

Systems engineering: An approach that can save millions of dollars in energy and construction costs

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Energy-efficient houses are now available across the Nation, homes built according to Building America principles. Four industry teams are currently producing houses that save both builders and owners thousands of dollars:

- The Building Science Consortium (BSC), Westford, MA
- Integrated Building and Construction Solutions (IBACOS), Pittsburgh, PA
- Consortium for Advanced Residential Buildings (CARB), Norwalk, CT
- The Hickory Consortium, West Wareham, MA
- Industrialized Housing Partnership, Clearwater, FL

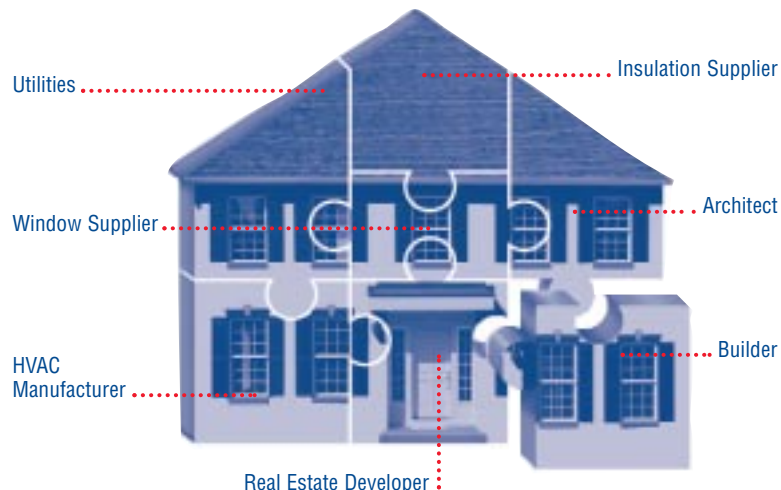
Systems engineering views the house as an integrated system of components and incorporates improvements that all together yield optimal energy and cost savings, quality, and performance.

America's new homes can be cost-effective to build as well as energy-efficient to live in. In fact, the energy consumption of new houses can be reduced by 50 percent with little or no impact on the cost of construction. To show how, industry and the U.S. Department of Energy (DOE) have joined forces in an innovative program called Building America.

Building America looks at the full picture, bringing together all those who previously saw only single pieces of the jigsaw puzzle. Its basic concept involves approaching a house as an integrated system of components and planning the best combination of design and engineering features that cut costs and energy use by involving the entire team — architects, builders, building materials suppliers, real estate developers, utilities, and financial backers — at the start. Designing from the ground up, energy-saving strategies can be easily incorporated at little or no extra cost. Past experience led builders to believe it costs more to install energy-efficient features; but now, using a systems engineering approach, they can increase the quality and performance of a home without greatly increasing its price. By taking advantage of the interaction between the building envelope and mechanical systems, builders can save money and produce more comfortable houses.

The Building America program has four teams, comprising more than 80 different companies. These teams, each including a number of Fortune 500 corporations as well as small businesses, are now producing energy-efficient, environmentally sensitive, affordable, and adaptable homes on a community scale. Their goals:

- To build 2,000 of these homes by the year 2000.
- To facilitate the adoption of the systems engineering approach in 70 percent of the new housing market within 10 years.



Getting results: Selling energy-efficient houses, with the same profit margin

“Energy efficiency
is no longer
obtained at
premium cost.”

—STEVEN WINTER
CARB

Building America teams are putting homes on the market that offer the comfort and energy efficiency Americans want, at construction costs comparable to traditional housing. In developments throughout the Nation, Building America homes are demonstrating the savings.

As the “For Sale” signs go down and families move in, the electric meters record the savings. Using test results and this real-life data, DOE documents the benefits of energy technologies and supplies builders with case studies that show how to adopt similar strategies.

A SYSTEM OF COST-SAVING TRADE-OFFS

The systems engineering approach is based on coordination. Cooperative efforts yield better solutions and enable the team to look at interactions among different energy features. Results from all four teams show that improving the thermal integrity of the home’s envelope allows a reduction in the size and cost of its mechanical systems. Savings can then be reinvested in items like high-performance windows that further reduce energy use and costs. Some of the innovations used by the teams are:

Advanced framing systems

Innovative framing and insulation methods are demonstrated by the Building America teams. Setting wood studs farther apart allows more room for insulation and cuts materials costs. The Building Science Consortium (BSC) built its Prairie Crossing homes in Grayslake, Illinois, using 2x6 studs instead of 2x4s, set 24 inches apart instead of 16 inches. This method enhances the strength of the house, and, since 30 percent fewer pieces have to be assembled, framing takes less time and labor costs are significantly lower. By using materials efficiently, the team reduced construction costs and was able to reinvest these savings in additional energy-saving features.

A tightly sealed house envelope

To construct a tight thermal envelope, BSC homes use a new double air-barrier system. Rigid foam sheathing is glued to the framing, and the drywall is caulked air-tight, eliminating the need for polyethylene barriers and house wrap. A controlled ventilation system improves comfort by allowing occupants to regulate air flow.



From the outside, the Prairie Crossing houses built by the Building Science Consortium don't look any different from other houses in the Grayslake, Illinois, area. Yet these Building America homes, constructed with advanced framing techniques and a double air-barrier system, use about half the energy of nearby homes.

The Hickory Consortium used factory-made modules to build townhouses in Cambridge, Massachusetts. These units — featuring a ground-source heat pump, increased levels of insulation, innovative air-tight sealing technology, and high-efficiency windows — use an estimated 55 percent less energy than comparable housing.



Shorter, less costly ductwork

The combined benefits of placing the heating system in a central location, installing energy-efficient windows, and improving the insulation of a house enable builders to use shorter duct runs — a move that can cut material and installation costs by over 50 percent and also save energy. New round ducts only 8 inches in diameter, cheaper to install and easier to maintain, are used in houses built by the Integrated Building and Construction Solutions (IBACOS) consortium.

Disentangling the infrastructure

If not only the ductwork but also the plumbing and wiring are placed inside the conditioned space, the house envelope is no longer broken by entry and exit points. The IBACOS team is building houses that offer easier maintenance while providing options for speedier construction and reduced materials costs.

A smaller, less expensive mechanical system

Once the house is tightly sealed, a smaller system is needed to condition it. Builders can realize substantial savings on heating and cooling system costs, as demonstrated by a test house built in Maryland by the Consortium for Advanced Residential Buildings (CARB). The house requires only a 1.5-ton system, while comparable homes require 2.5-ton capacity.

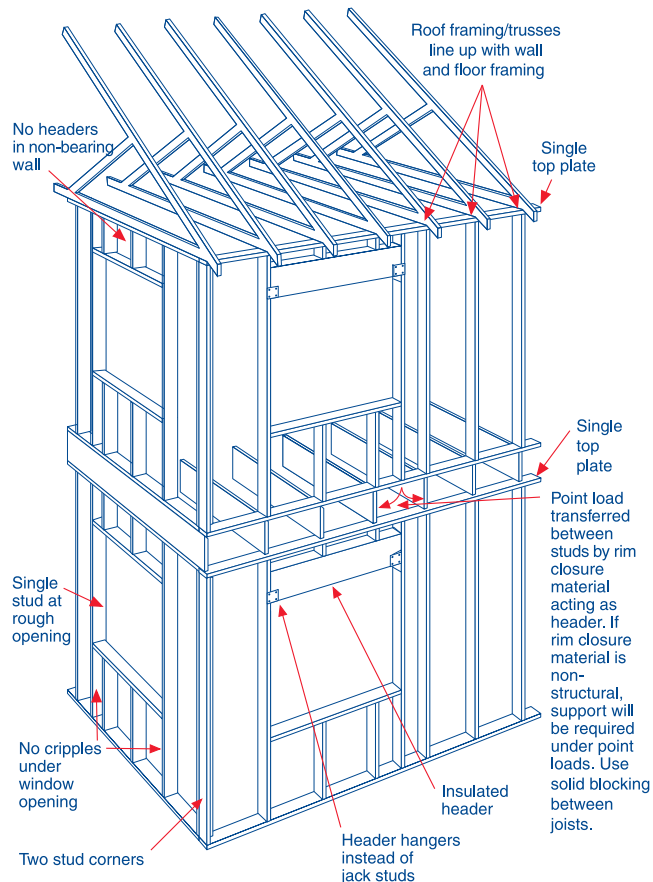
Modular construction

Houses built by the Hickory Consortium incorporate factory-made modules that stack one on top of the other, reducing construction time and costs. Instead of a simplified duct system, Hickory houses are divided into zones, each with its own thermostat, so that zones can be heated or cooled independently. Treating the modular construction process as a system, energy and environmental efficiency, health features, and high quality can be built in at the factory — resulting in lower costs to the home buyer.

“ Builders find that many things that are beneficial from an energy efficiency standpoint are also beneficial from a productivity standpoint.”

— BRAD OBERG
IBACOS

Advanced Framing System





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/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

GAINING A COMPETITIVE EDGE

Innovative Building America methods can provide builders with a number of competitive advantages. For instance, the use of Building America methods can dramatically reduce warranty problems and callbacks, caused most frequently by moisture and comfort issues. Reducing the number of framing studs, for example, can cut moisture bridging and drywall cracking, two major warranty issues. Instead of fixing problems after the fact, builders can apply new methods that prevent problems from occurring in the first place — saving unnecessary costs and increasing customer satisfaction.

By offering improved comfort and lower utility bills, builders using Building America principles have an edge over those offering less efficient housing. Reduced energy consumption, increased affordability, and greater comfort make these new homes immediately attractive to buyers. And the Building America Program demonstrates that builders can deliver these houses at little or no extra cost.

The Building America Program is the pre-eminent community/builder resource for energy-efficient, affordable housing under the Federal Government's Partnership for Advancing Technology in Housing (PATH). Building America houses also are certified as Energy Star through the cooperative guidelines set by the Environmental Protection Agency and the Department of Energy.

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