

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

- Name: Illinois First Challenge Home
- Location: Downers Grove, IL
- Layout: 3 bedroom, 2.5 baths, 3 floors
- Conditioned Space: 3,600 ft<sup>2</sup>
- Completion: June 2013
- Climate Zone: 5A
- Category: Custom

**Performance Data:**

- HERS Index without solar PV: 35
- HERS Index with solar PV: NA
- Projected annual utility costs: \$483
- Builder costs over to-code construction: \$135/sq foot.
- Annual Energy Savings: 5,287 kWh, 1,384 therm

A peat bog may not sound like the best place to build a house, but that was what builder Brandon Weiss had to work with and what he ended up with may be one of the healthiest houses in all of Illinois. The 3,600-square-foot custom home built by Weiss Building & Development LLC is the first home in Illinois certified to the U.S. Department of Energy Challenge Home criteria, which requires that homes meet the EPA Indoor airPlus guidelines. A tight building envelope, super filtration of incoming air, and third-party verification of the toxicity levels of all materials used in the home were among the health advances incorporated in the house, but first the builder needed to take care of the water issues.

The homeowner was attracted to the low price and large size of this low-lying lot in an established, tree-lined neighborhood in the Chicago suburb of Downers Grove. The bargain price tag gave him a vacant lot sitting on 25 feet of peat and a history of water problems.

Weiss sunk steel-reinforced bell-bottom caissons 35 feet into the ground, then erected steel framing on the piers about 4 feet above ground and set the floor joists on the framing. To handle stormwater runoff, a series of underwater storage tanks and drainage pipes were installed in the peat ground behind the house. During large storms, rain can flow under the house to the drainage system, which retains the water below ground and slowly releases it into the city storm water system. There was a 100-year flood a month after construction was finished. "The site drained in 3 hours," said Weiss. "It also drained the neighbors' site. The neighbors said, before we installed this system, it would take four days for puddles to disappear after big storms (and they'd never seen a storm as large as this one). Needless to say, the neighbors are ecstatic with the work we did."

This house was designed by Architect Tom Bassett Dilly in a craftsman style with four steps up to the deep front porch. The porch is sided with the same treated



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.

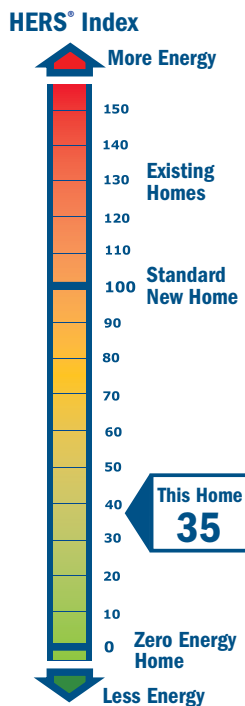
The ENERGY STAR-rated dishwasher, clothes washer, and refrigerator; and 100% energy-efficient lighting are among the energy-saving devices inside the home. All plumbing fixtures comply with EPA WaterSense criteria.

The windows are American-made, triple-pane with insulated vinyl frames and low-e coatings on two surfaces to prevent heat loss in the winter and minimize heat gain in the summer. Most of the windows are on the south for passive heat gain in winter; roof overhangs were designed to keep out the higher summer sun.



**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.



wood lap siding that covers the rest of the home. The siding extends down to 6 inches above the grade, cleverly hiding the fact that the home is built on piers. An insect and rodent screen extends from the siding 6 inches into the ground.

The 2x6 24-inch on-center framed walls are dense packed with R-23 of blown fiberglass insulation. The builder incorporates several advanced framing practices into his walls that reduce the amount of unnecessary framing to allow more room for insulation, starting with 2x6 24-inch on-center framing, which provides a thicker wall cavity with less interruptions than standard 2x4, 16-inch on-center framing. Corners are framed with two studs instead of three, headers over windows are insulated and not over-engineered with more wood than is necessary to support the weight, and windows on non-bearing walls have no headers. To ensure an air-tight building shell, a water-based sprayer-applied elastomeric sealant was applied every place where wood meets wood — from the seams in the plywood, to the top plates and sill plates, to everywhere the plywood touches the framing in the wall cavities. Because the room corners where two pieces of drywall come together can often be a source of air leakage, interior walls that are non-load bearing are set in from the exterior wall framing to allow space for drywall to fit behind the intersecting wall.

On the exterior of the walls, two inches (R-13) of coated rigid polyisocyanurate is attached to the plywood sheathing. This continuous foam layer reduces conductive heat loss (i.e., the thermal bridging that can occur when heat is transferred through the walls via the studs). Over the foam, the home is wrapped in a weather-resistant house wrap. All seams are taped and flashings around windows and doors are properly integrated with this house wrap layer to ensure that any rain that gets in will drain down and out. Plywood furring strips are installed vertically over the house wrap every two feet to provide a 3/4" ventilation gap behind the wood siding. Vents at the top and bottom of the wall are protected with insect screen. The ventilation gap allows any water that finds its way behind the exterior cladding to drain down the wall and out the vents where it is directed away from the home by a kick-out flashing at the base. The gap also prevents moisture driven through nail holes in the siding from reaching the sheathing and allows any residual moisture to dry.

“The siding we use has a 50-year warranty on the product and a 30-year warranty on the finish, but this installation technique will prolong the life of the finish because of the drying out potential as well as the even temperatures on both sides of the siding,” said Weiss.



From inside you'd never know the home is perched 4 feet above grade on steel piers sunk 35 feet into the peat soil. A comprehensive underground storm runoff system carries rainwater deep below grade to percolate into the soil rather than pooling on top like it used to. When a 100-year flood hit a month after construction, the site drained in 3 hours, days sooner than it had in previous smaller storms.

The unvented attic was insulated along the roof line with about 12 inches (R-38) of open-cell spray foam. But before the insulation was installed, all of the seams in the plywood roof decking were sealed with sprayer-applied elastomeric sealant. The roof has multiple flashings around the entire perimeter, as well as around any penetrations. First, gutter apron is installed along the edges, then a 6-foot wide border of self-adhesive ice and water shield is installed, then outside drip edge flashing is installed along the edge. A synthetic felt is installed over the whole roof deck and overlaps the ice and water shield.

Weiss has a passion for flashing. Multiple flashings and air-sealing techniques were used including the house wrap, sealant, self-adhering flashing tape, kick-out diverters, and other materials to help direct the drainage of water around doors and windows, off roofs and siding, and away from the house. Windows were quadruple flashed and installed with pitched sills tilted to direct water out. Electrical and plumbing outlets through the exterior walls were installed with pre-formed plastic flashing. “Redundancy was handled everywhere in the home where we saw a potential risk. If something fails down the road, there is a back-up ready,” said Weiss.

Weiss Building & Development LLC is so certain its flashing detailing will prevent water damage that it offers clients a 10-year warranty against leaks in their roof, window, or wall assemblies.

This quality construction started in the preliminary design phase—the builder, architect, client, energy rater, siding contractor, and roofer were all part of the design team from day one. The team talked through how every major component of the building shell would interact. “We broke out designs and details for every change and every penetration in the envelope. These details even went into wall elevation, and detailed drawings done in the architectural phase,” said Weiss.

The three-story home has a finished attic and a bonus room above the attached garage. To ensure air quality, Weiss installed a double wall between the house and garage. Each wall was composed of 2x6s at 24 inches on center. Two inches of rigid EPS foam insulation separate the walls and the wall cavities on each side are with faced with netting and filled with blown-in fiberglass. Every seam in the walls was sealed with sprayer-applied elastomeric sealant. Weiss tested for air leakage with a blower door test and found 0 air changes between the garage and the bonus room above and between the garage and the house.

## HOME CERTIFICATIONS:

DOE Challenge Home

ENERGY STAR Version 3

EPA Indoor airPLUS

NAHB National Green Building Standard  
– Emerald



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.

Weiss made extensive use of testing equipment throughout the building process to ensure quality control. While DOE Challenge Home and the National Association of Home Builders Green Building Standard (two certifications Weiss achieved) both require third-party testing and inspection, Weiss went well beyond the minimum requirements. Weiss used his own blower door equipment, in conjunction with a smoke machine, to look for air leaks after framing, after air sealing, after insulation, and after drywalling. Weiss also used a thermal imaging camera throughout construction to help detect air leaks.

The attention to detail paid off. The home achieved a whole-house air leakage rate of 1.25 ACH 50 (60% better than ENERGY STAR Version 3.0 requirements).



Weiss personally approved every material used in the construction—from the paints and drywall to the cabinets and flooring—to make sure every product met the criteria of the Underwriter Laboratories' GreenGuard Gold standard, ensuring that they are VOC- and formaldehyde-free and nontoxic.

Air-tight construction that keeps garage fumes out of the house was just one of many exceptional air quality practices the builder employed. Every material and product used in the house's construction, from the concrete to the caulk to the flooring, was selected or approved personally by Weiss. Every material met the low- or no-VOC and formaldehyde-free requirements of the Underwriters Laboratories GreenGuard Gold program (formerly known as GreenGuard Children & Schools). Beyond that, the home was tested for sVOC's, tVOC's, aldehydes, and particulates. 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 furnace was not installed and the sealed ductwork was not commissioned until the house had a final cleaning.

To maintain clean air in the home, an energy recovery ventilator (ERV) provides continuous ventilation with a balanced amount of incoming and outgoing air. The incoming air is cleaned with a MERV 15 electronic air cleaner then distributed throughout the home via the furnace supply ducts. Stale air is returned to the ERV via separate return registers located in the bathrooms, and laundry room. A highly efficient, 95% AFUE sealed-combustion gas furnace and 17 SEER air conditioner heat and cool the home. All ducts are sealed and insulated and are located within conditioned space in the home; most are routed through open-web floor joists. Hot water is provided by a 96% efficient gas tank water heater. A compact plumbing plan was designed with the copper piping routed in short, direct runs through the open-web floor joists.

## KEY FEATURES

- **Path:** performance
- **Walls:** 2x6, 24 in. o.c. advanced framing, R-23 dense packed fiberglass in wall cavity plus 2 inches (R-13) coated rigid polyiso, house wrap, 3/4-inch vertical plywood furring strips for drainage gap, insect screens, engineered wood siding
- **Roof:** unvented attic, sealed roof deck seams with water-based sprayer-applied elastomeric sealant then insulated at roof line with 12 inches (R-38) open-cell spray foam
- **Foundation:** pier foundation: steel columns set on steel bell-bottom caissons set 35 ft. deep in peat soil. Steel I-beams and wood trusses set 4 feet above ground. Underside is plywood sealed at all seams, 18 inches of blown netted fiberglass, 4 inches of EPS, finished plywood. Ground cover is geotextile fabric and stone. There is an access under the deck.
- **Windows:** triple-pane, low-e, insulated vinyl, U=0.2, SHGC=0.22, low-emissivity coatings on two surfaces
- **Air Sealing:** 1.25 ACH 50
- **Ventilation:** ERV continuous, supplies through HVAC ducts, returns from baths and laundry
- **HVAC:** 95% AFUE gas furnace, 17 SEER air conditioner
- **Hot Water:** 96% efficient gas storage water heater
- **Lighting:** 100% LED and CFL
- **Appliances:** ENERGY STAR-rated dishwasher, clothes washer, and refrigerator
- **Solar:** solar ready with conduit to roof and framing supports installed
- **Water Conservation:** drought-tolerant landscaping, rain barrels for irrigation
- **EPA WaterSense:** all plumbing fixtures equivalent to WaterSense criteria
- **Other:** all finishes and adhesives 3<sup>rd</sup> party tested and certified to GreenGuard Gold standard
- **Electric Car Charging Station:** ready with 240-volt outlet in the garage