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Designed and Built in Collaboration with:

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Building Science Corporation

Engineer of Record

EBL Engineers, LLC

Contractor

Therrien Waddell

Subcontractor

Bethesda Bungalows



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Net-Zero Energy Residential Test Facility



Purpose

The Net Zero Energy Residential Test Facility, located at the National Institute of Standards and Technology (NIST) in Gaithersburg, MD, enables the development and demonstration of measurement science needed to achieve net-zero energy residential homes that are safe, comfortable, and desirable. The facility was initially used to demonstrate that a home, typical in size/features of those in an upscale community in the metropolitan D.C. area, can produce as much energy from renewable sources as it consumes on an annual basis. The facility is subsequently being used to generate "real world" field data to validate and improve building performance models and to improve laboratory based measurements of systems and components to better represent field performance.



Unique Capabilities

The facility was designed to ensure that it would meet current and future measurement science needs to enable the nation to achieve its sustainability and comfort goals. The inherent capabilities of this facility include:

- Evaluation of design strategies, technologies, and ventilation strategies to provide quality indoor environments consistent with energy efficiency goals
- Development of the measurement science to characterize "as-installed" performance of various space-conditioning, water heating, integrated systems, and appliances, as well as the building's thermal envelope
- Development of the measurement science required to capture the efficiency of various techniques for distributing conditioned air throughout a residential structure
- Improvement and validation of models used to predict the energy consumption and indoor air quality of buildings
- Studies of earth-coupled heat pump systems using various ground-coupling techniques
- Evaluation of methodologies and standards to interface with the Smart Grid, and test procedures for assessing Smart Grid-enabled appliances
- Evaluation of the relative merits of various building control systems and strategies
- Assessment of interactions between the building envelope, HVAC systems, and solar systems
- Evaluation of models that predict annual energy production of solar energy systems and aid modelers in how to best use these models



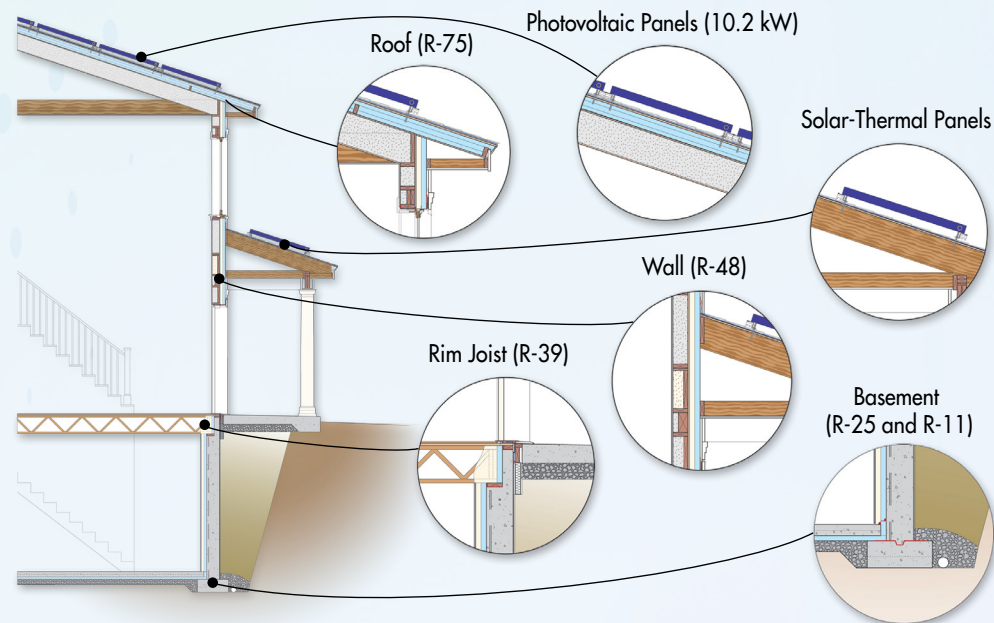
Unique Features of NIST's Net-Zero Energy Residential Test Facility

Building Envelope/Materials

- Advanced framing and insulation techniques
- Fenestration units easily replaceable
- All ductwork within conditioned space
- Building components selected to minimize heat loss/gain
 - Basement slab – R-11¹
 - Exterior below grade walls – R-25
 - Exterior above grade walls – R-48
 - Roof – R-75

Photovoltaic System

- Scalable array allowing researchers to select four power outputs between 2.6 kW and 10.2 kW²
- Tandem direct to alternating current inverters allow side-by-side test option
- Array layout, instrumentation package, and time lapse photos aid understanding of string level performance



¹ The R-values (ft² · °F · h/Btu) associated with the various building envelope assemblies are approximate

² The photovoltaic power output is the projected output at standard reporting conditions

Water Heating and Distribution Systems

- Closed loop solar thermal water heating system and multiple collector array size and storage tank capacity configurations
- Capable of providing hot water and/or solar assist to earth-coupled heat pump systems
- Heat pump water heater used to supply water heating requirements not provided by solar system
- Highly instrumented water distribution system

Smart Grid

- Incorporates smart grid meter/network capabilities for smart appliances/equipment

Air Distribution Systems

- Multiple zoning capabilities (floor vs high wall supplies, perimeter vs central)
- Conventional duct system
- Small duct, high velocity air distribution system
- Dedicated ductwork for dehumidification and heat recovery systems

Space Conditioning Systems

- Air-to-air central and multi-split heat pump systems
- Earth coupled heat pump system with three distinct earth coupled fields
 - Three vertical well loops (1, 2, or 3 active)
 - Horizontal and slinky loops, each configurable to 3 different total lengths

Simulated Occupancy

- User specifies detailed occupancy and activity schedule of virtual family
- Schedule implemented by facility's monitoring/control systems
- Occupants' heat and moisture generation emulated

Monitoring/Control Systems

- Lights, appliances, and water use fixtures are operated to simulate the use patterns of a typical family.
- Every electrical circuit within the facility is instrumented to enable measurement of point of use energy consumption.
- Instrumentation/control equipment power is isolated from the facility both electrically and thermally.

