C A S E   S T U D Y

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A Wisconsin High-Performance Home

Mike and Melba Sullivan live in a high-performance home in Stevens Point in central Wisconsin. The main floor is 1,936 square feet, including a breezeway airlock entry and upper loft study/guest space. The lower level is partially finished.

The very conservative energy usage of this all-electric home was carefully tracked and documented from 1998 to 2002.

Designed by Architect Tom Brown of Stevens Point, the home was built Gimme Shelter Construction of Amherst.

A "high-performance" home is one that integrates an exterior building envelope that uses advanced framing, insulating and air-sealing techniques.

It uses high-efficiency mechanical, electrical, lighting and ventilation systems. The layout of interior spaces relates to the site orientation and incorporates passive solar design elements.

The house is comfortable and safe for the occupants, takes advantage of natural light, and responds to local climatic conditions.

The National Association of Home Builders Research Center (NAHBRC) selected the Sullivan Residence for their EnergyValue 2000 Gold Award.

It was deemed the most Innovative/Advanced residence in a cold-climate region in the country.

The home has been featured on the annual Fall Tour of Solar Homes, sponsored by the American Solar Energy Society, and on tours sponsored by the Midwest Renewable Energy Association at their annual "Energy Fair."

CASE STUDY

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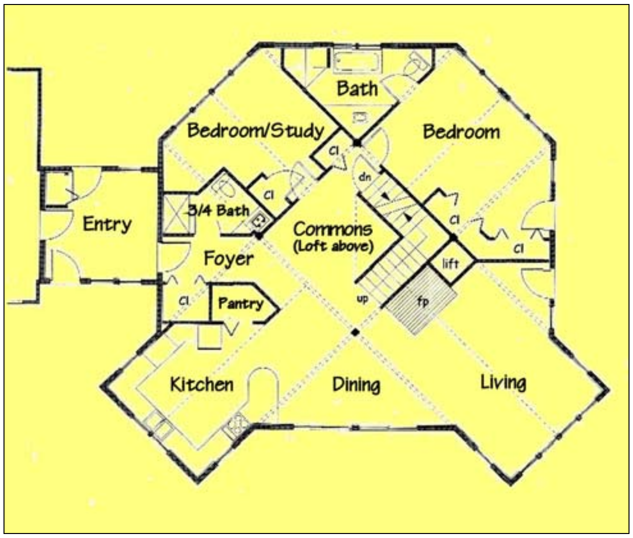
Design Concept Construction Method



The Floor Plan

The design is a variation on an octagonal plan. The cruciform layout has a maximum exterior framing bay of only 14 feet, resulting in modest spans and compact spaces.

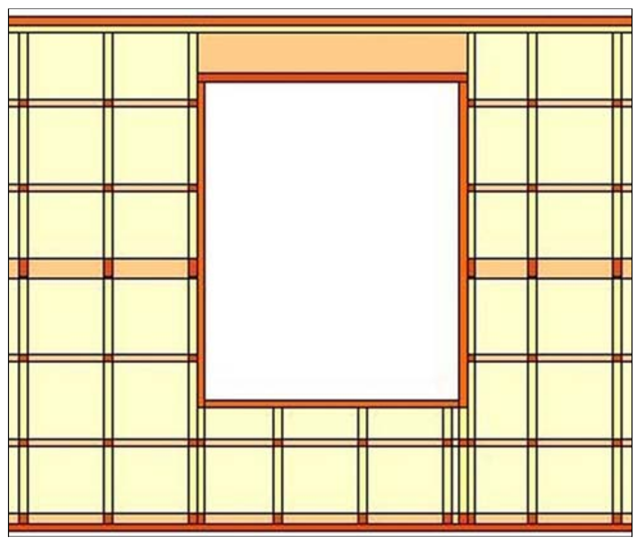
The open plan takes advantage of shared spaces in the kitchen, dining and living areas along the east-west axis of the south-facing site.

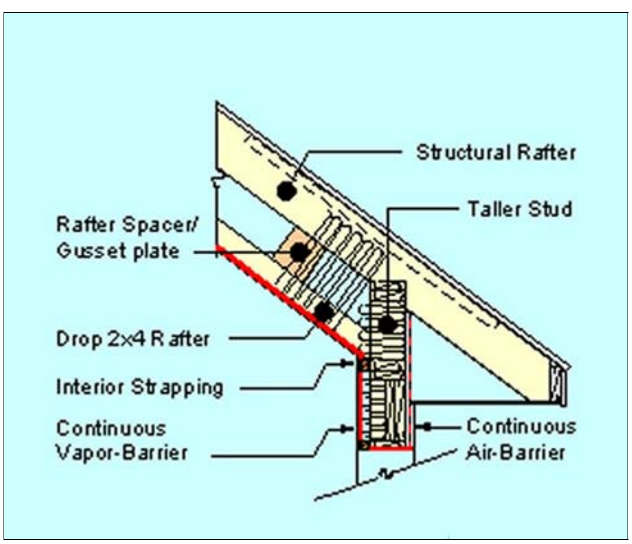
A central loft area provides natural ventilation and additional living space. The airlock entry connects with the attached garage workshop.

The Building Envelope

The house uses a variation on conventional 2x6 construction. Critical framing details are modified to ensure continuity of the air and vapor barriers.

An R-31 interior strapped-wall is an integral thermal break between the inside and outside wall surfaces. Raised-heel roof framing has R-50 insulation. The R-28 foundation is insulated on the interior perimeter. Blown-in-Blanket (BIBS) fiberglass and blown-cellulose insulation are used.





Passive Solar Design

South-facing windows represent 10% of the gross floor area, with another 10% distributed on the north, east and west walls. Roof overhangs are sized to permit maximum sun in winter and prevent direct sun in summer.

85 tons of interior thermal mass is provided by two levels of radiant concrete floor slabs, thicker gypsum drywall with thin-coat plaster, and a centrally-located masonry heater.

Passive cooling is provided by the operable loft windows.

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Heating, Cooling, Ventilation Systems

Controlled Ventilation

Blower-door tested for air-tightness, a dedicated mechanical ventilation system is provided. A “heat recovery ventilator (HRV),” or air-to-air heat exchanger, replaces inside air with fresh outdoor air to maintain air quality.

The system is controlled by a de-humidistat, monitoring pre-set indoor humidity levels; and occupant timer switches in bathrooms, kitchen and laundry areas. A portion of the heat from the exhaust air is recovered and transferred to the incoming fresh air supply.

Geothermal Heating

The home is heated with a closed-loop ground-source water-to-water electric heat pump. Five 800’ loops of exterior buried tubing harvest energy from the earth, which is exchanged in the heat pump for distribution through tubing in the radiant concrete floor slabs.

There is no mechanical cooling system. Provisions were made for a whole-house ventilation fan, but it has not been needed. The building envelope, roof overhangs and passive cooling prove sufficient for comfort.

Central Masonry Heater

A centrally located masonry heater looks much like a conventional fireplace. It is a highly-efficient wood-burning system, using a pre-fabricated high-mass core and an elongated serpentine flue to store heat from a wood fire for later release. The heat from a short hot fire can be stored and re-radiated for up to 24 hours.

Although rarely used here, this clean-burning unit can easily provide primary or backup heat for an open plan residence.

CASE STUDY

Documented Thermal Performance

Monthly utility bills were tabulated on both a seasonal and annual basis. The winter usage devoted solely to heating can be estimated by subtracting the average monthly summer energy use from the winter use.

Heating degree days (HDD) are a measure of local climatic conditions, available from the local utility. An "Energy Intensity Index" is determined by dividing the actual or calculated energy usage by the area of the home and the number of heating degree days for the home's location. This index can be used to compare any home in any climate.

Actual Energy Use

(1998-2002 four-year average)

Winter Heating Only Use (October to April)
7,566 kwh $212.67

Winter Total Use (October to April)
13,630 kwh $465.61

Summer Monthly Average Use (May to Sept.)
1,011 kwh $42.16

Annual Total Use (April to April)
19,703 kwh $711.35

(does not include ~ $8/monthly meter charge ~ $100)

Steady State Heat Loss

(25.82 MM Btu use @ 3,413 Btu/kwh) /
(5,990 HDD (October to April))/
(24 hours/day x 90 degrees TD @ -20F) =
16,166 Btu/hour @ -20F

Energy Intensity Index

(25.82 MM Btu use) /
(5,990 HDD (October to April))
= 4,311 Btu/HDD /
(1,936 square foot area) =
2.23 Btu/HDD/square foot

This all-electric home takes advantage of "time-of-day" electric rates, which differ between peak and off-peak usage periods. Electricity costs averaged $.03/kwh for off-peak use, and $.12/kwh for peak period use. The time-of-day rates resulted in a savings of $366.39 (37%) over using average standard rates of $.06/kwh for all periods.

The combination of passive solar design, high-performance building envelope, and high levels of interior thermal mass resulted in 89% of its energy use occurring during off-peak periods.

A "high-performance" residence takes advantage of an integrated approach toward its design and construction. Careful attention to detail, informed choices of building materials and systems, combine to conserve energy.

Site configuration, interior layout, window size and placement, construction method and quality control are important factors in achieving optimal performance and comfort.

A comfortable home, easy to heat and cool with modest energy usage, can be built in any style.

For More Information

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