Photovoltaic Array Ignores Common Design Rules

From the start of the design process, our team decided that one of our major goals was to create a house that would appeal to the American public and in doing so, certain design decisions were made that fly in the face of conventional solar design rules-of-thumb. Ideally, all the photovoltaic [PV] panels would be oriented directly south with a tilt angle equal to the latitude of the location (approximately 40 degrees for Washington, D.C.). Our final house design includes roofs at 22.5, 16.5, and 0 degrees, with the 16.5 degree roof facing southwest. However, after many simulations and calculations were performed, we found that the roof tilts and orientations for our desired house design would result in annual electricity production equaling over 90% of the production achieved by the optimum design. Our design provides a more conventional and appealing architectural design without significantly compromising energy performance.

Another design goal of ours was to use every square foot of roof area available to us for power production. This results in a system that is much larger than what is normally recommended and again breaks some of the rules of thumb for solar design. Because of the current initial cost of PV systems, solar systems are generally kept to a minimum size. However, we wanted to show that solar systems can exceed the energy needs of the American public, including transportation with a small electric vehicle. We hope this will help bolster the public's interest and acceptance of solar power, and as a result, the economies of scale will lower the cost of PV systems and help eliminate economics as a deciding design parameter.

Another unique feature of CU's PV system is the manner in which it is mounted to the roof.

The PV panels are mounted on rails, which in turn are mounted directly to the metal ribs of the standing seam roofing using S-5 clamps. This is a unique mounting system that eliminates any penetrations through the weather sealing of the roof and therefore preserves the integrity of the building envelope.

All of the DC electricity generated by the PV array makes its way to the Tech Pod where it is stored in batteries or it is converted to standard 120V or 240V AC electricity for use in the house. The battery bank is designed to provide up to 4 days of energy for the house if the sun ever fails to shine for an extended period of time. The battery bank is larger than normal, but it is needed for the competition. To decrease the size of the battery bank in a standard residential system, one could add a backup generator or possibly a small wind system to help provide back up power in the event of bad weather.

We decided to use inverters from Trace Engineering to perform the DC to AC conversion of the PV power. By utilizing standard AC power in our house we are increasing public appeal by allowing for the use of all standard household appliances and electrical equipment.