



**Outcome: Energy Savings Benefits Outweigh Added Costs**

The homes built by Fish Construction in NE Portland exceeded program expectations. The efficiency of the unit built to exceed 2008 Code by 15% actually performed at 18% better than 2008 Code, and the home intended to be 30% better performed 31% more efficiently than 2008 Code.

This efficiency translates to utility bills cut by approximately 18% to 31% respectively, saving the occupants \$5,000 to \$13,000 over 30 years (at today's energy prices). For both homes, 80% - 97% of the cost savings are associated with the reduction in electricity usage for space heating & cooling and water heating. Approximately 60%-70% of the cost savings come from reduced heating needs, while providing the occupant the added benefit of greater thermal comfort.

In addition to the grant funds noted above, the homes received approximately \$1,625 (6507 NE 7th at 15% above 2008 Code) and \$2,900 (8019 NE Holladay at 30% above 2008 Code) in incentives from Energy Trust of Oregon, reducing the up-front incremental costs by 28% and 21%, respectively. This case study illustrates that even in the absence of the PEEHP grant program, given the advantages of greater comfort to the home occupants, significantly reduced energy bills, and potentially higher asset value, there is a strong case for investing in higher performance homes.

**Successes and Challenges: An Interview with the Builder**

**Did implementing the required efficiency measures make the project more complex than you expected?**

Some added complexity is to be expected with increased efficiency. Several of the measures for this project were new to us and I would estimate that an additional 20 hours of time was required to learn and manage on the job. Ultimately, I am happy with the results of the PEEHP project, what I have learned, and the products I have seen.

**Were there any unexpected costs?**

The energy efficiency measures came in on budget for the 15% house. There were no price increases for materials on either house, but small changes to the scope of work added about \$500 to the budget for the 30% home. A deeper front door frame was needed to accommodate the rigid foam sheathing, and we had to frame an enclosure around the mini-split heat pump in the attic to create conditioned space.

**Would you recommend the efficiency measures to other projects?**

Yes. I am impressed with the efficiency of the electric mini-split heat pump, and the ease with which it worked. The spray foam insulation is a good system, and effective at air sealing the home. The high-efficiency furnace and heat pump we used in the 15% house make for a comfortable and efficient home, and I would use them again if a buyer wanted them.

It is important for builders to know that well insulated and tightly sealed homes require heating systems to be sized appropriately for the heating/cooling loads and size of home. Adequate ventilation and air circulation systems are also important to maintain air quality and evenly distribute heat.

**What would you, as the builder, do differently next time?**

It is important to make it easy for the inspectors to approve the efficiency measures. On the 30% home, we installed the rigid foam before shear wall inspection. Thankfully, a home inspector who was familiar with the structural capacity of the foam was willing to work out a solution with us.

We will also plan to educate the homeowners about how the energy efficiency systems work. This is very important to avoid misuse that affects occupants overall comfort.

**Have your homes made an impression on the homeowners?**

The homeowners have been very happy with the efficiency features. In this entry level price range, the efficiencies are a great value. The market conditions in Portland were such that the sales prices of these homes were the same as similar homes in the area that did not have the added energy features. From my perspective as a home builder, without incentives, it will take a shift in the perception of the average buyer to justify the added costs of the highest efficiency features. The PEEHP has demonstrated that there is a balance of features between the 15% and 30% efficiency increase levels that can be used in a home at minimal added cost to generate a significant benefit in terms of comfort and lower utilities..

**Program Contacts:**

For more information about the PEEHP case studies, visit: [www.portlandoregon.gov/bds/PEEHP](http://www.portlandoregon.gov/bds/PEEHP)

Learn how Energy Trust resources and incentives can help you build and sell high efficiency homes, call Energy Trust's trade ally coordinator at 1.877.283.0698, option 1.

**Project at a Glance**

**Site Location**  
NE Portland

**Utility Partners**  
Pacific Power & PGE

**Building Type**  
Single Family Detached

**Number of Bedrooms**  
3

**Unit Square Footage**  
1,456 sf

**Total Grant Award**  
\$19,086

**Certifications**  
ENERGY STAR®  
Earth Advantage®

**Project Team & Subs**

**Contractor**  
Fish Construction NW

**Mechanical Engineer**  
Central Air

**Designer**  
Troxel Home Design

**Interiors**  
Advanced M&D Sales

**Landscaper**  
NW Property Maintenance

**Insulation**  
JB Insulation

**Framing**  
TJ Home Builders

**Plumbing**  
Euro Plumbing

**Vendors/Products**

**Mini-split Heat Pump**  
Mitsubishi

**Heat Pump Water Heater**  
General Electric

**Air Source Heat Pump**  
Coleman

**Elec. Tank Water Heater**  
Bradford White

**ERV**  
American Standard

**Windows and Doors**  
Medallion Industries

**Trusses**  
Evergreen Truss

**CASE STUDY: 6507 NE 7th Ave & 8019 NE Holladay St High Efficiency Achieved in Modest Single Family Homes**

**Program Overview**

The Portland Energy Efficient Home Pilot (PEEHP), a competitive grant program, was developed to encourage the construction of energy efficient homes in the Portland area. Participating builders were required to build a minimum of two new homes to exceed the energy efficiency standards of the 2008 Oregon Residential Energy Code (2008 Code). The PEEHP grant provided funding for builders to implement the energy saving measures necessary to increase the efficiency of their homes by 15% or 30%.

Several diverse development projects received awards. The average award was \$4,266 per unit that performs 15% more efficiently than 2008 Code and \$10,320 per unit that performs 30% more efficiently than 2008 Code. Grant recipients include Fish Construction NW, Inc., Terrafirma Building, Inc. for Portland Community Reinvestment Initiatives (PCRI) and Habitat for Humanity Portland/Metro East.

Administered by the City of Portland, grant matching funds and technical assistance for the PEEHP were provided by the National Home Builders Association, the Home Builder's Association of Metropolitan Portland, Portland General Electric (PGE), NW Natural Gas, Pacific Power, and Energy Trust's New Homes program. This public/private partnership leveraged \$113,000 in grant funds, resulting in energy saving measures for 14 homes.

**Project Summary**

In February of 2010, PEEHP awarded Fish Construction NW a grant worth \$19,086 to construct two detached single family houses in Northeast Portland. The project features one home that is 15% more efficient, and one home that is 30% more efficient than the 2008 Oregon Residential Energy Code requirements.

Before construction, the builder consulted with Energy Trust and Earth Advantage Institute to determine what actions needed to be taken to meet the efficiency goals of the PEEHP.

Fish Construction typically installs gas heat in the homes they build, and had received a previous PEEHP grant to build a high-efficiency gas heated home.



For their second PEEHP project, Fish Construction was required to follow an electric energy path for heating and ventilation.

The 15% above 2008 Code home features a ducted, electric, high-efficiency heat pump accompanied by a high-efficiency gas furnace as the back-up heat source. Use of this combination of heating sources was the decision of the builder to assure adequate heat in coldest of temperatures. The 30% above 2008 Code home uses electric mini-split heat pump technology exclusively. The 30% home also uses an electric heat pump water heater as well as an energy recovery ventilation system (ERV) to preheat fresh outdoor air, before it is distributed through the home.

*"I am happy with the results of the PEEHP project, what I have learned, and the products I have seen."*  
Builder Justin Wood,  
Fish Construction NW

Overall efficiency was further improved by upgrading windows and modifying the home's framing to increase insulation. Tightly sealing the building envelope and HVAC

ducts, and locating heating systems within the conditioned envelope are all measures that were taken to prevent heat loss. The resulting homes are more affordable to operate and healthier for the owners.

Aggregate Cost of Project		
Efficiency above 2008 code	15% Unit	30% Unit
List price per unit	\$249,000	\$239,000
Actual cost of upgraded efficiency measures per unit	\$5,814	\$13,800
Grant award per unit	\$5,814	\$13,272



What does it take to create a highly efficient home?

Fish Construction NW made modest adjustments to a standard house plan to achieve very high efficiency for the two-story detached homes. The energy and associated utility savings realized in these homes, as compared to a 2008 Code home, were achieved by a combination of high efficiency heating equipment for space and water, advanced framing techniques (studs placed 24" on center to reduce thermal transfer through the wall), greater insulation throughout the house (for example, from R38 to R60 in the attic), more efficient windows (U-0.30 rather than U-0.35), duct placement inside conditioned space and improved duct and whole house envelope tightness (minimizing heat loss), and the addition of an energy recovery ventilation system for the 30% more efficient home to recover and circulate warmed fresh air, keeping the indoor air quality constant in the tightly sealed home. The homes also feature ENERGY STAR® appliances and lighting. The combination of these features makes a big difference in the overall efficiency of the homes.

The builder met the efficiency goals for each home by implementing the grant required construction methods and measures, however, other factors also contributed to the efficiency and sustainability of the homes. These two-story detached houses are approximately 1,500 square feet each, with 3 bedrooms and 2.5 baths. The houses have a compact, family-size floor plan with no wasted space, which both reduces the amount of building materials needed and also reduces the heating and cooling demand. All of these features keep the houses affordable for first-time homebuyers. Both of these houses are sited near multiple bus lines, allowing for car-free living. They have low-flow plumbing fixtures and low-maintenance landscaping for water conservation. Low VOC finishes and paint assure good indoor air quality. The occupants of the homes have the opportunity to save significantly on the cost of their utilities, experience a home with consistent comfort, and enjoy the time afforded by less property maintenance.



PEEHP Energy Efficiency Features

15% Unit

- Ducted air-source electric heat pump (9.5 HSPF)
- Ductwork sealed with mastic paste and located within conditioned space
- Duct blast administered to ensure tightly sealed ductwork with less than 6% leakage
- 93% EF (efficiency) 50 gallon electric tank water heater
- High-efficiency envelope w/ maximum 5 ACH @ 50 Pa (air changes per hour)
- R-21 fiberglass batt wall insulation
- R-38 floor joist cavity batt insulation over unconditioned crawlspace
- R-49-attic insulation
- U-0.32 U-value windows
- ENERGY STAR® certified spot ventilation fans
- 100% of light fixtures are fitted with ENERGY STAR® rated compact fluorescent lights (CFL)

30% Unit

- Ductless electric mini-split heat pump (9.7 HSPF)
- Heat pump water heater (GE 2.35 COP)
- High-efficiency envelope w/ maximum 2.5 ACH (air changes per hour)
- R-30 wall insulation achieved with 2" spray foam and 3.5" of fiberglass batt in the wall cavity and 1" rigid foam exterior cladding
- R-36 floor joist cavity insulation, 1" spray foam and R-30 batt over unconditioned crawlspace
- R-60 attic insulation w/ 12" raised heel truss system
- U-0.30 U-value windows
- 70% efficiency energy recovery ventilator (ERV)
- 100% of the light fixtures are fitted with ENERGY STAR® rated compact fluorescent lights (CFL)

Both Units

- ENERGY STAR® rated appliances and lighting
- ENERGY STAR® and Earth Advantage® home certifications
- Advanced frame 2x6 wall construction with studs 24" on center
- High-efficiency envelope sealed with caulk and foam

*"I am impressed with the efficiency of the electric mini-split heat pump, and the ease with which it worked."*

*Builder Justin Wood, Fish Construction NW*

Each PEEHP home received an EPS

EPS™ is an energy performance scoring tool brought to you by Energy Trust to help home buyers assess a home's energy consumption, costs, and carbon emissions. It also helps builders frame the value of energy efficiency features they include in their homes.

The Easy Way To Compare Energy Use

Energy efficiency, utility costs and environmental impact are important factors to consider when buying or building a home. They can affect the real and perceived value of a home, but are not always easy to quantify. EPS compares a home's energy consumption, costs and carbon emissions with those of similar sized homes in Oregon.

Measuring Energy Use and Costs

EPS calculation is based on several factors: building size, air leakage and ventilation, insulation, windows, heating and cooling systems, water heating, lighting, major appliances and standard operating conditions. Actual energy use will vary with occupant behavior and weather. Fuel costs are based on retail prices of each gas and/or electric utility at the time the EPS is issued.

Carbon Emissions

A home's energy consumption affects carbon emissions and impacts the environment. EPS estimates these emissions from the electric production and natural gas consumption of the home to create a carbon score. You can change your carbon footprint by purchasing renewable energy options from your utility or other carbon offset programs.

For more information about EPS, contact Energy Trust at 1.877.283.0698 or visit [www.energytrust.org/eps](http://www.energytrust.org/eps).

To view EPS details for the PEEHP case studies, visit the PEEHP web site: [www.portlandonline.com/bds/peehp](http://www.portlandonline.com/bds/peehp).

Setting Goals: Determining a 2008 Code Baseline Efficiency Standard

The intent of the PEEHP is to provide costs and feasibility data for constructing single and multiple-family houses to the 2008 Oregon Residential Energy Code (2008 Code) in comparison with constructing homes that perform 15% and 30% more efficiently than the 2008 Code.

To track the relative improvement in efficiency of the homes in this case study, appropriate efficiency measures were determined using the 2008 Oregon Residential Energy Code requirements as a baseline.

The 2008 Code requires that certain prescriptive standards be met, and beyond that, builders are required to choose one of nine additional energy efficiency options. The baseline 2008 Code path for this home was the most commonly selected path in new construction for natural gas homes - *Option 1: installation of high efficiency HVAC equipment.*

Gathering Data: Estimating Costs

The PEEHP grant process funded the incremental cost of energy efficiency measures over what is required by the 2008 Code. To determine the additional construction costs to be covered by the grant, each builder was required to provide cost estimates from three different subcontractors for the work to be performed.

Further, each subcontractor had to provide bids for the costs associated with building the home to 2008 Code, to 15% above 2008 Code, and to 30% above 2008 Code, as appropriate based on the different energy efficient measures selected by the builder.

Based on this information, it was possible to calculate incremental costs. Using the lowest bids, the grant covered the cost difference between the "code home" and the higher efficiency home (see the performance table for exact figures).

Achieving Results: Modeling and Verification

Through Energy Trust's New Homes program, Andrew Shepard, a green building

consultant with Earth Advantage Institute, provided ongoing technical assistance to Fish Construction NW by examining building plans and building practices, and identifying opportunities for energy savings. Energy modeling software was used to calculate efficiency goals and the measures necessary to achieve those goals. The consultant estimated the savings from individual efficiency measures to assemble a package of measures to meet the homes energy use reduction targets. To ensure the calculated savings were achieved, third-party modeling and verification services were conducted, including:

- Home energy use modeling using the REM/Rate software tool. REM/Rate is published by Architectural Energy Corporation of Boulder, Colorado, and complies with Residential Energy Services Network (RESNET) protocols for modeling home energy ratings.
- Third-party testing, involving at least two physical inspections, a duct blast, and blower door test verified that systems and materials were correctly installed and working properly. An EPS confirmed the level at which a home is performing.

Home Energy Performance Information					
Builder	Fish Construction NW		Home Address	6507 NE 7th Ave & 8019 NE Holladay St	
Home Style	Single Family Detached Homes		Square Feet	1456 sf	
Heating Source	Electric Heat Pumps		# of Occupants	4 people, based on 3 bedrooms per unit	
Energy Efficiency	Meet Code	Required by Grant 6507 NE 7th Ave	Actual** Construction 6507 NE 7th Ave	Required by Grant 8019 NE Holladay St	Actual** Construction 8019 NE Holladay St
Efficiency Increase**	Code	15%	18%	30%	31%
Incremental Cost of All Measures**	0	\$5,814	\$5,814	\$13,272	\$13,922
Est. Annual Energy Cost Savings	\$1250 (Total Cost/ Yr.)	N/A	\$150	N/A	\$392
Annual kWh Savings	0	1,983	1,659	4,941	4,142
Annual Carbon Emissions	14.5 tons/yr		12 tons/yr		4.4 tons/yr
EPS*	48 (6507 NE 7th) 49 (8019 NE Holladay)	38	39	30	31

\*A lower EPS score reflects less energy use and lower operating costs. Energy Trust is in the process of modifying the formula for calculating EPS scores. Under this new methodology, the EPS scores for gas or electric homes constructed in the same way would be very similar. For more details visit: [www.energytrust.org/library/meetings/other/EPS\\_HES\\_Proposal\\_CAC.pdf](http://www.energytrust.org/library/meetings/other/EPS_HES_Proposal_CAC.pdf)

\*\*Actual construction cost and savings data may differ from that funded by the grant due to a number of factors, including a) different equipment being installed compared to what was originally planned, b) use of a different contractor to improve installation or warranty services, and c) variation in the bidding approach of the contractor.