Synagogue Passive Solar Design Dramatically Cuts Annual Energy Use

David A. Bainbridge ©2014

A remarkable building in San Luis Obispo, California shows what we should expect from all of our buildings. The San Luis Sustainability Group has designed more than 200 solar buildings and all of their skills were brought to play in the Congregation Beth David's naturally heated, cooled, ventilated and lighted new synagogue.

This delightful building was completed in December 2006 and was the first green, passive, LEED certified public building in San Luis Obispo County. From the very beginning, solar orientation was emphasized and the building was developed along an east-west axis. The goal was to heat and cool the facility with natural energy flows rather than relying on a large central heating, ventilation and air conditioning system powered by fossil fuels. Eliminating the HVAC system saved as much as $160,000, providing money for passive solar components including higher performance windows, interior and exterior light shelves, thermal mass storage water tanks, and automated natural ventilation. The ventilation challenge was met with a sophisticated venting system with supplemental fans and design refinement and validation with computational fluid dynamics (CFD).

The design team used modeling and more than 300 solar buildings worth of experience to create the very effective design. Hour by hour weather data for five years was available from a utility weather station located on the corner of the site and two models were used to optimize the performance of the building. Thermal performance modeling and design optimization was done by Phil Niles using Energy 10. CFD was also used to predict airflow in the courtyard and the sanctuary, and to satisfy building officials that the ventilation system would work even during periods with a large occupancy.

The budget for this building was typical for a standard building at the time of construction. The green components had to be cost effective as well as efficient. The east wall of the sanctuary and the north wall of the social hall were constructed with straw bales. The advantages of this type of construction include using a local "waste" product, sequestering carbon, superior insulation, optimized two-hour fire resistance, and superior sound dampening. In addition, the cost of providing curvilinear forms desired for these wall sections would have been cost prohibitive with any other construction system.

The synagogue is designed for natural lighting and artificial lighting is not needed during daylight hours. Daylighting features include south facing dormers for deep rooms like the social hall and kitchen. Skylights help lift moderately deep rooms like the library and offices, and many of these are operable to assist with natural ventilation. Twenty one light tubes were used to add light to smaller spaces like the north side of the classrooms, halls and restrooms. Light tubes were also used to balance lighting at the rear of the sanctuary. South facing rooms include light shelves to bounce light into the rooms without glare.

The south walls of the sanctuary, social hall, library and classrooms were designed for direct solar heat gain in winter utilizing steel tank water walls for thermal mass. The east-west orientation of the building made it possible to add sixty-five tons of water for thermal mass. The glazing for the south side was chosen to allow more energy to penetrate the rooms for heating.

Solar control in summer provided by overhangs and light shelves. Operable windows, high and low, and twenty interior transoms were carefully designed for effective automated night ventilation cooling. The night ventilation coupled with the large amount of thermal mass, provides sufficient cooling for daytime hours. During the initial operating/commissioning period, monitoring and control could be done by over the internet by the construction manager.

Performance and satisfaction have been very high. The building works well even during extreme events such as maximum crowding in summer. The building is warm and bright in winter and cool in summer. The water tanks could have been slightly thicker to modulate heat gain more, but comfort is excellent. Energy use was 80% below California Title 24 standards at first and now is closer to 90% below, better than predicted. This may seem remarkable, but it is well within reach for almost all buildings.

Congregation Beth David Synagogue is a brilliant project by a skilled design team, but applying the same techniques can benefit any building. The critical step is considering integrated design at the very first stages of site choice and location so that the building can be oriented properly without increasing costs. Energy codes and LEED should be revised to encourage better design at these early stages, rather than providing simply prescriptive points for a checklist of items that are good, but perhaps not sufficient.

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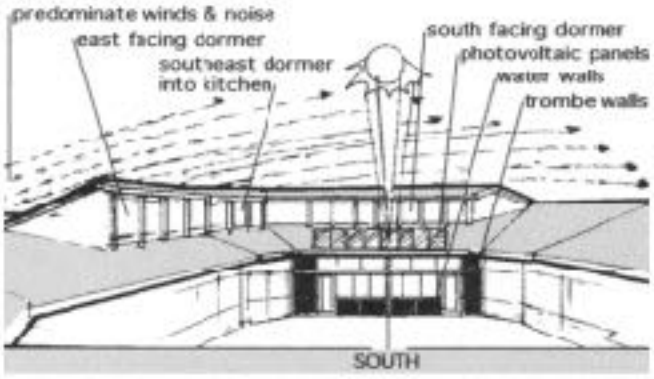
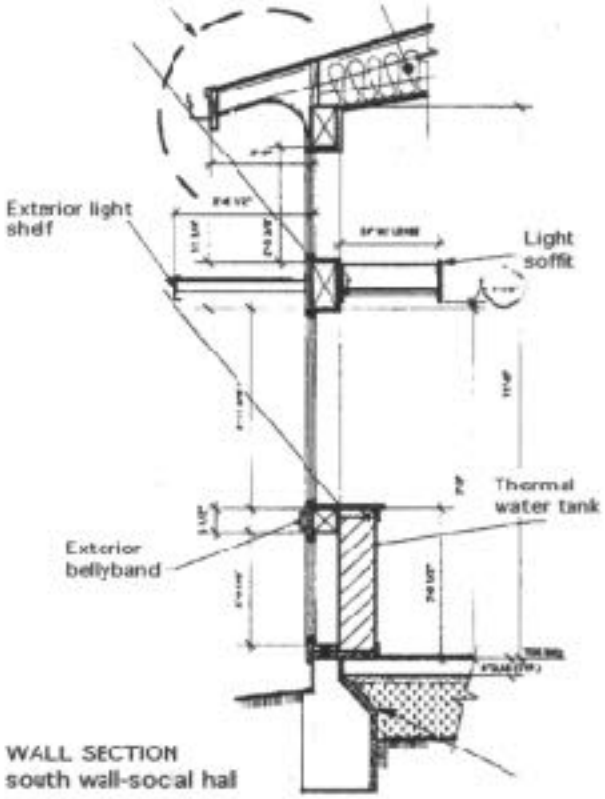
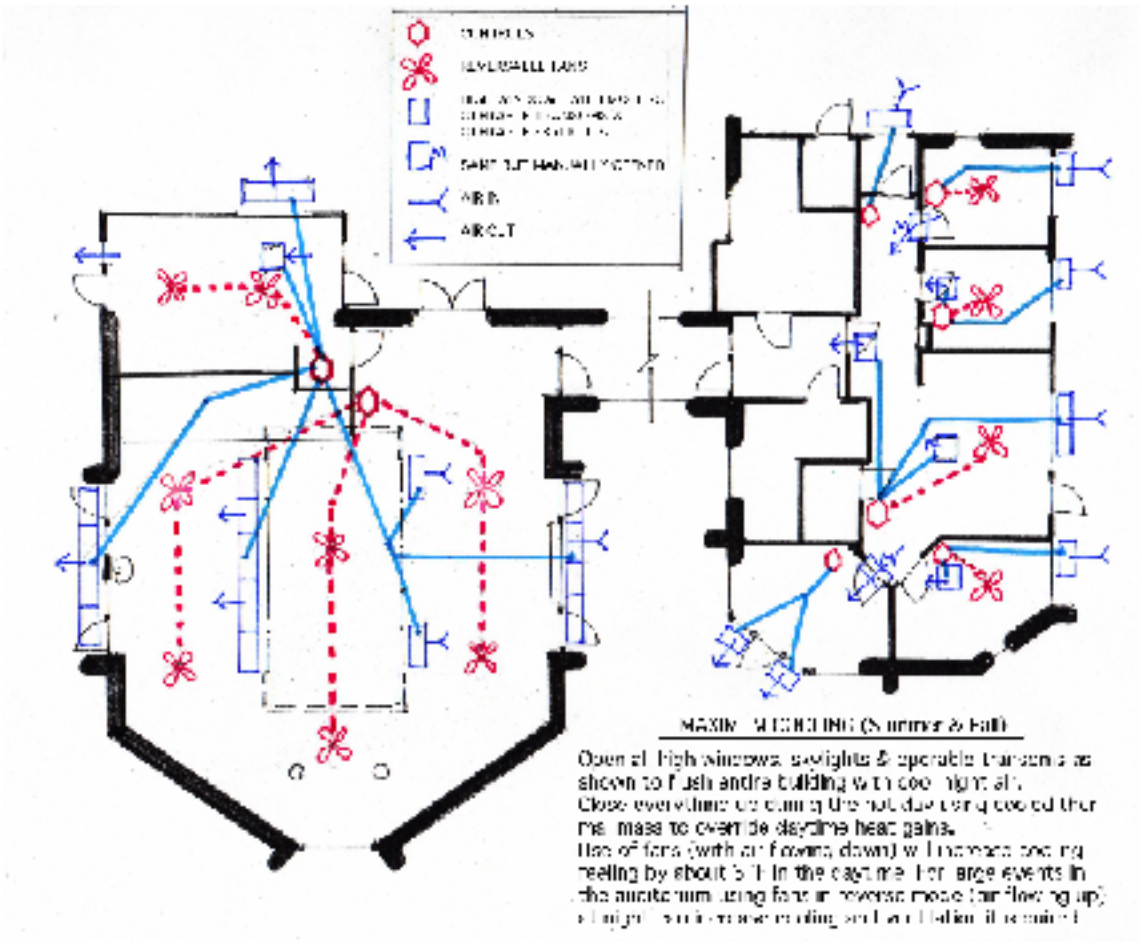
The author: David A. Bainbridge, now retired, was Associate Professor of Sustainable Management, Alliant International University. He received the American Solar Energy Association Passive Solar Pioneer Award in 2004 and special commendation for his work on the passive solar sections of the California Solar Tax Credits from the California Energy Commission in 1978. He is the coauthor of the Straw Bale House and the ISES Pocket Reference Handbook for Passive Solar Architecture.

All buildings should be required to go through a couple of seasons before they are reported in the press. Too often a shiny clever building looks good, but doesn't perform very well. I have seen a couple of platinum buildings that were not doing very well... A ten year waiting period would be even better—and a detailed survey should be done on comfort and health.

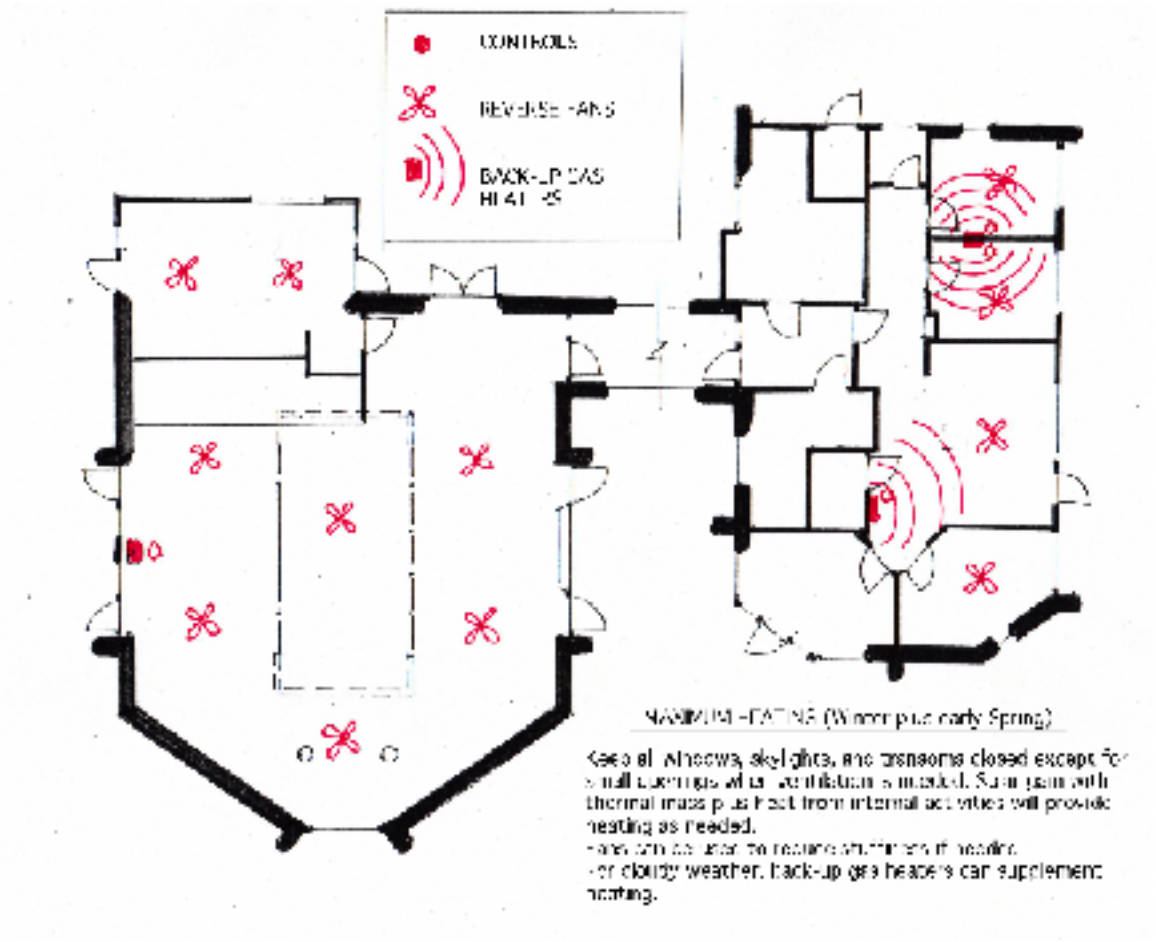




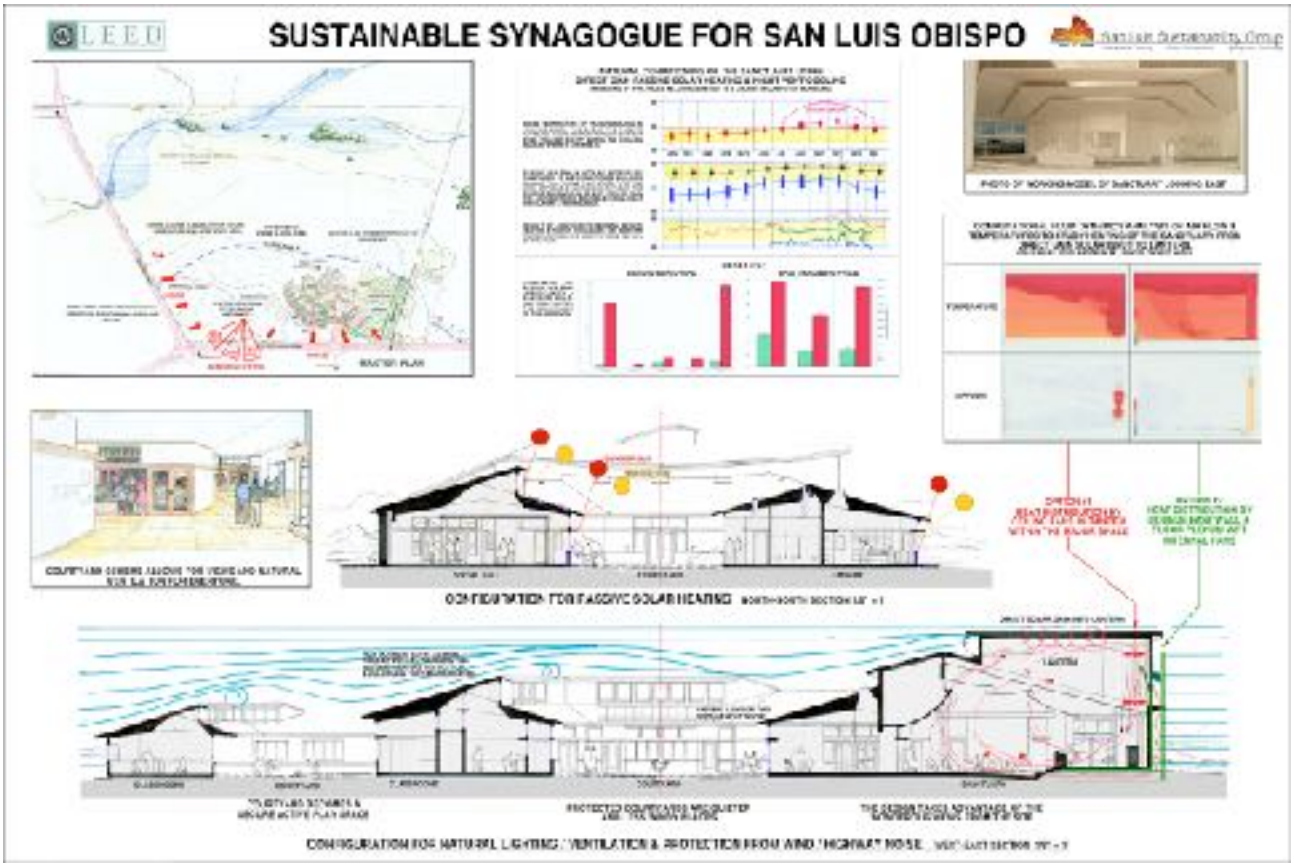
Details of CBD



Cooling Mode



Heating Mode


LEED
SUSTAINABLE SYNAGOGUE FOR SAN LUIS OBISPO

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Congregation Beth David Synagogue, water wall under construction and existing. Light shelf for natural lighting. Design SLOSG.

Congregation Beth David, San Luis Obispo, California
San Luis Obispo Sustainability Group