

Passive Solar Home Bishop, CA



2015



1983



David Bainbridge
January 11, 2015

One of my favorite projects

Author with
water tank
behind
lower window



The Test of Time

I feel strongly that most homes and buildings featured in architecture and design magazines are unsustainable and often look better than they live. Buildings should only be written up after a few years so that occupants can come to understand whether it is comfortable and healthful, what works, what doesn't, and how much it will cost to operate and maintain over the decades. The Beck/Casey House in Bishop, California is a good example of a house that works. It was completed in 1983.

Architect: Brock Wagstaff, Wagstaff Architects 275 Miller Avenue #202 Mill Valley, CA 94941 (415) 383-2160

Solar consultant: David A. Bainbridge, Sustainable Design, 8850 Capceno Road, San Diego, CA 92126 858-693-1451 sustainabilityleader@gmail.com

Builder: David French, Bishop, California

Owners: Cliff Beck and Alice Casey, 684 Autumn Leaves Circle, Bishop, CA 93514

The story

In the 1970s and early 80s I was involved in passive solar design, research and education. Cliff Beck read one of my books on passive solar design and tracked me down in early 1981. He and his wife had recently moved to Bishop and were planning to build a new home for their growing family. They had found a passive solar house plan they liked in a book (1979 NYSEDA solar awards book) and asked for my advice on its suitability for Bishop. They had carefully reviewed the plans and saw that a number of changes would be required to meet their needs. In addition, this was a post and beam, not a regular form of construction in Bishop. It also relied on

isocyanurate insulation that Cliff considered a risk in case of fire. The plan would also need to be redone to meet California energy and earthquake codes. I met with the Becks in Bishop in September 1981 to talk over the plan and options.

I began the process with a careful review of the Bishop climate and weather. Bishop is a cool desert climate with 5 inches annual rainfall, 4191 heating degree days (base °65F) and 80% possible sunshine. It was clear a passive solar design could work well for heating. Although the record low was -7°F the winter dry bulb design temp would be 11°F (99%) but more typically low winter temperatures would be in the 30°Fs. The summer design dry bulb (99%) would be 102°F. Summer highs would be over 100°F but the average maximums were in the mid 90's. Good orientation and overhangs would provide solar control during the hot summer. Cool nighttime temperatures in midsummer (34°F average daily swing, with average nighttime low 56°F even in July) would enable a night ventilated high mass home to provide good thermal comfort. Maximum wind speeds are 75 mph and big wind events are not uncommon. Dust storms may occur several times a year with high levels of very fine, salty dust. Humidity is very low in summer, commonly below 15%.

Cliff's brother Kirk began work on a new house plan. This came along but it eventually became clear that a professional might be helpful. I had worked with Brock Wagstaff on several projects and felt he would be a good match for the Becks. As an inveterate climber and mountaineer he would also relish the trips to the eastern Sierra from the Bay Area. By late fall 1982 a contract was signed and the design work could begin in earnest.

The first thought would be for about 2000 square feet, but this ultimately grew to 2436 square feet. The walls would be 2x6 with R-19 fiberglass insulation and the attic/ceiling insulation would be about R-30. Not as much as I would like, but design compromise is inevitable when you are a solar consultant. The builder did an excellent job installing the vapor barrier. This played a key role in air tightness for the home.

I ran through my design day calculations on shell performance and solar gain and developed an estimate of desired window area and thermal mass to be supplied by sheetrock, tile, concrete, and steel rectangular water tanks with sacrificial anodes and selective surface paint?. The goal was for about 180 square feet of south facing glass and 7000 pounds of water to supplement the existing mass of the building. An air to air heat exchanger would help retain energy while adding fresh air.

As is often the case, and appropriately so, energy was not the driving concern. Ultimately the water wall mass was cut back to 3 tanks with 45 cubic feet of water (almost 3000 lbs). These were placed in the children's rooms and kitchen. More windows than energy logic would dictate were added to non-solar orientation to capture the stunning views. The second story living room provides views of the Sierras and White mountains. Pella skylights with pole operated shutters were used to bring in even more light.

Two Thelin- Thompson model T-1000 woodstoves with direct outside intake air vents provided winter heating. These small stoves were designed for mobile home use, but because of the energy efficiency in the home and the large number of clear sunny days and passive solar performance

they worked very well. The Beck's would light the kitchen stove in the mornings to warm the breakfast area, and then have a fire in the living room stove when they got home from work or on the weekends. Backup heat is provided by an electrical forced air unit that is there primarily to keep the pipes from freezing during periods of time they are not at home in the winter. It is on very infrequently. Cliff says they can hear it cycle on at night when outside temperatures dip into the low 30s. A Revere flat plate with double wall anti-freeze filled heat exchanger provides solar preheat for water. A ceiling fan over the spiral staircase helps bring warm air down from the second floor and also adds cooling in the summer.

Construction started in December 1982 and was completed in September 1983. The builder worked on a fixed profit time and expense basis. This reduced the pressure for haste and made it easier to build a carefully crafted home. The builder remained a friend throughout the stressful process of building the home. The building loan was provided by Bank of America. The final cost was about \$201,000 including architecture and consulting costs, about \$80 sf. Not out of line for the time for a custom home.

Nine foot ceilings add delightful space and straight grain doug fir 5-1/2" x 1-3/8" trim on all interior walls gives the inside a unifying warmth. The double-helix oak staircase was made in Vermont and shipped assembled, carefully padded. It had to be screw rotated through the front door.

Building comfort

The proof the the pudding is in the eating and the ultimate test of a building is the comfort and feel of the spaces. As Cliff noted in a recent letter, "The house remains a joy to live in." Cliff and Alice and their children have all enjoyed the house. Even after 31 years it is still a delight every day. Bright, beautiful views, comfort, quiet and economical. Even with air temperatures inside at 60°F the unifom radiant temperatures provide thermal comfort. The builder is still a friend and frequent fishing companion.

Building energy performance

Energy use has not been monitored as wood was used for supplmental heating on their previous residence as well as this home. The 1300 sf home they had been in had energy bills often 1200 kwh month with considerable wood burning, compared to 1000 kwh for this much larger house. Estimated wood use for the season went down from 1.5 to 0.75 cords. We might consider this a Factor 4 house, twice the size/half the energy use. Good for 1983, but today we would prefer to see a Factor 10 house--using only 1/10 as much energy.

For many years the family collected cut and split their firewood. In 2010 they finally got tired of cutting, splitting, and hauling wood and cleaning up the bark, splinters and sawdust that go along with schlepping wood through the house to the hearth, amd then again into the stove. A Quadra Fire "Mount Vernon" pellet stove was installed that uses 40 pound sacks of pellets. These are a bit heavier than pieces of firewood, but they produce no mess in storage or in charging up the pellet stove. It uses less than a pallet of pellets a year. They have appreciated the thermostat,

setting it to come on at 5 AM to warm the living area and kitchen before they get up is a welcome luxury.

The solar water heater which has a large capacity circa 90 gallons is used as a preheater for a standard 40 gallon electric water heater. We have never used the electric heater in the solar tank and this probably has help extend its life. A swamp cooler was added to provide additional cooling on the hottest summer days but is used only a few days a year. It is particularly helpful on dusty days in late summer when windows must be kept closed. Electricity use went up with the addition of a hot tub and more recently addition of a plug in Prius.

Over 31 years this home has probably saved more than 20 _____? cords of firewood or about 100,000? kwh of electricity. This savings on electricity have netted the Becks more than \$10,000 dollars* and prevented the emission of 40 tons of global warming gases to the atmosphere. The firewood did add some additional particulates and pollutants to the local air shed.

The building shell, leaks, maintenance

Even on a blustery day you feel no air currents in the house. The air to air heat exchanger became contaminated with mold secondary to condensation after about 20 years and was disconnected it to avoid blowing mold through the house. After 20 years the air infiltration has increased as wood shrank. Indoor humidity is typically in the 40's most of the time. If because of heavy usage, parties, etc. condensation develops I turn the heat exchanger on in the exhaust mode and this increases the intake of outside air through small cracks and windows, etc.

The double pane Posey windows have held up well but require regular repainting. The cedar siding was the victim of the intense sunshine more than the low humidity. It did not actually shrink much but the soft phloem began to pull away from the tighter grain and it began to look like an old deck that had been in the sun for many years. This looked better with painting. Hardie Plank lap siding would have been a better siding choice for this challenging environment.

Cliff became distracted while filling the water tank in one of the bedrooms. My cry, "Oh S**t" could be heard for miles. The carpet was taken up and dried. The oak flooring in the hall swelled and then receded to its original size. One "freeze proof" faucet froze and leaked into a wall but the damage was minor. The water tank in the kitchen leaked after more than 25 years, probably because it had been set on plywood isolation pieces to help prevent rust. The plywood may have held water from condensation and floor mopping against the surface of the tank. It was replaced by four shrouded 55 gallon drums of water in 2012?.

Overview

Design works best when everyone plays well together. This project was a success because the owners were committed to sustainable design. They wanted and got a high quality home that would be comfortable, durable and lovely to see and live in. The joy it has brought them over the years is also a tribute to the architect and builder and to me - who helped bring it all together. As

Cliff told me recently, “I’ve always thought that what we succeeded in doing was to build a house that is aesthetically beautiful, comfortable and healthful with great views and just a minimal sacrifice to solar and energy savings principles.”

*dry hardwood firewood delivered in Bishop in 2015 is \$435 chord.



Living room 1985
Wood stove to left



Water tank
Steel tank with sacrificial anode.



Family portrait 1985
South wall of house behind



Staircase to living room



Living Room 2015



Water drums with lattice
Replacement mass for kitchen.



Looking up the staircase

Further reading

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