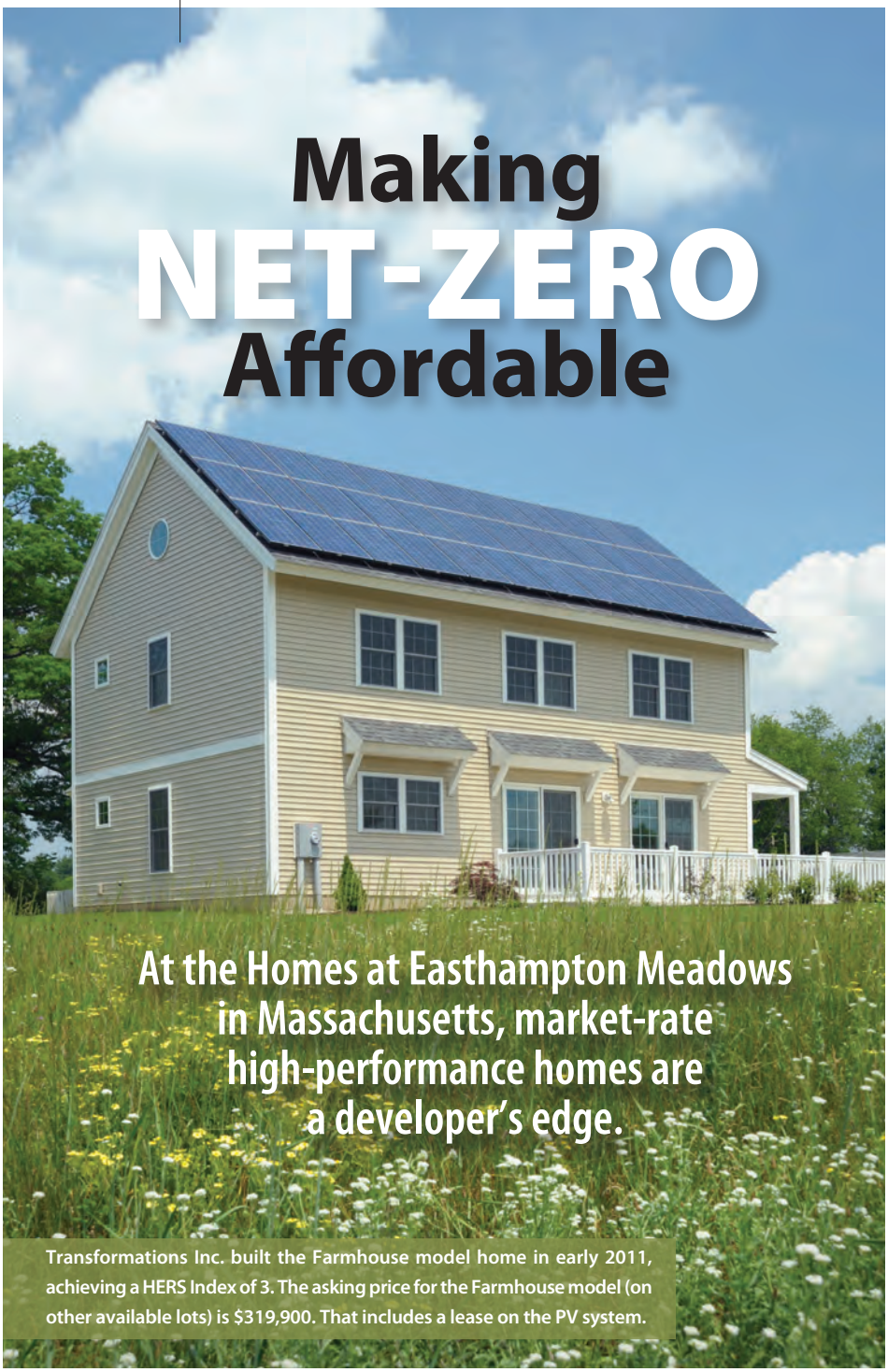
Making NET-ZERO Affordable



At the Homes at Easthampton Meadows in Massachusetts, market-rate high-performance homes are a developer's edge.

Transformations Inc. built the Farmhouse model home in early 2011, achieving a HERS Index of 3. The asking price for the Farmhouse model (on other available lots) is $319,900. That includes a lease on the PV system.

Text by **R. CARTER SCOTT**
Photos By **DAVID RYAN**

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My firm has been building renewable energy-powered houses according to sustainable practices for years. In 2008, we competed in the Massachusetts investor-owned utilities' Zero Energy Challenge — an experience I detailed in these pages (see "The Zero-Energy Home Challenge," November/December 2008 issue). After the competition, my company focused on bringing down the costs of these net-zero-energy homes. We converted our existing project pipeline with 12-inch-thick walls that, with the help of solar electric systems on the roofs, enable them to produce as much power as they consume.

In January of 2010, I received a phone call from Pam Goodman, president of Beacon Communities Development LLC (beaconcommunitiesllc.com). Beacon is a multi-family home developer/manager that has developed more than 9,000 units of housing. It had permitted and built two phases of a project in Easthampton, Mass. The second was an innovative intergenerational rental development for households committed to adopting children who had experienced foster care and for people over 55 who wanted to be involved in the lives of children. Pam was interested in doing something "different" on the third and final phase, which included 33 single-family homes. She had heard about our cost-effective construction techniques for high-performance homes and wanted to see what Transformations could do for her company at this site.

Keeping the Homes Affordable

The Homes at Easthampton Meadow is a mixed-income development. The majority of the market-rate homes were expected to be priced at $300,000 to $330,000. Nine homes selling in the $125,000 to $150,000 range are set aside for low-/moderate-income first-time homebuyers. I needed to keep the costs in line to keep this project financially feasible.

The project had been subdivided and the homes designed, bid out and were ready to go online when the housing collapse hit the local market. The plan was to build to the Energy Star standards, which at the time entailed a Home Energy Rating System (HERS) Index of no more than 85. The project was put on hold for a couple of years.

When Pam came to me, she wanted something to differentiate this project from those in the surrounding area. My goal was to bring that HERS Index down to 0 to help her sell the homes. The budget I proposed was just over $102 per square foot for the hard costs for building the model home. Overhead, general expenses and a

The builder proposed to reduce the 2009 International Energy Conservation Code home with a HERS Index of about 91 to around 40, before a PV system is factored in. The team achieved that using a super-insulated shell design, triple-glazed windows and high-efficiency appliances.

margin were added to that number. I suggested that the photovoltaic (PV) systems could be optional to bring down the first-time costs to the homebuyers.

The next step was to redesign the homes to take advantage of solar electric systems, which are especially cost-effective with Massachusetts incentives. That meant giving the homes an open roof area facing within 30 degrees of true south (in this part of the country, true south is about 14 degrees west of magnetic south).

Architect Benjamin Nickerson of Woodstock, Vt., along with Betsy Pettit and Honorata Wytrykowska of Building Science Corp. in Somerville, Mass., created plans with gable ends to the street (Greek Revival, Victorian and Farmhouse designs) to take advantage of sunlight from the side. We created designs that could incorporate solar on the front or back of the homes (colonial, saltbox, ranch and cottage designs), all in keeping with the New England style.

Beacon Communities has a secret weapon: Mercedes Fernando, a designer in touch with what buyers want in homes these days. She took a Farmhouse model plan we had built previously and redesigned it with a bigger kitchen, more south-facing glass, a nice master bathroom and a walk-in master closet. She kept roughly the same amount of glass and square footage as we had previously. Leveraging the large volume of units that Beacon produces, she was able to work with suppliers to reduce costs. We upgraded the vinyl bathroom floors to tile and the kitchen and bath counters from plastic laminate to granite. Mercedes accomplished all this while maintaining the original budget.

Reducing Baseline Energy Usage

The plan I proposed was to reduce the homes' energy usage approximately 56 percent. That brought the 2009 International Energy Conservation Code home with a HERS Index of about 91 to around 40, before a PV system is factored in.

We have been blessed by being a part of the U.S. Department of Energy's Building America Program. A couple of years ago, Betsy Pettit and some other ace members of the team at Building Science Corp. (www.buildingscience.com) led a charrette to look over our first Zero Energy 2008 Farmhouse model and suggest improvements. There were about 10 engineers and four architects at the table — some of the industry's best and brightest. One suggestion was that we try the Navien instantaneous gas water heater. It has a 98 percent efficiency rating and installed cost of about $1,800. This approach would prove to be much more cost-effective than using active solar thermal or combined PV-and-solar thermal systems. It took about five hours to get through about 25 slides with all of the charrette group's intense conversations!

We tweaked our super-insulated shell design for the home. For a home with a full basement, we now install 2-inch rigid insulation under the slab for a total of R-10, and 3.5 inches of high-density foam on the basement walls for a minimum of R-20. If the home has a slab-on-grade design, we use 6 inches of rigid insulation under the slab (R-30) and 4 inches on the slab edge (R-20). We still use the 12-inch-thick walls filled with low-density Lapolla foam insulation (R-value of 3.9 per inch or R-46.8 for the cavity wall) and 18 inches of cellulose in the attic (R-63 cavity). Harvey Industries recently upgraded its triple-glazed windows with krypton gas, attaining a more cost-effective unit U-value of 0.20.

These homes are built to minimize air infiltration and leakage. That helps reduce drafts, resulting in a more comfortable home. The low infiltration helps us reduce our peak heat load to 12,100 British thermal units per hour for the Farmhouse model home. In other words, it can be heated with the equivalent amount of energy required to operate two 1800-watt hair dryers! That is the amount of energy it takes to raise the inside temperature to 70°F (21°C) when it is 2°F (minus 17°C) outside.

For heating and cooling systems, we use Mitsubishi Mr. Slim dual-stage heat pumps (indoor units are MSZ-FE12NA and the outdoors units are MUZ-FE12NA). We typically have one unit on the first floor and one unit on the second floor. These units produce 92 percent of their capacity at 5°F (minus 15°C) and keep producing heat down to minus 13°F (minus 25°C).

A Panasonic Whisper Quiet ERV (Energy Recovery Ventilator) is included in the homes. This is a quiet unit — 0.3 sones on low and 0.8 sones on high setting.

The Massachusetts New Homes with Energy Star program offers builders very good incentives on energy-efficient homes. For single-family homes in 2011, the incentives are $750 for Tier 1, $1,250 for Tier 2 and $8,000 for Tier 3. To achieve Tier 3 with our model home, we had to reduce the home's energy consumption (without solar electric panels) by 45 percent as compared to the reference home. That worked out to a HERS Index of about 40. With the Tier 3 incentive, the marginal cost to go from a HERS

70 to HERS 40 was around $3 per square foot. This proved to be cost-effective for the project.

Getting to Net-Zero-Energy

Massachusetts has some fantastic incentives for PV systems. The solar renewable energy credits (SRECs) are the big story. The Massachusetts Department of Energy Resources (DOER) has created a renewable portfolio standard (RPS) solar carve-out mandating a certain amount of the state's total electric supply that must be provided by solar PV. The goal is to increase the amount of solar electricity supplied each year until 400 megawatts (MW) of SRECs are installed, providing about 1 percent of the electricity supplied in the state (see the RPS Solar Carve-Out page on the DOER's website: mass.gov/doer).

An SREC is generated when a qualified system generates 1 MW. New systems today receive SRECs for 10 years (40 quarters). Over time, the DOER will reduce the number of years the SRECs are good for — with a maximum decrease of four quarters in a given year (i.e., soon SRECs will be good for nine years, then eight years and so on). In 2010, the first year for SRECs, the penalty to the utility company if it did not achieve its solar carve-out (5 percent of the 5 percent RPS) was $600 per megawatt, or 60 cents a kilowatt-hour. The SRECs were selling for about $580 on the open market. Aggregators were charging between 5 and 7 percent to buy the SRECS, aggregate and sell them to the utilities. The net for the PV system owner was $539 per megawatt, or 53.9 cents per kilowatt-hour in 2010. That is a pretty big incentive. Of course, the value of the electricity generated is in addition to the positive environmental attributes of the solar production represented by SRECs. So in some parts of Massachusetts, PV systems were producing about 74 cents a kilowatt-hour!

The table on page 43 estimates the declining value of the SRECs over the 10-year period for a 10.08-kilowatt (kW) system. But rather than the value declining unpredictably, last summer the DOER suggested fixed rates for the SRECs over the next 10 years. This income of about $46,000 represents 10 years of SRECs from a system with minor shading, a 10/12 roof pitch and a solar orientation close to due south.

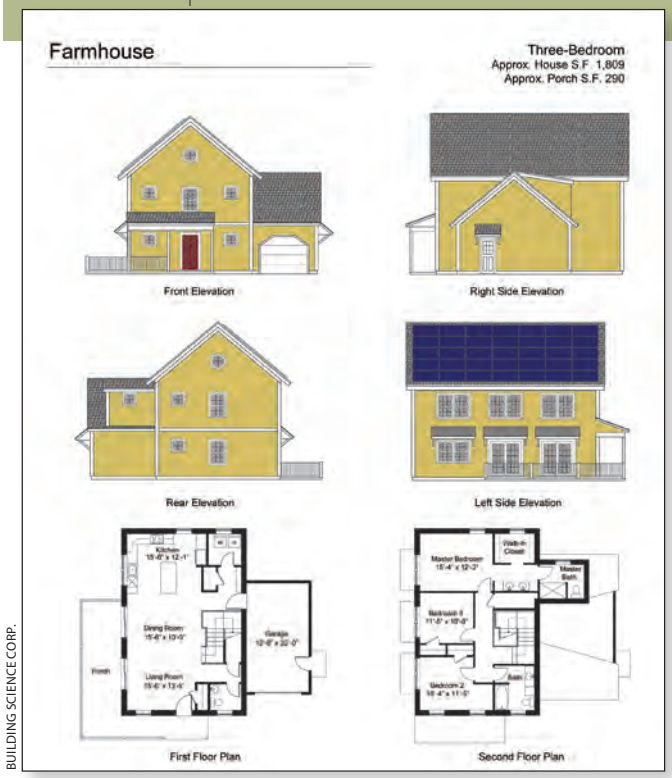
There are additional local incentives. The Massachusetts Clean Energy Center offers rebates of up to $4,250 for a 5-kW system. In addition to the federal tax credit of 30 percent of the system cost, Massachusetts has a $1,000 state tax credit for the homeowner.

Mitsubishi dual-stage heat pumps produce 92 percent of their capacity at 5°F (minus 15°C) and keep producing heat down to minus 13°F (minus 25°C).

A low-infiltration design helped reduce the Farmhouse model home's peak heat load to 12,100 British thermal units per hour — the equivalent amount of energy required to operate two 1800-watt hair dryers! That is the amount of energy it takes to raise the inside temperature to 70°F (21°C) when it is 2°F (minus 17°C) outside.

These houses are *zero-energy attainable*, in that the owner has the ability to produce as much energy as the house consumes by installing a PV system or purchasing PV power. The various model homes have different open-roof spaces for PV panels, and therefore, different capacities to produce on-site electricity.

With the available incentives described above, homebuyers can have the PV systems



BUILDING SCIENCE CORP.

The homes are designed for PV. For instance, the Small Saltbox design accomodates a 14.4-kW system on the back of its roof. The excess energy generated by a PV system can be used to charge electric and hybrid electric vehicles.

Massachusetts Solar Renewable Energy Certificates (SRECs) for a 10.08-Kilowatt System	
SRECs Generated Per Year*	11
Year 1 ($550 ACP rate per SREC minus $20 and a 5 percent aggregation fee)	$5,538.50
Year 2 ($550 ACP rate per SREC minus $20 and a 5 percent aggregation fee)	$5,538.50
Year 3 ($523 ACP rate per SREC minus $20 and a 5 percent aggregation fee)	$5,256.35
Year 4 ($496 ACP rate per SREC minus $20 and a 5 percent aggregation fee)	$4,974.20
Year 5 ($472 ACP rate per SREC minus $20 and a 5 percent aggregation fee)	$4,723.40
Year 6 ($448 ACP rate per SREC minus $20 and a 5 percent aggregation fee)	$4,472.60
Year 7 ($426 ACP rate per SREC minus $20 and a 5 percent aggregation fee)	$4,242.70
Year 8 ($404 ACP rate per SREC minus $20 and a 5 percent aggregation fee)	$4,012.80
Year 9 ($384 ACP rate per SREC minus $20 and a 5 percent aggregation fee)	$3,803.80
Year 10 ($365 ACP rate per SREC minus $20 and a 5 percent aggregation fee)	$3,605.25
Total Rebates	**$46,168.10**

* SREC projections use proposed alternative compliance payment rates suggested by the Massachusetts Department of Energy Resources on Aug. 2. A market rate discount of $20 below the cap is assumed.

paying for themselves. There are two primary options for getting the solar on the roof. The first is through a power purchase agreement (PPA), a great option for someone who lacks the cash or borrowing ability to buy. I've seen PPA agreements for $0 down that allow the homebuyer to purchase electricity for 10 percent less than the local utility's current rate.

The second option is for the buyer to purchase the system. We find that the systems pay themselves back in six to seven years if purchased with cash. If financed with as little as no money down, premium 18 percent efficient panels can pay for themselves in less than 10 years — including the financing costs. That means a homebuyer can have 15 to 20 years of power after paying off the system with 100 percent borrowed funds.

Taking Net-Zero to the Next Level

Some of our home models actually can produce more electricity than the home is modeled to use. Here is where it gets really exciting. As a SunPower dealer, we have access to SunPower solar panels, with efficiencies of more than 19 percent (vs. typical panels in the 14 to 15 percent range). Consequently, we can get up to 50 percent more power in the same square footage of collectors. With enough roof space, that produces more energy than the homeowners will likely use in their homes. We can now use this energy to charge electric and hybrid electric vehicles.

Our Small Saltbox design packs a whopping 14.4-kW on the back of its roof. The 1,239-square-foot (115-square-meter) home comes in with a HERS Index of minus 28. Another design in a different development uses PV on a carport as well as the main roof. We were able to get this home to model a minus 56 HERS Index, possibly the lowest in the country at this time. With homes like these, we not only address the 40 percent of carbon emissions associated with buildings, but we go after the 40 percent of carbon emissions associated with transportation!

With the expert local help of David Hardy of David Hardy Contractors LLC, we built the Farmhouse as the model home in early 2011, achieving a HERS Index of 3. The sale price to buy the Farmhouse model (on other available lots) is $319,900. That includes a lease on the PV system. Transformations signed a $6.8 million contract to build out the full community of 33 homes in June. As of August, two homes had already gone to purchase and sale (see David Ryan at homeseasthamptonmeadow.com for listings). Five or more homes are expected to be in the ground this fall. **ST**