



The “Right” Rate of Return for Energy Efficiency

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By Paul Emrath, Ph.D.

Economics and Housing Policy

In the housing industry, it has become common practice to use a rate of return to evaluate the cost and benefits of energy efficiency. The National Association of Home Builders (NAHB), for example, has a policy that classifies a change in building codes as cost effective if it returns at least 10 percent in energy savings the first year.

Another, perhaps more common, approach uses a rate of return to discount future energy savings to their present value equivalent. In this context, the rate of return is supposed to capture a home buyer’s time value of money (how a buyer makes trade-offs when evaluating costs and benefits that will be realized at different times). Often, the current rate on a fixed-rate mortgage is used for this purpose.

An important advantage of the one-year rate of return in NAHB’s policy is its simplicity. In comparison, the present value calculation is more complicated, requiring many assumptions that may be difficult to understand. This makes it relatively easy to introduce unrealistic assumptions and use the calculation to produce unrealistic results.

This article argues that the common practice of using the current mortgage rate to discount energy savings is, in fact, one these unrealistic assumptions. In particular, the assumption fails to capture borrowing constraints and doesn’t reflect the way buyers actually evaluate alternatives when deciding on which features to include in a new house.

The article presents evidence from three different sources about rates of return that more realistically reflect household decision alternatives:

- The 11.5 percent average rate households are paying on their consumer debt (from the Fed’s latest survey of consumer finances), reflecting the value of something they could sacrifice at the margin to invest in an additional home feature.
- The 13.2 percent average gross return to owners of rental property (from in a new survey funded by HUD and conducted by the Census Bureau) reflecting what households would have to pay for a home feature if renting rather than buying.

- The 14.1 percent average rate of return home buyers say they need to invest in energy efficiency in response to a direct question (in NAHB's most recent consumer survey).

The 10 percent return in NAHB's current policy is slightly below the rates mentioned above but is at least in the general neighborhood. The current mortgage rate, on the other hand, is under 4 percent—which is far too low. Using a rate this low to discount savings on utility bills will classify as cost effective some features that are clearly priced higher than the market will bear.

Use and Misuse of Rates

In building codes and other applications, it has become common practice to use a rate of return in some fashion to evaluate the cost and benefits of energy efficiency. What is the right rate to use in this context? And what is the right way to use it?

A popular choice has been the current rate on a 30-year fixed rate mortgage (FRM). Probably the most common way to use it is to discount future savings in a present value calculation. This is the preferred method, for example, in the Department of Energy's (DOE's) [Methodology for Evaluating Cost-Effectiveness of Residential Energy Code Changes](#).

Theoretically, there is nothing wrong with the present value approach, but for an asset as complex as house it requires many assumptions that are difficult to specify in a reasonable way and often difficult to understand—leading to suspicions that the assumptions are being manipulated to achieve a predetermined outcome.

It is largely for this reason that NAHB, along with some other organizations, prefer a simpler calculation that considers only the return to the investment in the first year (first-year savings divided by the initial investment). This calculation can also be turned on its head, dividing the initial investment by the first-year savings, which is conventionally called a simple payback period.

NAHB's 2008 policy on "Cost-Effective and Affordable Energy Codes and Standards" defines increases in energy efficiency as cost-effective if they "Result in a simple payback (initial cost divided by first-year savings) to the home buyer that does not exceed 10 years." This is equivalent to saying that the home buyer must get at least a 10 percent return on an energy saving investment the first year.

Requiring a 10 percent return will classify fewer energy saving expenditures as cost effective than discounting the savings at the current mortgage rate of approximately 3.5 percent¹ (unless a present value calculation nets out some

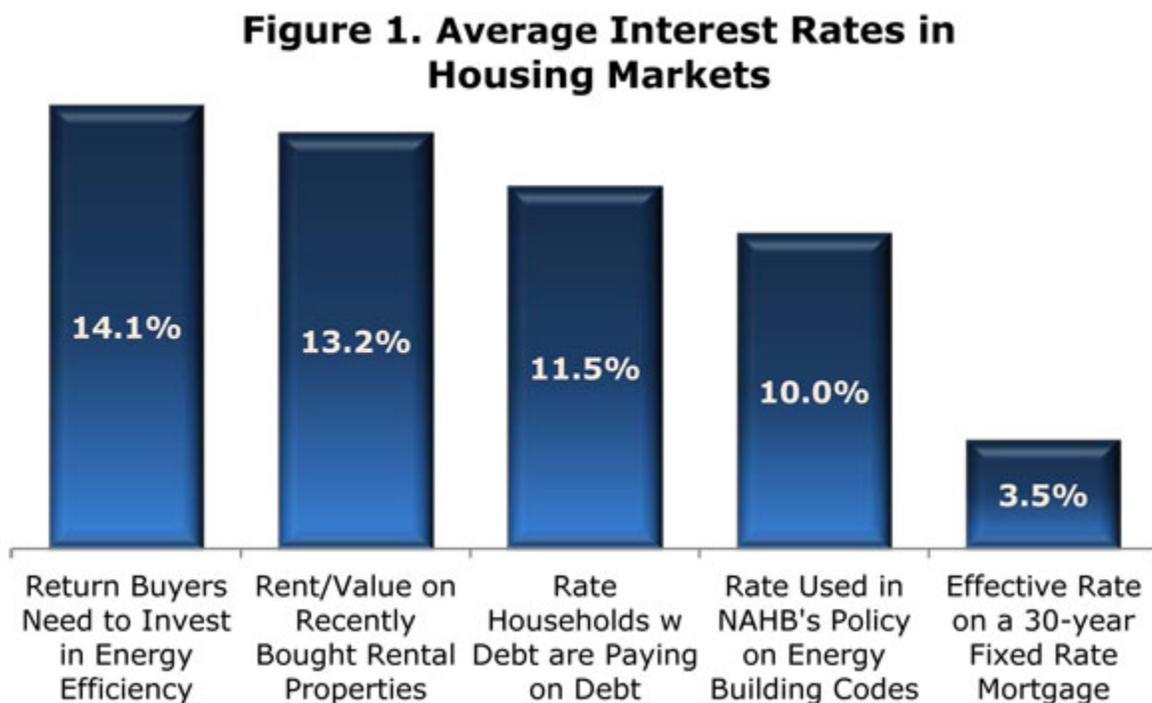
substantial depreciation, maintenance or other costs). The mortgage rate is convenient because it's readily available, and superficially seems reasonable because it's based on actual loan activity, but there really is no justification for using it as a discount rate.

The discount rate in a present value calculation is supposed to capture the borrower's time value of money (how much the borrower would be willing to pay in the future to get a benefit today), and ideally would be based on the return available on the best alternate investment.² It's difficult to argue that a mortgage rate reflects a home buyer's time value of money, as mortgage payments and benefits of homeownership are both realized over time. The typical buyer is expecting both to be enjoying the amenities in the home and making mortgage payments five years after the purchase date.

The next section looks at some rates of return that may better capture the way housing decisions like an investment in energy efficiency are made in practice.

Average Rates in Housing Markets

This section compares the current mortgage rate and payback period in NAHB's energy policy to three rates associated with housing market behavior: the rate homeowners and renters with debt are paying on the debt, the gross rate of return to owners of rental property, and the return home buyers say they need to invest in energy efficiency in response to survey questions (Figure 1).



Asking buyers how much they're willing to pay for energy efficiency has been a standard feature of NAHB consumer surveys for many years. The most recent example appears in the 2013 publication [What Home Buyers Really Want](#).

What Home Buyers Really Want shows that buyers³ are, in fact, quite concerned about energy efficiency and what it means for their utility bills. From a list of 120 different home features, the most popular (rated essential or desirable by the most buyers) was Energy-Star rated appliances, and the third most popular was an Energy-Star rating for the whole home. In the section on windows, the three most popular features all had to do with energy efficiency.

Elsewhere in the survey, a little over three-quarters of buyers agreed with the statement that "knowing the projected utility costs of a home is very important," and 73 percent agreed that projected utility costs are important enough to influence their purchase decision. Just over 70 percent even agreed that they would prefer to purchase a home from a builder who provides energy ratings. In a trade-off question that offered a choice between a highly energy efficient home with lower utility bills and a home that is less efficient but also costs 2 percent to 3 percent less, 89 percent of home buyers chose the energy efficient home.

This still leaves the question of how much home buyers will pay up front to achieve a specific reduction in utility bills in the future. In answer, home buyers on average said they are willing to pay \$7,095 up front to save \$1,000 annually in utility costs. In other words, they require a 14.1 percent return to make an up-front investment in energy efficiency.

It's always possible that in practice respondents won't behave exactly as they say they will when answering survey questions, although there's no obvious reason home buyers in this survey would deliberately understate how much they'd pay for energy efficiency. One way to get information on rates of return household decisions without relying on survey answers is to look at the interest rate households actually pay to borrow.

Information on household debt is available in the Federal Reserve Board's [2010 Survey of Consumer Finances](#) (SCF). According to the SCF, three-quarters of all households have outstanding debt. On average, the highest interest they are paying on any of this debt is 11.5 percent. This captures a choice households could make to invest in energy savings. At the margin they could give up debt on which they're paying 11.5 percent to invest in energy efficiency.

Energy efficiency is also an important consideration in rental housing. A way to see what tenants have to pay for energy efficiency, or any other amenity, in rental housing is to look at the gross return (rental income divided by the value) to owners of the properties. For a long time, there has been no comprehensive information on rental properties in the U.S.,

but HUD has recently initiated a new Census Bureau-conducted survey—the [Rental Housing Finance Survey](#) (RHFS)—to fill this gap.

According to the first (2012) edition of the RHFS, the average ratio of rental receipts to value for properties that have been purchased since 2008 is 13.2 percent.⁴ In the typical case, renters pay their own utilities. For example, in the 2011 American Housing Survey (also funded by HUD and conducted by the Census Bureau) over 30 million of the 35 million renters in the U.S. directly pay their own electric bills. In this typical case, an average property owner will invest \$1,000 in an energy saving feature if tenants are willing to pay \$132 more a year in rent for the increased efficiency.

The 13.2 percent is a gross rate of return to the property owner. The rental property owner’s actual rate of return would be net of depreciation, financing, maintenance, taxes and other expenses. The 14.1 percent reported in *What Home Buyers Really Want* is similarly a gross return, in the sense that home buyers are saying what they’d pay for an energy saving feature without netting out financing, depreciation, and other ownership costs.

As Figure 1 shows, the rate of return buyers say they need to invest in energy efficiency, the rate households with debt are paying on the debt, and the gross return to owners of rental property are all at least slightly higher than the rate of return required by NAHB’s energy policy, and much higher than the current rate on a 30-year FRM.

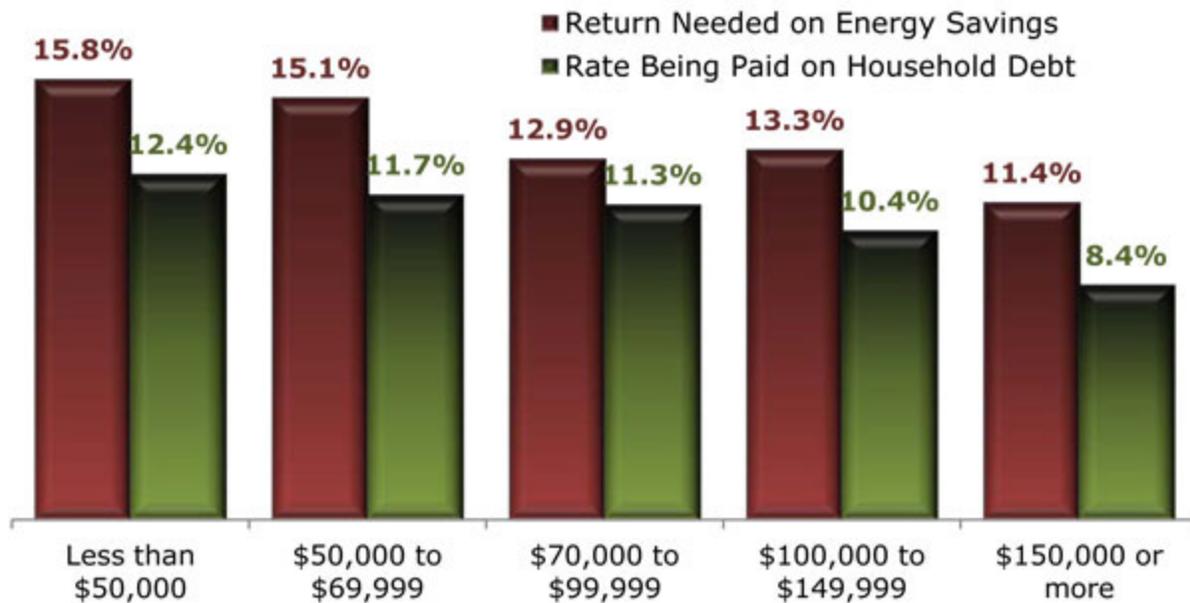
Different Rates for Different Customers

Some types of households may require different savings, relative to the initial cost, to invest in energy efficiency. For example, conventional wisdom suggests that time value of money as captured by rates of return should be higher for households with lower incomes, as lower income households are more concerned with day to day existence and living paycheck to paycheck. In other words, lower income households need a greater future return to persuade them to give up something today.

Both NAHB’s *What Home Buyers Really Want* and the Federal Reserve’s SCF do, in fact, show this relationship between interest rates and income. In NAHB’s survey, the rate home buyers say they need to invest in energy efficiency ranges from 11.4 percent for buyers earning over \$150,000 a year to 15.8 percent for buyers earning at least \$150,000.

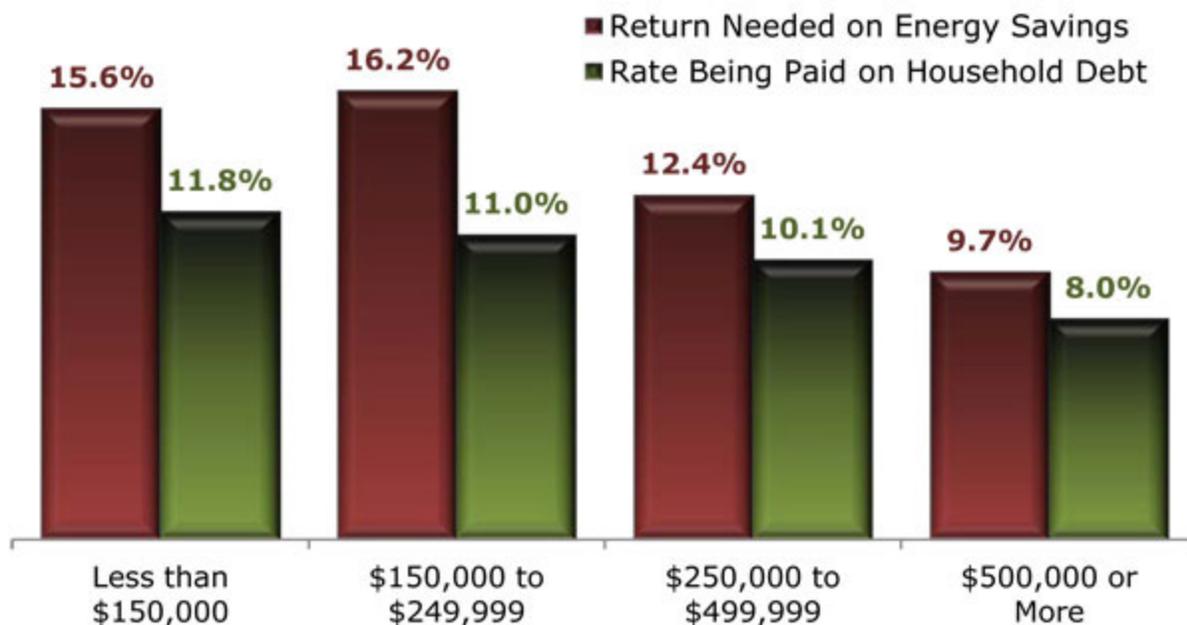
Although interest rates paid on debt by households in the SCF is a few percentage points lower, the pattern relative to income is the same. The rate households are paying on debt ranges from 8.4 percent for those earning \$150,000 a year or more, to 12.4 percent for those earning at least \$150,000 (Figure 2).

Figure 2. Avg Interest Rate by Household Income



Because incomes and home value tend to be correlated, it's not surprising that rates of return also tend to be higher for households living in, or expecting to purchase, more modestly priced housing. In NAHB's survey, the rate home buyers say they need to invest in energy efficiency ranges from 9.7 percent for buyers who paid or expect to pay over \$500,000 a year for home, up to 15.6 percent for those who paid or expect to pay less than \$150,000. Again the pattern is the same in the SCF, where the rate homeowners are paying on debt ranges from 8.4 percent for those in living in homes valued at half a million dollars to more, to 11.8 percent for those living in homes valued below \$150,000 (Figure 3). Additional breakdowns are shown in Table 1, available in the additional resources box at the top of the online version of this article. One notable result in the table is that the rate of return required on an investment in energy efficiency and interest being paid on debt are both higher for renters than for home owners. This is consistent with the tendencies shown in Figure 2, as renters tend to have lower incomes than home owners (the 2011 American Housing Survey shows median income of \$28,400 for renters, compared to \$60,000 for home owners).

Figure 3. Avg Interest Rate by Value of Home



The table also shows that “only” 62 percent of renters and 65 percent of households with incomes below \$50,000 actually hold debt—considerably below the average for all households—even though both groups are paying a considerably above-average rate on the debt they hold. The relatively low share of debt holders among renters and lower income households is likely to indicate inability to get a loan more than unwillingness to borrow at current rates.

Conclusion

NAHB surveys indicate that most home buyers care about energy efficiency and are very interested in features of the home that will lower utility bills. This helps explain why NAHB has been a strong advocate of voluntary energy efficiency programs for builders and remodelers, and worked to develop a program like the ANSI-approved [*National Green Building Standard™*](#).

But this doesn’t mean that home buyers are willing or able to pay an unbounded amount for future energy savings. When asked, home buyers on average say they need to save 14 percent of the upfront cost per year to make an investment in energy efficiency. This is about equivalent to the 13 percent they’d typically have to pay to rent a home with that feature, and only about 2.5 percentage points higher than the average rate households are actually paying on debt.

So what’s the right rate of return to use when trying to judge the cost effectiveness of a particular energy saving feature? If not somewhere near the 11 percent plus numbers discussed above, it won’t accurately reflect housing

market behavior. The 10 percent implied in NAHB’s policy on Cost-Effective and Affordable Energy Codes and Standards is below this, but only slightly. The current rate on a 30-year FMR—commonly specified as the discount rate of choice in present value analyses of energy efficiency—is far too low, however.

To be fair, the higher rates described above are primarily gross rates of return that don’t subtract or in any way adjust for maintenance or other ownership costs. Many of the present value methods contain provisions for subtracting costs like these before applying a discount rate. The DOE methodology for evaluating energy codes nets out items such as property taxes and replacement costs, for example. But unless these expenses are substantial enough to produce the equivalent of a double-digit gross return, discounting energy savings by the mortgage interest rate will classify as cost effective some features that are clearly priced higher than the market will bear.

This doesn’t mean that buyers are apathetic about energy efficiency or are unwilling to pay for it—NAHB consumer surveys provide clear evidence to the contrary—only that they are unwilling to pay as much for it as an armchair analyst might calculate. It should come as little surprise if builders tend to oppose attempts to mandate a particular feature that their customers won’t buy at the current price.

Mandating features that provide less return than buyers want creates particular problems at the affordable end of the housing spectrum—where first-time buyers and buyers with modest incomes are likely to be living paycheck to paycheck and therefore need a higher return in exchange for an immediate sacrifice. This is a general problem that arises when more costly construction practices are mandated. It tends to differentially price first-time buyers and buyers with modest incomes out of the market.

¹ Based on the effective rate on Freddie Mac commitments for a 30-year FRM with an 80 percent loan-to-value ratio in April, 2013.

² A realistic way to view the home buyer’s decision process is as follows: the buyer will want to keep adding amenities to the home as long the amenities generate benefits at rate above that which would have to be paid on the mortgage. A typical buyer can probably think of a large number of amenities that would qualify, but is constrained by a finite capacity to borrow, and so is forced to make trade-offs. An appropriate discount rate on energy efficiency would thus be the rate of return the buyer expects to realize on the top amenities that might have to be sacrificed at the margin—a double kitchen sink, extra ceiling or exhaust fans, laundry room, larger garage, brick siding, crown molding, etc. As the return the buyer expects to get on these amenities is primarily psychology and difficult to observe, it’s necessary to look elsewhere for the “right” rate.

³ The survey is based on 3,682 respondents who either bought a home within the past 3 years, or expect to buy one in the next 3 years.

⁴ The calculation is restricted to recent purchases to avoid extreme rent-to-value ratios driven by values that may have appreciated or depreciated drastically since the purchase.