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The Value of Low Energy Technologies for Occupant and Landlord

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ABSTRACT

The level of our household energy consumption depends not only on our activities, but also to a high degree on the choice of technology we use in our homes. In many situations, energy-efficiency measures are associated with energy cost savings. However, these technologies also bring significant other potential benefits related to the natural environment and lifestyle. These issues tend to be more significant decision drivers to consumers than energy savings, but valuing and comparing these non-financial benefits is inherently difficult.

The Zero and Low Energy House (ZALEH) project is the first New Zealand research project attempting to quantify a wide range of non-energy benefits (NEBs) for home occupants. These include outcomes such as improvements in comfort, bill control, health, noise, maintenance and the environment. Both positive and negative impacts were investigated to identify the net value that the occupant placed on the outcomes. The results suggest that most residents place a much higher value on the lifestyle benefits from energy-efficiency features of their homes than on energy savings.

Also benefits to landlords tend to be of similar magnitude as the energy savings.

Keywords: energy, technology, non-energy benefit.

Introduction

The 21st century is seeing a worldwide trend towards achieving a sustainable environment and eco-societies. New Zealand is an island country with limited usable resources and is also a developed country facing strong population and natural consumption growth. Pressures are therefore placed on energy, housing and water, often with detrimental effects on a wide range of environmental aspects (as well as social and economic effects).

The Zero and Low Energy House research project (ZALEH) studies in-depth the effects of advanced energy technologies and simple insulation retrofits on residents and compares them with the expectations of normal house residents for utilising low energy technologies. The project's main focus is the real life performance of these technologies, rather than their technical potential in the laboratory. The research results therefore aim at quantifying real life values that can be achieved for New Zealand home occupants. The challenges and opportunities of an eco-building environment are presented to create an improved sustainable environment in the future.

Background

International research suggests that home occupants do value the benefits of low energy technologies, not only in respect to lower energy bills but also for a range of other energy unrelated reasons.

A recent study of new houses in Florida found a much higher gain in the resale value of low energy houses compared with the conventional comparison homes, despite the similarities between the two groups of homes in location, original sales price and floor area (Coburn et al 2004). The authors suggest that this difference in resale value can at least be partially attributed to the energy features of the homes. The occupants mainly quoted noticeable energy cost reductions as the reason for the increased property value.

According to Nevin et al (1998), residential real estate markets assign to energy-efficient homes an incremental value that reflects the discounted value of annual fuel savings. The capitalisation rate used by homeowners was expected to be 4-10%, reflecting the range of after-tax mortgage interest rates during the 1990s, and resulting in an incremental home value of $10 to around $25 for every $1 reduction in annual fuel bills.

But the financial effects of energy savings are not the only benefits which have successfully been quantified in overseas studies. A study conducted as part of the European SAVE program evaluated employment benefits of energy-efficiency projects (Energy Saving Trust 2000). The report suggests that the direct employment benefit is between 10 and 58 person-years for each £m invested for each of the investigated projects. In addition, there are indirect employment benefits of more than twice the direct employment effects.

The New Zealand study reported on in this paper focuses on direct home occupant benefits. Quantifying these occupant perceived benefits, and any problems, is considered to be an important step for addressing market uptake barriers. The study therefore focuses on consumer perceptions, rather than physical outcomes such as actual energy cost savings or indoor temperature increases, because it is ultimately the consumer perception which will motivate or otherwise the consumer to change their behaviour and purchasing patterns.

An extensive meta-study conducted in the USA in 1999 collated NEBs such as carbon dioxide or arrearage reductions, increased jobs in the community and other benefits not related to a unit of energy from almost 100 individual studies of low income household energy improvement projects (Riggert et al 2002). In conclusion, the meta-study found that when all of the benefits are counted, the NEBs alone often exceed the cost of a typical energy-efficiency improvement program by a wide margin and provide significant private, public and environmental benefits.

Methodology

Unlike some similar projects in New Zealand, the ZALEH project aims at quantifying the value perception of these benefits to the consumer rather than the saved cost. The Wellington School of Medicine and Health Science research, for example, has conducted an extensive study on the health benefits of insulating homes (Howden-Chapman et al 2004). That study is able to show significant health benefits due to insulation, which are based on the saved cost of medical treatment. The ZALEH study, in contrast, takes a value-based approach independent of the actual health cost, but based on the value perception of the home occupants. It is therefore more applicable for marketing planning rather than public health policy development.

Because the objective of this survey was to quantify the occupants' value perception of energy technologies, the appropriate methodology had to be based around a survey approach rather than physical performance metering (energy, temperatures, etc). An analysis of only the physical performance changes of the building would not permit a value association.

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 2002). The quantitative approach and 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 activities to target groups such as builders, decision-makers and other sub-groups. It will permit them to address those energy technologies which show the greatest NEB benefits, using terms and benefits that the end users value and respond to.

- *Provides data for improved program benefit-cost analyses:* The quantitative values for program- or intervention-related NEBs can be and have been used in revised public purpose tests, 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 cost/benefit computations. The user may choose to include all NEBs or only a subset of the overall NEBs in the cost/benefit computations – or there may be different cost/benefit computations depending on the perspective upon which the test is based. One specific application for quantified NEBs 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 NEBs 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 recognised and attributed to features in insulation-retrofitted homes, but also of zero and low energy homes, as well as to capture consumer perceptions in homes which do not have any specific energy features at all. An ideal survey sample would include houses that:

1. Have experienced low energy technologies.
2. Are without bias, i.e. do not have invested a significant amount of money and might therefore post-rationalise the outcome. This phenomenon is known as "cognitive dissonance".
3. Are representative of the population.

In reality there is no such sample group that would fulfil all these requirements. It was therefore necessary to survey a number of different groups, which each met some of the criteria. The table below shows the types of households surveyed in this project.

Table 1: Group of houses included in the surveys

	experienced	*unbiased*	*representative*	#
1. Low energy houses	x			23
2. Randomly selected		x	x	58
3. Retrofit project participants (low income)	(x)	x		25

Each of the groups had some limitations. The low energy house group members were generally very compassionate about the energy technologies and, because they had invested in the technologies, may not have been completely unbiased in their value perceptions. The randomly selected house group included mainly houses which did not have any particular energy technologies implemented. Their responses therefore reflect expected technology performances rather than actually experienced performances. The low income group consisted of a number of Housing New Zealand Corporation (HNZC) houses in Dunedin, which had, over the last few years, received insulation and hot water cylinder upgrades. These occupants were probably providing unbiased feedback (the interviewees were assured that the survey responses were processed anonymously). However, the energy upgrades were comparatively small and cannot therefore be seen as representing feedback for low energy technologies. Furthermore this group was obviously demographically skewed towards low income occupants.

The surveys focused on two main aspects: the first was the identification of barriers and the opportunities to overcome these; the second was to quantify the value which occupants placed on the benefits of low energy technology or simple energy improvements.

These benefit measures included those that were experienced by the occupants of low energy and retrofitted houses (groups 1 and 3) as well as perceived benefits by those that were theoretically expected by occupants of randomly selected houses that had not received any particular energy technology upgrades (group 2). Due to the limited survey fund, this study has been conducted using three methods: via telephone interviews with a corresponding mail questionnaire in the low energy house research; face-to-face visiting interviews for the retrofitted HNZC houses; and an online web-based survey for the randomly selected houses. All surveys covered barriers to energy technologies as well as the NEB evaluation.

Results from low energy houses

Selection criteria

The households were invited to participate in the project via public advertisements. All accepted applications went into a draw for some incentives to participate in the project. A series of minimum acceptance criteria was used for inclusion in the project. These included:

- solar or heat pump water heating
- insulation significantly better than New Zealand Building Code (NZBC) requirements
- double-glazing throughout
- solar design features such as trombe walls or others
- energy bills of less than $15 per month per occupant
- Renewable energy technologies such as photovoltaic panels, wind energy etc.

Participants did not have to meet all of these criteria since the objective of the study was not to find the most energy-efficient houses in New Zealand, but rather to identify value perceptions by people who have experienced some low energy technologies. Approximately half of the house applications were finally accepted using a simple unweighted scoring system for the six criteria. In some cases, a house was accepted because it featured one or two interesting technologies, although overall it could not be classified as “low energy”.

All 23 accepted houses have insulation installed in their houses, most of them levels clearly above NZBC minima and 90% of households have double glazing and/or sun-tempering technologies. Only one household uses an electric hot water cylinder without solar water heating and other heating systems. Therefore, almost 90% of households in the sample have installed water heating technologies such as a solar water heater, wetback or wood-fired hot water heater. However, there were no instances of heat pump usage, evaporative cooling systems, active air systems, embedded phase-change materials or other advanced technologies.

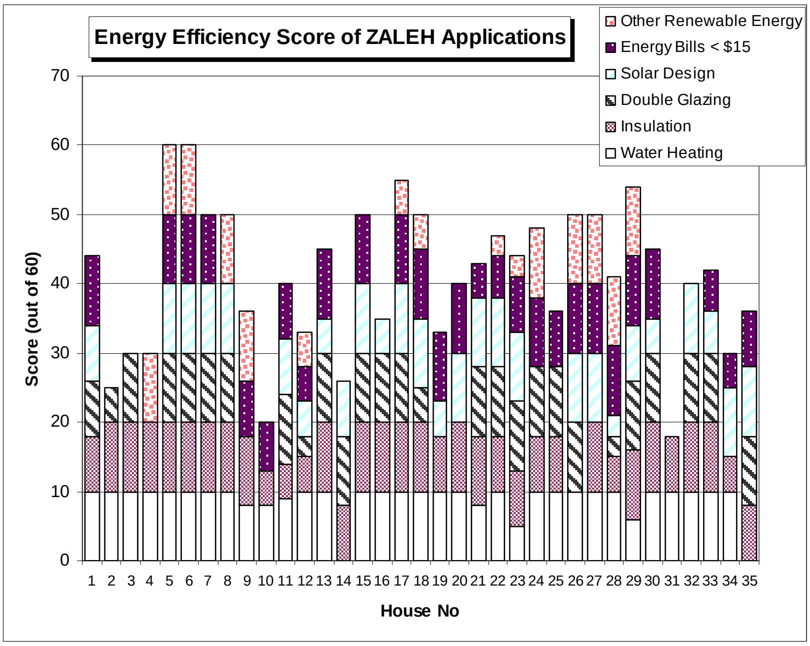

Figure 1: Acceptance criteria for the Low and Zero Energy Project. (Note: that some of the initial applications did not include sufficiently detailed specifications to be included in the scoring system.) Threshold for acceptance was set at 30 points

House values and energy technology costs

The median market value of the surveyed low energy houses (excluding value of the section) is about NZ$350,000 and the median floor area is almost 250 m². Most energy technologies have a low relative cost and lead to reasonable energy savings per year, as shown in Table 2. The percentage increase in the cost of building the house is very small, between 1% and 2.5%.

Table 2: Median costs of reported technology (or related design) costs and energy savings from sample households

Technology Name	*Technology Cost*	*Annual Energy Savings*
(as reported by the occupants)		
Insulation	$5,500	$450
Double glazing	$5,500	$300
Water heating	$4,000	$400
Space heating and cooling	$4,000	$200
Special house design feature	$10,000	$300

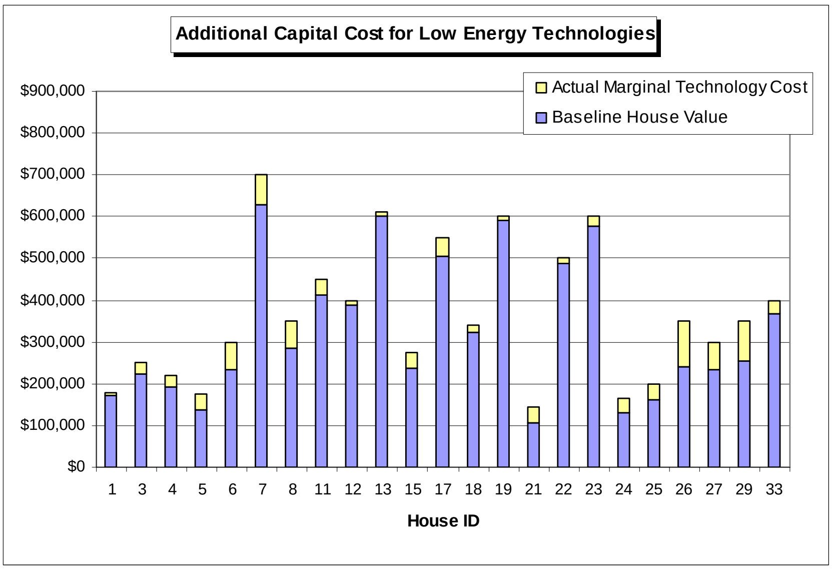

Figure 2: Technology cost

The advanced features of these homes included: advanced house design (96%), solar water heating (96%), advanced glazing (91%), advanced space heating and cooling (91%), high insulation levels (83%), special house features (61%), micro-energy generation (35%) and other features (22%).

Non-energy benefits

The most challenging aspect of the study is quantitatively valuing the "cannot see" positive and negative NEBs. 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 NEBs, including "willingness to pay", comparative and labelled magnitude scaling approaches (Skumatz 2001). For this project, two of these methods were used: a variation of the willingness to pay, and the comparative assessment methods. The results were designed to provide information on the net value of the NEBs emanating from the advanced technologies as recognised by the ZALEH residents.

The interviews asked about specific NEBs (both positive and negative) associated with individual measures. In the questionnaires we asked, for each NEB category, whether there was a change and if it was positive or negative. The prompted benefit categories included:

- *Appearance:* changes in appearance of the home.
- *Bill control:* measures (and bill impacts) led to a feeling of greater or lesser control over the energy bill.
- *Comfort:* house features led to greater or lesser comfort in this home than others.
- *Environmental*: features led to environmental benefits or problems.
- *Features:* energy equipment or measures had better or worse features, options.
- *Health:* features were perceived to make the home more or less safe or healthy to live in.
- *Maintenance:* the features had lower or higher maintenance requirements.
- *Moving:* the energy features led to the occupants being able to avoid a moving, either because of lower bills, greater benefits, value and service from the home, or other reason.
- *Noise:* the homes had lower or higher noise levels, either from outside the home, or from the energy using equipment inside the home, or both.

- *Notices:* the energy usage changes due to the technologies led to lower bills, which changed the occupants' ability to pay and therefore may have reduced late payment notices or similar calls from the utility on bill-related issues.
- *Other: other unprompted benefits or problems categories included higher cost (the major one), and a variety of other benefits or negative impacts and changes.*

Table 3: Annual NEB values by technology and NEB type in New Zealand dollars

	Appliance	Glazing	HVAC	Insulation	Micro generation	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%
% of houses 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 (Bicknell 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 some technologies, and parts might be difficult to find. Although these issues were not probed in the New Zealand work, concerns might be similar.

Figure 3 shows the reported benefits from all low energy technologies which were installed in the sample houses. The figure shows that on average the value of the sum of the NEBs by far outweighs the energy cost savings.

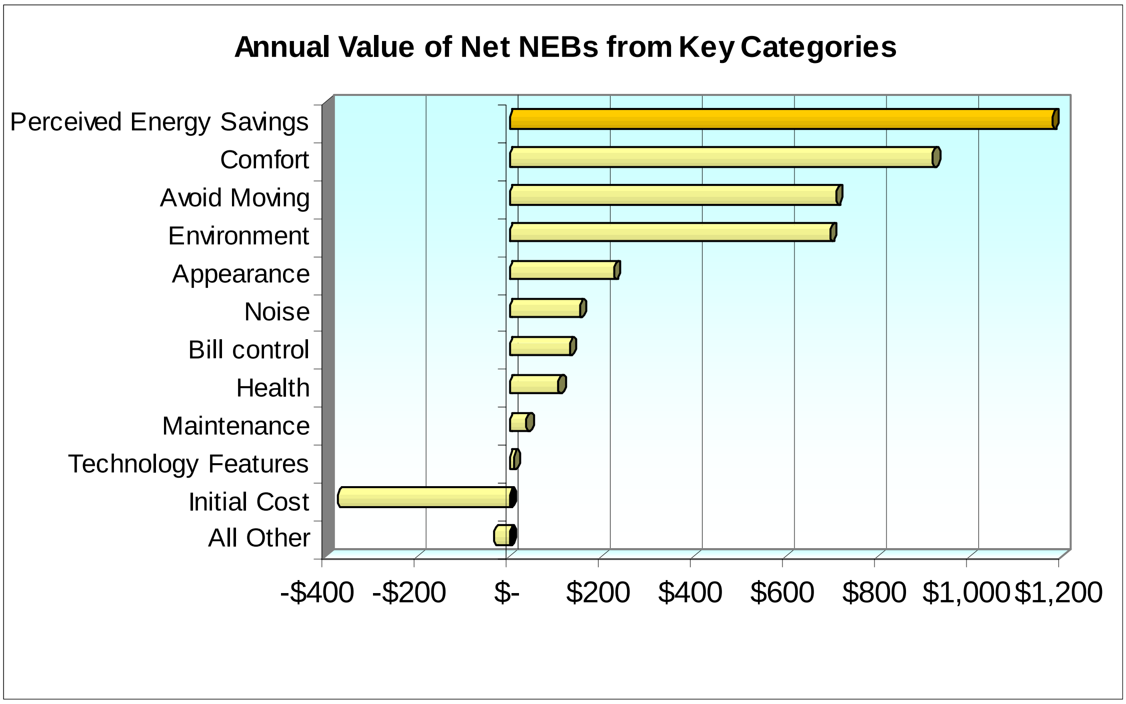

Figure 3: Non-energy benefits

Low income houses with ceiling and floor insulation upgrades

These surveys were conducted via face-to-face visiting interviews in a number of HNZC houses in Dunedin. These houses were only retrofitted by installing insulation into the ceiling, and some with floor insulation and/or a hot water cylinder wrap.

Forty-eight of the respondents said that they had not experienced an energy cost change since their houses were retrofitted, compared to 36% of participants where the energy cost had decreased and 16% of households where the energy cost had increased. Note that these results are based on respondents' feedback rather than actual energy bill analysis. These results seem plausible because only the insulation was upgraded, which may not necessarily lead to significant energy savings.

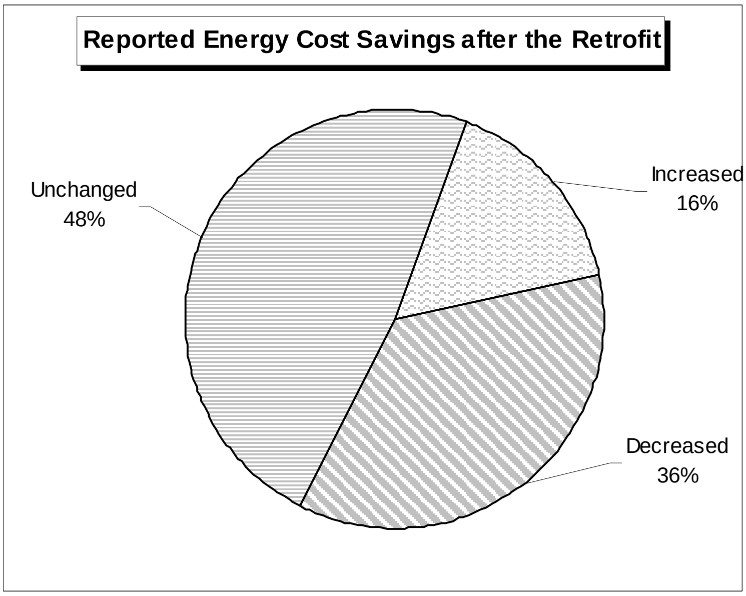

Figure 4: Reported energy savings

Most respondents did not experience any energy cost saving. However 78% of respondents reported that their living conditions were significantly better than before the retrofit such as warmer floor temperatures in winter (“Kids do not wear socks as much now”, “It takes a lot less longer to heat whole house from just the fire”, “Our health has improved”, etc).

Randomly selected households

This group consisted of 58 houses which were randomly selected nationwide and these participated in an online internet survey. Most of them had not installed superior insulation, double glazing or solar water heaters, nor had they applied particular solar design techniques. The responses from this group are therefore a reflection of perceived rather than experienced benefits and problems with low energy technologies.

Comparisons and application

Cost saving comparison between the three sample groups

Figure 5 shows the reported energy saving estimates from the three survey groups. The graph only shows savings from insulation improvements, but as noted before the insulation levels which were considered varied widely between the HNZC houses on the one hand and the low energy and randomly selected houses on the other. It is interesting to note that the experienced energy savings in the low energy houses is quite similar to the savings which were expected by the randomly selected houses. A similar pattern also appeared for savings from double glazing and solar water heating.

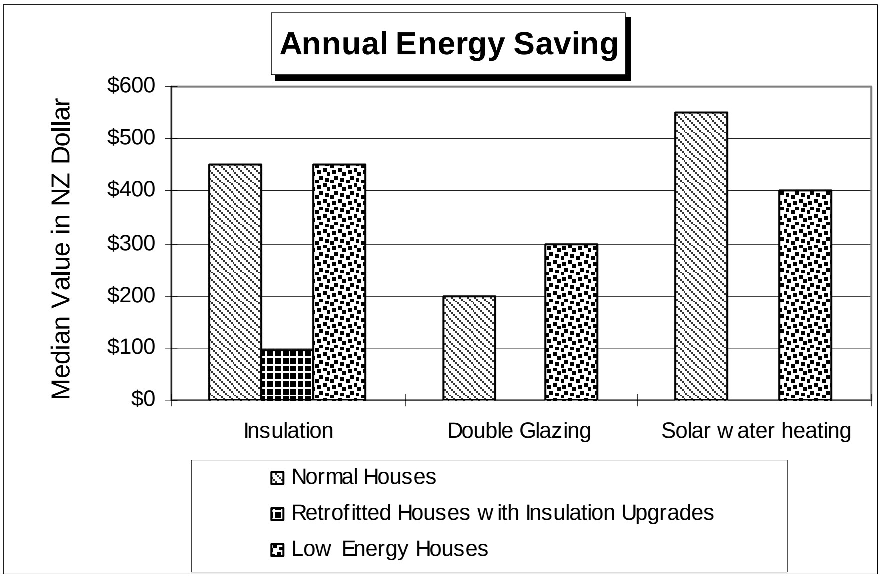

Figure 5: Comparison of the energy cost saving between three different survey groups

Non-energy benefit comparison between the three sample groups

The following figures compare the value perceptions of the NEBs by the low energy house occupants, the randomly selected group and the retrofit. The graphs show how the respondents weigh the value of individual NEBs and problems compared to the reported energy savings.

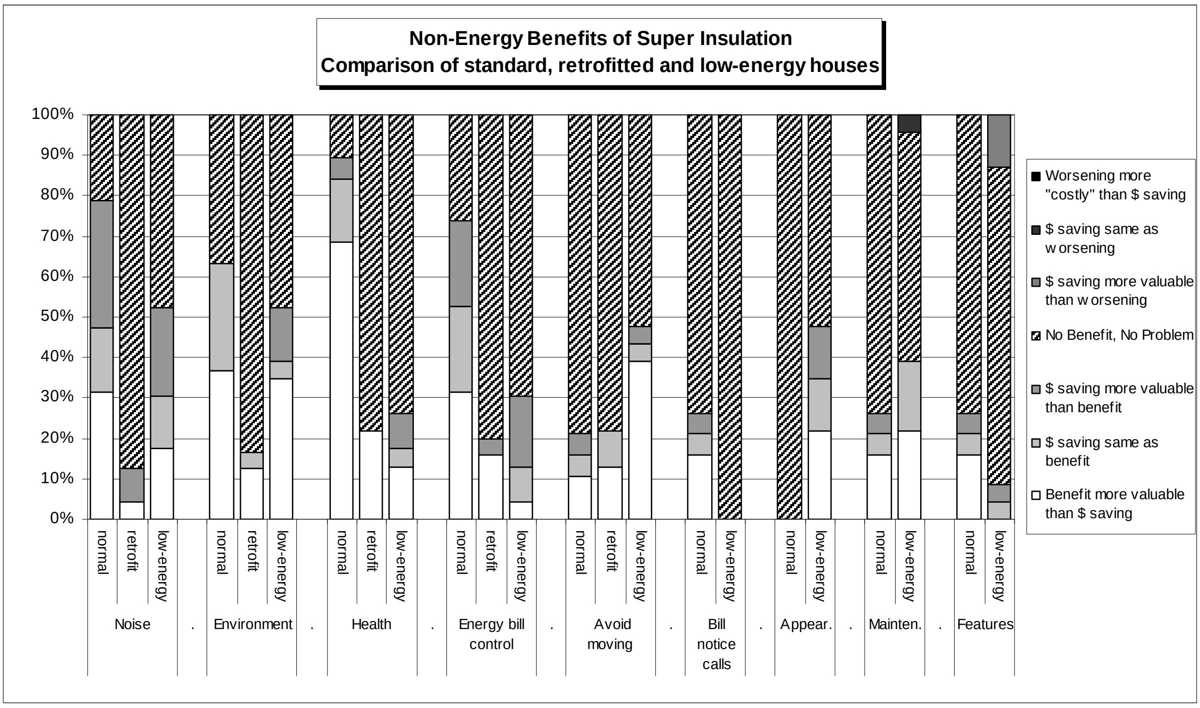

Figure 6: The value of NEBs compared to the energy cost savings. Some benefit questions in the three sample groups are different. Therefore, in Figure 6, some bars include all three surveyed groups, some only two

Some interesting differences become apparent from this analysis. While most of the NEBs are rated similar by both groups' appearance, bill control and health are clearly seen as different.

Appearance: A number of houses in the low energy house group featured extra thick walls or uncommon construction methods such as straw-bale or rammed earth walls. These were considered positive by the respondents. It may be that normal house occupants did not consider other construction methods and referred mainly to insulation products hidden in the building structure. Therefore they reported no positive or negative value.

Bill control: The demographic analysis of the low energy house group shows that the members have household incomes significantly above the New Zealand average. It is therefore not surprising that for these respondents electricity bill payments were not of high concern.

Health: A similar argument could be made for health improvement. The low energy house occupants were financially well off and presumably could afford to keep their houses at sufficiently healthy temperatures irrespective of the thermal performance of the building. It is, however, interesting that the randomly selected respondents placed such a high value on the health improvements through better thermal insulation.

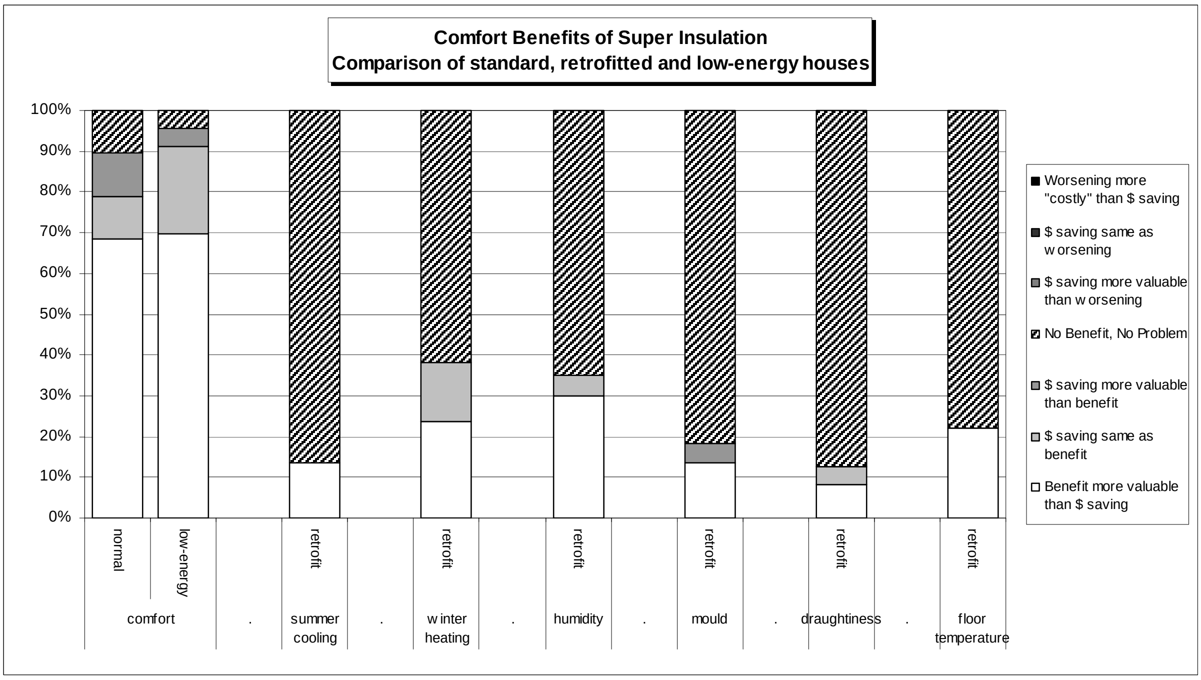

Figure 7: The value of comfort benefits compared to the energy cost savings

Figure 7 shows the value perceptions of comfort benefits from the insulation. The different aspects of comfort were split in the retrofit house sample to improve the response accuracy by the house occupants. The individual comfort components are rated lower than the overall comfort improvement in the low energy and the randomly selected houses. None of the comfort components was improved consistently in all of the retrofitted houses. On average, only about a quarter of houses had reported comfort improvements within each comfort subset. The highest scored improvements occurred for winter heating and humidity benefits. The data suggest improving the insulation in only one component of the building, namely the ceiling, often does not achieve noticeable comfort improvements.

Benefits to property managers and landlords

In a parallel study, face-to-face interviews were conducted early in 2005 with real estate company The Professionals in Whakatane. The interviews asked whether the energy-efficiency improvements led to any noticeable changes in rental behaviour and what impact that had on the company's performance. The Professionals in the area manage several hundred rental properties, of which approximately 100 have received energy-efficiency upgrades (mainly insulation improvements and hot water cylinder wraps).

Each tenancy change is associated with costs to the real estate agency. These costs are mainly contributable to advertisement and administration work, as well as a lost property management fee. Table 4 details the approximate costs component of re-leasing a rental property.

Table 4: Re-lease cost to real estate agency

Task	*Time effort*		
Sign up (street sign)	0.5		
Reference check on tenants	0.5		
Taking prospective tenants to property	2.0		
Sign-up	0.5		
General administration	0.5		
Initial inspection	1.0		
Miscellaneous	0.5		
Total	5.5	@ $30	$165

In addition to the re-lease cost, the real estate agency/property manager loses on average one week property management fee. At a 9.5% rate of the average weekly rent this represents approximately $20 in a typical Whakatane rental property.

The total cost of a tenancy change in this case is therefore $185. The experienced tenancy term increase from one to four years therefore represents a cost saving of 75% of this, which is $139 per year and house. For The Professionals, who are managing 100 of these retrofitted houses, the annual savings from the energy improvement programme are therefore almost $14,000 per year.

In addition to the re-lease cost there are direct rental losses to the landlord, which were estimated at about $200 in the Whakatane case for an average vacancy period of one week. A 75% saving due to insulation improvements equates to $150 per year and property.

The total saved cost to property manager and landlord from the energy-efficiency improvement is therefore approximately $290 per property and year. This saving is comparable to the estimated annual energy savings from the insulation and hot water cylinder retrofits.

The rental property savings from energy-efficiency improvements are obviously strongly dependent on local rental markets. The turn-over period of approximately one year on average may be higher than the New Zealand average and may be particularly representative of the lower income tenants who were involved in the Whakatane retrofit program. However, also the average vacancy period of one week may be shorter than the New Zealand average. A longer vacancy period would correspondingly increase the property manager's re-lease cost and the amount of lost rental income to the landlord.

In this case study the property management cost was attributed to the real estate agency. These costs will also occur if the property is managed by the landlord directly rather than through a property manager. In that case, the cost is carried directly by the landlord. It could, in fact, even be argued that the re-lease cost increases in that case because the landlord is likely to engage a real estate agent to advertise for new tenants, and will need to cover also their fees at commercial rates, which may be higher than the assumed in-house cost of $30/hour in the property management scenario considered here.

Assuming a house size of 150 m², and approximate cost of $16/m² for 200 mm ceiling insulation and $4/m² for reflective foil floor insulation, the insulation retrofit costs the landlord $3,000. Heating energy cost savings from this measure are estimated to be 2000 kWh or $320 per year ($6.50 per week) based on an approximate ALF (ALF 2000) calculation.

The cost for insulating the hot water cylinder is approximately $150. Energy savings due to the hot water cylinder insulation are estimated at 380 kWh per year equating to $60 per year ($1.20 per week).

If the energy cost savings and/or associated comfort improvement to the tenant can be captured through a corresponding rent increase, the total annual return to the landlord increases by $670 ($290 associated with tenancy period extension, $320 heating energy savings to tenants, $60 hot water cost savings to tenants).

This makes the energy-efficiency improvement a commercially viable option with a payback period of less than five years. This ignores other associated maintenance benefits related, for example, to warmer indoor temperatures (less mould and condensation on the ceiling) which will also have cost saving benefits.

Table 5: Summary of net benefits of insulation and water cylinder wrap improvements

Impact	*Annual Value*
Lower tenant change cost to property manager	$125
Fewer vacancy period property management fee losses	$15
Fewer vacancy periods rent losses to landlord	$150
Space heating energy saving to tenant	$320
Hot water energy saving to tenant	$60
Total	$670

It should be noted that while the property manager’s re-lease cost represents a net cost from a national economic perspective, the lost rental income can not be aggregated in that way, since the tenants will presumably occupy another property during the vacancy. The rental income is thus only shifted to a different landlord, rather than lost to the economy.

Cost/benefit application

The potential application of these results was explored on a typical cost/benefit analysis for insulation improvements. Historically these types of analysis were conducted by the New Zealand regulators to determine optimum insulation levels for the NZBC. The analysis weighs energy cost savings up against insulation cost expenses.

Although the intention of this approach is to provide best-value-for-money solutions to the consumer, the method has inherent shortcomings. Although it is widely accepted that there are significant NEBs from energy technologies, the traditional cost/benefit analysis does not account for these. One of the reasons for the lack of including these wider benefits is that NEBs are inherently difficult to quantify in economic terms. However, excluding them from the analysis effectively assumes a $- value as well, which incidentally is $0. Therefore such an analysis will ultimately not lead to best-value-for-money solutions.

The following example illustrates this. The surveys in zero and low energy houses suggests that house occupants value NEBs from superior insulation more than twice as high as the associated energy savings.

Figure 8 shows the net present value for insulating a lightweight construction in Wellington for a range of whole building R-values. The y-axis shows the net present value based on the capital investment of increased insulation in roof, walls and floor for a standard residential building with single glazing (circles) and double glazing (bullets). The values shown in the example are taken from the last update of the NZBC.

The two graphs show that when NEBs are not included (graph on the left), the slopes of the net present values for the single glazed scenarios have a slight minimum at 0.95ºC/W, and double glazing options are less cost-effective. If NEB values at twice the value of the energy savings are considered, the graph changes dramatically and the best value options are double glazed solutions at much higher composite insulation levels. (The lowest NPV option is to the right of the last calculated data point, i.e. higher than the last computed composite R-value of 1.4ºC/W.)

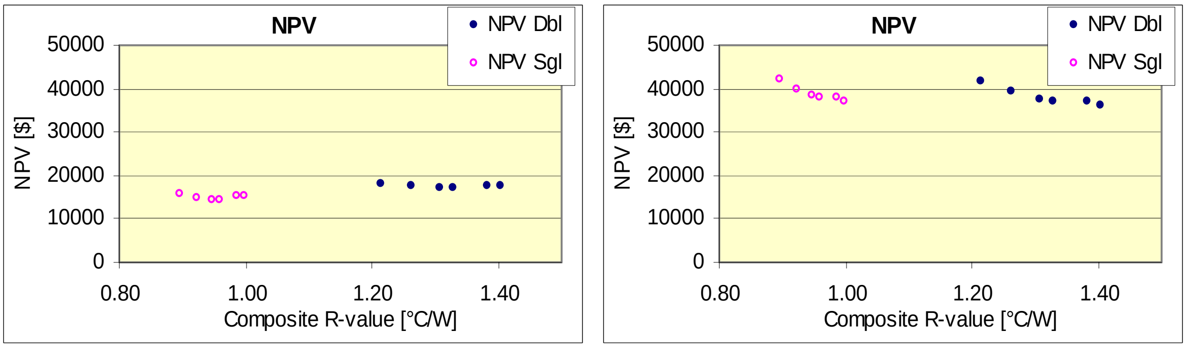

Figure 8: Cost benefit analysis (double glazing scenario)

This interpretation of the NEB results is presented here as an indicative approach. It is obvious that national NZBC targeting cannot be based on such a small and unrepresentative sample as the low energy house group is. What this research and this cost-benefit analysis demonstrate, however, is that the effects of including NEBs in a more holistic cost benefit analysis are profound and by far outweigh parameter variations for insulation cost, discount rates etc.

Conclusion

This study examined the value of NEBs of energy technologies in three different sample groups:

- low energy houses
- randomly selected houses
- low income houses with insulation retrofits.

The study found that the energy savings experienced by the low energy house sample matched quite closely the perceived potential energy savings by the group of randomly selected respondents who had not employed low energy technologies in the buildings. The low income respondents reported they could not perceive such a significant change presumably because their houses were only retrofitted with a partial insulation upgrade (no wall insulation).

The research further demonstrates the potential of financially quantifying the non-energy related benefits from energy technologies. The low energy house respondents reported that to them NEBs were on average approximately 2.5 times more valuable than the reported energy savings.

The research also surveyed the benefits to a real estate company in Whakatane who are managing approximately 100 houses which have received insulation upgrades over the last few years. The survey respondent estimated that the tenancy period for insulated properties is on average four times as long as the tenancy period for un-insulated properties. This reduces the property management cost to the real estate company by $140 per year and property, with a further rental income of $150 to the landlord due to reduced vacancy periods.

This finding has potential applications in conducting a more holistic cost/benefit analysis to determine best-value-for-money solutions for energy-efficiency projects of building regulations, as well as opportunities for well targeted marketing of low energy technologies.

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