U.S. DEPARTMENT OF **ENERGY** | Energy Efficiency & Renewable Energy

DOE ZERO ENERGY READY HOME™

U.S. DOE ZERO ENERGY READY HOME 2019 WINNER *Housing Innovation Awards*

Imery Group

Monroe Farmhouse
Monroe, GA

BUILDER PROFILE

Imery Group
Athens, Georgia; ImeryGroup.com
Luis Imery, 770-294-1014
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FEATURED HOME/DEVELOPMENT:

Project Data:

- Name: Monroe Farmhouse
- Location: Monroe, GA
- Layout: 3 bdrm, 3 bath, 1.5 fls, 1,863 ft^2
- Climate: IECC 3A, mixed-humid
- Completed: October 2018
- Category: custom for buyer

Modeled Performance Data:

- HERS Index: without PV 46; with PV -13
- Projected Annual Energy Costs: without PV $1,250; with PV $100
- Projected Annual Energy Cost Savings: (vs typical new homes) without PV $1,050; with PV $2,150
- Projected Annual Energy Savings: without PV 8,200 kWh; with PV 19,500 kWh
- Added Construction Cost: without PV 25%; with PV 35%
- Savings in the First 30 Years: $91,600

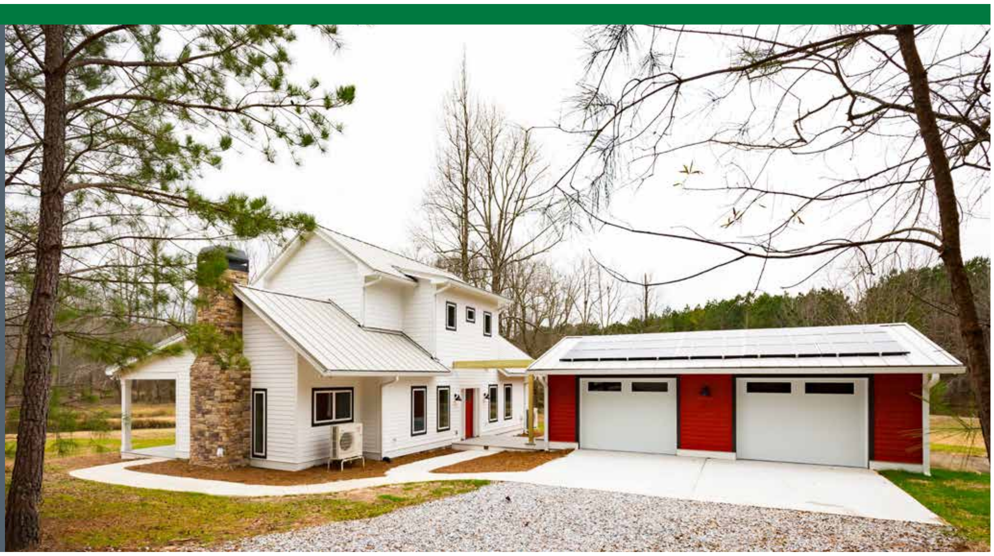
When Mark Kuntz, Chief Operating Officer of Mitsubishi Electric Trane HVAC U.S., got ready to build on an 11-acre property he owned in Monroe, Georgia, he knew he wanted a zero energy home; he just needed the right builder to make his dream a reality. Kuntz found that builder in Luis Imery, the owner of Imery Group and winner of multiple Housing Innovation Awards from the U.S. Department of Energy.

Imery, a custom home builder who has a development, design, and energy rating business in Athens, Georgia, has been a partner with DOE's Zero Energy Ready Home program since the program began in 2013 and has built seven homes certified through the program.

The DOE Zero Energy Ready Home program provides builders with a game plan for building zero energy homes that are more energy efficient, comfortable, and durable than current code requires, along with 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 Version 3.0, 3.1, or 3.2 and the U.S. Environmental Protection Agency's Indoor airPLUS program. 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 them.

Kuntz definitely wanted the solar panels installed. Kuntz hoped to generate and store enough power to be self-sufficient. He had learned about bi-direction inverters on a trip to Japan and hoped to install them on his own house to store solar-generated power in an electric vehicle and pump it back to the house when needed.

Imery Group of Athens, Georgia, built this 1,863-ft², 3-bedroom, 3-bath modern farm house near Monroe, Georgia, to the high performance criteria of the U.S. Department of Energy's Zero Energy Ready Home program. The durable, energy-efficient home is packed with high-performance features and an 8.2-kW array of solar panels on the detached garage roof will provide enough power to meet all the power needs of the house and an electric vehicle.



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

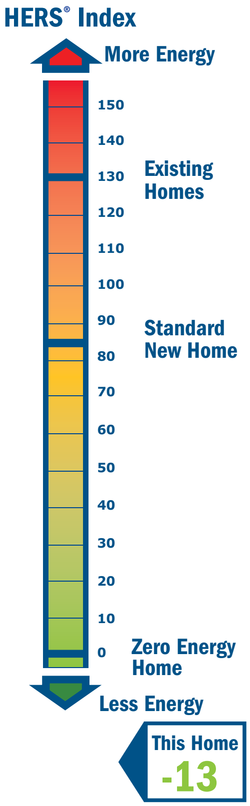
3 **DUCT SYSTEM** located within the home's thermal boundary

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.



The lot provided some challenges for solar potential. The wooded 11-acre parcel already had a 3.5-acre pond, a barn, a shed, an existing occupied home that was staying, and limited locations suitable for a drain field. Kuntz originally hoped to convert the shed into a home, but after site visits he and Imery decided the shed would not work due to its orientation, existing trees, and structural limitations. They thought however, that the barn could be repurposed as a detached two-car garage with solar panels installed on the roof and the new zero energy home could be built next to it.

To achieve the goal of a home that performed at net zero or better, Imery sought to first design a highly insulated building envelope that would be resilient to the location's ever present precipitation and humidity. The next step was to add high performance HVAC, then to determine how much solar would still be needed to get to zero. "We relied heavily on our experience with Zero Energy Ready Homes, Passive House design, and energy modeling software, as well as the HVAC expertise of Mitsubishi's construction team," said Imery. Imery designed a modern farm house-style home that was 1,863 ft², with one and a half floors, 3 bedrooms, 3 baths, and no basement. The home design achieved a projected Home Energy Rating System (HERS) index score of 46 without PV, or minus 13 when the PV was added, far below the HERS 80 to 100 of typical homes built just to code and even well below the HERS 0 of a home that makes just as much power as it uses over the course of a year.

"The moment we had established a good schematic design of the home and a baseline energy model, we then proceeded to estimate the construction cost of the home," said Imery. "Our process goes through a reality check at this point to minimize the risk of designing something that the owner can't afford. We completed the estimate and came in within the target budget, which then allowed us to complete the architectural design and value engineer the home."

One result of this value engineering process was that Imery decided to change his wall design from a 2x6 24-inch on-center wall with R-6 exterior rigid foam sheathing to R-3 exterior sheathing installed over 2x4 studs staggered on 2x6 plates, where the studs are spaced 12 inches apart, with studs staggered to touch the interior edge and the exterior edge every 24 inches. This wall gave them the same performance as the 2x6 stud wall according to the energy models, and allowed the R-21 of blown cellulose to wrap around the inside edges of each stud, preventing thermal bridging across the wall. Thermal bridging was further stopped by the R-3 layer of rigid foam adhered to the coated OSB exterior sheathing product. The sheathing was taped at the seams to seal out air and water, then was topped with a stiff corrugated plastic rain screen product before installing the fiber cement siding.

The home sits on a raised slab foundation to protect it from potential flooding from the nearby pond. A coated OSB sheathing with an adhered inside R-3 layer of rigid foam is taped at the seams to keep out air and moisture. The sheathing will be topped with a corrugated plastic rain screen product before installing the fiber cement siding.

The builder incorporated several advanced framing features into the framed walls, including insulated three-stud California corners, insulated headers over windows, and no solid headers on non-load-bearing walls, ladder blocking at interior/exterior wall intersections, and reduced lumber around windows and doors. Air sealing techniques included using canned spray foam and caulk to seal top and bottom plates, rough openings around windows and doors, and interior wall penetrations around mechanical, electrical, and plumbing, etc. Open-cell spray foam was installed in hard-to-reach places and critical areas such as band and rim joists. On the exterior, any penetrations through the envelope were sealed with either stretch tape or traditional tape. Third-party blower door testing is a required part of the DOE Zero Energy Ready Home certification. Testing of this house showed air leakage of 2.69 air changes per hour at 50 Pascals.

Energy modeling and past experience with Passive House strategies also influenced attic design, helping Imery to determine that a vented attic with blown cellulose was a better option than an unvented attic with spray foam on the underside of the roof decking. Imery designed vaulted ceilings with scissor trusses chosen to accommodate R-50 of blown cellulose. The roof decking consisted of a coated OSB sheathing product that was taped at the seams and flashed, then topped with 1x4-inch furring strips and 26-gauge standing-seam metal roofing.

Because the home site was less than 100 feet from the lake, Imery chose a raised slab foundation to minimize flooding risks. A footing was poured then a 3-foot stem wall was constructed out of 8-inch concrete masonry unit (CMU) blocks that were filled solid with concrete. The interior of this CMU perimeter was filled with dirt that was compacted, then topped with 4 inches of #57 stone, which was leveled. This was topped with 1 inch of R-10 rigid foam. Then 6-mil polyethylene vapor barrier sheeting was laid and the seams were taped, then the 4-inch concrete floor slab was poured.

“Controlling water in all of its forms is paramount for the durability of the home and the quality of the air inside the home,” said Imery. “The end result was fantastic—a home that kept water intrusion out, with a good sweater (exterior continuous insulation), and properly ventilated walls and attic.”

For windows, the owner requested triple-pane windows. Energy modeling actually showed more benefit from insulating the edges of the foundation slab then from upgrading from double-pane to triple-pane windows. The owner found a bargain on triple-pane windows and they ended up installing both the triple-panes and the slab-edge insulation. The triple-pane, argon-filled, vinyl-framed, mostly casement

HOME CERTIFICATIONS

- DOE Zero Energy Ready Home Program
- ENERGY STAR Certified Homes Version 3.1
- EPA Indoor airPLUS
- DOE Zero Energy Ready Home Quality Management Guidelines
- EarthCraft House

“Despite extremely energy-efficient design, there was no compromise on aesthetics and only a reasonable cost premium.” *Homeowner*

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.

A prototype split-system heat pump water heater was tested in the home that pulls heat from outside rather than inside in winter. ENERGY STAR appliances and LED lighting add to energy savings, while low- and no-VOC paints and finishes contribute to cleaner indoor air.

style windows had an insulating value of U-0.19, a low solar heat gain coefficient (SHGC) of 0.23, and two low-e coatings, which limit heat transfer. Most of the windows face south, allowing the home to benefit from passive solar heat gain in the winter. To minimize unwanted solar heat gain from the high summer sun in this hot-humid climate, all of the south-facing windows were protected by either a covered porch or deep overhangs.

The builder used energy modeling and worked with an HVAC consultant and Mitsubishi's construction team to help design the HVAC system, which consisted of three ductless mini-split heat pumps (one in each bedroom) and one ducted mini-split (to supply the common areas), with a heating efficiency of 10 HSPF and a cooling efficiency of 20 SEER. The ducts for the ducted heat pump were all short, rigid metal ducts located in conditioned space. The three ductless units are hooked to one outdoor condenser, while the ducted mini-split is connected to a second outdoor condenser. That second compressor is shared with a prototype split heat pump water heater being tested by Mitsubishi. This split system uses the HVAC's outdoor condenser to capture heat from the outdoors during the winter so it isn't robbing the home of space heat to heat the water as other heat pump water heaters typically would. In the summer, it will use the heat pulled from inside the home by the HVAC system, rather than that heat being discharged outside, so in that sense it's contributing to cooling the home as well.

For ventilation the builder installed an energy recovery ventilator (ERV) with a relative humidity sensor on the intake port to limit outside air intake on very humid days. Imery also installed a separate in-wall dehumidifier to better manage latent loads given the expected low cooling load in the home. Bathroom exhaust fans were equipped with condensation sensors. All of the components are monitored by wireless devices and settings can be adjusted remotely.

Regarding the solar panels, Imery's team originally determined that a 5.1-kW system would meet the net zero goal, but the client had access to discounted solar panels and upgraded to an 8.1-kW system. Thirty panels were installed and wired to a bi-directional inverter to then feed the house on true net metering. The bi-direction inverter will allow the homeowner to store solar-generated power in an electric vehicle and pump it back to the house when needed, or to a solar battery bank.

"We were ultimately able to determine the most cost-effective combination of assemblies," said Imery. With the PV panels and the high-performance building envelope and mechanicals, Kuntz should pay less than $10 a month in power bills. The home is estimated to save $2,150 per year in energy costs compared to a home built to code.

KEY FEATURES

- **Walls:** 2x4 24 in. o.c., staggered on 2x6 plates; advanced framing; R-24 total: ½″ drywall, R-21 cellulose; R-3 taped coated OSB sheathing, ⅜″ rigid rainscreen, fiber cement cladding.
- **Roof:** Gable roof; ½″ drywall, taped coated OSB sheathing, flashing, 1x4 furring strips, standing seam metal roof, ENERGY STAR Cool Roof certified.
- **Attic:** Vented attic, 15.5″ R-50 blown cellulose, 6″ R-21 open-cell spray foam on rim bands and knee walls, 8″ to 10″ raised energy heels.
- **Foundation:** Raised slab 8″ concrete-filled CMU stem wall, compacted dirt base, 4″ #57 stone, 1" R-10 rigid foam under slab and on perimeter, poly taped at seams, 4″ concrete slab.
- **Windows:** Triple-pane, argon-filled, low-e2, vinyl casement frames, U=0.19, SHGC=0.23.
- **Air Sealing:** 2.69 ACH 50.
- **Ventilation:** ERV with humidity sensor, MERV 8 filters, condensation sensors on bath fans.
- **HVAC:** 3 ductless mini-split heat pumps to 1 outside compressor, 1 ducted mini-split to 2nd compressor shared with a split-system water heater, 10 HSPF, 20 SEER; dehumidifier.
- **Hot Water:** Prototype split-system 80 gal. heat pump water heater shares HVAC outdoor condenser, est. EF 3.5; compact plumbing with PEX piping.
- **Lighting:** 90% LED, 10% CFL, motion sensors and timers.
- **Appliances:** ENERGY STAR refrigerator, dishwasher, ceiling fans, and bath fans.
- **Solar:** 8.2-kW PV system; inverter can disconnect from grid, battery storage.
- **Water Conservation:** WaterSense-labeled fixtures, drought-resistant landscaping.
- **Energy Management System:** Internet connected appliances, HVAC, PV tracking.
- **Other:** Wider doors, zero thresholds in bathroom, low-to-no-VOC products.

Photos courtesy of Imery Group

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