

CONSTRUCTION DETAILS

200 Madrone Court, Winters

Year House Completed: March 2000

Photovoltaics Installed: June 2004

Architect: Julie Haney

Builder: Arabis Construction

Mechanical Designer: David Springer (owner)

Mechanical Contractor: Paul Jull and Marshall Hunt



Building Envelope

Wall Framing: Standard 2 x 4 frame construction with insulated headers and OSB sheathing

Wall Insulation: R-15 high density unfaced fiberglass batt between studs
R-4 foil faced polyisocyanurate board on exterior of studs, seams taped to provide an air barrier
Perimeter of slab insulated with R-10 extruded polystyrene with termite barrier and coated to protect exterior surface

Ceiling Insulation: R-38 unfaced fiberglass batt
Radiant barrier laminated to underside of roof sheathing

Windows: Andersen wood frame and Milgard vinyl frame
Low-E² glass, U-value = 0.34, SHGC = 0.34

Passive Solar: House oriented to face north-south, 3' overhangs provide summer shade, porch and trellis shade windows that are not shaded by overhangs, large south window area and minimal east-west window area provides passive heating in winter and reduces summer heat gain.

Thermal Mass: To store heat in summer and winter and stabilize indoor air temperatures, all walls are covered with 5/8" drywall (1/2" is standard). Tile floors, fireplace rock, and granite countertops also contribute to thermal mass.

Other: Bottom plates and top plate penetrations caulked, special attention to draft-stopping between floors and at soffits.

Heating & Cooling Systems

Distribution: First floor radiantly heated by ½” cross-linked polyethylene (PEX) tube embedded in 4” concrete slab, 12” on center. Separate heating zones in living areas and master bedroom.

Second floor heated by variable speed air handler (NightBreeze). The rate of airflow varies with the amount of heating that is needed, reducing fan energy and noise.

Heating Source: Voyager 94% efficient condensing water heater with 40 gallon stainless steel tank and integral heat exchanger.

Cooling Source: 2-ton 12 SEER condensing unit coupled to a stainless steel flat plate heat exchanger that chills water.

Ventilation: NightBreeze system provides both summer ventilation cooling and winter fresh air ventilation using an automatically controlled outside air damper. (See NightBreeze brochure for more information.)

Description of Operation: In winter the radiant heating system provides primary heating and the second floor air handler provides supplemental heat but is rarely required. The NightBreeze system automatically delivers a prescribed volume of fresh air to maintain indoor air quality. When the outdoor temperature is below 45°F ventilation air is heated by the air handler coil. The water heater provides all required heat.

In summer the NightBreeze system ventilates the house at night with cool outdoor air, thereby cooling off the thermal mass in the house, which absorbs heat the following day. If the house does not cool off to 72°F by 4 AM then the air conditioner chills water that runs through the floor, and shuts off at 8 AM. The air conditioner uses about 25% less energy when operated in the cool morning hours. The floor stores the cooling, keeping the house comfortable through the day, and meets all the cooling needs except for prolonged periods of hot weather. If the temperature upstairs reaches 80°F, then the air conditioner will also run, but instead of cooling the floor, cools air using the NightBreeze air handler. This will only occur after several days of very hot temperatures. Only very rarely does the air conditioner operate between the hours of 12 PM and 6 PM, which is PG&E’s “on-peak” period.

Since the house is on time-of-use (E-7) electric rates, the cost of on-peak power is about \$.30/kWh and off-peak power is about \$.08/kWh. The PV system generates about 36% of its power during on-peak periods when rates are higher, improving revenues. Since the air conditioner rarely runs on peak, the amount of electricity purchased at the higher rate is very low.

Water Heating

Water Heater: Voyager condensing water heater, 94% efficient, 100,000 Btu input, electronic ignition, stainless steel tank, and internal heat exchanger for space heating.

Distribution: Branched copper piping with hot water recirculation pump controlled by a motion sensor in the kitchen. All hot water pipes are insulated.

Lighting: To minimize air leakage to the attic, no ceiling can lights were used. The surface-mount ceiling fixtures are hard-wired compact fluorescents (CFL's). Screw-base CFL's were used in all other fixtures that would accommodate them. Incandescent lights are on dimmers. A skylight was installed in the bathroom for daylighting.

PV System

Solar Modules: 8 - RWE Schott ASE300-DG/50, 2.4 kW DC (STC)

Inverter: 1 - SMA SWR2500U SBD

Cost:

PV Modules:	\$9308
Inverter:	\$1730
Racks:	\$860
Total Parts:	\$11,898
Rebate:	\$6538
Net Cost:	\$5360 (owner-installed)

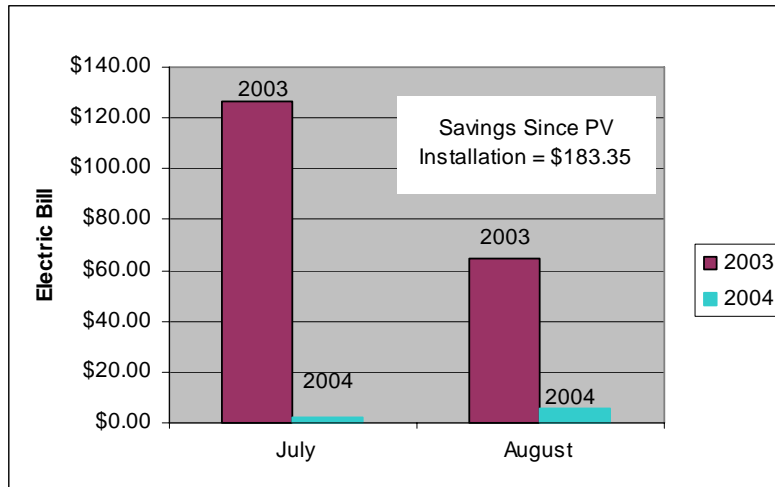
Projected Generation: 3660 kWh per year

**Savings Value:
(E-7 Rates)** \$392 on peak (at \$.30 per kWh)
\$186 off peak (at \$.08 per kWh)
\$578 total (\$48 per month)

Expected Payback: 9.3 years

Cash Flow: If the net cost were amortized at 6% for 15 years the annual payments would be \$543, which is \$35 less than the value of the energy savings (assuming no electric rate increases). This does not include the 7½% state tax credit or any increase in electric rates.

Actual Utility Savings to Date



Solar Thermal System (future)

A solar water heater for heating domestic hot water and the spa is planned. Piping was installed at the time of construction to facilitate installation of the system, which will also provide some space heating. The spa was installed with a heat exchanger and plumbing to enable connection to the solar thermal system. The system will employ a drainback tank that, with the Voyager water heater, will provide hot water storage. If the spa needs heat, it will draw heat from the solar collectors, and the Voyager water heater will provide supplemental heat.

Swimming Pool System

Swimming pool pumps are usually the largest user of home electricity. One way of reducing pump energy is to install a two-speed pump. The physics of pump operation dictate that if pump speed (and flow rate) is reduced by half, the power the pump consumes is reduced by one-eighth. Therefore, running the pump twice as long at half the speed theoretically reduces energy use by 75%. In actuality, pumps do not operate quite as efficiently at low speeds, but energy savings of 60% can still be achieved.

Since the pool sweep does not operate very well at high speed, we run the pump at high speed for one hour per day and at low speed for 5 hours per day. This combination achieves the required 1 turnover per day and saves more than 30% compared to a standard pump/filter system.

Another feature that saves energy and water is the automatic pool cover. The cover is opened during the day and closed at night to trap heat and minimize evaporation, and reduce chemical loss. It also keeps debris out of the pool, especially on windy days, reducing the required operating time of the pool sweep and filter.

For more information on energy efficiency, visit to www.davisenergy.com.