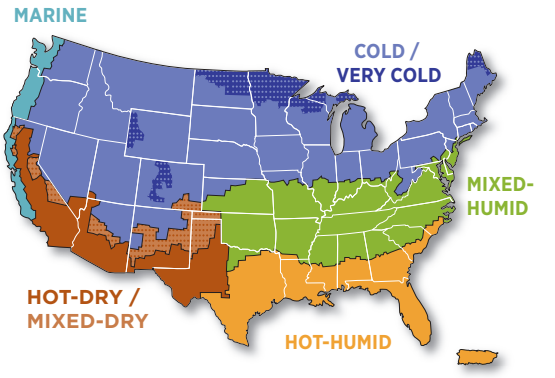
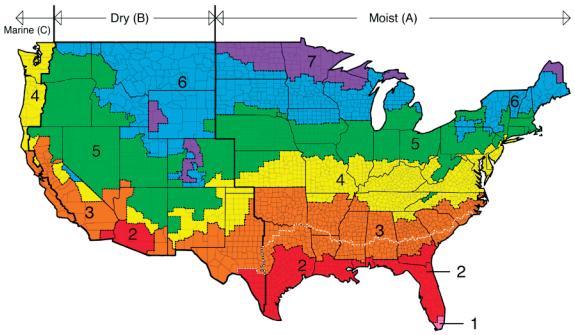
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

# Building America's Optimized Solutions for New Homes

# Cold Climate




IECC Climate Zones

= 1 = 2 = 3 = 4 = 5 = 6 = 7

## Climate Zone Maps

Map of Building America climate regions (top) for program reporting and IECC climate zones (bottom) as a reference for compliance information

The U.S. Department of Energy's (DOE's) Building America program has been a source of innovations in residential building energy performance, durability, and affordability for nearly 20 years. This world-class research program partners with many of the top U.S. home builders, contractors, and manufacturers to bring cutting-edge construction and design solutions and resources to market.

The most recent goal of the Building America program is to demonstrate how cost-effective strategies can reduce home energy use by more than 30%[1] in new homes, in all climate regions, by 2015. As part of the strategy to prove that this level of performance is achievable in the market, DOE created a labeling program called the DOE Zero Energy Ready Home (ZERH) program.

Working together, Building America and ZERH programs have created a series of optimized solutions to demonstrate how builders have achieved, and often exceeded, these high savings goals. These optimized solutions provide guidance to all builders to cost effectively meet the 30% energy savings goal in their climate zones.

Building America's five major climate regions include cold/very-cold, mixed-humid, hot-humid, hot-dry/mixed-dry, and marine. These climate regions are outlined in the figure at left, along with a map of the International Energy Conservation Code (IECC) climate regions for comparison[2]. This document outlines the Building America recommendations for achieving 30% savings in the cold climate region (approximately IECC zones 5-8).

Due to the tradeoff decisions that are made when building a home, there are hundreds of ways to meet the 30% performance goal. The performance levels listed in the cold climate table below, show just one way to cost effectively meet this goal. The far right column provides options for common building practices that could also be used to meet the performance goal.

Building America SM U.S. Department of Energy

Photo (top left): Leif Juell, Alternative Power Enterprises, Inc.

## DOE's Building America Solution Center

Decades of research in energy efficient design have led to the Building America Solution Center. Builders and contractors are encouraged to use this resource to improve the durability and performance of energy efficiency options listed in Table 1.

The Building America Solution Center provides access to expert information on hundreds of high-performance construction topics, including air sealing and insulation, HVAC components, windows, indoor air quality, and much more.

Users can navigate the Solution Center in one of four ways:

- Building components
- Labeling program checklists
- Alphabetically
- By publications

Registered users can also save customized content in their own field-kits!

Find what you are looking for on the Building America Solution Center website: ***basc.energy.gov***

## Table 1. Building America Optimized Solution: 30% Savings for the Cold Climate

| Measure | Performance | Options |
|---|---|---|
| **THERMAL ENCLOSURE** | | |
| **High-R Ceiling** | R-49 | • Unvented Attics<br>- Spray Foam Underside Roof<br>- Spray Foam and Permeable Insulation<br>- Exterior Rigid Insulation Over Sheathing<br>- SIP Roof<br>• Vented Attics<br>- Blown-in Insulation<br>- Batt Insulation |
| **High-R Walls** | R-21 cavity and R-5 continuous | • Single-Wall Cavity Insulation with Advanced Framing<br>- Spray Foam<br>- Spray Foam and Permeable Insulation<br>- Exterior Rigid Insulation<br>• Double-Wall Cavity Insulation<br>• SIP Walls<br>• Insulated Concrete Walls |
| **High-R Foundation** | R-15 continuous | • Exterior Rigid Foundation Insulation<br>• Interior Foundation Insulation<br>- Rigid Insulation plus Batt<br>- Cavity with Batt or Blown-in<br>• Shallow Frost-Protected Foundation |
| **High-R Window** | R-3.7 | • ENERGY STAR® Certified Window<br>• R-5 Window recommended |
| **Air Tightness** | 2 ACH50 | • Air Sealing<br>• Air Barriers |
| **HVAC SYSTEM** | | |
| **Heating Equipment** | 94% AFUE (Gas), or 10 HSPF (Electric) | • Direct Vent Gas Furnace<br>• Air-Source Heat Pump<br>• Geothermal Heat Pump<br>• Ductless Mini-Split Heat Pump |
| **Cooling Equipment** | 13 SEER | • Air-Source Heat Pump/Air Conditioner<br>• Geothermal Heat Pump<br>• Ductless Mini-Split Heat Pump |
| **Whole-House Ventilation** | ASHRAE 62.2 | • Exhaust-Only Ventilation<br>• Supply-Only Ventilation<br>• Balanced Ventilation |
| **ENERGY EFFICIENT COMPONENTS** | | |
| **Water Heating** | EF>0.8 | • Gas Storage<br>• Gas Tankless<br>• Heat Pump Water Heater<br>• Solar |
| **Lighting** | ENERGY STAR | • CFL<br>• LED |
| **Appliances** | ENERGY STAR | |
| **Exhaust Fans** | ENERGY STAR | • Individual Room<br>• Central Exhaust |
| **Ceiling Fans** | ENERGY STAR | |

In depth descriptions, installation guidance and code compliance information for most of the options listed in Table 1 are available on the Building America Solution Center website (*basc.energy.gov*).

The case studies in this section show real-world examples of builders meeting the 30% goal. These case studies show that builders can reach the 30% savings target even if they don't meet all of the recommendations in Table 1. Tradeoffs are often based on local materials, labor costs, and market preferences.

## New Town Builders: Denver, CO

For home builders, the mountain top is a net-zero energy home—a home so energy efficient that, with the addition of a few solar panels on the roof, it will generate as much power as it uses each year. Denver area's New Town Builders has reached that summit. New Town announced in 2012 that every home it builds at Stapleton will earn a Zero Energy Ready Home certification from the U.S. Department of Energy showing that it is a zero energy-ready home with a super-efficient building shell and all the wiring in place for installation of a rooftop solar photovoltaic system.

Over two decades of experience have taught New Town the value of considering duct layout early in the design process so that duct runs can be integrated into framing plans while there is an opportunity to make modifications if needed to allow for the shortest, most direct ducting possible. This, together with right sizing of the system, helps ensure the most efficiency and best performance in terms of comfort from the HVAC equipment.

See the full case study online:
*http://energy.gov/sites/prod/files/2013/11/f5/hiawinner_newtown_100213.pdf*

## Transformations, Inc: Townsend, MA

The eight homes built by Transformations, Inc., in a subdivision in Devens, MA, not only produce more energy than they consume, they are affordable for middleclass buyers.

"We have been working for years to drive down the cost of high-performance homes," said company president Carter Scott. "It costs about $100 a square foot to build a code house here; our high-performance homes are only $1.43 above this [yes, that's about a dollar and a half], including the land and driveway." As a result, the first home was built and sold within 6 months, and the others were all sold or under agreement within a year of the first.

The outside wall is sheathed with a coated oriented strand board (OSB) product that serves as an air and moisture barrier and rain screen when the joints are sealed with the manufacturer's proprietary tape. This coated sheathing replaces house wrap as the home's weather-resistive barrier.

See the full case study online:
*http://www1.eere.energy.gov/buildings/residential/pdfs/hiawinner_transformation_production_100213.pdf*

## Garbett Homes: Herriman, UT

Completed in July 2013, the 4,111-ft$^2$ zero-energy home in Herriman, Utah (just outside Salt Lake City), is claiming two impressive firsts: the first U.S. Department of Energy Zero Energy Ready Home production home certified in Utah and the first net zero-energy production home built in Utah.

Much of the planning and modeling involved a tightly sealed and highly insulated building envelope. "In our energy modeling, our input data required that the blower door test come in at 1.0 ACH 50 or lower," said Damian Mora, an in-house energy coordinator for Garbett Homes. "Our final testing exceeded this mark, testing at 0.8 ACH 50."

See the full case study at:
*http://energy.gov/sites/prod/files/2013/11/f5/hiawinner_garbett_100213.pdf*

## Preferred Builders, Inc: Old Greenwich, CT

The "Performance House" by Preferred Builders, Inc., the home has earned a host of green building awards and certifications including designation as the second home in the country to earn the U.S. Department of Energy Zero Energy Ready Home certification.

Underneath its quaint exterior, the home is all 21st century performance, starting with footings made of concrete that has an additive to make it waterproof. At the top of the foundation walls, a copper flashing termite barrier was installed under the pressure-treated sill plate and wrapped up around the bottom of the rigid foam. Finally, the foundation walls were treated on the exterior with a rubberized spray-on waterproof coating.

All of the windows are low-emissivity, argon-filled with highly durable pultruded fiberglass frames. Windows on the north, east, and west have a U factor of 0.28 and a solar-heat gain coefficient of 0.27, while south-facing windows have a U value of 0.30 and an SHGC of 0.46. Deep 2-foot overhangs shade the windows from high summer sun but let in low winter sun. The roof uses "cool roof" shingles with a solar reflectance index of 29 that meets ENERGY STAR and LEED for Homes criteria.

See the full case study online:
*http://www1.eere.energy.gov/buildings/residential/pdfs/doe_ch_case_studies/ch_preferredbuilders_06-04-13.pdf*

### Zero Energy Ready Home

The Zero Energy Ready Home label establishes a framework for continuous improvement that will help propel the market toward net-zero energy performance. In the future, a consumer will have the option to buy an affordable Zero Energy Ready Home anywhere in the United States — a home that can seamlessly accept a small photovoltaic solar array to offset the energy use of the home over the course of a year.

ZERO ENERGY READY HOME
U.S. DEPARTMENT OF ENERGY

Find technical resources and learn how to become a Zero Energy Ready Home partner on the Building Technologies Office website:
*http://energy.gov/eere/buildings/zero-energy-ready-home*

Through targeted research, industry partnerships, and collaboration with related DOE residential initiatives, Building America works to make cost-effective, energy-efficient homes a reality for all Americans.

Along with energy savings, the program also focuses on solutions that lead to:

- Risk identification and mitigation
- Improved indoor air quality, which can benefit occupant health
- Higher comfort levels in all rooms throughout the home
- Durable and moisture-resistant building designs and renovation
- Increased builder profitability through reduced construction time
- Opportunities for new product designs that save energy, material, and installation costs.

1 Compared to the most recent House Simulation Protocols, roughly consistent with IECC 2009 and updated lighting, appliances and miscellaneous electric loads: *http://energy.gov/sites/prod/files/2014/03/f13/house_simulation_protocols_2014.pdf*

2 A detailed description of Building America climate regions is available at *http://energy.gov/eere/buildings/climate-zones*