Building AMERICA SM
U.S. Department of Energy

Research that Works

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

The Program

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

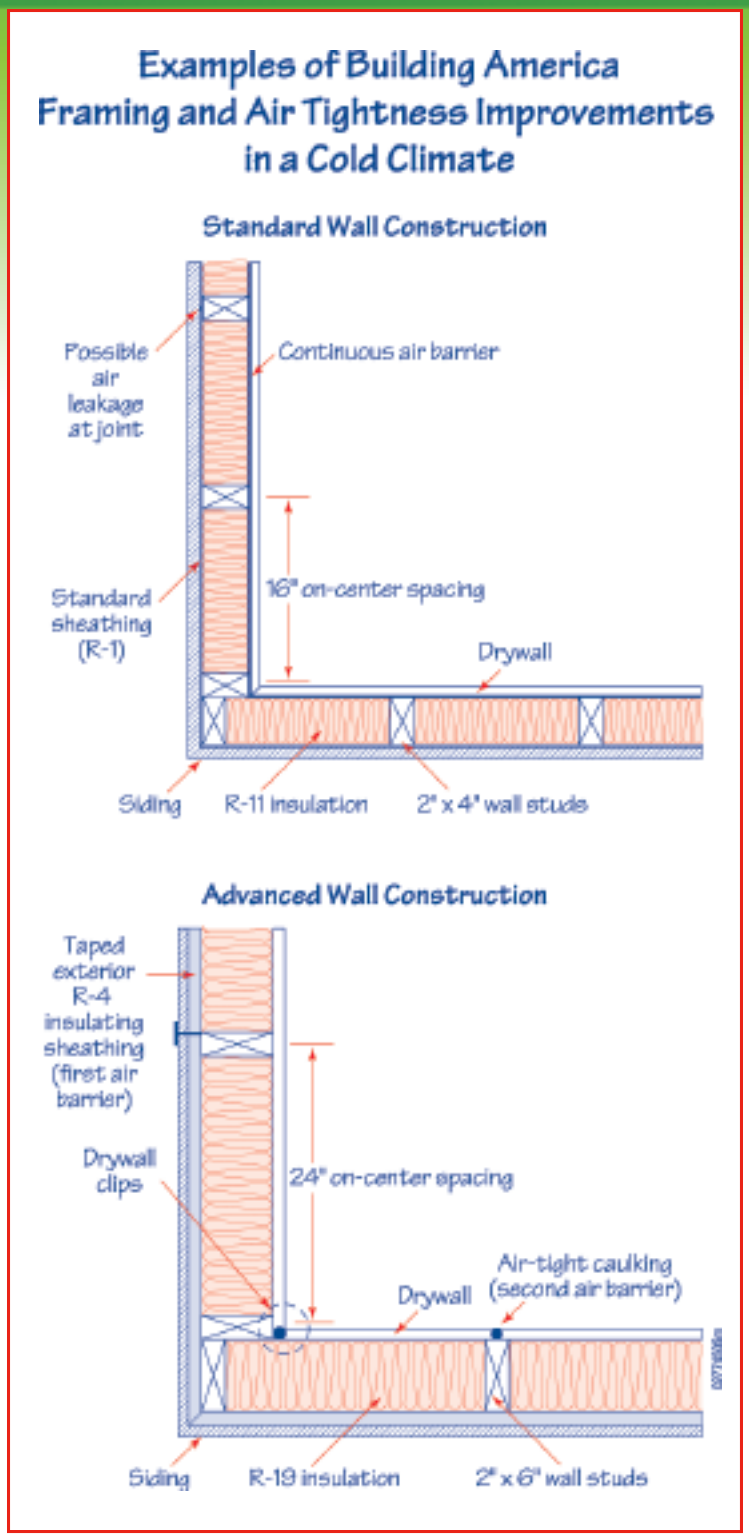
- Reduce whole-house energy use by 40–70% and reduce construction time and waste
- Improve indoor air quality and comfort
- Integrate clean onsite power systems
- Encourage a systems-engineering approach for design and construction of new homes
- Accelerate the development and adoption of high-performance residential energy systems.

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

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

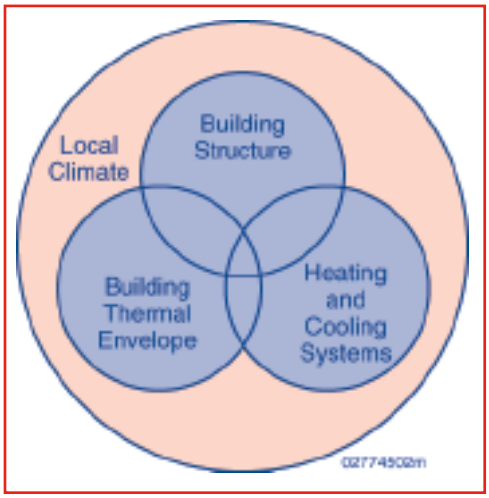


The whole-house approach often uses **advanced framing** *and a* **double air barrier** *to improve insulation and air tightness in cold climates.*

The Systems-Engineering 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-in. spacing instead of the more common 2x4 studs on 16-in. 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 **systems-engineering 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-in. spacing	2x6 advanced framing, 24-in. 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

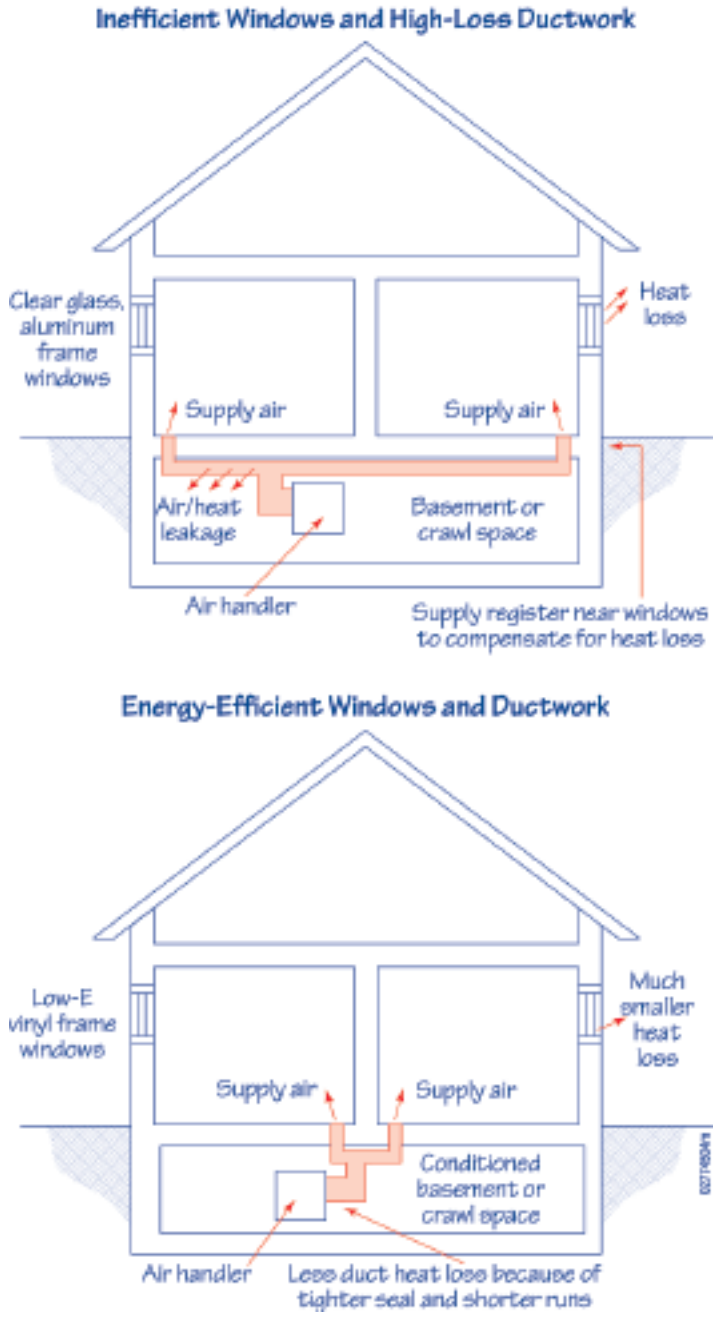
*Estimated costs for production builders. Actual costs vary depending on specific features and supplier discounts. (Negative indicates cost savings, positive indicates additional costs.)

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



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

Visit the Building America House Performance Database for detailed information on Building America teams, partners, builders, and suppliers: **www.buildingamerica/gov**.

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. The five Building America teams bring together hundreds of different companies.

Building Science Consortium (BSC) www.buildingscience.com

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 and Country Homes
- U.S. Green Fiber

Building Industry Research Alliance (BIRA) www.bira.ws/

Team Leader: ConSol
Key Industry Partners:

- Astoria Homes
- AstroPower
- Celebrate Homes
- Centex Homes
- Dow Chemical
- Forecast Homes
- Greystone Homes
- Griffin Communities
- Morrison Homes
- Pardee Homes
- Perma-Bilt Homes
- Premier Homes
- Shea Homes
- Standard Pacific Homes
- William Lyon Companies

Consortium for Advanced Residential Buildings (CARB) www.carb-swa.com

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) www.ibacos.com

Team Leader: IBACOS, Inc.
Key Industry Partners:

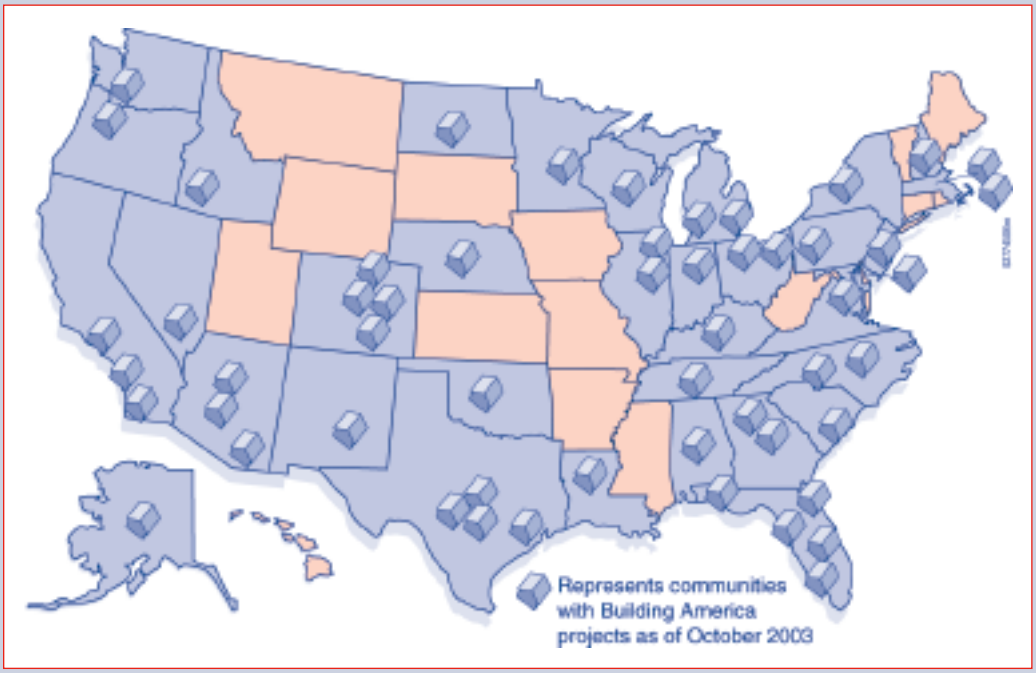
- Burt Hill Kosar Rittelmann
- Carrier
- Civano Development Corporation
- The Estridge Companies
- Farm Homes
- Fortis Homes
- GE Appliances
- GE Plastics
- Hedgewood Properties
- John Wieland Homes
- Kohler
- Medallion Homes
- Montgomery and Rust
- Morrison Homes
- New Era
- Owens Corning
- Playa Vista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

Industrialized Housing Partnership www.fsec.ucf.edu/bldg/baihp/

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 and 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 and 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 2003, the Building America approach has been used in the design of more than 20,000 houses in 34 states. This success is a result of the efforts of more than 250 builders implementing projects in many cities across the United States.

Visit the Building America Web site at **www.buildingamerica.gov** to learn more about Building America and for a full listing of Building America house projects with detailed specification.

Research that Works

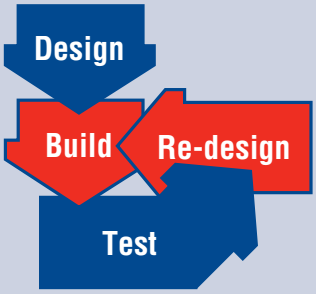
Building America's systems-engineering approach unites segments of the building industry that have traditionally worked independently of one another. Building America forms teams of architects, engineers, builders, equipment manufacturers, material suppliers, community planners, mortgage lenders, and contractor trades.

The concept is simple: systems engineering can make America's new homes cost effective to build and energy efficient to live in. Energy consumption of new houses can be reduced by as much as 50% with little or no impact on the cost of construction.

In order to reach this goal, Building America teams work to produce houses that incorporate energy- and material-saving strategies from design through construction.

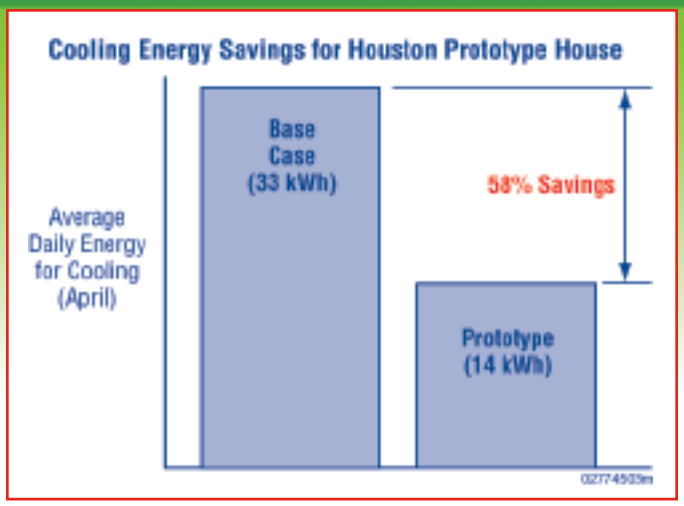
First, teams analyze and select cost-effective strategies for improving home performance. Next, teams evaluate design, business, and construction practices within individual builder partnerships to identify cost savings.

Cost savings can then be reinvested to improve energy performance and product quality. For example, a design incorporating new techniques for tightening the building envelope may enable builders to install smaller, less expensive heating and cooling systems. The savings generated in this process can then be reinvested in high-performance windows to further reduce energy use and costs.



The initial "test" home is the field application of proposed solutions. The team builds this prototype home according to their strategic design, tests each system for efficiency, and makes any necessary changes to increase efficiency and cost effectiveness. Before additional houses are built, these changes are incorporated into the design. This process of analysis, field implementation, re-analysis, and design alteration facilitates ultimate home performance once a design is ready for use in production or community-scale housing.

Understanding the interaction between each component in the home is paramount to the systems-engineering process. Throughout design and construction, the relationship between building site, envelope, mechanical systems, and other factors is carefully considered. Recognizing that features of one component can dramatically affect the performance of others enables Building America teams to engineer energy-saving strategies at little or no extra cost.



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 40–70% 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.buildingamerica.gov**.

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 onsite power 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 energy efficiency strategies and integrating onsite power systems, the Building America Program will ultimately develop homes that produce as much energy as they use.

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

EcoDynamic Homes TM/PIX04672

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

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

Research and Development of Buildings

Our nation's buildings consume more energy than any other sector of the U.S. economy, including transportation and industry. Fortunately, the opportunities to reduce building energy use—and the associated environmental impacts—are significant.

DOE's Building Technologies Program works to improve the energy efficiency of our nation's buildings through innovative new technologies and better building practices. The program focuses in two key areas:

- **Emerging Technologies**
  Research and development of the next generation of energy-efficient components, materials, and equipment
- **Technology Integration**
  Integration of new technologies with innovative building methods to optimize building performance and savings

U.S. Department of Energy
Energy Efficiency and Renewable Energy

An electronic copy of this factsheet is available on the Building America Web site at **www.buildingamerica.gov**

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.buildingamerica.gov | **www.pathnet.org** | **www.energystar.gov**

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