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

Case Study

THE GALLOWAY FAMILY HOME

Energy-efficient Habitat for Humanity house uses 30 percent less energy

Habitat for Humanity's Jimmy Carter Work Project is an internationally recognized annual event where Jimmy and Rosalyn Carter join Habitat for Humanity volunteers in a week-long "blitz build." During the 1997 event, more than 2,400 volunteers constructed 50 houses in seven rural Appalachian areas of Kentucky and Tennessee.

Inclusion of energy-efficient features in the construction of affordable housing offers many benefits to low-income homeowners, including reduced operating costs and improved comfort. However, a number of barriers prevent inclusion of energy features: initial costs, the need to incorporate energy efficiency into the construction designs and plans from the beginning, and the need to alter current construction practices in the field.

The U.S. Department of Energy's Office of Building Technology, State and Community Programs (BTS) recognizes these challenges. Through its Partnerships for Affordable Housing program, BTS is supporting simple and clear guidelines to help Habitat for Humanity affiliates and other affordable housing providers to incorporate energy-efficient features into their homes.

BTS teamed with Habitat for Humanity on its 1997 Jimmy Carter Work Project to demonstrate that significant, cost-effective energy improvements can be achieved in affordable homes through simple changes in the construction process and in the application of materials. This Jimmy Carter Work Project also demonstrated that a whole-house systems approach to improving energy efficiency, as implemented through a set of simple guidelines, is volunteer-friendly and can be adopted by Habitat affiliates and housing providers nationwide. Habitat for Humanity has since organized a Green Team to promote these principles among its member affiliates.

GALLOWAY HOUSE COMBINES ENERGY EFFICIENCY AND AFFORDABILITY

The Galloway family home is one of four designs constructed during the 1997 Jimmy Carter Work Project. The house is estimated to use about one-third less energy for heating and cooling compared with a house featuring standard construction. Annual savings are estimated at $88.

Energy features for the four designs were selected following guidelines developed by the Partnerships for Affordable Housing program and based on the following criteria: cost-effectiveness, simplicity of implementation (Habitat projects rely on volunteer labor), and total costs.

A 34-item energy-efficiency construction checklist was used on-site during construction to make sure the energy design intent was successfully implemented. In addition, an energy advocate was designated for each of the houses to oversee the implementation of energy measures. These energy champions educated construction leaders and volunteers on energy-efficient construction techniques and supervised crews performing energy tasks.

INCREMENTAL COST SUMMARY

Features	Material Cost*
Wall insulation	+$165
Attic insulation	+$ 91
Attic baffles	+$ 40
Windows	+$410
Infiltration reduction	+$ 50
Total Incremental Cost	**+$756**

* Excludes labor costs (Habitat for Humanity projects rely on volunteer labor).

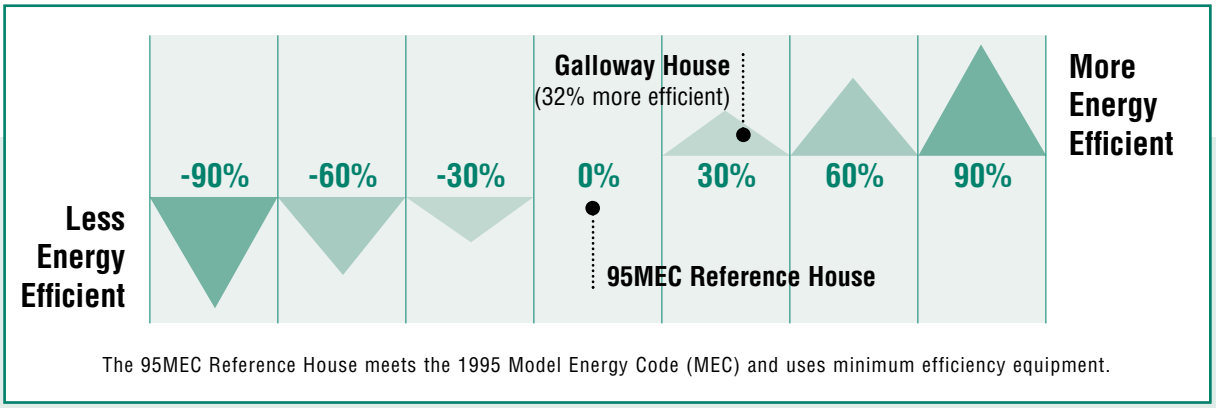
The energy-efficient features of the Galloway home added less than $800 to the total material costs for this house. These features will save the Galloway family an estimated $88 per year in utility costs.

Significant energy improvements were made to the 1997 Jimmy Carter Work Project houses. The walls have R-15 fiberglass batts with R-2.5 rigid board insulation; the attics are insulated with R-38. Careful installation techniques ensure complete insulation coverage. Double-pane, low-emissivity (low-e) windows provide improved insulation. Infiltration improvements provide a tighter building envelope: total envelope air leakage is ≤ 0.4 natural air changes per hour. The mechanical system features sealed, insulated ducts: duct leakage to the outside is ≤ 100 cfm25.

Additional energy options (not selected for these Habitat houses) could further improve the four designs, including:

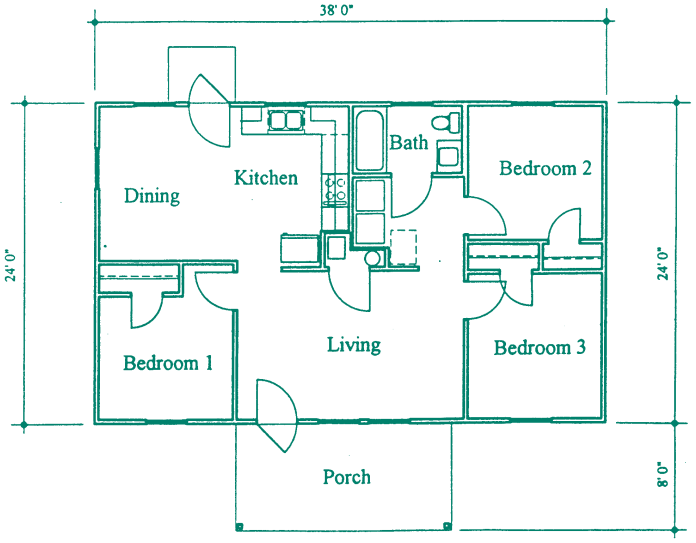
- Locating ducts inside the conditioned space of the home
- Using advanced energy-efficient wall framing to allow for fuller insulation coverage at corners of exterior walls, in headers, and at junctions between interior and exterior walls
- Using raised heel trusses in the attic to allow for fuller insulation coverage over exterior walls

PERFORMANCE COMPARISON



The 95MEC Reference House meets the 1995 Model Energy Code (MEC) and uses minimum efficiency equipment.

THE GALLOWAY FAMILY HOME



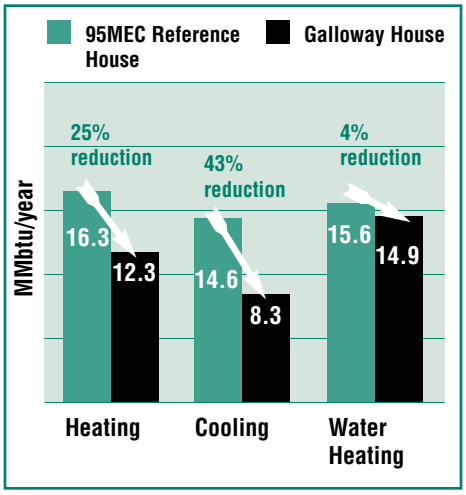
HOUSE CHARACTERISTICS

- *Area: 912 sq. ft.*
- *Bedrooms: 3*
- *Baths: 1*
- *Foundation: crawlspace*
- *Windows: 82 sq. ft. of window area*
- *Architectural enhancements: broken roof line; large front porch*

- Installing higher efficiency heating and cooling equipment
- Insulating crawlspace walls rather than the floor

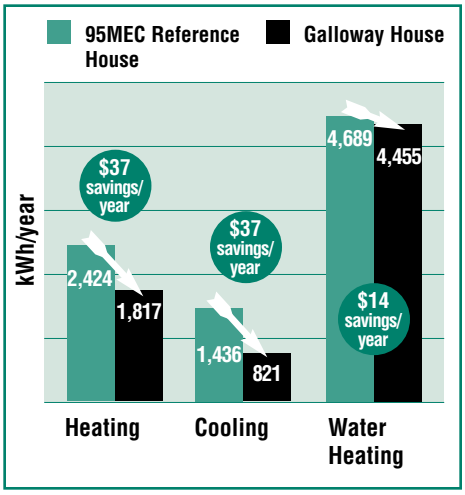
In addition to conserving energy, the energy-efficient measures implemented in the Galloway house will reduce harmful power plant emissions of carbon dioxide by 2,185 lb/year; sulfur dioxide by 22 lb/year; and nitrogen oxides by 8 lb/year. Applying sustainable energy principles to building design and construction not only reduces energy consumption and increases the affordability of homes, it also helps reduce environmental impacts.

HEATING AND COOLING LOADS



The energy-efficient features of the Galloway house considerably reduced the annual estimated heating and cooling loads compared with a reference house that meets the 1995 Model Energy Code (MEC) and uses minimum efficiency equipment. This reduction in annual loads also reduced the need for larger heating and cooling equipment. Using the Air Conditioning Contractors of America's Manual J calculation, the design loads were calculated to determine the proper sizing of equipment.

ENERGY CONSUMPTION AND COSTS



The energy-efficient measures applied to the Galloway house reduced the combined heating and cooling energy consumption to less than 70 percent compared with a 95MEC reference house. The reduction in heating and cooling consumption results in significant estimated energy and cost savings for the Galloway house. Cost savings assume annual energy costs at $0.058/kWh.

THE GALLOWAY FAMILY HOME

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ENERGY FEATURES

✓ Insulation Details

- Insulation levels exceed 1995 Model Energy Code requirements
- Attic has R-38 blown-in fiberglass compared with standard R-30
- Attic hatch is covered with multiple layers (about R-10) of rigid board insulation
- Blocking used around attic access to achieve full insulation coverage
- Soffit dams and rafter baffles used to achieve full insulation coverage over exterior walls
- 2x4 walls have R-15 fiberglass batts with ½-inch (R-2.5) rigid board insulation over exterior sheathing compared with standard R-11
- Wall insulation cut to fit in small spaces and around wiring and electrical boxes
- Exterior wall behind bathtub insulated before tub was set in place
- Floors have R-19 fiberglass batts
- Floor insulation installed flush to floor and secured with insulation hangers (rods)
- Floor insulation cut to fit around plumbing, wiring, and ducts

✓ Window Qualities

- Exceed 1995 Model Energy Code requirements (total window R-value of 2.2)
- Wood-framed (compared with standard metal-framed with a thermal break)
- Double-pane glass for improved insulation effects
- Low-e glass for reduced solar gains in summer and reduced internal radiated heat loss in winter
- Large porch overhang for shading

✓ Infiltration Attributes

- Total envelope air leakage ≤ 0.4 natural air changes per hour
- Bottom plate sealed to foundation with caulk
- Exterior wall behind bathtub air-sealed using plastic sheeting caulked to framing
- Windows and doors sealed into rough opening with backer rod or caulk
- All wiring and plumbing penetrations in exterior walls, floors, and ceilings caulked
- Bathtub drain penetration sealed with rigid board insulation and caulk
- Plumbing pipes and electrical boxes sealed to drywall with caulk
- Bathroom ventilation fan sealed to ceiling with caulk
- Joints in rigid board exterior wall insulation caulked or taped

✓ Mechanical Equipment Properties

- Heat pump with a seasonal energy efficiency ratio (SEER) of 10 and a heating system performance factor (HSPF) of 6.8
- R-6 duct insulation
- Return duct plenum in hallway sealed
- Duct boots sealed to floor with caulk
- Ducts well sealed (duct leakage ≤ 100 cfm25)
- Bathroom ventilation fan vented to outside

ENVIRONMENTAL/HEALTH FEATURES

- 6-mil plastic installed over crawlspace ground and lapped at foundation and joints
- Passive radon mitigation system installed in crawlspace
- Construction waste recycled

Printed with a renewable-source ink on paper containing at least 50% wastepaper, including 20% postconsumer waste.

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