Building America Case Study
Whole-House Solutions for Existing Homes

Multifamily Individual Heating and Ventilation Systems

Lawrence, Massachusetts

PROJECT INFORMATION

Construction: Retrofit

Type: Multifamily, affordable

Builder: Merrimack Valley Habitat for Humanity (MVHfH) *www.merrimackvalleyhabitat.org*

Size: 840 to 1,170 ft^2 units

Price Range: $125,000–$130,000

Date completed: Slated for 2014

Climate Zone: Cold (5A)

PERFORMANCE DATA

HERS Index Range: 48 to 63

Projected annual energy cost savings: $1,797

Incremental cost of energy efficiency measures: $3,747

Incremental annual mortgage: $346

Annual cash flow: $1,451

Billing data: Not available

The conversion of an older Massachusetts building into condominiums illustrates a safe, durable, and cost-effective solution for heating and ventilation systems that can potentially benefit millions of multifamily buildings. Merrimack Valley Habitat for Humanity (MVHfH) partnered with U.S. Department of Energy Building America team Building Science Corporation (BSC) to provide high-performance affordable housing for 10 families in the retrofit of an existing mass masonry building (a former convent).

The original ventilation design for the project was provided by a local engineer and consisted of a single large heat recovery ventilator (HRV) located in a mechanical room in the basement with a centralized duct system providing supply air to the main living space and exhausting stale air from the single bathroom in each apartment. This design was deemed to be far too costly to install and operate for several reasons: the large central HRV was oversized and the specified flows to each apartment were much higher than the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) 62.2 rate; an extensive system of ductwork, smoke and fire dampers, and duct chases were specified; ductwork required a significant area of dropped ceilings; and the system lacked individual ventilation control in the apartments.

The design proposed by BSC includes a small HRV in each apartment with a small duct system for distribution. This system eliminates smoke and fire dampers, reduces penetrations through rated assemblies, and adds unit occupant control of flows at a comparable net cost.

Key Energy Efficiency Measures

HVAC

- Hydronic heating provided by condensing gas, combination space/domestic hot water heater with high output baseboard radiators
- No air conditioning
- Individual unit balanced, multipoint HRV ventilation system
- Kitchen range hood vented outside

ENVELOPE

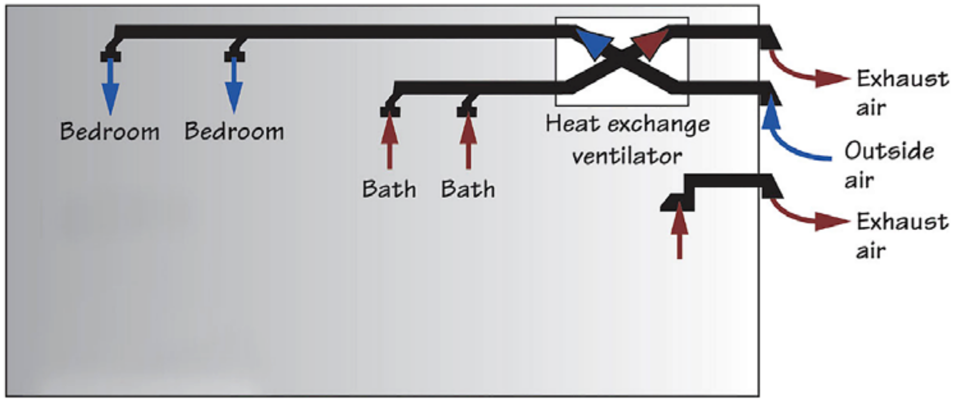
- R-69 unvented flat roof with 6 in. extruded polystyrene (XPS) rigid foam insulation on the exterior (R-30) and 6 in. closed cell spray foam insulation between the rafters (R-39)
- R-36 unvented sloped roof with 6 in. closed cell spray foam insulation between the rafters (R-39)
- R-30 XPS rigid foam insulation on interior of above grade brick walls
- R-20 closed cell spray foam insulation at foundation walls
- R-10 XPS rigid foam insulation below slab
- Double-pane, low-e vinyl windows. U = 0.30, solar heat gain coefficient (SHGC) = 0.30
- Infiltration Rate Goal: 1.7 air changes per hour at 50 Pascals

LIGHTING, APPLIANCES, AND WATER HEATING:

- 100% Compact fluorescent lighting
- ENERGY STAR® appliances
- Condensing gas, combination space/domestic hot water heater

For more information, see the Building America report, *Retrofit of a Multifamily Mass Masonry Building in New England,* at: *www.buildingamerica.gov*

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



The compartmentalization strategy of using a separate HRV in each apartment unit results in a much smaller and more compact distribution system. The HRV will be located in a mechanical closet in each apartment and the common areas. A small duct system will provide ventilation to the bedrooms and will draw stale air from the bathrooms.

Use of individual unit space heating and domestic hot water systems greatly reduces the distribution losses associated with these systems at a comparable net cost to centralized systems. BSC further developed the initial mechanical design provided by a local engineer, which included individual gas hot water boilers for each apartment and the common areas. The proposed system was a high-efficiency, sealed combustion, condensing combination space/domestic hot water heater with a buffer tank and standard finned tube radiation baseboard. Some noteworthy features and BSC's additional developments include:

- Combination heat/hot water boiler—this unit has separate taps for space heating and domestic hot water; thus, a single unit can provide heat and domestic hot water for an apartment without the complexities associated with converting a standard one-tap boiler to serve as a combination heat and hot water unit.
- Buffer tank—the purpose of the original 80-gallon buffer tank was to prevent short cycling of the boiler during part load operation. The manufacturer maintains, however, that the boiler is designed to operate in part load conditions and does not recommend a buffer tank for this application.
- Standard baseboard—standard finned tube radiators must operate at high temperatures to heat a space. BSC instead recommended a high output, two-pipe baseboard to ensure low return water temperatures so that condensation will be achieved at the boiler.
- Series distribution—the original design included a primary-secondary loop system and specified the secondary loop with baseboard radiation piped in a series configuration. BSC upgraded to a parallel distribution design, with homeruns connected to a stainless steel manifold, to reduce pumping energy and allow some degree of radiator zone control.

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

For more information, visit:
www.buildingamerica.gov

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