

# Armory Park del Sol

Tucson, Arizona

## Moving Toward Zero Energy Homes

### Zero Energy Home Soaks Up the Southwestern Sun

**T**he rooftops in Tucson's Armory Park del Sol neighborhood are soaking up sunlight and generating their own power. The builder, John Wesley Miller Companies, combined traditional Mission style architecture with the latest energy efficiency components and techniques – then added solar energy to the all-electric homes to generate electricity and heat the air and water.

***“What we’re literally doing here is building a small power plant one house at a time.”***  
– John Wesley Miller, president,  
John Wesley Miller Companies

Every home in the development is highly energy efficient – using roughly 50% less electricity than average area homes and qualifying for Tucson

Electric Power's lowest electric rate. Solar hot water and solar electric panels come as a standard feature on all the homes. The panels are rooftop mounted on the flat rooftops typical of the area.

While these homes boast energy performance way beyond most new construction, John Wesley Miller Companies wanted to push the envelope of home design even further. One of the homes was specially designed and engineered to use zero net energy over the course of a year – a Zero Energy Home. Just like a typical home, this Zero Energy Home is connected to the utility. At times the home draws electricity from the utility, and at other times, when the home makes more electricity than it uses, it rolls the home's utility meter backward.

To master the challenges of building a Zero Energy Home, John Wesley Miller turned to the U.S. Department



**The Armory Park del Sol homes feature roof top solar electric and solar hot water panels, which are hidden from the ground.**

of Energy's Zero Energy Homes initiative to tap into the latest R&D from DOE's labs. The NAHB Research Center, working closely with National Renewable Energy Laboratory researchers, Devereaux Architects, and a team of subcontractors and suppliers, were able to balance aesthetics and efficiency in the home design.



U.S. Department of Energy  
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*Bringing you a prosperous future where energy is clean,  
abundant, reliable, and affordable*

## About Zero Energy Homes

To take U.S. home energy performance to a higher level, DOE created the Zero Energy Homes (ZEH) initiative, bringing the latest R&D out of the laboratory and into homes. Both energy efficiency and renewable energy technologies - like solar water heating and solar electricity - serve these homes. DOE's goal is to help builders create homes that produce as much energy as they use over the course of a year. ZEHs are connected to the utility grid, and some are even energy generators, rolling the utility meter backward when they produce more electricity than they consume.

DOE selected four teams that are working with researchers at the National Renewable Energy Laboratory to introduce the ZEH concept into the single-family, new-home construction industry. The four teams are ConSol, Stockton, California; Davis Energy Group, Davis, California; NAHB Research Center, Upper Marlboro, Maryland; and Steven Winter Associates, Norwalk, Connecticut.

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## Research that Works



### A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.



**U.S. Department of Energy**  
**Energy Efficiency**  
**and Renewable Energy**



### The home's A/C unit (center) and an integrated solar water and space heating system. Solar collectors provide space and water heating with backup heat provided by a tankless water heater (white square on wall).

Working from scratch, the team devised a 1,718-square-foot floor plan that offers three bedrooms, two full baths, high ceilings, an open great room, a private master suite, and outdoor living spaces.

The home features a 4.2-kilowatt photovoltaic array and an integrated solar water and space heating system. The solid masonry construction with insulation and efficient windows keeps out unwanted heat, along with a reflective roof coating and radiant barrier roof decking. ENERGY STAR® appliances, a very high efficiency A/C system, and soft white fluorescent lighting perform well but use minimal electricity.

The home is expected to use 7,000 kilowatt-hours of energy annually, compared with 18,000 kWh for a conventional home in Tucson. NAHB Research Center engineers are monitoring the home's performance; details are available at [www.toolbase.org/ZEH](http://www.toolbase.org/ZEH).

The Zero Energy Home cost about 20% more to build than the other homes in Armory Park del Sol. The home sold in less than a month to owners who like that it looks like a conventional home, yet is a Zero Energy Home powered by the sun. In summer 2004, after the home has been occupied and monitored for a full year, engineers will know if the home met the net zero energy goal.

## Key Features

Energy Efficiency	
Appliances	ENERGY STAR® horizontal axis washer, dryer, refrigerator, dishwasher
Ceiling/Attic/Roofing	Three-ply built-up roofing with reflective coating Radiant barrier roof decking R-41 fiberglass batt ceiling insulation
Walls	Solid-filled masonry block R-14, 2" polyisocyanurate exterior insulation
Windows	Low-e, argon-filled, U-factor 0.32, SHGC 0.35 Minimal glazing on south and west
Heating/Cooling	Tankless water heater to boost water temperature from solar for space heating (see below) 18 SEER A/C unit with variable speed blower, Puron refrigerant Efficient ceiling fans
Lighting	Fluorescent lamps and fluorescent fixtures
Photovoltaics	4.2-kW photovoltaic array, roof-mounted Two 2.5-kW inverters
Solar Domestic Water and Space Heating	Four, 4' by 8' solar water collectors, unpressurized, drainback system 210-gallon hot water tank with heat exchanger supplies hydronic space heating Short hot water plumbing runs in conditioned space Polyethylene (PEX) 3/8" diameter tubing for hot water pipes

## Project Information

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Produced for the  
U.S. Department of Energy  
by the National Renewable  
Energy Laboratory,  
a DOE national laboratory

DOE/GO-102003-1829  
December 2003



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