

**DOE CHALLENGE HOME
CASE STUDY****StreetScape
Development, LLC**

Libertyville, IL

**BUILDER PROFILE****StreetScape Development, LLC**

Libertyville, IL

President, John McLinden

john@streetscapedev.com, 312-401-2600

<http://streetscapedev.wordpress.com>**FEATURED HOME/DEVELOPMENT:****Project Data:**

- Name: School Street Homes
- Location: Libertyville, IL
- Layout: 3 bedrooms, 3.5 baths, 2 floors plus basement
- Conditioned Space: 2,763 ft²
- Completion: April 2013
- Climate Zone: 5A
- Category: Custom

Performance Data:

- HERS Index without solar PV: 45
- HERS Index with solar PV: NA
- Projected annual utility costs (without solar): \$1,727
- Projected annual energy cost savings (compared to a home built to the 2006 IECC, without solar): \$1,157
- Annual PV production revenue: NA
- Builder's added cost over standard construction: 3%-4%
- Annual energy savings: 3,738 kWh; 746 Therms

“How do you live?” semi-custom home builder John McLinden likes to ask homebuyers at their first meeting. McLinden posed this question to homebuyers at an urban infill development of 27 single-family homes and 15 condos in Libertyville, a suburban community north of Chicago. One couple's desire for environmental responsibility prompted McLinden to invite them to be the owners of the builder's first U.S. Department of Energy-certified Challenge Home.

McLinden first heard about Challenge Home from DOE Building America Chief Architect Sam Rashkin. McLinden shared Rashkin's book *Retooling the U.S. Housing Industry* with homebuyers Quintin and Megan McGrath who had recently signed a contract for a single-family two-story home. They embraced the idea of reaching for the higher efficiency levels embodied in the Challenge Home certification.

The result is a beautiful 2,763-ft² Challenge Home with a Home Energy Rating System (HERS) score of 45 (compared to 100 for a standard home) in an urban infill development in Libertyville, IL. The Neo-Colonial two-story design has a front porch that faces the street, welcoming neighborhood interactions. (The attached garage is tucked into an alley behind the home.)

The home's fiber cement siding has a 50-year limited warranty and is insect and rot resistant. Behind the exterior siding are the energy-efficient details. The 2x6 wood-framed walls are filled with R-20 open-cell spray foam insulation. Instead of house wrap, the builder chose to cover the oriented strand board (OSB) sheathing with a vapor-permeable, weather-resistant asphalt coating that is painted on with a roller. The thick black liquid completely adheres to the OSB surface, preventing water penetration and reducing air leakage. Unlike house wrap, the coating needs no mechanical fasteners, has no seams, and is permanently attached. The product is also unaffected by surfactants, surface-activated contaminants found in nearly



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.

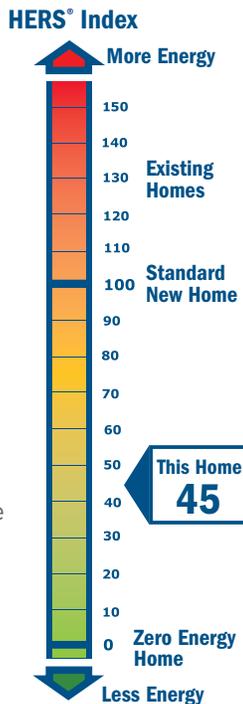
Instead of house wrap, the home's OSB sheathing is covered with an asphalt-based, vapor-permeable coating that provides a weather-resistant barrier to protect the walls from liquid water damage; the coating also reduces air leakage.

Homeowners Quintin and Megan McGrath placed a Challenge Home sign in their front yard during construction and said they became known as the 'energy home.' "We are very much part of our community, and we know we are influencing homes not yet built."



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.



all siding and cladding materials, which reduce the water-shedding ability of some house wraps.

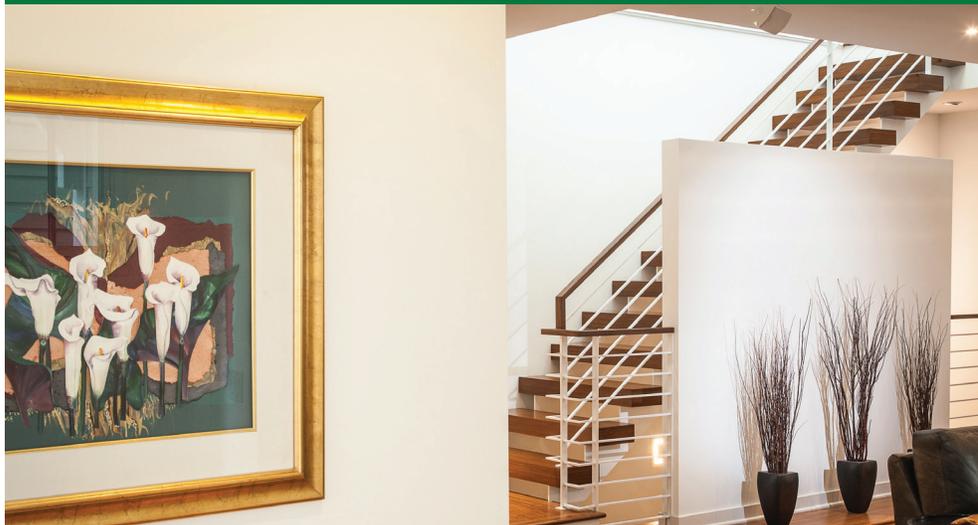
Grey-colored 30-year fiberglass shingles were installed on the roof over an underlayment of felt paper. The underside of the unvented roof was covered with 14 inches of open-cell spray foam for an R-50 insulated and sealed attic. To complete the home's thermal enclosure, R-13 of rigid foam insulates the concrete foundation walls. The spray-foam wall and attic insulation contributes to the home's air-tight enclosure. A blower door test for whole-house air leakage showed a very low leakage rate of 1.89 air changes per hour at 50 Pascal's pressure.

The homeowners love the comfortable feel of the super-efficient building enclosure. Part of this comfort is attributable to the uniquely configured whole-house HVAC system. The builder chose a small-duct high-velocity central heating and cooling system. "Most HVAC systems in America, like 90%, use a forced-air low-pressure duct, which is not an efficient way to move air," said McLinden. This system uses small two-inch-diameter ducts that supply air to each room at high velocity (600 cfm instead of the typical 100-200 cfm of most central air handlers). These jets of air move the air like water in a whirlpool, encouraging greater mixing of temperatures between high and low points in the room and from room to room, which can reduce drafts.

A gas-fired tankless water heater provides heat for both the furnace and for domestic hot water needs. "This tankless water heater is 98% efficient, engineered and built in the United States, and it's a smart appliance. It learns the hot water habits of the occupants and will program itself to provide hot water at optimal times," said Robert Schildgen from the consulting firm, Priority Energy. Water is heated by the hybrid tank/tankless water heater and piped to a heat exchanger in the air handler. Air from the return ducts heats up as it flows through the air handler to the supply ducts while the slightly cooler water is returned back to the water heater.

"This system is efficient because we are recovering the semi-heated water and just heating the difference. With a traditional gas furnace, extra heat from the burners is lost up the chimney," said Quintin McGrath.

According to the air handler manufacturer, the system also controls humidity better, by passing cool air over evaporator coils at a 30-degree temperature differential rather than the 15-degree temperature differential of conventional



The School Street Challenge Home is part of the School Street District development in downtown Libertyville, Illinois. The project consists of 26 single-family homes and 15 loft condominiums crafted inside a re-purposed 74-year-old school. All homes meet ENERGY STAR, and one home is a Sarah Susanka-designed not-so-big home. Developer McLinden invited Susanka to participate in the development after reading her books.

systems. This provides for greater heat removal, which translates to greater comfort levels, 30% greater humidity removal, and higher energy savings because the thermostat can be set higher while maintaining comfort.

“The heating and cooling systems are efficient. During the Green Built Home Tour, we had 50-60 people in the house during the day. It was 90 degrees outside, and our total kilowatt hours for the day was 8.5. At our fully loaded utility rate of \$0.12/kWh, the AC costs us about 1 dollar a day. This type of thing is amazing to me,” said Quintin.

The furnace, the air conditioner, and a heat recovery ventilator (HRV) all use the same central air handler, which is located in the basement, and a network of small-diameter high-velocity supply ducts transport conditioned air through the home’s basement, first, and second floors. The 2-inch flexible ducts are insulated to R-6 and sealed with a proprietary process that passes sealant through the inside of the ducts, resulting in less than 24 cfm of total air leakage from the ducts. This combination of insulation and air sealing significantly improves the efficiency of the duct system and the overall heating and cooling system. Dampers separate the floors into three zones and air flow to each zone can be controlled remotely by the home automation system or by the thermostats. “A pair of flush-mounted remote temperature sensors are wired to each of three thermostats with one thermostat for each level of the home. The sensors provide an average temperature across the whole floor of the home, rather than a single point, which allows the system to provide a higher level of comfort throughout,” explains Kurt Schorsch from Priority Energy.

The homeowners have not noticed noise problems from the high-velocity ducts. They also appreciate the fact that the small 5-inch-round supply registers come in a variety of custom finishes that blend in with the ceiling and bamboo flooring.

Ventilation for the airtight home is provided by the HRV, which draws fresh air in from outside and conditions it with outgoing air before distributing the air throughout the home using the HVAC supply ducts. “The longer we live in the house, the happier we are with the HRV. It seems to provide us with improved quality of air [over what they had in previous homes]. “My wife Megan has allergies and asthma. The air is fresh and clean in our home, and she feels a whole lot better. Her medications are lower,” said Quintin.

HOME CERTIFICATIONS:

DOE Challenge Home

ENERGY STAR Version 3

EPA Indoor airPLUS



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.

Lighting is very important to the homeowners. “My wife and I were born and grew up in South Africa,” said Quintin. “Living there, you take advantage of the environment. Buildings are designed for natural sunlight.” The house contains ample ENERGY STAR windows and skylights. The fiberglass-framed, double-pane, argon gas-filled windows have a U factor of 0.28, a solar heat gain coefficient of 0.30, and low-emissivity coatings to reduce winter heat loss and summer heat gain.

The home is lit with 90% LED lights for energy efficiency. They are rated at 3000K to give the home a more natural, sunlit feel. Spotlights are carefully placed to illuminate specific areas. “We just love the lighting. My lights are all on the smart home automation system. I have a couple of logic button key pads around the house. I can control a whole series of lights with one button,” said Quintin. Some lights are set on reverse dimmers to brighten gradually when turned on in the morning. The intelligent home automation system turns on interior and exterior lights when the homeowners return at night. Window blinds are sensor-controlled to automatically raise and lower in response to weather conditions, sunlight, heat, and interior cooling settings.

All major appliances and ceiling fans are ENERGY STAR rated or equivalent. All faucets are low flow and all toilets are dual flush to conserve water.

Features like the motion sensor-operated garage exhaust fan, bamboo flooring, and carefully designed HVAC system were among those that helped the home exceed the EPA Indoor airPLUS Checklist criteria.

The home meets the DOE Challenge Home requirement of being made solar-ready with conduit and wiring installed to the roof and the electrical panel but solar panels have not yet been installed. Homeowner Quintin expresses some regret that the home’s roof structure was already established when the builder learned about Challenge Home. “Unfortunately, we have an east-west-facing roof, and the efficiency is not yet high enough for us to warrant putting solar in, but we are watching this,” said Quintin. “My advice for others thinking about a Challenge Home is to build for Challenge Home from the start. The sooner you do this, the easier it is.”

So, after two months of real billing data, how is the house doing? For this homeowner who is passionate about finding ways to conserve energy, this is an exciting question. As the builder McLinden states: “So many people buy things, like electronic equipment with all these bells and whistles, and they never use them. Not Quintin; he is putting this house through its paces.” For electricity, the home is using about half the energy (when compared by size) of the homeowners’ previous house.

KEY FEATURES

- **Path:** performance
- **Above-Grade Walls:** fiber cement siding; liquid-applied, vapor-permeable weather-resistant barrier; 2x6 frame; 5.5-inch cavity with R-20 open-cell foam
- **Roof:** R-49 open-cell spray foam on underside of roof deck
- **Foundation:** basement
- **Below-Grade Walls:** R-13 fiberglass in 2x4 wall cavity
- **Windows:** ENERGY STAR low-E, double-pane, fiberglass framed. U=0.29, SHGC =0.30
- **Air Sealing:** 1.89 ACH 50
- **Ventilation:** balanced ventilation (HRV) with independent ducting. Sensible recovery efficiency 74%, 80 cfm continuous, meets ASHRAE 62.2, MERV 8 filter
- **HVAC:** tankless water heater for hydro coil in furnace. High-velocity small-diameter duct system, all ducts located in conditioned space and insulated to an equivalent R-6, sealed and tested to less than 24 cfm total leakage. All three floors are zoned with an electronically controlled damper system. 12 SEER AC.
- **Water Heating:** tankless 98% efficient water heater
- **Duct Sealing:** internal proprietary duct sealing
- **Lighting:** 90% LED, 10% CFL, sunlight sensors on window shades
- **Solar:** solar-ready for solar thermal and PV panels
- **Appliances:** ENERGY STAR ceiling fan, dishwasher, clothes washer
- **Water Conservation:** low-flow faucets, dual-flush toilets; WaterSense tub in main bathroom
- **Other:** bamboo flooring; extensive daylighting; home automation-controlled blinds for heat control; motion-sensor garage exhaust fan

All photographs by Quintin McGrath.

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

For more information on the **DOE Challenge Home**,
go to www.buildingamerica.gov/challenge

PNNL-SA-98677 September 2013



www.BuildingAmerica.gov