TEN WAYS TO IMPROVE A NEW HOME

Musings of an Energy Nerd

Contemplating residential energy use

TEN WAYS TO IMPROVE A NEW HOME

To keep future energy bills low, remember these ten key points

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Buying an inefficient refrigerator is an expensive mistake. But at least the solution is simple: you can always buy a new refrigerator.

If you build an inefficient house, however, you may have an unfixable problem on your hands. Some newly built homes are so poorly designed, sited, and built that it would be cheaper to demolish them and start again than to correct all their flaws.

Assuming you get the details right from the start, the incremental cost of better energy features will be affordable, and you'll still be smiling when energy prices double. But if you get the details wrong — if you choose cheap windows or build a leaky ceiling — you may be stuck with a white elephant.

The great tragedy of poorly built new homes is that many details that would have been easy to include at the time of construction are notoriously difficult to retrofit. To be sure your new home is an energy miser, not an energy hog, follow these ten important steps.

Measure, don't guess. The performance of any new home depends on the integrity of the home's air barrier. Since the only way to determine a home's air leakage rate is to measure it, every new home should be tested with a blower door.

1. Design a small house

Avoid the temptation to build big, even if you think you can afford it. If you build a spare bedroom, remember that as long as you own the home, you'll be paying taxes on it, heating it, cooling it, ventilating it, and vacuuming it. Maybe all you really need is a fold-out couch.

If you've ever been lucky enough to visit friends in Paris, Madrid, or Rome, you know that it's possible to live a luxurious, civilized life in a small apartment. If it weren't for building code requirements, I'd advise you to design your next house like a sailboat; failing that, at least use boat design principles for inspiration.

2. Orient the house properly

Passive solar design principles aren't very complicated; a few simple steps can save significant amounts of energy.

If you're building on a lot that is large enough to give you some flexibility, try to orient the house with the long axis aligned east-west. That provides the best orientation to take advantage of winter sunlight; it also makes it easier to avoid afternoon overheating.

In a cold climate, it's best if your south elevation is unshaded. In a hot climate, however, you probably want to preserve as many trees as possible.

3. Plan your windows carefully

It's painful to see an otherwise well-designed home with bad windows. Unfortunately, such houses are extremely common.

It's the designer's job to be sure that windows are properly sized, properly oriented, properly shaded, and properly glazed. Designers should always use energy modeling software when sizing windows.

If you drive through a new residential development in Texas or Georgia, it's easy to tell which houses have oversized windows — just look for the curtains and shades. Many of these homeowners have paid for windows that might as well be covered with sheetrock — to avoid glare and overheating, the owners are forced to retreat behind curtains or blinds. If these homes had been properly designed, the windows would have been fewer, smaller, better shaded, and equipped with low-solar-gain glazing.

Windows in a hot climate — and west-facing windows in almost all climates — need glazing with a low solar heat gain coefficient (SHGC) — 0.30 or lower. In a hot climate, east- and west-facing windows should be minimized.

In climates with a significant heating season, it makes sense to orient about half of a home's windows to the south. Cold-climate builders should seriously consider using triple glazing — at least for the north, east, and west windows, and perhaps for the south windows too. South-facing windows should have a high SHGC — 0.42 or higher.

In all climates, south-facing windows should be protected by a roof overhang that shades the windows during the hottest time of the year. Finally, all windows in all climates should include low-e glazing.

If your house is small and tight, you may be able to save some money on your heating and air conditioning equipment; use those savings to upgrade your windows. Good windows cost significantly more than run-of-the mill windows, and they're worth every penny.

4. Design your air barrier

A home's air barrier is like a three-dimensional balloon surrounding the home's conditioned space. A builder needs to know exactly where that balloon is located, and exactly how it will be built.

The details of your air barrier design need to be finalized before the excavator shows up to dig your foundation. An air barrier is too important for job-site improvising by head-scratching framers, roofers, and window installers.

It's not enough to say, "I'm using Tyvek as an air barrier." If Tyvek is part of your air barrier system, you should be able to answer all of these questions before you begin building:
What happens at the base of the wall? How is the Tyvek tied in to your concrete foundation?
What happens at Tyvek seams?
What happens when Tyvek is cut for window installation?
What happens when the plumber installs a sill cock?
What happens at the top of the wall? How is the Tyvek tied to the ceiling air barrier?
Do any electrical boxes interrupt the air barrier?
How are floor and ceiling penetrations dealt with?
Of course, your air barrier may not include Tyvek — you might be using the airtight drywall approach, or you might be depending on spray polyurethane foam. That's fine, as long as your air barrier system is designed ahead of time.

5. Install above-code insulation

The building code describes the worst house that can legally be built. If you build a home any worse than code requirements, you can be arrested or fined. That's a pretty low bar, especially when it comes to insulation.
Architectural fads come and go, and many people live to regret certain choices — for example, a blue toilet, or fake exterior plastic quoins on the corners of a Dallas "chateau." But nobody has ever regretted installing extra insulation.
If you can find a way to build your foundation, walls, and ceiling with 50% more insulation than the code minimum, or even twice as much, you'll never regret it.

6. Install a drain-water heat-recovery device

A drain-water heat-recovery device (for example, the GFX or Power-Pipe) is a simple and cost-effective way to reduce the amount of energy used for domestic hot water. The typical unit consists of a 3- or 4-inch diameter copper drainpipe surrounded by a spiraling cocoon of 3/4-inch copper tubing. When installed vertically in a plumbing waste line, such a device can transfer about 55% of the heat energy in the drain water to the incoming supply water.
In a home where the residents prefer showers to baths, this simple device with no moving parts can save between 20% and 25% of the energy used for water heating. The price for a 3-inch diameter 5-foot long GFX unit is $710.

7. Keep all ducts inside the thermal envelope

Putting ductwork in an unconditioned attic should be a criminal offense. An attic is almost as cold as the exterior in winter, and can be much hotter than the exterior in the summer. During the summer, the difference between the cool air in the ducts and the surrounding attic air is much greater than the difference in temperature between the indoor and outdoor air. So why is attic ductwork insulated to only R-4 or R-6, while the attic floor gets R-38 or more?
The air in a supply duct is at a much higher pressure than the air inside or outside a house. Most duct seams leak, so a significant portion of the air passing through attic ducts typically leaks into the attic. Moreover, leaks in return ducts allow hot, humid attic air to be pulled into the air handler.

Needless to say, installing a furnace or air handler in an attic causes even more problems than merely installing ductwork there. In an energy-efficient home, all of the HVAC equipment and all of the ductwork must be located within the home's conditioned space. No exceptions — end of story.

8. Upgrade the ventilation system

By now, most builders know that a tight home requires a mechanical ventilation system. If you're building a very good home, its envelope should be really, really tight.

Do yourself a favor and invest in a high-quality ventilation system — in other words, a heat-recovery ventilator (HRV) or energy-recovery ventilator (ERV) with dedicated ventilation ductwork. The system should pull stale air from the bathrooms and laundry room and deliver fresh air to the living room and bedrooms.

The most efficient available ERV in the US is the RecoupAerator 200DX (equipped with an ECM motor) from Ultimate Air.

9. Address lighting and appliances

For any home, the most cost-effective energy upgrade is to replace all incandescent bulbs with compact fluorescent lamps (CFLs). In recent years, the light output quality and dependability of CFLs have significantly improved. If you haven't visited a lighting showroom recently, you'll be surprised at the wide range of available fixtures specifically designed for CFLs. So make sure that every home you build is incandescent-free.

Lighting design is as much an art as a science. Here are some principles for effective lighting design:

It's better to bounce light off the ceiling than aim light at the floor. Ceilings should be white.
Include lots of task lighting; there's no need to light up the whole room like a baseball field if all you need is a reading light or work light.
Avoid the temptation to control a group of fixtures with a single switch. Individual toggle switches, one per fixture, should be installed in several locations to provide lighting flexibility. Don't line up all of a room's light switches in a single location like ducks in a row.
Avoid fixtures with elaborate shades or diffusers that limit the amount of light that leaves the fixture. It's crazy to hide a nice 70-lumen-per-watt CFL behind a heavy lamp shade.

Selecting the right appliances and equipment can save a significant amounts of energy. Keep in mind:

Some appliances are optional. Instead of shopping for efficient equipment, you might want to consider omitting a dishwasher, clothes dryer, air conditioner, automatic irrigation system, or swimming pool pump. Less is more.
Elaborate heating equipment makes little sense in a small, well insulated house. If your heating bill is only $500 a year, you don't need to spend tens of thousands of dollars on a ground-source heat pump or a radiant floor system.
Energy use is more important than energy efficiency. Energy Star labels can be misleading, since they usually compare an appliance only to other appliances of the same size. That's why a large Energy Star refrigerator can use more electricity than a small refrigerator without an Energy Star label. The same problem exists with labeled televisions. Ignore the Energy Star label; instead, compare wattage or kilowatt-hours per year.

10. Perform a blower-door test

Air sealing is too important to leave to guesswork. The only way to know a home's air leakage

rate is to perform a blower-door test; that test should be performed on every single home you build.

If the test is performed before drywall is hung, and if you're standing by during the test with lots of caulk and cans of spray foam, it won't be too late to fix some of the defects revealed by the blower door.

It's extremely challenging to build a house that meets the Passivhaus standard of 0.6 air changes per hour (ac/h) at 50 Pascals of depressurization. But even if you only reduce your air leakage rate down to 1.6 or 1.8 ac/h @ 50 Pa, your house will still be significantly tighter than most new homes.

TAGS: **AIR SEALING**, **BLOWER DOOR**, **ENERGY EFFICIENCY**, **ENERGY MEASURES**, **INCREMENTAL COSTS**, **NEW HOME**, **WINDOWS**

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