Boulder ZED Design Build

Boulder, CO

BUILDER PROFILE

Boulder ZED Design Build
Boulder, CO
Brian Hludzinski, bhlud@yahoo.com
303-981-7342
www.BoulderZED.com
Rater: Sustainably Built, 303-447-0237
sustainablybuilt.com

FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: ZED 2
- Location: Boulder, CO
- Layout: 4 bedrooms; 3 baths; 2 floors
- Conditioned Space: 2,504 ft^2 with basement
- Climate Zone: IECC 5B, Cold
- Completion: June 2013
- Category: Custom

Modeled Performance Data:

- HERS Index: without solar PV: 38; with PV: 0
- Projected Annual Utility Costs: without PV $1,693; with PV $116
- Projected Annual Energy Cost Savings: with PV $3,680
- Builder's Added Cost Over 2009 IECC: +20-30%
- Annual PV Production Revenue: $1,577
- Annual Energy Savings: with PV -292.9 MMBtu

Boulder, Colorado, builder Brian Hludzinski loves his city, but he admits trying to find suitable lots among the urban parcels available is like trying to solve a three-dimensional jigsaw puzzle. Boulder's urban growth boundary limits construction on the outskirts of the city, pushing builders to reclaim small (~7,000 ft^2) urban in-fill lots where the city's progressive building codes restrict solar shadow, square footage, and wall dimensions, limiting new home builders' design options. Hludzinski's solution has been to buy aging 1950s ranchers, take them down to the foundations, and rebuild on the standard rectangle footprints with varied, two-story elevations, modern designs, and detached garages.

Hludzinski has used his passion for energy conservation to create a niche product—ultra efficient "recycled" homes that are well received in a green-friendly market. Hludzinski's latest creation bears the DOE Zero Energy Ready Home label from the U.S. Department of Energy, certifying for prospective home owners that the home meets a host of stringent energy-efficiency requirements.

The home, a 2,504 ft^2 two-story with four bedrooms and three baths, achieved a Home Energy Rating System (HERS) score of 38 without photovoltaic (PV) panels. In comparison, typical existing homes score about 120, and new homes built to the 2009 International Energy Conservation Code score about 100. When the 8.175-kW PV system is included, the home scores a 0, meaning it makes nearly all the energy it uses each year.

Hludzinski follows more or less the same process on each house. He starts by taking down the original structure and retaining only the existing crawlspace, foundation walls, footings, the first floor framing, and subfloor. Occasionally he will keep an exterior wall, especially if it is brick. With the debris removed and recycled, Hludzinski fills in the crawlspace vents with rigid insulation, installs an active radon collection pipe on the dirt floor, covers this with white 15-mil

ZERO ENERGY READY HOME U.S. DEPARTMENT OF ENERGY

The U.S. Department of Energy invites home builders across the country to meet the extraordinary levels of excellence and quality specified in DOE's Zero Energy Ready Home program (formerly known as Challenge Home). Every DOE Zero Energy Ready Home starts with ENERGY STAR Certified Homes Version 3.0 for an energy-efficient home built on a solid foundation of building science research. Advanced technologies are designed in to give you superior construction, durability, and comfort; healthy indoor air; high-performance HVAC, lighting, and appliances; and solar-ready components for low or no utility bills in a quality home that will last for generations to come.

The 2x6 24-inch on-center stud-framed wall cavity has 2 inches of closed-cell spray foam plus blown cellulose, while on the outside the OSB sheathing has a liquid-applied membrane that serves as a drainage plane, and air and vapor barrier. Over the membrane the builder installed an exterior insulation and finish system (EIFS) consisting of 4 inches of rigid foam EPS, a water-resistant base coat and an acrylic co-polymer finish coat.

WHAT MAKES A HOME DOE ZERO ENERGY READY HOME-CERTIFIED?

1 **BASELINE**
ENERGY STAR Certified Homes Version 3.0

2 **ENVELOPE**
meets or exceeds 2012 IECC levels

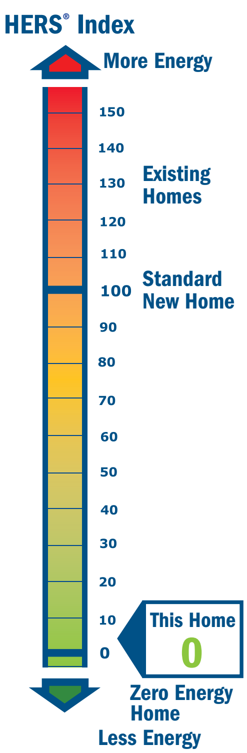
3 **DUCT SYSTEM**
located within the home's thermal boundary

4 **WATER EFFICIENCY**
meets or exceeds the EPA WaterSense Section 3.3 specs

5 **LIGHTING AND APPLIANCES**
ENERGY STAR qualified

6 **INDOOR AIR QUALITY**
meets or exceeds the EPA Indoor airPLUS Verification Checklist

7 **RENEWABLE READY**
meets EPA Renewable Energy-Ready Home.



polyethylene vapor barrier, then spray foams the foundation walls with 3 inches of open-cell spray foam insulation to create a sealed, insulated, conditioned crawlspace.

Hludzinski chose a crawlspace foundation because of Boulder's high water table and recent flooding. Boulder experienced a "thousand-year" flood in 2013 that raised the water table even higher. After helping friends pump and repump their basements in the aftermath of the flood, Hludzinski decided that a crawlspace was a safer construction method. In Hludzinski's homes, the crawlspace concrete foundation stem walls extend 16 inches on average above grade. The crawlspace floor is usually 36 inches below the exterior grade.

The above-grade walls were constructed of 2x6 studs set 24 inches on center. After the walls were sheathed with OSB, Hludzinski installed 2 inches of closed-cell spray foam in each stud cavity to provide an insulating coating as added air sealing, then the remainder of the cavity was filled with blown cellulose. On the exterior, over the OSB, a liquid-applied membrane coating was applied to provide a drainage plane, air, and vapor barrier. Hludzinski then installed one 4-in. layer of EPS rigid foam and fastened through the foam to the studs with wind-lock screws. Over this, an exterior insulation and finish system (EIFS) cladding was applied. The walls have a total insulation value of R-38.

The entire home has vaulted ceilings composed of 14-in. engineered roof joists that were sheathed with a coated OSB sheathing product which uses a proprietary tape for sealing seams to create an air barrier and drainage plane. Above the roof deck, 3.5 inches of polyisocyanurate rigid foam insulation was installed. Below the roof deck, 1 inch of closed-cell spray foam provided additional insulation and air sealing. The remainder of the 14-inch I-joist cavity was filled with blown cellulose for a total roof insulation value of R-60.

To match the high-performance building enclosure, Hludzinski selected a high-performance mechanical system, including a ground-source heat pump that has a 3.9 coefficient of performance (COP) for heating and a 20.6 energy efficiency rating (EER) for cooling. Due to excavation costs, ground-source heat pumps can be expensive to install; however, because Hludzinski constructed such a well-insulated building enclosure, his heating and cooling loads were very low (11.0 kBtuh for heating; 16.2 kBtuh for cooling). Therefore, he only needed one 300-ft-deep well to be drilled to install piping for the 1.25-ton heat pump system. According to Hludzinski, the ground-source heat pump costs $3,500 for the

The cathedral roofs consist of engineered roof rafter I-joists that create a 14-inch space which is first air sealed with 1 inch of closed-cell spray foam then filled with blown cellulose for a total attic insulation value of R-60.

equipment, plus $5,000 for the drilling, plus $4,000 to install the ducts. (However, this includes the cost of the ducts for the 95% efficient energy recovery ventilator (ERV), which uses a separate return ducting system.)

For ventilation, the ERV pulls fresh air from outside and passes it through a filter and heat exchanger where it crosses paths with outgoing stale air, transferring heat from the warmer air to the cooler air in the process. The fresh air from the ERV is circulated throughout the house via the central air handler system while seven dedicated return vents pull stale air from the bathrooms, kitchen, laundry room, and master closet. In addition, Hludzinski installed timed ERV boost switches in the bathrooms to control spot ventilation in those areas.

For hot water, Hludzinski installed an air-source heat pump water heater with an 80-gallon tank and an energy factor of 2.40.

All of the windows in the home, including those in the doors, are triple-pane. The R-7 windows have foam-filled, fiberglass frames. An ENERGY STAR-labeled refrigerator and dishwasher were installed. All of the lighting is high efficiency; 80% of the fixtures are LED and 20% are CFL. The ceiling fan is ENERGY STAR-rated.

Hludzinski installed an 8.175-kW solar photovoltaic panel system on the roof of the house. In all of his homes, the roofs are designed with future solar installation in mind. All of the vents and chimneys are on the north side of the roof ridge and the south-facing roof is as simple as possible to provide a large expanse for solar panels. "I think in the future, people are going to want to put on as much solar as they can, so we don't want them to be limited," said Hludzinski.

Hludzinski met the DOE Zero Energy Ready Home criteria to install plumbing fixtures that comply with the U.S. EPA's WaterSense requirements and to install a hot water recirculation loop for hot water fixtures located away from the water heater. The recirculation pipe is less than 60 feet long and has less than 8 feet of branch piping to fixtures. He installed a smart lawn irrigation system with a rain sensor and water-efficient spray heads, and amended the clay soil for better plant growth with less irrigation. He also selected drought-tolerant plants for the landscaping.

HOME CERTIFICATIONS

DOE Zero Energy Ready Home Program

ENERGY STAR Certified Homes Version 3.0

EPA Indoor airPLUS

ENERGY STAR

Building AMERICA
U.S. Department of Energy

Every DOE Zero Energy Ready Home combines a building science baseline specified by ENERGY STAR Certified Homes with advanced technologies and practices from DOE's Building America research program.

Hludzinski also took the extra step of installing separate drain lines for grey water fixtures (sinks and showers) and black water fixtures (toilets). These drain lines run separately to the crawlspace where they are combined to discharge to the sewer. "My theory is that people will be reusing the grey water in the future, most likely for irrigation," said Hludzinski. He went onto explain that Boulder's legacy water rights regulations currently prevent homeowners from using the grey water, but he has plumbed the house to make that possible should the laws change.

Other features include passive solar design elements such as 5/8-inch drywall for thermal mass, window positioning for beneficial solar gain and daylighting, and window overhangs for summer shading. Unlike most of the existing 1950s housing stock, the new home was designed with a two-car garage. The garage is detached and completely separate from the house, opening up the south wall to daylight and reducing the possibility of toxins entering the home.

The home has VOC-free cork and bamboo flooring and finger-jointed wood trim. The laminated wood cabinets are Forest Stewardship Council (FSC) certified and all cores are certified as having no added urea formaldehyde (NAUF). Hludzinski selected porcelain tile flooring because it does not require annual sealing with potentially harmful products.

Hludzinski's environmental commitment was evident in the old home's deconstruction. Lumber was reused as blocking and framing in the new home and the garage, and salvageable materials were donated to building supply stores. All demolition masonry and concrete, as well as scrap tile, was buried on site instead of being taken to a land fill, and 16,450 pounds of asphalt roof shingles, scrap metal, and scrap wood were recycled. Less than 2,000 pounds of construction waste was sent to the land fill.

This is the third home Hludzinski has built using the "recycled" foundation approach, not counting his own home. Hludzinski builds and sells his homes on speculation. Although realtors set up the appointments with prospective buyers, Hludzinski takes an active part, often coming to showings and personally walking potential buyers through the homes. "I have found these to be very informative for the home buyers and for the realtors as well. Many times they had no idea what was in the house or why," said Hludzinski. "I've been lucky," he adds. "On this home we had an appraiser who took a green building class and understood what I put into the house and I found buyers who are interested in what I have to offer."

The new homeowner's utility bills for the all-electric home totalled $253 for the year for two adults and two young children. In addition to dollar savings, the homes also offers a level of comfort and dependability rarely matched in new or existing homes. Hludzinski shares a story to illustrate. "In 2013, when we had the floods, the electric company was really far behind in getting electricity to homes. On my most recent project I had a 3-month wait for my permanent power line with only one 20-amp temporary line running to the house. We were down to single digits at night. I had one space heater, no one was living there, and the house never got below 54 degrees at night. When the sun came out during the day it would go up to 64."

Photos courtesy of Brian Hludzinski.

KEY FEATURES

- **Doe Zero Energy Ready Home Path:** Performance
- **Walls:** 2x6 24-inch on-center framing with 4 in. rigid foam EPS over OSB sheathing; wall cavity has 2 in. closed-cell spray foam plus blown cellulose; liquid-applied membrane over sheathing for drainage plane; air and vapor barrier under EIFS; total R- 38
- **Roof:** 3.5 in. polyiso rigid foam above roof deck; no attic; all vaulted ceilings with 1 in. closed-cell spray foam; blown cellulose in vaulted roof framing cavity of 14-in. engineered rafters; total R-60
- **Foundation:** Existing stem wall insulated with spray foam on interior; crawlspace vents sealed; 10-mil vapor barrier over crawlspace floor and walls
- **Windows:** Triple-pane, argon-filled, foam-filled fiberglass frames; R-6, U=0.17, SHGC=0.24 or 0.38
- **Air Sealing:** 0.49 ACH 50
- **Ventilation:** 95% efficient ERV; MERV 10 filter; dedicated return ducts; supply integrated with HVAC distribution
- **HVAC:** 1.25-ton ground-source heat pump (3.9 COP, 20.6 EER)
- **Hot Water:** 2.4 EF air-source heat-pump water heater in mechanical room
- **Lighting:** 80% LED; 20% CFL; ENERGY STAR ceiling fan
- **Appliances:** ENERGY STAR-rated dishwasher; refrigerator
- **Solar:** 8.25-kW PV installed
- **Water Conservation:** WaterSense fixtures; hot water recirculation loop; plumbed for grey water recovery; smart lawn irrigation with rain sensor; xeriscaping; soil amended
- **Other:** Passive solar design elements; tuned windows; window overhangs; 5/8 drywall for thermal mass; renewable cork and bamboo flooring throughout; all trim is finger-jointed wood w/no VOC finish; laminated wood cabinets FSC certified; all cabinet cores are NAUF; daylighting throughout; detached garage