summer solar gain. Even though the lights are installed to a density of 1.1 W/ft^2, the maximum recorded density has been 1.0 W/ft^2 due to daylighting controls. The daylighting, which provides 67% of the lighting in the retail area, reduces cooling loads to the point that conventional air conditioning is not needed, even though it is typically installed in retail buildings in this climate.

Additional Features

The store also has 9 kW of PVs integrated into the standing seam metal roof. Natural ventilation between the doors and the automatically controlled clerestory windows provides all the cooling loads for the space. Radiant floor heat is designed to provide extra heat to the occupied areas, including the cash registers. The designers decided on the hydronic radiant floor system for the retail/office area because of (1) the reduced noise from the elimination of the fans, (2) the improved comfort from the warm floor, and (3) the ability to have multiple zones within one large open space for better heating control. The energy management system controls the lights, natural ventilation, and heating system. The overall annual energy cost savings has been measured at 53% compared to a similar store built to meet the minimum requirements of ASHRAE Standard 90.1-2001.

The following how-to tips were implemented in this project: QA1, QA3, QA16, EN4, EN14, EN22, EN23, EN26, EN 27, DL1, DL2, DL3, DL7, DL9, EL13, EL14, EL15, EL16, EL19, PL1, PL2, and PL4.

BIGHORN HOME IMPROVEMENT CENTER	
Processes for Achieving Energy Savings	**Description of Project Elements**
Envelope	
Opaque Envelope Components	R-38 c.i. above deck insulation. R-19 insulated cavity between 24 in. o.c. steel studs, plus R-12.5 or R-5 c.i. for exterior insulation. R-10 c.i. under entire slab floor and vertically along footings.
Vertical Glazing (Envelope)	U-factor 0.24, 9.2% window-to-wall ratio.
Window Design for Thermal Conditions	0.44 SHGC, clerestory windows opened and closed by EMS as part of the natural ventilation system.
Window Design for Daylight	Overhangs on north and south clerestories.
Lighting	
Daylighting	North and south clerestories, high dormer windows, white walls, floor, and vaulted ceiling of the retail area, 5 levels stepped controls, EMS control based on interior photocells, occupancy sensors in restrooms and offices.
Electric Lighting Design	1.1 W/ft^2 pendant-type, fluorescent fixtures, 5 lighting levels to match daylighting availability.
HVAC	
Equipment	85% efficient gas boilers for radiant floor heating system, no air-conditioning system, all cooling provided with natural ventilation.
Ventilation	Natural ventilation through EMS-operated clerestory windows and open front door.
Controls	9 radiant zones separately controlled by EMS with wall and slab-mounted temperature sensors.
Service Water Heating	
SWH	Two 10 gal electric hot water heaters for the restrooms and service sinks.
Additional Savings	
Plug Loads	Vending machines disabled during off-hours.
Exterior Lighting	HID, EMS controlled by photocell for 2 hours after closing and 1 hour before opening.
Other	9 kW of building integrated PV, 400 W demonstration wind turbine attached to building.