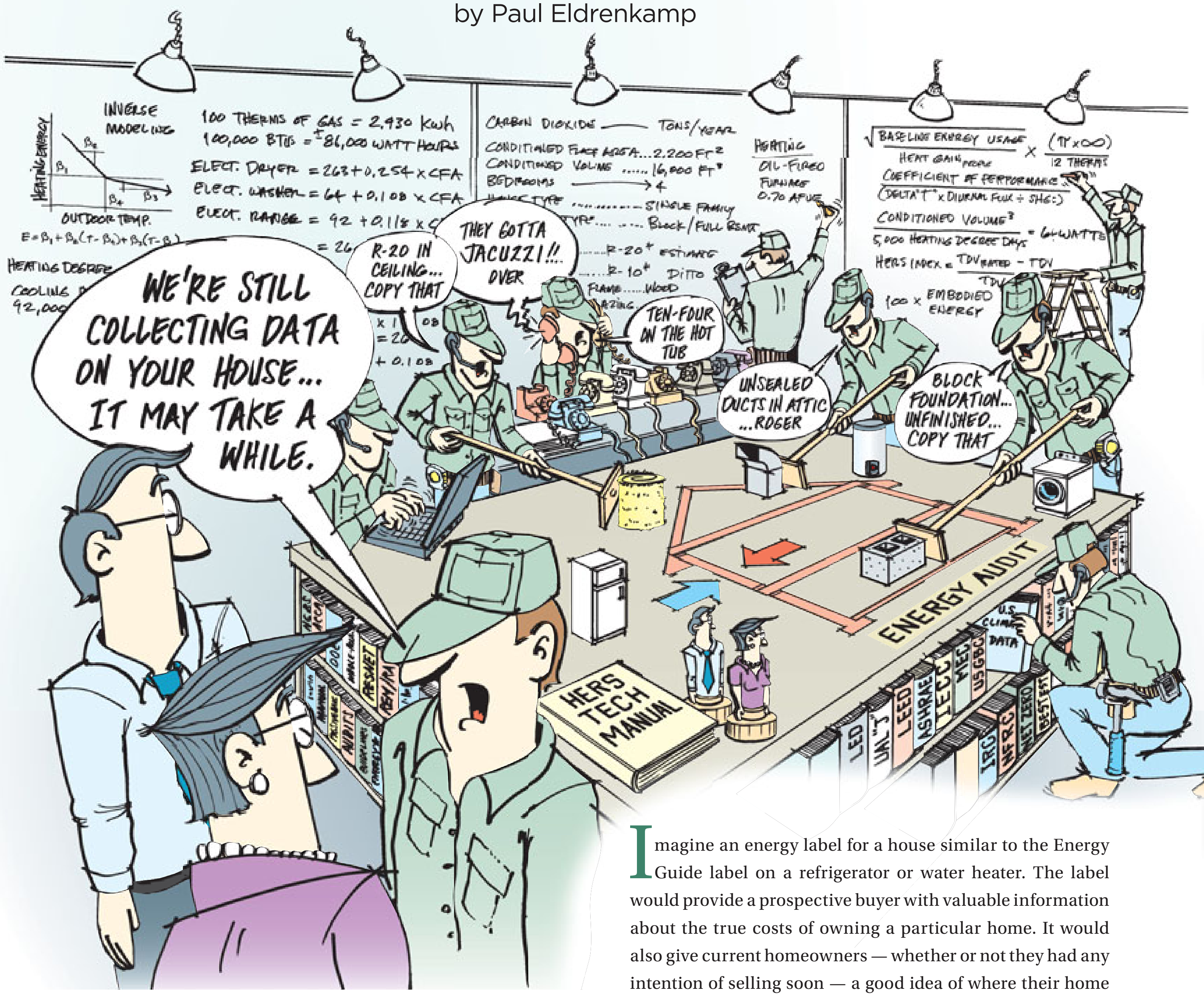
A Simple Approach to Home Energy Rating

by Paul Eldrenkamp

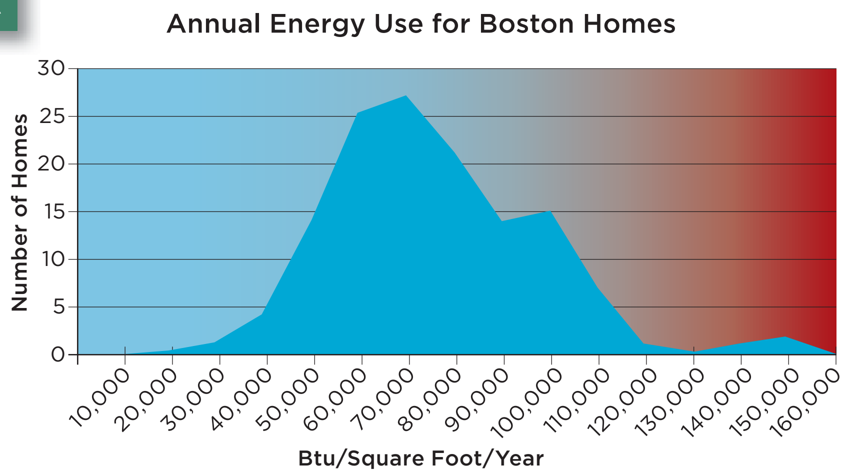


Here's a manageable way to track and analyze the energy usage of your customers' homes

Imagine an energy label for a house similar to the Energy Guide label on a refrigerator or water heater. The label would provide a prospective buyer with valuable information about the true costs of owning a particular home. It would also give current homeowners — whether or not they had any intention of selling soon — a good idea of where their home stood with regard to energy efficiency, and to what degree they might be able to improve that efficiency.

Energy labeling for homes is an idea that's been frequently proposed but, until recently, only selectively implemented. The European Union, for instance, is in the early stages of adopting a mandatory energy-rating scheme for buildings; it's likely only a matter of time before the idea becomes widely adopted in the U.S.

A



To date, the author has gathered annual energy-use data on more than 130 homes that he has worked on in the Boston area. The graph (A), contained in a multi-tab spreadsheet used at client meetings, shows the number of homes at a given annual energy consumption in Btu per square foot, and helps customers understand how their home's energy use compares with other homes in their area. The benchmark data (B) suggests targets for energy improvements, and the list of guidelines (C) shows how a home compares with common efficiency standards.

B

Benchmarks for Energy Improvement

Here are some Btu/sf/yr benchmarks for Boston's climate (5,600 heating-degree days per year):

15,000 or below: Outstanding! With a little solar, you might be close to net-zero energy

15,000 to 30,000: Still outstanding, but a stretch to reach net zero

30,000 to 40,000: Some room for improvement, but it will be hard without a major exterior insulation retrofit

40,000 to 50,000: Some low-hanging fruit left

50,000 to 60,000: About average for single-family homes; you have some opportunities

Over 60,000: There are some serious savings opportunities; time to get going!

C

Energy-Efficiency Guidelines

(Numbers are approximate and assume 68°F day/64°F night thermostat setpoints)

	Btu/sf/yr	kwh/sm/yr
Mass. Code (7th edition)	54,000	170
Energy Star	45,000	142
Passive House (source energy; site energy would be about two-thirds less)	38,000	120
Within reach of net-zero energy	15,000	47
As far as you can get without exterior insulation (in my experience)	40,000	126
Average existing home within my data set	70,000	220

HERS Rating Not Always Called For

The most common energy rating in the U.S. is the HERS index. HERS — which stands for Home Energy Rating System — is a key component of the EPA's Energy Star homes program. A HERS index is a numerical "energy score" for a home. An index of 100 means a house meets the 2004 IRC code minimum for efficiency measures; an index of 50 means the home is anticipated to use 50 percent of the energy of a house built to code; an index of 0 would indicate a zero net-energy home. Energy Star requires a HERS index of 85 — 15 percent better than code. The older homes my remodeling company works on often have baseline HERS scores in the range of 130 to 200 or so, meaning they're 50 percent to 100 percent less energy-efficient than a new home built to code.

While certainly possible, it's not that easy to generate a HERS score for an older home. A wide range of data needs to be entered into a software program — typically, REM/Rate from Architectural Energy Corp. (archenergy.com). With an existing home you often don't have plans you can use for takeoffs, so you have to spend several hours making measurements of existing conditions, and you're also often guessing at what levels of insulation might be behind the wall finishes. It can cost $800 to $1,200 or more to get a quality HERS score of an existing home. We do it routinely for our major renovations, because with the HERS software we're able to do a number of what-if scenarios for possible energy improvements, and it becomes a very useful design tool.

Utilities Worksheet

Name:	Mary and Joe Wright	# of household occupants:	4
Address:	1 Maple Road, Lexington, MA 02421		
Square footage of living space (do not include basement):	2,800		
Square footage of basement:	1,400		
How much of the basement is finished? (sq. ft.)	1,200		

Fill in information from your utility bills for gas and electricity. For oil, propane, or firewood, note the amount delivered each month.

A

Year	Month	Therms/ Natural Gas	Kwh/ Electricity	Gallons/ Fuel Oil	Gallons/ Propane	Cords/ Firewood
2009	January	359	1,111			
	February	303	1,222			
	March	224	868			
	April	139	622			
	May	53	715			
	June	27	821			
	July	21	1,305			
	August	18	1,407			
	September	19	879			
	October	87	878			
assumed	November	179	767			
assumed	December	287	986			
2008	January	320	1,138			
	February	285	926			
	March	239	714			
	April	146	712			
	May	89	769			
	June	21	962			
	July	19	1,288			
	August	19	1,111			
	September	24	1,029			
	October	79	855			
	November	179	767			
	December	287	986			

See next page for more information and caption

Measuring Usage

For many jobs, though, a HERS rating can be way too big a hammer. And there is a simpler way to "rate" a home. It's not as good as a HERS rating, but it's a lot cheaper to generate and — in many cases — nearly as useful.

The "rating" I'm talking about is a Btu per square foot per year calculation. It's generated this way:

Take a year's worth of energy usage for a house — total therms of gas, kilowatt-hours of electricity, and gallons of heating oil or propane (I'll get to wood later). Then use the table on the facing page to convert those totals to Btu.

Total up all the Btu used from all sources (the total will be in the tens or hundreds of millions) and divide by the square footage of living space. The Btu/sf/yr "score"

B

Additional Information:	
Heating system (choose one):	Forced Air
Heating system fuel (choose one):	Gas
Age of boiler or furnace (approx. yrs.):	9
Heating thermostat setting (F) — at home/day:	68
Heating thermostat setting (F) — away/night:	65
Central air?	Yes
Number of through-wall room a.c. units:	0
Number of window-mounted room a.c. units:	0
Are electric heaters used?	No
Are dehumidifiers used?	Yes
Number of refrigerators or stand-alone freezers:	1
Is the clothes dryer gas or electric?	Electric
Is the range gas or electric?	Electric
Are wall ovens gas or electric?	None
Water heater:	Gas
Hot tub?	None

Notes: Furnace is high-efficiency variable-speed Bryant. Gas water tank is only 40 gallons due to space limitation, but we occasionally run out of hot water. We use an electric space heater on the coldest few days of the year to help warm the bedrooms. Thermostat is set to 69 degrees for a few hours each day, from 5:30 to 8:30 a.m.

C

Annual Totals, Converted to Btu/sf		
Square footage of living area:		2,800
	One-Year Total	Two-Year Total
Therms natural gas	1,716	3,423
Kwh electricity	11,581	22,838
Gallons oil	0	0
Gallons propane	0	0
Total Btu/yr	211,137,534	210,134,466
Btu/sf/yr	75,406	75,048
Conversion Formulas		
	Btu	kwh
1 therm of gas	100,000	29.3
1 gallon of heating oil	138,700	40.6
1 kwh of electricity	3,413	1.0
1 gallon of propane	91,000	26.7
1 cord of hardwood	19,000,000	5,565.3
1 cord of mixed wood	17,000,000	4,979.5
1 square foot = .0929 square meter		
1 square meter = 10.76 square feet		
1 kwh/sm = 317 Btu/sf		

A form filled out by the homeowner tallies the home's annual energy use (A) and collects other information about the house (B). The author enters the information into a spreadsheet, then uses the size of the home and a set of programmed conversion factors to convert the annual totals to Btu/sq.ft. (C). Year-over-year data can provide useful information about the net effect of any energy improvements made during a remodel.

for a single-family home in the Boston climate (which has an average of 5,600 heating-degree days and about 900 cooling degree days) will typically be somewhere between 25K and 160K or so, with lower scores being better scores — better, that is, if efficient use of energy is your objective.

The graph at the top of page 35 shows the Btu/sf/yr scores for more than 130 different homes that my company has worked on in metropolitan Boston. It's a good sampling of my market niche. The horizontal axis is total Btu/sf/yr; the vertical axis is the number of homes in the data set at that level of energy usage. Using this graph and a home's utility records, I can show customers where their energy usage falls relative to other homes in the area.

Understand the Limitations

I need to be open about the limitations of this scoring method, which I'll enumerate here.

1 It's climate-specific. If you live in northern Minnesota or Florida, my data will be useless to you. In my opinion, however, it's worth your while to put together a similar data set for your own climate, as I'll explain in a bit.

2 This method "rewards" larger homes — or, put another way, it penalizes smaller homes. Larger homes often use more energy overall than smaller ones, but they're less energy-intensive; they use less per square foot. The Btu/sf/yr scoring device does not correct for that imbalance. For that matter, though, most scoring systems — including HERS and even Passive House — penalize small homes. To a large extent it's because smaller homes have more surface area (which is where the heat loss occurs) relative to living space, and there's just no way around that fact of geometry.

3 The numbers can vary widely depending on how you define "square foot of living space." For instance, houses in my service area will use about the same amount of energy whether the basement is finished or not. Given that the heating equipment and distribution pipes and ducts are usually in the basement (in my part of New England, anyway), the basement is tantamount to heated space even if it's not finished. So a sure way to reduce your Btu/sf/yr score is to finish off the basement. I occasionally wonder if I should just include the basement as living space regardless of whether it's finished.

In any event, for every house we score this way, I note square footage of both finished and unfinished basement spaces, so I can run the numbers whichever way I choose in the future. If you're going to be tracking this sort of data about the houses you work on, it's a good idea to track more information rather than less, anyway. (We always note the age of the house, the architectural style, the type and age of the boiler, and so forth.)

4 *The Btu/sf/yr measurement considers site energy, not primary energy. What this means is that I'm not correcting for the fact that a fossil fuel-based electrical generating plant has to burn about three Btu of fossil fuel energy (primary energy) to deliver one Btu of electrical energy to my house (site energy). With gas and oil usage there are some delivery losses, too, but they're not nearly as pronounced as with electricity. This mainly matters if you have a lot of houses in your data set that are heated with electricity and a lot that are not, in which case you may want to track them separately. If your data set is pretty consistently fossil-fuel heat only (gas, oil, or propane), you don't really have to worry about site energy versus primary energy, unless you want to start to calculate carbon footprint.*

5 A Btu/sf/yr score differs significantly from a HERS score because it's an "operational" rating, whereas the HERS number is an "asset" rating. An operational rating is based on actual energy usage — real data regarding how much energy the home used over the course of a year. How efficiently (or inefficiently) the occupant operates the home will affect its operational rating. An asset rating, on the other hand, is based on characteristics of the building completely independent of who's living there or how it's used. Both are useful ways of measuring a building, but they come at the problem from very different angles.

6 If you want close comparisons of data collected in different years, you'll need to correct for weather. Here, for instance, are the heating-degree day totals for Boston for the last five complete years:

Year	HDD	% diff. from 2005
2005	5,875	
2006	5,007	–14.8%
2007	5,649	–3.8%
2008	5,426	–7.6%
2009	5,653	–3.8%

What this table tells me is that 2005 was much colder than 2006. So I shouldn't really compare total energy usage between those two years without approximating how much of my total energy usage was for heating only, and then correcting that figure against the baseline year.

In the table, I've used 2005 as a baseline, and the percentages in the third column indicate how much less heating energy was required in subsequent years compared with the baseline year. Say I used 1,000 units of energy for heating in 2005. Then, if nothing about my usage patterns changed (no efficiency improvements to the house, no change in thermostat settings), in 2006 I would have used about 14.8 percent less than I used in 2005, or about 852 units of energy.

Note that in climates with significant cooling loads, you need to factor in cooling-degree days in a similar fashion. Heating- and cooling-degree data can be found on the Internet, or your local utility may be able to provide it.

7 You have to be careful with fuel-oil usage. Usually oil customers will be able to tell you how much oil was delivered and when, but it can be harder to figure out just when the oil was burned for heat. If they had a 300-gallon delivery on December 10, 2008, for instance, how much of that 300 gallons went toward 2008 energy usage and how much toward 2009 energy usage? I find that if I can average two or more years of oil delivery data, I can get pretty close to actual annual usage.

8 Also, be aware that if you're analyzing a home that uses wood for heating, it can really throw off the numbers — especially if the homeowner doesn't know how to burn wood for heat. I find that in suburban Boston, homes with fireplaces or wood-burning stoves that are used only occasionally have a normal range of Btu/sf/yr scores if we don't include the wood usage, but if we do include the wood usage, the numbers go way out of kilter. That makes me think that wood is burned in many of these homes primarily for aesthetic reasons rather than resource efficiency. You'll have to figure out how to account for wood usage in your own data set, based on the types of homes you calculate the score for.

9 Finally, in the case of a house that has some solar power, you want to account for gross energy usage, not net usage. If a house uses 10,000 kwh in a year, but only 5,000 kwh came off the grid and 5,000 came from a PV system, you still want to use the total usage of 10,000 kwh in your calculations (note that this confuses the site energy-versus-primary energy consideration in its own way).

Mining Opportunity

So, with all these caveats, why do I even bother calculating Btu/sf/yr? For one thing, it's pretty easy to remain aware of all the issues that I noted above and account for them as you accumulate data over time and as you compare a particular house against your data set.

But primarily I like Btu/sf/yr because it's really easy to put together. Yes, you probably need data for 40 or 50 houses that you've worked on to start to give some statistical validity to your chart, but to get Btu/sf/yr data for a house you just need a year's worth of energy bills, the square footage of the house, and a very simple spreadsheet. It takes a couple of minutes.

And I don't think you have to be that worried about the nuances — not yet. Most of the houses we work on use a lot of energy — a lot more than they should. So we're talking about blunt broadaxes rather than razor-sharp scalpels to make energy-usage reductions in most of these homes. I often don't even bother with the degree-day correction — it just isn't that significant, given the magnitude of a particular home's energy usage. I can calculate the Btu/sf/yr score for a new client, locate it on the graph on page 35, and learn quite a bit about how to approach that house and that client. If the score is 160K, I know that we have all kinds of opportunities — and that I will have the clients' full attention when they find out what an outlier their home is.

I also know that if the residential sector is to do its part in reducing greenhouse gas emissions by 80 percent by 2050, we need to get the average from about 80K down to less than 40K. So if the client is something of an environmental crusader, and the house is even a little bit above 40K Btu/sf/yr, we can have an engaged conversation about measures that will bring it down. Having this sort of data at my disposal can really change the conversation at a sales meeting.

What's more, once we have the baseline energy usage for a home before doing any work on it, we can then measure the impact of our work over time. In that way we can monitor whether we achieved the desired results — and if we didn't, we can start to figure out why not. This is an invaluable feedback loop; having this capability gains me real credibility in the sales process. It also helps make me a better, more effective contractor over time.

Paul Eldrenkamp *owns Byggmeister, a design-build remodeling company in Newton, Mass.*