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Setting the STANDARD for QUALITY

Energy Labeling and Energy Billing Analysis

Philip Fairey[1] and David Goldstein[2]

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Discussions of building labels worldwide have pointed out the difference between "asset value" labels, which are based on how a building performs at standard operating conditions and "operational value" labels, which are based on measurements of energy consumption using the operating conditions that are in use at a particular time. Most products, such as cars or appliances, are rated using asset value labels with a standardized operational component—for example, cars are rating by EPA miles per gallon (mpg) but are not resold based on the mpg that the seller actually obtained. But for buildings, analysts generally recognize that both results are useful.

These two types of labels are very distinct and different ways of characterizing energy use, with different purposes.

At this summer's Westford Symposium, the U.S. Environmental Protection Agency (EPA) made a presentation, entitled "ENERGY STAR Qualified Homes Stuff." About one-third of the presentation was dedicated to discrediting the HERS Index, which is, at present, an asset value rating (although RESNET is in the process of adding an operational component).

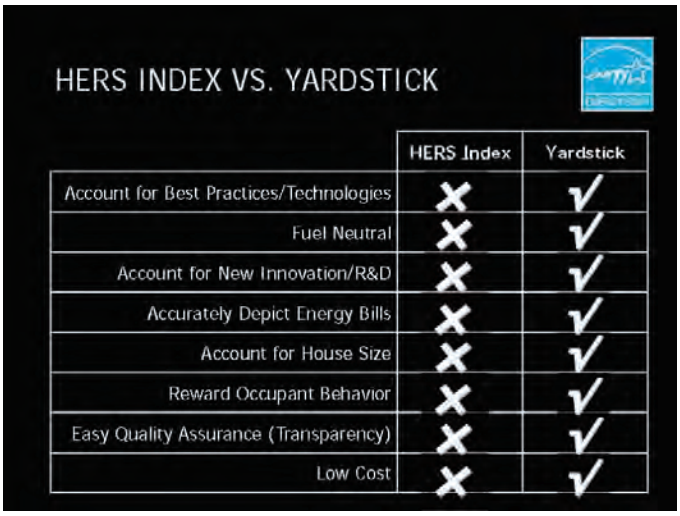

Figure 1. Completed EPA "checklist" comparing the HERS Index and the EPA Yardstick.

As illustrated by the slide in Figure 1, much of the presentation was based on a checklist prepared by EPA to evaluate the differences between the HERS Index and EPA's Home Energy Yardstick. Figure 1 from the presentation shows the EPA Yardstick to be acceptable and the HERS Index to be unacceptable in every single category!

What exactly is the EPA Home Energy Yardstick? It is a web-based statistical analysis tool that compares the reported energy use of a given home against data provided in the 2001 Residential Energy Consumption

[1] Deputy Director, Florida Solar Energy Center and President, RESNET Board of Directors
[2] Energy Program Co-Director, National Resources Defense Council and Vice President, RESNET Board of Directors

Survey (RECS) to determine the home's percentile energy use compared against the reported RECS data, adjusted for climate, number of occupants and house size. Thus, a home with a Yardstick score of 9.9 would have an adjusted energy use that is less than 99% of existing homes of that size, number of occupants and in that weather category. This is a completely operational rating.

We need all the tools we can muster and the Yardstick is a useful tool. But it is certainly not all things to all people as the EPA purports. For example, it is widely known in building science circles that the independent variables used by the analysis (weather, home size and number of occupants) can explain only a portion of the annual energy use of any given home. The unexplained variance in home energy use, when using only these variables, is normally greater than ±40% of the mean. This is a rather large statistical variance and over an entire population of ±3 standard deviations, it can result in errors as great as ±120% for any given home. Thus, the physical attributes of any given home can be severely over or under estimated by the Yardstick. In fact, more than 1/3 of all homes will have building energy use attributes that are more than 40% different than the Yardstick projection.

The heart of the issue is that, as examples of different types of energy indicators, the Yardstick and the HERS Index have completely different (and complementary) uses and purposes. Neither one is necessarily correct or incorrect – they simply measure different things. The Yardstick uses utility bills to characterize the energy use of the home *as it is used by its occupants*. The HERS Index provides *a measure of the relative energy use of the home based on its physical characteristics and a standardized set of operating characteristics*. The HERS index, like a car's miles per gallon rating or an air conditioner's SEER label, is based on an engineering "model" of its physical attributes and a standard set of operating assumptions. This is called an "asset" rating because it looks at the impacts of the home's physical assets (energy attributes) rather than at the way the home is "operated" by its occupants.

It is widely known in the building science community that a large fraction of actual home energy use is driven by the lifestyle and operating characteristics of the inhabitants themselves. As a result, the Yardstick actually says more about the energy habits of the inhabitants than it does about the physical attributes of the home.

The HERS Index does the opposite. It speaks only to the physical energy attributes of the home under a standardized set of operating assumptions. This is an important distinction that must be addressed.

RESNET explicitly and purposefully chose to remove lifestyle from consideration in the HERS Index. It does so by using set of consensus-based, standardized operating conditions that is applied to all homes consistently. This has two results: first, only the physical attributes of the home impinge on the HERS Index and second, the HERS Index does not predict the impacts of lifestyle choices made by the specific occupants of the home.

When both ways of looking at home energy use are combined, together they can provide a valuable tool for the home occupants, helping them understand how and why their energy use habits differ from the standard operating conditions and providing a customized assessment of

the energy and cost impacts of improvements to the home. However, to do this, one needs to go quite a few steps beyond the Home Energy Yardstick. The critical value of utility billing data is that it provides a basis from which to "calibrate" the engineering model of the home to the occupants' lifestyle. Without the calibrated engineering model, the energy use history is not very valuable because it contains no information about the physical attributes of the home. It is analogous to saying that we can know something about the eating habits of households by examining their monthly or annual grocery bill. In reality, we would know very little about their eating habits without knowing the actual items (the attributes) contained in their grocery cart.

However, with a calibrated engineering model of a home, a large number of engineering assessment opportunities becomes accessible. One can now ask multiple types of "what if" questions; not only what happens if a physical attribute is changed but also what happens if a particular operating characteristic is changed? A calibrated model also has great value in assessing the cost effectiveness to the homeowner of a broad range of home energy retrofit options. These options can be individually and collective evaluated very quickly to rank order them by any number of economic indicators from internal rate of return to simple payback. Of course, this same engineering exercise can be performed using the "standard" operating assumptions that are used for the HERS Index if one wants to make similar decisions based on an unknown "typical" user, as would be the case if the home is changing ownership or if a standardized energy label is desired.

What is RESNT doing with these challenges?

Much of the national discussion on home energy ratings and especially retrofits has devolved to an over simplified "slogan" – existing homes are different than new homes. But the physics that determine their energy use are certainly not different. We badly need to change the conversation. The national discussion needs to be re-focused and centered on "standard" operating conditions and "calibrated" operating conditions rather than on "new homes" and "existing homes." Not using the correct terminology to describe the challenges only confuses the issues. After all, a new home becomes an occupied home as soon as the first occupants move in and an existing home is an unoccupied home as soon as the occupants move out.

And there are good and valid reasons to have both standard and calibrated operating conditions. Energy "ratings" used for labeling should always use standard operating conditions; otherwise the rating label has no basis for comparison. An energy rating label based on the previous occupants' energy use habits would say little to nothing about the physical energy attributes of the home and would make it virtually impossible to compare the physical energy attributes of one home against another. This would be unconscionable.

On the other hand, a calibrated engineering model is extremely useful for decision making by the current occupants of a home. So there must be both capabilities if the home energy marketplace is to be well served.

RESNET has established an Occupied Home Software Task Force and Working Group. This group is working on standardizing methods and procedures that can be used to exploit utility billing analysis to create calibrated engineering models of occupied homes. This would allow

analysts to much more accurately project energy use and savings potentials where there is a billing history. RESNET is also working very closely with the National Renewable Energy Laboratory (NREL) and the U.S. Department of Energy (DOE) on a new software verification test suite called BESTEST-EX, which can be used in the accreditation of software tools capable of creating calibrated engineering models for occupied homes.

In summary, there are two good and valid ways of characterizing home energy use:

- An energy "asset" rating (or label), based on a standardized set of operating assumptions, which depicts the energy performance of the home's energy attributes relative to other homes
- An operational assessment of the home's energy use based on an actual set of home occupants, which includes the impacts of the inhabitants' lifestyle.

Both have value in and of themselves. Additionally, they can be combined through calibrated engineering models to provide powerful tools of significant value in assessing building retrofit opportunities as well as to provide energy asset ratings and for energy labeling purposes for all homes, new or old. RESNET will continue to work with all its partners and collaborators to achieve national resolution and consensus on these important challenges of our time.