

Up-Front Payback for Energy Improvements

by Ken Zenzel



Builders often justify the cost of energy design improvements in terms of lower energy bills over time (see "Energy Upgrades: Cash Flow vs. Payback," *Focus on Energy*, 4/96). But people sometimes don't realize that energy-efficient design can also have an immediate payback. In cooling climates, for example, design and construction details can reduce peak cooling loads. This allows the builder to reduce construction costs for air conditioning by installing smaller equipment, smaller ductwork, and smaller electrical service.

For 20 years or more, contractors have sized cooling equipment by a simple, traditional formula: one ton per 600 square feet of floor area, plus half a ton. But if you build a house to the standards specified in the *Model Energy Code* and make other modest improvements, you

can cut that capacity requirement in half. Some design choices that reduce cooling loads, such as reorienting windows, may not add cost at all. And choices that do add cost, such as purchasing double-glazed or low-e windows, may pay for themselves right away.

Since most builders are now building tighter and insulating better, the typical new house has reached the point of diminishing returns in the areas of air-tightness and insulation. So instead of focusing on those issues, I'm going to look at two other areas where many builders could still make major gains: windows and ductwork.

Windows

Compass orientation (north-south, or east-west), shading, frame type, low-e coatings, and the amount of

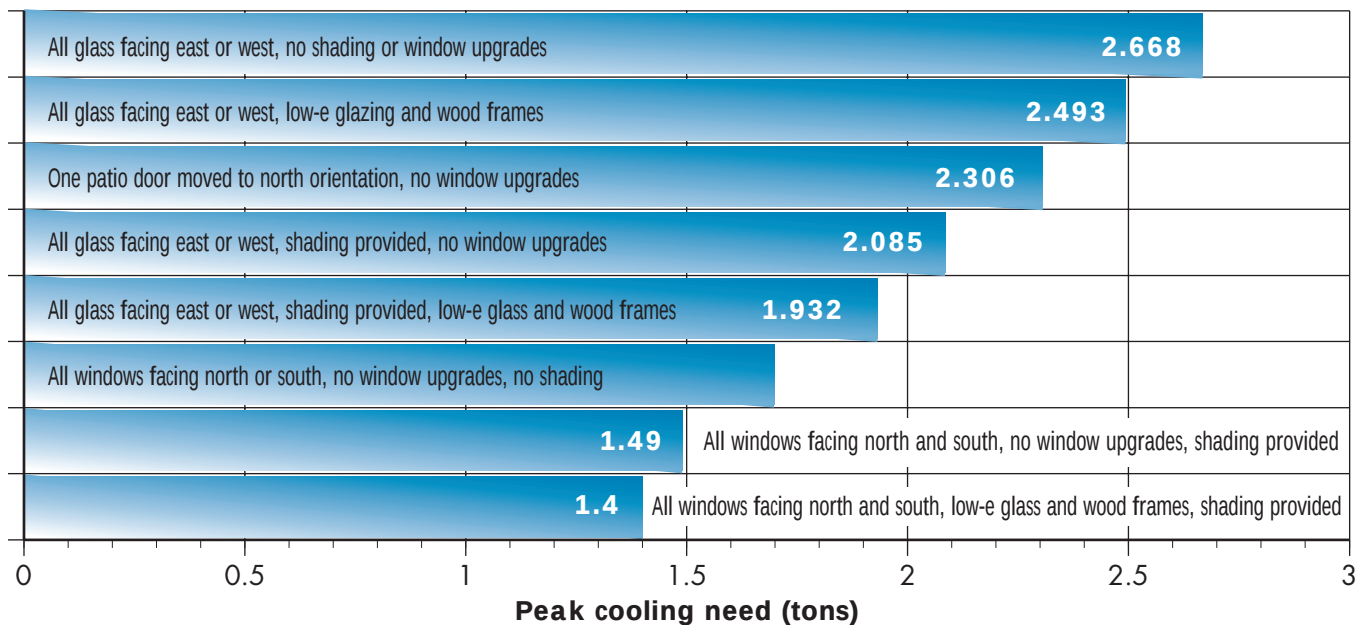
glass area all affect the heat gain contribution of windows. By building with these factors in mind, you can dramatically reduce the amount of cooling a house needs.

Simple double-pane windows with aluminum frames have an effective insulating value of less than R-2, compared to at least R-14 for walls. So in terms of insulating value alone, the total amount of window area has an obvious effect on cooling needs.

However, the greatest part of the savings in eliminating or moving windows comes from reducing solar gain through the glass. Replacing a west-facing patio door with a wall, for instance, can reduce cooling loads by a quarter of a ton. Moving windows from an east or west exposure to a north or south exposure and adding shades or blinds can cut a home's total cooling load by as much as 40%.

It may cost nothing to reorient a floor plan or to choose a site with a favorable exposure for a specific plan. But if significant window area must face east or west, consider wood or vinyl frames and low-e glass — and compare the added cost to the

Cutting Peak Cooling Loads



Using software based on Manual J, the author calculated peak cooling loads for a typical 2,000-sq. ft. home in Virginia with 235 square feet of glazing. Cooling needs can be sharply reduced by correctly locating windows. In the base case at top, metal-frame windows are all on the east or west walls of the building; the house requires more than 2.6 tons of cooling, requiring in practice a 3-ton air conditioner. Buying low-e

wood-frame windows would cut the peak load below 2.5 tons; but simply moving a patio door to the north wall would drop the load by nearly a quarter ton. Even without buying advanced windows, the cooling requirement can be reduced below 1.5 tons by realigning the house so all the windows faced north or south, and providing shading for windows. This provides an immediate cost savings of hundreds of dollars.

immediate savings of downsizing air conditioning.

Also, consider the potential for natural shading. You may be able to plant a tree that will shade windows or relocate a window so it will be shaded by an existing tree.

Ductwork

If you reduce the need for cooling, you save on ductwork as well as equipment, since smaller systems require smaller ducts and registers. Beyond that, reducing duct leakage and minimizing radiant heat gain by ducts lets you further reduce the size of the air-conditioning equipment.

Even in new systems, leaky ductwork often wastes 20% to 30% of system capacity because conditioned air leaks out of supply ducts and unconditioned air is drawn into return ducts. Duct leakage can also increase general air leakage by creating pressure differentials between the inside and outside of a house.

For home energy analysis in the state of Virginia, we measure duct losses in terms of cubic feet per minute (cfm) per square foot of floor area. In typical new homes, we frequently measure ductwork losses of 20% — as much as 400 cfm of duct leakage in a 2,000-square-foot house. A reasonably conscientious hvac installer may commonly cut those losses in half. But Virginia utility rebate programs require builders to reduce total ductwork leakage in cfm to 3% of the floor area in square feet (60 cfm in a 2,000-square-foot home), a level that takes real effort to achieve.

Typical flaws in duct systems include loose connections of starter

collars to trunks, gaps around boot penetrations through ceilings and floors, loose-fitting panels on air-handler cabinets, and use of wall or floor cavities as plenums.

To minimize energy losses from duct leakage to the outside, you can either require your hvac sub to eliminate such defects and reach an acceptable standard of duct leakage (a duct-blast test is a good way to verify this), or just figure out a way to locate your duct systems inside the conditioned space — for instance, between the first and second floor — rather than in an unconditioned attic or crawlspace. But bear in mind that relocating ducts to the between-floor area will only cut leakage losses if the perimeter of the floor system (band joist area) is itself well sealed.

Where ducts must be run through hostile spaces, you can help to limit the heat gain by raising duct insulation levels to R-6, or by cooling the attic with improved ventilation or an attic radiant barrier.

Figuring Your Savings

The gains you make by smart energy design will be blown if you let your hvac contractor sell you an air conditioner that is too big. Equipment for every house should be sized using an approved heat-loss and heat-gain analysis (such as Manual J), based on specific data for that house (see “Sizing Air Conditioners,” 8/96). Even using Manual J, hvac subs can easily manipulate the assumptions to corroborate their rule-of-thumb approach — for instance, by raising the assumed outdoor temperature and lowering the design indoor tempera-

ture until they get the “right” answer. To avoid that, require the use of the outdoor design temperature specified for your location by ASHRAE, and an indoor design temperature of 75°F. Then, do not arbitrarily increase the amount of equipment determined by the analysis.

The immediate cost savings from good energy design and construction are significant (see chart, previous page). For example, a relatively simple rearrangement of windows from east-west to north-south orientation, combined with window upgrades and shading for windows that stay on the east or west sides, could easily reduce cooling needs by more than a ton.

These gains are not additive, however — the first steps you take will yield the greatest benefit. For instance, if you lower your total cooling needs 30% by reorienting windows, the amount you stand to gain with another improvement like tightening ducts is reduced by that same 30%. So implement the least costly strategy first, then reevaluate to see if the next step is still cost-effective.

It's worth learning how to balance energy design costs against hvac costs. Even if the cost of upgrades isn't completely offset by the savings on air conditioning, your customers will still benefit from lower utility bills — and you will benefit from becoming known as a value-conscious builder. ■

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