



Building America Case Study
Whole-House Solutions for Existing Homes

National Grid Deep Energy Retrofit Pilot

Massachusetts and Rhode Island

PROJECT INFORMATION

Construction: Deep energy retrofit (DER)

Type: 37 comprehensive retrofits,
5 partial retrofits

Housing Type: 31 single-family, 8 two-family, and 3 three-family dwellings

Pilot Program Sponsor:
National Grid, www.nationalgridus.com

Technical Support Partner:
Building Science Corporation,
www.buildingscience.com

Contractors: Various

Projects Completed: 2009–2012

Climate Zone: Cold

POST-RETROFIT PERFORMANCE DATA

	Single Family	Multifamily
Annual Source Energy Use per Household (MMBtu, full DERs only):		
Median	100.8	84.1
Mean	112.0	85.0
Source Energy Use Intensity (EUI) (kBtu/ft²/yr, full DERs only):		
Median	38.9	48.9
Mean	44.5	51.7
Airtightness Achieved (ACH50):		
Median	1.4	—
Mean	1.9	—

From 2009 through 2012, National Grid conducted a pilot program to evaluate comprehensive deep energy retrofit (DER) of homes in Massachusetts and Rhode Island. Forty-two projects participated in the pilot. The pilot program set aggressive performance targets for the homes' building enclosures, incentivized heating and cooling system upgrades, and required mechanical ventilation and combustion safety measures. The completed projects achieved an average yearly source energy use that is 40% below the Northeast regional average.

Implementing a DER is a big undertaking that results in a significantly transformed building. Building Science Corporation, a U.S. Department of Energy (DOE) Building America team, provided technical support and review of project plans to guide projects toward effective management of the changing moisture, airflow, and heat flow dynamics. National Grid offered homeowners significant incentives (base incentives of \$35,000–\$42,000 for single-family homes) to spur implementation of comprehensive DER projects. The initial focus on whole-house projects allowed for evaluation of numerous enclosure component retrofits in a relatively small number of projects.

The experience of this DER pilot has led to the development of an ongoing component-based incentive program for high performance retrofit projects, sponsored by a consortium of electric and gas utilities operating in Massachusetts and Rhode Island.



Retrofit techniques that were adopted by many of the pilot projects include: (1) a house wrap air-control membrane on the walls with a direct connection to the air-control membrane of the roof (a.k.a. “chainsaw transition”); (2) multiple layers of rigid foam insulating sheathing added to the exterior side of the walls; and (3) high performance triple-glazed windows installed in plane with the face of insulating sheathing.

Key Energy Efficiency Measures

BUILDING ENCLOSURE PERFORMANCE TARGETS:

- R-60 attic or roof
- R-40 walls
- R-20 foundation walls
- R-10 slab
- R- 5 windows
- Total enclosure airtightness, 0.1 cfm50 /ft² enclosure area

HVAC PERFORMANCE TARGETS:

- Furnace, boiler: AFUE 95+
- Air-source heat pump or ground-source heat pump: 8.2+ HSPF
- Cooling: 16 SEER/13 EER

LIGHTING, APPLIANCES, AND WATER HEATING

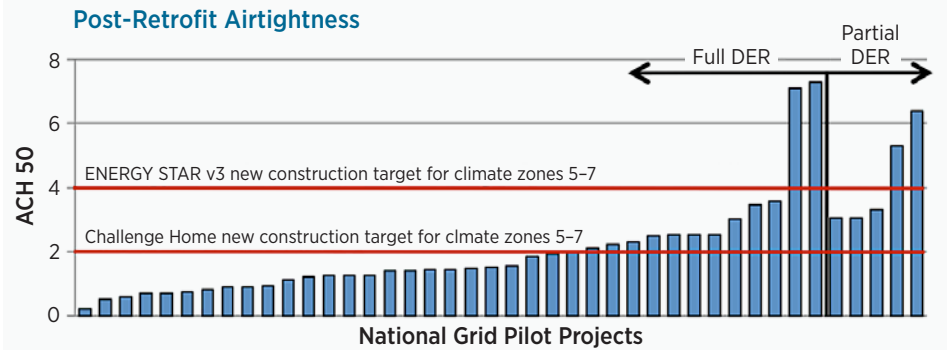
- 100% CFL or energy efficiency LED
- ENERGY STAR® appliances

REQUIREMENTS

- Combustion safety: forced draft or direct-vented combustion for fossil fuel heating and water heating equipment. Also applied to solid fuel-burning appliances.
- Mechanical ventilation meeting requirements of section M1507.3 of the 2012 IRC.
- Robust water management and vapor control required of the retrofit enclosure system.

For more information, see the Building America report, *Performance Results for Massachusetts and Rhode Island Deep Energy Retrofit Pilot Community*, at www.buildingamerica.gov

Image credit: All images were created by the BSC team.



Highlights and Lessons Learned

Post-retrofit energy use data were collected for 27 comprehensive DER projects. These data show:

- The mean per-household source energy use for the group is 107.2 MMBtu/year or approximately 62% of the regional household average.
- The group of single-family DER projects achieved an average source energy use intensity (EUI) of 44.5 kBtu/ft²/yr while the group of multifamily DER projects achieved an average source EUI of 51.7 kBtu/ft²/yr.

Post-retrofit air leakage testing was conducted at each project. These data show:

- Twenty-four of the projects achieve airtightness below the DOE Challenge Home target for the climate zone. For the comprehensive retrofits, the median airtightness is 1.43 A3CH50 and the mean is 1.9 ACH50.

Reported energy-related measure costs vary considerably. For the group of DER projects:

- Relative to conditioned floor area, energy-related measure costs range from \$16.17/ft² to \$54.04/ft². The average was \$34.59/ft²—well below the cost of high performance new construction!



Before and after images of one of the projects in the National Grid DER pilot program community. Benefits achieved through these projects include improved comfort, superior water management, elimination of ice dams, passive survivability, and, as seen here, aesthetic improvements.

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The U.S. Department of Energy's Building America program is engineering the American home for energy performance, durability, quality, affordability, and comfort.

DOE/GO-102014-4372 • March 2014