



## Building America Case Study Whole-House Solutions for New Homes

# John Wesley Miller Companies

Armory Park Del Sol, Tucson, AZ

### PROJECT INFORMATION

**Construction:** New home

**Type:** Single-family

**Builder:** John Wesley Miller Companies  
Tucson, AZ, 520-325-3313  
[www.johnwesleymillercompanies.com](http://www.johnwesleymillercompanies.com)

**Size:** 99 homes, includes two ZEH  
1,700 ft<sup>2</sup> and 2,168 ft<sup>2</sup>

**Price Range:** Not Available

**Date Completed:** 2007

**Climate Zone:** Hot/Mixed Dry, IECC 2B

**Team:** National Association of Home  
Builders Research Center (NAHBRC)

### PERFORMANCE DATA

**HERS Index:** 59-68 without PV

**Projected annual energy  
cost savings:** \$1,244\*

**Added first cost of energy-  
efficiency measures:** \$4,970\*

**Annual mortgage increase:** \$397\*

**Annual net cash flow to homeowner:** \$847\*

**Billing data:** Not available

\* Savings calculated without PV.

Solar home visionary John Wesley Miller teamed with the U.S. Department of Energy to build two zero-energy homes at his award-winning 99-unit development in Tucson's historic Armory Park neighborhood.

Miller was one of four builders selected to work on DOE's net zero-energy homes initiative. Through the initiative, Miller worked with the National Association of Home Builders Research Center (NAHBRC), the National Renewable Energy Laboratory, Devereaux and Associates Architects, and a team of suppliers and contractors to design one of the first true zero energy homes in the country in 2003. Four years later they improved on their design to build a second zero-energy home.

Both homes are located in Miller's Armory Park del Sol community. Every home in the community has thermal mass masonry walls covered with rigid foam insulation, high-performance low-E windows, tight 2.9 ACH50 air sealing, high-efficiency HVAC with transfer grilles for pressure balancing and ducts located in conditioned space, plus 1.5 kW of PV panels is standard on every home.

The first net zero-energy home at Armory Park is a 1,700 ft<sup>2</sup>, two-story home that uses 7,000 kWh of energy annually, versus 18,000 kWh for a conventional home, and it produces nearly all the energy it uses on an annual basis. The home's solar hot water system provides almost all of the homeowner's hot water and home heating needs. Total energy costs for the home were \$15 per month in 2005—including all heating, cooling, lighting, and appliance use.

Miller learned several lessons in constructing this first zero energy home that were incorporated into his second zero energy home, a 23% larger (2,168 ft<sup>2</sup>) home at Armory Park.

*(Photo top left)* John Wesley Miller combined thick masonry walls with rigid foam sheathing insulation, R-38 attic insulation, high-performance windows, and 14-SEER heat pumps, plus solar photovoltaic and water heating systems on all of its homes at Armory Park del Sol in Tucson.

## KEY ENERGY-EFFICIENCY MEASURES

### Standard Home HVAC:

- 14 SEER/7.7 HSPF heat pump
- Ducts in conditioned space; jump ducts
- Central fan-integrated exhaust ventilation with fresh air intake

### Standard Home Envelope:

- Foundation: Steel-reinforced floating slab, with foam-insulated edges
- Walls: Masonry wall superstructure (8-inch CMU) with R-10 (1.5 in.) polyiso rigid foam; 3-coat stucco finish
- Roof: Flat-roof I-joint design with R-38 blown insulation
- Overhangs and porches
- Dual-pane, low-E2 windows (U-0.35 and SHGC-0.29)
- Tightly sealed house, 2.9 ACH 50

### Standard Home Lighting, Appliances, and Water Heating:

- Integrated collector storage (ICS) solar hot water with tankless back-up
- 75% hard-wired for CFLs
- ENERGY STAR® appliances

### Solar:

- Standard on all homes: 1.5-kW PV and solar hot water collector
- 1<sup>st</sup> ZEH: 4.2-kW PV, 2<sup>nd</sup> ZEH: 5.7-kW PV

For more information, please visit:  
[www.buildingamerica.gov](http://www.buildingamerica.gov)



Solar photovoltaic and water heating panels are mounted on the flat roofs.

## Lessons Learned

- In the first zero energy home, a custom solar thermal water heating system was designed to meet 100% of domestic hot water and 90% of space heating needs. This system required a large custom tank that needed post-installation modifications to work and took up too much space inside the home. In the second ZEH, the solar thermal system was downsized by two-thirds with smaller roof top collectors and a much smaller tank that met 90% of domestic hot water needs, with a tankless gas water heater for back up. A SEER 17.6 heat pump was added for space heating and cooling.
- The solar photovoltaic system was increased by 65% (4.2 kW to 5.7 kW) to meet nearly 100% of electricity demand.
- Recessed can lights were replaced with high-efficiency lighting with predicted savings of 50% (2,548 kWh to 1,274 kWh).
- The roof insulation was increased to R-55 by adding 1.5 inches of foil-faced rigid polyiso foam above the framing in the flat roof above the R-38 blown insulation. Adding insulation above the roof framing was less expensive than increasing the depth of the flat roof cavity to accommodate more blown insulation.

“John Wesley Miller Companies worked with the NAHB Research Center to analyze its first-generation net zero-energy home at Armory Park del Sol. Together we came up with a list of energy-, space-, and cost-saving changes that simplify installation for us while still allowing the home to reach true net zero-energy use.”

*John Wesley Miller*

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