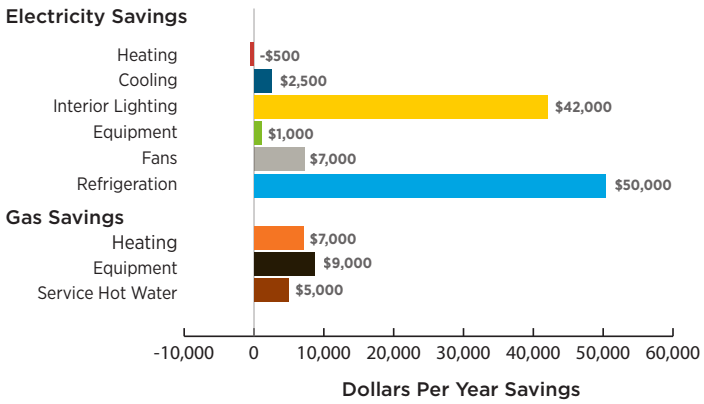
Whole Foods Market Retrofits Multiple Building Systems for Big Annual Energy Savings

Whole Foods Market partnered with U.S. the Department of Energy (DOE) to develop and implement solutions to reduce annual energy consumption in existing stores by at least 30% versus pre-retrofit energy use at its store in Edgewater, New Jersey, as part of DOE's Commercial Building Partnership (CBP) program.[1] The National Renewable Energy Laboratory (NREL) provided technical expertise in support of this DOE program. The store was also benchmarked against the requirements set by ASHRAE/ANSI/IESNA Standard 90.1-2004.[2]

The Edgewater store is a 12-year old, single-story, 49,000-ft^2 building selling packaged food, fresh produce, general merchandise items, and prepared food. Cutting energy use by 30% was challenging, because a large fraction (45%) of the store's energy powered energy-intensive cooking and refrigeration equipment not regulated by ASHRAE 90.1-2004 and therefore typically receiving less attention in terms of energy efficiency compared to building envelope, lighting, and heating, ventilating, and air-conditioning (HVAC) equipment during design.

NREL staff, private sector engineers, and Whole Foods Market engineers brought new energy efficiency measure (EEM) ideas to the table starting with DOE Advanced Energy Design Guide and Advanced Energy Retrofit Guide recommendations.[3] These EEMs were simulated by NREL using EnergyPlus software[4] to assess how much energy they could save. Model-based expectations of energy cost reductions are shown in the graph below. Whole Foods Market installed detailed submetering to measure the impact of the retrofit project on energy use.

Expected Energy Cost Reductions



Whole Foods Market selected efficient lighting and night curtains for open produce cases. *Photo by Pat Corkery, NREL 18596*

Project Type	Grocery store, retrofit
Climate Zone	ASHRAE Zone 5A, cool and humid
Ownership	Tenant, pays all utility bills
Barrier Addressed	Need for trustworthy data on EEM performance and reliability
Square Footage	49,000 ft^2
Expected Energy Savings (Versus ASHRAE 90.1-2004)	32%
Expected Energy Savings (Versus Pre-Retrofit)	29% total 791,000 kilowatt-hours (kWh)/yr of electricity 22,300 therms/yr of natural gas
Expected Cost Reductions (Versus Pre-Retrofit)[5]	$124,000/yr
Simple Payback Period	< 5 years
Expected Carbon Dioxide Emissions Avoided[6]	500 metric tons/yr
Retrofit Completion Date	Expected Spring 2014

[1] 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.

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

[3] Available through the Commercial Buildings Resource Database: http://buildingdata.energy.gov/cbrd/

[4] EnergyPlus: http://apps1.eere.energy.gov/buildings/energyplus/

[5] Using 2011 EIA annual average price of $0.13/kWh from http://www.eia.gov/electricity/sales_revenue_price/pdf/table4.pdf and $9.54/MCF (~$0.93/therm) from http://www.eia.gov/electricity/sales_revenue_price/pdf/table4.pdf

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

Decision Criteria

At Whole Foods Market, EEMs needed to meet criteria similar to those for any investment of capital to meet the company's obligation to its shareholders. The Edgewater location was selected by Whole Foods Market as a CBP retrofit project because the company wanted to test the feasibility of achieving 30% energy savings in the Northeast region. A motivated regional efficiency champion helped make the project possible. Strategies were evaluated against the following criteria:

Economic

EEMs were judged based on having a payback of 3–5 years, taking into account tax incentives, utility rebates, climate, capital costs, installation costs, operations and maintenance (O&M) costs, and energy costs. Additional economic factors included:

- Whole Foods Market pursues utility rebates where they are available and uses them to help guide where to undertake efficiency projects. Rebates were obtained from the local utility provider to help offset initial capital costs invested to lower energy use.
- Pilot funding of measures that do not meet the required simple payback threshold may be considered if other benefits are deemed sufficient to make the investment worthwhile. Whole Foods Market did not provide information on whether this consideration influenced the selection of EEMs for the Edgewater project.

Branding

Environmental stewardship is a key element of the Whole Foods Market brand. EEMs installed at Edgewater showed customers that Whole Foods Market acts in a manner consistent with its branding. Whole Foods Market prominently advertises its efforts to save energy in its stores.

Operational

Whole Foods Market took O&M costs into consideration when judging EEMs, both in terms of the business case for the technologies and their ability to deliver energy savings and services reliably. Whole Foods Market has developed strategies to share best practices for controlling and maintaining equipment from the Edgewater project across the company's multiple regions. Store development leaders work together with local operations leaders to make sure EEMs will not negatively impact store operations.

Policy

Sustainability is a focus of Whole Foods Market's business practices, in terms of waste reduction, water conservation, and energy use in its stores and distribution chain. The company has had green building standards and practices in place for years. CBP was an opportunity to dig into the details of how the stores use energy and cut energy use as a result. Whole Foods Market intends to reduce energy consumed per square foot by 25% company-wide by 2015.

National policy issues that impact energy efficiency choices include tax policy that incentivizes efficiency investments such as the EPAct 179D federal energy tax deduction.[7] Building codes and standards also influence the decision-making process.

Whole Foods participates in the voluntary U.S. Environmental Protection Agency GreenChill Advanced Refrigeration Partnership,[8] which encourages food retailers to use environmentally friendlier refrigerants, reduce refrigerant charge sizes, and eliminate leaks. These efforts reduce the impact of refrigerants on the ozone layer and climate, but are typically energy neutral at best and can even increase energy use.

Energy Efficiency Measures

The table on page 3 shows the EEMs considered during the design process, some of which Whole Foods Market decided to include in the Edgewater store retrofit. The EEMs in each building system are listed in order of decreasing energy savings. Because of the cost difference of electricity and natural gas on a per-Btu basis, cost reductions from EEMs may be ordered differently than energy savings, depending on the proportions of electricity and natural gas saved. Whole-building energy savings estimates were calculated for the approved EEMs relative to pre-retrofit energy use and included electricity and natural gas savings. The business case for the EEM packages depended on capital costs specific to Whole Foods Market and its suppliers which were not shared by the company. EEMs that were not applicable in all climates are marked with an asterisk (*). Climate-dependent EEMs should be evaluated to make sure they are a good match for the project's climate.

[7] DOE 179D Calculator: http://apps1.eere.energy.gov/buildings/commercial/179d/
[8] EPA GreenChill Partnership: http://www.epa.gov/greenchill

NREL and Whole Foods Market worked together to reduce produce area lighting power density at the Edgewater store to 0.8 W/ft2, a 20% decrease. *Photo by Ian Doebber, 18609*

Energy Efficiency Measures	Implemented in This Project	Will Consider for Future Projects	Expected Annual Savings	
			kWh/yr	$/yr
Envelope: 0% Whole-Building Savings Expected Versus Pre-Retrofit Energy Use				
*Apply 2-in spray-on polyurethane insulation to crawlspace ceiling, increasing the sales floor R-value to R-15.75.	No	Yes	244,000	8,000
Lighting: 3% Whole-Building Savings Expected Versus Pre-Retrofit Energy Use				
Reduce lighting power density throughout store.	Yes	Yes	141,000	32,000
Modify lighting schedules to save energy.	Yes	Yes	67,000	16,000
Add occupancy and daylighting sensors.	Yes	Yes	8,000	1,000
HVAC: 4% Whole-Building Savings Expected Versus Pre-Retrofit Energy Use				
Better control air conditioning capacity allowing reduction of pump and condenser fan power.	Yes	Yes	181,000	15,000
Stage condenser fans.	Yes	Yes		
Add variable frequency drive to supply fan motor serving the grocery sales area.	Yes	Yes		
Lower set point for sales floor dew point to 48°F.	Yes	Yes		
Raise sales floor cooling set point to 75°F.	Yes	Yes		
*Lock out HVAC precooling coil based on ambient temperature.	Yes	Yes		
*Add subcooling coils to increase moisture removal capacity and lower store dew point.	Yes	Yes		
*Control humidity based on outdoor air dew point.	Yes	Yes		
Refrigeration: 11% Whole-Building Savings Expected Versus Pre-Retrofit Energy Use				
Increase heat reclaim for service hot water heating from 10% to 30%.	Yes	Yes	156,000	5,000
Replace all existing evaporator fan motors in cases with electronically commutated motors.	Yes	Yes	71,000	9,000
Add doors to open medium-temperature dairy, deli, and packaged produce cases.	Yes	Yes	65,000	8,000
Add light-emitting diode fixtures in all low- and medium-temperature refrigerated cases and walk-in freezers.	Yes	Yes	60,000	8,000
Add alarms to refrigerated walk-in areas to reduce door open times.	Yes	Yes	52,000	7,000
Lower minimum saturated condensing temperature from 95°F to 70°F.	Yes	Yes	35,000	5,000
Include strip curtains and door sealing on all walk-in cooler and stocking doors.	Yes	Yes	25,000	3,000
Use anti-sweat control strategies in combination with reduced sales floor dew point.	Yes	Yes	18,000	2,000
Add night curtains to open meat and produce multideck cases.	Yes	Yes	15,000	2,000
Kitchen: 11% Whole-Building Savings Expected Versus Pre-Retrofit Energy Use				
Consider close-proximity exhaust hood designs and temperature- and particulate-driven control strategies to lower exhaust flow rates.	Yes	Yes	279,000	10,000
Replace kitchen equipment with best-in-class efficient options and turn off equipment at night.	Yes	Yes	261,000	9,000

*Climate-dependent EEM

Energy Use Intensities by End Use

Energy modeling with EnergyPlus was an integral part of the design process for the Edgewater store retrofit. Whole Foods Market was committed to reaching the CBP energy-savings goal for existing buildings, so each design decision was evaluated in the context of how it impacted the simulated store performance. If savings did not reach the goal, more work was done to identify additional opportunities. At the same time, modeled savings were used by the Whole Foods Market financial team to screen EEMs according to whether they met the company's investment criteria.

For some building systems, such as HVAC, modeling an entire package of EEMs was appropriate for Whole Food Market's decision making needs. In other cases, such as refrigeration, the business case for EEMs was assessed individually.

At each stage, the energy model of the proposed design was made as realistic as possible, coordinating with Whole Foods Market to understand the changes planned as part of the retrofit and incorporating knowledge about the number of people in the store over time, plug load diversity, real efficiency curves for HVAC systems, and other factors specific to Whole Foods Market stores.

To assess whole-building savings, three energy models were created as described below. The annual energy consumption of each model by end use, normalized by floor area (called energy use intensity or EUI) is shown in the graph at the bottom of the page.

Code Baseline

The first model represented minimal compliance with the prescriptive specifications of ASHRAE 90.1-2004 and ASHRAE 62.1-2004 for ventilation. Additional work was done to develop a refrigeration baseline, analogous to ASHRAE 90.1-2004, to capture the impact of energy-saving innovations when comparing to this baseline. The Edgewater Whole Foods Market code baseline model EUI was 191 kBtu/ft^2.

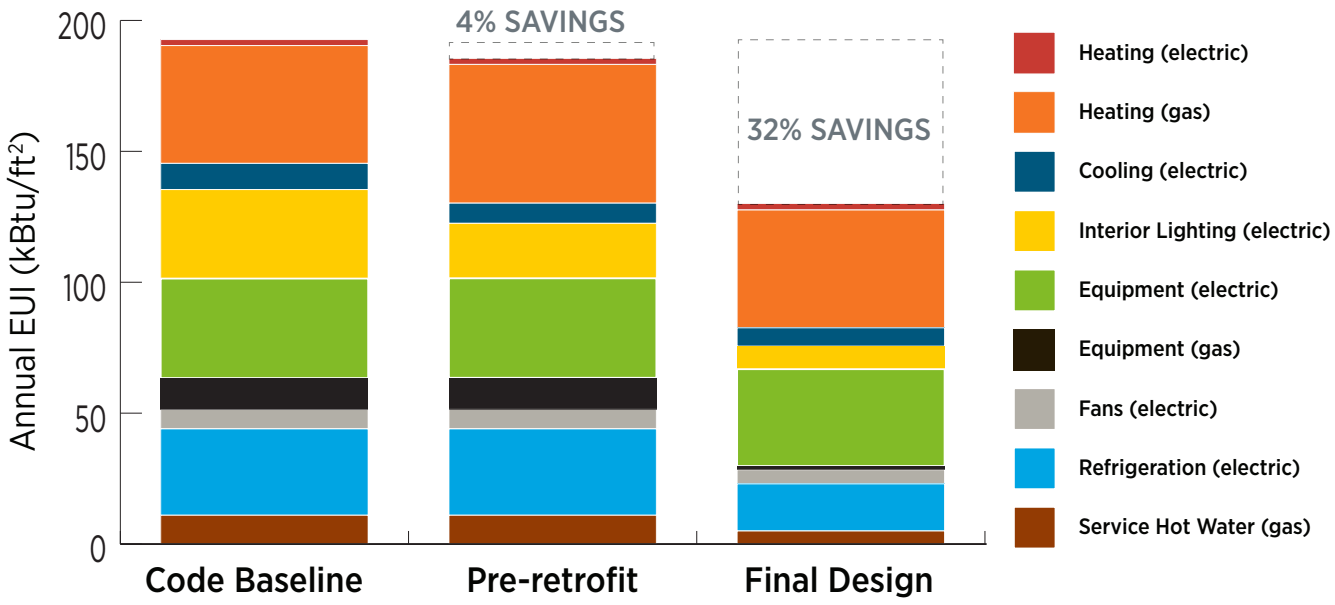
Pre-Retrofit

The second model represented the current energy use of the Edgewater store and had an annual EUI of 184 kBtu/ft^2, 4% below ASHRAE 90.1-2004 requirements. Savings resulted from lower lighting power density and more efficient HVAC equipment than ASHRAE 90.1-2004 required as well as kitchen and refrigeration equipment that were more efficient than standard selections.

Final Design

The third model incorporated the EEMs selected for the retrofit design. This model had an annual EUI of 130 kBtu/ft^2, equivalent to an annual energy savings of 32% versus ASHRAE 90.1-2004 and 29% versus pre-retrofit consumption.

Comparing EUI of Code Baseline, Pre-Retrofit, and Final Designs



Estimated Annual Energy Use and Percentage Savings by End Use

		Code Baseline	Pre-Retrofit		Final Design		
	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	Percent Savings Versus Pre-Retrofit
	Heating (electric)	2.3	2.3	0	2.5	-7	-7
	Heating (gas)	45	53	–18	45	1	16
	Cooling (electric)	10	7.7	23	7.0	31	10
	Interior Lighting (electric)	34	21	38	8.8	74	58
	Equipment (electric)	38	38	0	37	1	1
	Equipment (gas)	12	12	0	1.4	88	88
	Fans (electric)	7.4	7.5	-2	5.4	27	28
	Refrigeration (electric)	33	33	0	18	44	44
	Service Hot Water (gas)	11	11	0	5.0	55	55
	Total	**191**	**184**	**4**	**130**	**32**	**29**

Expected Building Energy Savings From Implemented EEMs versus Pre-Retrofit Use by End Use

Electricity End Use Category	
Heating	-4,000 kWh/yr
Cooling	20,000 kWh/yr
Interior Lighting	324,000 kWh/yr
Equipment	9,000 kWh/yr
Fans	55,000 kWh/yr
Refrigeration	387,000 kWh/yr
Electricity Total	**791,000 kWh/yr**

Natural Gas End Use Category	
Heating	7,600 therms/yr
Equipment	9,300 therms/yr
Service hot water	5,300 therms/yr
Natural Gas Total	**22,300 therms/yr[9]**

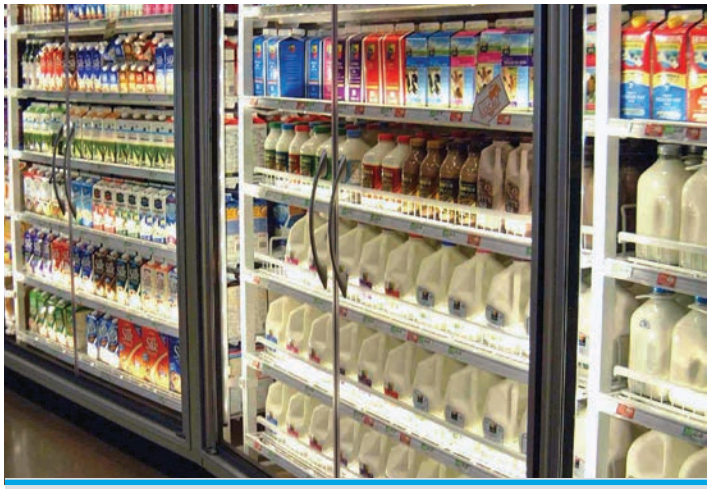
[9] Equivalent to 653,000 kWh

Lessons Learned

Whole Foods Market and DOE learned lessons during CBP that can help other companies achieve similar results. Several lessons from the Edgewater retrofit project that stood out include:

Build efficiency into company-wide habits

Whole Foods Market maintains a set of architectural and engineering principles that are updated to include best practices from projects such as the Edgewater retrofit, including the design process, successful EEMs, and the procurement process. These principles and results from EEM pilot testing are discussed at meetings where the leaders from all geographic regions are present.



Whole Foods Market found that efficient refrigeration cases with doors do not present an inconvenience to shoppers. *Photo by Jennifer Scheib NREL 18606*

Leased space can be efficient

Common wisdom about commercial building energy efficiency often makes reference to the "split incentive" problem where landlords do not invest in efficiency because they do not capture the resulting savings while tenants fail to invest in efficiency because they do not own the building. However, it is typical for large companies such as Whole Foods Market that pay their own utility bills to work closely with their developers and landlords to ensure they have rights built into their leases to deploy energy efficiency and renewable energy generation. According to Whole Foods Market, its energy saving efforts are not negatively impacted by leasing space for its stores.

> "We've been trying to prove the benefits of installing doors on refrigerated cases for increased acceptance by our regions. For some, installing doors was an innovation, because we want to satisfy and delight our customers — and that means making it easy for them to shop. It was considered more convenient to select products right off the shelf without having to open doors previously, but many customers have provided such great positive feedback about them."
>
> —Kathy Loftus,
> Global leader of sustainable engineering and energy management, Whole Foods Market Corporation

Collect customer feedback

Companies often have preconceived notions about the shopping experience in their stores that hinder innovation. When it came to refrigerated display cases and daylighting, Whole Foods Market tried out new EEMs and found that its concerns about impacting shopper experience were unfounded. The company was concerned that doors on refrigerated cases would present a barrier to customers and that light levels would not be pleasing unless the store was evenly lit by electric lighting. By deploying EEMs in a limited pilot test and collecting customer feedback, even at an anecdotal level, Whole Foods Market was able to stretch its ideas about what changes are acceptable to its clientele. In both cases, the EEMs received positive reviews from customers and are now are being used across the company's building portfolio.

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