



# Cold Climate Region 50+% Energy Savings

## Wisdom Way Solar Village

### Greenfield, MA

Developer/Owner:	Rural Development, Inc.
Location:	Greenfield, Massachusetts
Building Type:	Single Family Attached
Building Size:	1,100 - 1,500 sq ft
	2-4 bedrooms, 1.5 baths
Price:	priced from the low \$100s to mid \$200s
Status:	2 of 20 units completed
SWA Contact:	Robb Aldrich



Rural Development, Inc. (RDI) has been a pioneer in developing and building affordable, efficient, sustainable homes. RDI is a not-for-profit agency whose mission is “to advance the right of all people in Franklin County and the North Quabbin region to occupy environmentally responsible, energy efficient, affordable housing and to improve economic independence. Further, RDI strives to promote environmental awareness, and to operate in a manner that is respectful of the rural character of our region.”

In Spring of 2007, Rural Development, Inc. (RDI) completed their first “near-zero energy” home in Colrain, MA. Building on that success and lessons learned, RDI has again partnered with architects at Austin Design and engineers at Steven Winter Associates (SWA) to design and build a community of twenty tremendously efficient, affordable, solar homes (ten duplexes).

The homes at the Solar Village feature 12” double walls filled with dense-blown cellulose (R-42) and attics insulated with 14” of cellulose (R-50+). Most windows are triple-pane, but some southern windows are double-pane with coatings that allow for greater passive solar gain. Because the heating loads for the homes are so low, the homes will be heated with single, sealed-combustion, natural gas unit heaters on the first floor of each home. Each unit has a photovoltaic system of approximately 3 kW (exact size varies by unit) and a solar thermal system to provide most of the home’s water heating. Auxiliary water heating is provided by a sealed-combustion, tankless gas water heater.

Modeling of the homes predicts owners will need to purchase approximately 350 therms of natural gas each year. If occupants are conscientious, the PV systems should be able to provide all of the electricity used over the course of a year. RDI completed the first home in late in 2008.

**“Buyers are coming for the energy efficiency combined with the renewables - and the low utility bills. Others are coming for the sense of community the Wisdom Way Solar Village will create.”**

#### ENERGY EFFICIENT FEATURES

- Vinyl-framed triple and double pane windows (U-0.18, SHGC-0.23 on E,N,W facades / U-0.26, SHGC-0.37 on S facade)
- Dense blown cellulose insulation (R-40) in basement ceiling
- Loose blown cellulose insulation (R-50) in attic
- 12” double 2x4 wood framing with dense blown cellulose insulation (R-42) in walls
- Blown cellulose at rim/band joists (R-40)
- Sealed-combustion natural gas unit heater (83 AFUE) w/ Panasonic WhisperGreen exhaust fan to distribute heat to upstairs bedrooms
- Energy Star® Appliances
- 100% fluorescent lighting
- ASHRAE 62.2 compliant exhaust-only ventilation
- Mastic-sealed ductwork
- Solar thermal water heating system (68% solar fraction) with tankless gas auxiliary (0.82 EF)
- 3-kW PV system

#### GREEN BUILDING FEATURES

- Water-saver faucets, showerheads, and dual-flush toilets
- Low-VOC paints
- Hardi-board siding
- Marmoleum resilient floor

#### CERTIFICATIONS

- Energy Star® Homes HERS Indices of 10-20
- Participating in LEED® for Homes (Gold expected)
- DOE’s Builders Challenge

<http://www.ruraldevelopmentinc.org/>

**Steven Winter Associates, Inc.**

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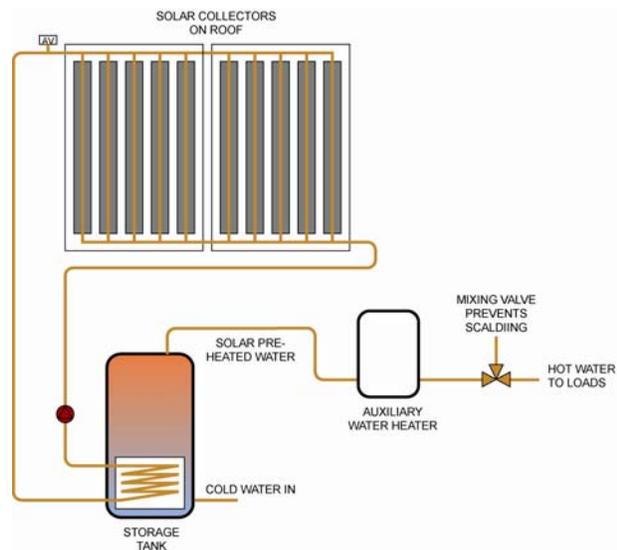
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The long-term goal of the Building America program is to develop cost-effective systems for homes that can produce as much energy as they use—zero energy homes. As teams increase the savings targets towards zero energy, maintaining cost neutrality is a key component. The added cost of higher efficiency technologies can sometimes be offset by reducing unnecessary waste in other systems or through utility bill savings. The annual mortgage payment is calculated based on a 30 year mortgage with a 7% fixed interest rate. For all home models, the cost neutrality is positive. PV is only cost-effective if the subsidies are included in the cost calculations. One key element in the cost equation is the \$5,000 savings from the lack of a conventional, central heating system. This savings is critical in the cost-effectiveness of the project.



Measure	Incremental Costs	
	Without subsidies	With Subsidies
Double-wall construction	\$2,500	\$2,500
R-50 attic insulation	\$300	\$300
R-40 floor insulation	\$540	\$540
Triple-pane windows	\$3,000	\$3,000
Solar water heating system	\$9,750	\$0
Heating System	(\$5,000)	(\$5,000)
Ventilation System	\$450	\$300
100% CFL	\$114	\$0
ENERGY STAR Appliances	\$190	\$190
added builder cost	\$11,844	\$1,830
Annual mortgage pmt. increase	(\$1,050)	(\$162)
annual utility savings	\$1,902	\$1,902
Net cash flow	<b>\$852</b>	<b>\$1,740</b>

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Ventilation System	\$450	\$300
100% CFL	\$114	\$0
ENERGY STAR Appliances	\$190	\$190
3.4-kW Photovoltaic system	\$24,827	\$4,574
added builder cost	\$34,171	\$6,404
Annual mortgage pmt. increase	(\$3,029)	(\$568)
annual utility savings	\$2,531	\$2,531
Net cash flow	<b>(\$498)</b>	<b>\$1,963</b>





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#### Challenges with Double-Wall Construction

The double-wall system has been a success for RDI; it is a straightforward way for them to achieve whole-wall R-values of above 40 ft<sup>2</sup>hr °F/Btu. There are certainly challenges associated with the technique, however. One of the consistent challenges was venting. The exterior walls were insulated before any of the vented appliances were installed (exhaust fans, dryer vent, water heater, space heater), so RDI carpenters needed to make accommodations for the installation of all venting penetrations.

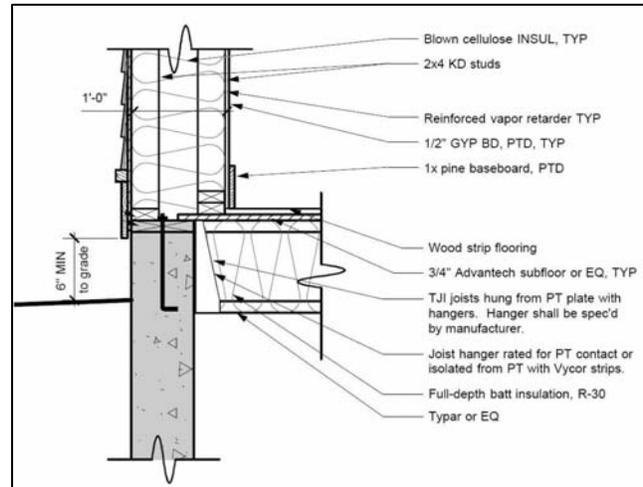
To allow for venting, RDI separated off portions of the wall with framing and netting; these areas were not filled with cellulose when the wall systems were insulated. These small cavities were insulated separately with fiberglass batts to facilitate venting. Because penetrating any part of the cellulose wall system can compromise the thermal integrity of a large section of wall, this strategy also allows for easier maintenance if venting ever needs to be accessed or replaced.

Two of the homes at the Village will be fully accessible, and all of the units will be visitable by people with disabilities. To bring the level of the first floor closer to grade, the first floor is hung below the sill plate rather than framed on top of the plate. Because there is no band joist between the basement and the first floor, venting from the basement was more complicated. Vent piping from the water heater and clothes dryer needed to be run up into the double-wall system before running outside. In some instances, the double-wall had to be made thicker (2-3") to accommodate vent piping. As with other vents, sections of the exterior wall were boxed out and insulated separately with fiberglass to allow for installation.

#### Unit Heaters

The very low design heat load of the homes (12,000 Btu/h or less) presents a challenge that Building America teams have begun to encounter with some frequency: equipment small enough to meet the load efficiently. RDI's solution to this was to install a single unit heater in every home rather than a central, distributed heating system.

The obvious concern raised by this arrangement – when heating is not actively distributed throughout the home – is comfort. However, the design loads in bedrooms (the only areas that are of major concern) will also be very low – approximately 2,000 Btu/h at a



design temperature of 2 °F. Internal gains combined with natural convection and conduction (from the rest of the house) will limit temperature differences. In addition, the simple air distribution system will further reduce variations in temperature. CARB believes it is very important to investigate the implications of comfort, energy savings, and cost savings in high-performance homes with such simple heating systems.

#### Exhaust Only Ventilation

In many cold-climate homes, exhaust-only ventilation is one of the simplest, least-expensive, lowest-maintenance, and most cost-effective mechanical ventilation systems. (Exhaust-only ventilation is typically only appropriate for homes without atmospheric or natural draft appliances.) CARB's chief concern with the strategy relates to adequate distribution of outdoor air so that all parts of the home receive adequate air changes. CARB hopes to further characterize the performance of exhaust-only systems and to evaluate enhancements – such as the simple air distribution system in these homes.

#### Northern Windows

CARB and RDI spent many hours attempting to find an affordable, high-solar gain, low U-value, triple pane window. The conclusion was that these products do not exist. Windows with the desired thermal characteristics were generally custom, fiberglass-framed windows which were far too expensive for RDI's budget. CARB found several vinyl-framed, triple-pane windows that had excellent U-values (0.20 Btu/ft<sup>2</sup>hr °F or below), but all of these vinyl windows also had very low solar heat gain (typically well below 0.30). Higher solar gain windows can help achieve further reductions in heating energy.



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CARB began working with RDI in 2005 on preliminary planning for the prototype “near zero energy” home in Colrain, MA (completed in Spring 2007). CARB continues to support RDI in achieving their energy goals – moving closer to zero energy practically and cost effectively. To get RDI’s take on this process – and on homebuilding issues in general – CARB submitted these questions to RDI. RDI’s Anne Perkins, Director of Homeownership Programs; Wendy Forbes, Home Ownership Programs Assistant; and Cynthia Bliel, Outreach and Education Coordinator, responded.

What are the most important services that Building America and CARB was/is able to provide?

Building America/CARB has designed the mechanical systems in our near zero net energy homes as integrated systems in the most cost effective ways possible. It has also been extremely helpful in gathering data which allows us to quantify the effectiveness of the energy efficiency measures and renewable energy systems employed in our projects. Finally, it has provided information and presentations to allow us to educate the public, prospective home buyers, and other developers/builders about the value of near zero net energy construction.

Do you see RDI continuing to implement the techniques and strategies that were pursued in this project in future communities?

Yes, RDI will definitely continue to implement these techniques and strategies in future communities. Because we are building affordable housing, Building America has worked with us to devise the most cost effective techniques to achieve our aims. As with any project, the first time is the most difficult. We expect to continue to build future communities and individual homes cost effectively. Also, it is likely that the cost effectiveness of these techniques and strategies will improve as they become more mainstream, due to some extent to the efforts of Building America and projects such as ours. As builders and the public become more educated, the demand for affordable products and solutions increases.

How difficult has it been to get sub-contractors (HVAC, plumbing, electrical, etc.) to get on board with what RDI is trying to achieve?

Because RDI has included subcontractors in the design phase, there has been an enthusiastic response

from them. They respect Robb Aldrich and his work with RDI and they turn to him with ideas of their own. Most of the subs like being on the cutting edge of energy efficient construction.

Briefly, are there any interesting lessons about the process of designing and building very efficient homes that you can share with other builders? Or about working with Building America?

The number one lesson is that home builders should start with lowering the heating and electric loads of buildings before they employ renewable energy solutions.

The other extremely important lesson is to assemble an integrated design team at the very beginning of the planning process and to keep in close touch with the team throughout. Creative solutions are much more likely to arise from the synergy of people with different areas of expertise working together. Although it is not generally possible to gather the large group of the design team together on a regular basis, those initial meetings create a base for the collaboration that is necessary for the project to proceed smoothly. It is also important to include the sub-contractors in the design process so that they can raise their concerns and also offer their invaluable hands-on experience. The more buy-in all the players have in the project, including future home buyers, the more they will be willing to try new approaches and think creatively when the inevitable complications arise.

What is your take on the current housing market and the future of certification programs such as EPA’s Energy Star and USGBC’s LEED for Homes?

The current housing market is tough, but we hope for change. The administration of Deval Patrick, governor of Massachusetts, is enthusiastic about developing zero net energy buildings and has created a Task Force to advise him. We trust that the new Obama administration will also be enthusiastic. The Energy Star homes program is gaining currency and we expect it to grow. The LEED for Homes program, however, is too fraught with reporting detail for the ordinary home builder to deal with. Unless it changes, we predict it will collapse from its own weight.