

High-Performance Home Technologies: Solar Thermal & Photovoltaic Systems

Case Study: John Wesley Miller Companies Armory Park del Sol – Tucson, AZ



A Neighborhood Beyond the Norm

A vibrant neighborhood within walking distance of a bustling urban center? A community garden, spacious sidewalks for bikers and pedestrians, and two public parks nestled between the houses? How about stylish homes with universal accessibility and cutting-edge energy efficiency? It may sound too good to be true, but not if you live near Tucson, Arizona. Here, within walking distance of the downtown commercial and business district is the Armory Park Del Sol community, offering homeowners a place to live without the hassle, headaches, and expense of suburban life. State-of-the-art energy saving technology is standard in all the homes, including photovoltaic (PV) electric power-generating systems and solar hot water heaters.

“We were told it couldn’t be done,” chuckles John Wesley Miller, owner of John Wesley Miller Companies (JWM), which built the development, “But it’s done well. We’ve always been involved in pushing the envelope of energy-efficient building.” Miller sought help from the National Association of Home Builders (NAHB) Research Center, a Building America partner, to select features and construction techniques that ensure every house in the community exceeds the Model Energy Code by 50 percent or more. Standard homes in Armory

Park del Sol are expected to use only 7 kWh per square foot per year.

The community also contains one of the first net-zero energy homes. This house produces nearly all the energy it uses on an annual basis. It uses only 4 kWh per square foot annually and the solar hot water system provides almost all of the homeowner’s hot water and home heating needs. Total energy costs in 2005 for the ZEH were about \$15 per month—including all heating, cooling, lighting, and appliance use.

Solar Energy First

“In 1973, I became enthralled and passionate about solar energy; I love it,” says Miller simply. His passion has evolved into a homebuilding creed that puts solar energy first.

For example, each of the 99 lots within the Armory Park del Sol was carefully configured to take full advantage of the sun. The desert-style house plans were chosen not only to be pleasing to potential buyers, but also because the flat roofs and parapet walls common to southwestern architecture are ideal for keeping PV and solar hot water panels

The southwestern architecture cleverly hides the rooftop PV and solar heater units from passersby. Armory Park del Sol is a neighborhood with wide streets, two parks and a community garden – all within walking distance of downtown Tucson.

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BUILDER PROFILE

Builder’s Name:

John Wesley Miller Companies

Where: Tucson, AZ

Founded: 1956

Development:

Armory Park Del Sol, Tucson, AZ

Square footage: 977 to 2,026 sq. ft.
(2-3 bedrooms and baths)

Price: \$373,000 - \$932,000



All homes come standard with a 1.5-kW photovoltaic system and solar hot water collector. (left) Photo courtesy of NAHBRC. (right) Photo courtesy of JWM.



KEY FEATURES

1.5-kW PV system with
25-year guarantee

Copperheart solar hot water collector
with 10-year guarantee

Seisco tankless water heater

R-38 ceiling insulation

Milgard dual-pane, low-E2 windows
with lifetime guarantee

14 SEER high-efficiency heat pump

Masonry wall superstructure

Copper water lines

Universal accessibility design
with 3-foot-wide doors on single-
level floor plans

hidden. All homes were installed with wind-resistant, 1.5-kW PV systems with programmable thermostats, backed by a 25-year guarantee. The Homeowners Association (HOA) restricts the placement and maximum height of trees to avoid adverse shading conditions that could interfere with the efficiency of the PV modules.

In addition, each house is outfitted with a roof-mounted Copperheart solar hot water collector, which combines thermal collection (i.e., water heated by the sun) and storage in a single unit. It is backed up by a Seisco tankless water heater to ensure hot water on demand. Parallel piping was installed to improve hot water delivery time as well. This hot water distribution system features small polyethylene (PEX) plastic pipes that branch off of the main pipe to each hot water use point, speeding up delivery time and reducing energy losses.

Insulation from the Elements

The interior comforts of a home can be difficult to shield from the extreme outdoor conditions found in Arizona. But JWM incorporates several best practices that protect against the temperature swings found in desert climates.

Masonry Construction

An Armory Park del Sol home has a masonry wall superstructure consisting of steel-framed walls, concrete, and exterior insulation, including a 3-coat stucco finish. This masonry construction, notes Miller, provides excellent thermal mass storage and insulation to protect the indoor environment from outdoor conditions. A side benefit for homebuyers is its sound-deadening properties.

In addition, the plumbing and electrical lines run inside the walls and ducts are in conditioned space—two factors that help reduce air leakage heating or cooling losses for a very tight house (2.9 ACH50).

HVAC System

JWM Companies works with a professional engineer to review house plans to assess the placement of ductwork and the proper sizing of HVAC equipment. At Armory Park del Sol, the ducts are sealed with mastic, tested for air leakage, and enclosed in soffits below the insulation along the central core of the house. Transfer grilles across doorways and a central return equalize air pressure throughout the house. The careful attention to the HVAC

system and its placement further contribute to the tightness of the construction.

Windows

Inferior windows can contribute to air leakage or heat transfer, which is why low-emissivity dual-pane windows were chosen for Armory Park del Sol homes. The spectrally selective coatings on these windows protect occupants from the heat and glare of the daytime sun, while the low U-value of 0.31 prevents indoor heat loss during the night.

Working Together

Over the years, John Wesley Miller Companies has formed several beneficial relationships that enhance its business practices. Long-standing relationships have been formed with local subcontractors and periodic meetings are held with staff and trades to review building practices and discuss issues. This ensures that all parties are on the same page when working with new techniques or materials.

The company has also formed a strong bond with Tucson Electric Power (TEP), the local utility. TEP aggressively promotes renewable energy power systems by offering rebates and other incentives. During the building of Armory Park del Sol, TEP performed periodic quality inspections during and after the construction process, confirming that Armory Park del Sol homes will be easy on the utility grid. TEP also agreed to a billing cap, so that heating and cooling bills are guaranteed not to exceed \$1 per day for 5 years (depending on the size of the house). The utility also offered rebates

for solar systems of \$2.40 - \$3.00 per installed watt, for a total rebate of \$3,600 - \$4,500 per house.

John Wesley Miller is a big believer in working with like-minded builders and others to achieve energy efficiency in homes. In addition to working with Building America, he is also involved with other national and local building organizations. “I’m currently working with a green building subcommittee on county building codes,” he says. “This is a volunteer program to create incentives for builders to do good things instead of penalizing them. Too long we’ve been fighting each other. It’s time to sit down at the table and work together to accomplish these common goals.”

The Bottom Line

Although energy-efficient building standards such as high-quality masonry, PV, and solar hot water systems ultimately save money for the homeowner, the up-front costs can sometimes cause buyers to turn away. This is often due to a misunderstanding or a miscommunication about the benefits and savings associated with the systems and techniques. Miller believes that education is the key to promoting sales of energy-efficient homes.

Notes Miller, “About 80% of our buyers looked us up on the web first. We probably have more Ph.D.s living in our little development than any other part of town. This doesn’t mean you have to be a genius to appreciate the homes we build, but it shows that education and a willingness to learn about energy efficiency can drive sales.”



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 (photo from NAHBRC).

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Copperheart Integrated Collector Storage water heaters are included on each JWM house. Photo courtesy of the Solar Store.

For more information visit:
www.buildingamerica.gov