BUILDING AMERICA TOP INNOVATIONS HALL OF FAME PROFILE

INNOVATIONS CATEGORY:

2. House-as-a-System Solutions
2.1 New Homes with Whole-House Packages

Community Scale High-Performance with Solar:

Pulte Homes, Tucson, AZ

Pulte Homes' Civano project in Tucson, Arizona, is one of the few communities in the United States to integrate passive and active solar with a comprehensive building science strategy.

Pulte Homes of Tucson worked with Building America to apply a suite of energy-efficiency measures integrated with passive solar design and solar water heating that reduced energy use more than 50% for a community of more than 1,000 homes. Solar has grown to become a prominent energy strategy for Pulte Homes in other divisions across the United States.

BUILDING AMERICA TOP INNOVATIONS

Recognizing Top Innovations in Building Science – The U.S. Department of Energy's Building America program was started in 1995 to provide research and development to the residential new construction and remodeling industry. As a national center for world-class research, Building America funds integrated research in market-ready technology solutions through collaborative partnerships between building and remodeling industry leaders, nationally recognized building scientists, and the national laboratories. Building America Top Innovation Awards recognize those projects that have had a profound or transforming impact on the new and retrofit housing industries on the road to high-performance homes.

Many builders remain resistant to adopting high-performance innovations based on misconceptions about high cost and design challenges. Thus, Building America projects such as Pulte Homes' Civano project in Tucson, Arizona, have an extraordinary impact, demonstrating the business case for adopting proven energy-efficiency measures along with solar energy systems for an entire community.

Building America has shown in numerous field demonstrations that critical economies of scale and maximum energy benefits can be realized when production builders select energy-efficiency measures that work together and implement them community-wide rather than as optional upgrades.

Pulte Homes found this to be true when it took over as master developer of the Civano project in Tucson in 2003. Civano started in the 1990s as a solar community with the ambitious goal of building 2,600 homes that used 50% less energy than local code-built homes and met at least 5% of their energy needs with solar. Most of the builders who constructed the 500 homes in phase 1 at Civano chose solar water heaters to meet the solar requirement, but many of these began to fail within the first year and electric bills were higher than expected.

Pulte sought the expertise of Building America research partners IBACOS and Building Science Corporation. They found that one-third of Civano's homes did not meet the heating and cooling energy requirements. They identified the source of the water heater failures as corrosion caused by chemical incompatibility between the city water and the copper pipes in the passive, integrated, direct solar water-heating systems that many builders installed. These open-loop systems resulted in high water heating costs in homes that had recirculating pumps hooked up to the bathroom faucets. The recirculating pumps forced heated water out of the tank and up to the rooftop solar collectors at night where it cooled off and had to be reheated with back-up heat.

"Pulte was successful at Civano because they took a standardized approach to incorporating energy-efficiency measures that could be applied to hundreds of houses."

Al Nichols, professional engineer and code reviewer for Civano

Pulte asked the researchers to identify a solar water heater system that would work in Tucson. Whole-house energy efficiency was also a priority, and Pulte used the "platinum-level" designs they had developed with Building America for homes across the country. Energy-efficiency measures in the new Civano neighborhoods, which Pulte called Sierra Morado, met the original Civano goal of 50% energy savings over local code (at that time the 2000 IECC). Homes ranged from 2 bedrooms with 1,276 ft^2 to 4 bedrooms with 4,071 ft^2.

With advice from IBACOS, Pulte chose active, indirect solar water-heating systems for the new homes. This type of system circulates a glycol fluid in a closed loop through a 40-ft^2 flat-plate solar collector mounted on the roof. An electric pump circulates the solar fluid from the collector down to a heat exchanger where it transfers its heat to the potable water in an 80-gallon tank in the garage. Pulte's tightly built Sierra Morado homes included other important measures to reach the goal of 50% energy savings over code (see sidebar).

Building Science Corporation evaluated 11 Pulte house plans against the 1995 Model Energy Code. The computer modeling predicted a total energy cost reduction of $500 to $850 annually.

A University of Arizona study of Pulte's Civano homes found that its solar water heaters provide a savings up to 2,200 kWh per year.

Key Lessons Learned

Building America researchers identified several lessons learned from the problems early builders had at Civano with failed solar water-heating systems: 1) choose a solar thermal collector with single, not double, glazing for less heat buildup in high-temperature climates; 2) test local water compatibility with water-heating systems; 3) choose closed-loop systems; 4) use chemical water softeners to avoid some chemical incompatibility; 5) use active not passive systems; and 6) do not use continuous hot-water recirculation systems.

Building Science Corporation studied placement of solar panels at Pulte's Civano homes and found only a 16% difference in south, east, and west elevations. Even solar panels facing due east or west operated at 80% efficiency.

Efficient heating and cooling equipment located in conditioned space contributed to energy savings. Ducts and air handler are located in a sealed, conditioned attic insulated along the roof line with netted blown cellulose. This insulation technique works in Tucson's hot-dry climate, but would not work in more cold and more humid climates.

Solar energy continues to be part of Pulte's pursuit of better-built, more energy-efficient homes. In Las Vegas in 2009, Pulte began working with NV Energy and DOE to develop Villa Trieste, a neighborhood of <70 HERS homes with roof-integrated solar-electric power systems. In Sun City, Arizona, Pulte's Del Webb division is building homes with 1.8-kW solar-electric power systems that is grid-connected and use 50% less energy than typical code-built new homes.

Solar water heaters generate 2,200 kWh/year, enough to recoup the cost of the system within 4 to 6 years.

KEY ENERGY-EFFICIENCY MEASURES

HVAC:

- SEER 14 air conditioner
- 90% AFUE sealed-combustion gas furnace
- Ducts and air handler in insulated, conditioned attic
- Duct leakage: None to outside, 5% of flow maximum

Envelope:

- Unvented attic with tile roof
- Blown cellulose at roof line
- Walls 2x6 @ 24 o.c. R-19 with R-4 EPS or Walls 2x4 @ 16 o.c. R-13 with R-4 EPS
- Windows Low-E2, U=0.39, SHGC=0.33
- Infiltration 2.5-in^2 leakage area per 100-ft^2 envelope

Solar:

- Active, indirect solar water-heating system with 40-ft^2 flat-plate solar collector
- Passive solar orientation

REFERENCES

PNNL. 2007. *Building America Case Study: Pulte Homes, Civano, Tucson, Arizona*. Prepared by Pacific Northwest National Laboratory for the U.S. Department of Energy Building America, http://apps1.eere.energy.gov/buildings/publications/pdfs/building_america/ba_solar_casestudy_civano.pdf