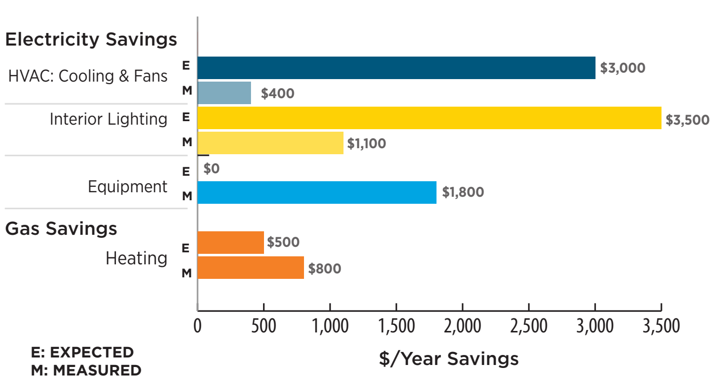
Efficiency is a Good Deal for Best Buy Corporation

Best Buy Corporation partnered with the U.S. Department of Energy (DOE) to develop and implement solutions to achieve 50% energy savings in new construction versus requirements set by ASHRAE/ANSI/IESNA Standard 90.1-2004[1] as part of DOE's Commercial Building Partnership (CBP) program.[2] The National Renewable Energy Laboratory (NREL) provided technical expertise in support of this DOE program. NREL's role in the Best Buy Partnership was to review and evaluate solutions developed by Best Buy and its architecture and engineering consultants as part of a thorough prototype redesign.

Best Buy selected a new store in Lakewood, Colorado, for the CBP collaboration. Its goal was to measure the performance of its latest "high performance" store design and to explore new energy efficiency measures (EEMs). Best Buy's energy use is dominated by the electronics products on display, making the 50% goal currently unattainable. However, aggressive lighting EEMs (including daylighting the main sales area and reduced lighting power density), demand controlled ventilation, and reduced plug load power density compared to a typical store (due to store program changes) brought the Best Buy energy savings to 22% savings versus the code baseline from October 2011 through September 2012, in line with model expectations. An in-situ submetering system allowed disaggregation of electrical loads. Additional EEMs were identified during the design process that could increase these savings in the future.

Best Buy is a participant in the DOE's Better Buildings Challenge,[3] a commitment to reduce energy use company-wide by 20%, and an EPA ENERGY STAR® partner, highlighting the products it sells that qualify for the ENERGY STAR label. The uptake of appliance efficiency standards has had a beneficial side effect of reducing Best Buy's plug loads over time.

Expected and Measured Energy Cost Reductions



Daylighting is a key strategy to save energy at Best Buy.
Photo by Dennis Schroeder, NREL 22076

Project Type	General merchandise (electronics), new construction
Climate Zone	ASHRAE Zone 5B, cool and dry
Ownership	Leased, pays all utility bills
Barriers Addressed	Short payback period for new technologies was required because of a short lease term
Square Footage	30,500 ft^2
Measured Energy Savings (Versus ASHRAE 90.1-2004)	22% total 82,000 kilowatt-hours (kWh)/yr of electricity 3,500 therms/yr of natural gas
Measured Cost Reductions (Versus ASHRAE 90.1-2004)[4]	$4,100/yr
Simple Payback Period	< 5 years
Carbon Dioxide Emissions Avoided[5]	77 metric tons/yr
Construction Completion Date	March 2011

[1] ASHRAE 90.1: https://www.ashrae.org/resources--publications/bookstore/standard-90-1-document-history#2004

[2] CBP is a public/private, cost-shared initiative that demonstrates cost-effective, replicable ways to achieve dramatic energy savings in commercial buildings. Companies and organizations, selected through a competitive process, team with DOE and national laboratory staff who provide technical expertise to explore energy-saving ideas and strategies that are applied to specific building projects and that can be replicated across the market.

[3] DOE Better Buildings Challenge: http://www4.eere.energy.gov/challenge/home

[4] Using $0.04/kWh of electricity and $0.23/therm of natural gas provided by Best Buy

[5] EPA Greenhouse Gas Equivalencies Calculator: http://www.epa.gov/cleanenergy/energy-resources/calculator.html

Decision Criteria

At Best Buy, EEMs had to meet the same criteria as any investment of capital to meet the company's obligation to its shareholders. Customer experience was also a primary consideration. Any EEM that potentially impacted that experience was closely scrutinized from a branding and a merchandising perspective. Lakewood was selected for the project because it offered a good mix of weather conditions, allowing Best Buy to test heating and cooling efficiency strategies and to compare the store's performance to that of a nearby "typical" Best Buy that was submetered for benchmarking purposes.

Economic

The primary economic criterion used by Best Buy was whether EEMs had a simple payback period of less than 3 years. Soft benefits, reflected in positive feedback from employees and customers, add value to measures such as daylighting and were considered in the decision-making process. Utility rebates are sought on a project-by-project basis where possible by Best Buy; however, they were not obtained for this project. No Best Buy department is consistently responsible for obtaining rebates; third-party consultants are used but only for specific projects. EPAct 179D federal tax deductions[6] were not included in the business case for EEMs because, although they do impact the company's bottom line, they do not affect the capital budget requested for efficient technologies.

Branding

As mentioned above, a seamless customer experience is a major commitment at Best Buy. Best Buy strives to minimize plug loads during unoccupied and even during occupied hours, for example not cooling sales floor refrigerators. However, many sales floor electronics products need to remain on when the store is open for customers to try. At the same time, Best Buy has branded itself as an environmentally responsible company, promoting ENERGY STAR-labeled products and supporting an extensive in-store electronics recycling program.

Operational

Best Buy's facilities and maintenance team was involved in decision-making around new EEMs. If a measure required frequent attention or maintenance to perform well, it was given a lower priority than a simpler strategy that would perform reliably. The same held true for equipment installation: to be selected, equipment installation and commissioning had to be straightforward.

Policy

Sustainability is a focus of Best Buy's business practices, in terms of recycling, sustainable building design, and energy use reduction, among others. The company received bulk LEED™ certification at the Silver designation and tracks both store energy performance and sales of ENERGY STAR®-rated products. As mentioned above, the company was an early participant in the DOE Better Buildings Challenge and purchases significant amounts of "green" power from renewable resources.

The company maintains an energy management team, focused on rolling out a centralized energy information system across the company. This team is distinct from the prototype design management team, though the two groups collaborate.

Lastly, the company has been moving to a smaller footprint store format, which inherently reduces absolute energy consumption (for example, a 20,000-ft^2 store will use less than a 60,000-ft^2 store) regardless of energy use intensity (EUI) trends.

Project Notes

As a matter of corporate policy, Best Buy does not share the capital cost of individual EEMs or packages of EEMs. Equipment costs vary for different manufacturers and different customers. Therefore, the economic details of EEMs are not presented. Additional notes include:

- In the past, the prototype team was responsible more for maintaining design and construction documents; more recently, though, the team has become proactive in pursuing energy improvements. The team in charge of prototype development is also responsible for the company's LEED-related activities.
- In general, Best Buy pursues a strategy of gradual improvement of its store prototype designs. However, for this project Best Buy hired outside architects and engineers to fully review the design and build a business case for new EEMs, with the CBP goals in mind.

[6] DOE 179D Calculator: http://apps1.eere.energy.gov/buildings/commercial/179d/

Energy Efficiency Measures

The table below contains the EEMs considered for the Lakewood, Colorado Best Buy. Whole-building savings numbers only account for the EEMs approved by Best Buy and include electricity and natural gas. EEMs that are not applicable in all climates are marked with an asterisk (*). EEMs that are climate dependent should be evaluated based on the project location. EEMs are listed in order from greatest to least savings in each end use. Because the cost of natural gas was only about 20% of electricity on a per-Btu basis, EEMs that mainly saved natural gas such as demand controlled ventilation had relatively small energy cost reductions despite significant energy savings.

EEM	Implemented in This Project	Will Consider for Future Projects	Expected Annual Savings	
			kWh/yr	$/yr
Envelope: 1% Whole-Building Savings Expected Versus ASHRAE 90.1-2004				
*Increase roof insulation to R-19.	Yes	Yes	9,000	2,000
Lighting: 10% Whole-Building Savings Expected (4.4% Measured) Versus ASHRAE 90.1-2004				
*Daylight the store, including main sales area.	Yes	Yes	49,000	2,000
Reduce installed interior lighting power density to 1 W/ft^2.	Yes	Yes	45,000	3,000
HVAC: 14% Whole-Building Savings Expected (1.5% Measured) Versus ASHRAE 90.1-2004				
Improve EER to 11.5 and improve fan efficiency for sales floor packaged rooftop HVAC units.	Yes	Yes	136,000	5,000
Use variable-frequency drives on RTU supply fans serving the main sales floor.	No	Yes	129,000	2,000
*Install heat recovery on RTUs serving the main sales area with bypass when heat recovery not needed.	No	Yes	111,000	3,000
*Reduce HVAC cooling capacity by 1/3 (going from 90 tons to 60 tons).	No	Yes	59,000	3,000
Use demand controlled ventilation controlled by carbon dioxide levels in the store.	Yes	Yes	39,000	200
Convert HVAC system for back of house from constant volume system with bypass to a variable air volume.	No	Yes	6,000	700

*Climate-dependent EEM

Energy Use Intensities by End Use

Energy modeling was an integral part of the design process for the Lakewood store. The architecture and engineering firms Perkins + Will and Dunham Engineering thoroughly re-evaluated the architectural, electrical, and mechanical design of Best Buy's store prototype and suggested changes to improve energy efficiency. The firms worked with Best Buy to screen the EEMs against Best Buy's business criteria, using energy cost savings from EQuest energy simulations and costs provided by Best Buy. NREL simulated the final design package in EnergyPlus[7] to provide third-party verification and evaluated some of the most promising EEMs that did not clear Best Buy's economic hurdles to study their potential impact on energy consumption.

To determine whole-building savings versus code, two building models were developed, as described below. NREL modeled each EEM separately by adding it to the baseline model and calculating the energy savings versus the code baseline. The entire EEM package corresponding to the final building design was also modeled to capture interactions between EEMs and between building systems. All models were run with the observed weather from Lakewood Colorado.

A third model (not shown) was developed that included the impact of additional HVAC EEMs that were not part of the final design, such as adding variable-frequency drives to RTU supply fans and putting heat recovery on two RTUs serving as dedicated outdoor air delivery units. The additional EEMs raised model savings to 34% versus ASHRAE 90.1-2004.

Code Baseline

The first model represented minimal compliance with ASHRAE 90.1-2004 requirements (parameters are taken from Appendix G, though building orientation was fixed according to the store orientation, rather than rotated as specified by Appendix G) and ASHRAE 62.1-2004 for ventilation. The Lakewood Best Buy code baseline model had an EUI of 92 kBtu/ft^2.

Final Design

The second model represented a store built and operated to Best Buy's current new store prototype specifications as represented by the Lakewood store; it had an annual EUI of 67 kBtu/ft^2, 25% below code. Savings resulted from lower lighting power density, daylight harvesting, improved building envelope, and more efficient HVAC equipment than ASHRAE 90.1-2004 required. Miscellaneous electric loads were identical in the baseline and final design models. Installed power and schedules for this end use were taken from a nearby store in Centennial, Colorado, where electrical submeters were installed for benchmarking.

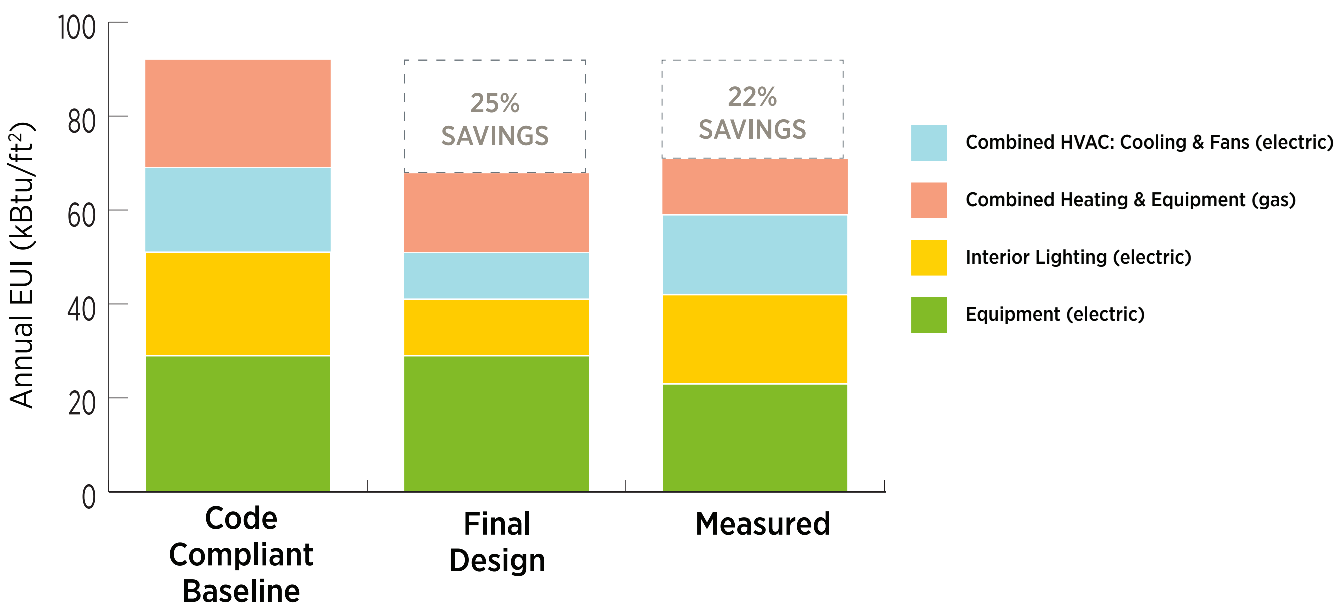
The energy model of the final design was based on Best Buy's design development documents, construction drawings, and knowledge about its occupant density, plug load diversity, real efficiency curves for HVAC systems, and other factors specific to Best Buy stores.

Measured Energy Use

From October 2011 through September 2012, the store consumed 71 kBtu/ft^2, 22% below the code baseline. HVAC and lighting energy savings fell below expectations while the difference was made up by plug load reductions (25% during store hours) and natural gas savings. Greater attention to reducing nighttime lighting power would have maximized energy savings from the lighting EEMs.

[7] EnergyPlus: https://apps1.eere.energy.gov/buildings/energyplus/

Comparing Estimated EUI of Energy Models and Measured Energy Use



Annual Energy Use and Percentage Savings by End Use

	Code Baseline	Final Design		Measured	
End Use Category	Annual EUI (kBtu/ft²)	Annual EUI (kBtu/ft²)	Percent Savings Versus Code Baseline	Annual EUI (kBtu/ft²)	Percent Savings Versus Code Baseline
Heating (gas)	23	17	26	12	48
Cooling and Fans (electric)	18	9.9	45	17	6
Interior Lighting (electric)	22	12	45	19	14
Equipment (electric)	29	29	0	23	21
Total	**92**	**67**	**25**	**71**	**22**

Building Energy Savings From Implemented EEMs by End Use

Electricity End Use Category

	Expected Savings (kWh/yr)	Measured Savings (kWh/yr)
Cooling and Fans	71,000	9,100
Interior Lighting	86,000	27,000
Equipment	0	46,000
Electricity Total	**157,000**	**82,100**

Natural Gas End Use Category

	Expected Savings (therms/yr)	Measured Savings (therms/yr)
Heating	2,100	3,500
Natural Gas Total	**2,100**[8]	**3,500**

8 Equivalent to 61,500 kWh.

Notes: Natural gas consumption for service hot water was relatively small and not considered in the study.

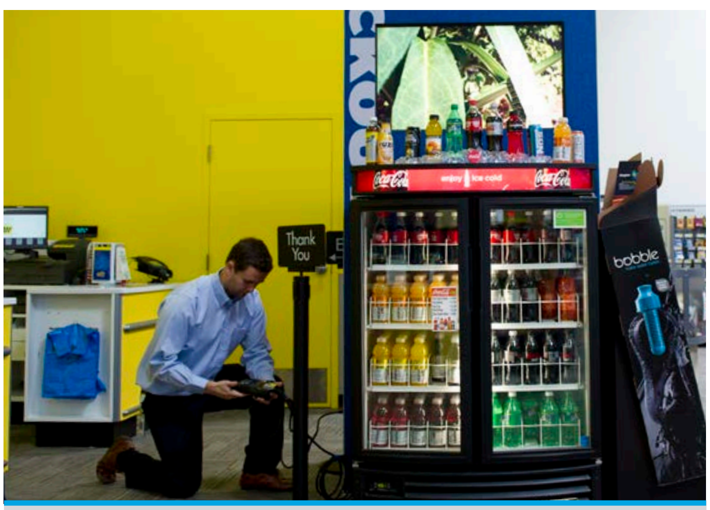
Lessons Learned

As part of the CBP work on the Lakewood store, Best Buy and NREL learned several lessons that can help other companies save energy. Highlights are included below:

Light the way to greater efficiency

Daylighting has been a major success story for Best Buy, to the degree that the company is pursuing it as a retrofit measure in existing buildings. The Lakewood store was designed to use just 12 kBtu/ft²/yr for lighting, 45% below a lighting EUI corresponding to ASHRAE 90.1-2004 requirements. The store reached only 19 kBtu/ft²/yr because store lights were often on at night for long stretches of time. In addition, many lessons have been learned along the way:

- Serious attention must be paid to wiring, fixture installation, and sensor calibration during the installation and commissioning processes.
- It is not advisable to rely on a one-time calibration of the system, because daylight characteristics shift over the course of the year.
- If multiple building control systems (security, building automation system, lighting control system) interact with store lighting, they must be integrated to realize the full savings potential of the system. Otherwise one system may turn the lights on contrary to design intent. A best practice is to invest in a single system that handles all building monitoring and control needs.



Plug loads at Best Buy include sales floor electronics items and other miscellaneous loads such as checkout lane coolers and cash registers. *Photo by Dennis Schroeder, NREL 22075*

Analyze whole project's business case

Companies often look at a list of EEM options and choose those that individually meet their investment hurdles. This approach provides flexibility and the ability to add efficiency in a piece-wise manner until capital budgets are reached. However, the business case and energy savings for a combination of EEMs may be better than for the individual measures. Often, EEMs that might be rejected because of a longer payback period can be combined with low- or no-cost EEMs to result in an overall package that pays back in an acceptable time range.

> "Our new enterprise energy management system has transformed us from reactive to proactive when it comes to saving energy."
>
> —Danielle Tallman,
> Prototype and sustainability manager, Best Buy Corporation

Size mechanical systems appropriately

Prototype store designs, with a single configuration of packaged RTUs, save large companies time and effort because they simplify the store design process. However, this simplification can lead to extra cost and energy use when the mechanical system is not sized appropriately to the load it must meet. In the Lakewood case, NREL estimated that the mechanical system could be significantly reduced from its current capacity and still meet the store's heating and cooling needs. The capital and operating cost reductions could be invested in other measures to save additional energy. NREL recommends performing project-specific equipment sizing calculations as a best practice to avoid oversizing.

Recognize the power of data

Best Buy invested in a company-wide enterprise energy management system that is managed by an external partner. The partner tracks store energy use, status of lights, HVAC parameters, and other indicators, and contacts stores when corrective action is needed. Before this change was made, there was often a longer delay before problems were identified and fixed.

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