

## Case Study

### Randy and Sally Knight Residence

Location: Atascadero, CA  
Architect: Jennifer Rennick Architect  
Services: Energy Modeling



#### Overview

This is a private residence for a couple in Atascadero, a physics professor and an artist with as much interest in the building science of a passive thermal home as much as in comfort and beauty. Striving for zero or very low-energy, the design-build team optimized the building orientation and envelope and sized the photovoltaic panels to cover the energy use.



#### Construction

The walls are straw bale - rice straw from the Sacramento Delta that otherwise would have been burned and added to air pollution in the Central Valley. The bales are 24 inches thick, covered on both sides with stucco. The environment inside the sealed wall is anaerobic, so mice and bugs are not a problem. And bale walls are extremely fire resistant. The nominal R-value for insulation is R33, but tests have

shown that well constructed bale walls can be up to R50. For structural reasons, the second floor walls are stud walls but with 2x6 rather than 2x4 studs, insulated to R20 with blown-in insulation. The ceilings are insulated to R36.

The construction method is "post and beam" so the bales are non-load bearing. The wood is FSC certified or is "engineered wood" made from sawmill scraps. The Santa Fe style vigas (the exposed ceiling beams) are from storm-felled yellow pine in the Sierras

The 5-inch-thick concrete slab provides thermal mass and thermal inertia. Like in old southwestern adobe houses, the thick walls, large overhanging eaves, and lots of thermal mass keep the interior cool – without air conditioning – even on 100° summer days. In a string of 8 days at and above 100°, the maximum inside temperature was 79° on the first floor and 85° on the second floor. More typical 90° summer days see maximum temperatures of 75° downstairs, 80° upstairs. Venting the house at night rapidly drops the temperatures back to the low 70s. In winter, the sun provides nearly all the heat required by using large south-facing windows to let in sun, large thermal mass to hold the sun's heat, and the high insulation value of the bale walls and R36 insulation in the ceiling.



## Systems

Downstairs supplemental heat consists primarily of a gas fireplace that uses 35,000 BTU/hr. There is also in-floor hydronic heating in the library and master bedroom. Upstairs supplemental heating consists of a 1500 W electric baseboard heater in the study and a 2000 W electric baseboard heater in the studio. Although using electricity for heating, rather than gas, is usually a poor choice from an energy perspective, the team chose electric over gas and sized the PV system to make the home electrically neutral over the course of a year. However, with the upstairs being less thermally insulated than downstairs, the baseboard heaters are running slightly higher than anticipated in the colder months.

## Performance

The couple carefully monitors performance – both thermal comfort and electricity generation – and updates the information on a public blog.

<http://www.calpoly.edu/~rknight/StrawBaleHome.html>

“To test how well this is working, we conveniently were out of town for 3 weeks in late November and early December. Other than a pet sitter coming in once a day, the house was just sitting there doing its thing. Supplemental heat (more on that later) was turned off downstairs. Upstairs, baseboard heater thermostats were left at 65°. Three data loggers – one upstairs, one downstairs, and one outdoors – recorded the temperature every 30 minutes for 23 days. Although I plan later to install a pyranometer to measure actual solar energy coming through the windows, for the time being I'm using the daily production of the PV panels as a proxy for solar input. Here are the results:

