Durable Energy Builders

Houston, TX

BUILDER PROFILE

Durable Energy Builders LLC
Houston TX, Hugh Ker Thomson
info@durableenergybuilders.com
832-265-7353
www.durableenergybuilders.com
Rater: Infrared Solutions, Inc.
kmoore@infraredsolutions.us, 979-229-2647

FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: Drummond House
- Location: Houston TX
- Layout: 6 bedrooms, 5+3 half baths, 3 floors
- Conditioned Space: 5,947 ft^2
- Completion: 2010
- Climate Zone: IECC 2A, Hot-Humid
- Category: Custom

Modeled Performance Data:

- HERS Index without PV: 39, with PV: 29
- Projected Annual Utility Costs: without PV $2,300, with PV $1,700
- Projected Annual Energy Cost Savings (compared to a home built to the 2009 IECC): without PV $4,200, with PV $4,800
- Annual PV Production Revenue: $410
- Annual Energy Savings: without PV 1,924 kWh; 44 therms, with PV 1,541 kWh; 44 therms

When Hugh "Ker" Thomson and his wife bought a lot in the Houston suburbs they never dreamed their future home would become the subject of a Texas A&M University Energy Systems Laboratory research project, a PhD thesis, the topic of more than 20 AM radio shows, two local TV news stories, three USGBC open house events, a solar home tour, a city-wide home tour, a green building tour, a front-page article in the *Houston Chronicle*, and a feature article in the *Journal of Green Building*; and the impetus for a new career for Thomson as head of his own construction company.

All the Thomsons knew was that they wanted a home that would keep their family safe, healthy, and dry, with power and water, regardless of whatever storms might come their way in hurricane-prone Houston.

Ker Thomson's research into home building practices led to construction of a home that met the U.S. Department of Energy (DOE)'s strict Zero Energy Ready Home performance requirements, which include ENERGY STAR Version 3.0 and EPA Indoor airPLUS certification, 2012 International Energy Conservation Code insulation levels, and solar or solar-ready features. The home was also the first home in Houston to achieve LEED for Homes platinum level and the Institute for Business and Home Safety's Fortified for Safer Living certification.

When Thomson began looking into home building, he realized that the traditional "sticks and bricks" construction methods used in Texas at the time were not going to get him the long-term durability he was looking for. As he noted, in Houston's Gulf Coast climate, the humidity rarely gets below 75%, temperatures hover in the 90s most of the summer, rain comes in downpours totaling nearly 50 inches a year, and hurricanes wreak havoc every 15 to 25 years. In such a climate, said Thomson, code-minimum homes built of OSB and wood with vented attics and standard windows and doors are sitting ducks for termites, roaches, ants, and rodents

ZERO ENERGY READY HOME U.S. DEPARTMENT OF ENERGY

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 Certified Homes Version 3.0 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.

Durable Energy Builders built this three-story custom home in Houston, Texas, from ICFs to withstand the Gulf Coast climate's heat, humidity, termites, and occasional hurricanes. The 11.5-inch-thick steel-reinforced, insulated concrete walls provide quiet, dry, and exceptionally comfortable interiors in a long-lasting building envelope that can withstand the elements. High-efficiency triple-pane zone 1 hurricane-rated windows were installed. "They can take an 8-ft 2x4 flying at 40 mph. They are practically impossible to break," said Thomson.

WHAT MAKES A HOME DOE ZERO ENERGY READY HOME-CERTIFIED?

1 **BASELINE**
ENERGY STAR Certified Homes Version 3.0

2 **ENVELOPE**
meets or exceeds 2012 IECC levels

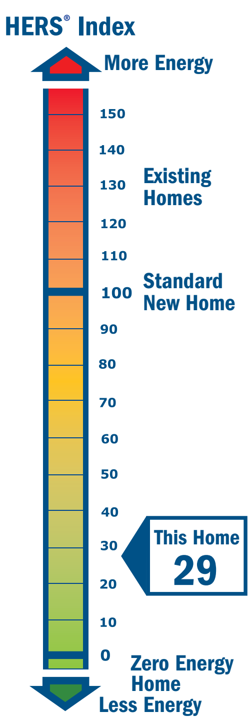
3 **DUCT SYSTEM**
located within the home's thermal boundary

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.



in the attic and walls; water damage, mold, mildew, dry and wet wood rot; and rapid deterioration of HVAC, electrical, and hot water systems that are typically installed in the vented attics where they are subject to 140°F temperatures in the summer, below-freezing temperatures in the winter, high humidity, varmits, and wind-driven rain during tropical storms. "It had become clear to me that traditional home building is done for maximum profit on the day of sale, and I was looking to build for the long haul," said Thomson.

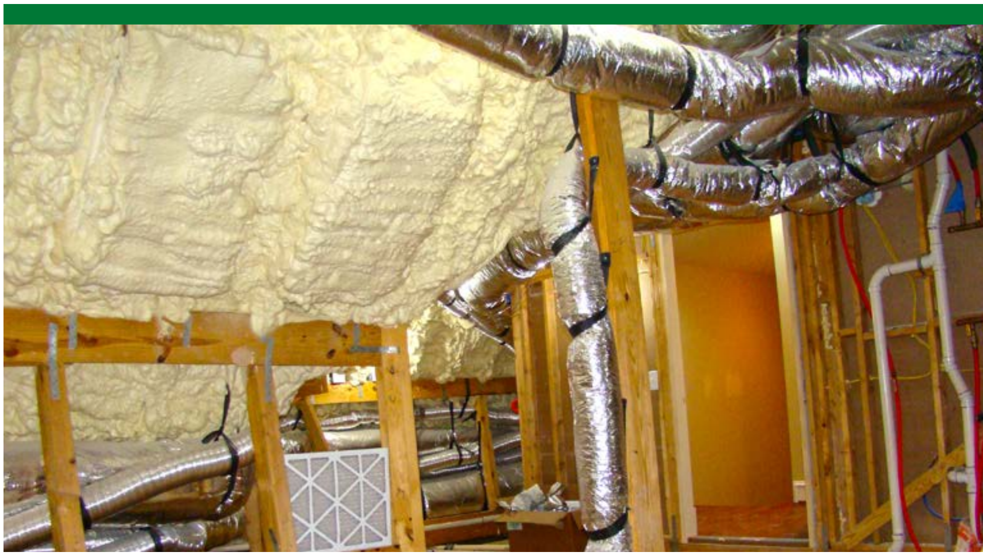
Thomson's desire for something better led eventually to the Texas A&M University's Energy Systems Lab, which agreed to work with Thomson to design, build, and collect data on the home. Together they researched all of the sub-systems of the house (walls, windows, attic, roof, HVAC, electrical, etc.) and considered over 300 different products and technologies, with the goal of developing an energy- and resource-efficient, long lasting, cost-effective, whole-house approach Thomson calls the "Durable Energy Building (DEB)" system. Their methodical study of wall types led Thomson to choose insulated concrete forms (ICFs) for the wall system. While he found a designer (Rice Residential Designs) and an engineering firm (the Interfield Group) who were comfortable with his approach, he could not find an interested builder in Houston, so Thomson formed his own company, Durable Energy Builders, LLC, to do the general contracting. At the suggestion of Rice, he found a partner, Jim Kuchenbrod, an experienced builder who had used ICFs in Colorado.

Because the site had shifting clay soils, the structural engineers called for a foundation built on sixty-three 15-ft-deep belled concrete piers. The perimeter was excavated for a 4-ft foundation wall. The rebar-reinforced concrete foundation walls and a grid of reinforced concrete support walls sat on these piers. Cardboard "void" boxes were set in place between the concrete grid supports and a 5-inch-thick floor slab was poured. Thomson explained that the cardboard void boxes will eventually disintegrate leaving a 10-inch insulating air pocket between the foundation and the ground.

The walls were constructed of 11.5-inch-thick ICF blocks consisting of two 2.5-inch layers of extruded polystyrene rigid foam sandwiching a 6.5-inch-thick layer of concrete. The walls were wrapped in a multilayer radiant vapor barrier, then an air gap was installed over this consisting of 1x1.5-inch vertical battens screwed into the ICFs at 6-inch intervals. Over this was installed the cladding, which included stucco, stone, or brick. Inside, 5/8-inch fire-rated drywall was attached

"I would rather put money into the mortgage up front (which is fixed and tax deductible) then spend it on water, power, and insurance (which are variable and not tax deductible).

— Ker Thomson, owner
Durable Energy Builders, LLC



Unlike Houston's typical vented attics, which can reach temperatures of 140°F in summer and dip below freezing in winter, this unvented attic stays clean, dry, and comfortable thanks to a thick layer of open-cell spray foam, which coats the underside of the ceiling deck to provide a highly insulated, sealed attic space for HVAC equipment and usable storage. "A sealed attic keeps out rodents and insects. It's easier to maintain the HVAC system in the easily accessed, semiconditioned attic, which also provides 1,400 ft^2 of storage space," said home owner and builder Thomson.

directly to the ICFs. The ICF walls and foundation provide significant thermal mass with an "effective R value" of R-35 to R-60 said Thomson.

The home has a sealed attic that was insulated along the underside of the roof deck with open-cell foam, which was sprayed to cover all of the wood elements of the roof assembly to a thickness of 5 to 7 inches with excellent insulation and air-sealing properties. The spray foam brand was chosen because it met the fire code requirements (flame spread index of <20 and smoke development of <400) and did not need an ignition barrier in the attic. The attic had an "effective R value" of R-40 to R-50.

All of the roof framing was nailed, screwed, and hurricane strapped, then anchored to the ICF wall system. An ice and water shield was applied over the entire roof deck of 5/8-inch plywood. A multi-layer radiant barrier/vapor barrier was installed over this then 2×2 treated battens were screwed into the roof deck and rafters. The battens were installed in horizontal rows with staggered 4 to 6 inch gaps to allow any heat accumulating under the roof panels to flow up the slope of the roof and out the top cap. The roofing product was an asphalt coated horizontal metal roofing system with a 150-mph wind rating.

The ICF construction provided an airtight home. Blower door testing showed an air leakage rate of 0.59 air changes per hour at 50 pascals (ACH 50). To provide fresh air, two energy recovery ventilators (ERVs) were installed. The ERVs have separate ducts to bring in outside air through a filter and exhaust stale air outside. These two air paths cross in a heat exchanger that transfers heat and humidity from the warmer path to the cooler path. The ERVs were integrated with the home's two HVAC air handlers, so they supplied fresh air to the return side of each air handler. The ERVs provide fresh air to exchange all the air in the home three times a day. "The dust is minimal and the air quality is pristine" said Thomson.

The home is equipped with two 19 SEER heat pumps. A traditionally built 6,000-ft^2 home would have 3 to 5 HVAC systems providing 12 to 14 tons of air conditioning. Manual J calculations called for this house to have two zones with two 4-ton compressors and two air handlers. Although the heat pumps will provide heat, the house is so well insulated the Thomsons were in the home for their third winter before the heat actually came on!

HOME CERTIFICATIONS

DOE Zero Energy Ready Home Program

EPA Indoor airPLUS

Institute for Business and Home Safety Fortified Home

ENERGY STAR Certified Homes Version 3.0

LEED for Homes, platinum

"The public is being sold a house of straw by the wolf and no one is looking at how these homes are really made. You can build a high-performance home for the same cost over the long term as a cheap stick-built house. We've got to educate the public. They need to hear that the high-performance home is going to last longer, and it's going to be healthier. It's going to make you money, it's going to save you money."

— Ker Thomson, owner
Durable Energy Builders, LLC

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.

Metal architectural features were purchased prefabricated and brought to the site for quick installation and a cost savings over carved solid wood features.

For domestic hot water, the Thomsons installed solar water heating panels and an 80-gallon holding tank plus a hybrid small tank condensing water heat for backup.

The 18-panel, 3.2-kW, solar PV array meets most of the home's electricity needs and wiring is in place to add more as it becomes cost effective. Thomson had considered adding enough panels and batteries to go completely off grid, but that would have tripled the cost of the system. Instead, he installed a natural gas generator integrated with the PV panel via a "smart panel" so that household utilities automatically switch to the generator during power outages.

Thomson noted that Houston's city water, though safe, has a high mineral content and an unwelcome taste and smell. Concerns about water supply and water quality led to another unique aspect of the home, the rainwater collection system for both irrigation and potable water. The system combines several technologies. The gutters were lined with perforated plastic tubes that keep out leaves and debris, while collecting rain from 75% of the roof and directing it to a sealed, underground 11,500-gallon cistern. From there, water is pumped directly to the yard for irrigation or through a filtration unit for potable water in the home. The indoor filtration system, which filters city water or harvested rainwater, uses ultrafine membranes to remove particles larger than 0.02 microns combined with a carbon filter and UV sterlizer to deliver "bottled water-quality" drinking water while extending the life of household appliances and plumbing. During drought periods, an integrated back-up system adds city water to maintain the cistern's water level at at least 25% capacity. Although the unit cost $30,000, the Thomsons felt the cost was worth it in terms of water security and water quality.

Thomson noted that the increase in cost over code construction was about 15% on a home this size. But that 15% increase yields a 40% reduction in cost to insure; a 72% reduction in utility bills; a roof and siding that will last a lifetime; and fewer worries about pests, mold, and rot. The annual operating costs are reduced by more than the increase in annual mortgage costs. Mortgage interest is tax deductible while home repair costs are not. On top of this, said Thomson, are the incalculable benefits—increased comfort, safety, security, usable storage space, survivability in the event of storms, air quality, and health. "My son's asthma symptoms have all but disappeared. He went from daily inhaler use to only seasonal use and respiratory infections have dropped by 80%."

Photos courtesy of Durable Energy Builders LLC.

KEY FEATURES

- **DOE Zero Energy Ready Home Path:** Performance
- **Walls:** 11.5-inch ICFs (two 2.5-inch layers XPS, 6.5-inch concrete); multilayer radiant vapor barrier; 1x1.5-inch battens; stucco, stone, and brick cladding
- **Roof/Attic:** 5-7 inches (R-22-25) open-cell foam sprayed on underside of rafters.
- **Foundation:** Raised slab
- **Windows:** Triple-pane, argon-filled, metal-clad wood-framed, low-emissivity windows with U=0.29 and SHGC=0.23
- **Air Sealing:** 0.59 ACH 50, 1,580 cfm 50
- **Ventilation:** ERV
- **HVAC:** 19 SEER heat pumps, ducts in insulated attic
- **Hot Water:** Solar water heating with instantaneous gas back up
- **Lighting:** 100% LED
- **Appliances:** ENERGY STAR dishwasher, clothes washer, refrigerator
- **Solar:** 3.5-kW PV, solar water heating system, solar DC connection on heat pump
- **Water Conservation:** Low-flow fixtures; central manifold with main uses close to water heater; rainwater harvesting to 11,500-gallon cistern for irrigation and filtered for potable water
- **eMonitor Management System:** Auto control of lighting and other electronics
- **Other:** 14.5-kW gas-powered backup generator; hurricane strapping; impact-resistant glass
- **Other Features:** Wheat chaff interior doors; no-VOC paints and finishes; central vacuum; metal not wood framed arches; formaldehyde-free cabinets

Many of the efficiencies and essential elements of our approach can be had for significantly less (as little as 2-4% added cost over to-code construction), depending on what choices the client makes. Safe, efficient, cost effective, green—if you can live in this, why would you choose anything else?"

— Ker Thomson, owner
Durable Energy Builders, LLC

PNNL-SA-106855, November 2014, Rev. May 2015