

ment system delays the use of the electric service hot water system to shift this load to off-peak periods. The cooltowers use a wetted medium at the top of a tower to eliminate the need for conventional air conditioning—cool air naturally falls down the tower and into the building without fans. An uninterruptible power supply (UPS) system is integrated with a 7.2 kW PV system. The UPS enables the bookstore to operate its cash registers, telephones, and security system during the park’s frequent power outages.

The integrated design resulted in a building that costs \$0.43/ft<sup>2</sup> to operate and consumes 27.0 kBtu/ft<sup>2</sup>—a 65% energy savings compared to a similar store built to meet the minimum requirements of ASHRAE Standard 90.1-1999.

The building uses very little energy for heating and cooling when the outdoor temperature is between 60°F and 75°F. The design team set and committed to energy performance goals early in the process, used energy simulation models to predict energy performance and guide design decisions, and continuously monitored, evaluated, and improved performance.

The following how-to tips were implemented in this project: QA1, QA3, QA8, QA9, AQ10, QA16, EN2, EN8, EN13, EN22, EN23, EN26, EN 27, EN 29, DL1, DL2, DL3, DL7, DL8, DL9, DL10, EL5, EL7, EL9, EL10, EL12, EL13, EL14, EL15, EL16, EL19, EL28, HV13, HV14, HV21, PL1, PL4, PL4, EX2, EX4.

ZION NATIONAL PARK VISITOR CENTER AND BOOKSTORE	
Processes for Achieving Energy Savings	Description of Project Elements
<b>Envelope</b>	
<i>Opaque Envelope Components</i>	Roof R-30 c.i. SIPs. 6 in. steel-framed walls with R-21 expanding foam cavity insulation with 1-1/2 in. R-7 extruded foam exterior insulation.
<i>Vertical Glazing (Envelope)</i>	U-factor 0.26 north and west windows, 28% window - wall ratio.
<i>Window Design for Thermal Conditions</i>	0.37 SHGC north and west windows, clerestory windows opened and closed by EMS as part of the natural ventilation cooling system.
<i>Window Design for Daylight</i>	Overhangs on east and south clerestories, south and north view glass for daylighting.
<b>Lighting</b>	
<i>Daylighting</i>	East and south clerestories, south and north windows, EMS stepped controlled area lights based on interior photocells, motion sensor-controlled lights in offices, hallways, break area, restrooms, and storeroom.
<i>Electric Lighting Design</i>	1.0 W/ft <sup>2</sup> in bookstore, T-8 with 88% uplight fixtures, 2-W LED exit signs, compact fluorescents, fluorescent and metal halide exterior lights controlled by EMS.
<b>HVAC</b>	
<i>Equipment</i>	All cooling provided with passive, direct evaporative cooling (cooltowers) and natural ventilation. All heating provided by electric radiant heating panels. No ductwork or mechanical room.
<i>Ventilation</i>	Natural ventilation through EMS-operated clerestory windows.
<i>Controls</i>	15 radiant zones separately controlled by EMS with wall-mounted temperature sensors.
<b>Service Water Heating</b>	
<i>SWH</i>	Three 1.6 kW storage electric hot water heaters with EMS bypass to limit use during peak demand events.
<b>Additional Savings</b>	
<i>Plug Loads</i>	EMS controls heating panels, and service hot water heaters limit peak demand charges.
<i>Exterior Lighting</i>	EMS controlled exterior lights for 2 to 4 hours after closing.
<i>Other</i>	7.2 kW of PV integrated with a UPS system.

## CLIMATE ZONE 7—BIGHORN HOME IMPROVEMENT CENTER SILVERTHORNE, COLORADO

The BigHorn Home Improvement Center in Silverthorne, Colorado, is located in climate zone 7. It consists of an 18,400 ft<sup>2</sup> retail hardware store and a 24,000 ft<sup>2</sup> building materials warehouse. The building was designed for its mountain climate, which is heating dominated with more than 10,000 (base 65°F) heating degree-days. Hourly computer energy simulations were used to design the energy features with a goal of minimizing energy costs. The building was monitored to ensure that design goals were met.

Energy-saving features include retail sales floor lighting designed to 1.1 W/ft<sup>2</sup>, R-38 continuous roof insulation and R-19 wall insulation with R-12.5 or R-5 continuous exterior insulation, rigid c.i. beneath the entire floor to R-10 as well as the edges, glazing with a U-value of 0.24, motion sensors for restroom and office lighting, clerestory windows to provide daylighting, and daylighting controls to “dim” lights by turning off lamps (there are five steps of lighting levels). Plug loads, including vending machines, are only energized during business hours.

The building faces east, but the clerestory windows were designed to face north and south to best use the daylighting. The clerestories have overhangs to minimize the



Photograph courtesy of DOE/NREL

**Figure 4-13.** BigHorn Home Improvement Center entrance.



(a)



(b)

Photographs courtesy of DOE/NREL

**Figure 4-14.** (a) Daylighting controls dim lights when there is enough natural light. (b) Solar panels on the roof and clerestory windows.