Building America
U.S. Department of Energy
Research Toward Zero Energy Homes

COMPREHENSIVE ENERGY RETROFIT

Case Study:
Asdal Builders, LLC
Pittsburgh, PA

Asdal Builders achieved a HERS score of 65 and cut energy use by 80% with a gut-rehab of this 1930s era Pittsburgh home.

New Jersey home builder and remodeler Bill Asdal wanted to show that comprehensive retrofits were in reach of the ordinary builder. He and his team succeeded with a straightforward rehab of a Depression-era bungalow in Pittsburgh that brought the home's Home Energy Rating System (HERS) index scores from 185 down to an impressive 65, performance that makes the home 35% better than the 2006 International Energy Conservation Code.

Pittsburgh home pre-retrofit.

Bill and his team of staff and subcontractors did a total rehab, keeping the shell but stripping the walls down to the studs to seal, caulk, and insulate the building envelope; they also upgraded HVAC, water heating, appliances, lighting, and windows with higher performance but readily available products.

Asdal, a former chairman of the National Association of Home Builders Remodeler's Council, has been building and remodeling homes for more than 30 years and has been recognized for his energy efficiency efforts. In 2000 he was named National Remodeler of the Year; in 2006 he was awarded Green Remodeler of the Year at the National Green Building Conference, and he was recently inducted into the NAHB National Remodeling Hall of Fame. "Once you get energy efficiency in your blood, you can't build any other way," said Asdal.

Asdal took on the Pittsburgh rehab as a demonstration project for Affordable Comfort Incorporated (ACI), and the 1,300-square-foot home was open for touring during ACI's national Home Performance Conference in Pittsburgh in April 2008. Because Asdal wanted to show that the energy efficiency gains he achieved are accessible to the ordinary builder, he didn't incorporate a lot of high-tech gadgetry but relied on readily available materials and techniques. Energy consultant MaGrann Associates conducted an analysis of the project including a blower door infiltration test, which showed an air infiltration rate reduction from 0.53 ACH to 0.21 ACH and modeling of energy use, which showed a drop in total annual energy use from 271 million BTU to 92 million BTU. "The home is a solid model that proves these concepts can work," said Asdal.

BUILDER PROFILE

Asdal Builders, LLC
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Established: 1973

Number of Staff: 5

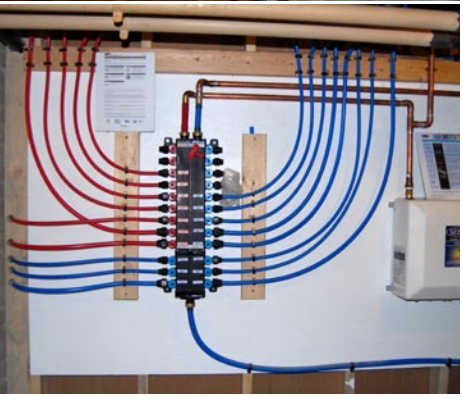
Homes per Year:
40 to 50 remodels,
1 to 2 gut rehabs

Featured Project:
1,550-sq-ft, 3-bedroom, 2-bath, bungalow with basement built in 1930 in Pittsburgh, PA.

HERS Index: 65

"This demonstration home is neither zero-energy nor free of the grid. What it is, however, is smart housing solutions well-delivered to meet a market need for efficient, affordable residences. Delivering on this premise, we all win."

Bill Asdal, Asdal Builders, LLC



(top) The band joists were insulated with pieces of rigid foam sealed in place with spray foam.

(bottom) A centrally located plumbing manifold minimizes hot water piping runs.

Energy Efficiency and Innovations

The home had a full basement but it was uninsulated. The first step was to caulk the sill plates and air seal the unfinished walls, and then apply an interior layer of rigid foam insulation. Over that the inside walls were framed with steel studs and all of the basement walls were insulated with fiberglass batts for a total insulation value of R-20.

Above-grade, 2x4, 16-inch-on-center walls were air sealed and insulated with 4 inches of blown cellulose. Exterior aluminum siding was replaced with a Crane Smartcore siding product with rigid polystyrene foam insulation. This was installed over Tyvek housewrap that was properly caulked and taped. Vaulted ceilings were filled with 10 inches of blown cellulose and flat ceilings were insulated with 12 inches of blown cellulose. Band joist areas were air sealed with spray foam and pieces of rigid foam insulation. Doors and windows were replaced with high-performance products properly installed.

According to MaGrann Associates, who conducted blower door and other tests, "the infiltration test showed the retrofitted home to be very tight, particularly considering its age. MaGrann Associates usually sets a target of 1.0 cfm_{50} per square foot of conditioned space. We rarely see less than 0.5 cfm_{50}. This home measured 0.39 cfm_{50}."

The house had been heated with steam heat from a natural gas boiler that was fairly new but Asdal chose to replace it for safety reasons. The existing boiler used atmospheric combustion drawing oxygen from within the home, which can be a problem in a tightly sealed home. The new boiler is a sealed combustion, power vented unit meaning it draws combustion air from the outside via a dedicated pipe. This unit has a higher annual fuel utilization efficiency (AFUE) and also heats the domestic hot water. Potable hot water is also heated with an electric tankless water heater.

An old central air conditioning unit and leaky ducts were removed from the house and not replaced because it is expected that central air will not be needed thanks to the increased insulation, air sealing, and mechanical ventilation provided by timer-controlled bathroom fans, ceiling fans, and two energy recovery ventilators (installed in the second-floor hall and finished basement). ENERGY STAR appliances, lighting, and a programmable thermostat add to the energy efficiency package. Tables 1 and 2 show all of the energy-efficiency changes made by the builder and how they changed the home's energy score.

Asdal thinks the secret to getting such a low HERS index score was really focusing on doing things the right way. Air sealing correctly provides great improvements in energy efficiency. "We worked with a terrific local remodeler, plus a host of very reputable trade contractors. We work with the same contractors over and over. Every single one of them got retrained when they started working with us—the guys installing the pipes, the guys putting in the windows, the guys applying the caulk and foam, the guys putting on the siding—everybody. To get to these kinds of numbers, everybody has to know what they are doing, everybody has to be on their game," said Asdal. "There's a lot of learning that still needs to happen in the industry."

The sealed combustion boiler, mechanical ventilation, and air sealing details mentioned above have health as well as energy-efficiency benefits, such as keeping out carbon monoxide, venting other house fumes, and keeping out pollen, humidity, and pests. Asdal also worked with manufacturers and suppliers to find healthy and sustainable products to bring into the home—such as cork flooring and low-VOC paints and finishes.

Dollars and Sense

Is energy-efficiency rehabbing commercially viable? "Yes it absolutely is," said Asdal. Asdal estimates the rehab costs on this home were about 15% higher than standard construction due to the energy efficiency increases. In return, the homeowner gets a better home overall and lower operating costs.

"We went from a HERS index of 184 to 65 with a 70-year-old shell; those are powerful results," said Asdal.

According to Asdal the energy-efficient remodel was a win-win all the way around. "Reduced consumption, without sacrificing comfort and lifestyle, is an immense societal goal. This is the ultimate recycling project—100% of the structure was saved, we didn't add one square inch to the building footprint," says Asdal. The homeowner gains a finished, insulated basement that adds 400 more square feet of livable space, plus updated, safer appliances, guilt-free energy bills, and a healthier home that uses an estimated one-third of the energy it used before.

The Bottom Line

"Energy bills are shaping impetus. Make no mistake, this effort is nothing short of building a new industry around mainstreaming home performance. The road-map I see is 'remodeling' the remodeling industry to ramp up our skills of analysis, pre- and post-testing work, and delivering on promised performance results. It includes reshaping consumer thinking from 'first cost' to making life cycle costs and operational costs a higher priority," said Asdal.

Spray foam was applied around piping and wiring holes and around pieces of rigid foam fitted in the rim joists

Table 1. Before and After Comparison of Energy-Efficiency Upgrades

Measure	Pre-Retrofit	Post-Retrofit
Foundation walls – unfinished	Uninsulated 8-inch concrete block	R-5 rigid (XPS) insulation on interior from sill plate down 4 feet
Foundation walls – finished	Uninsulated 8-inch concrete block	R-15 Owens Corning basement wall system
Above-grade walls	2x4 wood framing, no insulation	2x4 wood framing, 4-inch blown cellulose
Siding	Uninsulated aluminum over dimensional sheathing	Crane triple 6-inch Smartcore with integral polystyrene insulation over housewrap
Band joist areas	No insulation	R-13+ spray applied foam or rigid insulation board sealed in place with foam
Vaulted ceilings	No insulation	2x6 rafters furred out to 10-inch depth, filled with blown cellulose insulation, R-5 XPS used as air barrier in attic areas.
Flat ceilings	No insulation	2x6 joists, 12-inch blown cellulose insulation
Basement windows	Glass block U-value = 0.60 est SHGC= 0.69 est	Same
Above-grade windows	Single-pane wood framed with aluminum storm windows; U-value = 1.07 est, SHGC = 0.70 est	Double-pane vinyl-frame windows, U-value = 0.32, SHGC = 0.25
Exterior doors	Solid wood frame panel, single-pane glass	Fiberglass, insulated (Therma-Tru)
Air sealing	None	Air sealing to comply with ENERGY STAR thermal bypass checklist, primarily using ZeroDraft materials and methods

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Key Energy-Saving Features

- Basement walls insulated to R-5 rigid XPS plus R-15 fiberglass batt
- Walls insulated with 4-inch blown cellulose plus Crane Smartcore siding with rigid polystyrene
- Ceiling insulation – vaulted 10-inch blown cellulose, flat 12-inch blown cellulose
- Band joist areas air sealed with spray foam and rigid foam
- Windows – double-pane vinyl-framed
- Doors insulated fiberglass
- Power-vented gas boiler for heating and domestic hot water with electric tankless back up water heating
- Ventilation from two energy recovery venilators, timer controlled bathroom fans and ceiling fans
- ENERGY STAR lighting and appliances

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Energy-efficient windows were flashed and integrated into the housewrap.

Measure	Pre-Retrofit	Post-Retrofit
Space heating (boiler)	108 kBtu/hr, 80.2% AFUE, atmospheric vented	Variable output boiler 84% AFUE, power vented
Central air conditioning	Carrier, est. 20 years old, SEER unknown	No AC; mechanical ventilation, ceiling fans, window AC could be added if needed
Thermostat	Manual	Programmable
Water heating	Storage tank, natural gas, atmospheric vented, est. energy factor = 0.58	Storage tank indirectly heated by boiler, est. energy factor = 0.77; also Seisco electric tankless unit for summer and peak loads, EF=0.99
Mechanical ventilation, whole house	None	Two Panasonic WhisperComfort energy recovery ventilators, installed in 2nd floor hall and finished basement, automatic timer controls to provide fresh air per ASHRAE Standard 62.2
Spot ventilation	None	Panasonic WhisperQuiet fans in bathrooms with timer controls
Lighting	100% incandescent	31% ENERGY STAR, 69% compact fluorescent
Refrigerator	Approx 20 years old	Whirlpool side-by-side 618 kwh/yr ENERGY STAR labeled
Dishwasher	None	Whirlpool built-in, EF = 0.65, ENERGY STAR labeled
Clothes washer	Approx 20 years old	Whirlpool front loading, ENERGY STAR labeled

Source: Bone, Dave. 2008. Final Report – *Energy Upgrades ACI Demonstration Home 406 Reetz Ave., Pittsburgh PA*, MaGrann Associates, Moorestown, NJ available at http://homerevival.typepad.com/magrannfinalreport.pdf

Table 2. How the Upgrades Changed the Score

Measure	Pre-Retrofit	Final
Infiltration rate (maximum)	0.53 air changes per hour or 0.99 cfm_{50} per square foot of conditioned floor area	0.21 air changes per hour or 0.39cfm_{50} per square foot of conditioned floor area
Duct leakage (to outside)	0.5 cfm_{25} per 100 ft^2	No ducts installed
Combustion safety test results	Adequate draft, no significant spillage	Worst-case CAZ depressurization found to be -5.9 Pa (within limits recommended by BPI), no CO or gas-leakage issues found
HERS Index Score	184	65
Est. Total Annual Energy Use*	271 MMBtu	92 MMBtu

* Modeled using REM/Rate software.

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