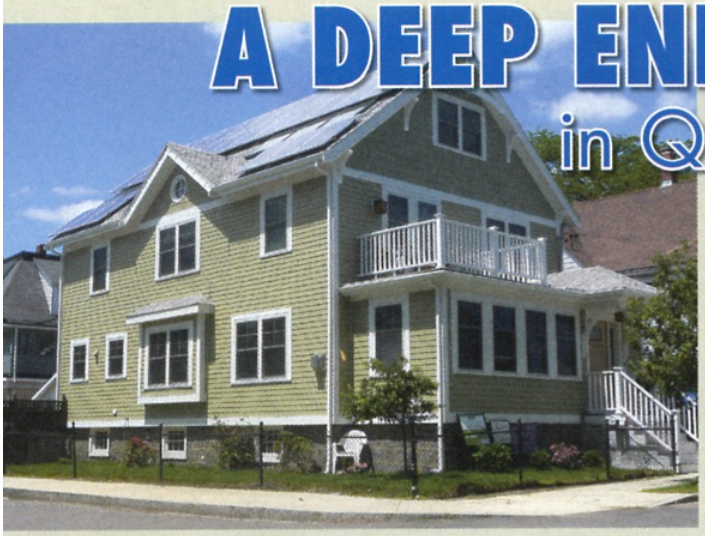
A DEEP ENERGY RETROFIT in Quincy, Massachusetts



Courtesy Timeless Architecture

The Halls expanded their living space but shrunk their energy bills by investing in energy-efficient building techniques and a 6.25 kW PV system.

Thomas and Margaret Hall bought their house in Quincy, Massachusetts, 15 years ago. As their family grew, they decided to expand the two-and-a-half-story, 1903 home. Their three children had been sharing a single bedroom, and they wanted a home office and to accommodate an aging parent. The plan started out with a very simple second-story addition.

"Part of what an architect does is set a vision for the client," says Henry MacLean, principal architect for Timeless Architecture. The Halls were open to MacLean's ambitious proposal—that they take part in a Deep Energy Retrofit pilot program hosted by National Grid. At that time the utility company, which serves several eastern states, including Massachusetts, was offering incentives of up to $42,000 for single- and multi-family residences that met rigorous standards for a whole-house energy retrofit.

The Halls decided to go one step further and participate in the Thousand Homes Challenge (THC). These projects must demonstrate a 70% reduction in energy use through a year's worth of monitoring. National Grid kicked in an additional $10,000 incentive for projects that met the standard (see "A Thousand Paths to Energy Efficiency" sidebar on page 74).

MacLean cites cooperation among the team of builders, subcontractors, and consultants as the key to the project's success. Building Science Corporation, an architecture and building science consulting firm, acted as energy consultant throughout the process. One of the teaching tools was a mock-up wall assembly, which included window flashing and air-sealing details and showed the attachment of the two overlapping layers of exterior insulation.

The revamped design retained the home's original footprint but added more than 900 square feet of living space, including a full second story and two home offices on a new third floor. A 6.25 kW grid-tied PV system and six-collector solar hot water system provide up to 60% of the home's annual energy and hot water needs.

The climate in Quincy is challenging, with cold winters and hot, humid summers. Air conditioning was a requirement. Hydronic floor heating was installed in both the basement and first story; a hydro-air system heats the rest of the house. The heating is from a trifuel system: in solar-thermal mode, the gas is "locked out," regardless of outside temperature.

A Carrier air-to-air heat pump takes over when the solar thermal can't meet demand. The heat pump works well during the swing seasons but becomes less effective at lower temperatures. Natural gas is used only when the outside temperature dips below the balance point—36°F and when the solar thermal heating isn't available.

The THC total energy consumption threshold was determined at 11,522 kWh per year, which includes grid electricity and natural gas (converted from Btu). To put this in perspective, similarly sized homes in the area use an average of 70,000 kWh per year. The Halls monitored their energy usage from July 2011 to July 2012—the fossil fuel consumed totaled 8,936 kWh, or 77% of the threshold.

MacLean praises the Halls for their cooperation and involvement. Before embarking on their project, he had three or four clients consider a DER, but reconsider during the design/development phase. "Even with the incentive, it's an eight- or nine-year payback," he says. "That's a big commitment." The Halls' project represents the first DER south of Boston, and one of about 20 statewide.

The Halls' Expanded Efficiency

Tour	Green Buildings Open House Pro Tour; sponsored by Northeast Sustainable Energy Association & National Grid
Owners	Thomas & Margaret Hall
Designer	Timeless Architecture • otimearch.com
Builder	Grifcon Contracting
Project location	Quincy, Massachusetts
Date completed	December, 2010
Type of residence	Single-family (includes two home offices)
Square feet	3,560 (from 2,647; retained original footprint)
Construction method & materials	Wood frame with two layers overlapping exterior rigid insulation & Hardie fiber-cement siding; concrete slab over existing granite foundation & basement
RE system	6.25 kW grid-tied PV system; SunRun lease
Heating	Phoenix Evolution VersaHydro radiant (hydronic) floors in a trifuel system: solar thermal first, then electric heat pump. Natural gas is used as when temperature is below 36°F and no solar thermal is available
Cooling	Carrier air-to-air heat pump (COP 4.08 @ 47°F; 2.8 @ 17°F)
Water heating	Phoenix Evolution VersaHydro gas storage water heater with heat exchanger for input from six Velux integrated SHW collectors
Insulation	Roof: 10 in. of Icynene spray-foam; 4 in. rigid polyiso foam (R-60); Walls: two interwoven layers of polyiso foam (R-40); Basement: 2 in. closed-cell foam over foundation; 3.5 in. fiberglass batts in framing
Windows	Paradigm triple-paned, low-e argon-filled (U-value = 0.2)
Lighting	CFLs
Miscellaneous	Energy Star appliances
Air-quality features	Lifebreath heat recovery ventilator: 190 ECM, 88% efficiency, installed through AHU & central duct system
Other green features	Rain barrels from rain leaders with overflow to ground
Rebates & incentives	National Grid DER program: $40,000 plus $10,000 for meeting THC threshold; Electricity from grid at set rate of $0.11 per kWh for 20 years
Certifications & awards	National Grid DER (2011); ACI 1000 Home Challenge (2012); NESEA Pro Tour (2012)