Efficiency *Dos* and *Don'ts* From an Energy Nerd

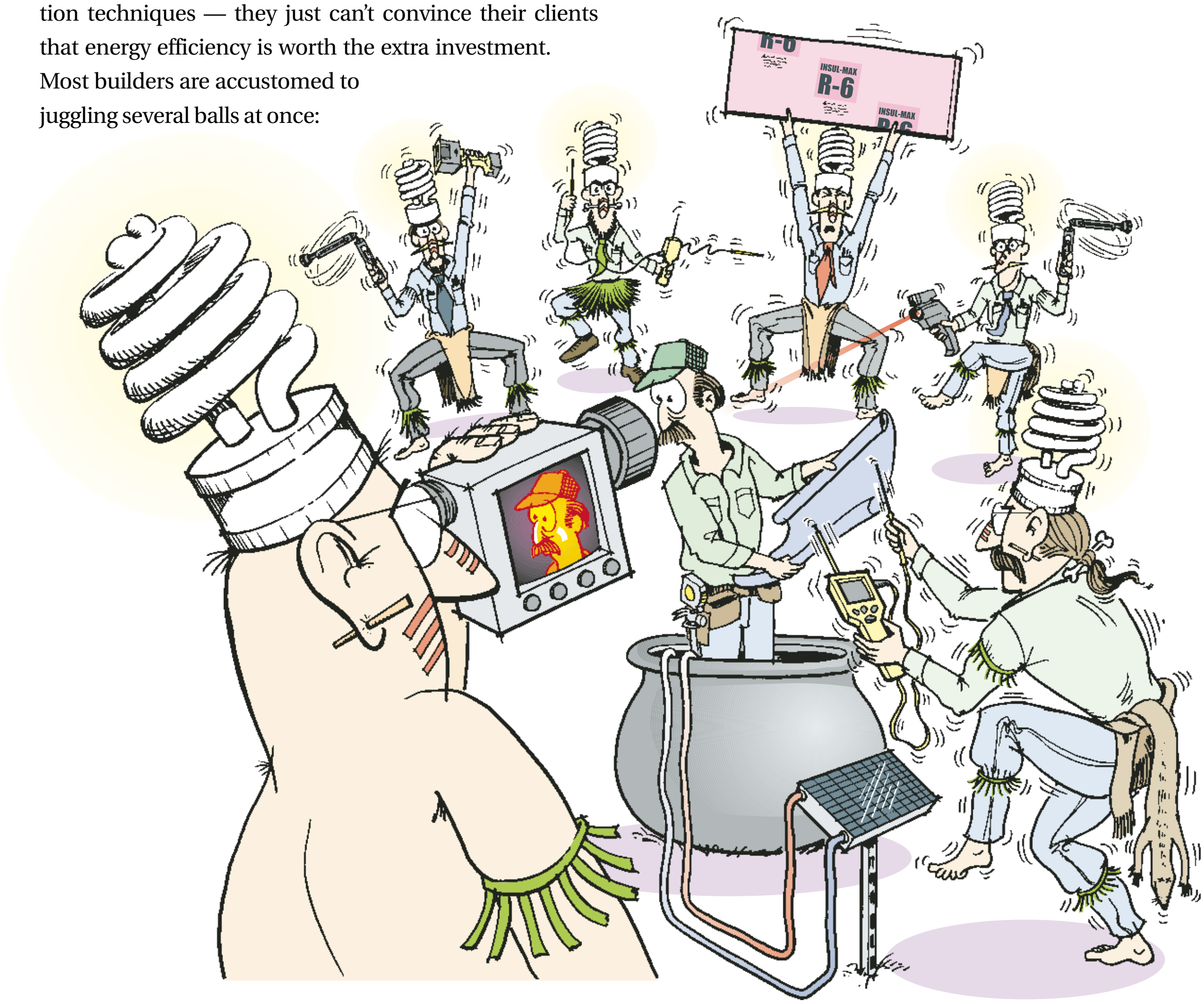
by Martin Holladay

With high fuel prices here to stay, now is the time to get it right

Although I used to be a builder, I now work as a reporter for an energy-efficiency newsletter. Joining the tribe of energy nerds has altered my perspective, making me single-minded and opinionated. Watching new-home builders in action, I can often be heard to mutter, "Why do they always build it that way?"

Of course, I realize that many of the builders I grumble about are actually familiar with energy-efficient construction techniques — they just can't convince their clients that energy efficiency is worth the extra investment. Most builders are accustomed to juggling several balls at once: They need to satisfy their clients, keep the local building inspector happy, and make a profit.

Sometimes, however, a builder gets lucky and lands a client who insists on a high-performance home and is willing to pay for it. To help you get ready for that day, here's a list of dos and don'ts from an energy nerd's perspective — starting with the don'ts.



Don't Design a Complicated Roof

For those who espouse the principle "form follows function," the ideal roof is a simple gable over an unheated attic, much like the roof on the house we all drew in kindergarten. Unfortunately, designers these days are fond of complicated roofs — ones with enough valleys, dormers, and intersecting planes to make the home look from a distance like an entire Tuscan village.

Such roofs are difficult to insulate without resorting to spray polyurethane foam. Though spray foam is effective, it's also expensive. In most cases, simple roofs are easier to insulate, easier to ventilate, and far less prone to ice dams than complicated roofs.

Don't Install a Hydronic Snow-Melt System

Snow can be removed from a driveway with a shovel, a snow-blower, or a plow. It can also be removed by burning great quantities of fuel to heat water circulating through buried pipes.

In rare cases — for example, at the home of a handicapped client — a hydronic snow-melt system makes sense. In most homes, however, such systems are uncalled for.

In 60 years, when global climate change has made snow rare, history books will explain to our grandchildren how hydronic snow-melt systems used to work. Our descendants will shake their heads, astonished that their ancestors burned fossil fuels so wantonly.

Don't Build a Poorly Insulated Slab

In a hot climate, an uninsulated slab in contact with cool soil can lower cooling costs. In a cold climate, though, slabs should be well-insulated.

Some cold-climate builders, having learned that heat rises, install thick attic insulation while leaving their slabs uninsulated. But heat actually moves from warm to cold in all directions. While it's true that in winter the soil beneath a slab is warmer than the outside air, a slab can still lose a significant amount of heat.

In cold climates, a basement slab should be insulated with at least 2 inches of extruded polystyrene (XPS) under the entire slab. For a slab-on-grade home in a cold climate, specify 3 or 4 inches of XPS under the entire slab, with additional vertical foam at the slab's perimeter.

Foil-faced bubble pack (R-1.3) is no substitute for adequate insulation; under a slab, it's virtually useless.

Don't Insulate Rim Joists With Unfaced Fiberglass

Although fiberglass insulation is a thermal barrier, it is not an air barrier. If unfaced fiberglass is used to insulate a rim joist, moist indoor air can filter through the batt, leading to condensation at the cold rim joist. The result, eventually, is mold and rot.

There are several acceptable ways to insulate a rim joist. Rigid foam insulation can be installed on the exterior of a recessed rim joist; small pieces of rigid foam can be inserted in each joist bay from the inside; or spray polyurethane foam can be used to seal the entire rim-joist area.

Don't Install Recessed Can Lights on the Top Floor

Despite their tendency to cast strange shadows on people's faces, recessed can lights retain an inexplicable popularity. Ignoring the pleas of lighting experts — who note that it makes more sense to light the ceiling than the floor — many customers still request recessed cans.

When installed in an insulated ceiling, these fixtures are an energy disaster.

Some builders have switched to "airtight" cans. But airtight cans are not completely airtight. The amount of leakage depends on the care exercised when installing the gasketed trim kit, and any future trim changes can affect the fixture's airtightness.

It is much easier to air-seal electrical boxes installed for surface-mounted fixtures than to air-seal a recessed can. Just say no to recessed cans.

Don't Install Oversized Hvac Equipment

Compared with homes built 30 years ago, today's houses are more airtight and better insulated, so their heating and cooling loads are smaller.

Yet many hvac contractors continue to use old rules of thumb to size furnaces and air conditioners, often throwing in a generous safety factor for good measure.

Oversized furnaces and air conditioners cost more than right-sized units. Oversized equipment frequently operates less efficiently, too, because it suffers from short cycling. An oversized air conditioner often shuts down before it's had a chance to wring much moisture out of the air, compromising comfort.

Although hvac contractors usually claim to have performed detailed load calculations, you should insist on seeing written evidence. Heating and cooling loads should be calculated for each room and must be based on accurate specifications for window sizes, orientation, and U-factor, and for the installed glazing's solar heat coefficient. Don't let your contractor talk you into adding a safety factor to a calculated load.

Experience has shown that builders who want right-sized hvac equipment need to educate themselves on this issue and double-check the work of their hvac sub.

If you don't feel qualified to verify your sub's calculations, at least specify two-stage equipment that can operate at partial load most days of the year.

Don't Install Hvac Equipment Or Ducts in an Attic

An attic is almost as cold as the exterior in winter, and can be much hotter than the exterior in summer. While attic floors are often insulated to R-38, attic ducts are usually insulated to a measly R-4 or R-6.

During the summer, the difference in temperature between the cool air in the ducts and a hot attic is much greater than the difference in temperature between the indoor and the outdoor air. So why does attic ductwork have so much less insulation than a wall or a ceiling?

Moreover, the air in a supply duct is at a much higher pressure than the air inside a house. Since most duct seams leak, a significant portion of the volume of air passing through attic ducts usually leaks into the attic. Any leaks in return ducts allow the blower to pull hot, humid attic air into the air handler.

Installing a furnace or air handler in an attic causes even more problems than merely installing ductwork there. A recent study found that the leakage of a typical air handler, coupled with the leakage at the air-handler-to-plenum connection, amounts to 4.6 percent of the airflow on the return side. If the air handler is installed in an attic, a 4.6 percent return-air leak can produce a 16 percent reduction in cooling output and a 20 percent increase in cooling energy use. Any duct leakage would make the situation even worse.

In most homes, hvac equipment and ductwork belong in the basement or crawlspace. If it's absolutely necessary to build on a slab, include a utility room for hvac equipment and install ducts in air-sealed interior soffits.

Don't Install a Powered Attic Ventilator

Many builders assume that hot attics are a problem. If soffit and ridge vents don't keep an attic cool, they may decide to install an exhaust fan in the attic to improve attic ventilation. This is almost always a mistake.

If an attic has no ductwork or hvac equipment and its floor has a deep layer of insulation, high attic temperatures don't matter much. In fact, high attic temperatures can help lower winter heating bills.

Several studies have shown that a powered attic ventilator often draws its makeup air from air leaks in the attic floor, pulling conditioned air out of the house instead of in from the soffits. This, of course, increases the homeowner's energy bills.

Don't Use a Standard Furnace Fan To Distribute Ventilation Air

Most new homes include some type of whole-house mechanical ventilation system — for example, a passive outdoor-air duct connected to a furnace's return-air plenum. Some builders provide ventilation by connecting a heat-recovery ventilator (HRV) to the home's forced-air ductwork.

Both methods have an Achilles heel: They depend on the furnace fan to distribute ventilation air. In homes equipped with air cleaners, homeowners may leave the furnace fan running continuously.

This can carry a substantial energy penalty. Furnace fans are designed to move a lot of air — up to 1,400 cfm — yet most homes require only 50 or 100 cfm for ventilation. In fan-only mode, certain furnaces can draw as much as 700 to 800 watts.

One solution is to specify a furnace with a blower powered by an electronically commutated motor (ECM) that draws 200 to 250 watts in fan-only mode. Another is to choose a different type of ventilation system — a simple exhaust-only system or an HRV with dedicated ventilation ductwork.

Don't Install a Humidifier

Homes with very dry indoor air during the winter are usually leaky. Make the building more airtight, and it won't be as dry.

Installing a humidifier is so risky it should be avoided like the plague. In cold climates, almost all moisture problems are worsened by elevated indoor humidity. High levels of indoor humidity are associated with wet walls and wet roof assemblies.

If homeowners want a humidifier, warn them about the dangers of humidification. If they insist, let them install it themselves after you leave the job.

Address the Basics First

The design of an energy-efficient house begins with a well-insulated, air-sealed shell and very efficient hvac equipment, which means a minimum 90 percent AFUE (annual fuel utilization efficiency) furnace and 13 SEER (seasonal energy efficiency ratio) air conditioner.

Anyone intending to build an energy-efficient house needs to be sure these basic requirements are met before considering exotic (and expensive) components like photovoltaic modules.

Do Orient the House Properly

Passive-solar design does not need to be complicated; a few simple steps can save significant amounts of energy. Yet most new-home builders still pay almost no attention to orientation.

If the lot size permits, a house should always be oriented with its long axis aligned in an east-west direction. In most climates, about half the home's windows should be facing south. In hot climates, it's important to minimize the number and size of west-facing windows.

Do Install Basement Wall Insulation

According to the prescriptive requirements of the International Energy Conservation Code, basement walls should be insulated in climate zones 4 and higher.

Basement walls can be insulated from the exterior or the interior. Most builders find that installing interior basement insulation is easier and cheaper than installing exterior basement insulation; far too often, however, they get the details wrong.

Interior basement insulation is effective only if the work is properly detailed and meticulously installed. The rim-joist area must be air sealed (either with sprayed polyurethane foam or very careful caulking), and the rim-joist area and walls must be carefully insulated with rigid-foam sheets or sprayed polyurethane foam. Never use fiberglass batts to insulate basement walls.

Exterior basement insulation usually performs better than interior basement insulation. It locates the wall's thermal mass within the building's thermal envelope; if installed properly, it can be used to protect the rim-joist area. Also, by keeping the concrete warm, it prevents the condensation and moisture problems often associated with interior basement insulation.

Do Install Better Windows

Windows represent the weakest thermal link in most building envelopes. Unfortunately, the U.S. Department of Energy has chosen to set a very low bar for Energy Star windows, so Energy Star labels provide little guidance to builders. In most parts of the country, in fact, an Energy Star window is equal to a code-minimum window.

Specifying windows can be complicated, but a few general principles apply. Casement windows usually have less air leakage than double-hung windows. In heating climates, the best windows will have a lower U-factor than windows minimally complying with Energy Star standards (U-0.35). Consider investing in windows with argon-filled triple glazing and two low-e coatings; such windows are available with a whole-window U-factor as low as 0.17.

In south central and southern climate zones, Energy Star specifications call for windows to have a maximum solar heat-gain coefficient (SHGC) rating of 0.40. In these zones, consider purchasing windows that beat this standard — that is, windows with an SHGC below 0.40. Specifying glazing with a very low SHGC is especially important for west-facing windows, since these are the ones most likely to contribute to overheating.

Do Install Rigid Foam Wall Sheathing

Many cold-climate builders still cling to the belief that foam sheathing creates a wrong-side vapor retarder and therefore contributes to wall rot. In fact, the inside surface of foam sheathing will be much warmer than the inside surface of OSB or plywood sheathing, and will therefore be less likely to support condensation. Foam-sheathed walls, if built correctly, are less likely to have moisture problems than walls sheathed with OSB or plywood.

Foam sheathing wraps a home's walls in a warm jacket, keeping the framing warm and dry and greatly reducing thermal bridging through studs. Furthermore, if foam sheathing is held in place with vertical strapping, a rain screen is created behind the siding.

Builders making the switch to foam sheathing must choose one of three strategies for bracing walls against racking. They can install traditional 1x4 let-in braces, diagonal steel strapping (for example, Simpson TWB straps), or, at the corners, sheets of well-nailed 1⁄2-inch plywood. The plywood can then be covered with 1⁄2-inch rigid foam to match the thickness of the 1-inch foam installed everywhere else.

Of course, before settling on a bracing method you should make sure your local building inspector approves of your plan.

Do Install a Drain-Water Heat-Recovery System

One of the simplest and most cost-effective ways to reduce energy used for domestic hot water is to install a drain-water heat-recovery device.

The best-known such device is the GFX, which consists of a length of 3- or 4-inch copper drainpipe surrounded by a spiraling cocoon of 3⁄4-inch copper tubing (see *Notebook,* 3/97). Designed to be installed vertically in a plumbing waste line, a GFX unit transfers about 55 percent of the heat energy in the drain water to the incoming supply water. In homes where residents prefer showers to baths, a GFX can save 20 percent to 25 percent of the energy used for water heating.

The best thing about a GFX unit is its indestructibility: Having no moving parts, it is likely to last as long as the house in which it's installed. Model S3-60, the whole-house model (a 3-inch copper drain 60 inches long), costs $520.

Do Install a Solar Hot-Water System

Rising energy prices have made solar hot-water systems a good investment in most parts of the country. At sites beyond the reach of natural gas pipelines — where conventional water heaters must be fueled by either propane or electricity — an investment in a solar hot-water system will usually have a fairly quick payback.

A substantial fraction of the hot-water needs of most families can be met by two 4-foot-by-8-foot collectors. It's almost always better to have an oversized storage tank than an undersized tank; if the budget permits, install a 120-gallon stainless-steel indirect water-heater tank from Amtrol, Bradford White, Burnham, Heat Transfer Products, Triangle Tube, or Viessmann. An instantaneous gas water heater can be used for backup.

Do Upgrade the Mechanical Ventilation System

Because an energy-efficient house has a well-defined air barrier and very low air-leakage rates, mechanical ventilation is essential.

Ventilation can be provided with a simple exhaust-only system (a timer-controlled bath exhaust fan, for example) or a passive supply system (such as a passive fresh-air duct, controlled by a motorized damper and connected to a furnace's return-air plenum).

But the most efficient way to provide fresh air to every room is with an HRV or an energy-recovery ventilator (ERV). Currently, the most energy-efficient ERV available is the RecoupAerator 200DX from Stirling.

Do Install Dedicated Ventilation Ductwork

Every HRV deserves dedicated ventilation ductwork. Ducts designed to distribute air for heating or cooling are not optimal for distributing ventilation air, so don't try to use the same ducts for both purposes.

A forced-air heating system usually draws its return air from a big grille in the hallway. An HRV, on the other hand, should draw its exhaust air from bathrooms, utility rooms, and the laundry room. Unlike forced-air heating ducts, ventilation ducts are sized for low airflow; usually they measure only 4 inches or 6 inches in diameter.

Do Install a Better Lighting Package

Installing compact fluorescent instead of incandescent bulbs is probably the most cost-effective energy upgrade in any home. Now that the quality of compact fluorescent bulbs has improved and prices have dropped, make sure all your houses are incandescent-free.

A good source of information on energy-efficient lighting, the "High Performance Lighting Guide," is on the Web at www.ibacos.com/hpl1.html.

Do Arrange for Blower-Door Testing

Do you know how much air leaks under your rim joists or bottom plates? If you're still a blower-door virgin, you haven't yet earned the right to brag to customers about construction quality. Most blower-door contractors can recount stories of proud builders humbled by the revelations of a door-mounted fan.

Once you're familiar with the lessons taught by whole-house depressurization, you'll probably be more conscientious with gaskets and spray foam on your next house.

Tweaking the Recipe

It goes without saying that it's possible to build a high-performance house that deviates from these guidelines. The recommendations are based on logical principles, but they inevitably reflect my own biases. Furthermore, specifications for an energy-efficient house depend greatly upon local climate.

Before settling on any construction details, you should always investigate methods used by other energy-efficient builders in your region.

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