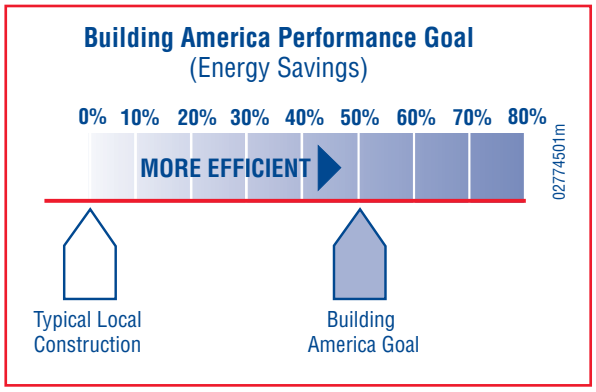
Whole-House Approach Benefits Builders, Buyers, and the Environment

The Program

The U.S. Department of Energy's (DOE) Building America Program is reengineering the American home for energy efficiency and affordability. Building America works with the residential building industry to develop and implement innovative building processes and technologies — innovations that save builders and homeowners millions of dollars in construction and energy costs. This industry-led, cost-shared partnership program aims to:



A multi-year goal of Building America is to **reduce energy use** *by an average of 50% compared to typical local construction.*

- Reduce energy use by 50% and reduce construction time and waste
- Improve indoor air quality and comfort
- Encourage a systems engineering approach for design and construction of new homes
- Accelerate the development and adoption of high performance in production housing.

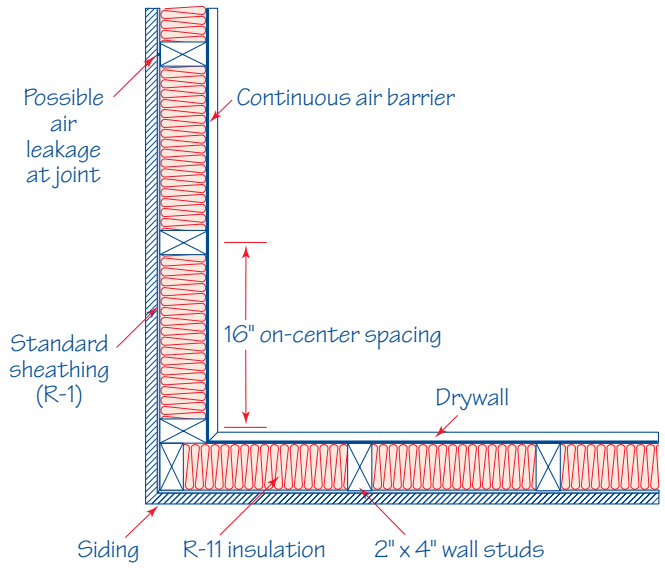
Warren Gretz, NREL/PIX08743

Prefabricated wall panels *await assembly at the Meadow View community in* **Longmont, Colorado**. *McStain Enterprises is the builder partner.*

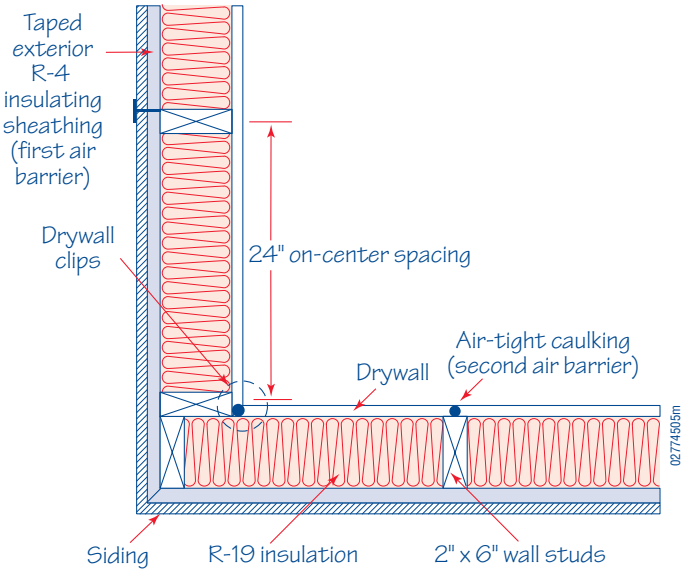
Warren Gretz, NREL/PIX08742

Examples of Building America Framing and Air Tightness Improvements in a Cold Climate

Standard Wall Construction



Advanced Wall Construction

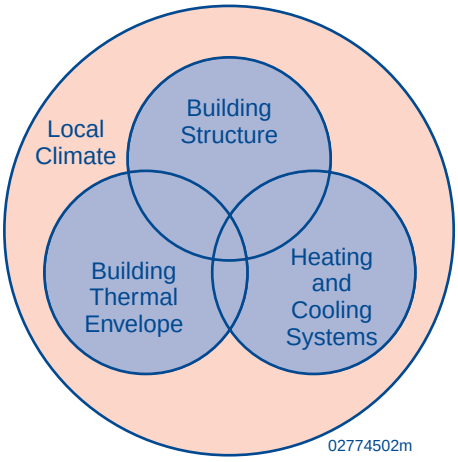


The whole-house approach often uses **advanced framing** *and a* **double air barrier** *to improve insulation and air tightness in cold climates.*

The Whole-House Approach

The teams design houses from the ground up, considering the interaction between the building envelope, mechanical systems, landscaping, neighboring houses, orientation, climate, and other factors. This approach enables the teams to incorporate energy-saving strategies at little or no extra cost. Examples of innovative design improvements that result from this systems-engineering approach include:

- **Advanced framing systems.** By using 2x6 studs on 24-inch spacing instead of the more common 2x4 studs on 16-inch spacing, the builder greatly improves the insulating value of the walls and reduces labor and lumber required to assemble the framing. Structural Insulated Panels (SIPs) and other innovative wall systems may also be used to create an airtight, highly insulating wall construction.
- **Integrated envelope sealing package.** Combinations of taped sheathing systems, air-tight caulking of drywall, and better workmanship lead to lower air infiltration rates and reduce heating and cooling loads on mechanical systems. Mechanical ventilation is often added to ensure adequate fresh air for building occupants.
- **Energy-efficient windows.** Low-emissivity coatings and vinyl frames provide much higher levels of thermal insulation than standard windows with clear glass and aluminum frames. In hot climates, an additional spectrally selective coating may be added to reduce the amount of solar heat entering the house. Exterior shading and house orientation can also be used to control solar gains.



Using a **whole-house approach**, *Building America considers performance and interactions of all building systems.*

One Example of Building America Cost Trade-offs in Hot-Dry Climate

Standard Practice	Building America	Cost Impact*
Roof vents	Unvented roof	- $250
Uninsulated roof deck	Insulated roof deck	+ $700
2x4 framing, 16-inch spacing	2x6 advanced framing, 24-inch spacing	- $250
Clear glass windows	Low-e, spectrally selective windows	+ $500
4-ton air conditioner	2-ton air conditioner	- $1000
Natural ventilation	Controlled ventilation	+ $100
Total cost of upgrades		- $200

* Estimated costs for production builders. Actual costs vary depending on specific features and supplier discounts. (Negative indicates cost savings, positive indicates additional costs.)

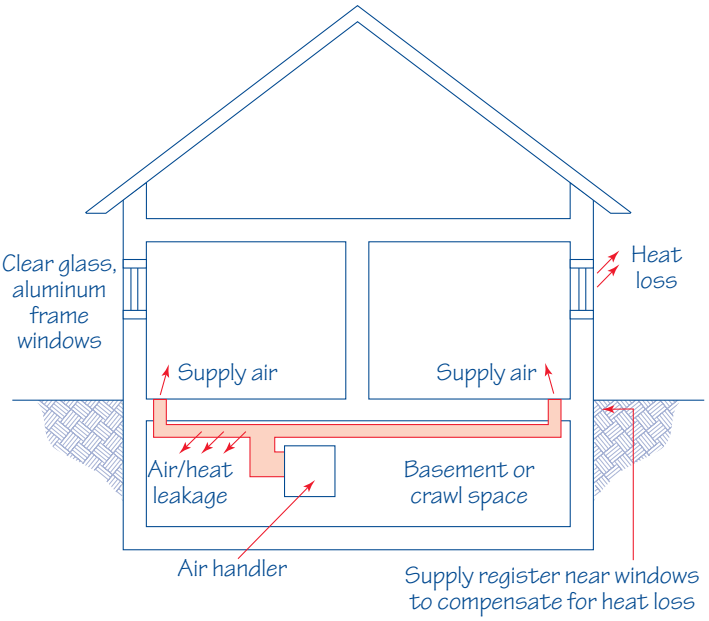
Optimally sized mechanical systems. Significant reductions in heating and cooling loads allow the installation of smaller, more efficient heating and cooling systems. Mechanical systems with capacities more closely matched to actual loads also provide greater comfort.

Ductwork improvements. Heating and cooling ducts can be moved into conditioned space from the attic or basement, which reduces heat loss to or from the outside environment. Better duct sealing helps prevent the loss of conditioned air. Centrally located heating and cooling systems also lead to shorter supply and return duct runs, lowering construction cost and further reducing air leakage. The addition of return air transfers enhance comfort and minimize negative pressures that can cause moisture problems in humid climates.

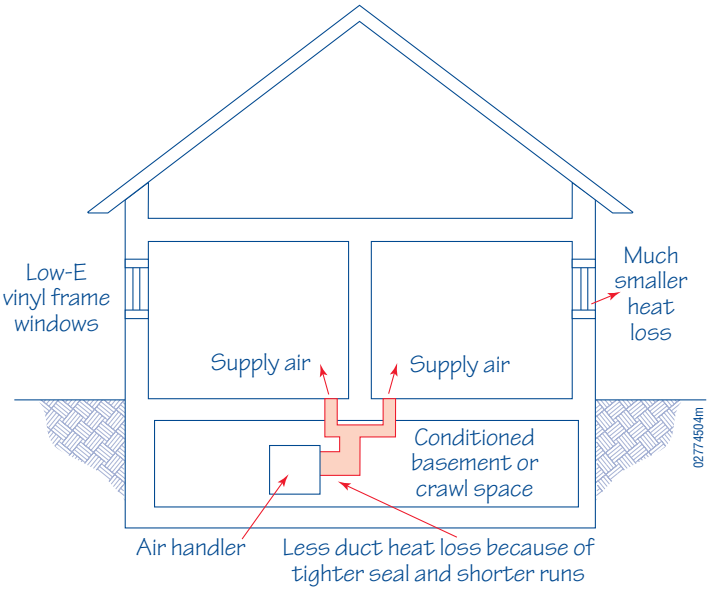
Factory construction. Factory-made modules may reduce construction time and costs, and may also improve energy and resource efficiency. Better quality assurance and higher productivity may occur under factory conditions with a controlled environment, leading to tighter building envelopes and less wasted material.

Examples of Building America Window and Ductwork Improvements in a Cold Climate

Inefficient Windows and High-Loss Ductwork



Energy-Efficient Windows and Ductwork



***Windows** and **air ducts** are frequently major contributors to heat loss in a home. Energy-efficient windows allow the use of shorter ducts that are easier to seal and less expensive to install.*

Building America Industry Teams

The Participants

Building America's systems engineering approach unites segments of the building industry that have traditionally worked independently of one another. It forms teams of architects, engineers, builders, equipment manufacturers, material suppliers, community planners, mortgage lenders, and contractor trades. There are five teams comprising more than 150 different companies.

Building Science Consortium (BSC)

Team Leader: Building Science Corporation

Key Industry Partners:

- Artistic Homes
- Ashland Construction
- Centex Homes
- DEC Therma-Stor
- Del Webb
- Dow Chemical
- Greenbuilt Homes
- Habitat for Humanity
- Hans Hagen Homes
- Ideal Homes
- Investec
- John Laing Homes
- Kaufman and Broad
- The Lee Group
- PPG
- Pulte Homes
- RPM Homes
- Southface Energy Institute
- Sturbridge Construction
- Town & Country Homes
- U.S. Green Fiber

Hickory Consortium

Team Leader: Hickory Corporation

Key Industry Partners:

- Acorn Laboratories
- Building Science Engineering
- Cardinal Homes
- Center for Maximum Potential Building Systems
- Coachman Industries/All American Homes
- Epoch
- Excel Homes/Avis America
- Hampton Architect
- Oaktree Development
- Pella Windows
- Tamarack Technologies
- University of Central Florida

Consortium for Advanced Residential Buildings (CARB)

Team Leaders: Steven Winter Associates

Key Industry Partners:

- Andersen Windows
- Beazer Homes
- Cambridge Homes
- Champion Home Builders
- Crosswinds Communities
- Del Webb
- Honeywell
- ITW
- McStain Enterprises
- Mercedes Homes
- Mitchell Homes
- Owens Corning
- Ryan Homes
- Simpson Strong-Tie
- US Steel
- Weyerhaeuser
- Whirlpool
- York

Integrated Building and Construction Solutions (IBACOS)

Team Leader: IBACOS, Inc.

Key Industry Partners:

- Burt Hill Kosar Rittelmann
- Carrier
- Civano Development Corporation
- The Estridge Companies
- Farm Homes
- Fortis Homes
- GE Appliances
- GE Plastics
- Hedgewood Properties
- John Wieland Homes
- Kohler
- Medallion Homes
- Montgomery & Rust
- Morrison Homes
- New Era
- Owens Corning
- Playa Vista
- Pulte Homes
- US Gypsum
- U.S. Army
- Venture Homes

Industrialized Housing Partnership

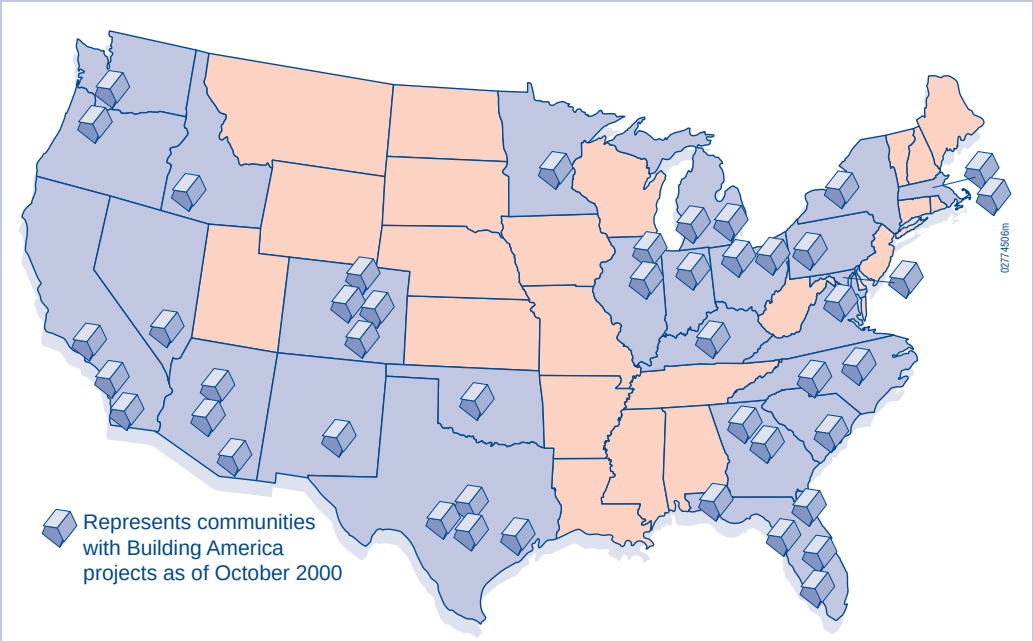
Team Leader: Florida Solar Energy Center

Project Co-Funders: Florida Energy Office and Northwest Energy Efficiency Alliance

Key Partners:

- American Energy Efficient Homes of Central Florida
- American Lung Association
- Atlantic Design & Construction
- Beck Builders
- Cavalier Homes
- Centex Homes
- Champion Enterprises
- D.R. Wastchek, LLC
- Energy Rated Homes of Nevada
- Fleetwood Homes
- Florida H.E.R.O.
- Florida Power Corporation
- Friedrich Air Conditioning Company
- Habitat for Humanity
- LaSalle Air Systems
- Nomaco, Inc.
- North Carolina A&T State University
- Oregon Office of Energy
- Pacific Northwest National Laboratory
- Palm Harbor Homes
- Southern Energy Homes
- Town & Country Homes of Texas
- Tyvek Weatherization Systems
- University of Central Florida
- Valley Manufactured Housing
- Washington State University Energy Program
- York International, Manufactured Housing Division

Building America Partners by State

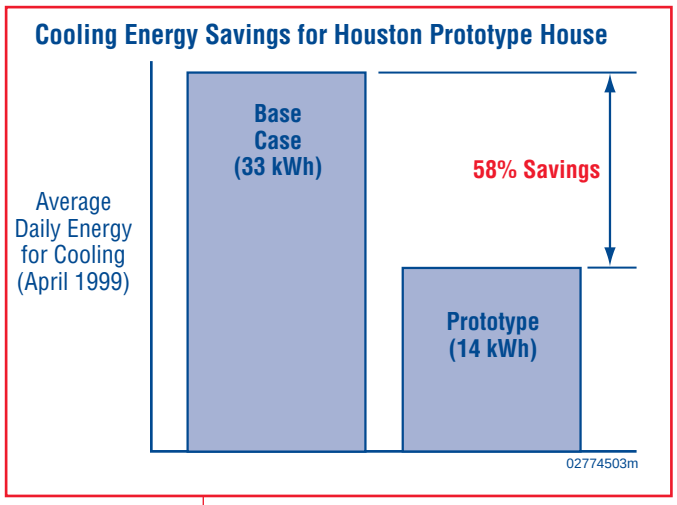


The Projects

As of October 2000, the Building America approach has been used in the design of more than 2,000 houses in 24 states. This success is due to the efforts of more than 60 builders implementing projects in 48 different cities across the United States.

State	City	Builder Partner
Arizona	Grand Canyon	National Park Service
	Phoenix	VIP Homes
	Phoenix	Pulte Homes
	Phoenix	Del Webb Corp.
	Phoenix	Palm Harbor Homes
	Tucson	Pulte Homes
	Tucson	Civano
California	Southern California	RGC
	Simi Valley	Beazer Homes
	Sylmar	Lee Homes
Colorado	Clear Creek County	Van Geet
	Denver	Wonderland Builders
	Denver	Habitat for Humanity
	Longmont	McStain Homes
	Pueblo	Domega Homes
	Pueblo	Tierra Concrete Homes
Florida	Ft. Myers	Pulte Homes
	Gainesville	Florida H.E.R.O.
	Jacksonville	Pulte Homes
	Melbourne	Mercedes Homes
	Pensacola	Mitchell Homes
	Plant City	Palm Harbor Homes
Georgia	Atlanta	Hedgewood Properties
	Atlanta	Venture Homes
	Cobb County	Habitat for Humanity
	Fairburn	Ashland Homes
Idaho	Boise	Hidden Springs
	Boise	Super Good Cents/Natural Choice
Illinois	Grayslake	Sturbridge
	Vernon Hills	Town & Country
Indiana	Indianapolis	Estridge
Maryland	Frederick	Ryan Homes

State	City	Builder Partner
Massachusetts	Boston	CWC/Thomas Construction
	Cambridge	Epoch Corporation
Michigan	Detroit	Crosswinds
	Grand Rapids	Pulte Homes
Minnesota	Minneapolis	Centex Homes
	Minneapolis	Hans Hagen Homes
	Minneapolis	Pulte Homes
	Minneapolis	Town & Country
Nevada	Las Vegas	Pulte Homes
	Las Vegas	Watt Homes
New Mexico	Albuquerque	Artistic Homes
New York	Rochester	Ryan Homes
North Carolina	Charlotte	Pulte Homes
	Raleigh	Carolina Country Builders
Ohio	Cleveland	Greenbuilt
	Cleveland	Tesco Builders
	Toledo	Randal Homes
Oklahoma	Norman	Ideal Homes
Oregon	Salem	Super Good Cents/Natural Choice
Pennsylvania	Chambersburgh	New Era Building Systems
	Pittsburgh	Kacin Builders
	Pittsburgh	Montgomery & Rust
South Carolina	Charleston	McIntire
Texas	Austin	CMPBS
	Austin	Doyle Wilson
	Georgetown	Del Webb Corp.
	Houston	Beazer Homes
	San Antonio	Medallion Homes
Virginia	Fairfax	Pulte Homes
Washington	Olympia	Super Good Cents/Natural Choice



Results of **side-by-side testing** *of a Building America prototype house in* **Houston, Texas,** *and a base-case house constructed using the builder's standard practice. Beazer Homes is the builder partner. Testing was conducted by the National Renewable Energy Laboratory.*

Warren Gretz, NREL/PIX04670

A worker installs high efficiency, **argon-filled windows** *with low-emissivity glass on this Building American home in the Prairie Crossing community in* **Grayslake, Illinois**. *Sturbridge Construction is the builder partner.*

Warren Gretz, NREL/PIX04671

The Results

Each Building America team is constructing test homes and developing community-scale projects that incorporate its systems innovations. DOE's National Renewable Energy Laboratory (NREL) provides feedback on the systems-level benefits of energy technologies and design strategies implemented by the teams. Results to date demonstrate that Building America homes use 30% to 70% less energy than conventional homes and are more comfortable. These results are documented in Building America project summaries, case studies, and on the Building America Web site at www.eren.doe.gov/buildings/building_america/.

Benefits for Builders

Building America helps builders to develop a competitive advantage by reducing construction costs and improving the quality of the houses they build:

- Reduced callbacks and warranty claims
- Lower material and labor costs during construction
- Reduced purchase cost of mechanical equipment
- Less construction waste
- More options for the same sales price
- New product opportunities for manufacturers and suppliers
- Learning from other builders
- Prominence in the marketplace
- Advanced energy system integration, including photovoltaics and solar hot water.

Benefits for Homeowners

Building America's partnership with builders also provides important benefits to homeowners by improving the quality and affordability of the product they buy:

- Lower utility bills
- Greater comfort
- Better indoor air quality
- Energy-efficient mortgages
- Higher resale prices.

Benefits for the Nation

The energy-efficient, healthy, and environmentally friendly houses created under Building America contribute to a better quality of life for all citizens:

- Less reliance on fossil fuels
- Reduced greenhouse gas emissions
- More affordable homes for first-time homebuyers
- Lower medical costs resulting from unhealthy or unsafe living conditions
- Job creation in the energy-efficient building materials and equipment industry

Homes of the Future

The research conducted by Building America teams improves the quality and performance of today's homes and provides valuable information for homes of the future. By supporting the development of innovative building methods and technologies that achieve significant energy and cost savings, the Building America Program is helping to shape the future of American homes.

Civano/PIX08777

Civano/PIX08776

Heating and cooling ducts are routed through open-web floor joists in a **sealed crawl space** *for this Building America house in the Civano Community in* **Tucson, Arizona**.

Building America Program/PIX04673

A third-story **module** *is lifted into place on a prototype Building America duplex in a* **Cambridge, Masschussetts** *infill project. Epoch Corporation is the modular builder partner.*

EcoDynamic Homes ™/PIX04672

BUILDINGS FOR THE 21ST CENTURY

Buildings that are more energy efficient, comfortable, and affordable ... that's the goal of DOE's Office of Building Technology, State and Community Programs (BTS). To accelerate the development and wide application of energy efficiency measures, BTS:

- Conducts R&D on technologies and concepts for energy efficiency, working closely with the building industry and with manufacturers of materials, equipment, and appliances
- Promotes energy- and money-saving opportunities to both builders and buyers of homes and commercial buildings
- Works with state and local regulatory groups to improve building codes, appliance standards, and guidelines for efficient energy use
- Provides support and grants to states and communities for deployment of energy-efficient technologies and practices.

David Beal, FSEC/PIX09705

Florida Solar Energy Center/PIX09688

Two **showcase manufactured homes** *being monitored side-by-side on the* **North Carolina A&T State University campus**. *A section of another manufactured home (below) is produced by Palm Harbor Homes in* **Plant City, Florida**.

Visit our Web sites at:

www.eren.doe.gov/buildings/building_america

www.pathnet.org/home.html

www.energystar.gov

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