Building America
Efficient Solutions for Existing Homes

Case Study: Retrofit of 1915 Home

Dayton, Washington

PROJECT INFORMATION

Construction: Retrofit

Type: Single-family home

Builder:
Chapman Heating & Air Conditioning

Size: 2,600 ft^2

Date Retrofit Completed: July 2011

Climate Zone: Cold, IECC Zone 5

PERFORMANCE DATA

HERS Index:
Pre-retrofit = 125
Post-retrofit = 90

Projected annual energy cost savings:
$2,375/yr (66%)

Projected annual site energy savings:
94 MBtu/yr (62%)

Total cost of efficiency improvements:
$11,500

Rate of return: 22%

Billing data:
Pre-retrofit = $3,500/yr
Post-retrofit = will be available in 2012

Built in 1915, this two-story, three-bedroom home with an unfinished basement and 2,600 ft^2 of living space is typical of many older homes found in eastern Washington. Through the U.S. Department of Energy's Building America program, researchers from the Pacific Northwest National Laboratory worked with local energy rater Energy Incentives, Inc., to assist the home owners in cost-effectively reducing their energy use by over 50%. The researchers used Energy Gauge USA simulation software to model retrofit packages and predict the most cost-effective retrofit measures within the homeowner's budget.

The presence of asbestos insulation on the boiler made it more cost-effective to pursue efficiency measures that left the boiler in place to avoid the additional costs of disposal. Major energy and cost savings were achieved by installing a multi-headed ductless heat pump to complement the existing hydronic heating system, leaving the boiler to provide supplemental heating during times of exceptionally cold weather. The homeowners are also considering further improving energy efficiency and thermal comfort by insulating and air sealing the building envelope.

(Left) The original diesel boiler, encapsulated in asbestos, was left in place to eliminate removal and asbestos remediation costs, as well as provide a robust supplemental heating source in extremely cold weather. (Right) The new SEER 16, HSPF 9.4, four-head ductless heat pump system will drastically reduce fuel costs and energy consumption.

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KEY ENERGY-EFFICIENCY MEASURES

HVAC:

SEER 16, HSPF 9.4, 4-head ductless heat pump with zonal controls

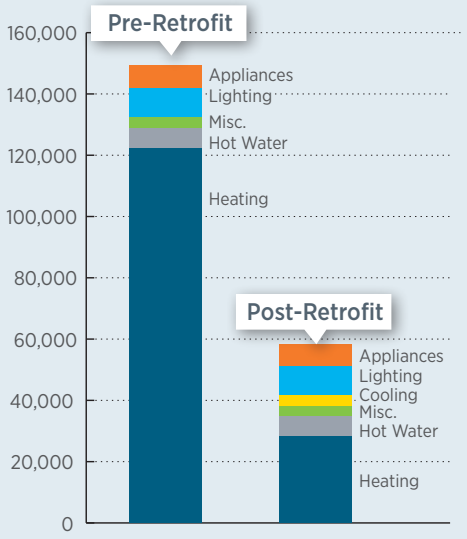
Envelope:

Anticipated updates included air sealing and insulating at basement rim joists using spray foam insulation, fully insulating basement walls with foam board, insulating partially insulated exterior walls with blown-in cellulose, and adding insulation in sloped ceiling cavity.

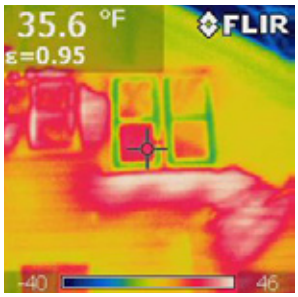
Lighting, Appliances, and Water Heating:

- ENERGY STAR® refrigerator
- Minimal miscellaneous electric loads

For more Information, please visit:
www.buildings.energy.gov



This chart shows the projected site energy savings resulting from the heat pump installation, as modeled in Energy Gauge.



(Left) PNNL is using circuit-level electrical metering at the panel and an indirect metering approach on the boiler to collect data on the home's energy usage. *(Center & Right)* In the next phase of retrofit, the homeowner is considering insulating the basement, the leakiest part of the building envelope, with spray foam at the uninsulated rim joists *(center picture)*. The homeowner is also pursuing finishing the basement with rigid foam board to further reduce air leakage and heat transfer through the basement walls, as well as air sealing and adding insulation in the partially insulated west wall *(right picture)* and sloped ceiling cavity.

PNNL will meter and collect data on the electricity and fuel consumption of the heating systems and major appliances in this home, as well as temperature and relative humidity in several locations. This information will allow PNNL researchers to fully characterize the energy and comfort performance of the dual heating systems and monitor the impact of any addition insulation and air sealing work as it occurs.

Lessons Learned

- The key to cost-effective retrofits in this classic historic house was to avoid unnecessary replacement and upgrading costs by leaving the asbestos-encapsulated boiler intact.
- Fuel cost and availability was a key consideration when selecting the best heating system for this home. Natural gas was not available and Washington state code prevents propane systems from being installed in the basement. Switching to an efficient heat pump with zonal controls was the best solution to save energy and reduce expensive diesel fuel costs.
- The scope and timeline of retrofits are often dictated by captital cost and available budget when retrofits are financed by homeowners. In this case, measures were prioritized based on energy savings potential and cost-effectiveness. Implementaiton will occur over time.

"While the ductless heat pumps heat differently, it's a pleasant surprise when we pay our utility bill!"

Judy Robertus, *homeowner*

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For information on **Building America** visit **www.buildingamerica.gov**. The website contains expanded case studies, technical reports, and best practices guides.

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