Project Summary

Pulte Homes—Las Vegas, Nevada Cost-Saving System Trade-Offs for Hot, Dry Climates

Unvented Roof, High-Performance Windows, Combo Domestic Hot-Water and Air-Conditioning Unit
vs.
Vented Roof, Conventional Double-Glazed Windows, Furnace and Air-Conditioning Unit

Building America is an industry-driven program sponsored by the U.S. Department of Energy (DOE) for applying system engineering approaches that accelerate the development and adoption of innovative building processes and technologies. The goal of the program is to produce energy-efficient, environmentally sensitive, affordable, and adaptable residences on a community scale. Field support is provided by the National Renewable Energy Laboratory (NREL).

Building America houses in Las Vegas, Nevada, are using state-of-the-art building materials and systems to provide residents with much lower energy bills than standard construction.

The houses use spectrally selective glass, which lets visible light through but keeps the solar gain out, and an innovative unvented roofing system that changes the home's thermal barrier from the ceiling to the roof deck. Ductwork and air conditioners are located "inside," surrounded by attic air at close to 75˚F rather than as much as 140˚F, as in a typical home.

These homes are constructed from 2x4 or 2x6 framing with insulated cavities. A layer of foam insulation on the exterior under the stucco provides a highly insulated wall assembly. Unvented roof construction can make the building enclosure as much as 50% tighter than standard construction, reducing ceiling drafts and improving comfort and energy efficiency.

Heat is provided during winter months through a fan-coil (water-to-air heat exchanger) installed in the air handling unit.

Hot water is piped to the fan-coil from the hot-water tank when the house thermostat calls for heat.

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These houses can be so energy efficient in the heating mode that conventional furnaces are no longer necessary. Gas water heaters, located in garages, provide hot water whenever needed and also provide space heating for the homes. In other houses, the furnace is downsized and uses a more efficient closed combustion design.

In the cooling mode, the energy-efficient, spectrally selective glazing system and unvented roof construction allow designers to use air-conditioning units that are as much as 30% smaller than those of typical construction.

The key problem addressed by the Building America approach is the effect of air leakage of ductwork and air handlers located in vented attics. By moving the thermal and air-tightness plane to the roof deck (right), all of the ductwork and air handlers are now located within the conditioned envelope (below).

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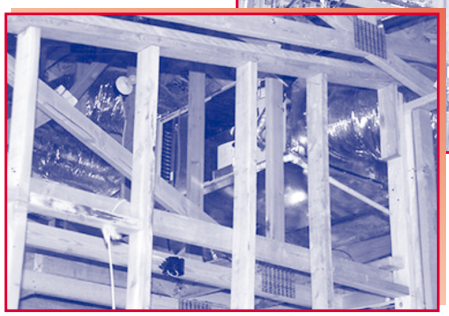

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The houses built under the Building America program in Las Vegas are superior in performance and provide lower operating costs (i.e. utility bills and maintenance) than typical houses. Building America houses save money for the home owner by reducing electric air-conditioning costs and gas heating costs with little or no additional investment. The homes also significantly benefit electrical utilities by reducing peak demand and installed cooling capacity.

Most importantly, Building America houses usually have better indoor air quality than typical houses. Building America homes with supply air ventilation reduce negative pressures that can result in soil gas, radon, and pesticide ingress and spillage, back drafting of combustion appliances, and the nuisance of dust marking on carpeting.

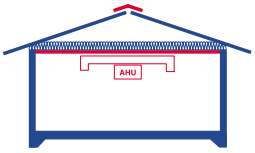
BUILDINGS FOR THE 21ST CENTURY

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.

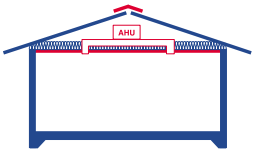
Comparison of Energy Performance of Vented Roofs vs. Unvented Roofs in Las Vegas

House 1
(Ideal Case)
Fully ventilated attic, no ductwork in attic, perfect air barrier at ceiling



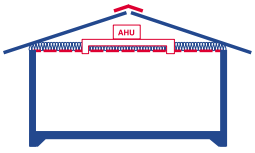
Air handler unit (AHU) and ductwork completely inside the conditioned space.

House 2
Fully ventilated attic, perfectly sealed ductwork and AHU in attic, perfect air barrier at ceiling



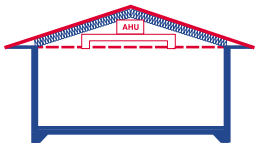
Energy performance -3% to -5% penalty compared with ideal case due to conductive losses across the ductwork and AHU.

House 3
(Leaky Construction)
Fully ventilated attic, leaky ductwork and AHU in attic, imperfect air barrier at ceiling



Energy performance -15% to -30% penalty compared with ideal case due to air change induced by leaky ductwork. House 3 is a more realistic "base case" for typical residential construction.

House 4
Non-ventilated attic, insulation tight to underside of roof deck, leaky ductwork and AHU completely inside the conditioned attic, typical ceiling construction



Energy performance -3% to -5% penalty compared with the ideal case (House 1). However, it allows for as much as 20% to 30% savings over leaky construction (House 3).

*Incremental Cost Summary to Achieve Building America Performance Level for Typical House Layout in Las Vegas**

Not installing roof vents	$ -250
Installing insulation at underside of roof deck	+750
High-performance windows	+500
Savings on air-conditioning system	-1000
Controlled ventilation system	+100
Integrated heating domestic hot-water system in place of furnace	-100
Total Incremental Cost	**$ 0**

** Estimated costs for production builders. Actual costs vary depending on features selected by the builder/developer team.*

Leakage is no longer an impediment to the safe and efficient operation of heating and cooling equipment in Building America houses. Although an energy penalty is associated with thermal gains due to the unvented roof construction, an offsetting thermal benefit is associated with the reduction of pressure differentials and thermal losses from the HVAC system. The net positive effect is estimated to be as much as a 20% to 30% reduction in cooling energy compared to leaky construction and a significantly safer building enclosure (see figures above).

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