U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

DOE ZERO ENERGY READY HOME™

Housing Innovation Awards

Brookside Development

Singer Village
Derby, CT

BUILDER PROFILE

Brookside Development, LLC, Woodbridge, CT
Mark Nuzzolo, 203-389-5660
mark@brooksidedevelopment.com
www.brooksidedevelopment.com
Rater: Steven Winter Associates, Matt Slattery
mslattery@swinter.com

FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: Singer Village
- Location: Derby, CT
- Layout: 4 bedrooms; 2.5 baths; 2 floors
- Conditioned Space: 4,456 ft^2 w/bsmnt
- Completion: December 2013
- Climate Zone: IECC 5A, cold
- Category: Production

Modeled Performance Data:

- HERS Index: without PV 45, with PV 26
- Builders Cost Over 2009 IECC: without PV $6,448
- Projected Total Annual Energy Cost Savings: without PV $1,730, with PV $3,014
- Projected Annual Utility Costs: without PV $2,110, with PV $1,159
- Annual PV Production Revenue: $1,284
- Annual Energy Savings: without PV 6,319 kWh, 654 therms gas

Builder Mark Nuzzolo of Brookside Development, LLC, has energy savings all sewn up at his new development, Singer Village in Derby, Connecticut. The high-performance homes are located on acreage surrounding the historic Singer House, once home of the granddaughter of Isaac Merritt Singer, founder of Singer Sewing Machines.

The first home constructed in the seven-home community has earned certification from the U.S. Department of Energy's Zero Energy Ready Home program. The program requires homes to meet a host of energy, health, and durability requirements including those of the ENERGY STAR Certified Homes program, and the U.S. Environmental Protection Agency's Indoor airPLUS and WaterSense programs. In addition, they must meet DOE Zero Energy Ready Home prescriptive or performance requirements and a checklist of "renewable-ready" solar power measures that ensure the home is wired and plumbed for solar photovoltaic and water heating panels as soon as the homeowner is ready to install them.

The home was honored with a 2013 Connecticut Zero Energy Challenge Award sponsored by the State of Connecticut. The development itself, Singer Village, was designed to meet the National Association of Home Builders' National Green Building Standards criteria and will become the first development in the State of Connecticut to achieve a multi-star certification. This certification recognizes the builder's efforts to design a development that reduces storm water impact on local waterways and infrastructures, preserves native habitat and wetlands, minimizes erosion, and reduces environmental impacts during excavation and construction.

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.

Brookside Development's first DOE Zero Energy Ready Home serves as a model home at the Singer Village, a seven-home development on the Singer estate in southern Connecticut. Exceptional construction quality allowed the home to achieve a HERS score of 45 without photovoltaics included, or HERS 26 with a 7-kW PV system included.

What makes a home a DOE ZERO ENERGY READY HOME?

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

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

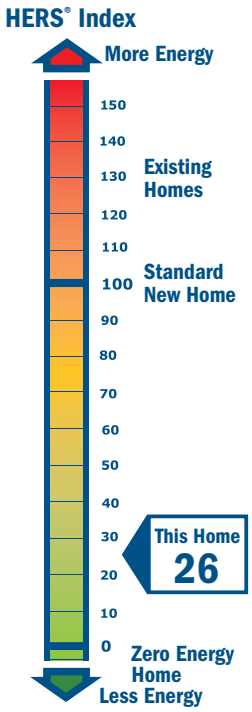
3 **DUCT SYSTEM**
located within the home's thermal boundary

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.



Nuzzolo, a veteran home builder who has built more than 400 homes over a 30-year career, has been recognized with numerous home building industry awards from the Home Builders Association of Connecticut. Although educated as a lawyer, Nuzzolo has chosen real estate development and has served the industry both as president of the New Haven Home Builders Association and as a current member of the association's board of directors. He is also a Certified Green Professional. Mark's wife D.J. Collins works with him as a builder, marketer, and coordinator of sales.

Nuzzolo has been participating in the ENERGY STAR Certified Homes program since 2004. He took a serious look at increasing the energy efficiency of his homes in 2008 when oil prices rose and the recession hit hard. "I thought, we're never going to sell a house in this market doing the same old thing. Let's change the equation from initial cost of the home to the cost of home ownership. We decided to push the envelope," said Nuzzolo. Nuzzolo began participating in the Energize CT New Construction Program, which offers incentives to builders who build energy-efficient homes, with tiered amounts based on the level of energy efficiency the builder achieves.

Through this program, Brookside began working with Steven Winter Associates, a research partner in the DOE Building America Program, who told Nuzzolo about the DOE Zero Energy Ready Home program.

With one DOE Zero Energy Ready Home done, Nuzzolo plans to build the remaining six homes at Singer Village to meet the program criteria. "The only thing I have to figure out is making the WaterSense water distribution requirement work with all of our house designs," said Nuzzolo. "The other requirements all make sense. Building a house this tight, you almost have to do the things Building America requires."

According to Nuzzolo, building to the DOE Zero Energy Ready Home requirements only cost him about $6,000 more than building to a home built to code (the 2009 International Energy Conservation Code).

Nuzzolo starts with a standard 2x4 16-inch on-center wood-framed wall, then boosts the performance with a "flash and batt" approach that includes spraying 1.5 inches of closed-cell high-density spray foam into every wall cavity then filling the remaining cavity space with unfaced fiberglass batts. "I've tried both open-cell and closed-cell spray foam. The closed-cell spray foam increases the strength of

Closed-cell spray foam was applied to the walls up to and over the top plate in a "flash and batt" approach that used 1.5 inches of spray foam to air seal and insulate the wall cavities, which were then completely filled with 2 inches of unfaced fiberglass batt. An additional R-6.5 of foil-faced polyisocyanurate was installed as a continuous rigid foam sheathing on the exterior to reduce thermal bridging and provide a combined wall insulation value of R-25.

the wall and provides exceptional air sealing," said Nuzzolo. On the exterior, the studs are covered with R-6.5 foil-faced polyisocyanurate rigid foam insulation installed over 7/16 in. OSB sheathing. This continuous layer of foam provides a thermal break between the framing and the exterior wall surface, preventing heat loss through the studs. The sheathing is taped at the seams to provide a continuous drainage plane for any rainwater that might get through seams in the vinyl siding. The walls have a total R-value of R-25.

The vented attic has 19 inches of cellulose piled on the ceiling deck for an insulation value of R-68. All vaulted ceiling sections are filled with R-50 of closed-cell spray foam.

The heating and cooling equipment is located in the basement, which is insulated from the ceiling to 3 feet below grade with R-10 of foil-faced, glass-fiber-reinforced, polyiso rigid foam insulation. The builder chose a foil-faced product because the foil facing offers a code-accepted thermal break, i.e., building codes allow it to be left without a covering of drywall. Therefore, the basement can be left for the homeowner to finish as desired. Beneath the slab is 10 inches of packed gravel and a visquene vapor barrier to keep moisture out of the slab and minimize radon.

For HVAC, Nuzzolo chose a heat pump with a gas furnace for back-up. The 2-ton heat pump has a heating system performance factor (HSPF) of 8 and a seasonal energy efficiency ratio (SEER) of 14 (minimum federal appliance standards are 7.7 HSPF and 13 SEER). The high-efficiency gas furnace has a fuel utilization efficiency (AFUE) of 96%, far exceeding the federal minimum of 78% AFUE. All of the HVAC equipment and ducts are located within the home's conditioned space and the system has a MERV 10 filter for cleaner air. The builder worked with Steven Winter Associates to select the HVAC equipment and settings. They recommended setting the heat pump switch point to 50°F, which means if the outside temperature drops below 50°F, the heating system will switch to the natural gas furnace. "Analysis by Steven Winter Associates showed the heat pump lost its cost effectiveness below 50°F because we have natural gas on the site," said Nuzzolo.

The home was designed with the roof space and orientation to install 5 kilowatts worth of photovoltaic panels. Metal conduit has been installed from the attic to the electric panel to accommodate PV installation. "We have tremendous solar capability on the site," said Nuzzolo. "The beauty of a heat pump is that it can absorb excess capacity." The local electric utility lets the meter spin backwards

HOME CERTIFICATIONS

- DOE Zero Energy Ready Home Program
- ENERGY STAR Certified Homes Version 3.0
- EPA Indoor airPLUS
- 2013 Connecticut Zero Energy Challenge Award, affordable category
- NAHB National Green Building Standard, whole development

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.

Table 1. Calculated Costs and Savings Based on Estimated Increased Builder First Cost for Various Efficiency Levels

	DOE ZER Home w/PV	DOE ZER Home w/0 PV	2009 Code Home	2003 Code Home	Existing Home
Purchase Price (Value)	$461,000	$449,900	$444,900	$369,900	$310,000
Down Payment	$93,000	$89,980	$88,980	$73,980	$62,000
Loan Amount	$368,800	$383,920	$355,920	$295,920	$248,000
Length of Mortgage (years)	30	30	30	30	30
Yearly Mortgage Interest Rate	4.5%	4.5%	4.5%	4.5%	4.5%
Mortgage Amount	$1,869	$1,824	$1,803	$1,499	$1,257
Insurance	$100	$100	$100	$100	$100
Property Tax	$766	$766	$766	$725	$700
Est. 1st Year Maintenance Cost	$10	$10	$50	$150	$300
Heating	$48	$48	$99	$199	$257
Water Heating	$10	$10	$27	$29	$32
Cooling	$5	$5	$8	$20	$40
HVAC Fan	$11	$11	$14	$26	$30
Lighting Appliances & Misc.	$98	$98	$115	$115	$115
Services	$32	$32	$32	$32	$32
PV Savings	($107)	$-	$-	$-	$-
Estimated Tax Benefit (Based on 25%)	($534)	($525)	($522)	($456)	($405)
Estimated Total Monthly	**$2,308**	**$2,379**	**$2,492**	**$2,439**	**$2,458**

Even if the initial purchase price of the DOE Zero Energy Ready Home were more than a code-built home, homeowners would still pay less each month when utility bill savings are considered, and homeowners get a much higher quality home as well.

crediting the homeowner for every kilowatt produced up to the amount used by the home, at a rate of 19 cents per kilowatt. But, once the meter reaches 0, any surplus electricity produced is credited back to the homeowner at 4 cents per kilowatt rather than 19 cents per kW. With the dual-fuel system, the homeowner can adjust the switch point on the heat pump to rely on electric power (the heat pump) for heating after the meter has reached zero to "absorb" the excess electricity, explained Nuzzolo.

To further increase energy savings, the home is equipped with an ENERGY STAR refrigerator and dishwasher. The lighting includes a mix of high-efficiency strategies – the exterior and interior lights that are used most often are LED-based lights (about 10% of the total fixtures); the remaining 90% are CFLs. There is a daylight sensor on the exterior lamp. The ceiling fan in the master bedroom is ENERGY STAR rated. The water heater is a tankless gas water heater with an energy factor of 0.92.

The home meets all of the EPA Indoor airPLUS requirements for healthy air including a passive radon venting system; low-VOC paints, finishes, and carpets; moisture management details; and an exhaust ventilation system that meets ASHRAE 62.2 ventilation requirements.

After completing his first DOE Zero Energy Ready certified home, Nuzzolo said he enjoyed the experience and he's learned from it. "I've got the expertise now. The next house we do, we're streamlining the design and possibly reducing the size to go for a lower price point," said Nuzzolo. "I may adjust the products and reduce the size but I don't want to compromise the energy efficiency. Your best shot at getting an energy-efficient house is to build it that way from the start. Once the envelope is closed in, you've pretty much lost your opportunity."

Photos courtesy of Brookside Development, LLC.

KEY FEATURES

- **DOE Zero Energy Ready Home Path:** Performance
- **Walls:** R-6.5 polyiso on exterior (taped to act as drainage plane); 2x4 16-in. o.c. walls with R-18 flash and batt insulation; 1.5-in. of closed-cell spray foam and 2-in. fiberglass batt; vinyl siding
- **Attic:** R-68 (19-in.) of cellulose at attic ceilings; R-50 of closed-cell spray foam in vaulted ceilings
- **Foundation:** Conditioned basement with R-10 foil-faced rigid insulation from top of wall to 3 ft. below grade; 10 in. gravel plus vapor barrier under slab.
- **Windows:** 2-pane, argon-filled, vinyl-framed with foam filling; low-e windows U=0.28, SHGC=0.30; basement U=0.46, SHGC=0.61
- **Air Sealing:** 2.03 ACH 50
- **Ventilation:** Meets ASHRAE 62.2; continuous exhaust fans; 90 cfm
- **HVAC:** 2-ton heat pump (HSPF 8, 14 SEER); 3-ton gas furnace (AFUE 96); ducts inside, MERV 10 filter
- **Hot Water:** Tankless gas; EF 0.92
- **Lighting:** 10% LED; 90% CFL; daylight sensor on exterior lamp; ENERGY STAR ceiling fan
- **Appliances:** ENERGY STAR refrigerator and dishwasher
- **Solar:** Ready for a 7-kW PV system
- **EPA WaterSense Fixtures:** Yes
- **Electric Car Charging Station:** No
- **Other Features:** Storm water management during and after construction; invasive species removed; rain garden designed to accept all runoff from home; conservation easement planned

PNNL-SA-105438 September 2014