

**DOE ZERO ENERGY READY
HOME™ CASE STUDY****Palo Duro
Homes, Inc.**

Albuquerque, NM

**BUILDER PROFILE****Palo Duro Homes, Inc.**

Albuquerque, NM

Tom Wade, President

505-750-7256

www.palodurohomes.com**FEATURED HOME/DEVELOPMENT:****Project Data:**

- Name: Morrison Home
- Location: Aztec, NM
- Layout: 3 bedrooms, 2 bathrooms, 1 story
- Conditioned Space: 2,064 ft²
- Completion: September 2012
- Climate Zone: 2B
- Category: Production

Performance Data:

- HERS Index without solar PV: 49
- HERS Index with solar PV: NA
- Projected annual utility costs: without solar \$1,899
- Projected annual energy cost savings (compared to a home built to the 2006 IECC): without solar \$945

Palo Duro Homes, Inc., certified its first home to the U.S. Department of Energy (DOE) Zero Energy Ready Home program criteria in late 2012, and as of September 2013, the New Mexico production home builder has already certified 65 DOE Zero Energy Ready Homes, far more than any other builder in the program.

Father and son team Jerry and Tom Wade have a history of high-performance home building. They began working with DOE's Building America program on research projects to improve production home building nearly a decade ago. As a partner in DOE's Builders Challenge, they certified 235 homes to Builders Challenge criteria, operating under the name Artistic Homes. Although their name has changed, their dedication to energy efficiency remains as strong as ever.

With construction of their first DOE Zero Energy Ready Home, the company has committed to DOE Zero Energy Ready Home certification, ENERGY STAR for Homes Version 3, and EPA Indoor airPLUS certification on every home it builds.

The company's first DOE Zero Energy Ready Home, in Aztec, New Mexico, was also certified to the LEED for Homes Gold standard. One of the remarkable things about Palo Duro's homes is how ordinary they look. Palo Duro is building an exceptionally high-performance product and making it affordable for the average home buyer. With prices in the range of \$250,000 to \$350,000, these incredibly efficient homes are within the reach of the working class.

The efficiency starts with an ordinary wood-framed wall done very well, with 2x6 rather than 2x4 framing and studs spaced 24 inches rather than 16 inches apart, so the wall is sturdy but has a deeper cavity for insulation. Other advanced framing measures like open headers above windows and doors on non-load-bearing walls, 2-stud rather than 3-stud corners, and single top plates and bottom plates mean



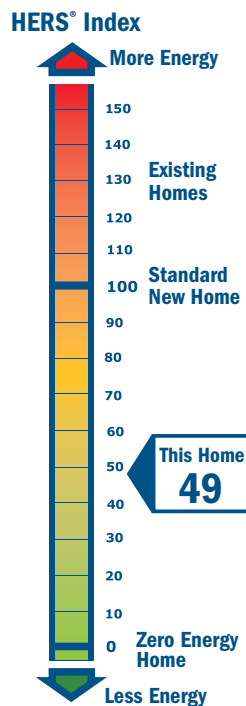
The U.S. Department of Energy invites home builders across the country to meet the extraordinary levels of excellence and quality specified in DOE's Zero Energy Ready Home program (formerly known as Challenge Home). Every DOE Zero Energy Ready Home starts with ENERGY STAR for Homes Version 3 for an energy-efficient 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.

Palo Duro uses advanced framing techniques like 2x6 24-inch on-center framing, open headers above windows on non-load-bearing walls, 2-stud corners, ladder blocking where walls intersect, and single top and bottom plates. These techniques reduce the amount of lumber in the wall, allowing more room for insulation and reducing costs and installation time.



ZERO ENERGY READY HOME CERTIFIED:

- 1 **BASELINE**
certified ENERGY STAR for Homes Version 3.0
- 2 **ENVELOPE**
meets or exceeds 2012 IECC levels
- 3 **DUCT SYSTEM**
located with 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.



there is less wood framing in the walls. This allows more space for insulation and causes less thermal bridging (which occurs when wood studs transfer heat through the wall). The wall cavity is filled with R-21 of blown-in formaldehyde-free fiberglass insulation. The walls' exterior is covered with OSB sheathing, two layers of building paper, and stucco cladding.

Advanced framing offers several advantages besides improving the thermal performance of the wall. Less framing is used resulting in lower lumber costs. Construction time can be greatly reduced too because there are less pieces of wood to cut, carry, and install. Research by Building America has shown combined savings of \$1,000 per home when multiple advanced framing techniques are employed.

Training the subcontractors to understand these techniques can take some persistence but the result is faster assembly time and a more effective wall. Tom Wade has gained a reputation for training. "We've had framers that Tom has worked with for years. He has trained them so they are so effective and efficient, they can get a house framed in a couple of days and take a whole house start to finish in three months," said Palo Duro's home energy rater, Justin Erickson, of E3 Energy, LLC.

"We hold a preconstruction meeting at each home to talk about framing so the construction team can meet with the truss manufacturing engineer to ensure that their 24 inch on-center trusses will fit exactly on our 24-inch on-center wall studs," said Tom Wade, co-owner of Palo Duro. "We have a quality management plan that is broken down into several scopes of work categories for different components of the house and we hold scopes of work and pre-construction team meetings routinely throughout construction."

Advanced framing is carried through to the roof trusses, which are also 24 inches on center and are aligned with the wall studs to carry the load through the single top plates. The trusses have raised heels to ensure insulation can cover the top plates. Rather than piling insulation on the floor of a vented attic, Palo Duro chose to air seal and insulate its attics along the underside of the roof line, with R-38 of open-cell spray foam. This "cathedralized" attic provides a semi-conditioned space for the home's HVAC equipment and ducts that is protected against New Mexico's harsh climate. The foam contains a fire-retardant so it does not need to be covered with drywall. To protect the roof, the builder uses peel-and-stick ice and water shield along all eaves and valleys. The roof is covered with 30-pound felt and asphalt shingles.



In addition to a range hood and bath exhaust fans, Palo Duro also installs a heat recovery ventilator in every home. The HRV brings in fresh air that is filtered through a HEPA quality filter before being distributed throughout the home by the HVAC ducts. As the fresh air enters the home it is passed through a heat exchanger where it is heated or cooled by outgoing air to reduce energy losses due to ventilation.

The foundation is slab on grade with R-10 rigid foam under the slab and R-5 perimeter insulation on the interior face of the footing, separating the slab edge from the footing wall.

The homes have only five windows. Palo Duro uses dual-pane, low-E, argon-filled windows that have an insulation U-factor of 0.34 and a solar heat gain coefficient (SHGC) of 0.32.

The home's heating and cooling is provided with a heat pump that has exceptionally high performance with a cooling efficiency of 21 SEER and a heating efficiency of 10 HSPF, well above the minimum federal standards of SEER 13 and 7.7 HSPF. The heat pump's air handler has an electrically commutated (ECM) fan motor, which is more efficient than a split capacitor motor because it allows the motor to run at variable speeds.

The air handler and ducts are all run through the sealed and insulated attic, with supply registers in the ceilings. The attic is accessible with pull-down stairs. Duct leakage to the outside is almost completely eliminated; duct testing showed leakage to the outside of 1 cfm at 25 Pascals. The air leakage for the whole house was tested with a blower door test and showed air leakage of 356 cfm at 50 Pascals pressure differential. The blower door test is one of several tests and inspections that must be conducted by a third-party energy rater for the home to meet DOE Zero Energy Ready Home criteria.

The water heater is a 95% efficient propane-fired, tankless, on-demand model. The water heater is centrally located in the attic, primarily to meet the EPA WaterSense criteria, which requires that all hot water lines be less than 50 feet in length from the water heater to the hot water fixtures (or that a water recirculation system be installed).

Palo Duro's first DOE Zero Energy Ready Home was certified without solar panels mounted on the roof. However, the home was solar energy-ready with wiring installed from the roof to the electrical panel. The home was situated and the roof was angled and pitched to maximize the potential for solar power production.

The home has low-flow shower heads and faucets. All of the lighting fixtures have compact fluorescents. The dishwasher is ENERGY STAR rated.

HOME CERTIFICATIONS:

DOE Zero Energy Ready Home

ENERGY STAR Version 3

EPA Indoor airPLUS

LEED – Gold

Palo Duro markets its homes to middle-class buyers who get extraordinary value at ordinary prices.



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

To ensure the indoor air quality of these air-tight homes, every Palo Duro Home has a heat recovery ventilator (HRV) or energy recovery ventilator (ERV) installed. The HRV is located in the attic near the air handler. It draws in fresh outside air that is ducted to the heat pump's air handler for distribution to the home through the HVAC ducts. Before the fresh air reaches the HVAC ducts, it passes through the HRV's heat exchanger where the incoming air is heated or cooled by outgoing stale air. The HRV is efficient enough to transfer up to 85% of the heat from the outgoing air to the incoming air. The fresh air also passes through a HEPA quality air filter with a MERV 16 rating capable of removing smoke, pollen, mold, and bacteria from the incoming air.

Palo Duro also installs radon mitigation equipment as a standard precaution on all of its homes. A home's potential for radon accumulation can't be measured until after the home is built, but radon mitigation systems are most easily and cost effectively installed while the home is under construction.

Indoor air quality is verified with the Indoor airPLUS Checklist, which homes must pass to receive Zero Energy Ready Home Certification. Palo Duro understands indoor air quality is an important part of where home construction is headed. "We really think that the next big issue for home owners of the future is not only "is my home energy efficient?" but "is my home healthy?" said Erickson.

Tom Wade credits the whole-house approach, which takes into account ventilation, moisture management, and other aspects of the home's systems to ensure a healthy home. "Our construction team integrates environmental and resource-efficient approaches into every aspect of the building process to minimize environmental impacts and to ensure the safest and healthiest living environment for our home owners."

Palo Duro's homes typically score below a HERS 50, without photovoltaics installed. The builder has constructed a few dozen homes that combine low energy use and solar power to be called true net zero energy homes, homes that produce as much energy as they consume in the course of the year.

"What Tom Wade is doing with Palo Duro Homes is leading the country in producing a working-class family home that is healthy, safe, durable, energy efficient, and ready for renewables," said Erickson.

"We have made every effort to create homes that are as energy efficient, low maintenance, and sustainable as possible," said Tom Wade. "We are intentional in the building process to ensure that the home owner can rely on two main qualities in their home: predictability and consistency. The high quality of construction and materials ensures predictable performance. And the energy efficiency and water savings will ensure consistently low utility bills for long-term cost savings along with low environmental impact." Wade's goal is to produce 200 to 300 of these homes per year.

KEY FEATURES

- **Path:** performance
- **Above-Grade Walls:** 2x6 studs 24-inch on-center, advanced framed, R-21 blown-in fiberglass; OSB; 2 layers of building paper; stucco
- **Roof:** sealed attic, insulated on underside of roof deck with R-38 open-cell spray foam with fire-retardant; OSB; ice-and-water shield; 30-lb felt; asphalt shingles
- **Foundation:** slab on grade, R-5 perimeter insulation, R-10 (4-ft) under-slab insulation
- **Below-Grade Walls:** NA
- **Windows:** dual-pane, low-E, argon-filled, U=0.34, SHGC=0.32
- **Air Sealing:** whole-house tested at 356 cfm 50 Pascals
- **Ventilation:** balanced HRV
- **HVAC:** 21 SEER, 10 HSPF air source heat pump with ECM fan
- **Ducts:** in sealed attic; R-6 insulated; duct leakage to outside 1 cfm 25 Pascals; total duct leakage 50 cfm 25 Pascals
- **Water Heating:** 95% EF propane tankless water heater
- **Lighting:** 100% CFL
- **Solar:** solar-ready wiring
- **Appliances:** propane range; ENERGY STAR dishwasher
- **Water Conservation:** meets WaterSense
- **Other:** Meets Indoor airPLUS

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

For more information on the
DOE Zero Energy Ready Home program
go to <http://energy.gov/eere/buildings/zero-energy-ready-home>

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www.BuildingAmerica.gov