





jcpenney Retail Renovation

jcpenney Is Sold on Energy Efficiency

jcpenney is teaming with the U.S. Department of Energy's (DOE's) Pacific Northwest National Laboratory (PNNL) to find ways to save energy at its store in Colonial Heights, Virginia. As a participant in DOE's Commercial Building Partnerships (CBP) program, jcpenney is working with PNNL to explore energy design measures (EDMs) that may be applied at over 1,100 jcpenney sites across the nation. Computer modeling predicts 45% improved energy performance, returning nearly $64,000 in energy savings plus about $23,000 in maintenance per year, for the Colonial Heights store compared to baseline operations.

Site Selection

jcpenney and PNNL selected Colonial Heights after evaluating several potential sites for an energy upgrade. One reason this site was chosen was because it was already scheduled to undergo renovation. In their site selection criteria, jcpenney placed a high priority on working on buildings that were already slated to be upgraded. This approach allows for energy saving measures where such measures might otherwise be too expensive. For example, upgrading roof insulation when a new roof is already planned means the company doesn't have to pay twice for the roofing membrane.

Pacific Northwest NATIONAL LABORATORY

"jcpenney's goal is to be a leader in performance and execution within the retail industry. With more than 100 million square feet of space in our stores, aggressive energy management plays a vital role in moving us toward this goal."

Myron E. (Mike) Ullman, III, jcpenney chairman and chief executive officer, press release dated March 9, 2007
EPA Names jcpenney 2007 ENERGY STAR Retail Partner of the Year

jcpenney has been a long-time leader in environmental stewardship. The company is a partner in the Environmental Protection Agency's ENERGY STAR program and was the first retailer to qualify for the ENERGY STAR label. In 2011, jcpenney received its third consecutive ENERGY STAR Sustained Excellence Award for ongoing efforts in energy management. jcpenney has qualified for Gold and Silver Leadership in Energy and Environmental Design (LEED) certifications for both new and existing buildings from the U.S. Green Building Council.

jcpenney: Dedicated to Energy Management

jcpenney's dedication to energy management is further reflected in its energy savings goals:

- Reducing building energy consumption by 20% by 2015
- Increasing ENERGY STAR building certifications to 400 stores by 2013
- Updating more than 800 stores for an overall energy savings of almost 6%
- Retrofitting more than 240 stores with energy efficient lighting systems
- Expanding advanced metering technologies to 165 facilities
- Developing an Advanced Energy Management pilot program, which achieved energy savings of 15% in 10 trial stores

Colonial Heights Project at a Glance

LOCATION
Colonial Heights, Virginia

BUILDING TYPE **Retail**

BUILT **1989**

AREA **107,216 ft²**

NUMBER OF FLOORS **1**

CLIMATE ZONE **4A**

PEAK OCCUPANCY
671 customers and staff

ENERGY SAVING GOAL
30% less energy use than existing operations

ESTIMATED ENERGY SAVINGS
45% compared to historic operations

49% compared to renovation if EDMs not installed

ENERGY USE INDEX (EUI) BEFORE RENOVATION
64 kBtu/ft²/yr

EUI PROJECTED AFTER RENOVATION
35 kBtu/ft²/yr

On-Site Inspection

To fully explore the energy saving opportunities, PNNL and jcpenney engineers and lighting designers conducted a comprehensive building energy audit of the Colonial Heights store. On-site visits are vital to gathering the information needed for analysis and understanding the condition of the building and equipment and how it is being operated. On-site inspections allow for measurements of building operation and equipment performance. These measurements are important to establishing a baseline building model and for confirming that plans and other documentation are accurate.

Whole building integrated design impacts refers to treating a building as a system. A change in one building component will interact with other components. With careful design, energy savings in one area can produce energy savings in another. For example, at Colonial Heights, reducing the lighting load not only results in less energy used for lighting, but also reduces heat loads, making it easier to cool the building. Additional insulation and an energy recovery ventilator on the roof further reduced load. As a result, jcpenney could install smaller, more efficient HVAC systems at less cost.

jcpenney brought in its in-house experts in lighting design, mechanical engineering, and controls, who were actively engaged in all aspects of the inspection. "These are the top experts at jcpenney," said PNNL researcher Mike Rosenberg, "and they were in there with us after midnight counting light bulbs and verifying circuits."

The team was also joined by Wayne Cook, an electrician who has serviced the Colonial Heights store for many years and knows the building extremely well. jcpenney invited Cook for his in-depth knowledge of the building and its history, and the team agreed that Cook's presence paid dividends. Said Rosenberg of Wayne, "Facility electrical and engineering staff often operate behind the scenes. Although they are out of sight to most customers, these individuals often have the best handle on how a building operates and the history behind it. Wayne Cook was an invaluable source of information for the project."

The on-site inspection included installing monitors to better understand some loads. A number of monitors were installed to measure energy consumption and operating schedules for fans, pumps, heating equipment and miscellaneous electric loads.



Investing in Energy Savings

When evaluating energy design measures, jcpenney looks at the life-cycle cost to ensure that it meets their business criteria. A design measure must have an internal rate of return meeting a minimum threshold over its life before jcpenney will invest in it.

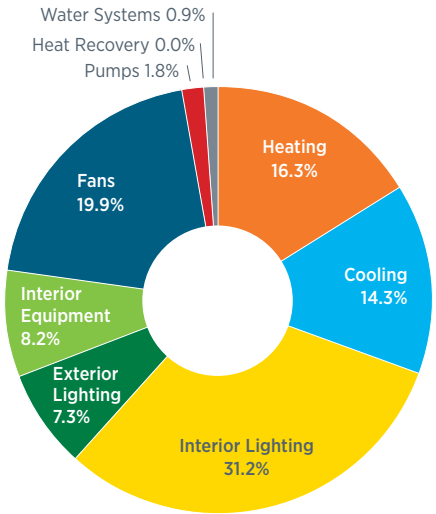
Modeling the Possibilities

PNNL researchers used building simulation models to examine potential EDMs at Colonial Heights. The models helped predict how the EDMs would perform; allowing jcpenney to make decisions about their building based on economic and performance expectations. Models are a cost-effective way to identify complex energy reduction strategies, and enable building owners to explore energy renovation scenarios before any work takes place.

Initial modeling at jcpenney included spreadsheet analyses and Trane Trace models that the company's engineers often use. PNNL followed this with a whole-building analysis using DOE's EnergyPlus™ simulation program—a powerful and versatile tool that uses data on heating, cooling, ventilation, lighting, and other energy using systems to predict how EDMs will perform. The model allows users to explore any number of potential EDMs and accounts for interactions between different types of loads. For example, reducing the energy consumed for lighting will also reduce the need for cooling. Using the model, Partners can make choices based on expected results rather than educated guesses.

The team used EnergyPlus to validate that the energy strategies identified at Colonial Heights were best suited for jcpenney's budget, time, and material constraints. The team refined the EnergyPlus model with utility bill data, which revealed that electrical demand costs accounted for 51% of the building's annual energy cost, followed by electric energy use at 42%, and natural gas at 7%. This helped show where energy use reduction would be most cost effective and how such changes would positively affect the whole building.

jcpenney Colonial Heights Existing Building Energy End-Use Breakdown



EnergyPlus: A Powerful Whole-Building Simulation Tool

The Colonial Heights team needed a calibrated energy model to assess the savings potential of several EDMs for the 107,000 ft^2 building, but because of unique HVAC systems, it may have been impossible to get an accurate model using common simulation tools. EnergyPlus enabled modelers to simulate this equipment and develop an aggressive list of EDMs. This versatility will be especially beneficial to future jcpenney retrofit projects because other stores use the same equipment.

Immediate Benefits

The audit identified several immediate improvement opportunities at Colonial Heights including:

- The main fan system was running at a low speed, 24 hours a day, instead of shutting off completely when the store was unoccupied.
- Two large electric heaters meant for freeze protection were set to 65 degrees, warming the ventilation air being brought in from outdoors, even when cooling was needed.

jcpenney quickly corrected both these situations, and upgrades to the building energy management system will help prevent them from occuring again.

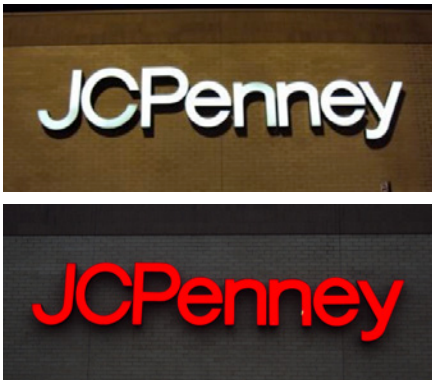
"Going to LEDs makes it more comfortable to shop at the cosmetics counter. Also, products under the heat sometimes get too hot and must be thrown away. Since LEDs produce less heat, there is less spoilage."

Chris Morgan, Energy & Engineering Senior Manager, jcpenney



Lighting Retrofit Package: Energy & Maintenance Savings

Package cost	$133,603
Energy savings	421,994 kWh/yr (-3,043 therms)
Energy cost savings	$27,259/yr
Maintenance savings	$19,903
Simple payback	2.8 years
Net present value of savings	$338,923
Benefit-to-cost ratio	3.5
Total building energy savings	15.5%



(Top) Old neon sign at jcpenney Colonial Heights, Virginia. (Bottom) New LED sign.

Energy Design Measures

The recommended EDM package resulted in predicted energy savings of 45% of the Colonial Heights store's historic baseline energy use. The EDM package saves 49% of the energy that would have been used in the store when new features included in the renovation are incorporated into the baseline. These features include a new cosmetic sales area with increased accent lighting, a portrait studio, increased sales area lighting, and increased ventilation needed to meet code requirements. The package met jcpenney's business criteria with an estimated internal rate of return of 15.6% based on JCPs internal financial calculations.

Lighting

Lighting accounted for about one third of the total building energy at Colonial Heights. A PNNL lighting expert worked with jcpenney to assess potential improvements. Although the connected lighting load at Colonial Heights was already very low (1.1 W/ft^2 compared to the ~2.5 w/ft^2 allowed by ASHRAE Standard 90.1-2004, thirteen lighting EDM opportunities that met jcpenney's business criteria were found, resulting in key lighting improvements. Examples of the most effective lighting EDMs are as follows:

- **LED LIGHTING.** A large portion of lighting savings at Colonial Heights came from replacing all of the 50 watt incandescent display lighting in the store with 16 W LED lighting. LEDs were also installed as case lighting at the cosmetic counters instead of fluorescent lighting, which according to jcpenney, improved the shopping experience and product longevity.

- **PARKING LOT LIGHTS.** jcpenney replaced the 1000 watt metal halide lamps in their portion of the parking lot with 320 watt pulse start ceramic metal halide lamps for an energy savings of 78,020 kWh per year. It was

during this exercise that jcpenney discovered that all its parking lot lighting turned off at 12:00 AM, contrary to jcpenney security policy, which requires some parking lot lighting to be left on from dusk to dawn for associate security. The energy savings measures identified by the team allowed jcpenney to restore parking lot security lighting while still meeting the 30% energy savings goal.

- **LIGHTING CONTROLS.** The lighting circuits in the store had become out of sync, causing lights to be on when they weren't needed (e.g., retail display lighting on during housekeeping hours). After some quick adjustments and several hours of the electrician's time, appropriate circuiting and switching was restored. The team also found non-functioning occupancy sensors and identified other areas where occupancy sensors could be added.

- **SIGNAGE.** Three large jcpenney neon signs were replaced with energy-efficient LED signs.

The overall lighting package was estimated to save a 421,994 kWh and $47,162 per year at a capital cost of $133,603, resulting in a simple payback of 2.8 years.



(Top) New High-Efficiency Rooftop Packaged Air Conditioning. (Bottom) New High-Efficiency Air-Cooled Chillers.

HVAC

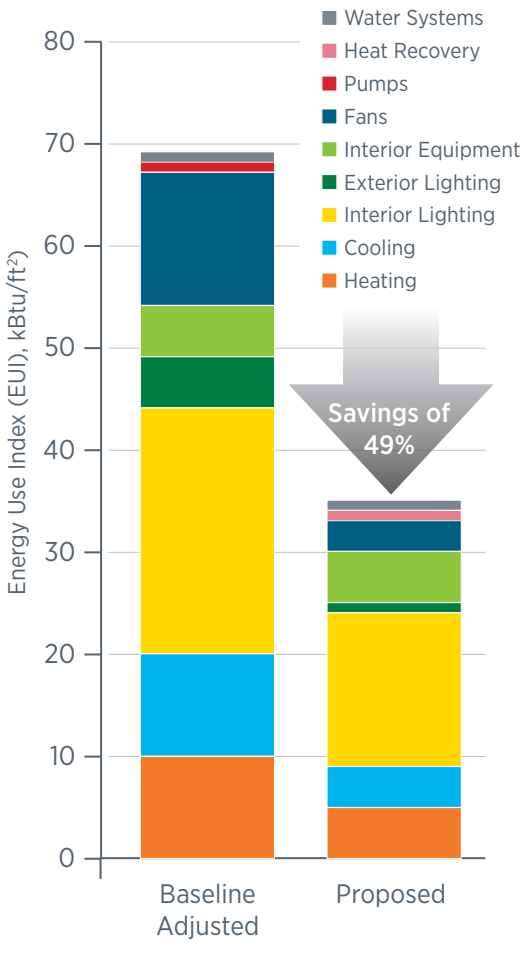
Much of the Colonial Heights HVAC system was near the end of its useful service life and needed replacement, presenting a good opportunity for replacement with more efficient equipment which otherwise might not have been cost effective. jcpenney made several HVAC changes, including:

- Modifying HVAC equipment runtime to more closely match store operation.
- Replacing two packaged RTU (rooftop unit) air conditioners serving the office and salon with high efficiency units with functioning economizers.
- Resizing and installing high efficiency air-cooled chillers and chilled water pumps, downsized to meet reduced building loads.
- Installing an energy recovery ventilator to recover exhaust air energy from the sales area, restrooms, and salon to pre-condition sales area ventilation air.

Insulation

Because the roof at Colonial Heights was scheduled for replacement, the team suggested that it would be a cost-effective time to add insulation. jcpenney added two inches of R-12 polyisocyanurate insulation at a minimal cost and with significant benefits, prompting a decision to evaluate extra insulation for all future re-roofing projects.

Annual Energy End-Use Results









(Top) Interior LED lighting upgrades improve the shopping experience with enhanced color rendition and save energy.

(Middle) Replaced 1,000 Watt Metal Halide (MH) with 340 Watt MH in parking lot lighting.

(Bottom) Soda machine with retrofit vending miser.

The Rest of the Package

In addition to the EDMs described above, the final package of recommended EDMs included the following:

- Add entry door weather stripping
- Replace the two packaged RTU air conditioners with new, high efficiency units
- Install demand controlled ventilation (based on CO_2 concentration) on main air handling unit to reduce outdoor air ventilation air when building is less than fully occupied
- Install an energy recovery ventilator, to recover exhaust air energy from the sales area, restrooms, and salon to pre-condition ventilation are in the sales area
- Replace large supply fan motors with premium efficiency motors, downsized to meet reduced load
- Replace chillers with new high efficiency, air-cooled scroll chiller, downsized to meet reduced load
- Replace chilled water pump with two high efficiency pumps and motors, downsized to match new chilled water flow rate
- Clean chilled water coil to reduce air-side pressure drop and increase heat transfer
- Abandon pneumatic controls and air compressor
- Optimize and retro-commission HVAC controls system
  - Optimize HVAC equipment run time—remove opt start, shorten schedules
  - Optimize AHU SF speed control—limit maximum speed at all times, reduce fan speed to zero during setback hours
  - Divide sales floor zoning—allow fans and heaters to modulate to meet individual zone requirements
  - Reset outdoor air damper minimum to bring in required ventilation
  - Set electric plenum preheaters at main air handler for 40°F (freeze protection only)
  - Fix relief fan control so fan is off when commanded
  - Lower heating setpoint in vestibules and stockrooms from 68 to 60°F
  - Correct operation of stock room gas fired unit heater—burner is out and fan is running 24/7
  - Remove unnecessary fan-powered boxes—replace five fan-powered boxes on perimeter where re-heat is needed (building control system)
  - Abandon transfer fan to alterations room
  - Add miscellaneous unit heaters, baseboard heaters, and exhaust fans to DDC system so they can be de-energized at night
- Add vending misers to vending machines in break room

Performance Upgrade

Working together, jcpenney and PNNL identified EDMs that are estimated to improve the Colonial Heights store's energy performance by nearly 45%. The total cost of the measures amounts to $647,127, with energy cost savings of $63,879 and maintenance savings of $22,817. Dividing costs into the savings provides a simple payback on the measures of 7.5 years. jcpenney based its decisions on which measures to install on the internal rate of return (IRR). The IRR for these EDMs was 15.6%. jcpenney recognizes these EDMs as a sound investment. But in addition this company is focused on energy savings as part of its corporate culture.



Main natural gas meter with a pulse-output monitor installed to gather 15 minute interval data on gas use.

Going Forward

The Colonial Heights site is typical of jcpenney buildings in terms of age, lighting, and mechanical systems, making it a great candidate to select EDMs and lessons learned that will likely apply at many jcpenney stores.

jcpenney has installed all of the measures described in this case study potentially achieving savings of 45% of historic energy use. In comparison to the store's energy consumption with new and upgraded features included in the planned renovation, savings amounted to 49%. Future metering and monitoring of the energy using systems and utility bills will enable jcpenney and PNNL to ensure the EDMs are functioning as anticipated and the predicted energy savings will be realized. The graph at the end of this profile shows projected energy savings in comparison to what the renovated store would have used without the energy upgrades.

Metering to Validate Performance

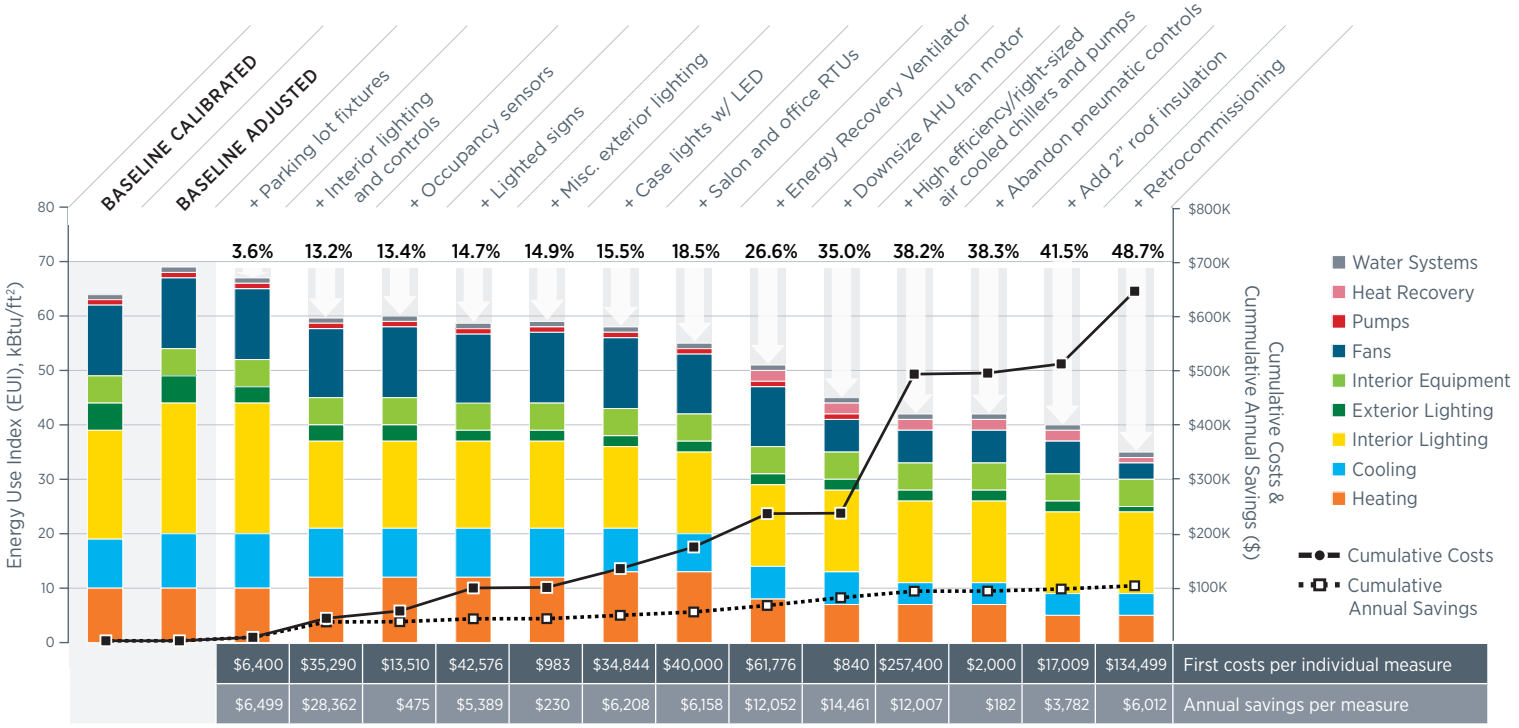
jcpenney has agreed to allow their site to be used to collect metered data from almost every electrical load in the store—much greater detail than would have been required to confirm energy savings. This study of miscellaneous energy loads will help researchers determine how big these loads are and find strategies for reducing them.

PNNL and jcpenney will monitor building energy use after EDMs are installed to verify performance. In addition to the study of miscellaneous energy loads, metering will include temporary measurements of power, temperatures, and illumination, and long-term trending using the store's energy management control system. PNNL will monitor this information as well as utility bills for up to 18 months to track performance during both the heating and cooling seasons. jcpenney purchased the meters used for the long term trending, and they will remain in place so the company can continue to monitor the store's operating performance on an ongoing basis.

"When this building was constructed about 20 years ago, the selection process was undoubtedly not very scientific. Technology has evolved since then, and new information is available before decisions need to be made. jcpenney is making use of that knowledge."

Chris Morgan, Energy & Engineering Senior Manager, jcpenney

jcpenney Annual Energy End-Use & Savings Preliminary Results



These bars shows the potential incremental energy savings achieved at the Colonial Heights jcpenney store in comparison to what the renovated store would have used with new features such as a redesigned cosmetic counter and photography studio. Rounding errors can obscure small differences between EDM packages. Results are based on EnergyPlus model simulations of the whole building and the entire EDM package. When individual measures are considered separately, savings may be dependent on related measures. All of the measures are needed to achieve overall savings.

Commercial Building Partnerships

The U.S. Department of Energy (DOE)'s Commercial Building Partnerships program provides assistance through national laboratories to companies and organizations that design, build, own, manage or operate portfolios of buildings. DOE offers technical assistance and guidance on implementing energy efficient technologies to transform commercial buildings. Companies and organization work with DOE, national laboratories, and private-sector experts to achieve energy savings that meet their budget and other criteria. The goal is to achieve whole building energy savings of 30% or better in retrofits when compared to existing energy use, and 50% or better in new construction compared to a minimally code compliant ASHRAE Standard 90.1-2004 baseline.

Partners provide a living laboratory in their work with the Commercial Building Partnerships.e Partners' buildings provide opportunities to test and validate DOE's advanced building models and technologies. The buildings help researchers to understand energy loads and operations and the information that companies need to make good decisions about energy efficiency.

DOE national laboratories identify energy design measures to meet energy saving goals through design reviews, building inspections, modeling, and packaging recommendations that can be replicated in future projects. Collected information provides the operational and cost data needed to make a solid business case for investment in high-performance buildings. These findings enable replication throughout Partners' building portfolios and the commercial building sector at large.

U.S. DEPARTMENT OF ENERGY
Energy Efficiency & Renewable Energy

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