

What Else Does an ENERGY STAR® Home Provide? Quantifying Non-Energy Impacts in Residential New Construction

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ABSTRACT

As energy efficiency programs have matured, evaluators and other market actors have become aware that measuring energy and demand savings alone understates effects these programs have on participants, sponsors, and society as a whole. Non-energy impacts (NEIs) can boost program cost-effectiveness and, in the case of participant NEIs, help market programs. However, NEI measurement is difficult since it often involves program participants putting a monetary value on intangible goods. NEI quantification for new construction programs faces an additional difficulty over the process for retrofit programs in that participants cannot make before-and-after comparisons. This study estimates participant NEIs for ENERGY STAR homes through careful questioning and response cross-checking to reduce bias.

The study examines seven NEIs: thermal comfort, reduced outside noise, lighting quality, indoor air quality, safety, higher resale or rental value, and protection from energy price increases. NEIs are quantified through a survey of 70 recent ENERGY STAR homebuyers who were first asked if they believed their home provided a particular NEI, and, if so, their sources of information, what influence the NEI had on purchase decisions, and valuation relative to the savings on energy bills provided by ENERGY STAR homes.

Homebuyer survey findings are compared to the NEI valuations provided through depth interviews with 30 ENERGY STAR builders. Builder estimates of the values homeowners place on NEIs are higher than those provided by the homeowners for thermal comfort, noise reduction, indoor air quality, and safety. Estimates for resale or rental value are very close for the two groups and builders give considerably lower estimates for lighting features and energy bill protection.

Introduction

Non-energy impacts (NEIs) have been a widely recognized but difficult to quantify effect of energy efficiency programs over the past decade. NEIs are often referred to as non-energy benefits (NEBs); this paper, however, uses the term non-energy impacts (NEIs) to account for the fact that some effects may be negative. Efficiency improvements in a home or business or, in the case of the Massachusetts New Homes with ENERGY STAR Program (Program), new homes that are more efficient than the baseline, have impacts beyond electric demand and electricity, gas, and oil consumption savings. ENERGY STAR homes provide a variety of NEIs ranging from those that are relatively easy to quantify, such as water conservation, to those that are much more difficult to measure, such as the homeowner's sense of satisfaction in helping reduce greenhouse gas emissions. The program sponsors already claim some of the more easily quantifiable NEIs, such as water conservation. This report addresses seven NEIs which had not been previously studied in connection with the Massachusetts Program :

- Thermal comfort in terms of temperatures and draftiness
- Noise levels in terms of the amount of outdoor noise the home's occupants can hear inside the house
- Lighting quality combined with longer lighting life given the use of CFLs and fluorescent fixtures
- Indoor air quality given reduced air infiltration and improved ventilation helping keep out dust, pollen, humidity, and car exhaust
- Safety of the new home's heating system along with improved ventilation making the home safer in terms of carbon monoxide levels and gas leaks
- Anticipated ease of selling or leasing the home in the future and higher resale/leasing value
- Knowledge of some protection against rising energy prices; that is, as energy prices increase, energy bill savings will also increase

NEI quantification for new construction programs inherently faces the issue of participants not being able to make before-and-after comparisons. Thus, ENERGY STAR homeowners are seldom able to compare living in their newly constructed homes to living in newly constructed non-ENERGY STAR homes and will likely compare their new homes with their previous, most likely older, homes, while non-ENERGY STAR newly constructed homes may be quite efficient. This project has tried to deal with this issue by giving clear instructions in the survey instrument and highlighting instances throughout the paper where comparisons to older homes may be occurring.

Methodology

Two research activities provided information about these seven NEIs: a survey of 70 homeowners who have purchased ENERGY STAR-certified homes over the past two years and in-depth interviews with 30 builders who participated in the Program in 2008.

Homeowner Survey

Seventy homeowners were surveyed via computer-assisted telephone interviewing (CATI) from November 14 through 24, 2008. The sample was obtained from a list of homes certified in 2007. The interviewers confirmed that each house is newly constructed, and that the respondent is one of the buyers. Hence the sample represents only owner-occupied new homes, not newly constructed homes that are for rent. The interviewers further confirmed that each respondent had moved into the home on or before January, 2008 and had thus spent at least part of a winter in the home. Respondents were also asked if they knew that newly constructed homes could be labeled ENERGY STAR homes and, if so, whether their new home was an ENERGY STAR home. Again, respondents who had not heard of ENERGY STAR homes or did not know they had bought one were terminated from the survey. The requirement that respondents knew they had purchased an ENERGY STAR home allowed the survey to examine the sources of information about NEIs and the role of NEIs in the purchase decision. It is important to note, however, that this survey is not intended to be representative of all ENERGY STAR homeowners; indeed, the last survey to measure awareness, conducted in January of 2007, found that only 55% of ENERGY STAR homeowners in Massachusetts knew they have bought an ENERGY STAR home.¹

The homeowner survey covered the following areas:

¹ Nexus Market Research Inc. and Dorothy Conant, *Evaluation of the Massachusetts ENERGY STAR Homes Program*, May 2007

- Whether homeowners believe their new home, because it is ENERGY STAR certified, provides a particular NEI.
- How homeowners learned of a particular NEI
- Whether homeowners learned of a particular NEI before or after purchasing the home and, if before, whether the NEI influenced their purchase decision
- Annual value placed on an NEI in relation to energy bill savings. Values could be expressed in dollars or as a percentage of bill savings
- Demographic and housing characteristics

Homeowner survey respondents were asked to estimate an annual monetary value for the NEIs they experience in their homes. The survey used a direct scaling method, asking respondents to value NEIs as a percentage of energy savings. Respondents were asked to assume that ENERGY STAR homes saved \$400 per year in energy costs compared to similar, newly constructed non-ENERGY STAR homes. This figure is considered an average and is reported in both the Massachusetts New Homes with ENERGY STAR Program website (<http://www.massenergystarhomes.com/homebuyers/benefits.htm>) and the national website (http://www.energystar.gov/index.cfm?c=new_homes.nh_benefits).

The survey first asked homeowners if they believed their new home had a particular NEI and whether it was positive or negative. Taking the thermal comfort NEI as an example, respondents were asked if they believe their new home, because it is an ENERGY STAR home, is more comfortable than other new homes, less comfortable, or no different in its comfort level. Those who believed it was more comfortable were asked to place a value per year on this increased comfort either in dollars or as a percentage of energy savings. Those who believed it was less comfortable were asked how much the decreased comfort took away from the value of living in an ENERGY STAR home, either in dollars or as a percentage of energy savings. NEI values for those who believed their new home was no different in comfort level from non-ENERGY STAR new homes were set to zero.

Assigning monetary values to intangibles such as comfort is not an easy task and respondents who responded that they did not know were further prompted with the following questions:

“In terms of energy bill savings, would you say increased comfort is worth nothing, about one-fourth of typical annual energy bill savings, about one-half of typical annual energy bill savings, about three-fourths of typical annual energy bill savings, about equal to the typical annual energy bill savings, or more than energy bill savings? If the latter, how much more?”

The NEIs for respondents who still could not provide an answer are treated as missing in the calculation of average NEI values.

Builder Interviews

Thirty in-depth interviews were conducted during the months of December 2008 and January 2009 with builders who participated in the Program in 2008. In addition to program delivery issues, the builder interviews contained a section on the seven NEIs paralleling the homeowner survey. Builders were asked:

- Whether they believed ENERGY STAR homes provided a particular NEI
- If so, how often they or their salespeople talked about the NEI with prospective homebuyers
- If they did not mention the NEI, whether they thought homebuyers were aware of it anyway
- How much they thought homeowners value the NEI in relation to energy bill savings

The builder interviews used a direct scaling approach, similar to that used in the homeowner survey, for estimating NEIs. The builder interviews first briefly described the homeowner survey and asked builders to estimate the value homeowners placed on NEIs relative to estimated annual savings of \$400 on

their energy bills. Builders were told they could assign a negative value to an NEI if they believed homeowners saw it detracting from their experience living in an ENERGY STAR home. NEI estimates from builders who believe ENERGY STAR homes do not provide a particular NEI (for example, are no more comfortable than other new homes) are set to zero.

Findings

Perceptions

Homeowners overwhelmingly believe their new homes provide positive NEIs in thermal comfort, a higher resale or rental value, and protection against energy bill increases. A majority also believe their new homes provide noise reduction and better lighting features, while only about one-half believe their homes provide better indoor air quality or more safety. Table 1 shows, first, the percentage of homeowner respondents who say ENERGY STAR homes provide a particular NEI (for example, they are more or less comfortable than other new homes) and then the percentage of the total who say the NEI is positive (for example, ENERGY STAR homes are more comfortable than other new homes). These findings are similar to the results of a recent evaluation of the New York ENERGY STAR Labeled Homes (NYESLH) Program where 92% of participants believed they had positive NEIs in thermal comfort; 75% in noise reduction; 67% in better indoor air quality; and 42% in safety.²

Table 1: Homeowners Who Say Home Provides NEIs

NEI	Believe new home has NEI (n=70)	Positive NEIs (n=70)
Thermal comfort	87%	86%
Noise reduction	70%	67%
Lighting life/quality	81%	61%
Indoor air quality	53%	51%
Safety	49%	46%
Resale/rental value	81%	80%
Energy bill increase protection	94%	93%

It has been theorized that, despite the instructions given at the time of the survey, homeowners who believe their ENERGY STAR home has a positive NEI are comparing it with their previous, most likely older, home rather than other newly constructed homes. Table 2 shows differences by age of previous home among homeowners who say their new home has positive NEIs. There appears to be no consistent relationship between the age of the previous home and having a positive NEI in the new home; in some cases respondents with older previous homes are more likely to say they have a positive NEI; in other cases the opposite is true.

² Summit Blue Consulting, LLC and Quantec, LLC. *Non-Energy Impacts (NEI) Evaluation Final Report* Prepared for New York State Energy Research and Development Authority, June 2006.

Table 2: Homeowners Who Say Home Provides Positive NEIs by Age of Previous Home (all homeowner survey respondents who know the age of their previous home)

NEI	Previous home 10 years old or less (n=12)	Previous home over 10 years old (n=45)
Thermal comfort	92%	82%
Noise reduction	67%	67%
Lighting life/quality	83%	53%
Indoor air quality	75%	47%*
Safety	58%	38%
Resale/rental value	67%	80%
Energy bill increase protection	92%	96%

*Significantly different from newer homes at the 90% confidence level.

Builders are more likely than homeowners to believe ENERGY STAR homes have positive NEIs in six out of the seven NEIs, as shown in Figure 1. Furthermore, the proportions of builders who believe ENERGY STAR homes are quieter and have better indoor air quality are significantly higher than that of homeowners at the 90% confidence level. However, the proportion of builders who believe the lighting life and quality of ENERGY STAR homes is a positive feature for homeowners is significantly lower, at the 90% confidence level, than the proportion of homeowners holding this view.

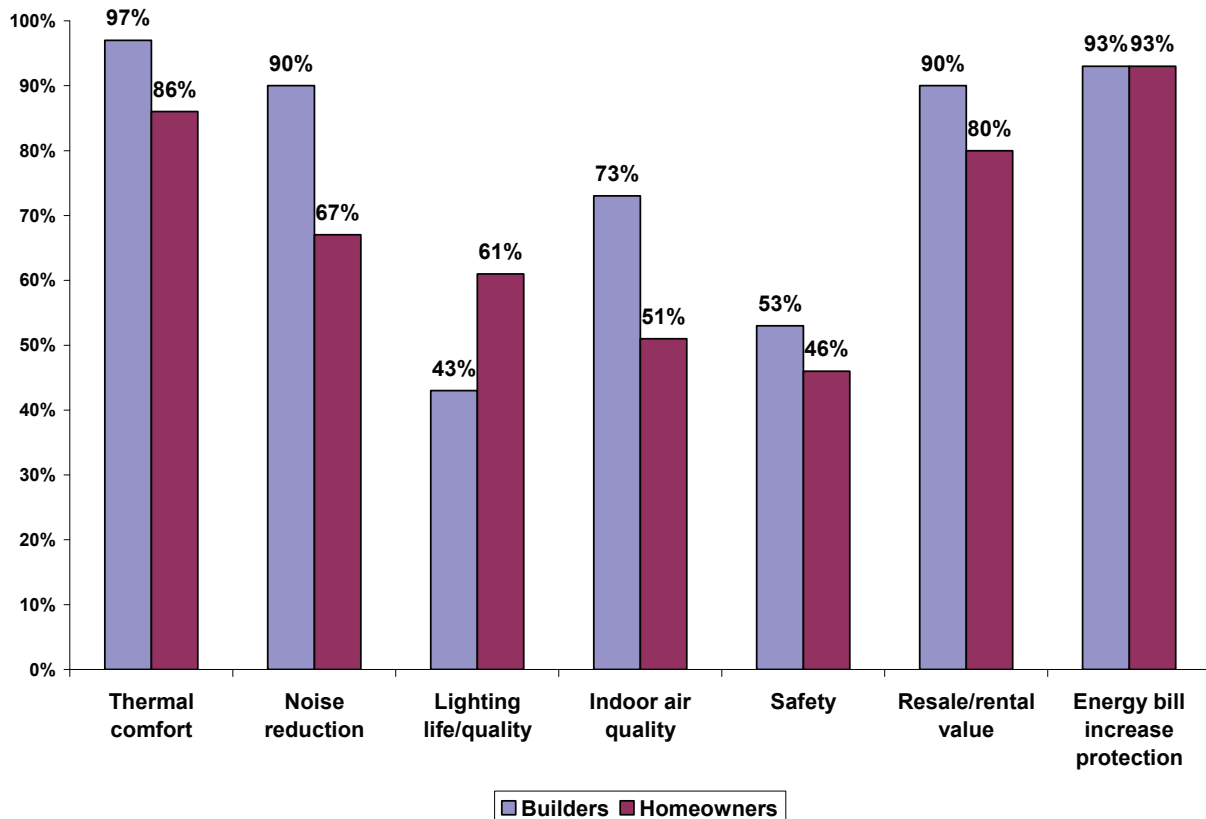


Figure 1: Builders and Homeowners Who Say ENERGY STAR Homes Provide Positive NEIs

Sources of Information

Sources of information for homeowners who believe their homes provide positive NEIs vary by the type of NEI. Builders are an important source for thermal comfort and noise reduction while many respondents say they simply figured out higher resale/rental values and energy bill protection on their own. However, experience living in the home is an important source of information for lighting life/quality, noise reduction, indoor air quality, safety, and thermal comfort. It may be that a sizable portion of respondents who cite experience living in the home are comparing the performance of their new home against that of their old home. (Table 3)

Table 3: How Learned of NEI

(all homeowner survey respondents who believe their homes have a positive NEI; multiple responses)

	Thermal comfort (n=60)	Noise reduction (n=47)	Lighting life/qual. (n=43)	Indoor air quality (n=36)	Safety (n=32)	Resale/renta l value (n=56)	Energy bill protectio n (n=65)
Builder	57%	45%	14%	33%	28%	18%	23%
Experience living in home	33%	51%	56%	44%	44%	0%	0%
Media ads	20%	4%	19%	6%	9%	9%	11%
Booklet or other literature	12%	4%	12%	6%	19%	4%	5%
Internet	8%	6%	5%	3%	6%	9%	9%
Family, friends or co-workers	9%	6%	7%	6%	9%	5%	6%
Realtor or salesperson	7%	9%	12%	6%	6%	9%	6%
Just realized	7%	6%	0%	6%	3%	4%	6%
Home show	3%	0%	7%	0%	0%	2%	1%
Common knowledge	2%	0%	4%	0%	0%	0%	2%
Program implementer	2%	0%	2%	0%	0%	0%	0%
Architect	0%	0%	2%	6%	0%	0%	0%
Store displays	0%	0%	2%	0%	0%	0%	0%
Figured it out	0%	0%	0%	0%	0%	43%	35%
Own research	0%	0%	0%	0%	0%	7%	2%
Don't know	2%	0%	5%	14%	6%	20%	21%

Four-fifths of builders who believe ENERGY STAR homes provide more thermal comfort than other new homes say they or their salespeople always or fairly often discuss this with prospective homebuyers; a majority also say they always or fairly often discuss noise reduction, lighting, indoor air quality, resale or rental value, and energy bill protection. (Table 4) Fewer builders discuss safety. One builder noted that he has to discuss lighting since CFLs often don't come on right away when customers are going through a home.

Table 4: How Often Discuss NEI with Homebuyers
(all builders who believe their homes have NEIs)

	Thermal comfort (n=29)	Noise reduction (n=27)	Light life/ qual (n=29)	Indoor air quality (n=22)	Safety (n=16)	Resale/rental value (n=25)	Energy bill protection (n=28)
Always	59%	44%	38%	45%	31%	40%	43%
Fairly often	21%	19%	31%	27%	6%	24%	21%
About half the time	7%	7%	7%	14%	19%	8%	7%
Not that often	10%	15%	7%	9%	31%	8%	7%
Never	3%	15%	17%	5%	13%	20%	18%
Don't know	0%	0%	0%	0%	0%	0%	4%

Responses shown in Tables 3 and 4 confirm that many ENERGY STAR builders are discussing thermal comfort with their customers, and that homeowners remember hearing about this NEI from the builder. While builders also claim they often discuss noise reduction, lighting, indoor air quality, resale or rental value, and energy bill protection with customers, fewer homeowners remember hearing about these NEIs from builders. This may be due, in part, to the fact that homeowners were surveyed at least a year after moving into their new homes.

For all the NEIs studied, homeowners most often say they learned of the existence of an NEI before deciding to buy or build the home. (Table 5)

Table 5: When Learned of NEI
(all homeowner survey respondents who believe their homes have a positive NEI)

	Thermal comfort (n=60)	Noise reduction (n=47)	Light life/qual (n=43)	Indoor air quality (n=36)	Safety (n=32)	Resale/rental value (n=56)	Energy bill protection (n=65)
Before decided to buy/build	70%	55%	75%	78%	72%	54%	55%
After decided to buy/build	28%	43%	23%	19%	28%	32%	37%
Don't know	2%	2%	2%	3%	0%	14%	8%

Further, most of those who knew of NEIs at this point say the presence of NEIs influenced their decision to buy or build an ENERGY STAR home. (Table 6)

Table 6: Did the NEI Influence Your Decision to Buy or Build an ENERGY STAR Home?
(all homeowner survey respondents who say they learned their homes have a positive NEI before deciding to buy or build)

	Thermal comfort (n=42)	Noise reduction (n=26)	Light life/qual (n=32)	Indoor air quality (n=28)	Safety (n=23)	Resale/rental value (n=30)	Energy bill protection (n=36)
Yes	86%	65%	59%	71%	61%	67%	72%
No	12%	35%	41%	29%	39%	30%	28%
Don't know	2%	0%	0%	0%	0%	3%	0%

Homeowner survey respondents who believe they have positive NEIs thus appear to have learned of these NEIs early in their home buying process and give them some weight in their purchase decision. It is important to remember, however, that this survey is limited to respondents who knew they had bought an ENERGY STAR certified home. It is reasonable to assume that these home buyers are also more likely than others to be aware of NEIs and give them more weight in deciding to purchase an ENERGY STAR home.

NEI Valuation

Table 7 presents the mean values assigned to NEIs by homeowner survey respondents who either did not believe their home provided a particular NEI (value set to zero) or who could express a value either in dollars or as a percentage of energy savings. This means that respondents who believe their home provides a particular NEI but who cannot, even after prompting, assign a value to it, are set to missing. The means in Table 7 include both positive and negative NEI values. Upper and lower bounds of values are calculated at a 90% confidence level; the lower bounds provide a conservative estimate that may be considered for planning purposes.

Table 7: Mean NEI Values from the Homeowner Survey
(all homeowner survey respondents except for those who could not assign an NEI value)

	Thermal comfort (n=61)	Noise reduction (n=64)	Lighting life/quality (n=63)	Indoor air quality (n=61)	Safety (n=63)	Resale rental value (n=53)	Energy bill protection (n=51)	Total
<i>Mean NEI Value</i>								
Dollars	\$279	\$146	\$144	\$126	\$105	\$259	\$386	\$1445
% Bill Savings	70%	37%	36%	32%	26%	65%	97%	361%
<i>Lower Bound NEI Value*</i>								
Dollars	\$210	\$110	\$105	\$91	\$72	\$170	\$161	\$919
% Bill Savings	53%	28%	26%	23%	18%	43%	40%	230%
<i>Upper Bound NEI Value*</i>								
Dollars	\$348	\$182	\$183	\$161	\$138	\$348	\$611	\$1971
% Bill Savings	87%	45%	46%	40%	35%	87%	153%	493%

*Calculated at a 90% confidence level.

The total estimate shown in the last column of Table 7 is simply the sum of the values placed on the seven NEIs considered. As a check on double-counting, at the end of the NEI section of the survey, homeowner respondents were provided with the sum total of their valuations and asked:

“When we add the values you have placed upon the features of an ENERGY STAR home that we just discussed—we come up with XX% of the home’s annual energy cost savings. Would you say this figure is correct—that these seven features are worth XX% per year of annual energy cost savings to you?”

Only one of the 70 homeowner respondents did not agree that the total accurately represented the value of the seven NEIs; he worked with the interviewer to adjust individual values to acceptable levels. It may be that other survey respondents agreed that the totals were accurate since they were close to the end of the survey and did not want to repeat earlier questions. This may have the effect of overstating the totals reported.

Similar NEI values were obtained from a survey of NYESLH Program participants using a direct scaling approach. Ease of selling the home was valued at just over 60% of energy bill savings with indoor air quality at over 50% and thermal comfort and reduced noise levels at over 40%. This study, however, assumed energy bill savings of \$600 per year.³ Overall participant NEI values from zero and low energy homes in New Zealand ranged from 150% to 280% of energy savings. The most highly valued NEIs were increased comfort, helping the environment, and not having to move from the home due to high energy costs.⁴

³ Summit Blue, op cit.

⁴ Stoecklein, Albrecht, & Skumatz, Lisa. (2006). “Using Non-Energy Benefits (NEBs) to Market Zero and Low Energy Homes in New Zealand.” *Proceedings from the ACEEE Summer Study Conference 2006*. Pacific Grove, CA: American Council for an Energy-Efficient Economy.

Builder estimates (means) of how much homeowners value NEIs are shown in Table 8.

Table 8: Mean NEI Values from the Builder Interviews
(all interviewed builders except for those who could not assign an NEI value)

	Thermal comfort (n=29)	Noise reduction (n=28)	Lighting life/quality (n=28)	Indoor air quality (n=28)	Safety (n=29)	Resale rental value (n=27)	Energy bill protection (n=27)	Total
<i>Mean NEI Value</i>								
Dollars	\$371	\$284	\$86	\$271	\$224	\$267	\$301	\$1804
% Bill Savings	93%	71%	22%	68%	56%	67%	75%	451%

Overall, builder estimates are higher than those provided by homeowners, though at a global level the results are similar enough to reinforce their validity. For individual NEIs, builder means are considerably higher than homeowner means for thermal comfort, noise reduction, indoor air quality, and safety; in the cases of indoor air quality and safety, builder estimates are significantly higher at the 90% confidence level. This is due, in both cases, to the higher proportion of builders than homeowners who believe ENERGY STAR homes are quieter and have better indoor air quality, as shown in Figure 1. Estimates for resale or rental value are very close for the two groups and builders give considerably lower estimates for lighting features and energy bill protection. (Figure 2)

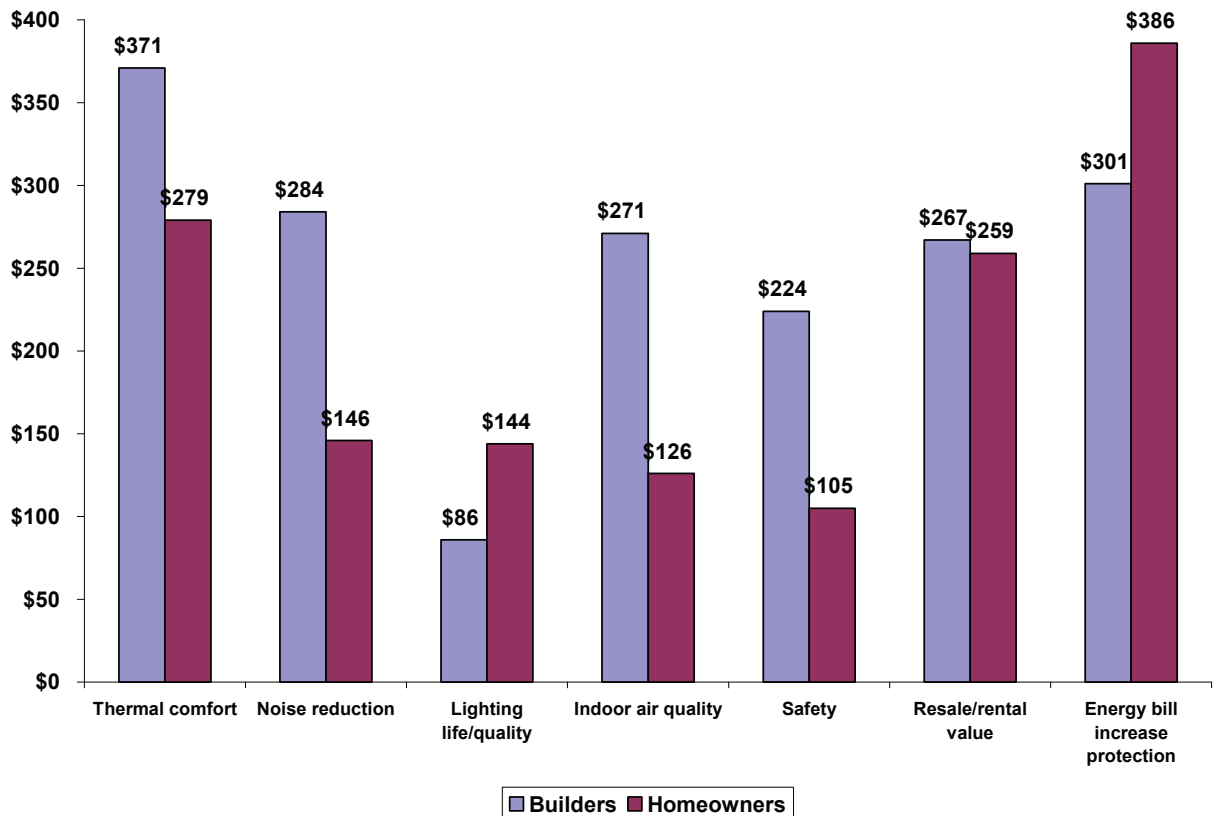


Figure 2: Builder and Homeowner Valuation of NEIs

It should be noted that the lower mean value estimate for lighting life and quality among builders than among homeowners is largely due to the higher proportion of builders who applied a negative value to this NEI. While only four out of 70 homeowners applied negative values to CFLs, four out of 30 builders did so. It would thus appear that builders are more likely to believe that homeowners do not like CFLs than is actually the case. One interviewed builder did acknowledge that he only hears the complaints about CFLs.

Conclusions

The homeowner survey and builder interviews point to several conclusions about NEIs.

- Thermal comfort is the best known and most highly valued NEI for homeowners. Close to nine-tenths of ENERGY STAR homeowners believe their homes offer more thermal comfort than other new homes and they value this feature, on average, almost as much as yearly energy bill savings.
- Builders are also most likely to talk to homeowners about thermal comfort and homeowners are most likely to remember learning about this NEI from builders.
- Taken together, homeowners value the seven NEIs more than annual savings on energy bills. Even if the survey, despite efforts to the contrary, had some double counting, a conservative estimate would put the value of the seven NEIs at about twice the amount of energy bill savings.
- After thermal comfort, homeowners place the highest value on increased resale or rental value and energy bill protection—features they largely figure out on their own.
- Builders are more likely than homeowners to believe ENERGY STAR homes offer better noise reduction, indoor air quality, and safety than other new homes.
- Builders are much more likely to give a negative value to CFL lighting; it is possible that homeowners don't mind the light quality and slowness to come to full brightness as much as builders think they do.

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