies and incentives available for their particular situations. Energy management teams can pay for themselves when efficiency measures are broadly implemented across building portfolios or when renovation or construction projects with large energy savings potential are targeted.
- **Establish consistent financial metrics.** All companies are concerned with their profit margins. To successfully cut energy use, companies establish financial metrics that they apply consistently to their investments. These companies recognize that energy efficiency offers an opportunity for a solid return and are willing to let the numbers speak for themselves.
- **Look for first-cost savings.** Especially in new construction, energy efficiency in buildings can lead to downsizing of heating, ventilating, and air-conditioning systems. The resulting first-cost savings can improve the business case for EEMs when considered as a whole-building package, even though they might appear uneconomic if evaluated in isolation.
- **Recognize value streams.** In most of their investments, companies look beyond first costs. They recognize and value investments that provide steady income or avoided costs over time. Such investments, which include energy efficiency, help to mitigate the risks of unforeseen cost escalation. To achieve energy savings, they use full life cycle costing when making efficiency investment decisions. A sole focus on quick paybacks can lead to wasted opportunities for long-term cost savings.
- **Consider noneconomic benefits.** Energy efficiency improvements may yield additional benefits beyond the bottom line, such as improved thermal or visual comfort. These improvements attract customers and keep them shopping longer and improve employee productivity.
- **Verify and maintain energy savings.** To maximize energy savings, companies verify that their projects perform as designed after the grand opening. They set energy targets for building subsystems during the design process, invest in commissioning, and check that goals are being met using measurements of energy use. They also measure the performance of building systems over time and keep their

buildings "tuned up" to make sure their investments in efficiency pay off as expected.

- **Seek continuous improvement.** Improving energy efficiency is not a one-time event. To further reduce energy use, companies track energy use and stay up-to-date on the latest technological developments and best practices and make energy use assessment and continuous improvement parts of regular operational practices.
- **Negotiate leases that facilitate saving energy.** In leased spaces, companies negotiate terms to avoid the so-called "split-incentive" barrier to saving energy. They are able to control design and equipment decisions in new construction and reserve the right to replace aging mechanical systems in existing buildings to avoid mounting maintenance and energy costs toward the end of the equipment's life cycle.
- **Take advantage of utility rebates and tax incentives.** Companies improve the business case for efficiency investments by successfully navigating the complexity of rebate programs to take advantage of incentives.[5] Sometimes it even pays for them to hire a third party to handle rebate logistics. Other opportunities include the EPAct 179D federal tax deduction[6] of the cost of energy-efficient property installed in commercial buildings.
- **Collect customer feedback.** Often, resistance to EEMs such as daylighting is based on untested assumptions about what customers do or do not like. Companies can be pleasantly surprised by positive customer reactions when they test these strategies in pilot stores.
- **Minimize tradeoffs**. In heating-dominated climates, steep reductions in internal gains, for example from decreased lighting power density, can increase heating demand during the winter, offsetting some of the EEM savings. Combining reductions in internal gains with measures that also decrease heating loads, such as adding insulation, installing demand controlled ventilation, and recovering exhaust waste heat, can help maximize energy savings.

[5] See the Database of State Incentives for Renewables and Energy Efficiency (DSIRE) at http://www.dsireusa.org/
[6] DOE 179D Calculator: http://apps1.eere.energy.gov/buildings/commercial/179d/

Highlighted Technical Solutions

- ***Demand responsive equipment and controls.*** Opportunities to ramp down equipment under reduced demand include using variable speed HVAC supply fans and condenser fans, demand controlled ventilation, and electric lights (in response to daylight or absence of occupants).
- ***Solid-state lighting.*** Solid-state track lighting provides a more efficient and longer lived option for spotlighting merchandise.
- ***Exhaust heat recovery***. In cold climates, much of the energy used to keep a store warm is lost along with exhaust air. Much of this energy can be used to warm incoming ventilation air. This EEM is especially cost effective when ventilation air is brought into the building using a dedicated outside air system, so that the number of heat recovery devices is minimized.

In a general merchandise store, sales floor lighting is the first place to look for big energy savings.

NREL/PIX 19509

Energy Efficiency Measures

Based on the experiences of leading companies, as reflected in DOE Advanced Energy Design Guides for new construction and Advanced Energy Retrofit Guides for existing buildings[7] as well as the CBP case studies presented here, many cost-effective (as defined by the criteria of the industry partners) EEMs are available that can achieve significant energy savings (see "Recommended EEMs" table below) in general merchandise stores. They are low risk, using readily available technologies. Some are low-cost measures that can be included in regular maintenance procedures. When combined with best practices for integrated design, procurement, controls, and delivery assurance, the list below provides an approach to cutting energy use across all building systems, adding up to significant whole-building savings. EEMs that are not applicable in all climate regions are marked with an asterisk (*) in the table below. Check that climate-dependent solutions are a good fit in your region.

Recommended EEMs

Envelope
Weatherstrip/caulk windows and doors where drafts can be felt.
*Add reflective roof covering.
*Increase roof insulation as part of other work required for maintenance.
*Design vestibules to prevent a direct path for wind to carry outdoor air into the store.
Lighting
Replace T12 fluorescent lamps and magnetic ballasts with high-efficiency T8 lamps and instant-start electronic ballasts.
Calibrate any existing lighting controls and optimize settings based on building usage patterns and daylight availability.
Adjust light levels to within 10% of the Illuminating Engineering Society (IES) recommendations for the tasks conducted in each area by delamping and/or relamping.
Improve janitorial workflow to consolidate activities in each area, allowing a reduction in operating hours for lighting.
Replace track lighting with ceramic metal halide or light-emitting diodes.
*Increase the availability of daylight by adding skylights; Install photosensors; use dimming ballasts to dim lights when daylighting is sufficient.
Manage lighting schedules on the sales floor by turning off lights during unoccupied hours to the extent possible.
Use sensors to control lighting in back of house areas (automatic on/automatic off in restrooms and stockrooms; manual on/automatic off otherwise).
HVAC
Test, adjust, and balance air handlers and flow modulation devices to ensure conditioned air volumes meet load requirements.
Verify or establish a comprehensive maintenance protocol for HVAC equipment.
Clean and/or replace air, water, and lubricant filters.
*Verify correct operation of outside air economizer.
Ensure correct refrigerant charge in cooling systems and heat pumps and repair any refrigerant leaks.
Increase thermostat setback/setup when building is unoccupied.
Reoptimize supply air temperature reset baset on current building loads and usage patterns.
Verify adequate deadband between heating and cooling.
Move improperly located thermostats to prevent over or undercooling/heating.
Optimize equipment staging/sequence of operation.
Suspend ventilation during unoccupied periods.
*Replace standard furnace with a high-efficiency condensing furnace.
Replace inefficient motors with correctly sized motors rated as premium efficiency by the National Electrical Manufacturers Association (NEMA).
Convert constant volume or dual duct air handling systems to variable air volume.

[7] Advanced Energy Design Guides and Advanced Energy Retrofit Guides are available at the DOE Commercial Buildings Resource Database: http://apps1.eere.energy.gov/buildings/commercial/resource_database

Recommended EEMs

*Upgrade to demand controlled ventilation to reduce outdoor airflow during partial occupancy.
Use a dedicated 100% outdoor air HVAC system to deliver ventilation air.
Evaporatively cool condenser coils.
Recovery energy from exhaust air streams using heat-exchange or enthalpy-exchange technologies.
Plug and Process Loads
Replace desktop computers with laptop computers where feasible; control computer power-management settings facility-wide through software, ensuring settings cannot be overridden.
Use timers for compressors and turn off lights on vending machines.
Provide power strips in easy-to-access locations to facilitate equipment shutdown.
Apply standby mode to registers when not in use; turn registers off when store is closed.
Obtain lower electricity rates by allowing the utility to disable nonessential equipment during peak load periods or by participating in a demand response program.
Verify that airflow paths around transformers are not blocked.
Verify balanced 3-phase power and proper voltage levels.
Replace equipment with ENERGY STAR® models.

Daylighting with skylights, especially in general merchandise stores with exposed high ceilings, has emerged as a way to cut down on energy consumption and improve visual comfort for shoppers and employees.

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Additional Resources

179D Federal Tax Deduction Calculator
http://apps1.eere.energy.gov/buildings/commercial/179d

American Council for an Energy Efficient Economy (ACEEE)
http://www.aceee.org

American Society of Heating Refrigerating and Air-Conditioning Engineers (ASHRAE)
http://www.ashrae.org/

Consortium for Energy Efficiency
http://www.cee1.org/com/com-main.php3

Database of State Incentives for Renewables and Energy Efficiency (DSIRE)
http://www.dsireusa.org

DOE Commercial Buildings Resource Database
http://apps1.eere.energy.gov/buildings/commercial/resource_database

ENERGY STAR information for retail stores
http://www.energystar.gov/ia/business/EPA_BUM_CH13_Retail.pdf

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