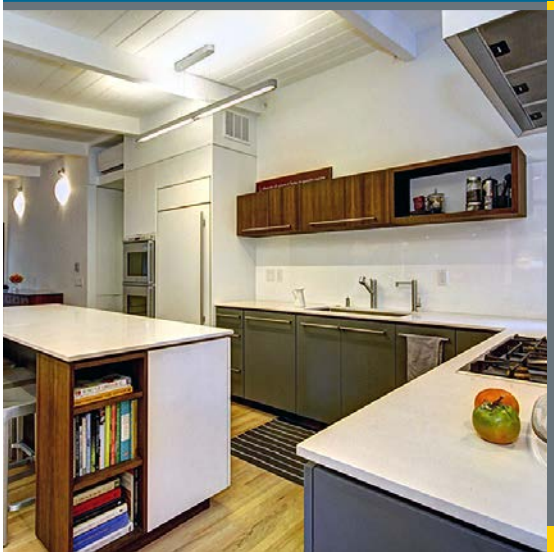

Building America Case Study

Sunnyvale Marine Climate Deep Retrofit

Sunnyvale, California

PROJECT INFORMATION

Construction: Retrofit

Type: Single-family

Partners:

Builder:
One Sky Homes of San Jose, CA,
oneskyhomes.com

Alliance for Residential Building Innovation, *arbi.davisenergycom*

Size: 1,658 ft²

Vintage: 1957

Date completed: 2013

Climate Zone: Marine

PERFORMANCE DATA

Source energy savings:
54 MMBtu/yr (40%)

Annual energy cost savings: $500

Incremental cost of energy-efficiency measures: $21,000

The U.S. Department of Energy Building America team, Alliance for Residential Building Innovation (ARBI), worked with One Sky Homes on a single-family home retrofit project in the marine climate of Sunnyvale, California. Because of this climate's low heating and cooling loads, significant energy savings can be difficult to achieve. The retrofit was designed (1) to meet rigorous Passive House and Building America program standards; and (2) to achieve substantial energy savings and improve comfort and indoor air quality for the homeowners.

The house is a 1,658-ft² single-story ranch design that was built in 1957 with a low-slope roof and no attic. The scope of the retrofit included air sealing; insulating the walls, roof, and floor (previously uninsulated); replacing windows; and upgrading the heating,ventilating, and air-conditioning (HVAC) system.

To measure the success of the retrofit, the ARBI team evaluated the home's pre- and post-retrofit energy use, compared actual energy savings to original predictions, and identified opportunities for cost savings in similar retrofits in this climate. The team also evaluated the effectiveness of the new HVAC system—a single mini-split heat pump unit with a separate compact distribution system—as a cost-effective strategy for low-load homes.

This project is one of very few retrofits designed to the rigorous Passive House standards. It demonstrated 40% source energy savings, which reduced the homeowner's annual utility costs by $500. Most importantly, the occupants are now comfortable and healthy in their home, and durability and safety issues, including mold growth, condensation, and indoor air quality, have been resolved.

An innovative HVAC solution using a single mini-split indoor unit and a heat recovery ventilator (HRV) supplies air directly to a great room. A separate compact distribution system with a single efficient fan exhausts air from the great room and delivers it to the bedrooms. This cost-effective strategy can provide space conditioning in small- to medium-size low-load homes.

Building America SM
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Key Energy-Efficiency Measures

HVAC

- Mini-split heat pump: 12 heating seasonal performance factor, SEER 25, nonducted.
- HRV with 84% thermal efficiency. Free-cooling bypass during the summer months.
- Mini-split and HRV supply air directly to a great room. Separate compact distribution system uses an efficient single fan to exhaust air from the great room and deliver it to the bedrooms.
- Spot ventilation at the kitchen and bathroom vented to outside.

ENVELOPE

- 2×4 walls with R-13 DensePack cellulose insulation + 2-in. poly-isocyanurate (R-12) exterior foam
- Flat roof with no attic space and 6-in. polyisocyanurate (R-38) over roof deck
- Raised floor with 4-in. polyisocyan-urate (R-24) foam in cavity and spray foam on girders and rim joists. Small slab area with 2-in. polyisocyanurate (R-12) over slab.
- Triple-pane windows: U-value/SHGC = 0.17/0.27 & 0.21/0.49, tuned by orientation for passive solar design
- Tightly sealed house, ACH50 = 1.5.

LIGHTING, APPLIANCES, AND WATER HEATING

- 90% compact fluorescent lighting
- ENERGY STAR® refrigerator, clothes washer, and dishwasher

For more information, please see the Building America report, *Sunnyvale Marine Climate Deep Retrofit,* at: *buildingamerica.gov*.

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

One Sky Homes designed this retrofit in the marine climate of Sunnyvale, California, to Passive House standards. The result is a beautiful, efficient home that eliminated health, safety, and durability concerns.

Lessons Learned

- Annual weather-normalized savings were $500 in utility costs and 504 therms in gas use, resulting in source energy savings of 54 MMBtu (40%).
- The addition of mechanical cooling improved comfort for the occupants and resulted in minimal increased electricity use of 143 kWh.
- The distribution system effectively maintained comfortable temperature conditions during the summer; however, during the heating season room-to-room temperature differences were frequently higher than those recommended by Air Conditioning Contractors of America Manual RS. With cost savings of $3,500 relative to a split-system heat pump, further work is warranted to validate this strategy, which has significant potential to be a cost-effective space conditioning strategy in small- to medium-size low-load homes.

> *"This research validated the feasibility and comfort constraints of a simplified, low-cost HVAC distribution strategy for small, low load homes that can be applied to Marine climate retrofits."*
>
> – Allen Gilliland, Owner
> One Sky Homes

- Actual energy use differs from model predictions, so correct occupancy assumptions are important for accurately evaluating the impacts of internal gains on space conditioning. This is most apparent in high performance homes in mild climates, where cooling loads from internal gains can be more significant than externally driven loads from solar gains and conduction from outdoors.

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

For more information, visit:
buildingamerica.gov

The U.S. Department of Energy's Building America program is engineering the American home for energy performance, durability, quality, affordability, and comfort.

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