Solar CalPoly

Cal Poly's goal is to create a beautifully concise home tuned to the climate, detailed for modern living, proportioned and sized to travel across the country pulled by a single truck; to reduce our household's footprint on the land and make the most effective use of space and resources. Simple. Fundamental. Elegant.

Thermal Comfort

Comprehensive Assessment

The Solar CalPoly team intended to enhance occupant comfort by providing a close connection between the indoor and outdoor spaces. To accomplish this, large glazed areas are used to maintain a visual connection with the outside and to provide daylighting whenever possible. In addition, every space in the house has an operable window. The envelope of the house was designed to reduce the need for mechanical systems: high R-value envelope components, low-e insulating windows, and tight construction to minimize unwanted air leakage. The windows on the south wall allow for direct solar gains during the winter while shading devices reduce these gains during the summer. A Trombe wall is incorporated into the south side of the house to provide thermal storage and dampen out the daily temperature swings. Through passive means alone, the house will be able to maintain a comfortable indoor environment for most of the year, adjusting with the seasons and providing a thermal connection with the outdoor environment.

When passive design techniques are not sufficient for occupant thermal comfort, mechanical means can be utilized to heat, cool and ventilate the space. A decision matrix was constructed to evaluate different heating, ventilating and air-conditioning (HVAC) systems using such criteria as efficiency, reliability, cost, ease of installation, etc. The rules and regulations of the competition having eliminated many common system types, the air-source heat pump was deemed the best choice after all factors were taken into consideration. Solar thermal space heating was also considered but it did not seem resource effective to design a separate system to accomplish this task. Although air-source heat pumps have a significant reduction in performance at low outdoor air temperatures, they compare well when evaluating overall efficiency and simplicity. Also, once a permanent site has been selected, the air-source heat pump could be converted to a ground source heat pump or a fossil fuel heating system could be added to the existing system to provide additional heating if required during the winter months.

A Carrier two-speed high efficiency heat pump with a nominal cooling capacity of 2 tons (24,000 Btu/hr) was selected based on its high efficiency. The cooling efficiency is rated up to 14 SEER (seasonal energy efficiency ratio) and the nominal heating system performance factor (HSPF) up to 8.5. With the two-speed system, the unit stays in low speed operation most of the time. This is important because the house is not large and the heat pump will usually be able to achieve all heating and cooling needs in low speed operation for lower monthly energy costs. This will also prevent the heat pump system from constantly cycling on and off while maintaining a specified indoor temperature for better efficiency and greater indoor comfort. A Carrier indoor air-handling unit with a variable speed fan and backup electric heating was chosen for the indoor unit. The variable speed fan can modulate the amount of air delivered to the space based on the required load while minimizing fan power requirements.

To meet indoor air quality requirements, outdoor air must be brought into the space during the heating and cooling seasons when it is not advantageous with respect to energy usage. An energy recovery ventilator (ERV) unit is used to minimize the heating and cooling loads associated with introducing outdoor air into the house. The ERV transfers both sensible and latent heat between the outdoor and exhaust air streams, thereby reducing heating and cooling requirements. Air from the house is exhausted from the bathroom and fresh air from the ERV is supplied to the indoor unit return plenum where it can be distributed to the house.

Supply air is transferred to the occupied space through a single duct. The interior space is open and there are no internal doors to separate spaces, allowing the air within the house to become well mixed. The supply air is introduced through registers at the ceiling level and mixes with the room air before circulating to the occupied zone. The supply duct is oversized to avoid high air velocities and excessive noise in the occupied space. In addition, the supply and return plenums are lined to reduce noise transmissions from the indoor air-handling unit to the occupied space.

The user controls for the HVAC system are located in the main living space and are easily accessible. The occupant can adjust the set-point temperature for heating and cooling. A CO2 sensor is located near the house thermostat and the ERV is automatically controlled based on CO2 levels in the space. There is also a manual override so that the occupant has control over the mechanical ventilation.