



Mandalay Homes

Foothills at the Dells
Prescott, AZ



BUILDER PROFILE

Mandalay Homes

Prescott, Arizona; MandalayHomes.com
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FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: Foothills at the Dells
- Location: Prescott, AZ
- Layout: 2 bdrm, 2 bath, 1 fl, 1,648 ft²
- Climate: IECC 4B, mixed-dry
- Completed: May 2019
- Category: production

Modeled Performance Data:

- HERS Index: without PV 55; with PV 37
- Projected Annual Energy Costs: without PV \$1,170; with PV \$500
- Projected Annual Energy Cost Savings: (vs typical new homes) without PV \$550; with PV \$1,250
- Projected Annual Energy Savings: without PV 4,100 kWh; with PV 10,400 kWh
- Added Construction Cost: without PV \$2,500; with PV \$5,800
- Savings in the First 30 Years: \$52,900

Mandalay Homes of Prescott, Arizona, has certified more homes to the exacting requirements of the U.S. Department of Energy's Zero Energy Ready Home program than any other builder in the country. The production builder had certified 826 homes as of September 1, 2019, including this one, a compact one-story 1,648-ft² home that has earned Mandalay its eighth DOE Housing Innovation Award. The builder has plans to construct 3,300 homes over the next 10 years, all to the specifications of the DOE Zero Energy Ready Home program.

Mandalay has been a partner with the DOE program since its inception in 2013 and has made a commitment to build all of its homes to the program requirements. "We are absolutely 100% committed. It is the best label to communicate quality and cost effectiveness in the market today," said Geoff Ferrell, who is the chief technology officer for Mandalay Homes.

Mandalay builds about 225 homes per year throughout Arizona, mostly for current homeowners looking to move up, although about 20% of its homes are entry level, 10% are luxury, and 10% are affordable.

"The DOE ZERH program represents the way to build homes for us. Anyone not moving towards this program is behind the curve, and reacting to code changes is very costly. DOE's Zero Energy Ready Home program is a great program to incrementally stay ahead of code and make common sense upgrades to differentiate us in the marketplace," said Ferrell.

The DOE Zero Energy Ready Home program gives builders a game plan to build homes that are more energy efficient, comfortable, and durable than current code requires, and a third-party verification process to help convey confidence to the homeowner that the home will deliver what it promises. That plan starts with certification to the program checklists for ENERGY STAR Certified Homes



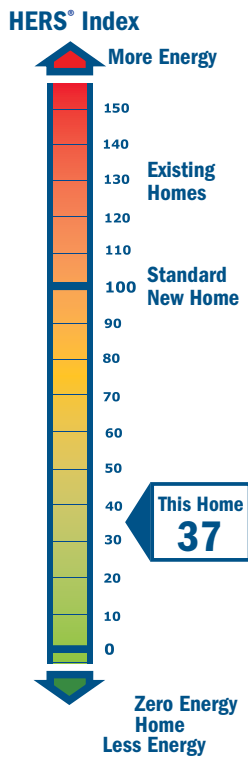
The U.S. Department of Energy invites home builders across the country to meet the extraordinary levels of excellence and quality specified in DOE's Zero Energy Ready Home program. Every DOE Zero Energy Ready Home starts with ENERGY STAR Certified Homes Version 3.0/3.1/3.2 for an energy-efficient home built on a solid foundation of building science research. Advanced technologies are designed in to give you superior construction, durability, and comfort; healthy indoor air; high-performance HVAC, lighting, and appliances; and solar-ready components for low or no utility bills in a quality home that will last for generations to come.

Mandalay Homes of Prescott, Arizona, built this 1,648-ft² one-story home in Prescott, Arizona, to the high performance requirements of the U.S. Department of Energy's Zero Energy Ready Home program. The home is packed with high-performance features to provide its home owners with a comfortable, healthy living environment and high efficiency. LED disc lights and bulbs, ENERGY STAR appliances, and EPA WaterSense labeled plumbing and irrigation add to energy and water savings. The home's double-pane windows and sliders are shielded by two low-e coatings and deep overhangs to minimize unwanted solar heat gain.



What makes a home a DOE ZERO ENERGY READY HOME?

- 1 **BASELINE**
ENERGY STAR Certified Homes Version 3.0/3.1
- 2 **ENVELOPE**
meets or exceeds 2012 IECC levels
- 3 **DUCT SYSTEM**
located within the home's thermal boundary
- 4 **WATER EFFICIENCY**
meets or exceeds the EPA WaterSense Section 3.3 specs
- 5 **LIGHTING AND APPLIANCES**
ENERGY STAR qualified
- 6 **INDOOR AIR QUALITY**
meets or exceeds the EPA Indoor airPLUS Verification Checklist
- 7 **RENEWABLE READY**
meets EPA Renewable Energy-Ready Home.



Version 3.0, 3.1, or 3.2 and the U.S. Environmental Protection Agency's Indoor airPLUS. Homes must also meet the hot water distribution requirements of the EPA's WaterSense program, the insulation requirements of the International Energy Conservation Code, and other mandatory requirements of the DOE program. In addition, homes are required to have solar electric panels installed or have the conduit and electrical panel space in place for it.

Mandalay now installs solar panels on the roofs of all of its homes. This home has 1.89 kW of photovoltaics, which is only six panels. Although this seems like a meager amount, Mandalay also included a 10-kW battery storage system on the home. The local utility uses a time-of-use rate structure and offers incentives for residential solar power produced during the early evening peak demand period. Ferrell noted that the 10-kW battery size is large enough to get most of Mandalay's homeowners through the daily peak period that the utility incentivizes. Mandalay has found that, for most of its homeowners, the battery covers about 8 hours of the homes' power needs each day and some homeowners are able to run on their own stored power all night until the sun comes up the next day and the battery starts re-charging.

This home has a Home Energy Rating System (HERS) score of 55 without PV; when the 1.86 kW of PV is included, the energy modeling software brings the HERS score down to a 37. However, according to Ferrell if the software were able to accurately account for the home's use of its own stored power during peak rate periods, the HERS score would look more like a 10 or 12.

Mandalay maximizes the power production from the PV panels it installs on each home by placing them at the ideal orientation toward the sun. Ferrell noted that Mandalay designs each home with roof sections facing in at least three directions, so it can get ideal solar production from every home regardless of the home's lot orientation within the community. To provide the builder with uninterrupted space for panel placement, Mandalay has taken pains to eliminate all pipes and stacks through its unvented roofs by moving exhaust fan vents to gable walls or soffits and employing Studor vents for plumbing stacks. Ferrell noted a clean roof deck is less prone to leakage down the road, has better thermal properties, is easier to install, and is more appealing aesthetically. The unvented attics are insulated on the underside of the roof deck with 7.5 inches of closed-cell spray foam. The vaulted ceilings provide a sense of spaciousness in this compact one-story home.

The exterior walls consist of 2x6 studs spaced 24 inches on center. "A key feature of our quality construction practices is our advanced framing program, which



Rigid foam wraps the exterior of the home under the stucco siding while open-cell spray foam fills the 2x6 wall cavities and covers the underside of the roof deck providing R-19 wall insulation and R-25 of attic insulation, as well as air sealing. Additional air sealing is provided via an aerosol spray sealant process that tightened the home to 0.7 air changes per hour at 50 Pascals. Mandalay routes all vents through gable ends, leaving a clean roof that is less prone to leaks and provides plenty of space for the 1.8 kW of solar panels.

reduces lumber use and waste by up to 13%. The material reduction helps deliver an even higher efficiency home that is more environmentally friendly at an extremely competitive price point,” said Ferrell. Advanced framing details include insulated three-stud corners, ladder blocking, and recessed insulated headers over windows. The wall cavities are filled with R-17 of open-cell spray foam in the cavities then wrapped with taped house wrap and covered with a continuous 1-inch-thick layer of rigid EPS foam for an R-19 total wall insulation value. The walls are covered with stucco cladding.

Mandalay uses a post-tensioned-slab foundation with an interesting slab-to-wall detail. The 2x6 wall bottom plates are placed on the perimeter of the slab so that they extend beyond it by 2 inches including sheathing. The entire perimeter of the slab edge (to a depth of about 18 inches) is then covered with 1.5 inches of a dense 3-pound closed-cell spray foam, which adheres to both the slab edge and the bottom edge of the overhanging bottom plate forming an air- and water-tight seal over the plate-to-slab seam. This dense spray foam hardens to a durable surface that requires no additional covering other than a layer of UV paint.

While the spray foam insulation in the attic and walls helps to air seal the building envelope, Mandalay takes the additional step of using a whole-house aerosol sealant process to ensure even the smallest cracks are closed off, resulting in a near Passive House airtightness level in this home of 0.70 air changes per hour at 50 Pascals. The aerosol process involves setting up sprayers in several rooms of the house which spray out tiny beads of nontoxic acrylic sealant that are carried through the air to any leaks in the building envelope while the house is pressurized with a blower door fan. The sealant particles accumulate along the edges of any cracks until they eventually fill in and seal off the areas of air leakage. As an example, Ferrell noted in a two-hour application the process cut leakage in one new home from 1,100 cfm to 134 cfm.

After participating in testing of the process, in 2017 Mandalay Homes opted to become a dealer so it could install the product in its own homes, and in fact Mandalay became the country's first dealer of the system.

To maintain air quality in the tight home, Mandalay installed an energy recovery ventilator which operates continuously 24 hours per day. The ERV is controlled by the smart thermostat, giving homeowners the ability to activate the high fan setting if needed. In addition to a central return grille, each bedroom has its own return grille and every return grille is equipped with a MERV 13 filter. The ERV also has two MERV 6 filters. Ferrell noted that even when operated continuously, the efficient unit uses less than \$3 per month. In addition, all of the bathrooms have exhaust fans that

HOME CERTIFICATIONS

DOE Zero Energy Ready Home Program - 100% Commitment

ENERGY STAR Certified Homes Version 3.0

EPA Indoor airPLUS

“The home is everything the buyer wants or needs and more.” *Geoff Ferrell, Mandalay Homes*



Every DOE Zero Energy Ready Home combines a building science baseline specified by ENERGY STAR Certified Homes with advanced technologies and practices from DOE's Building America research program.



An efficient heat pump water heater provides hot water for the all-electric home while the 10-kW battery storage system covers late afternoon energy demands.

have seen marked improvements in efficiency and trade communications, which has greatly reduced ordering, scheduling, and installation errors,” said Ferrell. “We also conduct multiple in-home quality assurance inspections as well as third-party inspections at pre-slab, pre-drywall, and upon final completion,” said the builder, who follows DOE Quality Management guidelines.

The production builder has also taken the unusual step of bringing more tasks in-house. Mandalay recently brought its framing crews on as staff rather than subcontractors. Mandalay also installs its own solar arrays and slab foam insulation as well as its own aerosol sealant, as mentioned earlier. “By bringing them in house we now have the ability to control our environment much better from a quality, scheduling, labor, and material sourcing standpoint,” said Ferrell. “We have found that our employees have a great deal of pride in Mandalay, and that pride shows up in the work they perform. We are decreasing cycle times, decreasing punch pick up work, and increasing the cost effectiveness of tasks performed.”

Ferrell said Mandalay has sought to put together the optimal combination of PV panels, battery storage, and energy-efficiency features in its iON Series homes. “Together we have worked to drive the cost so low that the system literally pays the homeowner cash back every month starting from day one,” said Ferrell, who noted the system may add \$20 per month over the cost of a home built to code but it can pay the homeowner back as much as \$80 per month in energy savings.

Photos courtesy of Mandalay Homes

are controlled by timer-based wall switches and also have humidity sensors that will automatically turn on the fan if high humidity is detected.

For heating and cooling, the home is equipped with a two-stage, 17 SEER/9.6 HSPF heat pump with a fully variable ECM motor and smart home connected user controls.

To ensure quality construction, Mandalay utilizes a web-based construction management software that allows the builder to plan and manage projects more quickly and efficiently with trade partners. “Since introducing this system, we

KEY FEATURES

- **Walls:** 2x6 24" o.c. advanced framing, R-19 total: open-cell spray foam in stud bays, 1" EPS foam, taped house wrap; stucco.
- **Roof:** Shed roof, architectural shingles or tiles; no penetrations or vents.
- **Attic:** Unvented vaulted ceilings, 7.5" R-25 spray foam.
- **Foundation:** Post-tensioned slab on grade, poured concrete; 1.5" 3-lb closed-cell spray foam on slab edge.
- **Windows:** Double-pane, argon-filled, low-e2, vinyl sliding frames, U=0.28, SHGC=0.22.
- **Air Sealing:** 0.7 ACH 50, AeroBarrier sealing system.
- **Ventilation:** ERV, continuous ventilation, MERV 13 filters; bath fans with humidity sensors and timers; MERV 6 filters on ERV.
- **HVAC:** Central air-source heat pump variable ECM controlled motor, 9.6 HSPF, 17 SEER.
- **Hot Water:** Heat pump water heater, 3.42 EF, 50-gal.; PEX piping, smart recirculation pump.
- **Lighting:** 100% LED, motion sensors.
- **Appliances:** ENERGY STAR dishwasher, exhaust fans, ERV, lighting, and water heater.
- **Solar:** 1.89-kW PV system, 10-kW battery.
- **Water Conservation:** WaterSense-labeled fixtures and toilets, smart irrigation, passive collection and distribution of rainwater.
- **Energy Management System:** Smart climate controls, integrated ventilation controls. Energy control software/hardware uses PV not grid power during evening peak.
- **Other:** All low-to-no-VOC products, recycled content materials.