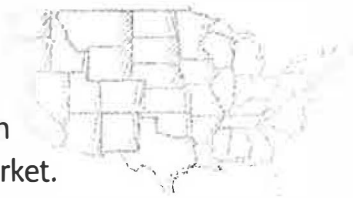
HERS Experiment Cause for Confidence

by James Cavallo



Home energy ratings seem reliable, but are they? We look at the results from one experiment that tries to answer this question for the existing homes market.

At last April's Affordable Comfort conference, I conducted a small HERS experiment to examine the relative variability of ratings in new and older homes. The experiment grew out of discussions with Oak Ridge National Laboratory Senior Researcher Mark Ternes and EPA Energy Specialist Mia South about how good the HERS tools currently employed in the new homes market are at identifying cost-effective conservation measures in existing homes. Older homes present challenges for raters that may not generally exist in new construction. These include the absence of blueprints, the inability to interview the builder, the difficulty of identifying the operating efficiency of installed equipment, and different envelope characteristics within the home caused by partial remodels over the years.

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Ratings of this just finished Park Ridge, Illinois, house, which measures approximately 4,000 ft² including the finished basement, ranged between 83.2 and 84.7—a difference of approximately 1.8%.

For precisely these reasons, the need for accurate ratings of older homes is acute. Just as one would not buy a used car from a newspaper ad without first having a mechanic look at it, most prospective buyers of older homes would prefer to have an objective inspector identify potential problems, rather than taking the seller's word that no problems exist. A rater should be able to distinguish a home that will cost more than $1,000 to heat during a cold Chicago winter from one that will cost only $400 a year for space heating. And for a homeowner facing the prospect of a $1,000 heating bill, the rater can identify opportunities to save energy.

The efficacy of ratings in existing homes hinges on two questions: How accurate are ratings in existing homes? and, How much does accuracy matter to the selection of conservation measures? Rather than speculate about the matter, I organized a small experiment to test the variability of ratings. To reduce one source of variability, I decided that all ratings would be conducted with the same tool, REM/Rate. Originally, I had hoped to find 30 experienced raters to rate each home. However, many auditors were busy attending the exciting workshops and short courses at the conference, so I ended up with just seven ratings.

Two homes were chosen to represent the very broad spectra that raters can find in the new-construction and existing-home housing stock. Neither of the homes was especially complex, but as raters took their measurements and conducted their analysis, they found sufficient detail for a challenge.

The new home in Park Ridge, Illinois, is typical in size and layout of the homes being built in the suburbs around Chicago. This four-bedroom, two-story house with finished basement is shown in the first photo. The home measures slightly more than 4,000 ft², including the basement. The house was completed in March 1999 and will be used as a sales model for the development around it.

The older home is located in Elgin, Illinois, and was built before 1940, probably sometime in the '20s or '30s. This two-bedroom house has a basement in which the furnace, water heater, clothes washer, and dryer are located. The raters disagreed as to whether the basement should be considered part of the conditioned space. Excluding the basement area, the house measured approximately 1,000 ft².

The rating process included a site visit to measure the homes' features, inspection of the blueprints for the new home (none existed for the Elgin home), and a blower door test. Each rater's site visit lasted more than one hour; some raters took more than two and a half hours. The raters were given time to enter their measurement on two computers that Affordable Comfort made available. Michael Holst of Architectural Energy Corporation provided the latest version of the REM/Rate software for the participants to use at the conference. With the assistance of John Marley of the Illinois Department of Commerce and Community Affairs, the software was supplemented with the measure libraries that are distributed in the Illinois HERS program. Because each rater had substantial rating experience, I felt it was important not to identify one rating as correct and the other ratings as incorrect. The process required all the raters to work independently, and they were asked not to discuss their findings until all had completed their analysis.

Four ratings were conducted on the new Park Ridge home. The ratings obtained were 83.2, 84.2, 84.4, and 84.7. The small number of observations makes computation of standard deviations unreliable. However, the range of the ratings—83.2 to 84.7—is less than 1.8% of the average rating (84.1). This tight range can be attributed in part to the fact that the raters had access to the blueprints and

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This house in Elgin, Illinois, was built sometime before 1940. It measures roughly 1,000 ft² excluding the basement. Ratings of this house ranged more widely—between 45.3 and 48.8—than did the ratings for the just-constructed house.

in part to the fact that there were energy labels on all the mechanical systems.

The lowest rating listed above was adjnsted from its original estimate after consultation with the rater. This rater was unable to conduct a blower door test because he had prior commitments at the conference. His estimated infiltration rate was considerably at odds with those of the other raters. When we discussed the issue and substituted an estimate in line with the measured findings, his rating increased from 79.5 to 83.2. This substantial increase would suggest the need always to measure, rather than estimate, infiltration rates.

Three ratings were conducted on the older Elgin house. The ratings obtained were 45.3, 45.5, and 48.8. The range—45.3 to 48.8—represents approximately 7.5% of the average rating (46.5). This range resulted partly from disagreement among the raters on whether the basement should be included in the conditioned space. One rater argued that the basement was "a glorified crawlspace"; the others included the basement because it was connected through the ducts and floor bypasses to the rest of the house. Not surprisingly, the first rater conducted the blower door test with the interior basement door closed, while the others left it open to the rest of the house. Other differences in the rating inputs had only a minor effect on the ratings.

After the raters completed their analysis, I examined the effect that the variability of ratings for the Elgin home had on choices for energy conservation measures. For each rating, I examined several standard conservation measures that could be included in a modest renovation project—one that would not require the residents to vacate the home. I used the improvement analysis component of REM/Rate and specified a savings to investment ratio (SIR) criterion of 1.2, because this ratio is more than 1 but less than 1.5. (An SIR of 1.5 would mean that the benefits of the conservation measures would need to outstrip the costs by 50% in order to be acceptable—a criterion I judged to be too severe.) I found that there was no difference among the various conservation measures chosen by REM/Rate's improvement analysis. The SIR was surpassed for air sealing (reducing natural ACH to .5); attic insulation; and upgrading the natural gas forced-air furnace from the current system to a properly sized 90-plus efficiency furnace. These improvements would raise the home's rating from 45.3, 45.5, and 48.8 to 63.8, 66.9, and 68.8, respectively. Energy savings ranged from $220 to $281 per year; costs ranged from $1,732 to $1,873.

The consistent choice of the conservation measures could be attributed to the poor efficiency of the older home. The opportunities for efficiency improvement are great if one is starting with a rating in the mid-40s. If the house had started at a higher level—say with an average rating of 75—then a large variation in ratings would significantly affect the choice of which energy conservation measures would meet the SIR criterion and which would not. For a house with an average rating of 75, measures that are near the SIR cutoff at the average rating could well be below the SIR for ratings that are above the average.

It seems safe to say that ratings in the low 50s or below are common in older neighborhoods of the Midwest. In the 1993 Residential Energy Consumption Survey (RECS), there is a frequency distribution of Midwest houses by BTU/ft²/heating degree-day (base 65). To do a very rough translation of this energy index into an approximate rating estimate, I multiplied the BTU/ft²/HDD by 4 and subtracted the result from 100. I found that more than 50% of houses built before the energy crisis of the 1970s may have ratings in the 50s or lower.

Moving a 1,000 ft² home in Chicago from a usage level of 15 BTU/ft²/HDD to the average level of houses built in 1970 or after, 7.54, would save the homeowner approximately $200 per year.

The older house in Elgin will soon be leased to a low-income family. The moderate retrofit that the house received did not include the identified efficiency improvements. Either the family moving in will be responsible for the higher-than-necessary energy bills, or the federal government will be subsidizing the high energy costs through a program such as Section 8 certificate. Regrettably, failing to make these cost-effective improvements constitutes a missed opportunity. Indeed, rating all Housing and Urban Development (HUD)-supported and Section 8 housing could provide significant opportunities for energy savings, because these dwellings often undergo retrofits just before or just after they are turned over by HUD.

Although the sample was small, the results of this experiment are valuable. They may be summarized as follows: First, the ratings that different analysts estimated varied more widely for the older home than they did for the new home. Second, for the older home, the identification of cost-effective energy conservation measures was insensitive to the variation in ratings. Clearly, these findings need to be verified in further experiments. But it is noteworthy that the separate ratings of the new home were in such good agreement, and that cost-effective efficiency recommendations can be arrived at even when divergences exist in the absolute rating value. These findings also suggest that it is appropriate to have confidence in ratings as a tool for identifying cost-effective energy measures in our older housing stock.

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