

Engineering Laboratory (EL)

Dr. S. Shyam Sunder, Director
100 Bureau Drive, Stop 8600
Gaithersburg, MD 20899-8600

Office of Facilities & Property Management

Stella S. Fiotes, AIA
Chief Facilities Management Officer
100 Bureau Drive, Stop 1900
Gaithersburg, MD 20899-1900

Architect of Record

Building Science Corporation

Engineer of Record

EBL Engineers, LLC

Contractor

Therrin Waddell

Subcontractor

Bethesda Bungalows

Technical Director

Dr. A. Hunter Fanney
100 Bureau Drive, Stop 8630
Gaithersburg, MD 20899-8630
Phone: 301 975 5864
E-mail: hunter.fanney@nist.gov

EL Web Site: www.nist.gov/el

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, will enable the development and demonstration of measurement science needed to achieve net-zero energy residential homes. The facility will initially be used to demonstrate that a residence, typical in size/features of homes in the metropolitan D.C. area, can produce as much energy from renewable energy resources as it consumes on an annual basis. It will subsequently be used to provide “real world” field data to validate and improve energy models and to improve laboratory based measurements of systems and components to better represent field performance. This facility, designed to achieve LEED Platinum certification, represents the joint efforts of NIST’s Engineering Laboratory, Building Science Corporation, the Department of Energy’s Building America Program, and NIST’s Office of Facilities and Property Management.

Unique Capabilities

The facility was designed to ensure that it would meet current and future measurement science needs to move the nation towards net zero energy homes. The inherent capabilities of this facility will enable:

- Improvement and validation of models used to predict annual energy production of solar systems
- 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 of distributing conditioned air throughout a residential structure
- Improvement and validation of models used to predict the energy consumption of buildings
- Studies of earth-coupled heat pump systems using various ground-coupling techniques
- Evaluation of various methodologies and standards to interface a residence to the Smart Grid
- Field evaluation of test procedures for standard and Smart Grid enabled appliances
- Evaluation of the relative merits of various building control systems and strategies
- Evaluation of design strategies, technologies, and ventilation strategies to provide quality indoor environments consistent with energy efficiency goals
- Assessment of interactions between the building envelope, HVAC systems, and solar systems



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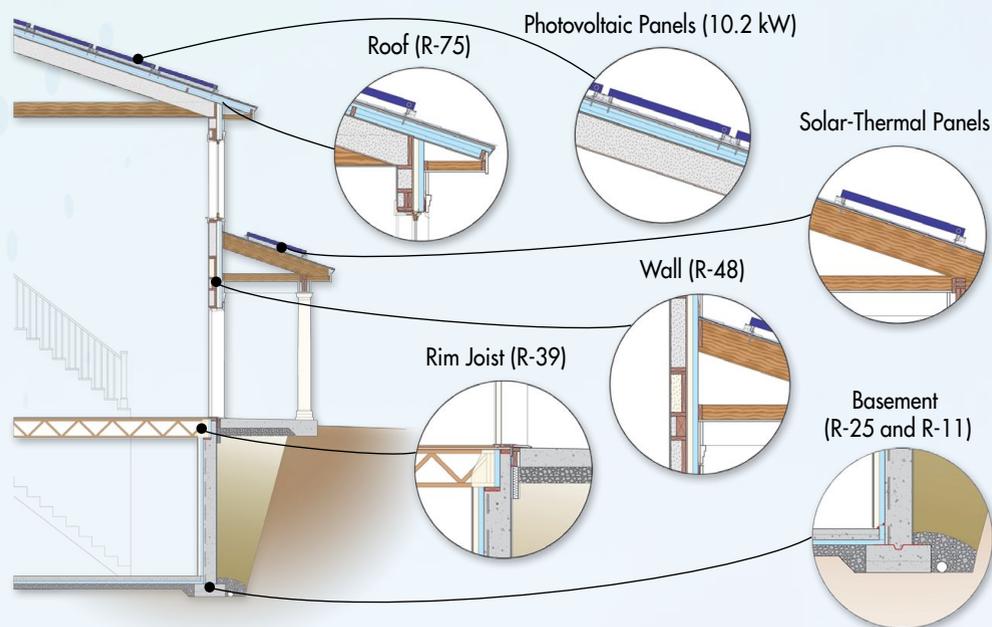
Unique Features of NIST's Net-Zero Energy Residential Test Facility

Building Envelope/Materials

- Advanced framing and insulation techniques utilized
- Fenestration units easily replaced
- All ductwork within conditioned space
- Extreme attention to building envelop details
- 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

- Reconfigurable array allowing researchers to select a power output between – 2.6 to 10.2 kW²
- Reconfigurable direct to alternating current inverters
- Rack mount system that facilitates testing of various photovoltaic technologies



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

Solar Thermal/Heat Pump Water Heating System

- Variable collector array size and storage tank capacity
- Closed loop system
- Capable of providing hot water and/or solar assist to earth coupled heat pump systems
- Heat pump water heater utilized to supply water heating requirements not provided by solar system

Smart Grid

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

Air Distribution Systems

- Multiple zoning capabilities (floor, register, perimeter vs central)
- Conventional duct system
- Small duct, high velocity air distribution system
- Dedicated ductwork for humidification/dehumidification/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)
 - Variable length horizontal and slinky loops

Safety

- Incorporates fire sprinkler system
- Incorporates fire/smoke detectors interfaced to NIST's emergency services division

Monitoring/Control Systems

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

