Getting Real About Energy Efficiency

by Paul Eldrenkamp

When it comes to the long-term energy performance of homes, there is little doubt — particularly after the recent spike in oil prices — that the marketplace is going to start expecting greater accountability and more sophisticated analysis. It's essential that those of us on the supply side (contractors and designers) keep up with the needs and priorities of the demand side (homeowners and home buyers). And the first step toward meeting those evolving needs is understanding the range of strategies we have to choose from.

In my experience, there are six main ways of thinking about household energy-efficiency improvements. In implementation, there aren't clear boundaries between these approaches; they're not mutually exclusive and in fact there can be significant overlap. But they do represent distinct ways of thinking about energy improvements — six different places from which to start the conversation.

There are several different ways to go about improving a house's energy performance. Contractors should be familiar with all of them.

Here they are, in order of analytical rigor:

Do some stuff and hope for the best

This seems to be how most weatherization work is done these days. A homeowner has no idea what his home's current energy usage is or how it compares with that of similar houses in the neighborhood, yet he has a general sense that there are opportunities for improvement. He hires an insulation contractor — often through a utility-rebate program — and has some insulation work done. Maybe this leads to an improvement, maybe not — nobody knows for sure, because nobody's really keeping score.

Or perhaps the homeowner has his kitchen renovated. The contractor, being a savvy, up-to-date "green" contractor, uses spray foam in the walls rather than fiberglass batts. Everyone assumes the extra cost is worth it — but again, no one knows for sure, because there's no attempt to compare pre-project and post-project energy usage, or even to ensure by means of a blower-door test that the spray foam was installed properly.

Roughly 90 percent of homeowners and contractors, I'd say, take this approach to energy improvements — which is why as a nation we're making such insignificant progress toward becoming a more energy-efficient society. For the most part, we're flying blind.

Do some stuff and measure what happens

With this approach, you do your usual energy improvements, but then you actually monitor whether or not those measures reduce household energy consumption. In my experience, the easiest analysis is to track Btu consumption from all energy sources over time and separate out the heating-load component from season to season based on local heating degree day data. Predominantly cooling climates will need to track cooling degree days. A detailed explanation of home energy performance measurement strategies is outside the scope of this article, but you'll find a good general introduction at homeenergy.org/consumerinfo/benchmarking-energy-usage.php.

Once you start keeping score in this way, you'll be able to figure out over time what works best, what works a little, and what doesn't work at all. Then, building on that knowledge base, you and your clients can start setting more specific targets and back them up with established past performance.

Calculate the payback period

The next step up is the payback calculation, which involves thinking in terms of what's cost-effective. For example, you may determine that it will cost $1,000 to upgrade your client's wall insulation, which will reduce his energy costs by $100 a year, so his simple payback will be 10 years ($1,000 total cost divided by $100 annual savings equals 10 years to recoup the cost). Various tools are available for this exercise; we use a simple spreadsheet developed by an energy consultant we work with.

A big problem with thinking in terms of payback period, however, is that what's cost-effective is a moving target — the extreme fluctuations in petroleum prices have made this abundantly clear.

Let's say we're planning an attic renovation and determine that it will cost $3,000 extra to upgrade the rafter insulation from R-40 to R-60. At current fuel oil prices, we estimate the payback to be 25 years, which doesn't sound like a good investment to the homeowner, who takes a pass on the upgrade. In five years, though, fuel oil prices have doubled or even tripled, and the extra insulation seems like a much better idea, so the homeowner gives us a call to see what we can do. Now, however, the upgrade is not going to cost $3,000 — it's going to cost $20,000, because we have to remove the drywall and insulation and start over.

Energy consultant John Krigger tells an anecdote about a similar — though larger-scale — issue in Germany in the 1990s: After reunification, the country embarked on a major project to add exterior insulation to the underinsulated masonry buildings in what had previously been East Germany. The designers calculated that the most cost-effective approach would be to add 2 inches of exterior rigid foam insulation with a stucco coating. Halfway through this massive undertaking, as Krigger tells it, they realized that the overall trend in energy prices actually made 4 inches of exterior insulation more cost-effective; the marginal cost of the extra 2 inches would be relatively small compared with the updated payback. The contractors were able to shift gears for the upgrades that had not yet been started, but it was too late for the buildings that had already been completed. Those buildings won't get another chance for several decades, when they're next due for major exterior renovations.

This brings up a complication with the concept of payback. Many home improvements have an expected service life of 40 years or more, meaning that good opportunities to make truly significant energy improvements in a particular area of a house come along only two or three times a century. So when we plan an improvement we need to anticipate what will be cost-effective over the course of several decades. This, in essence, makes "payback" a moral and ethical debate as much as an economic question: Since few homeowners can realistically expect to stay in their home for another 40 years, they have to decide what — if anything — to invest on behalf of future owners and occupants.

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Design to a percent use reduction

With this strategy, we calculate the owner's baseline usage and work out what an aggressive (but not unrealistic) reduction would be. Say the household uses 60 kBtu per square foot per year. And say we know from past experience with similar projects that in the course of a whole-house renovation we can bring that down by 25 percent — to 45 kBtu per square foot per year — without stretching the project budget too much.

That 25 percent sounds pretty good — and it is pretty good, in fact, by the standards of what's going on in today's marketplace — so everyone is happy. (We have found that using a HERS — Home Energy Rating System — index as a metric is the most effective way to design to a percent reduction, since each one-point reduction in the HERS score represents a 1 percent improvement. For more information on HERS scoring go to natresnet.org.)

The good news with this approach is that you know you're making progress that you can quantify. The bad news is that the degree of progress may be completely arbitrary or insufficient. If all houses reduce their energy usage by 25 percent in the next 10 years, we'll certainly all be better off — but will we be better off enough?

Design to a target energy budget

Which gets us to the concept of a target energy budget. This is an attempt to calculate how much a household's energy usage should be based on some overarching goal or goals, which can range from the personal to the global. For example, some owners might want a home that's able to weather an extended power outage; others might want a net-zero-energy house. Yet other homeowners may have set their sights on broader, more lofty objectives like national energy independence and long-term atmospheric carbon stabilization.

With this approach, you establish the target goal and then figure out the most cost-effective way to get there. In other words, the target goal drives what's cost-effective, not vice versa — an important shift in thinking.

Let's say the goal is a net-zero-energy house. You calculate what the site can produce over the course of a year from PV and solar thermal, and that becomes the energy budget for the house. In this case, it might be 17 kBtu per square foot per year, which becomes the budget you design to.

If, less aggressively, the goal is a house that can be lived in safely for up to a week with no power, only a "zone" of the house would need to be operable on 17 kBtu, while the energy budget for the rest of the house could be 35 kBtu.

At the opposite end of the spectrum, the homeowners may be motivated by the goal of a 2000-watt society (en.wikipedia.org/wiki/2000-watt_society). This would mean an individual (per capita) energy budget of about 17,500 kilowatt-hours per year for all activities: work, transportation, food, entertainment, housing, and so on. Given this overall budget, you might do some calculations and decide that your household energy budget should be about 12 kBtu per square foot per person. (Full disclosure: Doing this sort of mathematical calculation is really hard, but it can be an eye-opening intellectual exercise — and we have to start somewhere.)

The Passive House approach to home design (passivehouse.us) is based on a similar approach: It sets a very low budget for household energy usage based on estimates of what a worldwide sustainable per-capita household energy budget might be, and then provides the tools to help you design to that budget.

Don't forget that when you're designing to a target energy budget, the homeowners' commitment to living within that budget is really important. Their willingness to modify their behavior will obviously have a huge impact on the household's energy consumption.

Design to specific construction standards

Designing each project to a specific energy budget — or even to a percent reduction — requires a lot of analysis and can get complicated, time-consuming, and costly. A cruder but generally effective strategy is to establish insulation, air-sealing, and mechanical-equipment efficiency standards that you aim for on *all* your projects. Periodically you would verify that those are the "right" standards by measuring actual energy performance on a range of projects over time.

Here's one way to set those quality standards: Say you decide you want your projects to reach a HERS index of around 50 (prior to any "credits" for PV or solar thermal), or 50 percent of the anticipated energy usage of a code-level home. You'd calculate what levels of insulation, air-sealing, and mechanical efficiency were needed for a representative project to reach that score. This will yield a pretty good set of "draft standards" for you to start working with on all your projects; over time, you can fine-tune the standards as you gain more data about the actual energy consumption of the projects.

In our climate region — 5,600 heating degree days — there's a growing consensus that the following are useful target standards, though they still need to be tested over a wide range of homes:

- R-10 basement floors
- R-20 basement walls
- R-40 above-grade walls
- R-60 roofs
- U-0.20 windows
- Less than 1.0 ACH @ 50 as tested by a blower door
- High-efficiency whole-house ventilation

It might seem unrealistic to think that you could reach these levels of insulation — which also happen to yield a HERS index of around 50, prerenewables — over the course of just one renovation project. However, such standards can serve as the framework for an incremental strategy — a "master plan" that is followed over time as various parts of a house are improved, repaired, or replaced. Though not without challenges, this approach will practically eliminate potential regrets about missed energy opportunities.

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