Building America Comprehensive Energy Retrofit

Efficient Solutions for Existing Homes

Case Study: SMUD's Jean Avenue Remodel

SMUD Energy-Efficient Remodel Demonstration Program
Sacramento, CA

The deep retrofit of this 1950s home on Jean Avenue in Sacramento reduced its estimated annual energy cost from $2,539 to a predicted cost of only $880 a year.

BUILDER PROFILE

Builder: Del Paso Solutions
(530) 750-2982
www.delpasosolutions.com

Location: Sacramento, CA

Founded: 2009

Employees: 3

"This was an opportunity to tie innovations to the needs of low-income communities."

JAN SOLORZANO
Owner, Del Paso Solutions

Building AMERICA
U.S. Department of Energy

Retrofit in Low-Income Neighborhood Achieves 53% Energy Savings

With assistance from Building America, a Sacramento team is taking aging, foreclosed homes and retrofitting them to be more energy-efficient than a typical new home built to California code.

Five foreclosed and abandoned homes in Sacramento have been successfully retrofitted to reduce their energy use by more than 50%. The "deep retrofits" are part of a demonstration project undertaken by the Sacramento Municipal Utility District (SMUD).

"We wanted to learn how energy-efficient you can make an existing home, how much it costs, and how we can get these measures applied on a mass scale," said SMUD project manager Mike Keesee.

SMUD teamed with local builders and the U.S. Department of Energy's Building America program to achieve an ambitious goal of a 50% reduction in energy use. The team determined the most cost-effective measures, installed off-the-shelf energy-efficient components, and analyzed the results. The homes were showcased to the public and offered for sale to low- and middle-income families.

A foreclosed and abandoned home in Sacramento's low-income Del Paso neighborhood is a case in point. Built in the 1950s before California established energy codes, the 1,040 ft² all-electric home on Jean Avenue required extensive renovation. A local contractor, Del Paso Solutions, bought the home for $46,000 and received a rehabilitation loan from the Sacramento Housing and Redevelopment Agency.

The team replaced the home's leaky duct system with a ductless, mini-split heat pump. The roof-mounted outdoor unit pumps refrigerant to three separate indoor units. These "mini" units each heat or cool an area of the house.

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Project Manager
Sacramento Municipal Utility District

The agency's Vacant Properties Program works with local builders to return vacant and blighted homes to owner occupancy. Federal and state rebates and incentives also helped to fund the project.

The National Renewable Energy Laboratory (NREL), a Building America partner, used its BEopt energy analysis software to determine the most cost-effective energy upgrades for the Jean Avenue home.

"This was an opportunity to tie innovations to the needs of low-income communities," said Jan Solorzano, owner of Del Paso Solutions.

Work began in 2009. Del Paso Solutions performed a total remodel, including a new roof, windows, HVAC system, kitchen appliances, flooring, and counters. They achieved a remarkable 53% reduction in energy use.

Energy-Efficiency Features

The energy retrofit began with improvements to the home's thermal enclosure. When Del Paso Solutions replaced the roof, they added R-49 attic insulation, a radiant barrier to deflect heat, and ridge vents to improve ventilation. Accessibility was too limited to add insulation to the walls or the crawlspace beneath the house. However, contractors sealed all accessible joints, seams, and openings in the exterior walls, with caulk, foam, or weather-stripping.

The contractors added bathroom exhaust fans and a range hood for mechanical ventilation. When they converted a storage area into a second bathroom, the contractors filled the new 2x6, 16-inch on-center framing with R-20 blown-in cellulose insulation.

The renovated house was much tighter than expected, Keesee said. "We expected 6 to 7 air changes per hour, but blower door tests show an impressive 2.9 air changes per hour," he said. "It's pretty remarkable how tight you can make an existing home." Tests performed before retrofitting showed 13.6 air changes per hour. (All tests were performed at 50 Pascals of pressure.)

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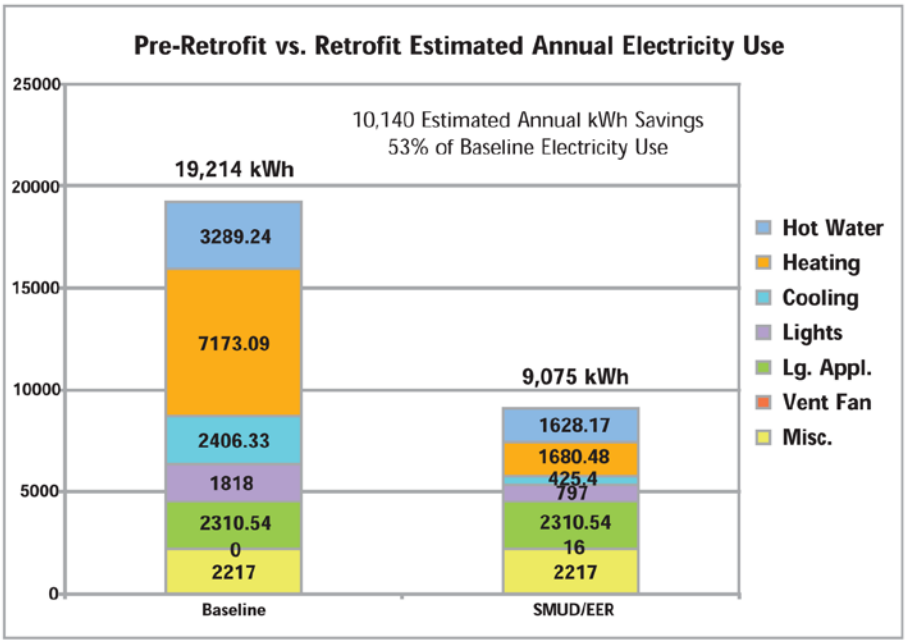
High-performance equipment also reduces the home's energy use. The original aluminum-framed windows had estimated values of U=0.71, SHGC=0.73. Del Paso Solutions replaced them with ENERGY STAR dual-pane, low-emissivity, vinyl-framed windows with values of U=0.32, SHGC=0.25. They replaced all the incandescent lighting fixtures with hard-wired ENERGY STAR compact fluorescent lamps and installed an ENERGY STAR dishwasher.



Innovations

To retrofit the Jean Avenue home's HVAC and water-heating systems, the team turned to innovative technologies.

The Ductless Mini-Split Heat Pump

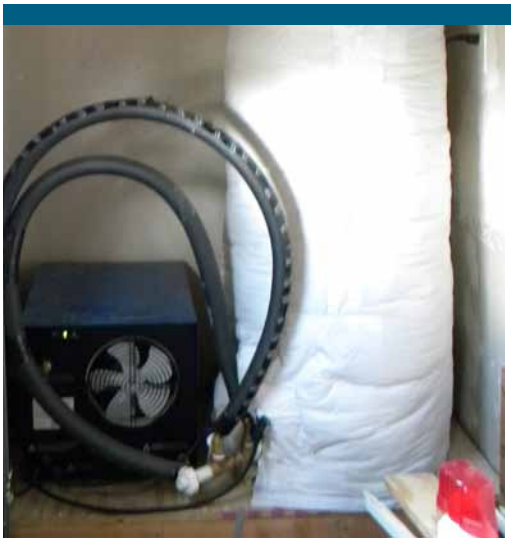
Most residential heat pumps combine an outdoor unit and a single indoor unit to condition the air. The indoor unit contains a fan that pumps the conditioned air into ducts for distribution around the house. The Jean Avenue home uses a ductless "mini-split" heat pump system instead. The system has one outdoor compressor unit with refrigerant lines connected to three indoor units, which are wall-mounted in the home's living room and two bedrooms. Each indoor unit is individually controlled by its own thermostat to provide zoned heating and cooling without ducts.

Solorzano called the innovative system "the answer for houses built without central heating." Mini-splits offer benefits not found with central forced air systems. They avoid the energy losses associated with ductwork, and occupants can gain additional energy savings by conditioning a room only when it is needed.

NREL estimates the mini-split heat pump will reduce the Jean Avenue home's energy consumption for heating by 59% and cooling by 67%. NREL used ACCA Manual J to size the system correctly for energy efficiency and effective control of temperature and humidity. The system has a cooling efficiency of 15 SEER and a heating efficiency of 9 HSPF.

Energy-Efficient Upgrades

- **HVAC** – *Before:* 7.0 HSPF/8.0 SEER heat pump.
  After: 9.0 HSPF/15 SEER ductless three-zone mini-split heat pump.
- **Water Heating** – *Before:* Electric, 40-gallon storage tank, EF 0.90.
  After: Heat-pump water heater, 2.5 COP, with new electric 40-gallon storage tank, EF 0.98.
- **Roof** – *Before:* Dilapidated, no vents.
  After: New, with ridge vents.
- **Attic** – *Before:* R-19 insulation.
  After: 15 inches blown-in R-49 cellulose insulation, radiant barrier.
- **Air Sealing** – *Before:* None.
  After: Caulking and weather-stripping.
- **Ventilation** – *Before:* None.
  After: ENERGY STAR range hood, ENERGY STAR bathroom fan with timer controls.
- **Windows** – *Before:* Aluminum frame, dual pane, clear, estimated U=0.71, SHGC= 0.73.
  After: ENERGY STAR, low-e, vinyl-framed; U=0.32, SHGC=0.25.
- **Lighting** – *Before:* Incandescent.
  After: 100% hardwired ENERGY STAR CFLs.
- **Ceiling Fan Lights** –
  Before: Incandescent.
  After: ENERGY STAR with pin-based CFLs.
- **Appliances** – *Before:* Unrated dishwasher.
  After: ENERGY STAR dishwasher.
- **Blower-door Test:** 408 cfm, 2.9 ACH @ 50 Pa.
- **Room Addition:** 2x6, 16-inch o.c. framing, R-20 blown-in cellulose insulation.



Del Paso Solutions installed a Geyser-R heat pump water heater by Nyle Systems. This air-source heat pump attaches to a conventional tank water heater and draws heat from the surrounding air to heat water. The heat pump was connected to a new 40-gallon electric storage tank. A heat-pump water heater uses one-third to one-half as much electricity as a conventional electric water heater.

The Heat-Pump Water Heater

While heat pumps are typically used for heating and cooling air, they can also be used to heat water. At the Jean Avenue home, an air-source heat-pump water heater is installed in the garage, where it is hooked up to a new 40-gallon electric storage tank. The heat pump's evaporator vaporizes a low-pressure liquid refrigerant into gas, then passes it into a compressor to increase its temperature. The heated gas then runs through a condenser coil in the storage tank to transfer heat to the water. The storage tank's electric-resistance heating element serves as a backup.

A heat-pump water heater uses one-third to one-half as much electricity as a conventional electric water heater. Because they draw heat from the surrounding air, they are most cost-effective in warm climates like Sacramento's. While they cost more up front, the extra cost is recouped, thanks to lower utility bills.

Dollars and Sense

Before the retrofit, the annual electric bill of the Jean Avenue home was estimated to be $2,539. NREL's analysis after retrofit predicts an annual cost of only $880. This represents a 65% savings, which will be a boon to the low-income buyers of the house.

The energy upgrades to the house cost $40,800. The rest of the renovation brought the total cost for the project to $120,000. These figures do not include utility incentives or federal tax credits. The home is now for sale.

The Bottom Line

Using off-the-shelf energy-efficient components and innovative HVAC and water-heating technologies, the team achieved a 53% reduction in the annual energy use of a home built before California had energy codes. NREL calculated the California Home Energy Rating System (HERS) score before the retrofit at 195. After the retrofit, an independent rater calculated its CA HERS score at 86. This is 14% lower than a typical new code-built home, which has a CA HERS rating of about 100.

Now SMUD aims to help many of its customers retrofit their homes to achieve similar energy savings.

"We want to bring what we've learned into our Home Performance Program," said Keesee. The Home Performance Program with ENERGY STAR is a project of the U.S. Department of Energy and the U.S. Environmental Protection Agency, and offers incentives to homeowners to use a comprehensive, "whole-house" approach to energy upgrades. Incentives include rebates, federal tax credits, and financing options.

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