

Moving toward Zero Energy Homes

Zero Energy Home Powers Up in North Texas



Peter Yost, Building Science Corporation/PX13574

It shouldn't be a surprise that energy would be a hit in Texas—but 8,000 people on the first weekend to tour a home that uses less than half that of a standard new home, and makes the rest itself? There is no magic in the technology and engineering, but clearly builder Jim Sargent and his systems thinking team have created something special at the Building America Zero Energy Home of Lone Star Ranch in Frisco, Texas.

At the first-of-its-kind Zero Energy Home in North Texas, energy-efficient technology and science are not thrown into and onto the home, but are integrated into every aspect of the home's design, walls, and equipment. Early in the design process, Sargent decided to make it a Building America project, and became a Building Science Consortium partner. A full-day design charrette in Westford, Massachusetts, became the first step in ensuring that this Zero Energy Home would be a systems-engineered expression of age-old and cutting-edge architecture and building science.

The Building America/Building Science Consortium approach to Zero Energy Homes is based on this premise: A home that consumes no more energy than its renewable energy systems can produce must excel in all aspects of home performance. The complete high-performance home must address:

- Energy efficiency
- Indoor environmental quality
- Durability
- Water efficiency
- Occupant comfort.

Let's take a look at how the Building America Zero Energy Home of North Texas stacks up on complete home performance.

Energy Efficiency — The key to any zero energy home is reducing the overall load as much as possible, keeping the renewable energy systems within the home's ability to support both their cost and their typical rooftop location. This means that all major systems in the house—the building enclosure, the mechanical systems (space heating/cooling/ventilation), domestic hot water, appliances, and lighting—must work together. As you look at the impressive list of energy features in this home (see sidebar on the right), keep these points in mind:

- The architectural design and details (sized overhangs and window shading, window locations and dimensions, and layout for temporal and space “zoning”) are accomplished with precision and beauty—the definition of high performance includes occupant convenience and comfort.

Key Features

Energy Efficiency

Building Enclosure

Roof — R-30 roof with vented, reflective metal roofing

Walls — R-14 high-mass Durisol® block

Windows — High-performance U = 0.38, SHGC = 0.29 with optimal shading, location, and placement

Floor — high-mass slab with 1-inch foam insulation

Heating/Cooling

Integrated solar water/0.84 EF tankless water heater

Multistaged chilled water powered by 3-zone, 14 SEER, 8.5 HSPF air source heat pump

Domestic hot water — structured plumbing with on-demand recirculation system

Ducts — mastic-sealed and inside conditioned space

Design — passive heating/cooling/natural ventilation

Lighting — 90% fluorescent package

Appliances — ENERGY STAR® clothes washer, dishwasher, refrigerator

Renewable Energy

Photovoltaics — Sharp 8-kW (peak) roof-mounted system with grid-tied inverter

Solar Hot Water — fully integrated, closed-loop, 2-panel rooftop system

- The design and performance of each system are synergetic with each of the others—no system competes to reduce overall energy load. A truly elegant example of this is the integration of the rooftop solar water system, the tankless water heater, and the modified heat pump. The key? A heat sink—the large, highly insulated hot water storage tank with two high-surface area heat exchangers.

The lower heat exchanger is connected to the rooftop solar system, the upper to the tankless water heater. Since the closed-loop solar water system can “communicate” with the space heating system through the tankless water heater coil, the hot water storage tank takes on or gives up heat as solar supply and domestic water/space heating needs demand. The water heater is a backup supply for space and domestic water heating. This system depends on a series of controls for efficient operation, but is much less complex than many systems with the same level of integration.

- The combined impact of all the features is a 45% reduction in overall annual energy consumption—181 MBtu for this home compared to 329 MBtu for a conventional home of the same basic dimensions and characteristics. With modest energy savvy, the homeowner’s remaining energy needs can be met by the renewable energy produced by the photovoltaic and solar hot water systems.¹

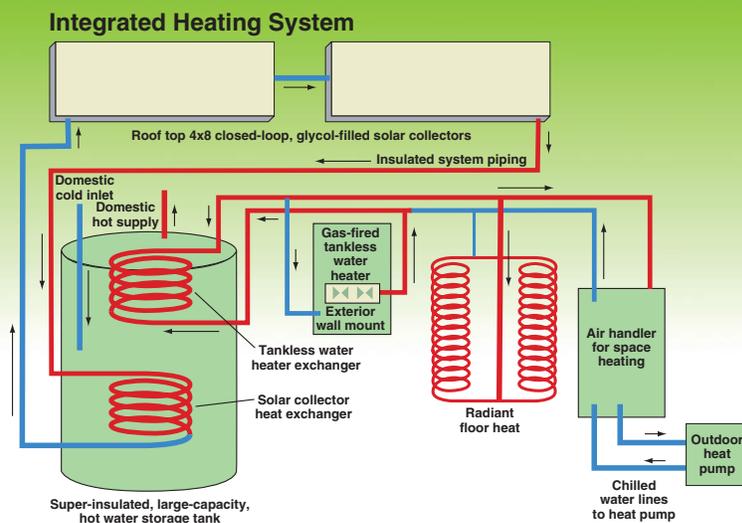
Indoor environmental quality — As the home becomes a more and more efficient environmental separator (keeping the outdoors out, and the indoors in), maintaining indoor environmental quality becomes a greater challenge. This Building America Zero Energy Home has a mechanical ventilation system integrated into the central heating, ventilation, and air-conditioning (HVAC) system, and no-combustion or sealed-combustion mechanical systems. The builder and architect selected materials for their low emissions and designed assemblies for their ability to manage moisture and mold.

Durability — A high-performance home is a lasting home, and maintains its performance over time. There is no simpler nor more effective way to reduce the environmental footprint of a building than by making it last longer. Durability is a three-legged stool that requires due diligence in design, specification, and workmanship. The architect, the builder, and the trades must achieve durability in concert. The

Building America Zero Energy Home of North Texas will long stand as a testament to durability, with its ventilated claddings,



Outside air intakes are neatly tucked under a second story eave.



Durability is all in the details—wrap-around overhangs, recessed windows, fibercement siding and trim, gutters, bath exhaust vents.



The wood fiber-cement block was selected for its ability to handle moisture in the building enclosure.

engineered wall assemblies, and painstaking attention to moisture control details.

Water Efficiency — Fresh water is as critical as energy in nearly every region of the country, even in Frisco, Texas, which receives nearly 40 inches of rain a year. This home has a comprehensive water conservation package:

- Delta® low-flow faucets and showerheads use 35% less water than conventional fixtures.

¹ Estimated energy performance is based on analysis relative to the Building America Benchmark House (www.buildingamerica.gov) that uses the EnergyGauge USA energy simulation tool. Assuming that electric energy uses not directly under builder control are also reduced by a proportional amount, it is possible for the home to achieve zero net energy. Actual annual energy use and associated utility bills will vary, depending on differences between the assumptions stated and actual occupant behavior.



From the inside—H-axis clothes washer—to the outside—rainwater cisterns—this home is a water miser.

- The Metlund® Hot Water D'Mand system recirculates cooled water in the hot water pipes back to the water heater.
- Toto® toilets require a single flush of 1.6 gallons or less.
- The Whirlpool® clothes washer uses up to 42% less energy and up to 59% less water than standard-efficiency clothes washers.
- The Whirlpool® dishwasher uses at least 25% less energy and 44% less water than conventional dishwashers.
- The WeatherTrak ET® irrigation controller reduces outdoor water use by up to 50%, yet maintains the health and vigor of turf and plants.

Occupant Comfort — A home that supplies its own energy needs over the course of a year would mean little if the occupants are dissatisfied or uncomfortable. As an Environments For Living® Platinum home, its thermal comfort is guaranteed throughout the entire space. And the meaning of thermal comfort is extended to cover hot water, as the structured plumbing/on-demand recirculation system provides hot water at every point of use “instantaneously” (and wastes no more than a cup of water in the process).

A Systems Approach to Building the Team? — The story of how the Building America North Texas Zero Energy Home team was built is too good not to tell.

- Custom builder Jim Sargent builds energy-efficient homes in North Texas for 30 years. He encourages his homeowners to keep track of their utility bills and let him know the results.
- Local Saturday radio home-show² host Chris Miles, a veteran home builder and remodeler, scoffs at a caller who said the June electric bill for his 2100-ft² home (built by Sargent) was just \$60.
- Sargent is invited to Miles’ radio show, Miles catches the systems-thinking bug, and the team is off and running.
- Sargent completes high-performance home building training (much of it sponsored by the U.S. Department of Energy’s [DOE] Building

² House Talk, AM660, KSKY.

America Program) and becomes the Energy and Environmental Building Association’s (EEBA) first Master Builder.

- Sargent and Miles “go for zero” after seeing a Zero Energy Home presentation by Lew Pratsch of DOE’s Building America Program at an EEBA conference.
- Jim Sargent sees architect Peter Pfeiffer’s homes (known for their elegant blend of technology and timeless architecture); Sargent and Miles agree that Pfeiffer must join the team.
- Sargent joins the Building Science Consortium and makes his Zero Energy Home a Building America project.
- Chris Miles and Jim Sargent build the North Texas Zero Energy Home, from start to finish, in a little more than three months.

The Final Analysis

But what does a “one-off,” nearly \$1 million Zero Energy Parade Home really mean, in the grand scheme of things? Project manager Chris Miles sees it this way:

“This home can help people make the right choices. They learn the cost and value of granite countertops and the master bath with whirlpool, as well as the high-efficiency appliances and solar water integrated heating. These are good things.”

For builder Jim Sargent, the proof is in the voting—his Building America North Texas Zero Energy Home was voted “Best House Overall.” “There are seven very beautiful homes here at the Parade, but the most popular one, the one everyone is asking so many detailed questions about, is this home. Performance pays,” says Sargent with a winning smile.

See the North Texas Zero Energy Home analysis on the Building Science Corporation Web site at www.buildingscience.com for more detailed information and discussion on the energy performance of this home.



Great unobstructed southern exposure for the photovoltaic and solar water panels, the “engines” of this Zero Energy Home.

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.

Research and Development of Buildings

Our nation's buildings consume more energy than any other sector of the U.S. economy, including transportation and industry. Fortunately, the opportunities to reduce building energy use—and the associated environmental impacts—are significant.

DOE's Building Technologies Program works to improve the energy efficiency of our nation's buildings through innovative new technologies and better building practices. The program focuses on two key areas:

• Emerging Technologies

Research and development of the next generation of energy-efficient components, materials, and equipment

• Technology Integration

Integration of new technologies with innovative building methods to optimize building performance and savings

For more information contact:
EERE Information Center
1-877-EERE-INF (1-877-337-3463)
www.eere.energy.gov



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

An electronic copy of this factsheet is available on the Building America Web site at www.buildingamerica.gov



Key Products/Partners

EEBA • www.eeba.org
Sharp • www.sharppusa.com/solar
James Hardie • www.jameshardie.com
KitchenAid • www.kitchenaid.com
Whirlpool • www.whirlpool.com
Durisol • www.durisol.com
Insulation for Life • insulationforlife.com
Environments for Living • www.eflhome.com
Icynene • www.icynene.com



For more information on this Zero Energy Home and its builder, contact Jim Sargent, Anderson Sargent Custom Builder LP, 3 Sargent Place, Waxahachie, TX 75165, PH: 972-617-3788 or visit the Web site: www.zeroenergyhomedallas.com.

Visit our Web sites at:

www.buildingamerica.gov

www.pathnet.org

www.energystar.gov



Building America Program

George S. James • New Construction • 202-586-9472 • fax: 202-586-8134 • e-mail: George.James@ee.doe.gov
Terry Logee • Existing Homes • 202-586-1689 • fax: 202-586-4617 • e-mail: terry.logee@ee.doe.gov
Lew Pratsch • Integrated Onsite Power • 202-586-1512 • fax: 202-586-8185 • e-mail: Lew.Pratsch@hq.doe.gov
Building America Program • Office of Building Technologies, EE-2J • U.S. Department of Energy • 1000 Independence Avenue, S.W. • Washington, D.C. 20585-0121 • www.buildingamerica.gov

Building Industry Research Alliance (BIRA)

Robert Hammon • ConSol • 7407 Tam O'Shanter Drive #200 • Stockton, CA 95210-3370 • 209-473-5000 • fax: 209-474-0817 • e-mail: Rob@consol.ws • www.bira.ws

Building Science Consortium (BSC)

Betsy Pettit • Building Science Consortium (BSC) • 70 Main Street • Westford, MA 01886 • 978-589-5100 • fax: 978-589-5103 • e-mail: Betsy@buildingscience.com • www.buildingscience.com

Consortium for Advanced Residential Buildings (CARB)

Steven Winter • Steven Winter Associates, Inc. • 50 Washington Street • Norwalk, CT 06854 • 203-857-0200 • fax: 203-852-0741 • e-mail: swinter@swinter.com • www.carb-swa.com

Davis Energy Group

David Springer • Davis Energy Group • 123 C Street • Davis, CA 95616 • 530-753-1100 • fax: 530-753-4125 • e-mail: springer@davisenergy.com • deg@davisenergy.com • www.davisenergy.com/index.html

IBACOS Consortium

Brad Oberg • IBACOS Consortium • 2214 Liberty Avenue • Pittsburgh, PA 15222 • 412-765-3664 • fax: 412-765-3738 • e-mail: boberg@ibacos.com • www.ibacos.com

Industrialized Housing Partnership (IHP)

Subrato Chandra • Florida Solar Energy Center • 1679 Clearlake Road • Cocoa, FL 32922 • 321-638-1412 • fax: 321-638-1439 • e-mail: subrato@fsec.ucf.edu • www.baihp.org

National Association of Home Builders (NAHB) Research Center

Tom Kenney • National Association of Home Builders (NAHB) Research Center • 400 Prince George's Boulevard • Upper Marlboro, MD 20774 • 301-430-6246 • fax: 301-430-6180 • toll-free: 800-638-8556 • www.nahbrc.org/

National Renewable Energy Laboratory

Ren Anderson • 1617 Cole Boulevard, MS-2722 • Golden, CO 80401 • 303-384-7433 • fax: 303-384-7540 • e-mail: ren_anderson@nrel.gov • www.nrel.gov

Tim Merrigan • 1617 Cole Boulevard, MS-2722 • Golden, CO 80401 • 303-384-7349 • fax: 303-384-7540 • e-mail: tim_merrigan@nrel.gov • www.nrel.gov

Oak Ridge National Laboratory

Pat M. Love • P.O. Box 2008 • One Bethel Valley Road • Oak Ridge, TN 37831 • 865-574-4346 • fax: 865-574-9331 • e-mail: lovepm@ornl.gov • www.ornl.gov

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

October 2004 • DOE/GO-102004-2017

Printed with a renewable-source ink on paper containing at least 50% wastepaper, including 20% postconsumer waste.

Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable