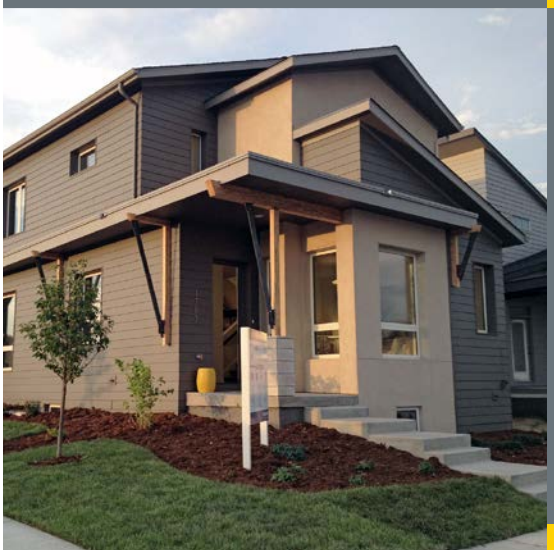


Building America Case Study

# A Production Builder's Passive House

Denver, Colorado (Midtown)

## PROJECT INFORMATION

**Construction:** New home

**Location:** Denver, CO

**Type:** Single-family, PH

**Partners:**

Brookfield Homes of Denver, CO, *brookfieldresidentialco.com*

IBACOS, *ibacos.com*

**Size:** 2,680 ft$^2$

**Sale Price:** $529,000 (originally priced at $569,000)

**Date Completed and Certified:** August 2013

**Climate Zone:** Cold

## PERFORMANCE AND COST

HERS Index:
- Builder's standard practice: 44
- PH: 28

Airtightness: 0.6 ACH50

PH upgrades: Totaling $85,000
- Windows: $21,000
- HVAC: $28,000
- Insulation: $11,000
- Framing, insulation, labor: $15,000
- Other items: $10,000

Without upgrades, a home with the same floor plan would be priced around $469,000.

Brookfield Homes Denver (Brookfield) started a homebuilding division in the Denver, Colorado, market in 2012. Even as a startup division, some of the homes it offers have better energy performance than those currently offered by many production builders in the area. Brookfield's first project is in a community called Midtown, in which the builder took on the challenge of increased energy efficiency by creating a Passive House (PH) certified* model home. Brookfield worked with the U.S. Department of Energy's Building America research team IBACOS to create this home, evaluate advanced building technologies, and use the home as a marketing tool for potential homebuyers.

Brookfield worked with KGA studio architects to create a new floor plan that would be constructed to the PH standard as an upgrade option. IBACOS worked with the design team to inform design changes to windows, heating, ventilating, and air conditioning (HVAC), and other systems that would be necessary to achieve the PH certification.

This two-story PH (with the first floor shown on top) includes three bedrooms and two and one-half bathrooms. The front of the home faces south and the exterior is clad in stucco and siding. These features are consistent with the builder's standard construction methods.

## Key Energy-Efficiency Measures

### HVAC

- Air conditioning: Lennox XC21 has a seasonal energy-efficiency ratio of 21.
- Heating: First Company fan coil unit with hot water coil. Heat is supplied by the Navien condensing combi unit; approximately 0.93 annual fuel utilization efficiency.
- Ventilation: Zehnder ComfoAir 350 energy recovery ventilator is 91% efficient.
- Ductwork: Uninsulated sheet metal. Inside conditioned space. Average total duct leakage <8 cfm/100 $ft^2$ conditioned floor area. Duct leakage to outside <4 cfm/100 $ft^2$ conditioned floor area.

### WINDOWS

- Glazing: Alpen 925
- Low-e
- U-value = 0.12
- Solar heat gain coefficient = 0.28.

### LIGHTING AND WATER HEATING

- 100% compact fluorescent lamps and light-emitting diodes interior, exterior, and garage
- Domestic hot water: Navien condensing combi gas boiler/water heater
- Water heater efficiency = 0.96
- Water heater location: Second-floor closet.

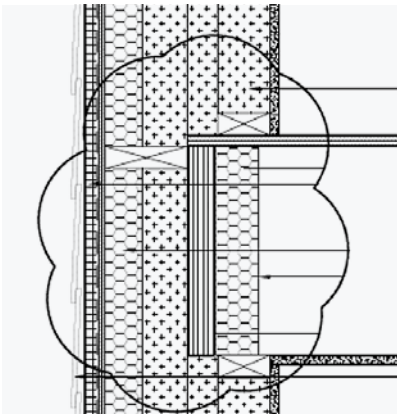
Image credit: All images were created by the IBACOS team.

Several design changes were made to meet the low-energy enclosure criteria of a PH. These changes to the thermal enclosure, basement insulation, and windows influenced the aesthetics. For example, the initial design included numerous small individual windows or groups of small and large windows. Brookfield realized, however, that too many windows and the high frame glazing area ratio would negatively impact the energy performance. Therefore, this design was changed to use larger openings and fewer multiple windows in each opening. The house on the far left in the photo is the PH; the other houses next to it are the builder's standard designs.

PH (far left), compared to the builder's standard design (right)

The team used a highly insulated exterior wall assembly for the PH. The builder's standard home uses 2 × 6 @ 24 in. on center advanced framing with a 1-in. flash coat of spray foam on the inside of the oriented strand board sheathing. Cellulose fills the remainder of the cavity. The PH uses a double-stud system (see figure). The resulting assembly has an opaque wall R-value of R-47.5.

**phaus.org/learn/passive-house-education/what-is-passive-house*



This exterior wall assembly incorporates a double-stud system. It consists of ⅝-in. drywall, 3½-in. blown-in cellulose, 2 × 4 (inside) and 2 × 6 (outside) staggered studs at 24 in. on center, 8½-in. blown-in cellulose, 2½-in. closed-cell spray foam, ½-in. oriented strand board, 1-in. extruded polystyrene, and cement fiberboard siding.

> *"As we build demonstration houses that qualify at the cutting edge of performance, we learn and can bring ideas from these avenues into our production homes."*
>
> – Brian Stamm, manager of operations, Brookfield Homes

U.S. DEPARTMENT OF ENERGY
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*buildingamerica.gov*

The U.S. Department of Energy's Building America program is engineering the American home for energy performance, durability, quality, affordability, and comfort.

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