

**DOE CHALLENGE HOME  
CASE STUDY****Weiss Building &  
Development, LLC**System Home  
River Forest, IL**BUILDER PROFILE****Weiss Building & Development LLC**Brandon Weiss, builder  
630-485-1818, Brandon@weissbd.com  
Chicago, IL  
[www.weissbd.com](http://www.weissbd.com)**FEATURED HOME/DEVELOPMENT:****Project Data:**

- Name: Chicagoland's First Certified Passive House
- Location: River Forest, IL
- Layout: 5 bedroom, 4.5 baths, 3 floors
- Conditioned Space: 4,763 ft<sup>2</sup> w/ bsmnt
- Completion: January 2013
- Climate Zone: 5A
- Category: System

**Performance Data:**

- HERS Index without solar PV: 27
- HERS Index with solar PV: NA
- Projected annual energy cost savings (compared to a similar house built to the 2009 IECC): without solar \$3,000
- Projected annual utility costs: without solar \$1,200
- Builder costs over to-code construction: approx. 4%
- Annual energy savings: 30,390 kWh

If 19-inch-thick walls make you think of castles in Europe, you might have a glimpse of where builder Brandon Weiss, founder of Weiss Building & Development LLC., gets his inspiration. Weiss spent two years as a professional basketball player in Germany and the Netherlands, where he got to see firsthand the durable and sustainable practices perfected by energy-conscious European craftsmen. "If they can build a home that last hundreds of years, why can't we?" asked Weiss. When he returned to the States and his homebuilding roots in Chicago, Weiss vowed to put into practice here what he'd discovered over there. He began studying building science in earnest, attending classes and reading everything he could about green construction. Weiss became one of the first 24 Master-Certified Green Professionals in the country through the National Association of Home Builders.

A host of certifications followed, including NAHB Graduate Master Builder, LEED Accredited Professional, and Building Performance Institute (BPI) Building Analyst & Envelope Professional credentials, along with awards such as the U.S. Green Building Council's 2013 Emerald Innovation Award, the NAHB's 2011 Best in American Living Award for Whole House Remodel, and the 2012 Builder of the Year and 2011 Remodeler of the Year from the Northern Illinois Home Builders Association, among others.

Weiss got to flex his building science muscles when he took on construction of his first house built to the requirements of the Passive House Institute and the U.S. Department of Energy's Challenge Home program. He actually received the Challenge Home certification on another home, in Downers Grove, IL, first, but this home was the first one constructed. With these two homes Weiss has committed to building all future homes to the Challenge Home certification, while offering to add certifications to the NAHB green standard, Passive House, or LEED according to the client's preference.



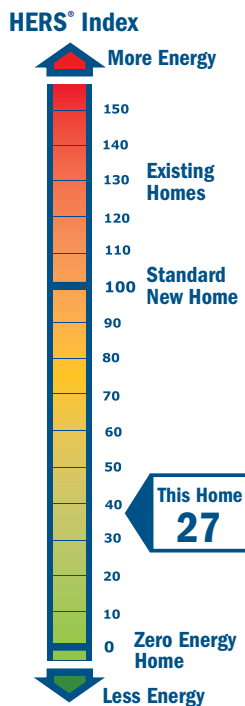
DOE Challenge Home builders are in the top 1% of builders in the country meeting the extraordinary levels of excellence and quality specified by the U.S. Department of Energy. Every DOE Challenge Home starts with ENERGY STAR for Homes Version 3 for an energy-efficient home built on a solid foundation of building science research. Then, even more advanced technologies are designed in for a home that goes above and beyond current code to give you the superior quality construction, HVAC, appliances, indoor air quality, safety, durability, comfort, and solar-ready components along with ultra-low or no utility bills. This provides homeowners with a quality home that will last for generations to come.

An ENERGY STAR-rated dishwasher, clothes washer, and refrigerator; an induction cooktop, condensing clothes dryer, and LED lighting are among the energy-saving devices inside the home. All plumbing fixtures comply with EPA WaterSense criteria. Weiss personally selected every material that went into the home to make sure it met the low- or no-VOC and formaldehyde-free requirements of the Underwriters Laboratories' GreenGuard Gold program (formerly known as GreenGuard Children & Schools). The home itself was tested for sVOC's, tVOC's, aldehydes, and particulates.



**CHALLENGE HOME CERTIFIED:**

- 1 BASELINE**  
certified ENERGY STAR for Homes Version 3.0
- 2 ENVELOPE**  
meets or exceeds 2012 IECC levels
- 3 DUCT SYSTEM**  
located with 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.



The Passive House Challenge Home located in River Forest, Illinois, is a 5-bedroom, 4.5-bath, 3,600 ft<sup>2</sup> two-story home (plus basement) that costs about \$237 less per month to operate than a similar sized home built to the 2009 IECC. For a home with no solar photovoltaic panels installed, it scored an amazingly low 27 on the Home Energy Rating System (HERS) score. For comparison, a house built to the 2006 IECC would score about 100 on the HERS index and a home built to ENERGY STAR Version 3 would score about HERS 70. The addition of a 3-kW photovoltaic system on the roof would easily bring the home to a true net zero, i.e., a home that produces as much energy as it uses in a year.

To get a home this energy efficient requires some serious building science. “The builder, architect, ICF contractor, and client all worked on design together from day 1. All of the details were hashed out at the design stage, making the building process very streamlined,” said Weiss. Weiss credits architect Tom Bassett Dilley, Biltmore Insulated Concrete, and especially homeowners Corinna and Rodrigo Lema for their contributions to the success of the project.

The homeowner had requested concrete walls because of their durability and reputation for withstanding the forces of nature. Weiss selected a concrete construction method known as ICF, using insulated concrete forms, which are like hollow foam blocks that stack like bricks to form two foam walls connected by plastic spacers. The foam walls become the forms for pouring the concrete and then stay in place to provide insulation. In this case, they provided 2.75 inches of rigid expanded polystyrene (EPS) foam on each side of the 6-inch concrete core.

Weiss added 2 more inches of polyisocyanurate rigid insulation on the exterior side of the wall and constructed a 2x4 framed wall on the interior side which was filled with dense-blown fiberglass insulation for 19-inch-thick walls that provided a whopping R-54 of insulation value. To protect the walls from the elements, the polyisocyanurate foam has an integrated weather-resistant coating; when seams in the foam are taped with a proprietary flashing and seam tape, the coating forms a water-shedding barrier. Over this, ¾ inch plywood furring strips were attached vertically every two feet to provide a vented drainage plane behind the engineered wood siding, allowing any moisture that might make its way pass the siding to have a path down and out of the wall. Screening is installed at the top and the bottom of the wall to keep insects out of this venting space.

The ICF walls served as the basement walls as well, extending five feet below grade to the footings. Before the basement slab was poured, 8 inches (R-40) of rigid EPS

“A lot of builders don’t understand the physics of building science. In Europe, to be an architect, you have to study building science in college. How can you build a quality home if you don’t understand this stuff?” Brandon Weiss



The home meets the Passive House Institute's strict criteria for air tightness and insulation. The builder employed several types of insulation and flashing in the 19-inch-thick walls and roof to provide redundant layers of protection against the elements.

Weiss purchased European-made triple-pane windows to meet the Passive House guidelines. The R-9 windows have insulated wood frames, insulating argon gas between the panes, a U value of 0.123 and a solar heat gain coefficient of 0.50, and an invisible low-emissivity coating on two surfaces to prevent heat loss in the winter and reduce heat gain in the summer.

foam was installed beneath the entire slab. A thick 10-mil plastic vapor barrier was laid between the EPS and the slab and was taped to the ICF walls to provide an air barrier under the slab.

To meet the uber air-tightness requirement of the Passive House standard [no more than 0.6 air changes per hour at 50 Pascals pressure (ACH50)], Weiss took extra care with the ceiling design. The holes typically found in a home's ceiling for electrical fixtures, exhaust fans, chimneys, ducts, lights, etc., can add up to dozens of potential sources of air leakage. Air leakage in the ceiling is exacerbated by the stack effect—the same forces that pull hot air up a chimney will attempt to pull heated or cooled air out of the house and into the attic, which is a waste of energy and can possibly cause moisture problems. Weiss got the total number of holes into the attic down to exactly six (two plumbing stacks, wiring conduit for future solar PV, a radon mitigation pipe, and a code-required attic access and attic light). He achieved this by installing two ceilings.

The top ceiling is a plywood layer nailed to the bottom of the attic trusses and piled high with R-100 of blown fiberglass. Every seam in the plywood layer was air sealed twice—with a proprietary air sealing tape on the house side and with elastomeric sprayer-applied sealant on the attic side. The six penetrations that did go through this layer were gasketed on both sides and taped with air-sealing tape. The second ceiling, made of drywall, hangs 5 inches below the plywood ceiling and is mounted on metal framing. The space in between is adequate to conceal the electric wiring for ceiling lights, water sprinkler piping, the 3-inch ductwork for the energy recovery ventilator (ERV), and other services that may require poking holes through the lower ceiling, while leaving the upper ceiling intact.

The ICF walls provided excellent air sealing. Any penetrations that did extend through the exterior walls (for plumbing, wiring, etc.) were sealed with air sealing caulk, gasketed on the inside and outside, and taped. The windows were taped with a vapor-permeable tape on the inside. Airtight drywall installation methods (such as caulking the drywall everywhere it contacts framing) were used to tighten things up even further.

To verify that his air sealing methods were bearing fruit, Weiss used his own blower door testing equipment, smoke machine, and thermal imaging camera to repeatedly check air tightness levels during construction. This was in addition to the mandatory third-party blower door testing done at the pre-drywall and

## HOME CERTIFICATIONS:

DOE Challenge Home

Passive House

ENERGY STAR Version 3

EPA Indoor airPLUS

Challenge Home requires that every home be tested and inspected by a certified home energy rater. "You can't claim quality unless you have third-party accountability and that's what programs like Challenge Home require." Brandon Weiss.



Every DOE Challenge Home combines building science specified by ENERGY STAR for Homes and advanced technologies and practices from DOE's Building America research program.

post-construction stages to meet Challenge Home criteria. All of this attention to air sealing detail paid off. Weiss and his team achieved an air leakage score of 0.38 ACH 50, well below the Passive House maximum of 0.6 ACH 50 and far below the 5.0 ACH 50 maximum required by Illinois code.

To ensure good air quality in a home this tight, an ERV provides continuous ventilation with a balanced amount of incoming and outgoing air. The incoming air is warmed or cooled by the outgoing air through the ERV's heat exchanger, which recovers 93% of the outgoing energy. Fresh outside air is drawn in through two MERV 13 filters at a rate of 0.3 ACH 50 or enough to refresh all of the air in the home every 3 hours. The air is supplied to all of the living areas and bedrooms through dedicated 3-inch ERV air ducts and air is drawn from the kitchens, baths, and laundry to be exhausted outside. Thanks to a very efficient ECM fan motor, the ERV can operate continuously 24/7 for 365 days of the year at a cost of about \$30 per year. The dual filters ensure air that is very clean to breathe and a virtually a dust-free home.

During construction, the house was continuously vacuumed out, including stud bays and open-web trusses. Subfloors were protected with breathable membrane so that sawdust and drywall dust did not get embedded into the subfloor. The two highly efficient 10 HSPF/26 SEER ductless mini-split heat pumps were installed but were not commissioned and operated until the building had a final post-construction cleaning in order to keep dust out of the equipment.

Weiss noted that having most of the insulation on the outside of the home's air barrier greatly reduces the potential for condensation within the wall cavity. Extra water-proofing layers were installed on the floors and walls in rooms that could get wet like bathrooms to keep moisture out of wall cavities.

Weiss purchased a European-made triple-pane window to meet the Passive House guidelines. The R-9 windows have a U value of 0.123 and a solar heat gain coefficient of 0.50. The windows have insulated wood frames with coated aluminum rainscreen cladding on the exterior, super-efficient spacers separating the glass panes, argon-gas fill between the panes, and invisible low-emissivity coatings on two surfaces to prevent heat loss in the winter and reduce heat gain in the summer.

According to Weiss, it costs him about 4% over the cost of a similar sized home built to code to add the energy upgrades. But, for the homeowner, according to Weiss, the home is a money maker from day one. In other words, when the amount to cover the builder's above-code costs is added to the mortgage, on a 30-year fixed mortgage at 4.75% interest, the homeowner's utility bill savings will more than offset the added costs to get a home of this quality, compared to a similar sized home built to code without all the energy-saving features. And homeowners will start seeing these energy cost savings in their first month's bill.

## KEY FEATURES

- **Path:** performance
- **Walls:** 11.5-inch-thick ICF walls (6-inch concrete core, 2.75 inches of EPS on each side), plus 2 inches polyisocyanurate coated sheathing with taped seams, plus 2x4 interior framed wall with dense-blown fiberglass for 19-inch (R-54) wall, ¾ inch furring for vented rain screen, engineered wood siding
- **Roof:** vented attic, R-100 blown fiberglass, double ceiling of plywood and drywall
- **Foundation:** basement with ICF walls, 8 inches (R-40) rigid EPS foam under slab, 10-mil vapor barrier between foam and slab.
- **Windows:** triple-pane, low-e, argon-filled, thermally broken insulated wood frame, R-9, U=0.123, SHGC=0.50. Additionally, the frames of the windows were installed on the interior and exterior.
- **Air Sealing:** 0.38 ACH 50
- **Ventilation:** ERV
- **HVAC:** two ductless mini-split heat pumps, 10 HSPF/26 SEER
- **Hot Water:** solar hot water with backup electric
- **Lighting:** 100% LED and CFL
- **Appliances:** ENERGY STAR-rated dishwasher, clothes washer, and refrigerator; condensing dryer, induction cook top
- **Solar:** solar PV-ready with conduit to roof
- **Water Conservation:** drought-tolerant landscaping; no-irrigation turf; rain barrels for irrigation; green roofs on garage and over house entry; underground on-site retention of stormwater run-off
- **EPA WaterSense:** all plumbing fixtures equivalent to WaterSense criteria
- **Other:** all finishes and adhesives UL GreenGuard Gold certified; recycled-content wood siding and blown insulation; no-VOC nontoxic finishes; bamboo and cork flooring; wheat straw core doors
- **Electric Car Charging Station:** garage wired for 240 volt

U.S. DEPARTMENT OF  
**ENERGY**

Energy Efficiency &  
Renewable Energy

For more information on the **DOE Challenge Home**,  
go to [www.buildingamerica.gov/challenge](http://www.buildingamerica.gov/challenge)

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[www.BuildingAmerica.gov](http://www.BuildingAmerica.gov)