Using Non-Energy Benefits (NEBs) to Market Zero and Low Energy Homes in New Zealand

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ABSTRACT

For a research project in New Zealand on zero and low energy houses (ZALEH), the authors conducted in-depth survey interviews to quantify benefits of and barriers to advanced homes technologies. The surveys included occupants of known ZALEH homes. The survey consisted of four major sections: an inventory of (advanced) equipment; a survey of technology performance issues, attitudes, and beliefs; questions to inventory and value positive and negative NEBs from various equipment; and detailed demographic and segmentation variables.

The research examined the overall non-energy benefits (NEBs), as well as the benefits from each of the range of advanced technologies included in the homes. We identified the sources of NEBs – including factors such as improvements in comfort, bill control, health, maintenance, noise, bill-related issues, the environment, and other factors. We examined the both positive and negative impacts, and used a set of detailed questions to identify the value that the occupant placed on each of the net impacts or benefits. The results showed ZALEH residents place a high value on the energy efficiency features of their homes, and that the relative level of benefits is on the order of those seen in US programs.

Background on NEB Valuation

This project was designed to measure the non-energy benefits (NEBs) that might be found in a set of zero and low energy houses (ZALEH) in New Zealand. The authors conducted in-depth interviews with occupants to discuss, identify, and quantify positive and negative impacts the owners recognize from advanced homes technologies. The advanced features of these homes included: advanced house design (96%), solar water heating (96%), advanced glazing (91%), advanced space heating and cooling (91%), insulation (83%), special house features (61%), micro energy generation[1] (35%), and other features (22%).

Over the past few years, research has been conducted to develop and test alternative valuation methods for commercial and residential NEBs (Skumatz 2002). This project provided an opportunity to quantify the array of NEBs that have been associated with low energy use homes – and develop information that serves at least two purposes:

- *Informs efficiency-related marketing, targeting, design, and outreach efforts*: Previous research shows that NEB analysis provides quantitative information that clarifies benefits and negative benefits/barriers associated with efficiency efforts – based on the field experience of those implementing conservation measures. Previous research demonstrated these methods for a variety of residential and commercial programs and measures (Skumatz 2002, Pearson and Skumatz 2001). The quantitative approach and

[1] Micro generation is considered generation by households through technologies like PV, small wind and hydro, etc.

information demonstrates which NEBs are especially important, and provides data on the relative size of the NEBs compared to direct benefits from energy savings and other direct sources. These findings can be sorted by demographics, measure type, or other factors that may affect the value and importance of the NEBs. These results point out which benefits are most important to various groups, providing opportunities to design program interventions and outreach to target buildings, decision-makers, and other subgroups. with the greatest NEB benefits, using terms and benefits that *they* value and respond to.

- *Provides data for improved program benefit-cost analyses*: The quantitative values for program- or intervention-related NEBs can and have been used in revised public purpose tests,[2] and to provide more complete information for assessing benefits and costs associated with programs. Dollar-related NEB benefits ("net" including positive and negative NEBs) can be added to direct cost and benefit information, enhancing program-related B/C computations. The user may choose to include all NEBs, or only a subset of the overall NEBs in the benefit/cost (B/C) computations – or there may be different B/C computations depending on the perspective upon which the test is based. One specific application for quantified non-energy-benefits may include programs in which post evaluation shows that the projected energy savings have not been achieved. Rather than considering these programs as failures, the financial valuation of non-energy-benefits can demonstrate a quantifiable positive outcome nevertheless, albeit not the originally intended one.

Most of the previous NEB work has assessed benefits associated with measure-based programs or audits that lead to measure changes. This project was designed to see if benefits were recognized and attributed to features of zero and low energy homes (ZALEH) in New Zealand, and to see if actual dollar values – or ranges – could be associated.

NEB Measurement Approach

The research trick is valuing these "hard-to-measure" positive and negative benefits. Skumatz Economic Research Associates, Inc. (SERA) has conducted extensive research to develop several measurement methods to quantify and "value" a wide range of participant and other NEBs. SERA pioneered the application of three different approaches in querying and measuring non-energy benefits, including "willingness to pay", comparative, and labeled magnitude scaling approaches (Skumatz 2002). For this project, two of these methods were used: a variation of the willingness to pay, and the comparative methods. The results were designed to provide information on the net value of the non-energy benefits emanating from the advanced technologies as recognized by the ZALEH residents.

The basic approach involved telephone interviews with residents in a sample of ZALEH homes. We asked about specific NEBs (positive and negative) associated with individual measures. Previous NEBs research and some preliminary work was used to develop a list of likely NEBs associated with the ZALEH homes / owner.

We asked about benefits prompted and unprompted. In the questionnaire, we asked about each NEB category on whether there was a change, and whether it was positive or

[2] Work by Skumatz for the California Utilities updating the Low Income Public Purpose Test, and information from Skumatz and other NEB analyses was used to develop NEB "adders" for Massachusetts PUC proceedings.

negative. The prompted benefits categories – phrased in the way that most people assigned the NEBs (positive) -- included:

- **Appearance**: Improvements in appearance of the home.
- **Bill control**: Measures (and bill impacts) led to a feeling of greater control over the bill.
- **Comfort**: ZALEH house features led to greater comfort in this home than others.
- **Environmental**: Features led to environmental benefits.
- **Features**: Energy equipment or measures had better features, options, or were nicer than non-ZALEH measures.
- **Health**: Features were perceived to make the home safer or healthier to live in.
- **Maintenance**: The features had lower maintenance
- **Moving**: The ZALEH home's special energy features led to them being able to avoid a move, either because of lower bills, greater benefits, value, and service from the home, or other reason.
- **Noise**: The ZALEH home had lower noise, either from outside the home, or from the energy using equipment inside the home, or both.
- **Notices**: The energy reductions due to the ZALEH home led to lower bills which improve their ability to pay and reduced their need to call or get notices from the utility on bill-related issues.
- **Other**: Other, unprompted benefits categories included higher cost (the major one), and a variety of other benefits or negative impacts and changes.

The results for overall valuations and for individual benefits categories is included in the following sections.

Total NEBs from the ZALEH Homes

The feedback and valuations from the respondents make it clear that there are NEBs deriving from ZALEH homes and they are highly valued. The results showed that the average estimate for energy savings from ZALEH home $1,300(NZ) per year.[3] The values reported by individual homeowners ranged from $400 to $3000(NZ). The NEB analysis found that, on average, residents estimated they recognized about $3,600(NZ) worth of value from the NEBs – including both positive and negative impacts from the range of conservation measures and features included in their homes. Thus, as a fraction of energy benefits, the households report that they received just over three times as much value from the NEBs from the ZALEH as they realized from the energy savings. If non-energy benefits were to be incorporated into the assessment of "payback" for the investment in the ZALEH measures, it would imply that the payback was significantly better than the payback excluding these benefits.

Results by Type of NEB

Table 1 shows the percent of the total NEBs that derive from each NEB category – on an overall basis. Most of the NEBs (almost three quarters) come from just a few categories:

[3] Note that the residents were asked to estimate the energy savings from measures; actual data on savings were not provided.

- Comfort (28%),
- Environmental benefits (a feeling of "doing good" for the environment) (22%), and
- Avoided moves (22%).

Other sources of NEB value included improved appearance, noise reduction, and bill control, and health benefits. It was somewhat surprising that health benefits were valued relatively low. Other New Zealand studies found evidence of significant health improvements following insulation retrofits (Howden-Chapman, *et.al.* 2004). The low rating in the ZALEH houses might be attributed to the fact that the sample was self selected and biased towards high income. These people might be able to heat their houses to comfortable healthy temperatures regardless of the thermal performance of the house and therefore might not have seen health improvements since living in a ZALEH home.

Improved features, maintenance, and benefits associated with late utility payments (notices) were fairly insignificant sources of recognized NEBs. Clearly, residents feel that ZALEH homes provide strong comfort, and environmental benefits, as well as benefits that allow or induce them to stay in the home and avoid moving. However, concern about the potential extra cost involved was a significant negative concern, representing 11% of the net NEBs assigned.

Table 1. Share of Total Net NEBs from Key Categories

	Percent of total NEB value by NEB category
Appearance	7%
Bill control	4%
Comfort	28%
Environmental	22%
Features	0%
Health	3%
Maintenance	1%
Moving	22%
Noise	5%
Notices	0%
Cost	-11%
All other	-1%

NEB Results by Measure

We also examined the measures that led to the greatest NEB value. The results, showing averages for homes with those measures, are provided in Table 2. Table 3 expresses these findings in percentage terms. The research indicates that the top three measures in terms of net NEB benefits were responsible for just under two-thirds of the overall NEB value provided in the ZALEH homes. The results show that the measures with greatest NEB values included:

- Special house design (26%),
- Insulation (24%), and
- Windows / double glazing (15%).

Other strong benefits were provided by solar water heating and space heating, representing another 19% of the benefits combined.

The strongest sources of benefits for each measure or feature are outlined below:

- **Special house features**: NEBs derived mostly from the comfort benefits, and the benefits it provided in avoiding moves.
- **Insulation**: Led to strong benefits in comfort and avoided moves.
- **Better glazing**: Improved windows provided especially strong comfort and noise benefits to residents.
- **Water heating**: Largest NEBs in this category came from environmental and comfort sources.
- **Space heating and cooling**: Comfort, environmental, and avoided moves were the greatest contributors to NEBs for these measures.
- **Appliances**: The biggest source of these benefits was environmental.
- Other special house features and micro energy sources had fewer observations: Most of these benefits from other special house features came from environmental and avoided moving sources. The micro energy users reported a wide variety of positive and negative benefits.

Table 2. Annual NEB Values by Technology and NEB Type in New Zealand Dollars

	Appliance	Glazing	HVAC	Insulation	Micro Gen	Other	Special Design	Water Heating	Total NEB Value	Pct of total NEB value
Appearance	$12	$82	$69	$301	-$69	$440	$952	$3	$1,379	7%
Bill control	$11	$134	$58	$292		$0	$0	$205	$795	4%
Comfort	$2	$1,080	$695	$1,895	$31	$60	$1,707	$763	$5,574	28%
Environmental	$161	$248	$382	$432		$1,600	$633	$1,291	$4,227	22%
Features	-$3	$55	$48	$4	-$129	$60	$0	-$2	$61	0%
Health	$0	$150	$175	$322	$100	$0	$0	$58	$653	3%
Maintenance	$28	$418	-$28	$262		$220	$0	-$131	$232	1%
Moving	$0	$264	$407	$1,640	$510	$714	$1,802	$295	$4,307	22%
Noise	$35	$702	$3	$368	-$83	$0	$0	-$17	$925	5%
Notices	$0	$0	$0	$0	$0	$0	$0	$0	$0	0%
Cost	-$44	-$366	-$154	-$612		-$441	$0	-$361	-$ 2,240	-11%
All other	$66	$120	-$120	-$244	-$331	$0	$0	$93	-$187	-1%
Sum	$269	$2,888	$1,537	$4,660	$349	$2,653	$5,094	$2,198	$19,648	100%
% with the measure	61%	91%	91%	83%	35%	22%	96%	96%	100%	
% NEBs for technology	1%	15%	8%	24%	2%	14%	26%	11%	100%	

While most of the benefit categories showed positive values, cost and maintenance were expressed as negative effects from the ZALEH homes and features. This matches findings from other work (Skumatz 2004). Interviews conducted as part of the other project indicated that participants were concerned that the maintenance for advanced measures might be more complex, that it might be hard to find contractors to repair measures, and parts might be difficult

to find. Although these issues were not probed in the New Zealand work, concerns might be similar.

Table 3. Results on Percent of NEB by Technology

	Appliance	Glazing	HVAC	Insulation	Micro Gen	Other	Special Design	Water Heating	Total NEB Value	Pct of all NEBs
Appearance	5%	3%	5%	6%	-20%	17%	19%	0%	7%	7%
Bill control	4%	5%	4%	6%	n/a	0%	0%	9%	4%	4%
Comfort	1%	37%	45%	41%	9%	2%	34%	35%	28%	28%
Environmental	60%	9%	25%	9%	n/a	60%	12%	59%	22%	22%
Features	-1%	2%	3%	0%	-37%	2%	0%	0%	0%	0%
Health	0%	5%	11%	7%	29%	0%	0%	3%	3%	3%
Maintenance	11%	14%	-2%	6%	n/a	8%	0%	-6%	1%	1%
Moving	0%	9%	26%	35%	n/a	27%	35%	13%	22%	22%
Noise	13%	24%	0%	8%	-24%	0%	0%	-1%	5%	5%
Notices	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Cost	-16%	-13%	-10%	-13%	n/a	-17%	0%	-16%	-11%	-11%
All other	25%	4%	-8%	-5%	n/a	0%	0%	4%	-1%	-1%
% of NEBs from technology	1%	15%	8%	24%	2%	14%	26%	11%	100%	80%
% of NEBs excluding "Cost "and "Other"	1%	14%	8%	25%	13%	14%	23%	11%	100%	

Differences in Results by NEB Valuation Method

Table 4 shows the overall and measure-specific values and multipliers for the ZALEH homes. The table shows value in two ways:

- A variant of willingness to pay in which we asked how much they would need to be given to agree to have the item removed from their home, and
- NEBs computed from comparisons with value relative to perceived energy savings from the measures.

Table 4. NEB and WTP Results and Multipliers

	Total (rounded)
WTP -- average for those with measure($)	$1,900(NZ)
Individual NEB values adjusted to "total" ($)	$3,600(NZ)
Energy savings by measure adjusted to "total" ($)	$1,300(NZ)
Multiplier of NEB value / energy savings	2.8
Multiplier of WTP value / energy savings	1.5

The results for the willingness to pay (or be paid) shows that the homeowners estimated they would need to be paid an average of about $1,900(NZ) to have the ZALEH features

removed. The highest value in those terms was provided by insulation, with windows and special house design features also important or highly valued by residents.

When asked in relative terms how valuable the measures were to residents, the households provided information that translated into a net value of about $3,600(NZ) per home.[4] The highest value items under the WTP method were again the highest valued items under this valuation method. The second method determined a value almost double the value provided through the willingness to pay method.

The energy savings that households estimated came from these measures was about $1,300 per year. When the computed NEBs were compared to energy savings estimates, we found that:

- When measured from WTP estimates, the NEBs were 50% more valuable than the energy savings (multiplier of 1.5) and
- When measured in relative terms, the computed NEBs were 180% more valuable than the energy savings (2.8 multiplier in the table).

While these two valuation methods provide different estimates, both indicate that NEBs were perceived to have significant value, and that these other benefits were perceived to be significantly more valuable than the energy savings deriving from the measures and features provided in the ZALEH homes.

Discussion of Overall Results

This implies that, regardless of which measurement method is used for the NEBs, when cost-benefit analyses are used to justify expenditures in measures, the builder or other decision maker may be underestimating the value of the measures or investments to homeowners. The computed payback figures are much longer than residents experience in terms of overall value.

Reviewing the values assigned by measure in Tables 2 and 3 above shows that the measures with the highest value multipliers relative to estimated energy savings are insulation, special house design, and glazing. These measures may be ones that, in particular, builders could "overinvest" in (using simple payback criteria) and have that investment by builders highly valued by customers.

It should also be noted that it is likely that the survey participants overestimated their energy savings.[5] However, the estimated non-energy-benefits are internally consistent, at least as a multiplier relative to savings. This is because, during the interview, the subjects were explicitly asked to compare non-energy-benefits with the dollar energy savings, each time explicitly quoting the dollar value of the estimated savings. The likely overestimation of the

[4] We asked the information in terms of both individual benefits as well as the overall benefits. The individual benefits were corrected or "scaled down" in this table to sum to the overall benefits they estimated. That is, the sum of comfort plus each other individual benefit category came to a higher number than they estimated for the total / overall net NEBs. The total NEBs computed from the sum of individual categories was 61% higher than the figures in the table. This tendency to overestimate individual benefits relative to the sum has been found in other research (Skumatz 2002).

[5] A large New Zealand study on actual energy use in houses found that the average energy consumption is approximately 10,000 kWh (Isaacs, *et.al.* 2003). This excludes fire wood usage, which is still comparatively common in older New Zealand houses. While ZALEH homes were intended to significantly reduce energy usage, at approximately NZ$0.13 per kWh this equates to almost 100% of the estimated energy savings in the ZALEH houses. However, most of the houses still report significant energy usage.

energy savings through the ZALEH technologies means that the NEB multiplier is in fact a conservative estimate when compared to more realistic actual or engineering calculated energy savings. Further, the Willingness to Pay values were provided as a direct dollar feedback – not related to energy savings. The findings in either case imply NEBs are recognized as valuable to the homeowners. The results show particularly valuable measures as recognized by homeowners are:

- Special housing design,
- Insulation,
- Glazing,
- Space heating and cooling,
- Water heating,
- Other special features, and
- Micro generation applications.

Summary and Implications

The analysis shows that comfort, environmental benefits, and avoided moving benefits each represent more than one-fifth of all the non-energy benefits realized by residents in the ZALEH.

- Residents gain the comfort from more insulated homes, better space heating, double glazing, solar water heating and special house design.
- One of the major NEBs associated with energy efficient appliances and solar water heating is environmental.
- Environmental benefits represent about a fifth of the NEBs delivered by these measures.
- Negative benefits (concerns) – largely costs and maintenance issues, can be associated with the advanced energy measures.

The results show that investment in ZALEH features may be lower than residents would be willing to accept. The data indicates that NEBs outweigh energy savings, and understate benefits recognized by homeowners by between 50% and 180%, or by $1,900(NZ) to $3,600(NZ) depending on valuation methods. Comparison to NEBs from other programs shows that these results are in line with savings from US residential programs. Skumatz (2001b, 2002) summarizes results from several low income and residential programs, and finds that participant NEBs on the order of 100-300% of energy savings are usual, depending on program type and target participant..

Further, outreach on ZALEH homes could emphasize some of the important benefits residents attribute to the ZALEH features, namely significant value from comfort, environmental benefits, and reduced need to move. Other important benefits include better appearance of the home, better control over bills, and health benefits.

Non-energy benefits (NEBs) are an often-ignored, but important set of benefits provided by energy-related measures and features in residential (and non–residential) buildings. Utilities may run energy conservation programs to reduce energy use, and builders may build homes that include energy saving features, measures, and designs. However, energy savings may not be – and appear not to be – the highest valued outcome of these measures and features to the residents or homebuyers. These results make sense to incorporate into:

- Initial decision-making about which measures / features to be included in new / remodeled homes (or into programs) and computations of costs and benefits from investment in energy using equipment, and
- Outreach / advertising to attract homeowners to these homes or to energy conservation programs that incorporate these measures. The value of these other benefits – may be stronger selling points for the measures than energy savings – and these benefits should be used as key sales messages in program outreach.

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