PCP/16

RF1 Housing Retrofit: Housing Interventions, Stock and Markets

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SUMMARY

INTRODUCTION

The purpose of this project is to provide information that is useful to Beacon in designing the programme which will lead to 90%+ of existing houses in New Zealand achieving a sustainability standard by 2012 and to identify any gaps in our knowledge that would require filling in order to meet the programme objectives.

To this end three deliverables were required from this project:

1 A high level summary of relevant sustainability related retrofit interventions worldwide and their success factors.
2 A recapitulation of existing knowledge regarding the housing stock.
3 An overview of the existing knowledge regarding the retrofit market in New Zealand.

No original research was to be undertaken as part of this project. However while the essential output was a collection of existing knowledge, this programme also sought to:

- Define what information is required.
- Establish whether this information is already available and if so where and in what form is the information available.
- Assess what level of credibility can be assigned to the information.
- Establish what information is missing and assess how crucial the information is in establishing a satisfactory baseline for further research.
- Establish how this information can be obtained.
- Make an initial assessment of whether we might be able to use/adapt information from overseas.

WORLDWIDE INTERVENTIONS

Internationally, interventions in the retrofit area are extremely modest, by comparison with those directed towards new buildings. Interventions in the energy sector far outnumber those in all other areas of sustainability intervention.

Interventions in energy, materials, water and health sectors were investigated. These correspond to the sustainability sectors in the 2004 Building Act.

In each case regulatory instruments, economic instruments, information tools and 'other' interventions were examined.

Governments prefer to use regulation wherever possible, but it is rare for regulation to be applied retrospectively to existing houses. The UK is exploring ways that mandatory compliance might be written into the Building Code for addition and alteration work and for retrofitted appliances and fittings.

There are examples of regulatory instruments which have been used to target specific aspects of existing house upgrading.

Economic instruments, some of which are mandatory and others voluntary are generally the most successful types of intervention in the existing housing sector. Often the most successful voluntary packages are accompanied by incentive or subsidy payments as well as having good information/advice backup systems.

Information tools rarely operate alone as interventions.

Amongst the 'Others' category of interventions, government 'greener' purchasing policies and support for research are regarded as being successful. Different types of intervention seemed to be the most successful in different sectors.

No examples of technology based interventions were found in any of the four areas investigated. New Zealand could be a pioneer in this sector. NEW1 is seeking to establish the need for new or improved technologies and there is a possible link between RF1 and NEW1 in this respect.

Many of the most successful interventions are hybrid forms comprising elements of two or more of the aforementioned intervention types.

It may well be possible to adapt some of the successful overseas interventions for use in New Zealand. However, care needs to be taken in such adaptation to ensure that the social and economic context and the particular cultural mores that apply in New Zealand are carefully considered and integrated with the proposed programmes, otherwise successful outcomes are unlikely.

Energy

In the energy sector, voluntary economic instruments were the most successful with private owner occupiers, while regulation was necessary with private rental owners. Mandatory minimum energy standards for appliances were also successfully employed.

The Canadian **Energuide** programme was the most successful intervention discovered. It is a hybrid voluntary economic instrument. It is intended to improve the energy performance of both existing and new houses. It has been operating since 1998 and finally 'took off' last year when small incentive subsidies were introduced. This year it is expected that about 100,000 assessments will be carried out. The related upgrading can occur at any stage after the initial assessment occurs. The subsidy is paid against actual performance improvement measured by a post retrofit assessment.

The success of this scheme appears to be due to a combination of:

- An affordable before and after assessment scheme linked to modest, performance improvement subsidies.
- An advice and information system which empowers the householder to develop a package of energy related improvements in line with their personal circumstances.
- Good technical information backup which enables a householder to carry out some of the improvements on a DIY basis.
- Involvement of licensed contractors in the assessment programme who can also carry out the work on site. Contractors are spasmodically checked to ensure quality and lack of bias.
- Encouragement of other bodies to add to the value of the central government subsidy.

Residential Energy Conservation Ordinances (RECOs) operate in some parts of the USA and Canada. These are mandatory regulatory interventions, specifically targeted at upgrading the energy performance of the very poorest performing houses. In this case a house that is about to be sold must be fitted with a number of simple energy saving features before its legal title is allowed to be transferred. These features are usually cheap and simple elements such as weatherstripping, gap sealing, cylinder lagging and in some places roof insulation.

The success of this intervention lies in:

- Application to all houses irrespective of ownership at point of sale.
- Simple low cost measures with rapid payback.
- An easy and cost effective enforcement procedure.
- Use of targeted capital subsidy packages particularly in the private rental sector in some areas.

Weatherization programmes in the USA are run by the Department of Energy in conjunction with state or city authorities and are specifically targeted at improving the energy performance of houses occupied by low-income families.

The success of these programmes is due to:

- The award of substantive capital subsidies.
- Associated assessment and advice protocol which helps to ensure that the most cost effective solutions to upgrades are formulated on a case by case basis.
- Increasing flexibility in what can be included as a feature which attracts a subsidy.

The mandatory **BASIX** assessment scheme will be applied to all consented alteration and additions in NSW from 1 October 2005 when a 25% less greenhouse gas emissions target will be set. This will rise to 40% on 1 July 2006.

The success of this scheme is likely to relate to its mandatory nature, however as it will not come into force for another 11 months, this supposition is pure conjecture.

Several other intervention types have been successfully utilised in this sector including:

- Capital subsidy programmes
- Premium loan schemes
- Preferential loan schemes
- Energy tax schemes
- Tradable permit schemes
- Energy audit programmes
- Energy performance labeling
- Information and advice schemes

All have their particular merits advantages and disadvantages as discussed in the full report. It may well be worth utilising one or more of these schemes in the retrofit intervention programme and so they all need further investigation.

Materials

In the materials sector landfill charges were the most successful intervention in improving resource recovery. 'Green' public procurement policies were successful across the whole area of resource recovery, deployment of sustainable materials and waste reduction. Information tools to inform and advise were also utilised but programmes did not always seem to be well thought out.

The Netherlands and Denmark have the most advanced systems of resource recovery in the world and have recently introduced zero waste legislation in the construction and demolition waste sector.

The success of this legislation is due to:

- The prior introduction of high landfill charges which took recovery rates well beyond the 90% point.
- Mandatory separation of materials
- Predominant use of 'waste' as road base
- Denmark has mandatory reporting policies in place to counteract illegal dumping practices

New Zealand has a national Zero Waste Strategy in place but a diverse collection of policies, because each local authority can set its own waste policy and landfill charges

There is very little legislation in any other aspects of material efficiency and conservation. What there is generally relates to health matters and is reported in that section of the report.

Green purchasing policy, where central and local government and government agencies lead from the front is the most effective intervention method across the whole materials sector. A number of assessment protocols are in place around the world such as **LEED** and **BREEAM** but none of these so far include a domestic retrofit assessment regime.

Lack of information and performance assurance seem to be the principal barriers to the employment of sustainable materials. There is a lack of knowledge and good published information in the area of design for disassembly and design to reduce waste.

Water

Very few interventions in the water sector were identified but it was generally agreed that water metering and charging were the most successful foundation blocks to achieving water savings and this can either be accomplished through central or local regulation.

The Australian **BASIX** web based planning tool which targets 40% reduction in potable water use will be applied to all alterations and additions from 1 October 2005.

It is too early to assess success, but it is a mandatory scheme and will be applied to all consented work.

Water saving appliances, fittings and fixtures are labeled in quite a few countries but there are no known regulations to mandate their use.

Health

There where few interventions in the health sector, probably due to the great uncertainties that still exist in this area. In this case, successful interventions were the imposition of mandatory standards relating to formaldehyde and VOC emissions.

Generally information tools were used to a considerable extent in this sector. The most successful scheme discovered is one recently introduced in Seattle, which is totally focused on retrofit. The programme includes advice on a full range of sustainability related features but 'sells itself' as the "**Healthy Home Program**".

The programme is still under development and the team is in the process of devising/organising an evaluation on its success. Preliminary indications are that there has been much interest in the scheme from residents but there is currently no feedback on whether interest has resulted in action.
Success factors are:

- Brightly coloured, visually appealing, simple to understand brochures, which provide clearly understood advice
- The willingness and availability of the programme leader to act as a contact/liaison point for further advice and clarification.

EXISTING HOUSE DATABASE SURVEY

The types of required data are in two main categories, physical characteristics of the housing stock, and occupant characteristics.

Information that is likely to be useful, (and reasons for its usefulness in brackets) are as follows:

Physical Characteristics of the Housing Stock

- Age structure of the stock, by region. (To identify pre-mandatory insulation houses, likely air-tightness and underfloor insulation retrofit potential, hot water cylinder replacement potential).
- Type of dwellings, i.e. stand-alone, semi-detached, terrace housing, apartments. (The retrofit programme may require different measures for different types of dwellings).
- Demolitions/conversions by age group (i.e. what type and numbers of housing will be lost and not require upgrading).

Occupant Characteristics

- Breakdown by owner-occupiers, and renters. (Different programmes will be required for owners and landlords.)
- Breakdown by family type, including forecasts, and household income, (retrofit measures may vary depending on the types of family, and affordability).

- Some cross tabulations where possible, e.g. house age cohort by household income.

Physical Characteristics

Total housing stock in New Zealand as at December 2003 was 1,571,000. We are currently adding to our housing stock at about 30,000 houses per year. Therefore our housing stock is likely to be very close to 1.6M units. Of this total about 1.05M houses were built before 1979 when mandatory thermal insulation standards were introduced. About 120,000 units are estimated to have been built in accordance with the enhanced insulation standards introduced in 2000.

Figures are taken from Quotable Value NZ data, modified to take account of known minor inaccuracies and are regarded as having a high level of credibility.

Dwelling Types

Figures taken from the 2001 Census, which is a highly accurate and credible source, indicate that 82% of houses in NZ are detached single family houses. Most of the rest are semi-detached or units in 1 or 2 storey blocks. Despite the upsurge in multi-storey housing these represent only about 3% of the total housing stock.

Demolitions

BRANZ estimate that there are about 2000 (0.13%) house demolitions every year. This indicates that we are not so much replacing our housing stock as adding to it. This means that the problem with substandard houses is not fixing itself over time, but rather that as older houses deteriorate, the problems will get worse unless we take timely action.

There is currently no official data collected on the numbers, age, location, condition, or the reason for demolition of NZ houses. This is regarded as a significant data gap which should be filled.

Occupant Characteristics

Owner–occupiers and renters

68% of New Zealand homes are owner occupied, 26% are privately owned rental accommodation and 6% are publicly owned according to the 2001 census. Owner occupancy fell about 5% between 1991 and 2001. This is seen as a continuing trend.

About 51% of all owner occupied houses are owned with a mortgage. There appear to be no figures available for privately owned rental property with a mortgage.

It is suggested that there is currently insufficient data available concerning private rental property both in terms of the houses themselves but also concerning owner and occupant characteristics. As this sector currently comprises over one quarter of all New Zealand households and is likely to grow for the foreseeable future, the lack of reliable data is seen as a very significant gap in our knowledge and one that needs to be remedied as quickly as possible.

Family Types

The largest growth in family type occurs in the 'Couples with no children' sector which is predicted to overtake the largest sector 'Two parents +child(ren)' in 2006. By 2012 the prediction is that there will be 100,000 more 'couples' than 'two parent' households, 520,000 compared with 420,000.
'One person' households are also predicted to increase and should current trends continue are predicted to exceed 'two parent' households by 2016. These trends suggest that more existing homes will be adapted for the needs of adults rather than for children in the foreseeable future.

Likely types of modifications:

1. Conversion of spare bedrooms into other uses like home offices and gyms.
2. Additional bathrooms including en-suite for visitors.
3. Subdivision of larger dwellings into smaller household units, with parts for rent.

Both type 2 and 3 modifications provide opportunities for sustainability retrofitting.

Household Incomes
Amongst owner occupiers there are 319,000 low-income households (< $30,000), 365,000 medium income $30,001 - $70,000) households and 250,000 high income ($70,001>) households. It may be necessary to devise different levels of retrofit programmes for the different income groups.

RETROFIT MARKETS

The Physical Context

Housing Profile
Only about 89,000 pre World War One houses now exist in NZ. They are generally large, good quality and well built timber houses. Post WW I houses were of the same native heartwood construction, but were smaller, of poorer quality and less well built. There was an upsurge in quality just before the WW 2, but shortages of materials and labour during and after the war brought about a second period of lower quality standards. NZ's native forests were depleted by the late 50s and increasing substitution of traditional materials occurred after this time.

The biggest and most rapid changes to house construction occurred after the introduction of the Building Act 1991. Serious defects have occurred in a significant proportion of monolithic walling systems used in multi-unit and complex single unit housing constructions. This precipitated the development of the new Building Act 2004 which aims to reverse the perceived decline in industry standards. Funding and labour devoted to rectifying the weathertightness problems referred to may well be in competition with the funding and labour required by Beacon to affect its mandate.

Materials which are now recognised as hazardous materials are a significant issue in existing houses. Chemical timber treatments, lead based paint, asbestos, lead and lead solder in plumbing, PCBs formaldehyde, solvent (VOCs) based materials, and some rots are all present to a lesser or greater degree across our existing housing stock. All are hazardous and all are costly to remove and dispose of correctly during retrofitting.

New Zealand houses have a well earned reputation for being cold, damp, draughty and mould ridden. Early indications from research being undertaken by the Wellington Medical School vindicate this widely held belief.

Water conservation has not been an issue in non-rural NZ until very recently and so water saving features are largely absent from existing houses.

Housing demand is changing due to the increased diversity of household make up, reduced birth rate, an aging population, reduced home ownership and the increased incidence of inner city living.

Renovations/Home Improvements
Of the $5300M spent each year by New Zealanders on renovations, improvements, decoration and maintenance, only about 20% is spent on consented work, essentially additions and alterations. The TNS survey concludes that the size of the renovation segment of the market in New Zealand is about $3200M. The renovation market, which includes additions and alterations, is the one which has the potential to incorporate sustainability related features as this expenditure is usually discretionary. The TNS survey also found that 60% of respondents said that they had undertaken home improvements in the previous 12 months.

All this information comes from creditable sources, mainly the annual BRANZ Alterations and Additions Survey and the biennial TNS Home Improvement Survey.

Retrofit Programmes in New Zealand
The main retrofit programmes currently operating involve Housing New Zealand and EECA who between them carry out retrofits on about 5500 house per year. This figure represents less than 0.04% of houses and is primarily focused on energy/comfort related upgrades. House owners spend about $1,050 million per year, or about 20% of the total existing house maintenance and improvement budget on alterations and additions. Research indicates that only a small percentage of this amount is spent on sustainability related retrofitting.

Virtually all the sustainability related retrofitting that occurs in New Zealand is related to energy saving or improving comfort levels in homes. Overseas research has indicated that most of the energy saving potential of such retrofit programmes is taken up by owners accepting higher comfort levels.

None of the active sustainability related retrofit programmes in New Zealand deal with water, materials/waste, or health to any significant extent. Only a tiny proportion of house owners seem aware of these matters and an even smaller fraction seems to be taking active steps to ameliorate this condition.

Retrofits Already Carried Out

Of our 1.6 million houses, about 1.033 million were built before thermal insulation standards were introduced in 1979. Only about 120,000 of our houses are thought to comply with the upgraded thermal insulation standards which became mandatory in 2000. These standards are about to be upgraded again, but will still fall well short of the thermal insulation standards specified in the NOW house brief.

Data from the BRANZ House Condition Surveys (HCSs) undertaken in 1994 and 1999 suggests that some 63% of existing houses built prior to 1979 have been retrofitted with the pre-2000 level of ceiling insulation. On average about 25,000 pre-1979 houses have been retrofitted with ceiling insulation per annum during the period 1976 to 1999. Subfloor insulation appears to have been fitted in less than 1% of these houses.

The HCSs also indicates that the incorporation of other sustainability related features such as double glazing and solar water heaters is still very low. In December 2003 EECA reported that there were some 22,000 (1.4%) of houses that had been fitted with solar water heaters. EECA estimates that 2000 new solar heating systems are installed each year. It has recently received funding to enable it to continue its 2000/2003 subsidy programme for an extra 444 house systems in 2004/2005.

In 1999 the HCS results suggest that only 2% of houses in NZ were fitted with double glazing. Although double glazing has become more prevalent in new houses since 2000 the total number of houses with double glazing is unlikely to have risen above 3%. It is not known what percentage of the double glazing has been retrofitted into existing houses.

Percentages of existing houses where other retrofit features are incorporated are very low; generally well down in single figures. In general terms it seems that very few New Zealanders incorporate sustainability features even when undertaking alterations or additions. The only exceptions are ceiling insulation (40%), HWC wrap (18%), and dual flush toilet cisterns (15%).

Government Interventions

Revisions to the Building Regulations 1992 following on from the Building Act 2004, the current review of the Residential Tenancies Act 1986, and the current development of the New Zealand Housing Strategy all present opportunities for Beacon to contribute to the development of policies which would support Beacon targets.

HNZ retrofit about 2500-2700 of their 66,000 houses each year. EECA currently funds or subsidises energy related retrofitting of about 3000 houses for low income families a year. This year extra funding has been made available and EECA expect to subsidise the retrofitting of about 6000 houses based on receiving matching funding from community trusts, local councils and utility companies.

The Human Context

There are significant benefits associated with the Beacon retrofit programme related to health, resource and economic sectors. In each case there are public, owner and occupier dimensions.

Improving the well-being of occupants results in a reduced burden on the health system, reduces absenteeism and improves people's satisfaction levels with their home. Making homes warmer and more comfortable tends to produce healthier living conditions and result in fewer respiratory and allergenic illnesses.

In terms of reduced resource use the Beacon programme directly contributes to several national strategies, NEECS; The NZ National Waste Strategy; The Climate Change Protocol; The Sustainable Development for New Zealand Plan of Action. Reduced resource use also is beneficial in reducing infrastructure costs such as the need for new power stations, landfills and increased capacity water and drainage mains. It also can help to reduce imports of new building materials and thereby the trade deficit.

Economic benefits accrue to house owner occupiers through reduced operating costs. It was difficult to find creditable cost benefit analysis information. In part this is because of the difference between potential and actual savings. For example adding insulation results in potential reduced energy use but many people prefer to increase comfort levels rather than save energy.

The benefits of improving house performance at the low end private rental market are not readily apparent. Occupiers also tend to be in favour of retaining the status quo, as improvements are inevitably followed by unwanted and in some cases unaffordable rent increases.

Winstone survey information suggests that around 60% of renovation is appearance driven and most of the rest is related to improving functional needs. However, closer inspection indicates that performance related improvement could be a part of the renovation in about 45% of circumstances. Less than #% of respondents considered improved house value as the prime motivator for renovation.

From the same survey more than 53% of renovations occurred within two years of purchase of the property.

Housing is the single most significant personal investment, accounting for 90% of net household wealth in NZ.

Surprisingly between 20-30% of high income households rent rather than own property. These properties are likely to be at the higher end of the property range and occupants are more likely to require higher performance levels than at the low wend of this market. Beacon may be able to influence performance upgrades more easily at the upper rather than at the lower end of the market

More than 85% of people carrying out renovation work financed that work taking out a loan.

Questioned about information sources for renovation most people claimed that there main source of information was their own ideas, but it seems likely that these have been influenced and informed by most other information sources. Designers (architects, interior architects, landscape architects and architectural designers) were only cited as sources of information in 3.5% of cases and interior decorators in about 3% of cases.

Over 80% of people claimed experience in renovation in the FR/Krehl survey. But the level of DIY competence is not defined.

The potential for sustainability related retrofitting is huge as so little work has been carried out in this area to date. Large sums of money ($5,300M) is spent of renovation each year and it appears that a high percentage of this money is debt free.

The main barrier is that most people do not regard sustainability as a motivating factor in terms of undertaking renovation or retrofitting work. None of the surveys yet carried out appear to ask why this is so or what would change owners priorities in this respect.

Much of the energy related cost involved will be recouped over time and will help to create a healthier and more comfortable environment. Expenditure related to improving well-being of occupants will be relatively easy to ‘sell’. Resource conservation particularly related to water and materials will constitute more of a challenge as personal benefits are less certain. How to bring about a change in attitudes of the ‘buying public' and the statutory authorities is the major challenge facing Beacon. A combination of stick and carrots is called for and many of the successful interventions in this field are discussed in the worldwide interventions section of this report.

CONCLUSIONS AND GAPS

It is self evident that the Beacon target for this sector is extremely ambitious. If Beacon is to achieve the objective, the need for a comprehensive co-ordinated plan of action which tackles all areas and groups is vital and urgent. All segments of the home ownership and renter market must become involved. All areas of government, industry bodies, industry related NGOs, and building industry professionals and operatives must be actively and positively engaged in the process.

Of all the interventions reviewed in relation to existing buildings, the Canadian **Energuide** Programme appears to be the most successful across all house owner sectors and seemed to have the most to offer our own programme. This programme was started in 1998 and has established 'stretch' targets for both existing and new homes. Their stretch target for existing homes is to make a 20% improvement in energy performance for 20% of their housing stock by 2010. Their 'stretch' target for new houses is for 80% of their new houses to match the energy performance of the **R2000** house by the same date.

If Beacon is to succeed across the sectors of energy, materials/resources, water and health and make meaningful interventions to bring 90%+ homes up to a defined sustainability standard by 2012, then it needs to be an order of magnitude more effective than **Energuide.** This is a very tall order.

It is necessary to establish short term, medium term and long term objectives and the interventions utilised may well be different in each timescale, for energy, resources, water and health. The objectives and interventions may be different in each of the house ownership segments and even between sub-groups within each segment.

It is clear that some interventions have been much more successful than others in specific sectors.

It would be well worth exploring regulatory ways and means of mandating improvement in standards of existing homes, as this would have the biggest effect of all conceivable measures in improving sustainability standards in New Zealand. Regulatory Interventions are such an even handed and generally cost effective means of inducing change in large segments of the community that it would be worth exploring options and opportunities in regard to this instrument.

Beacon is faced with a unique opportunity to tie sustainability standards in with the major revision of the NZBC currently underway. Undoubtedly regulatory interventions effect the greatest change in the least time in the area they target. Therefore, Beacon should put itself in a position to maximise our input and influence on what is contained in the revised regulations. The new NZBC will have a maximum influence on new buildings and it is highly unlikely that retroactive clauses will be incorporated into the Code that require existing buildings to be brought up to code levels of performance. However, it may be possible to include clauses which require segments of existing buildings to be brought up to Code performance during substantial remodelling projects and additions and alterations, and to require all appliances to meet higher sustainability standards than those that currently apply. These measures would have the effect of upgrading the existing housing stock over time but are unlikely to have a really significant effect on large numbers of houses by 2012 as the revised Code is scheduled to come into force in 2008.

Such regulatory instruments often require a prolonged period of development and implementation and we cannot rely solely on such a measure. Therefore, as a parallel exercise short and medium term interventions must be put in place.

There are many successful interventions in the energy sector and it may be that we can not only adapt such programmes for use in New Zealand but extend their coverage to all four areas of intervention.

Within the energy field the most successful programmes appear to be the Canadian **Energuide** system, the American/Canadian **RECO,** the Australian **BASIX** scheme the US **Energy Star** and our own **5 Star** and **MEPS** programmes. These should all be explored in greater depth to gain an understanding of their applicability to the Beacon situation. The US **LEED Residential** programme

and the Australian **BREEAM** programme warrant closer examination to discover whether we can use them to inform the building regulation changes and possibly introduce an effective assessment programme.

Landfill taxes (landfill charges) proved to be the decisive intervention in The Netherlands and Germany to enable a zero C&DW target to be realised. The landfill ban mandated in both these countries simply confirmed the pre-existing condition and ensured there would be no backsliding. This legislation also had the effect of stimulating all manner of innovations, incentives and market developments connected with recycling, materials reuse, and new waste based materials and industries. Such programmes need to be developed in New Zealand alongside the increasing buy-in of the **Zero Waste** philosophy by territorial authorities all over NZ.

Lack of information and knowledge seems to be the principal barrier to employment of sustainable materials, design for disassembly and design to reduce waste. This barrier must be removed.

Improving water efficiency and conservation requires the mandatory introduction of water metering to be successful. The Australian **BASIX** system seems to be a good model here. However, as a short term measure, new water saving standards could be set for all water fixtures and appliances offered for sale in New Zealand. We might be able to adapt **Energy Star** measures for use in NZ or adopt the Australian **AAA** system.

Health is at once urgent and further behind in terms of the understanding and certainty we can bring to bear in devising appropriate and effective solutions. However, we can start by drastically limiting emissions allowed from formaldehyde and VOCs emitting materials as has happened in Germany and Denmark.
Very little information was found on mandatory retrofit programmes. This is seen as the most equitable, and cost effective intervention method and research is needed to establish how regulations can be best applied to retrofit situations.

Research is needed into ways to overcome government's apparent reluctance to provide energy saving incentives to owner occupiers and private landlords.

There is an enormous amount of information on energy equipment and energy saving. In fact there is probably too much for most people to cope with. There is a need to find user friendly ways of helping people to navigate their way through this morass of information.

Ways need to be found to involve, utility companies, mortgage lenders and insurance companies, and ethical funding agencies in the process of upgrading houses.

Government needs to be seen to lead the way in upgrading its own properties and in establishing greener procurement policies.

Cost effective, user friendly retrofit packages that take the hassle, angst and uncertainty out of the retrofit arena need to be devised.

It needs to be easier for people to access and utilise sustainable and healthy materials with assurance and performance certainty.

Programmes need to be devised to support people who want to start sunrise industries in the area of resource recovery, making materials from waste, improving recycled content in existing materials and reusing materials. Currently, there is very little support and plenty of discouragement, even barriers in place in this sector.

More work is needed on achieving proper ventilation all through the year in NZ houses. Currently it is either too much or too little in most homes. It is as important in achieving healthy homes as insulation and controlling chemical emissions.

The main gap in the housing database survey is the sparse **information** available **on the privately owned rental segment of the market**. This has grown to 26% of all households and the trend continues upward. We need to know more information on the location, age, condition and materials

of the houses in this segment and to have more information on landlord and renter profiles. This sector is regarded internationally as a difficult area in which to create performance enhancements and so we need all the information possible. This is regarded as a high priority item.

The focus of this report is on the demand side of the retrofit market as set out in the proposal. The assumption made was that the supply side of the market would be covered by another of the research programmes. Should this not be the case, **there is a need to carry out a data collection exercise related to the supply side of the retrofit market.**

BRANZ is currently considering what other features of housing should be recorded in the latest HCS to aid the Beacon retro-fit programme. It would be very worthwhile to prepare questions which would go some way to filling in the information gaps identified in this report. The HCS covers only owner-occupied houses and it is likely that rental units will have lower standards of insulation retrofit. A separate survey for private sector rental housing needs to be considered.

There are big variations in the estimated annual number of house demolitions (1000-7000). This discrepancy amounts to some 40,000 units over the duration of the Beacon programme. Little is known of the profile of the demolished houses, their age, type, size, location, ownership, etc. A survey to find out these factors would be valuable in assessing the impact of demolitions on the housing stock.

While information has been provided on the average length of stay in a house it would be useful to have information on the average length of occupancy for owner-occupiers. This would allow an assessment to be made on the effectiveness of measures to apply mandatory labelling or performance standards at point of sale (see RECOs above).

RECOMMENDATIONS

1. Re-examine the Beacon targets set for this sector.
It is vital to the success that these targets are set with great care and judgment in terms of what is possible and achievable over the next seven year period otherwise a great deal of work and money could be wasted.

A high level of specificity is required, both in terms of setting the sustainability standard and establishing the percentage of existing houses to receive retrofitting by 2012.

It may be that the sustainability standard set and the percentage of houses affected is different for new and existing houses. It should also be considered whether houses of different constructions and ages should have different criteria applied to them and if so what the targets are for each of the four sustainability sectors (energy, water, resources and health).

2. Develop a Plan of Action
Once the performance levels and retrofit targets have been established then it is necessary to establish short term, medium term and long term objectives for energy, resources, water and health categories. The interventions utilised to achieve these outcomes may well be different in each timescale and sustainability category. They are more than likely to be different in each of the house ownership segments and even between sub-groups within each segment.

3. Define and develop intervention packages suitable for all the different housing segments.
These would have to be identified and assessed in terms of effectiveness, likely success, the numbers of households affected and the timescale required to put them in place, then they could be assigned a priority rating.

4. Identify potential partnerships with aligned retrofit programs.
These may be local, national or even international partners. It would be highly desirable to establish partnerships which could leverage expertise, experience or influence.

5. Develop a series of 'standard' retrofit packages
The development of a series of cost effective, user friendly, hassle free, retrofit packages which would bring houses up to the standard(s) set.

6. Develop retrofit demonstration projects

7. Research and make available reliable information on investment payback for sustainability related retrofitting.
Lack of such information is seen as a barrier to investment by some segments of the community.

8. Obtain more data on the types, age and condition of privately owned rented accommodation.
It is likely that special measures will have to be taken to achieve upgrading in this area. Despite the fact that about 26% of households live in privately owned rented accommodation, very little data is available on the types or ages of dwellings or the people who rent the accommodation. This is regarded as a gap in knowledge that should be filled.

9. Obtain information on the supply side of retrofit markets
This report only covers demand side factors as defined in the research proposal. If supplied side information has not been covered by other Beacon research programmes such as IND1 this constitutes a substantial information gap which should be filled.

10. DIY survey

No information was found on the competence, willingness and level of support necessary for owners to carry out retrofitting work themselves. Many of the basic retrofit measures outlined in this report are relatively straight forward and probably could be tackled by house owners. If work was carried out by owners this could be a major boost to the Beacon programme. A survey is recommended to establish the facts outlined.

11. Expand HCS survey

A series of questions needs to be devised to add to the BRANZ HCS. These could add valuable data to further support the Beacon retrofit programme.

12. Demolitions

Little is known of the profile of the demolished houses, their age, type, size, location, ownership, etc. A survey is recommended to find out the profile and numbers of demolished houses in NZ.

WORLDWIDE INTERVENTIONS

INTRODUCTION

The Building Act 2004 includes sustainability as one of its head criteria and requires energy and water efficiency and conservation and waste reduction be taken into consideration when each clause of the new regulations is framed. Health has always been one of the head criteria in the Building Act, but has been considered mainly in terms of water and drainage reticulation, with some attention also been given to daylight and ventilation provision. Increasingly, research findings support anecdotal evidence that indoor air quality and internal environmental conditions have a major influence on occupant health. Therefore, indoor air and environmental quality may also become part of the new building code requirements.

In order to make this investigation as useful as possible, findings have been categorised to cover the four areas likely to become embedded in the NZBC namely, energy, water, materials and health.

The US/Canadian **LEED** green building assessment programme is arguably the most advanced, most thoroughly researched, and well supported tool of its kind in the world. It assesses energy, materials, water, health and site. This generally correlates to the NZ Government categorisation of this subject. It was felt in relation to retrofit programmes particularly, where the context already exists, site could be subsumed into the other categories covered where required.

There is an excellent OECD report entitled *Environmentally Sustainable Buildings – Challenges and Polices*, published in 2003, which was the outcome of some four years of work by representatives of its 30 member countries. This report focuses on challenges and policies in place or required to reduce CO_2 emissions, minimise construction and demolition waste and prevent indoor air pollution, and describes many of the international interventions undertaken in these three areas. These three areas of report effectively correspond with the energy, and to a lesser extent the materials and health categories used in this report. The OECD report does not address water related interventions. It essentially focuses on government interventions although some other ideas such as greener purchasing support for R&D, technology (section 5.6), diffusion and voluntary instruments are also mentioned. Within its self impost limits, the OECD report represents an authoritative and comprehensive review of relevant international interventions. The RF1 report has extended its oversight to other sources of interventions such as utilities, non-government organisations, not for profit organisations and other groups and individuals.

The OECD study separates interventions into regulatory instruments, economic instruments and information tools. These are seen as useful sub-categories and have been adopted as sub-divisions in this report.

The investigation was carried out by:

- Search of library holdings at VUW Faculty of Architecture, BRANZ library, FRI library, National Library, HNZC library, Auckland School of Architecture library.
- Internet search.
- International contacts of the principal investigator and Professor Ray Cole.
- Visits in person to contacts and organisations in Vancouver, Seattle, Portland and San Francisco
- Follow up telephone calls where necessary.

Many of the contacts were on holiday when contacted and in consequence information continues to arrive to the date of reporting and no doubt will continue beyond this time. Most of the most valuable information was collected during face to face and telephone conversations.

In addition to the programmes investigated 50 retrofit building schemes in 11 countries were examined and analysed to determine which technologies had been employed to enhance sustainability related performance. An excel spreadsheet was prepared to analyse the results under the same four headings used in the main body of the report and in addition a number of overview

factors. The overview factors considered were objectives, measures of success, and environmental, social and economic sustainability.

The spreadsheet analysis is not part of the report per se, but is appended to the electronic version of this report for information.

GENERAL

The OECD report makes it clear that internationally government interventions for upgrading existing buildings have "been modest compared to intervention for new buildings although various policy instruments have been introduced in recent years, aimed at existing buildings" (OECD p36).

It also states that "This concentration of policy implementation on the new building sector can be justified, to some extent, by the fact that the energy performance of buildings is largely fixed as the time of new construction. Moreover, many of the energy efficiency measures can be incorporated into buildings with the least cost at the time of new construction" (OECD p60).

While these statements are made in the context of policy instruments for reducing CO2 emissions from existing buildings in the OECD report, our own investigations suggest that this statement is true of interventions across all of the sectors examined.

With the percentage of annual new house starts to existing housing stock running between 1 and 2% in the OECD (NZ1.5-1.8%), it seems paradoxical that there has been much less effort made to improve the sustainability of existing buildings compared with new buildings. Existing buildings perform less well than new houses in relation to virtually all sustainability criteria. There are also many times more existing houses than new houses, so the potential for making substantial performance gains in this sector, beneficially enhancing peoples' living conditions, and reducing national environmental burdens, is much greater in the existing house sector than it is in the new house area.

BRANZ estimates that there are only about 2000 old house disposals per year in NZ compared with about 30,000 new houses being built. Therefore we are not even disposing of our old houses to make way for new houses, we are simply adding to our numbers of houses on a continuing basis. The issues connected with the poor environmental performance of our existing housing stock are therefore not going to go away they are simply going to get worse and so must be addressed. Adding to the sustainability of our existing houses will incidentally beneficially enhance the net value of the nation's greatest capital asset, its building stock, which accounts for around half of New Zealand's gross fixed capital formation as well as reducing pressure on landfills, water resources and energy generation.

Governments have tended to primarily focus on regulation as their preferred vehicle for intervention. Regulations tend to apply only to those situations which occur after a particular piece of regulation is enacted. Therefore regulations are much easier to apply to new rather than existing buildings. Retroactive regulation is very uncommon around the world and is fraught with difficulties. This is almost certainly one of the principal reasons for the apparent disparity in the level of engagement of government interventions between new and existing houses. A further reason is that it is generally more difficult and expensive to upgrade existing buildings compared with new buildings and outcomes are less certain.

The good thing about regulations is that they establish a 'level playing field' situation that applies to all. The difficulty often is in establishing and effectively enforcing strict enough mandatory standards to elicit meaningful improvements in any given sector of legislation, in the face of almost inevitable stakeholder opposition. In New Zealand's particular situation in the aftermath of the Weathertight Building Investigation, when all sectors of the Industry recognised that standards had fallen below acceptable limits, we may be in a unique position to be able to put in place regulations that will deliver significant improvements in building standards. Even so, the new Building Act 2004 only regulates new buildings for additions and alterations, not for existing work.

In recent time governments have tended to become more flexible in their approach and have begun to use more economic instruments combined with information tools to achieve desired objectives. Often these economic instruments are incentive related and voluntary in nature. This combination of economic instruments and information tools is the most common device used in existing building interventions. In this situation the challenge is to strike a balance between making the incentives substantial enough to ensure take-up but not large enough to raise serious opposition from those who cannot take-up the opportunities presented. This last group see themselves as subsidising wealth enhancement of other segments of the population. This seems to be the reason that economic incentive packages or grants have been largely confined to low-income families or to public housing. This situation is changing however, as the need to improve sustainability standards becomes more apparent and more urgent.

There are three or possibly four categories of home ownership in New Zealand. If Beacon is to achieve its objectives, all sectors of the house owning/occupying community must be induced to improve sustainability standards in their accommodation. These categories are public housing, which constitutes 6% of the housing stock, private renting property which comprises 26% of housing stock and owner occupied houses which composes the remaining 68% of the housing stock. It may be worthwhile involving mortgage lenders and insurers in encouraging owners to undertake performance enhancing improvements.

Central government, through Housing New Zealand, and municipal government (WCC and CCC), who are together the principal public housing owners, have an opportunity to upgrade their own existing housing stock to the newly established sustainability standards. These standards should at least be in line with World Health Organisation (WHO) minima's for comfort and health. If central government is serious about enhancing sustainability standards in New Zealand homes and it brought its own houses up to the defined standard, this would have a very significant impact on the retrofit market and enable them to take the high ground if it were to require others to match this standard.

Internationally, the private renting market is generally acknowledged to be the most difficult sector in which to achieve performance improvements. This is because both owner and renter have a vested interest in not doing anything to improve the quality of the house. Generally the owner is most interested in maximising profit and the renter in minimising rent payments. Improving performance standards is seen by the owner as costing money, probably increasing their borrowing exposure and having no direct financial benefit attached, while for the renter, improvements in quality are seen to be an inevitable precursor to rent increases. People who rent property often have limited means or regard rent as 'money down the drain' as no capital appreciation results from rent payments. Therefore, although economic instrument driven interventions are generally favoured in the existing housing market, the introduction of regulatory instruments may be necessary in the private rental housing sector. This is likely to be so even if they are accompanied by incentives, realistic compliance timescales and financial support for renters.

It would be highly desirable to engage with people who rent property. A mechanism needs to be established whereby renters who improve their accommodation receive financial benefit for their input. There is no known intervention anywhere in the world which does this, but there is a definite gap here and such an intervention would be worthy of investigation.

Owner occupiers are the biggest owner group and are the one which can derive most personal benefit from carrying out retrofit. They are also the group most likely to have access to the means to do so. This group comprises a very diverse group of people who range from those who will carry out green retrofits if at all possible, to those who will not undertake such action unless they are obliged to do so. In the middle are those who might be persuaded to undertake performance related improvements provided they make environmental and financial sense. A significant issue with this group is that there does not seem to be enough reliable information about payback on investment. It also seems to be very difficult to access good and reliable information and skilled contractors to carry out work at an affordable price, in what is still regarded as a new and specialist area. 'Green' improvements are currently rarely acknowledged in terms of increased resale prices in the way that kitchen and bathroom improvements are and this too is a disincentive to invest. The specific characteristics and requirements of this diverse group need to be acknowledged and interventions targeted specifically to meet their needs and aspirations. Information and education may be enough in some cases, in other cases methods to decrease upfront costs, which would have the effect of reducing payback times

might be a successful incentive. In cases where people are very competitive, providing owners with information on how their house performs in relation to other similar houses may be enough of an incentive to initiate improvements.

Regulatory interventions account for by far the largest number of interventions in all sectors. Often they are not even recognised as interventions because they are embedded in building regulations or compliance standards. In revising regulations or compliance standards, levels of performance are commonly raised. Regulatory standards are normally cheap to promulgate, though compliance costs for building owners, manufactures and regulatory authorities are not always so cost effective. In some countries, including NZ, governments often require a cost benefit analysis to be carried out which can demonstrate national benefit and often economic benefit to the individuals most impacted by change, before they will introduce regulation. This was usually linked with first cost but increasingly, life-cycle costing or payback related costing systems are being considered, when action needs to be justified. Once a regulatory standard is setup in a particular area, it is relatively easy to increase the performance criteria when and if circumstances change. Resistance to regulatory change is very common particularly from industry stakeholders who often see disadvantage to themselves in changes to the status quo.

In general terms the spreadsheet analysis of sustainability related retrofit building schemes verified the findings of the OECD report and other research carried out by the principal investigator in respect to the objectives of the retrofit work undertaken.

Environmental sustainability was by far the most cited objective, with 98% of the schemes mentioning energy saving, 48% water savings and 42% resources (materials) conservation as an objective. Health improvement was cited in 4% of cases as an objective. Economic sustainability objectives were the next most cited objective set with 32% of all schemes mentioning cost savings. Social sustainability objectives were cited in only 12% or less schemes.

Many of the schemes did not appear to evaluate how successful the retrofit had been. Nevertheless some evaluation did take place. In 38% of schemes energy savings were regarded as a measure of success. Cost savings and payback were also cited in 30% and 20% of schemes respectively, as measures of success.

ENERGY

General

Energy related interventions are by far the greatest in number and variety of all types of interventions found relating to sustainability, and in fact exceed those in all other categories put together. Most OECD countries have energy saving programmes. Many of these interventions have quite specific targets, such as the US Department of Energy's **Weatherization** programme which targets low income families or **Energy Star** which, like the Australian and NZ **5 Star** rating system, informs consumers concerning the energy performance of electrical appliances and encourages manufacturers to make their products more energy efficient. By targeting specific groups or specific areas of energy performance, these programmes can be given very clear objectives and budget allocations. They often however have a very limited effect on national energy consumption. This is because of their very narrow scope, comparatively small take-up numbers and because most of the anecdotal evidence suggests that most energy performance gains are used up in providing better comfort levels for occupants. This is particularly the case when the pre-existing condition is one where occupants are cold and environmental conditions are below WHO minima's.

From the case study analysis of energy related retrofitting, by far the most common item included was insulation, which was cited in 62% of instances. Glazing was the next most common citation at 44% with photovoltaics (PV) being cited in 32% of cases. This last figure comes as something of a surprise as PV systems are still expensive and payback is very difficult to achieve. Solar water heating (30%), draught sealing (18%), energy efficient appliances (26%), energy efficient lighting (24%) and thermal mass design (24%), heat recovery (18%), solar heating panels (10%) were the next 7 items in terms of percentage citation. All the rest of the factors analysed showed citations in the low teens or in single figures.

In terms of passive solar design, solar gain, summer shading and passive ventilation were each cited in 16% of the case studies, while passive heating was only cited in 8% of the cases and passive cooling in only 2% of the case studies.

Despite a considerable number of interventions, energy consumption in the building sector rises year on year in almost every country in the developed world.

Regulatory Interventions

As stated above regulatory intervention programmes in existing buildings are not common. Retroactive legislation is generally shunned by governments unless the pre-existing condition is hazardous, and even then, mandated change tends to be the minimum required to overcome the specific problem. Voters tend to resent legislation which makes their previously legal home somehow illegal at the stroke of a pen, and as these measures impact everyone, such resentment can result in very serious political consequences. Effective compliance verification is also extremely problematic and the application of sanctions or penalties even more difficult. The only intervention discovered which falls directly in the above category is in Germany where a law introduced in 2002 requires all homes to carry out three very specific measures, (which have great potential for energy saving), by the end of 2006[1]. It will only be possible to gauge the success of this intervention after the target date. It would however be worthwhile to evaluate this programme at that point.

In Canada and in some states of USA, **Residential Energy Conservation Ordinances (RECOs)** have been introduced, which require building owners to implement a series of low cost energy conservation measures when selling or renovating their buildings. Measures tend to be very simple and specific, such as weatherstripping, gap sealing and roof thermal insulation, which are all easy to carry out and have rapid payback periods. The focus on buildings to be sold or renovated gives an element of choice to owners, links these interventions to larger financial transactions and spreads the duration of application. In many cases the measures required are so simple that they can be carried

[1] 3 measures, 1. Boilers installed before 1978 must be replaced. 2. Lofts that cannot be converted must be insulated to specified standards. 3. Boilers and pipes in unheated rooms must be insulated to specified standards. All work must be complete by the end of 2006.

out by the home owner themselves. Therefore, the problems and cost of employing a contractor are removed and the pressure on the industry to carry out these changes is considerably reduced. All these measures dilute opposition. Because a legal transfer of title is involved in a sale or building consent and verification process, in terms of additions and alterations, the task of compliance verification is relatively straight forward. In some jurisdictions, for example, registration of title transfer is linked with the production of evidence that the required upgrading has been carried out. This regulatory device applies equally to rented and owner occupied property and allows for the upgrading of the very poorest performing houses, where it would otherwise be very difficult to effect any improvement. While **RECOs** may not always generate optimal or even least cost solutions in a given situation, they do have the merit of making energy improvements across a broad front and tend, over time, to raise the energy conservation standard of all houses. With such a device in place it is relatively easy to raise the standard and target specific measures which would have maximum effect for minimal cost. Such measure can easily be linked with subsidies or grants for the poorest sections of the community.

Evidence concerning the success of these schemes is not readily available, but reports suggest that in San Francisco **RECOs** have resulted in the 'weatherization' of more than 160,000 properties and reduced energy consumption by 15%. This seems to be an approach that could be easily adapted to the New Zealand situation.

An interesting new mandatory regulatory initiative called **BASIX** has recently (1.7.04) come into force in New South Wales. This requires all new housing to use 25% less energy than the average existing NSW house, to achieve thermal comfort and energy use targets. From 1.10.05 this regulation will be applied to all additions and alterations. From July 2006 the energy reduction requirement will be 40%. This idea is quite interesting as the 'average' energy use figure will itself fall over time and new consented work will have to better this reduced figure by the 40%. Should circumstances change it would also be relatively easy to increase the 40% to something yet more challenging. This system is web based and allows owners/designers a variety of choices to meet the targets. It has a scoring system relating to both thermal comfort and energy use. This is obviously very new but it would be worthwhile to examine it in some depth and follow its progress. **BASIX** also sets mandatory water conservation targets which are discussed under the corresponding section of this report. It may well be possible to adapt this system for use in New Zealand.

The UK government has introduced legislation to set an **Energy Efficiency Commitment (EEC)** obligation on utility companies, to promote the energy efficiency of domestic customers, with a special focus on low-income customers. Utilities are required to achieve targets, by implementing programmes to promote the energy efficiency of their domestic customers. The cost of such **EEC** programmes is reflected in the customer's bill but is estimated at about $10 equivalent cost per annum per customer. Penalties are applied to the utility companies for non–achievement of the target figures. This measure, introduced in 2002 is a novel approach and its effectiveness is yet to be established but it would however be worthy of further investigation and monitoring.

Economic Interventions

With existing homes, voluntary economic interventions are by far the largest segment of intervention. Even so there are a number of barriers to the implementation of such programmes. OECD research suggests (OECD p81) that:
"It is very difficult to generalise cost effectiveness of a certain energy efficiency measure, because both the costs and the effectiveness of the measure are highly dependent on many specific elements of a particular building's design.
It is more expensive to incorporate many energy saving measures into existing buildings than into new buildings,
It is more difficult to assess performance of existing buildings as many elements of the fabric are hidden and
There are no existing regulatory frameworks for existing buildings."

Capital Subsidy Programmes

These are a popular way of inducing consumers to introduce energy saving measures into their homes. The OECD report on this subject suggests that there are often large numbers of 'free loaders'

taking up these programmes. This statement may be true in some cases but is certainly not universally true. In the case of the Canadian **Energuide** programme for instance, the numbers of participants grew enormously after a subsidy programme was introduced, even though subsidies are often quite modest. In the case of the **Energuide** programme they approximately equate to the government tax which is associated with the building work. In the UK the **HEES** grant average is about £600. In both cases these amounts are only a tiny fraction of the actual money spent by the owner. So capital grants of this nature seem more likely to provide a sort of 'tipping point' inducement for people to take action, rather than remain inactive.

Capital subsidy programmes are most often targeted towards low-income families. This is the primary focus of both the US Department of Energy's **Weatherization** programme and the UK's **New HEES** programme. In the US, California and Ohio give a full capital subsidy to tenanted properties which undertake a weatherization upgrade. This is in recognition that nothing at all would otherwise be done with this housing category. In the UK capital subsidies are given to landlords under the **New HEES** programme but here, in return for receiving the grant, landlords must agree not to raise rents for an agreed period after the granted upgrade. The DOE **Weatherization** Program is a US federally funded programme that upgrades about 90,000-100,000 homes a year and is mainly targeted at low-income families. Most of the work carried out is fairly simple, but unlike **RECOs** each individual house is assessed and a scheme devised which gives the maximum benefit for the least cost related to that particular property.

Capital subsidy programmes are however not just restricted to low income households or privately owned rental properties. There are capital subsidy programmes which can be taken up by all sections of the community. The most impressive of these is the Canadian **Energuide** programme. This has a number of unique features which in combination have made this one of the most successful programmes in the world. In 2004, while an 80,000 annual take-up was targeted, figures are being revised upward and seem to exceed a 100,000 plus assessment take-up, provided their assessors can keep up with demand.

The programme was developed by Natural Resources Canada Energy Efficiency Office. Applicants apply for an energy assessment of which 50% is funded by the Energuide programme. The existing house assessment is done on site, takes just over an hour and is home specific. At the end of the home visit, owners are given a report and upgrade options are discussed with the assessor. The report is downloaded into a programme database at the central office and owners are able to access this database and decide for themselves what work they want to carry out, on what timescale and discover what the subsidy is for carrying out that specific improvement in performance. They can then match this with their personal circumstances.

Once the work is done owners arrange another assessment. The subsidy is paid on the basis of the measured improvement in energy performance. In this programme the owners feel in control of the process and they can make their decisions based on high quality professional advice. It may well be that the subsidised assessment programme and the retention of control by house owners contribute most to the success of this programme, but the capital subsidy adds to its appeal, as does the excellent technical backup information available which enables house owners to do some of the upgrading work themselves. The programme also encourages provincial, city, county, governments and utility companies to 'top-up' the subsidy amounts within their own jurisdictions.
Worldwide, utility companies are becoming increasingly interested in supporting energy conservation programmes. For more than a decade utility companies in some countries have been involved in demand side management programmes, as they saw demand rising at a rate they could not match with new generation capacity. Many are now aware that it costs them less to reduce demand, than having to provide extra capacity to meet peak demand conditions. Programmes include, free replacement of tungsten with compact fluorescent lamps, free cylinder jackets, free energy saving advice and crafted tariff regimes which favour low peak demand take up, or allow cutting of power to hot water heating during peak periods. Some utilities also allow people with their own generating systems to run back their meters with surplus energy supplied to the grid. NZ utility companies have begun to appreciate the value of such programmes but action varies a great deal between companies.

Premium Loan Schemes

Several countries operate premium (low cost) loan schemes associated with specific retrofit items. Many of these are funded through government owned or controlled mortgage lenders such as The Japan Housing Loan Corporation or Norway's Husbanken. Another source of premium loans for sustainability related interventions are the substantial and increasing amounts of ethical funds available around the world. Interest free loans provided by central government are also useful tools but are usually associated with quite specific, high priority improvement schemes. Whatever the mechanism, these sort of loans can be very successfully used in support of government policy decisions. In Germany for instance, all dwellings built before 1978 are eligible for a subsidy which effectively reduces the interest rate by 3% on loans used to carry out energy efficiency measures, if the reduction in estimated energy usage is greater than a predetermined level. In NZ the government used to give an interest rebate for money borrowed to install a solar water heating system. This seems to be a very worthwhile system and might be reintroduced with a broader remit and backed up with more publicity and advice to house owners.

Energy Taxes and Tradable Permit Schemes
These are both independent of regulatory building frameworks and so can be applied equally well to existing and new buildings. Energy taxes are net revenue collectors, rather than being a cost on central government finances and administrative costs are low, so are quite attractive to governments. However, energy taxes which simply raise the unit cost of energy have a detrimental effect on the ability of low-income families in low quality accommodation to keep themselves warm. Therefore, if an energy tax were to be put in place, it would need to be balanced with provisions for the upgrading of homes at the low-income end of the ownership spectrum. Perhaps the energy tax revenue could be used to subsidise such upgrades.

Research demonstrates some relationship between increased cost of energy and the adoption of energy saving measures and technologies, but take-up varies greatly between different economic, social and cultural settings. Energy taxes have the effect of reducing payback periods for all energy saving interventions. Of all the intervention systems, energy taxes provide the highest level of flexibility in allowing house owners to devise least cost or preferred option solutions to reduce energy use related to their particular situations. Owners in this way feel much more in charge of their own destinies.

Tradable permit schemes are very new and seem to have originated with the tradable credit notions embedded in the Kyoto Protocol on Climate Change. The UK government is considering allowing utility companies, who have exceeded their energy efficiency targets under the EEC scheme (discussed above), to sell their surplus credits to companies who have not achieved their targets and would therefore be penalised under the scheme.

Information Tools

The OECD report suggests that the main purpose of environmental labeling schemes is to inform prospective buyers of the energy performance of the house. This is probably true but they also have the effect of serving as a reminder of energy performance to current owners and serve as a baseline from which energy improvements can be assessed. It is suggested that they are just as valuable in informing current owners of the energy performance of their house as prospective buyers. If for example information on average energy performance is issued, many house owners would be interested in knowing how their house performed in relation to this. Such information could be issued with energy bills. Energy bills are thought to be a good medium for disseminating energy saving information as people are already focused on the cost of energy when they read their bills.
The only widely used labeling scheme for existing buildings is in Denmark. In this case the standard format report that must be provided by the seller to a prospective buyer includes current energy information, an energy upgrade plan and a condition appraisal of building fabric and appliances which are to be sold with the house. However, empirical evidence suggests that even in an energy aware nation like Denmark, the energy report has failed to change the behaviour of potential buyers nor improved the market value of homes with good energy efficiency ratings.

Energy audit programmes are intended to help owners to make informed decisions about energy upgrades. The OECD sees the main barrier to such audits as being the cost involved. However the Canadian **Energuide** programme delivers a high grade assessment programme for about $200CAN

with 50% of this being federally funded. This is one of the most successful aspects of this Canadian programme and would be worthwhile investigating for adaptation to New Zealand conditions.

While in general terms, audits are worthwhile, owners need further information and help to carry out an upgrading scheme with the least trauma and greatest likelihood of success. Help is required in areas such as the prioritisation of tasks to achieve maximum cost benefit, finding, instructing, employing and supervising reliable tradespeople; giving owners access to information which enables them to carry out the work themselves. **Energuide** has a comprehensive information package and has links with tradespeople. This comprehensive information package contributes greatly to the success of the **Energuide** scheme.

Empirical evidence suggests that energy audit programmes are successful in influencing decision making, and in helping people to realise a substantially greater proportion of potential energy savings in an energy upgrade, compared with those people who undertook energy upgrades without having an audit carried out.

MATERIALS

General

Saving energy is recognised as important in most countries around the world, by governments and individuals alike. Both can see a direct financial return when they invest in energy saving programmes.

Resource conservation through the sustainable use of materials is not so well recognised as an issue requiring action and in consequence there are many fewer interventions in this sector.

Most of the interventions that do exist owe most to the urgent need to prolong the life of existing landfills and avoid the creation of new landfills. So the interventions are in general not directly focused on promoting resource conservation but on waste diversion, where resource recovery is only the incidental beneficiary. The Building Act 2004 itself focuses on waste reduction rather than the wider objectives set out in the NOW house brief for the use of sustainable materials in an efficient manner or the creation of durable, low maintenance, adaptable, easy to disassemble buildings.

In the case study analysis, waste minimisation was cited in 32% of cases, recycling, in 25% and use of renewable materials in 17% of projects. Use of durable materials was cited in 12% of cases. All other factors analysed including adaptability returned single figure citations.

The OECD report deals entirely with interventions in the resource recovery sector. It recognises three goals relating to short, medium and long term objectives. The short term goal is to reduce the final disposal of waste generated in the building industry and promote the reuse or recycling of Construction and Demolition (C&D) waste. The medium term goal is to increase the use of recycled materials in the building sector and the long term goal is to introduce a reuse/recycling strategy in the design process with the aim of achieving more effective ways of using C&D waste. All of these goals need to be implemented as quickly as possible, even though their realisation is likely to be on different timescales.

All of these three goals apply equally well to retrofit and to new construction. In fact in some ways retrofit accommodates the implementation of these objectives more easily than new buildings. It is quite common to recover and reuse elements of the building fabric, components, and materials removed during retrofitting, in the remodeled building. It is generally acceptable to use recovered materials and components from other buildings in a retrofit project, especially where they match elements or materials in the existing house. Because comparatively small numbers and amounts of materials are used in retrofit designs it is often possible to obtain these from recycling yards without having to undertake extensive searches. Furthermore, the 'actors' in the retrofit process seem more psychologically attuned and accepting of secondary (pre-used) and recycled materials and components being used to modify existing buildings.

Regulatory Instruments

Both The Netherlands and Denmark have laws which ban landfilling of most categories of C&D waste. Even before this ban was put in place in 1997 there was a very high level of recycling due to the high landfill taxes in place in both these countries. This made finding alternative methods of disposal very attractive to the industry. In both these countries C&D waste recycling has largely meant using the masonry waste as sub-base under roads. At the moment there are no known interventions which require demolition contractors or builders to find more uniform[2] recycling options for C&D waste in these nations. It can be seen therefore that resource recovery was not the primary objective of these regulations in either country.

[2] There are three levels of recycling; up-cycling where recovered materials are used for a higher grade purpose than the original use; uniform recycling where the recovered material is used for the same or an equal grade purpose; down–cycling where the recovered material is used for a lower grade purpose. We should be aiming for at least uniform recycling to minimise resource depletion.

Mandatory separation is one of the most used instruments to improve recovery rates of C&D waste. Denmark and The Netherlands are again the leaders here. Separated materials are much more likely to be used for recycling purposes. However, there must be markets for the separated materials if this is to be an effective resource recovery measure. Enforcement is difficult, but no more efficient or effective alternatives have yet been devised to lift the potential of site generated waste for use in recycling.

In the case of retrofitting, quantities per job tend to be very small and separation even more costly in relation to quantities of materials recovered. Yet as there is so much retrofit work undertaken, unless effective recovery systems are devised, then the loss of resources is quite significant. An effective method of encouraging compliance is to set landfill charges for mixed materials at a very high rate compared with separated C&D waste. In some instances charges for separated C&D wastes were set at zero. More effective still, are schemes whereby a manufacturer will lend a recycling bin to a site for the collection of specific wastes and uplift it in return for receiving the recyclable material for free or at minimal cost. In some countries, there are opportunities to deliver mixed wastes to transfer stations where they are separated out. These are often costly operations and tend to be operated only where landfills are under great pressure or where 'zero' waste regimes are in place. More than 50% of local authorities in New Zealand have adopted a zero waste strategy but tactics vary enormously and in some cases seem to be largely ineffective.

Mandatory delivery of demolition materials to processing facilities is in place in some cities, but it is only effective if markets have been put in place. With increasing regulation in this sector, illegal dumping is becoming an increasing problem. Many countries operate a demolition consent system and extensions of this system have been used to tackle this problem.

Mandatory reporting policies are in place in Sweden, Denmark and a number of other countries and cities around the world. To get a demolition permit, contractors must submit a waste management plan which includes information on amounts of materials to be disposed of and their destination. Denmark operates a landfill ban policy so finding destinations for demolition materials is particularly challenging in that country.

In Denmark, this strategy is applied if the waste generated is estimated to be more than a tonne. Therefore it is likely that small retrofits would escape this regulation but major alterations would not. This tool enables Danish authorities to track how waste is actually treated. This is useful to develop more effective intervention programmes for the future but it is also an effective deterrent to illegal dumping.

In San Diego demolition contractors have to prepare a waste plan and pay an up-front fee to cover land filling charges. The amount of this fee is dependant on the actual amount and type of demolition materials that will be generated. If contractors find alternative markets for a specified percentage of their demolition materials they have their fee rebated, on presenting the necessary diverted use verification documentation. This is also an effective tool against illegal dumping, as contractors pay the full fee up front. It is however a system that is open to under-reporting of original demolition quantities and over-reporting of diverted use quantities. Enforcement is therefore a major issue.

In some countries, licensing systems are in place. Only those with a licence may engage in demolition or disposal activities so that if licensees are found to be involved in illegal dumping they stand to loose their licence and therefore their livelihood. This too has proved to be an effective instrument to reduce illegal dumping.

The two most important pre-requisites for developing the recycled building materials market are that:

- Recycled materials need to be competitive with virgin materials both in terms of price and quality.
- Potential buyers need certification of the quality of recycled materials.

While the most direct method to promote the use of recycled materials in building construction is to impose standards that require use of recycled materials, no country has so far implemented this form of regulation although Japanese law requires contractors to make efforts to use as much recycled material as possible. In practice, mandatory regulations are very difficult to draft, as conditions vary so much from building to building according to OECD research.

This may be true as a first step but regulation may be possible if the ground is properly prepared. If for example, government buildings were required to incorporate a certain percentage of recycled materials content, then this will encourage, stabilise and grow the market. Once it is established what is feasible and reasonable, legislation could be written around this. Such leadership would also tend to reduce the marginal cost of replacing virgin materials with recycled materials or materials with recycled content.

It may be that in the first instance, public housing developments requiring retrofitting could be a suitable starting point for such a research and development process. Because state housing is composed of a number of the same house pattern it would be possible to run a control and a series of experimental retrofit packages in a monitored research programme.

OECD argues that establishing standards for the use of recycled materials is difficult to enforce, as there would need to be a clear labelling system, which would be expensive to develop and maintain. In NZ with its system of self certification and producer statements already in place, and a performance based building code, this may not be such a difficult or costly proposition, as it is in many other countries.

The imposition of minimum standards for the quality of recycled materials might well serve to overcome much of the reluctance of clients, designers, building inspectors and contractors to support the use of secondary materials in buildings. Such a system would be likely to reduce the anxiety many professionals feel in relation to indemnity insurance risks that are currently implicit in the deployment of such materials.

In 1999, The Netherlands introduced the Building Materials Decree that imposes minimum standards for materials containing hazardous chemicals. However this sort of specific regulation does not cover all the areas of concern. With New Zealand's performance based regulations it seems possible to identify acceptable or alternative solutions which would not impede the use of recycled materials in buildings. There may in fact be opportunities to undertake such work in the near future. In undertaking house retrofits, the team leader has used secondary materials and products of various types without experiencing any significant difficulties.

The new Building Act 2004 restricts itself to waste reduction and does not specifically require the deployment of sustainable and resource efficient materials and design. No examples of such regulation was found anywhere in the world. Therefore if Beacon wanted to propose regulation in this area, in support of establishing the NOW house measures as the sustainability standard, they would be breaking new ground.

Economic Instruments

Landfill taxes or tipping fees are a very effective mechanism to improve rates of resource recovery. Denmark, The Netherlands and the UK all consider that significant increases in landfill fees is the single biggest factor in achieving high recycling rates in the C&D sector. They are universally regarded as being even more effective than landfill bans, which have tended to be put in place only after landfill taxes have achieved already high rates of recycling. The higher landfill charges are set the more likely it is that landfill diversion schemes will be financially attractive and viable.

Fees can be used to improve landfills, to increase resource recovery rates, for information services, to give start up subsidies for companies wanting to make materials from waste or undertake recycling.

This system works best if the landfills are all municipally owned. The cost of running comprehensive landfill operations will rise and this will be reflected in landfill charges. Privately owned landfill operations, sometimes called 'cleanfills', which charge lower fees, can undermine this whole area of intervention. Demolition waste being disposed of in cleanfills is an issue because C&D waste is regarded as non-hazardous and so cleanfills can be quite literally a hole in the ground. Landfill operations which have to take all types of waste cannot financially compete as they have to provide complex systems to prevent pollution from the landfill, control hazardous waste and so on. If cleanfills were themselves taxed to bring their charges in line with municipal landfills, this could make a major difference to the effectiveness of landfill taxes and result in substantial increases in resource

recovery. Alternatively, licensed landfills can be phased out by not allowing any new licences and by not renewing licences for existing facilities, as is the case in Auckland.

Destinations for diverted materials are currently mostly in a down cycling mode. Masonry, crushed for base course material under roads, is by far the most common usage. More interventions are necessary to encourage higher grade use of diverted materials. Landfill taxes or fees are generally regarded as the most cost effective option for encouraging resource recovery and a significant inducement to finding innovative ways of reducing waste. A Danish study indicates that this instrument has contributed to innovation in technologies related to recycling in buildings. Administrative costs are modest.
The only known example of a tradable permit scheme in this sector is in the UK. In this case central government has established universal targets for waste diversion. In areas where diversion from landfill is high, local authorities can continue to landfill waste by buying permits from local authorities where the cost of diversion is lower and where they have exceeded the target. This mechanism will allow local authorities to meet the targets at the least possible cost. The cost of controlling and running such schemes seems to be low, but the scheme is very new and success factors are not yet clear.

The introduction of regulation, or the employment of economic instruments to require buildings to be designed to facilitate disassembly, is seen as costly and the outcomes as being too uncertain for action to be taken by any of the OECD member countries to date.

Virgin materials taxes are intended to reduce the amount of virgin materials utilised and encourage their replacement with recycled materials. As applied in the UK and Denmark they focus on concrete aggregates but could have a wider application. Such a tax could be used to reflect the environmental cost of consuming virgin materials, which is rarely reflected in their cost, and to counter subsidies given by governments to reduce energy costs or export subsidies. In other words, these taxes could be used to create a level playing field condition, where recycled materials can fairly compete with virgin materials. Danish and Swedish research is inconclusive as to the success of these initiatives. In general it is considered that such interventions would be more successful if the tax could be flexibly adjusted to reach a level where it could have a large impact on the use of materials.

While giving capital subsidies for the use of recycled materials is thought to be a promising tool for virgin material replacement, there are no known examples. It is considered that such an approach could be costly to support and administer. The provision of capital subsidies for processing plants is not common despite their low associated administrative costs, and the ease with which they can be withdrawn once a particular industry segment can support itself. In most OECD countries the focus of such a programme is on fixed processing plants to produce high quality recycled materials. In New Zealand there seems to be a need for such an initiative to also cover mobile plants, for use in rural areas by a number of authorities who might not otherwise contemplate resource recovery.

Information Tools

Voluntary information tools certainly hold a degree of promise in this sector. The **LEED Domestic** assessment programme gives points for designers to incorporate measures to make their buildings easy to deconstruct, reduce waste, incorporate materials with significant recycling content and to facilitate materials re-use, as well as the employment of sustainable materials and their efficient use. Production and dissemination of information concerning ways to facilitate design for disassembly and materials/component recovery is needed, both in professional training and in CPD courses, to make professionals in all sectors of the industry more aware of issues and to demonstrate ways in which they can be part of the solution rather than part of the problem.

Public procurement policies which require percentages of recycled materials, sustainable materials and design for disassembly to be part of the project brief can be very effective. In a growing number of American cities, the municipal authorities require public buildings to be **LEED** certified and it would be exceedingly difficult to obtain all the points required for certification without taking on board several of these sustainable materials initiatives. The domestic version of **LEED** is not yet up and running and the retrofit version is likely to be even further down the track. However, once resource

conservation becomes normal in the non-domestic sector, it will almost certainly also percolate into the residential sector.

Environmental labelling schemes are not thought to be effective, as the waste performance of domestic buildings seems to be of little concern to most potential buyers who see little potential for personal economic benefit in this sector. A programme such as a premium or preferential loan scheme would need to be linked to such a labelling scheme to make it effective.

The incorporation of secondary (second-hand, pre-used) materials into schemes is often impeded by a lack of timely information on its availability, source and cost. Electronic market places have been established in several parts of the world to help mitigate this problem. The UK's **SalvoWEB** is perhaps the most developed of these initiatives. This is free to both buyers and sellers. It is funded by the UK government and administered by the Department of Environment, Transport and the Regions. It is a self maintained system and users are free to enter or exit directly from the system without the need to contact a third party. This has the effect of keeping costs low. The main problem is likely to be the accuracy of maintaining currency of the information contained. Neither this scheme nor a similar one in Flanders, Belgium seems to have been widely used to date. The reasons for this are unclear. In New Zealand we have a whole series of local schemes which probably would be more effective if they were consolidated into a single system. One possibility is to build on the very well-known, successful and well organised **Trade-me** website, which though non-building specific, already has a number of specialist offshoots.

Certification schemes for secondary materials help to convince and assure end-users that recycled materials can be used with confidence to meet performance standards. Such interventions do not necessarily involve commitment by government. However, their introduction and use is likely to happen much more quickly if government provides technical and financial support, as well as approving certifying bodies. The operation of certification schemes involves considerable administrative costs. These in themselves can become barriers to the use of recycled materials if a full user pays regime is applied.

The provision of standard specifications is also a very useful information tool. Such provision is usually left up to a particular professional body or manufacturer

The introduction of new interventions throughout the area of resource conservation will require careful research not least in the area of the efficient use of materials. The aim here is to do any particular task with the least amount of material (resource). It also involves deploying the lowest grade of material appropriate to the task. The objective here is clear and laudable – to make the best use of resources available. However the dangers and challenges are commensurately prodigious. Only very careful and extensive research will deliver such advances. The most suitable interventions here are ones which fund research, development, dissemination and training, and promote the uptake of such advances at all levels in the building industry. Otherwise the research is wasted. One example of this is the research carried out in the US on efficient framing techniques called Optimum Value Engineering (OVE) in the 1960's and 1970's which can result in savings of 30% or more of the total framing package. Yet even today the vast majority of light timber frame houses include few if any OVE techniques. The reason for this is not entirely clear but is thought to be largely due to worker resistance.

WATER

General

In many countries water is as precious as energy; but yet while there are many energy interventions, water related initiatives are much less common.

Despite the abundance of the overall supply of water in New Zealand, certain parts of the country have experienced severe water shortages in recent times. This phenomenon seems likely to continue and probably will increase particularly in the eastern sides of the country, if climate change scientist predictions are played out. Water efficiency and conservation are written into the Building Act 2004.

There is no doubt that considerable savings in water use can be made in domestic buildings.

In the case study analysis, citations were quite low across all the water related factors examined. Water efficient fixtures rated an 18% citation, while rainwater collection and efficient hot and cold water systems were cited in 17% of cases. Water efficient appliances at 12%, greywater systems at 11% and water efficient toilets at 8% were the next most cited factors. Other factors such as stormwater detention and on-site blackwater treatment were hardly ever mentioned.

In terms of retrofitting houses there are significant opportunities to upgrade appliances, as kitchens and bathroom areas are common targets for retrofitting schemes and water using appliances are replaced several times during the life of a building.

Yet opportunities need to be translated into action and there needs to be some reason to save water. A few public spirited or environmentally aware people will do it because it is the right thing to do, but the great majority of people require a greater incentive. For most people that means a financial incentive. If money is going to be invested, where is the payback?

Regulatory Instruments

Around the world, the single agreed precursor to any management or conservation intervention is the universal installation of water meters and the charging of water rates based on actual water usage. Anecdotal evidence suggests that simply installing meters and charging for water usage has itself resulted in savings of close to 40% in water usage in some cases. Adding onto this a sliding scale charging system which penalises excessive water use would further promote water conservation, the utilisation of water efficient appliances and other water saving features such as rainwater collection, because to invest in such features would then make financial sense. Metering water in itself sends a message to users, in addition to the financial one, that water is not an infinite supply and needs to be used with greater care than we do today.

Water meters are installed in a number of places in New Zealand and all houses are charged according to how much water they use. Wellington Regional Council offers homeowners the choice of user pay meters, so there are precedents in New Zealand for this sort of action. It would be worthwhile to research the water saving effects of such initiatives prior to any wider application of metering.

Another regulatory instrument which is sometimes employed is to require water using equipment to meet certain water conservation standards as a condition of sale. This system is most commonly employed with regard to energy use but would work equally as well to lower water use.

Even with metering in place, landlords would be unaffected by generated costs. While central and local government owned rateable properties might be induced to install water saving appliances when replacing worn out existing appliances or during upgrades, private landlords would not be likely to follow the same line unless water saving appliances were mandated.

Water saving taps and shower heads are readily available. It would be relatively simply to legislate for the maximum water delivery rate of such appliances and only allow the installation of dual flush toilet cisterns. Such a measure would affect all building owners during replacement or upgrading.

These items are relatively cheap and it may be that there is a case for mandating the requirement that all taps and showers and cisterns comply with the required standards within a given period.

In this last case enforcement becomes an issue. It may be more cost effective to mandate this upgrade at point of sale as a condition of title transfer, or a part of the building consent process.
The Australian **BASIX** scheme which was mentioned under the 'Energy' section of this report also applies to water saving. It will be applied to consented additions and alterations from 1 October 2005. Water savings of 40% over average use figures will be required in all new work. The areas covered are landscaping, stormwater and interior water use. This is a mandatory system which might provide a starting point for a New Zealand specific system.

Economic Instruments

Economic interventions only work where there is a water metering regime in place. Capital subsidy programmes to help low-income families install water saving appliances might be considered. However, if all fixtures and appliances available for sale were what are currently termed 'low water usage' types, the unit price is likely to fall in a competitive market.

Premium loan schemes could be employed just as successfully with water saving initiatives as with energy saving schemes. The same comments apply.

Information Tools

The Australian **AAA** rating system provides information on the water efficiency of devices in the same way that the **5 Star** rating system provides information on energy efficiency.

Several of the green building assessment programmes include points for water conservation. The **LEED Domestic** system for instance, includes points for reducing potable water use, on-site water collection, on-site water treatment, on-site stormwater detention and flush water substitution. While these assessment systems are voluntary, they can make a significant difference if taken up by designers and owners. At the moment there are no known assessment systems which focus on retrofitting or remodelling of existing buildings.

Information programmes which give advice on the issues and ways to improve the water efficiency, conservation and management are worthwhile, particularly if there are back-up advisory services in place, which can give owners cost advice and put them in touch with skilled but reasonably priced tradespeople.

HEALTH

General

Health and safety have been the basis for building regulation around the world for much of the history of building control. However in the New Zealand Building Code, health is primarily dealt with in terms of water and drainage reticulation and to a fairly minimum extent by the setting of basic requirements for ventilation and daylighting. This is true of most countries.

However, it is becoming increasingly clear that indoor air pollution and moisture levels have a very clear link to people's health. Indoor air quality is becoming a significant issue in many countries. There are two aspects that relate to building design whether it is retrofit or new construction. The first is the materials used to build the building and the second is ventilation.

In the case study analysis the use of no/low toxicity materials was cited in 18% and passive ventilation in 12% of cases.

Materials can be a source of chemical offgassing which can have detrimental health effects. Levels of ventilation can determine the concentration of pollutants that can occur in a home. Increasing ventilation will have the effect of lowering pollutant concentrations.

In many countries, current thinking is to focus interventions on lowering the chemical emissions from materials used in buildings, rather than to increase ventilation rates. Superficially this seems sensible, for if we can lower sources of pollution below levels that are considered safe, then we do not need to increase ventilation rates. Unfortunately this is only partly true. Certainly we should be aiming to lower or eliminate noxious and toxic offgassing from building materials but in reality many of the indoor pollution sources come from other sources.

The worst air pollution comes from cigarette smoke, flueless gas heaters, burners, open fires, cleaning chemicals, air 'fresheners' 'bug bombs' and pest sprays. In some cases legislation may be the answer to removing these pollutant sources from our homes. The case for prohibiting the use of flueless gas heaters and burners is very strong. It may be possible over time to legislate for the lowering or elimination of chemical offgassing from cleaning and other household chemical sources. However to eliminate cigarette smoke from houses would be much more difficult to accomplish. In the meanwhile, increasing ventilation to reduce pollutant concentrations may be the most effective intervention we can make. All building materials to a lesser or greater degree take in chemical gases and re-emit them over time, in a process known as adsorption. This adds to the persistence of indoor air pollution. Effective ventilation is the primary method employed to mitigate this effect. Breathing envelope construction, in which envelope elements are vapour permeable and allow the transmigration of chemical gases to the outside through the building fabric, can also be effective in lowering indoor pollution levels.

Effective ventilation design is also the primary method of lowering indoor moisture levels to prevent the proliferation of dust mites and the growth of mould which are both sources of biological air contamination and allergenic/asthma reactions. It is generally considered that direct ventilation to the outside from gross sources of moisture is the best method of mitigating health effects. Bathrooms, toilets and kitchens as the primary sources of moisture in a house therefore need special ventilation consideration. Unflued gas heaters are major sources of moisture and ventilation of any spaces where they are used is necessary. While it is generally accepted that extract ventilation is provided in the case of bathrooms, toilets and kitchens, provision in living spaces with gas heaters is much more problematic as the heat will disappear with the extracted moisture and gas emission air.

In addition to creating appropriate standards for indoor air quality and preventing mould growth, a home requires the creation and maintenance of healthy environmental conditions at an affordable price. Therefore interventions might also focus on the establishment of comfort conditions for temperature, humidity, sound, daylight and sunlight and more contentiously, electromagnetic environment standards.

From the foregoing it seems clear that interventions in this field are likely to focus on reducing pollution sources, establishing appropriate ventilation coverage and rates and establishing healthy

environmental conditions in homes. These interventions apply just as much to retrofitting as to new homes. The biggest issue particularly related to retrofitting is to what extent such rules and regulations are applied to a house which is undergoing retrofitting or upgrading of parts of the house. In most jurisdictions the answer is that the regulations only apply to the part of the house which is undergoing upgrade and generally they apply only to the element being upgraded. Many opportunities for initiating sustainability related retrofitting elements are therefore not realised.

Creating and maintaining healthy environments is generally of much greater concern to occupants than to landlords, therefore creating effective interventions relating to privately owned rental accommodation is an area of challenge. Public housing is another area of challenge as tenants living in this accommodation are often the group least aware of the cause of deteriorating health conditions.

Regulatory Instruments

Regulation to mitigate indoor pollution in buildings has focused on setting emission standards for building materials. Formaldehyde and volatile organic compound emissions have been the main target of such regulation. Denmark and Germany have developed regulations which are both effective and cheap to administer. They focus on the application of strict maximum emission standards for materials containing formaldehyde. In both countries formaldehyde emissions are regarded as a 'solved problem'. Germany is also aiming to introduce regulation for VOC emissions. This is a more complex task as here we are dealing with many chemicals not just one. This type of regulation is effective and low cost and manufacturers seem to be willing to mitigate or eliminate health hazards connected with their products in a level playing field situation.

Ventilation levels and dispersion are also an obvious target for legislation and regulation. Building regulations in most countries have provisions for minimum ventilation levels. It is clear that ventilation can impact health in several ways. It would therefore be sensible to review ventilation requirements in the light of there expanded health role.

Economic Instruments

OECD research suggests that economic instruments in this sector are largely ineffective. However, there may be a case for subsidy programmes associated with the elimination of hazardous materials where occupants, especially low-income households could not otherwise afford to eliminate this health risk. Legislation to prevent the use of hazardous materials in new work and to remove and dispose of hazardous materials removed from existing buildings is already in NZ. Disposal methods are fairly primitive in many cases and essentially store the material for safe destruction at some future date.

Information Tools

Owners and occupiers as the direct beneficiaries of health related building improvements can play a big part in implementing healthier practices within their own homes. A great barrier to this is a lack of information concerning the issues and remedies available. City of Seattle and King Country have recently introduced a **Green Home Remodel** scheme which while essentially holistic in its approach, gives prominence to the healthy home aspects of the scheme. This programme is specifically targeted towards existing homes. It is very new and in fact is not yet fully operational. It is therefore not possible to assess success at this stage but the information packs have been well received. A programme to evaluate the success of the scheme is currently in the process of development.

Information tools are valuable resources in this area. However the effects of indoor air pollution, mould, dust and environmental performance of homes are still uncertain. This is in part due to the fact that each person reacts differently to the indoor environment of a home, but is also due to the fact that while the effects of single chemicals are understood to some extent, the effects of combinations of conditions and the chemical cocktails which occur in buildings are not well understood at all.

Nevertheless, improving owners and occupiers awareness of health matters and providing guidance and advice on how to mitigate health hazards is worthwhile and can be very cost effective. This is particularly the case in existing buildings where opportunities arise fairly frequently to make healthy choices and purchases and move a house incrementally towards more healthy conditions.

The effectiveness of environment labelling schemes for buildings seems to depend on how performance levels are indicated to consumers. Because of the uncertainly and variability regarding the impact of building design on human health it is difficult to devise a simple assurance protocol. Evidence suggests that introduction of such a scheme in Japan the **Housing Performance Indication Scheme** has had less effect on consumers/buyers than on manufacturers who were induced to make more low emission products in this area. The Japanese study also found that the labelling scheme appears to encourage innovation. Whether manufactures would react in a similar way in other cultural settings is unclear. Such labelling schemes are expensive as they require professional assessments and measurements being taken. If the main effect is on manufacturers then a more cost effective approach may be to target manufactures directly using some of the regulatory and economic devices already mentioned.

If whole building health related labelling schemes were to be introduced then it would seem to make sense to include it with a whole house assessment at point of sale.

Environmental labelling schemes for individual materials and products are a cost effective method of identifying 'healthier' products. They are a great help to owners, designers and contractors. Many of the existing assessment schemes such as Germany's **Blue Angel** programme already cover the impact of building materials on indoor air quality. If such a system is to be useful however, there needs to be materials and products which are identified as being 'healthier' in every use sector. This begs the question of whether such a scheme is to be voluntary or mandatory. Certainly only a handful of manufacturers participate in New Zealand's own **Environmental Choice** assessment programme.

The World Health Organisation proposed target values for indoor pollutant levels in 1983. Many countries have adopted these target values. Whilst not binding, the adoption of target values seems to have induced manufactures in some countries to develop materials and products which meet the targets for formaldehyde in 1977 and that appears to have helped to prepare the ground for implementing the regulation of formaldehyde emissions in 1986 in Germany. This combination of announcing targets but requiring compliance at a defined later date seems to be an effective method of establishing a level playing field, and improving standards without putting unnecessary stress on manufacturers or raising product costs.

EXISTING HOUSING STOCK DATABASE SURVEY

INTRODUCTION

This section provides information on the housing stock, and characteristics of the households occupying the stock. The purpose is to identify and provide information that is useful for designing the programme to undertake the retrofits, and to identify any gaps in our knowledge required for the programme.

Information that is likely to be useful, (and reasons for its usefulness in brackets) are as follows:

- Age structure of the stock, by region. (To identify pre-mandatory insulation houses, likely air-tightness, underfloor retrofit potential, hot water cylinder replacement potential).
- Type of dwellings, i.e. stand-alone, semi-detached, terrace housing, apartments. (The retrofit programme may require different measures for different types of dwelling).
- Demolitions/conversions by age group (i.e. what type and numbers of housing will be lost and not require upgrading).
- Breakdown by owner-occupiers, and renters. (Different programmes will be required for owners and landlords.)
- Breakdown by family type, including forecasts, and household income, (retrofit measures may vary depending on the types of family, and affordability).
- How long resident at the current address (enables an estimate of the rate of labelling of the stock if there was mandatory labelling of the house on re-sale.)
- Some cross tabulations where possible, e.g. house age cohort by household income.

The types of required data are in two main categories, physical characteristics of the stock, and occupant characteristics.

PHYSICAL STRUCTURE

Age structure of the stock

The main source for the age structure is the Quotable Value NZ database. It has an 80% coverage of all dwelling units and records age group by decade, floor size, location and a large amount of valuation related data. Insulation is not recorded. QVNZ data is not entirely consistent with recent dwelling building consents. However, the variance is not large, and using various assumptions to scale up the QVNZ data, the distribution shown in Figure 1 is derived.

Dwelling types

The most common dwelling type by far are stand-alone houses, followed by semi-detached houses, see **Table 1**. In recent years multi-storey apartment construction has increased dramatically, but these are still a very small part of the total dwelling stock. Semi-detached houses, and units in 1 or 2 storey blocks are almost all timber framed, and have similar cladding and linings to detached housing. The sustainability measures used in detached houses will generally be applicable to these multi-units, covering about 97% of the dwelling stock.

Figure 1 Dwelling stock by age group

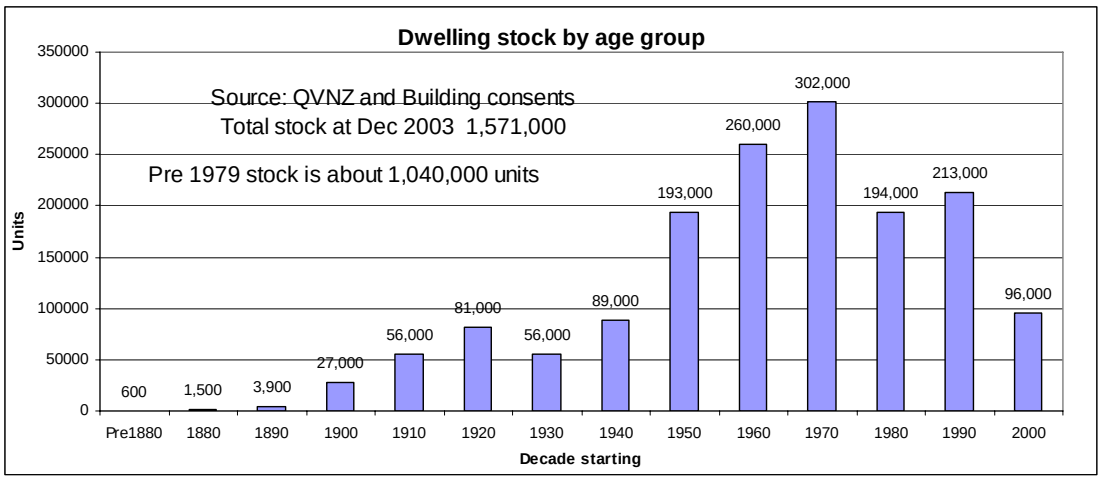


Table 1 Dwelling types in the 2001 census

Dwelling types 2001 census			
	Percentage	% adjusted Dec2003 (1)	Number
Separate house	82.0	82.0	1,288,908
Two units, semi detached	10.4	10.0	156,599
Three or more in 1/2 storey bldg	5.0	5.1	80,106
Units in a three or more storey bldg	1.2	1.7	26,143
One house/unit joined to a business	1.3	1.3	19,754
	100.0	100.0	1,571,510
(1) BRANZ estimate.			

Demolitions

There is no official data collected centrally (i.e. by Statistics NZ) on dwelling demolitions, even though a building consent is required. The BRANZ estimate is about 2,000 units per year, see the Appendix. Another estimate is a lot higher[3], at about 6,000 per year. The age groups of demolition are unknown but they are likely to be older houses rather than newer houses.

Owner-occupiers and renters

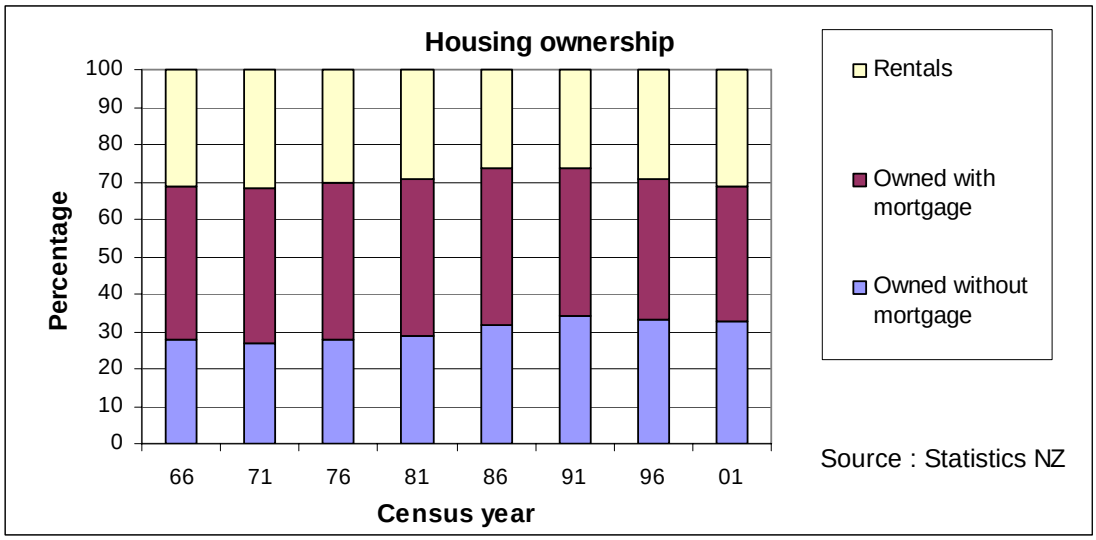
The 2001 census showed that 31.1% of households lived in rented accommodation, up from 26.5% in 1991, see **Figure 2**. Suggested causes for the decrease in ownership are:

- Changing priorities in expenditure by households.
- Delays in family formation.
- Student loan debts.
- Reduction in affordability for first home buyers.

It seems likely that these causes will remain a significant impact on the housing market over the next few years. Hence sustainability measures will need to be tailored for the rental segment, in addition to programmes reaching owner-occupiers. The major rental landlords are Housing New Zealand Corporation (66,000 units), Wellington City Council (2,300), Christchurch City Council (2,800), and other councils (6000). These four account for only 16% of all rentals, and the remaining 410,000 units are privately owned by small landlords, or in small trusts (some community trusts). It is not known what the dwelling age distribution is for rental units.

[3] Johnstone (1994) "The mortality of the New Zealand Housing Stock" – Architectural Science Review Vol 37.

Figure 2 Home tenure



Cross tabulations

There is little information about house age group by occupant characteristics.

Table 2 is from the BRANZ House Condition Survey of 1999 and show average household income against house age group. It indicates that the lower income groups tend to be owner-occupiers of houses built between 1950 and 1979, the main era when housing stock was expanding rapidly for the first home buyers, initially for the returning soldiers from WWII, then in the 1970s for the baby boomers. These houses tend to be of a fairly basic standard and of small to moderate size.

Table 2 Household incomes and house cohort

Household incomes by house age group BRANZ 1999 HCS												
	Percentage											
Decade start	Pre 1900	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	All
<$10,001	0	5	0	0	0	0	3	1	3	5	8	2
10,001-20,000	0	5	9	9	4	11	7	12	3	5	4	7
20,001-30,000	0	5	9	16	8	17	10	16	9	15	4	12
30,001-40,000	13	5	13	12	16	11	13	12	12	15	8	12
40,001-50,000	0	11	3	11	4	9	10	11	8	0	0	8
Over 50,001	75	63	53	47	56	40	45	41	57	58	68	51
Refuse	0	0	9	2	4	6	9	5	7	3	4	5
Don't know	13	5	3	4	8	6	1	1	3	0	4	3
	100	100	100	100	100	100	100	100	100	100	100	100
Number in sample	8	19	32	57	25	35	67	81	76	40	25	465
Average income ($000)	61	52	49	46	52	43	46	43	52	48	53	48

Table 3 shows house and land average value against house age group. It indicates that the houses built between 1950 and 1979 tend to be the houses with the lower valuations. **Table 4** shows house average floor area against the age group, and indicates that houses built between 1930 and 1959 have the lowest floor area. Note that floor areas are from QVNZ records and they usually pick up any subsequent additions which are included in the floor area in their database.

Table 3 House value and house age groups

House capital value by house age group BRANZ 1999 HCS												
	Percentage											
Decade start	Pre 1900	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	All
<$100,001	13	26	28	35	64	63	69	65	45	43	8	3
100,001-200,000	50	47	41	51	28	34	28	33	46	48	54	3
200,001-300,000	13	21	25	12	0	0	3	1	9	5	33	2
300001-400,000	13	5	3	2	0	0	0	0	0	5	4	11
400001-500,000	13	0	0	0	4	3	0	0	0	0	0	1
Over 500,001	0	0	3	0	4	0	0	0	0	0	0	1
	100	100	100	100	100	100	100	100	100	100	100	19
Number in sample	8	19	32	57	25	35	67	81	76	40	24	464
Average house value ($000)	219	170	173	137	130	106	100	108	128	136	189	130

Table 4 Average floor area and house age groups

House floor area by house age group BRANZ 1999 HCS												
	Percentage											
Decade start	Pre 1900	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	All
< 50 sqm	0	0	0	2	4	0	0	0	0	0	0	0
50-99	25	26	22	28	32	51	40	27	29	18	8	29
100-149	38	42	38	46	48	29	34	41	21	45	17	36
150-199	25	16	25	14	12	14	18	21	25	18	13	19
200-249	0	16	6	11	4	3	4	7	18	13	54	12
250-299	0	0	3	0	0	3	3	4	5	3	8	3
300-349	0	0	6	0	0	0	0	0	1	0	0	1
350-399	13	0	0	0	0	0	0	0	0	5	0	1
	100	100	100	100	100	100	100	100	100	100	100	100
Number in sample	8	19	32	57	25	35	67	81	76	40	24	464
Average floor area sqm	156	136	150	127	116	114	123	135	152	154	194	138

CHARACTERISTICS OF THE OCCUPANTS

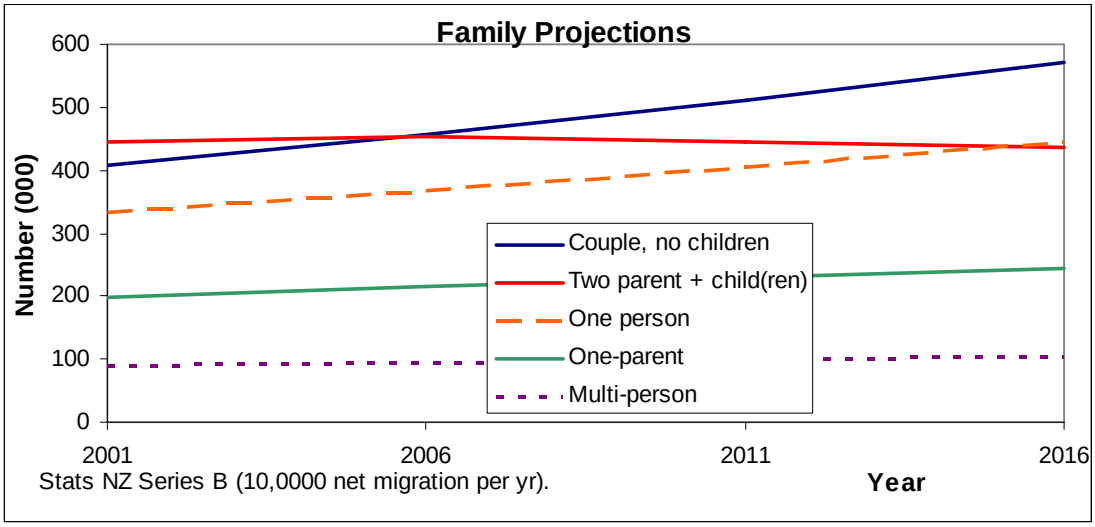
The following characteristics of households are discussed:

- Family type and forecasts
- Household income
- Moving house

Family types

The family types shown in **Figure 3** had the following number of families at the 2001 census; Two parents with children 446,000, Couple-no children 407,000, One-person only 333,000, One parent 198,000 and Multi-person 88,000. The latter are two or more people, not in a couple or parent-child relationship.

Figure 3 Family type forecasts



The forecasts are medium trend forecasts of mortality, fertility, 10,000 net migrations per year, and a medium "living arrangement" trend. The largest growth occurs in Couples, and One-person households, with an extra 164,000 and 112,000 households respectively, between 2001 and 2016. The implications for retrofit are that households with children become a significantly smaller proportion of the dwelling stock, and one person and couple household numbers rise significantly. This means that existing houses will be adapted for the needs of adults rather than children. The types of modifications likely are:

- Conversion of spare bedrooms into other uses (home gym, home offices).
- Additional bathrooms including en-suite for visitors.
- Sub-division of larger existing dwellings into smaller household units.

Household incomes

Household incomes of owner-occupiers are shown in Figure 4 and Table 5. It may be necessary to create different levels of retrofit programmes for the different income groups. Three possible groups are:

- Low income <$30,000 per year, 319,000 households,
- Medium income $30,001 to $70,000, 365,000 households,
- High income >$70,000, 250,000 households.

Figure 4 Household incomes

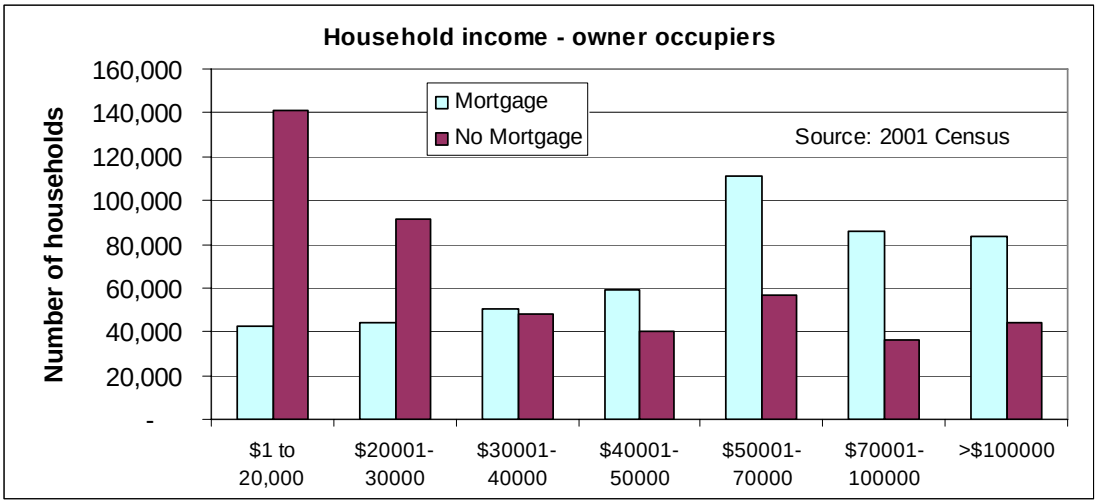


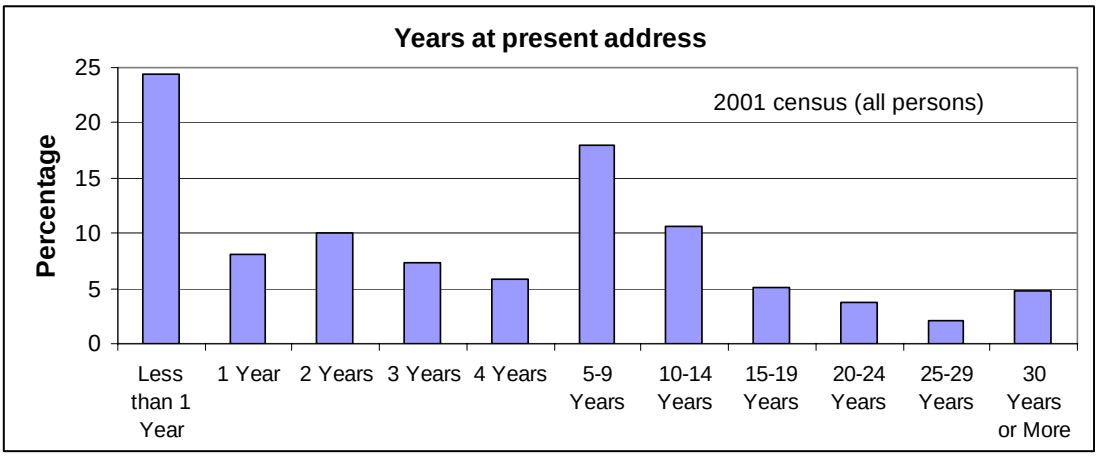
Table 5 Household incomes

Household income of owner occupiers 2001 census					
	Numbers of households				
	$1-30000	$30001-50000	$50001-70000	>$70000	Total
Mortgage	87,128	109,372	110,950	169,296	476,747
No mortgage	232,322	88,702	56,416	80,488	457,927
Total	319,450	198,074	167,365	249,784	934,674

Moving house

The census asks occupants how long they have resided at their current address. The results for the 2001 census are in **Figure 5**, which shows the percentages, by length of stay. Note that the data is for all persons including owners and renters. The largest percentage is for a stay of less than 1 year, and this probably consists mainly of renters rather than owner-occupiers. The average stay for all groups is about 8 years.

Figure 5 Years at current address



Cross tabulations

Table 2, Table 3 and **Table 4** show house age cross tabulated with household income, capital value, and average floor areas. Other tabulations that would be useful are house age with owners' perceptions of sustainability, and with family size and occupiers age groups.

Other

Other work by a co-author has suggested tailoring retrofit packages to various household income groups. Further work could be done on looking at expenditure patterns of different groups, using the Household Economic Survey (the 2004 version is soon to come out). The design of sustainability packages would be guided by current expenditure patterns on house maintenance goods and services by item. This gives some indication of what households already spend and where it may be able to be redirected to sustainable building improvements.

The Ministry of Social Development carried out a survey in 2000 for their economic living standards index survey, see the Appendix. Questions were asked about the problems owners had with their house, as well as full socio-economic data. It is suggested that talks continue with the Ministry on access to the results of their latest survey due in early 2005.

DATABASE SOURCES RELATED TO THE EXISTING HOUSING STOCK

A considerable number of databases are available relating to the existing building stock. The most pertinent databases are summarised below:

Census of Population and Dwellings (Statistics NZ)
The census is carried out every 5 years with the next census in March 2006. SNZ attempt to visit every dwelling and household but it is likely that they miss a very small number. (e.g. derelict buildings that are in fact occupied, SNZ not aware of the existence of some very isolated dwellings, or buildings which appear to be non-residential are in fact residential, sometimes illegally). The data recorded includes:

- Tenure (owner-occupier, rented)
- Dwelling type (separate house, 2 flats, >2 units in one or two storey, >2 units in >2 storeys, bach, etc)
- Number of rooms
- Number of bedrooms
- Unoccupancy status (temporarily away, home for sale/rent/etc)
- The 1976 census asked about wall and ceiling insulation, but not in earlier or subsequent censii.
- Censii prior to 1991, and again in 1996 only (not 2001) asked what type of fuel is used to heat water. Solar water heaters were provided as one option.
- Full socio-economic data about the occupants (family types, income, etc).

Note: No other information is recorded about the dwelling apart from the items above. The age is not recorded, nor size, nor additions work, or the house condition.

Building Consent series (SNZ)
All building work with safety and health implications requires a building consent. Minor maintenance and repairs are exempt. The consents are administered by territorial authorities (TAs), and the information centrally collected and published monthly by SNZ are:

- Contract or work value.
- Consent floor area (for new building only, not alterations/additions consents).
- Building type (for dwellings these are stand alone houses, horizontally attached units, and vertically attached units.)
- Number of units per consent for multi-unit dwelling consents.

The above is available back to the early 1970's. Prior to then limited consent data was published, mainly dwelling consent numbers and total value.

Household Economic Survey (SNZ)
This is a 3 yearly survey next due in late 2004, and before 1998 every year was surveyed in the Household Expenditure and Income Survey. It covers about 3,000 respondents and records expenditure in 7 main groups, Food, Apparel, Transport, Housing, Housing Operations, Other Goods and Other Services. The Housing Group includes:

- Rent
- Mortgage payments
- Payments to local authorities
- Property maintenance goods
- Property maintenance services
- Other housing expenditure.

Under Property Maintenance Goods there are 19 items listed separately for plant, equipment and tools, including power tools and hand tools. There are also 30 items listed separately for hardware and materials, including cement, sheet metal cladding, wood-based sheets, timber, plaster products, reinforcing steel, insulation, etc. This data enables estimates to be made of DIY activity by homeowners. Under Property Maintenance Services there are about 33 items listed separately, including fencing, roofing, re-piling, plumbing, wiring, HVAC, insulation, glazing/double glazing, painting, etc. This provides a measure of the types and amount of work contracted out by the household. At the item level, for maintenance goods and services, the number of household picked up in the survey is quite small, typically 1% to 4%, or 30 to 120 households, so the error margin is quite high. However, the survey does provide estimates of the types of work that household contract out on repairs, maintenance and renovation.

The Housing Operations Group includes expenditure on Fuel and Power, Appliances and Household Equipment, Furniture, Furnishings, Flooring, and Other.
The survey is 108 pages long and has a large amount of detail. Included are the number of appliances/facilities in the household by 29 items, including waterbeds, spa pools, electric night-storage heaters, heat pumps, gas heaters, electric heaters, LPG heaters, wet-back fires, slow combustion fire, open fires, central heating, and a number of whitewear appliances.

Quotable Value New Zealand (QVNZ)
This database has approximately 80% coverage of the existing building stock and is maintained by the crown owned entity QVNZ. QVNZ was previously a Government department and had a monopoly on the provision of data to territorial authorities for rating purposes. Now private valuers are used by some TAs for rating data. QVNZ claims to purchase this data from the other valuers in order to have a near complete record of the building stock. However a comparison of the QVNZ database base and the 2001 census for dwelling numbers is below (adjusted for timing differences). It indicates that the QVNZ database could be short by about 315,000 dwelling units, or about 20% of the total stock unit numbers. The reason appears to be that QVNZ records "assessments" which are usually individual units, but in cases where a house has an attached rental unit in the same ownership only one assessment or unit is recorded. Likewise some purpose-built rental blocks, owned by one person, may be recorded as one unit. Some isolated dwellings, and those that appear to be uninhabited or derelict, are likely to be missed by the QVNZ assessors, whereas the census surveyors go to great lengths to pick up all people in the census and record the house characteristics at the same time.

Table 6 QVNZ and 2001 census dwelling numbers

Comparison QVNZ and 2001 Census

	Number of units		Census adjusted	
	QVNZ	2001 Census	to Dec03	Ratio
Houses	1,019,842	1,236,785	1,293,485	0.79
Flats/ apartments	235,444	265,225	278,025	0.85
	1,255,286	1,502,010	1,571,510	0.799

Note: QVNZ data is to Dec 2003

They also publish data on urban property sales by half year, including numbers by house, ownership flat, and purpose built flat, all by region and age cohort.

Despite the shortcomings, the database is the best record of a wide variety of data on NZ housing. The QVNZ database includes:

- Address
- Owner
- Age of original building.
- Floor area (including additions)
- Building footprint area
- Section area
- Wall cladding type (6 categories) and condition (Good, Average, Fair, Poor, based on Valuers judgement using QVNZ criteria)
- Roof cladding type (7 categories) and condition (as for walls).
- Improvements Valuation
- Land valuation
- Overall quality (3 categories, Upper, Standard, Basic, based on the Valuers judgement using QVNZ criteria).

BRANZ House Condition Surveys
Two surveys have been done, in 1994 and 1999. A third survey is to start at the end of 2004.
Approximately 405 and 460 houses of owner-occupiers were surveyed in consecutive surveys, carried out in Auckland, Wellington and Christchurch. Houses were chosen randomly from the QVNZ database and the survey house age structure is approximately representative of the total housing

stock. However there may be some element of self –selection (toward better condition houses). The survey records:

- Building component (approximately 26 components) condition and type of materials.
- Floor area by level. Number of rooms/bedrooms/bathrooms.
- Grade, size, fuel, age, wraps, temperature setting of the hot water cylinder.
- Wet area fittings (bath, shower, heaters, heated rails, vents, etc.).
- Type, coverage and thickness of ceiling insulation.
- Presence of wall and underfloor insulation.
- Types and fuel of space heating.
- Fire safety equipment.
- Socio-economic data of the household (family type, incomes, ages, etc)

BRANZ housing forecast demographic model

The forecast model is in **Table 7** below. It is included because it provides an estimate of demolition rates based on the dwelling stock taken at the 5 yearly census intervals, and the number of building consents issued over the same periods. The formula is:

Dwell Stock (T) = Dwelling Stock (T-5) + Consents (5 year period) – Demolitions (5 years).

Hence:

Demolitions (over 5 yrs) = Stock (T-5) – Stock (T) + Consents (over 5 years). **Table 7** indicates a varying rate of demolitions between censii, including negative numbers. The latter may arise due to errors in counting the stock. The demolitions calculation uses the difference between two large stock numbers and a small error in either will cause large errors in the demolition estimate. However, over several censii this error will be less and the Table indicates an average demolition rate of about 1,000 per year since 1976.

Table 7 Demolition estimate in the BRANZ demographic housing model

New dwelling demographic model

Updated August 2004

Census year	76	81	86	91	96	01	06 (4)
Occupied Private Dwellings (1)	923,200	1,005,489	1,088,598	1,177,662	1,276,329	1,359,843	1,521,439
Unoccupied dwellings (1)	84,600	97,116	107,532	122,712	113,388	147,435	123,360
All Private Dwellings	1,007,800	1,102,605	1,196,130	1,300,374	1,389,717	1,507,278	1,644,799
Unocc dwell as % of stock	8.4	8.8	9.0	9.4	8.2	9.8	7.5
Dwelling consents (5 years) (2)	157875	108922	96911	103597	98541	115919	142521
Average consents per year				20719	19708	23184	28504
Demolitions per year (3)		2823	677	-129	1840	-328	1000
			Demolition average per year 1976 to 2001 =			976	
Usually Resident Population (1)	3,088,700	3,132,800	3,262,397	3373926	3618303	3737277	4,135,750
Population growth %pa		0.28	0.81	0.67	1.41	0.65	2.05
Persons per Occupied Dwelling	3.346	3.116	2.997	2.865	2.835	2.748	2.718

(1) Source: Statistics New Zealand
(2) Number of consents for the five years to the September proceding the census.
(3) Derived from the proceding rows: Demolitions (t) = (Stock(t-5) - Stock(t) + Consents(5 years))/5.
(4) BRANZ forecasts.

Main assumptions in the model are marked by a box=

Household Energy End-use Project (HEEP)

Now in its seventh year this project has extensively monitored energy use in 260 randomly selected houses plus another 81 selected houses in pilot studies. When complete in 2005 a total of approximately 400 randomly selected houses will have been monitored. Data includes:

- Space heating energy use and temperatures.
- Water heating energy use and temperatures.
- Appliance types.
- Hot water cylinder types and ages.
- Insulation types and coverage.

- Energy efficiency measures (efficient lights, pipe lagging, weather stripping, solar water panels, passive solar design, double glazing, etc).
- Socio-economic details of the households.
- House characteristics (floor type and area, cladding materials, windows sizes, orientation, etc)

Statistics NZ Housing Survey
This survey is currently being developed and it has not yet received approval to proceed. Preliminary planning is for an annual survey to record physical conditions of housing, and other physical attributes. It is being developed under a hierarchy of programmes starting with the Social Statistics Programme, the Housing Statistics Strategy, and the Housing Indicators Project. The survey will measure among other topics; physical condition of housing, room size, housing career patterns, and suitability of housing. The survey is at least a year away from implementation.

Economic living standards index survey (Ministry of Social Development)
The MSD survey was undertaken in early 2000, to assess living standards of a cross section of the population. Over 2000 people were surveyed. Extensive socio-economic data was collected. An accommodation section in the survey asks whether the occupant has any problems with draughts, dampness, plumbing, wiring, paintwork, windows, doors, roof, and foundations (nothing on insulation). This survey is expected to be repeated this year.

Demographic trends (SNZ)
This is an annual publication of demographic forecasts for various scenarios of fertility, mortality, and migration, with regional and TAs breakdowns. Forecasts of household formation by family type are available on request.

Population and Sustainable Development 2003
This publication is from Statistics NZ, Ministry of Economic Development, Department of Labour, and Ministry of Social Development. It identifies issues relating to the changing demographics, including aging, ethnic mix, and family types.

Centre for Housing Research
The Centre has published a number of reports on the housing market. The most useful is DTZ New Zealand (2004) "Changes in the structure of the NZ Housing Market, Volumes 1 and 2." It includes a range of data from official sources, namely Statistics NZ, on the housing stock, prices, rents, occupants, and limited data on the supply side, i.e. the building industry. The vast majority of the data is from other sources, and identified above, and there is little original analysis or interpretation. Data from the report that may be useful for retrofit includes:

- Building firm sizes.
- House price affordability (AMP affordability indices).
- Housing stock by region, age group and floor size (QVNZ data). Note that QVNZ data covers only 80% of the stock.
- Housing condition (BRANZ HCS).
- New house cladding types (BRANZ materials survey).
- Home tenure by region.
- Owner-occupier households by family type.
- Rented houses by household income, and age group.

Another publication is BERL (2003) "Review of statistical housing data", which identifies data in seven categories; affordability, suitability, habitability, tenure, security, crowding, and discrimination. Again the data relevant to sustainability retrofit has been identified above.

RETROFIT MARKETS

INTRODUCTION

This section of the report provides an overview of the existing knowledge regarding the retrofit market in New Zealand. The purpose of this overview is to enable Beacon to identify market potential in this sector and to convert this potential into a programme of work which will meet the Beacon targets for this sector.

Existing information available in New Zealand was sourced, gathered, analysed and interpreted and a gaps analysis undertaken.

The information gathered has been organised in three sub-sections, the physical context, the human context and the market potential.

The physical context describes the nature of the buildings undergoing retrofitting and the scope and the value of the work undertaken.

The human context examines the characteristics of the groupings of the people who undertake retrofits and their motivations.

The third sub-section brings these factors together and identifies **market potential** by an examination of opportunities, barriers and suggested ways of overcoming these barriers. It also seeks to identify gaps in the information currently available, what the implications are of these knowledge gaps and whether and how they might be filled.

THE PHYSICAL CONTEXT

General

The definition of the word 'retrofit' is quite fundamental to this section of the report. It can be liberally defined as 'any work carried out to a house subsequent to its completion' or narrowly as 'work undertaken to improve the original performance of the house' or in an even more focused way connected with the particular Beacon context as 'work undertaken to improve the sustainability performance of a house subsequent to its completion'. This report chooses to operate with the most liberal interpretation, but seeks to comment on aspects which relate to the narrower definitions.

The nature of buildings currently undergoing retrofit

Information on the value, age, household income and housing types is given in Section 2 of this report. Certain inferences can be drawn from this data which specifically relate to the retrofit market in NZ.

Only 89,000 houses built prior to 1920 remain in New Zealand. These houses, certainly those built before 1914, tend to be well built using native heartwood hardwood timber for frame, floors, roofs, interior walling, wall cladding and built-in fittings. Clay roof tiles and corrugated steel are the dominant roofing materials. These houses are, on average, larger than those built in New Zealand for the next 50 years. Skilled labour was available and the houses that remain from this era tend to be some of the best of their kind.

Anecdotal evidence suggests that the ownership of these houses is polarised with some being in the hands of relatively wealthy owner occupiers and others in the hands of private landlords. The relative proportions of ownership are unknown. It is known that the average household income for owners is higher than that for houses built during the next 50 years. Anecdotal evidence suggests that owner occupiers in this category tend to maintain their houses well and can afford to carry out extensive upgrading. These houses are popular with private landlords because they can accommodate many

tenants. Worldwide, private landlords tend to carry out the very minimum amount of maintenance and only mandatory performance upgrades. It does not seem likely that New Zealand will be different from the rest of the world in this respect, but little research has been carried out to support this subject in NZ.

Houses built after the1914-1918 War, while using similar materials to the pre-war era, were generally smaller and less well built, due to a shortage of skilled labour and materials. There were also fewer people and therefore less demand and people were on average poorer. This situation was prolonged by the Depression era and Second World War.

By the 1960s our stocks of NZ native timber were depleted and we were using an increasing amount of treated radiata pine. From the late 50s/early 60s, an increasing proportion of man-made materials or chemicals were included in houses. A number of these materials are now known to be inimical. Early timber treatments such as PCP are now recognised as being hazardous and the debate about the danger to workers, and of the leaching of these chemicals and their later chemical replacements into the ground, is ongoing. Treated timber releases toxic gas when burnt. The particleboard flooring that gradually took over from timber board flooring was formulated with high levels of urea formaldehyde glues. Offgassing of formaldehyde took place during laying and for some period after laying of the particleboard. Formaldehyde is a known carcinogen and chemical sensitiser. Most of the formaldehyde will have dissipated by now, but if the boarding has been painted then it can be released during disposal. Houses were generally painted using lead based paints which are hazardous to remove. Asbestos based products were used extensively from the 1950s onwards for floor tiles, ceiling tiles, external soffits and roofing. Lead plumbing has now largely been replaced but there is still a significant amount of lead solder jointed copper plumbing which is also regarded as inimical. **All of these materials are recognised as being hazardous and are costly to remove and dispose of properly during retrofitting.**

Houses built in the 50 year period 1920-1970 are smaller and have a lower average valuation than those built before or after that date. They are also occupied by people with lower but not drastically lower average incomes. Logically this might be expected to translate into identification of a large group of houses (302,000) which have a greater potential for retrofit than other houses. But there is no certainty concerning this supposition, as there is a lack of information which correlates the quality or performance of a house with income, house size or age of occupants. It may well be that such houses have a significant occupancy of singles, young couples and older people without children. The former group may not have a great deal of money but may have undertaken considerable DIY upgrading, while the second group may be downsizing and have retrofitted their house for a comfortable retirement. **We just do not know, without undertaking some targeted research in this area.**

The biggest numbers of new houses (755,000) were built during the 30 year period from 1950 to 1980 due to the combined effects of immigration policies and baby boomer families. Only in the years after 1970 do we see the average house size equating with the size of those houses built before 1920.

In the 1990s the average new house size was 189m² compared with 100m² in the 1960s. This increase in house size and floor area per person is a worldwide trend in affluent economies. The implication is that more resources, material, energy and water, are being deployed per person than in previous times. **This is a trend that Beacon needs to recognise and combat if Beacon's targets are to be achieved.**

Since the implementation of the 1991 Building Act in 1992 a greater variety of materials and building systems have been introduced into the new house market in NZ. While some have been successful, the combination of monolithic wall cladding with untreated timber, water absorbent thermal insulation, overly complex detailing, a de-skilled labour force and an absolute focus on minimising first costs has lead to some spectacular wall cladding failures. The biggest volume of such failures have occurred in Auckland in multi-unit housing and high end 'Mediterranean' style single family homes, but Wellington, Christchurch and other parts of the country have not been immune to such failures. While there is a major amount of retrofit work connected with overcoming these failures, the work will generally be funded only at a level which ensures compliance with the original performance targets and will not permit performance upgrading. In other words we are talking about restoration rather than improvement. Most of the houses concerned have been built within the last decade and it seems

unlikely that, once their weathertightness problems have been solved, further money will be spent on these houses, on a voluntary basis, for a number of years**. The biggest effect on Beacon of this situation may well be a negative one, namely the diversion of retrofit resources, both money and skilled workers, from the Beacon programme.**

One of the findings of the Parliamentary Select Committee report on Weathertighness was that an increasing percentage of houses were being built down to a first cost rather than up to a standard. Another was that durability, operating costs and maintenance costs were not of primary concern to most people in the Building Industry. We know that many houses have been designed and built to satisfy the absolute minimum requirements of the Building Regulations. It is well known that New Zealand homes of all ages require a great deal of maintenance and that there is a substantial amount of ongoing deferred maintenance in NZ[4]. An increasing number of New Zealanders are however selecting low maintenance envelope claddings, such as brick veneer and on grade concrete slab floors, if they have a choice.

Anecdotal evidence has long indicated that many older NZ houses are too cold and damp in the winter. The NZ population tends to have very high rates of asthma and other allergenic related illnesses and the contention is that these are house related. Heating of these houses is a major issue, both in terms of health and high energy usage. There are some 200,000 flueless gas heaters in use in NZ and these are thought to be a major source of indoor air pollution and moisture. The Wellington School of Medicine, which is part of the University of Otago, is currently carrying out a series of research programmes in this area. Early indications are that the evidential research supports the anecdotal contentions.

Water conservation has not been an issue where reticulated water supplies were available until the mid-1990s, when a series of draughts led to severe water restrictions being put into place in some parts of the country. Very few NZ homes incorporate water saving features. Single home water metering and charging is still the exception rather than the rule. Information on water saving measures in place is not collected centrally and is not required for Building Consent purposes.

Shifts in Housing Demand

Over the past 25 years, increased demand for extended family accommodation, delayed child bearing, the increase in divorce, remarriage and merging of family groups, and an ageing population have all contributed to a greater diversity of family types and living arrangements. The trends towards changing lifestyle preferences and needs, growing household diversity and labour market flexibility are likely to continue. The typical suburban home of the 1940s to 1970s was designed to meet the needs of nuclear families consisting of a husband, wife and two or three children. This means that the composition of a significant portion of the housing stock may not match the needs of current users.

From 1992 to 2003, annual increases in the total population varied between 21,000 and 69,000. Net migration was largely responsible for this fluctuation, removing over 10,000 people in the year of peak net outflow (1999) and adding nearly 42,000 in the year of peak net inflow (2003). This change reflects lower numbers of young people moving overseas, overseas students coming to New Zealand, New Zealanders returning to live permanently and new immigrants.

Housing demands are therefore changing in terms of size, planning and tenure type, with reduced home ownership, leading to an increased private rental market and more inner-city living.

The scope and value of retrofit work undertaken

General

In terms of the liberal interpretation of the word ‘retrofit’ adopted in this report, retrofit includes every kind of work on existing houses from decoration, through maintenance and repair, to restoration, renovation and rebuilding. It includes both consented and non-consented work. Consented work includes addition and alteration work in this context and may include restoration, renovation and rebuilding work. Non-consented work includes decoration work, repair or maintenance or work not covered by the NZBC. Both non-discretionary and discretionary spending is included in the liberal

[4] BRANZ House Condition Surveys 1994 and 1999

definition of retrofitting. Non-discretionary spending refers to work that has to be done, such as repairs and maintenance. Discretionary spending includes all other work including sustainability related performance enhancements. Discretionary spending may well be curtailed or delayed due to non-discretionary spending.

Renovations/Home Improvements

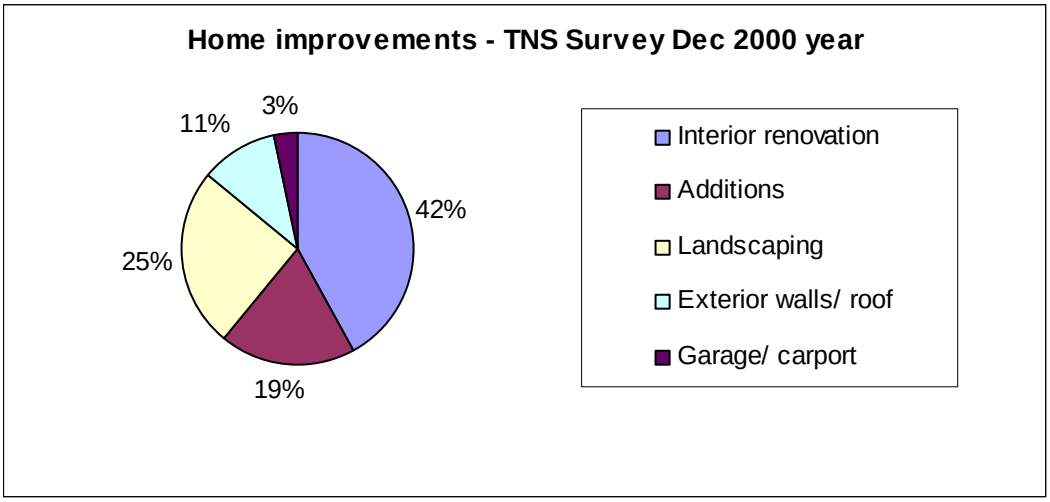
The three main sources of data on renovations and additions are building consents, the BRANZ Dwellings Alterations and Additions (A&A) survey, and the TNS Home Improvements Survey. TNS (Taylor Nelson Sofres Pty.) is a global market research company with headquarters in London. Building consents (from Statistics New Zealand) cover structural and health related work, and few details are provided. The BRANZ survey provides more details on consented work and covers 450 additions/alterations per year. The TNS survey is undertaken every two years and questions 2,000 homeowners on home improvements work (if any, i.e. decoration, additions, fencing, paths work) undertaken in the previous 12 months.

TNS Home Improvement Survey

This is a biannual survey of approximately 2,000 homeowners on types of renovation, additions, landscaping and other outdoors section work. This was formerly carried out by NFO CM Research Ltd. It has been undertaken since about 1985. Approximately 22 categories of work are reported, including insulation retrofit and the room types renovated. The value of improvements, renovations and additions, and the socio-economic details of the responding households are available.

The TNS survey picks up non-consented work (decorations, kitchen/bathroom renovation, outdoor landscaping, building maintenance and repairs, etc.), as well as consented work such as additions. TNS estimate that the total home improvements market is about five times the consented A&A market, i.e. about $5,300 M or similar in size to the new housing market. Approximately 60% of respondents said they had undertaken home improvements in the previous 12 months. The average expenditure of those doing improvements in the 2000 survey was $8,100 per year, significantly lower than the BRANZ survey, because TNS pick up minor non-consented work such as painting, decoration, repairs, and landscaping. For all owner-occupiers (including those doing no improvements) the average was about $5,500 per year. In comparison the Household Economic Survey (HES) of 2001 indicated the average expenditure by all owner-occupiers on property maintenance, tools and equipment, decoration and consented alterations and additions was about $4,100 per house. It is not known why the two surveys differ since they were both quite large, about 2,800 respondents for the HES and 2,000 for the TNS survey. However the HES, carried out by Statistics NZ, is likely to be more accurate but, unlike the BRANZ and TNS surveys, it does not provide a type of work breakdown.

Figure 6 Home Improvements (consented and non-consented work)



One conclusion that can be drawn from the TNS data is that interior renovation is larger than additions work and that if sustainability measures can be promoted to all the renovations segment, as well as the additions segment, the market size is about $3200M (i.e. $5300M x (42%+19%)), or three times the size of the consented A&A market.

BRANZ Materials Survey of alterations/additions to housing.

Table 8 Retrofits during house additions – BRANZ Survey

Percentages		
	Percentage incidence	
	Pre 1950s	1950s to 1970s
No retrofits	9	14
Ceiling insulation	38	37
HWC wrap	13	14
Energy efficient lights	4	6
Draught stripping	9	8
Underfloor insulation	0	2
Solar water heater	0	2
Low flow shower	2	4
Dual flush toilet	26	14
	100.0	100.0

(Sample size is 98 houses, and these numbers will increase as more quarterly surveys are done).

This survey has been underway since 1998 and covers approximately 450 consents per year for alterations and additions to dwellings, in selected TAs spread across New Zealand. It is a postal survey to builders and designers and is sent out every quarter. Data recorded includes additions and alterations, values, and the floor area of the additions. Incentives are offered for the survey return and a response rate of about 25% is achieved. Types of materials used as flooring and claddings are recorded. Recent surveys have included questions on types of energy efficiency retrofits in the existing house.

Building consent data is given in **Figure 7**, and the BRANZ survey breakdown of additions is shown in **Figure 8**. The value of consented A&A work is about $1050M per year, compared to new dwellings work at $5,600M per year. The Figures indicate most A&A work is additions (78% or $820M) or about 15% of new dwelling work, representing a small but not insignificant market for installing sustainability features.

Figure 7 Alterations and additions consented work

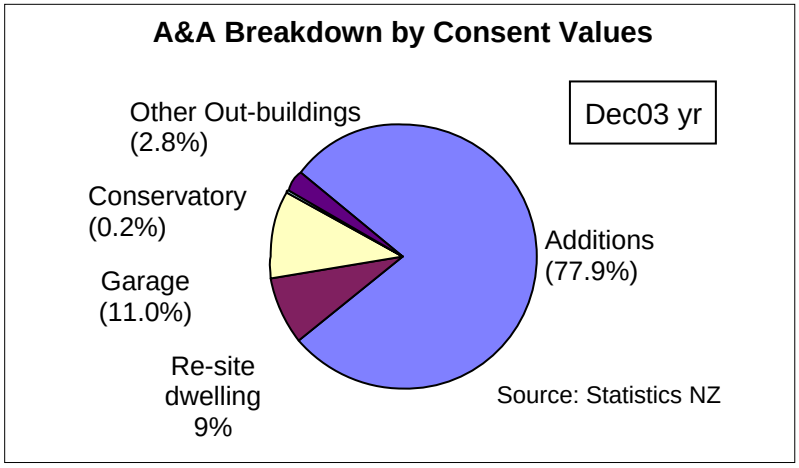
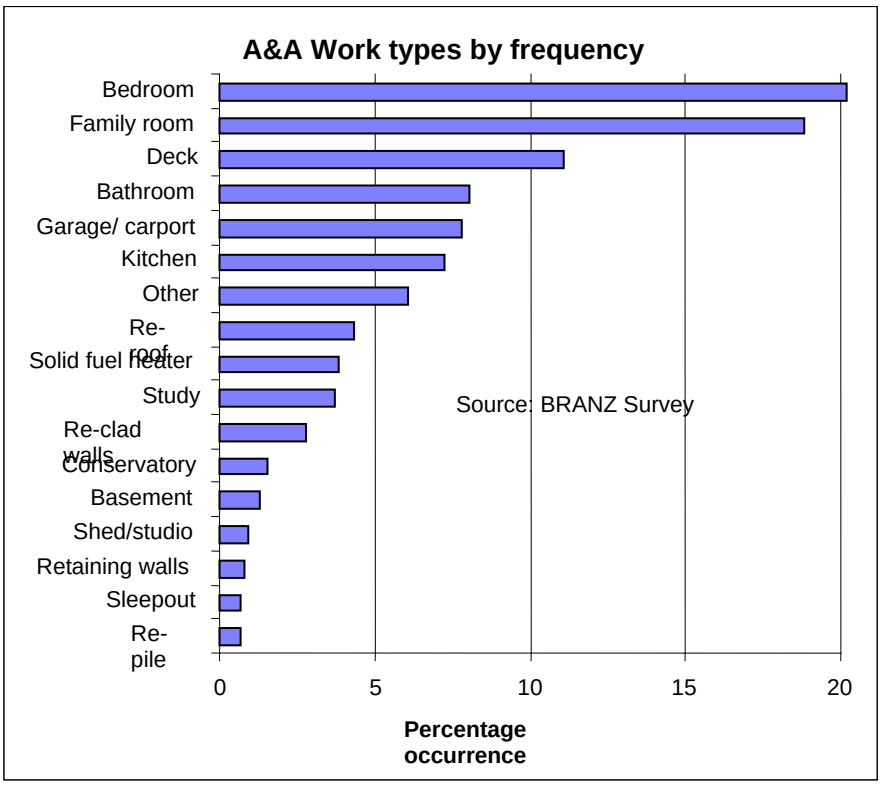


Figure 8 shows a more detailed breakdown of consented A&A work. The percentages are by the frequency of work type, not by work value. In 2003 the average expenditure by respondents to the BRANZ A&A survey was $48,000. Most activities provide an opportunity to install sustainability measures during the work.

Figure 8 Types of A&A work – BRANZ Survey



Sustainability Related Retrofits Already Done

In 1979 ceiling, wall, and underfloor (foil) insulation in new housing became mandatory (the NZ standard was dated 1978). The BRANZ House Condition Survey (HCS) of 1994 (sample size 402 houses) recorded the type of ceiling insulation, and the 1999 survey (465 houses) also recorded incidence of double glazing, underfloor insulation, air-tightness, solar water heaters and age of the water heater. The main finding was that about 63% (average of the two surveys) of pre-1979 houses

have been retrofitted with current code levels of insulation in the ceiling, i.e. about 651,000 pre-1979 houses. The remainder, 382,000 houses, have nil or inadequate ceiling insulation. In the 1976 census, the only census in which ceiling insulation was surveyed, the incidence was 7%, or 68,700 houses. This data gives a retrofit rate between 1976 and 1999 of about 25,000 houses per year.

Less than 1% of houses had been retrofitted with sub-floor insulation in the 1999 HCS survey. Two houses (0.4%) in the survey had solar hot water panels, but the percentage has a large error margin due to the small numbers involved. A more accurate estimate is the 1996 census when the number of houses with solar water heaters[5] was 10,900, a rate of about 0.8%. By December 2003 the number was estimated[6] to be 22,000 or 1.4% of the housing stock.

In 1999 the incidence of double glazing in the HCS for all houses was about 2%, almost all in the South Island. The Insulated Glazing Manufacturers Association surveys[7] of new housing indicate a rate of 69% in the South Island, and 6% in the North Island.

A number of Utility Companies and Trusts have also initiated programmes to improve the energy performance of some existing houses. Generally these aim to help low income households.

Typical of these initiatives is the recently announced Powerco programme to help with the upgrading of 250 homes in the Manawatu. Eligibility for consideration for inclusion is that applicants must be holders of a Community Services Card. Eastern Bay Energy Trust has invested $3.8 million to retrofit 4,000 houses with insulation to minimum building code standards[8]. The retrofits included ceiling insulation, weather-stripping, V-seal and door draught barriers, moisture barrier ground sheets, cylinder wraps and hot water cylinder wraps and hot water pipe lagging.

Cost of Retrofitting

There are a significant number of energy related retrofit measures that are typically low cost such as: cylinder wraps and hot water pipelagging; weatherstripping and draughtproofing; low flow water fittings and dual flush cisterns when replacement is necessary; compact fluorescent light bulbs; reused components and materials; undercover laundry line; heat transfer ducts; mechanical moisture extraction from moist areas. These can make a real difference with a quick payback and minimal cost outlay.

Other retrofit performance enhancements are more expensive but can result in even greater health improvements and energy, water and resource savings. These include, replacement of flueless gas heaters; ceiling, underfloor and exterior wall thermal insulation; underfloor moisture barriers; heavy, sealed curtains with thermal linings; heat recovery systems for water and airborne heat; solar water heating; replacing worn out appliances with energy and water efficient equipment; glazing enhancements (energy management glass, double glazing, double windows); use of sustainable and healthy materials and finishes during renovation.

See Appendix for further information.

Government Interventions

The New Zealand Housing Strategy

A 2004 discussion document, Building the Future: Towards a New Zealand Housing Strategy, by the Ministry of Housing and Building[9] represents the first time in a number of years that government has set out a proposed framework for addressing key housing policy issues of today, as well as anticipating future needs. The strategy relates to both new and existing houses.

According to the discussion document, housing and housing markets have had an increasing impact on many New Zealanders over recent years. There have been growing concerns about the rising cost of housing, and the risks involved for households that bear increasingly high levels of debt. Concerns are being expressed that young people and lower income households are finding it harder to buy their

[5] Pollard (2003) Solar Action Bulletin, Porirua.
[6] EECA (2004) "Renewable energy – Industry status report. " East Harbour Management Services.
[7] Burgess (2004) "Double glazing in New Zealand – BRANZ Report DC0836".
[8] Bay Weekend. 10 July 2004
[9] http://www.hnzc.co.nz/nzhousingstrat/NZHS-DiscussionDocument.pdf. April 2004

own home and that the home ownership rate has fallen as a result. Others have been affected by problems related to housing quality, such as poor weathertightness, or sub-standard housing in rural areas.

The vision for the New Zealand Housing Strategy is that all New Zealanders have access to affordable, sustainable, good quality housing appropriate to their needs. The discussion document proposes a broad approach to achieve this vision and produce lasting, positive housing solutions for families and communities.

The strategy calls for a wide ranging review of government policies in the housing sector, several of which could have an influence on Beacon and in particular the retrofit market. These include:

- Discussing how to determine the most effective mix of housing assistance, and whether there are more innovative ways of addressing housing need.
- Examining whether more needs to be done to promote the ability of New Zealanders to buy their own homes, and how to better support and regulate the private rental sector to deliver good housing.
- Dealing with housing quality, and the concerns that have been raised about construction quality and the level of sub-standard rural housing.
- Reviewing how well the housing sector is placed to respond to the housing issues of today and the future.

The New Zealand Housing Strategy provides a vision and strategic direction for housing for the next 10 years. The final New Zealand Housing Strategy is due for release by the end of 2004. **This may provide an opportunity for Beacon to provide input into the ongoing development and implementation of this strategy to support the realisation of the Beacon targets.**

Government Actions to Improve Housing Quality

Government appears to be primarily concerned with issues regarding sub-standard housing, quality of infrastructure (sewerage and drinking water), and addressing inequality in the housing sector amongst vulnerable populations such as Maori, Pacific, and the elderly. National Energy Efficiency and Conservation Strategy (NEECS) and the baseline housing standard for New Zealand may lead to specific actions around retrofit.

The following retrofit related actions are proposed or are underway by the New Zealand Government or related agencies to improve the quality of New Zealand's housing.

- Housing New Zealand Corporation[10]**.** Continue the current programme of modernising state housing stock and undertaking energy efficiency retrofitting.
- Energy Efficiency and Conservation Authority. Continued support for the introduction of solar water heating and improve thermal insulation and infiltration control standards in existing housing.
- Centre for Housing Research, Aotearoa New Zealand (CHRANZ). This is part of Housing New Zealand. It is ccommitted to investing in and promoting housing research that provides an evidence base for policies and practices that meet New Zealand's housing needs.
- Housing New Zealand Corporation and the Ministry of Social Development. Continue to implement the five-year Rural Housing Programme to eliminate sub-standard housing in Northland, East Coast and Eastern Bay of Plenty.
- Ministry of Housing and Building. This ministry is currently undertaking a review of the Residential Tenancies Act 1986 to strengthen the provisions of the Act relating to the quality of rental housing. **This provides an opportunity for Beacon to make submissions**.

EECA residential retrofit funding programmes

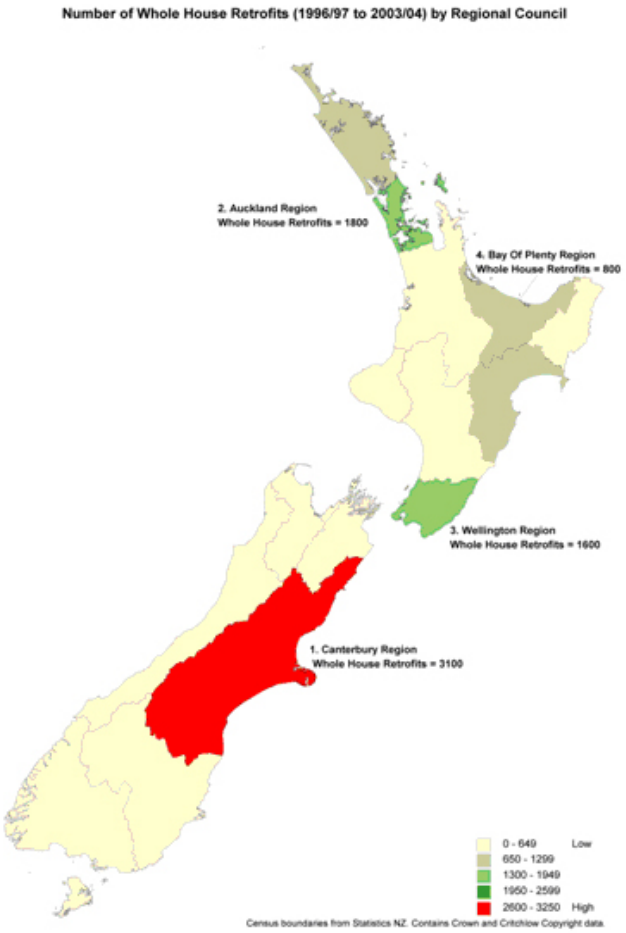
EECA has operated a number of schemes since 1996, to subsidise energy efficiency retrofit measures installed in existing housing. The common measures are ceiling and underfloor insulation, cylinder wraps, energy efficiency lights, pipe lagging, weather stripping, and low flow shower heads. The number of houses retrofitted and funded by an EECA subsidy under the Energy Saver Fund and the EnergyWise Home Grants schemes is approximately 12,000 whole house measures (defined as ceiling and underfloor insulation and draught-stopping of doors). A variety of other measures

[10] http://www.hnzc.co.nz/chr/pdfs/CHRANZ%20Vol%201%20FINAL.pdf

(including cylinder wraps, energy efficient lights, low-flow shower heads, and solar water heaters) have also been funded and can be located into regions. EECA has provided a breakdown by regional council, as shown in the map below, but they advise some work is required on the data for the earlier years, as it is believed some grants are missing from the database. Due to recent funding boosts announced in the 2004 budget EECA expect to subsidise 6,000 schemes in the current financial year. Funding will come from central government with matching funding from community trusts, energy companies and councils. The grants are only available to organisations that install insulation and other energy efficiency measures in older homes.

Running in parallel with the EnergyWise Home Grant Scheme there is also an EnergyWise Solar Water Heating Grant scheme. This programme has been operated since 2002. In the 2004 budget funding was provided to subsidise the installation of up to 444 extra solar water heating schemes (subsidy $450 each) in low-income family houses. EECA estimate that about 2000 unsubsidised solar water heating systems are installed annually at a unit cost of between $4000 and $7000 each. This scheme applies equally to new and existing homes.

Figure 9 EECA funded retrofits by region



EECA have undertaken scenario work for ceiling insulation retrofits, as shown in **Figure 10** below. The red area represents pre-1979 houses plus a percentage range (5% to 15%) of post-1978 houses that have inadequate ceiling insulation (i.e. insulation not placed as required). The BRANZ HCS in 1994 and 1999 indicate that 20% of post-1978 ceiling insulation was inadequate (including partial coverage only, R-values inadequate, nil insulation, and poorly fitted insulation). The newer post-1978 houses generally have better ceiling insulation than older post-1978 houses, however even some new houses have non-code compliant insulation.

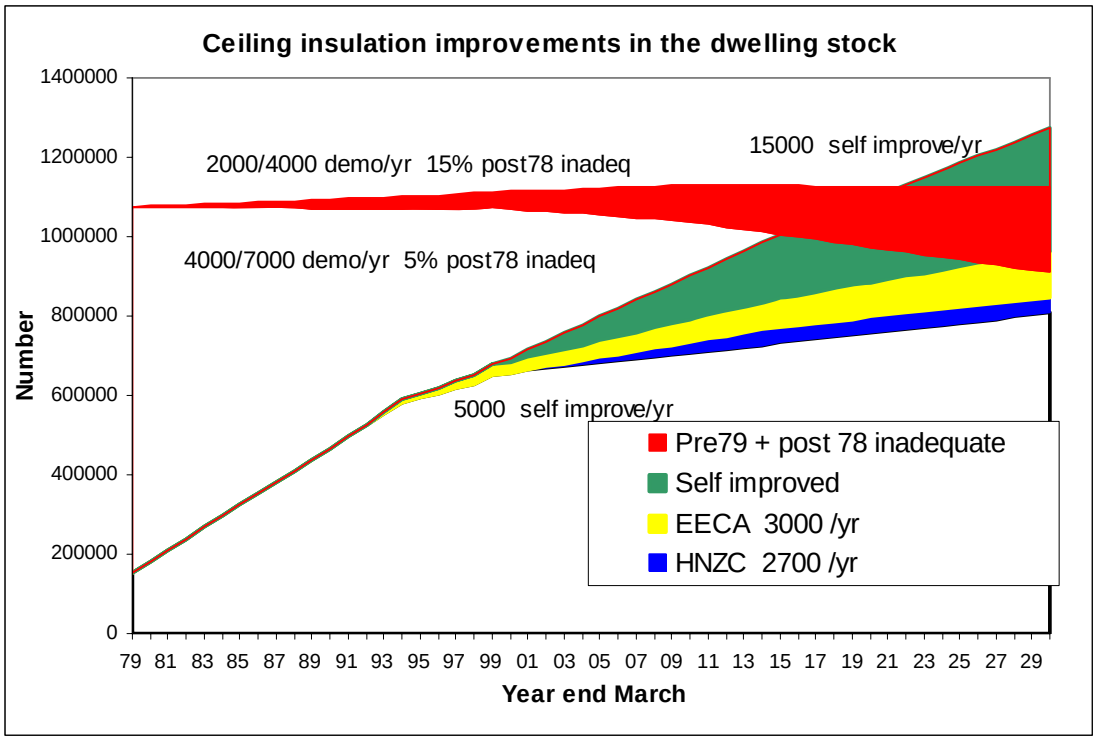
Various rates of demolition of pre-1978 houses are considered (2,000 to 7,000 per year). The lower part of the chart shows the numbers of retrofitted houses. The brown line is the number of the total stock that has been retrofitted, based on BRANZ survey results. The green, yellow and blue spaces represent various rates of retrofit by EECA funding, HNZC stock upgrade, and voluntary retrofit by private houses (5,000 per year to 15,000 per year). The chart indicates:

- With low demolition rates (2,000 per year) and a high defect rate in post-1978 houses (15%), plus EECA, HNZC, and a low self-improvement rate (5,000 per year), it is not until after 2030 that all houses are upgraded.
- With high demolition (7,000 per year) and a low defect rate in post-1978 houses (5%), plus EECA, HNZC, and a high self improvement rate (15,000 per year), it is about 2014 that all houses are upgraded.

The EECA model enables various parameters to be changed in order to see when the demand and supply lines cross (as represented by the red and green spaces).

It may be useful to develop a similar model for the Beacon programme.

Figure 10 EECA ceiling insulation retrofit model



HNZC retrofits

The Housing New Zealand Corporation (HNZC) has retrofitted about 11,000 units out of their stock of 66,000 units. They have a programme of approximately 2,500/2,700 retrofits per year.

THE HUMAN CONTEXT

Benefits

Benefits accrue in three distinct areas, health, resource and economic sectors. In each case there are public, owner and occupier dimensions.

Health Benefits

The commonly held belief, that many houses in New Zealand are cold, damp, mouldy and draughty, is currently being investigated and tested in a series of research programmes being undertaken by the University of Otago's Wellington Medical School. Three programmes are underway:

- A Housing, Crowding and Health Study
- An Insulation and Mould Study
- A Home Heating Study

These are long term research programmes and results are not yet available. However, some tentative preliminary results have been released relating to the Insulation and Mould Study:

- Overall, there was a small, but statistically significant, drop in energy usage when houses were insulated.
- Overall, once the houses were insulated, they were drier and slightly warmer.
- People in the insulated houses reported that their houses were significantly warmer.
- There was a significant improvement in the self-reported health of adults and children living in the houses that were insulated, compared to those whose houses were not yet insulated.
- Adults and children in the insulated houses reported visiting the GP less. The decrease in the number of visits was significant for the adults.
- Adults and children in the insulated houses reported that they were admitted to hospital less often for respiratory conditions.
- Adults, who were in the workforce and in insulated houses, were significantly less likely to report sick days off work, and children in these houses were less likely to have had days off school.
- Samples of normal household dust were collected in three of the communities and examined for allergens and mould. All houses had mould, but the amount and species varied a lot. Insulating the houses did not seem to change the amount of mould, but householders in the insulated houses reported less visible mould.

These benefits are confined to those emerging from carrying out energy related retrofitting. More results are expected to emerge over time and the degree of certainty is also likely to improve. Results to date tend to validate previous, commonly held beliefs.

None of the reports discovered quantified the economics of healthier living conditions. This is seen as a major deficiency in available information, as one or two visits to a doctor or one or two days off work can cost much more than some of the low cost retrofit options to improve the performance of a house, both at the national and individual level.

In overall terms it can be argued that improving well-being is more beneficial than any other sustainability related metric.

Economic Benefits

Potential economic benefits relating to retrofitting are very wide ranging, even discounting the economic related aspects of making our houses healthier, referred to above.

Major benefits accrue from reduced energy use. Energy conservation costs roughly 10% of the cost of providing a similar amount of new energy supply. By reducing the peak load requirements through energy related retrofitting, in line with the NEECS, the nation could avoid the need for major new power stations and power lines. Such measures could also mitigate the effects of the predicted energy shortfall later in this decade.

Potential benefits in this sector are not always realised in practice however. In one BRANZ[11] study the heat flow before and after fitting insulation in the roof and under the floor was monitored and it was found that the occupants were using the same amount of energy after adding insulation but had a warmer house. Internationally this phenomenon is well known. Danish studies in this area [12] found that up to 77% of potential energy savings were taken up by occupants in improving comfort levels in their homes rather than saving energy. This may also be the case in New Zealand particularly as many of the houses studied in the Wellington Medical School Studies experienced prolonged

[11] Roberts, P. 1998. Retrofitting Insulation: What are the benefits? BUILD September/October 1998.
[12] See Worldwide Interventions section of this report on Energy related Voluntary Economic Interventions

temperatures well below the recommended WHO minimum of 16˚C. However, other studies have found that even New Zealanders, who could afford to improve comfort levels in their home, would prefer to stay cold rather than invest money in improving energy performance.

The only published data found, relating to economic benefits accruing from retrofitting New Zealand houses, was the Technical Manual for the EECA Energy Saver Fund[13]. This manual provides energy savings per m² per year by 4 climate zones for ceiling insulation, underfloor insulation, wall insulation, weather-stripping, double glazing, cylinder and pipe wraps, low-flow showers, solar water heaters, heat pumps, energy efficient lights, etc. It also includes discounted lifetime energy savings and allows for different rates of take-back for the various measures. The manual is aimed at technical users and firms working in the field of energy efficiency. **It is not suitable for home owners but could provide a basis for developing a user friendly guide showing paybacks etc. for home owners.**

The return on investment data for retrofit projects is usually limited and there are major gaps in the knowledge. Almost all the economic assessments found related only to paybacks for energy related retrofit benefits. Quantified energy saving data based on before-and-after retrofitting residential homes was also very hard to find. Many reports claimed cost savings based on estimates or modelling but the difference between theoretical and actual benefits[14] are large enough to make homeowners cautious.

Case studies with general claims could be found but hard numbers based on measured data were missing.

There is no evidence to suggest that owners can obtain a cost premium at sale for houses which have undergone sustainability related retrofitting. This is in line with research carried out on this subject in other parts of the world.

Resource Benefits

Benefits accruing from water savings in homes tend to remain in the public domain, with less need for expenditure on storage, treatment, delivery and surface and foul water infrastructures. Such retrofitting also makes communities less vulnerable to droughts. To make such savings owners need to expend resources without hope of financial return except in those areas of the country with water meters and related billing structures. In consequence very little retrofitting work has been carried out in this area.

Benefits resulting from reduced use of materials currently also tend to remain in the public domain. Greater resource recovery from buildings and improved waste reduction tend to result in reduced pressure on landfills and reduced need to import building materials and products. For the average house owner the financial cost of resource recovery and reusing recovered materials tends to be equal or even greater than using new materials because of the increased labour cost involved. In some parts of the country the financial equation is different, notably in Auckland, because of the various imposts put in place by the Territorial Authorities, which make it financially viable to sell certain recovered building materials at competitive prices.

[13] EECA (1998) Background information on energy savings – Technical Manual. Energy Saver Fund.

[14] Stoecklein, A. Just How Effective is House Insulation. Build March/April 1999 p. 52-53. The comparisons between real measurements with calculations showed that actual thermal mass values were double the calculated values.

Private Landlords

There are identifiable health, comfort and in some cases cost benefits, for owner-occupiers to carry out sustainability related retrofitting. Public owners of rental properties theoretically have to maintain and improve their properties to a recognised standard which does not compromise the health of occupants. Landlords of privately owned properties however do not have these same imperatives.

Private landlords generally regard their properties as money making machines and will only voluntarily invest more of their money if this will result in better financial returns. Many people who rent in this market have few financial resources or regard expenditure on rent as 'money down the drain' and seek to minimise rental payments. They appreciate that money spent by a landlord in upgrading will result in higher rents and so generally 'suffer in silence'. It is clear that the rental market is growing and there may be an increased demand for better quality accommodation in part of the market. However, we do not know enough about this segment of the market to make such assertions with a high level of certainty.

Motivation

Winstone Wallboards carried out a survey of owners in 2003 who had recently renovated their home. The purpose was to better understand the drivers of the decision to renovate. The results are summarised in

Figure 11 and Figure 12.

In many ways the perceived benefits to the owner occupants of carrying out a retrofit programme are closely related to the motivation factors shown in

Figure 11. While the survey suggests that a good deal of renovation is appearance driven (about 60% of the triggers are appearance related), and the remainder relate mainly to the functional needs of the owner, such as the need for more floor space, there do appear to be opportunities to include sustainability related performance enhancements in roughly 45% of the circumstances identified in

Figure 11.

Appearance is obviously important to most people and this may be a lesson for Beacon, particularly in relation to 'selling' active solar devices such as solar water heaters and photovoltaic arrays and water collection and treatment devices like water storage tanks. At the moment these tend to be unsightly excrescences when added to existing houses. Either these need to be designed to be integrated into existing houses or owners need to be persuaded to see them as adding a desirable cache to their property.

Perhaps an even more surprising figure is that less than 3% of respondents considered improved house value as the primary motivator for renovation. Very few people, significantly less than 10%, declared the inclusion of sustainability related items such as health improvement or improved insulation as the primary motivator/benefit for carrying out the work, although some such notions might be included in 'updating/modernisation', 'bought to renovate', and 'adding space' categories of the survey.

Figure 11 Motivation for renovation

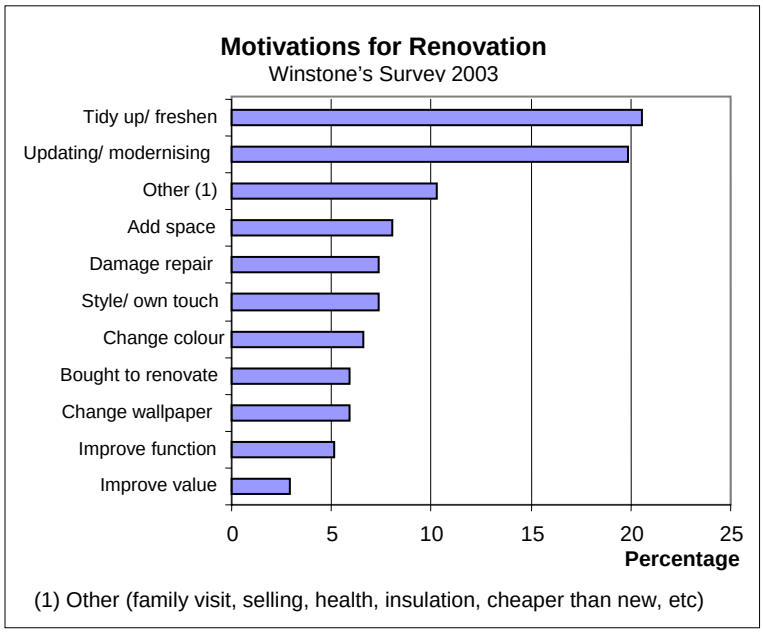
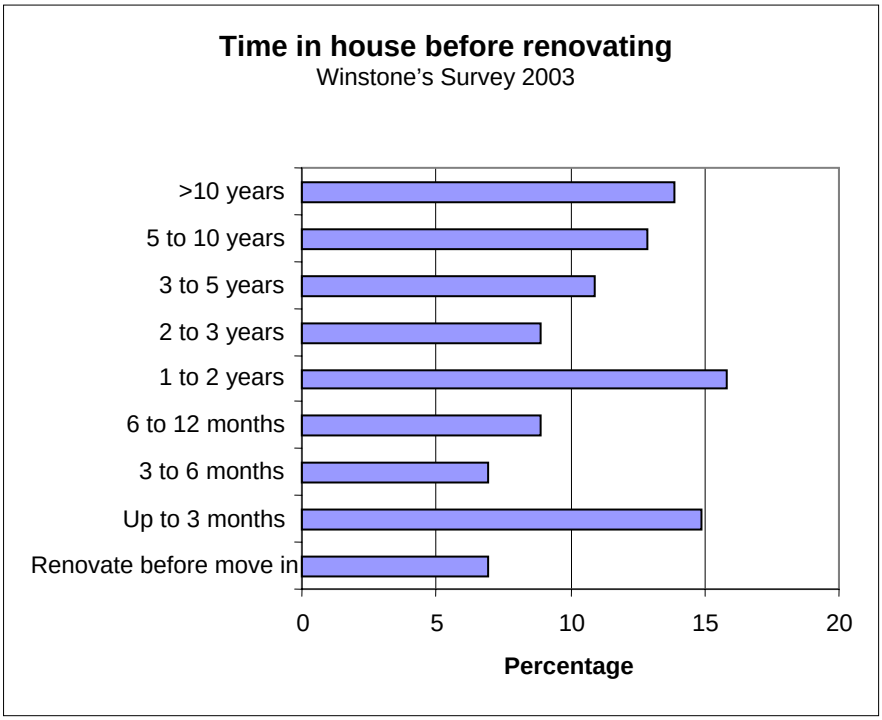


Figure 12 indicates that renovation is more likely to take place soon after purchase with 37% of owners undertaking renovation within one year of purchase and 53% within two years of purchase. However, in over 25% of cases, owners carried out renovation more than five years after purchase. It is not possible to tell from the information available whether the nature of the renovations carried out just after purchase, and those carried out after 5 years or more of ownership is different in kind. It might be speculated however, that items connected with 'bought to renovate' and 'making the home their own' would be carried out as speedily as finances permitted, while 'adding space' might be a longer term item resulting from changing needs.

Figure 12 Ownership period before renovation



No information was found to support the notion that home renovators are motivated by considerations of sustainability or Life Cycle Costing aspects. The Winstone survey of households that had recently completed a renovation, reported that 20% of homeowners were aware of sustainability issues and less than 5% acted to improve sustainability. Preliminary results from the Forest Research survey[15] also found that while increased comfort and warmth are strong motivating factors, sustainability itself is not directly considered.

Economic Factors

Housing is the single most significant personal investment in New Zealand[16] with housing valued at $310,000 M in 2003, which represents 90% of household net wealth.

We know from the 2001 census that of the 934,674 owner-occupied households, 51% had a mortgage; although a much higher proportion of higher-income households had a mortgage than low-income households. This may be because a high proportion of the mortgage free, low-income owner-occupiers are retired.

Extensive retrofitting may represent a significant investment on the part of the homeowner. In the case of rental properties the landlord will make improvements if he can get a return on the investment, either in increased rent or increased resale value. In the case of the owner-occupier the retrofit investment is competing for discretionary money. **Table 9** indicates that, in general, those with a high income (i.e. the wealthy) own their own homes and those with low incomes (i.e. the poor) rent. The trend is for an increasing percentage of people to rent rather than buy a home. The higher-income group will most likely be renting quality accommodation or may be renting their houses from a family trust or LAQC[17]. **There may be an opportunity for Beacon to influence spending on performance upgrades for the upper end of the market.**

Table 9 House ownership by household income, 1991 and 2001

Household income	2001 (934,674)	1991
Nil or loss	46.0%	63.9%
$1-$5,000	42.0%	56.3%
$5001-$10,000	48.0%	56.3%
$10,001-$15,000	57.8%	63.5%
$15,001-$20,000	64.6%	72.3%
$20,000-$25,000	61.2%	71.7%
$25,001-$30,000	69.2%	72.0%
$30,001-$40,000	67.0%	75.7%
$40,001-$50,000	70.5%	79.2%
$50,001-$70,000	75.3%	82.7%
$70,001+	80.5%	87.2%

Source: Statistics New Zealand, http://www.stats.govt.nz/census.htm

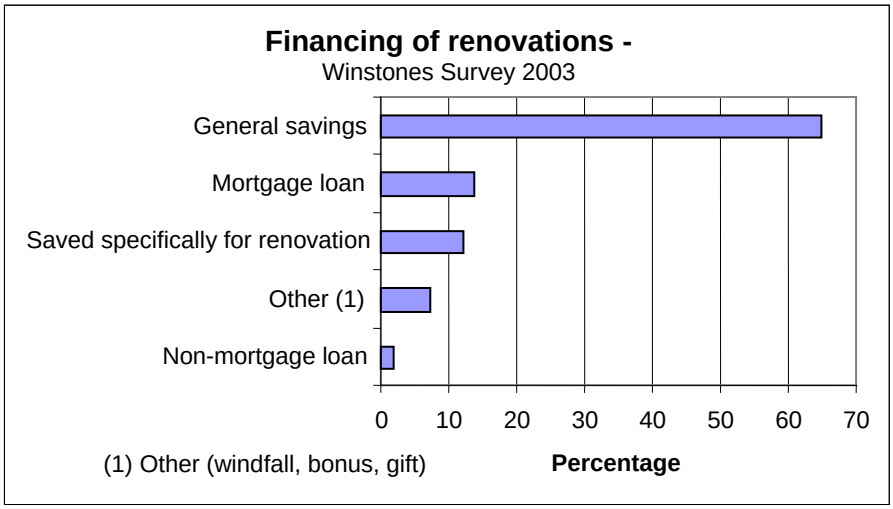
From a retrofit point of view those households with significant net wealth and savings in the form of shares and bonds could afford to improve the performance of their existing homes and they have finances available to do so. This group will be generally financially knowledgeable and will probably only make the investment if they are convinced that it is money well spent, that the claimed benefits are real and the inconvenience is acceptable. For this group Building Code minimums may not be good enough and they may be willing to go well beyond minimum values. To convince this group to embark on a retrofitting programme, a menu of options backed up with good reliable data on the benefits and cost of retrofitting will have to be made available. For this group returns as low as 5% may be acceptable, as this will still represent a better return on invested capital after tax, than the net return from money earning interest in a bank.

[15] Krehl, T. 2004. Retrofit Survey. Preliminary findings, Unpublished, Forest research , Rotorua
[16] http://www.rbnz.govt.nz/statistics/monfin/household.xls
[17] A Loss Attributing Qualifying Company (LAQC) is simply a normal company that has elected to be an LAQC. With a normal company, if the company were to make a loss, losses can only be offset against future profits.

For the group of owner-occupiers who have high levels of current debt, good reliable data on the benefits and cost of retrofitting will have to be made available and some form of payment assistance, incentive or subsidy may be required to enable them to undertake performance related retrofitting, as they are likely to be fully committed to servicing their current debt out of disposable income.

The numbers of households in each of these two categories are unknown.

Figure 13 Financing of renovation



For retired people comfort and health arguments may be persuasive when they are preparing their house for retirement. **This could be an opportunity for Beacon.**

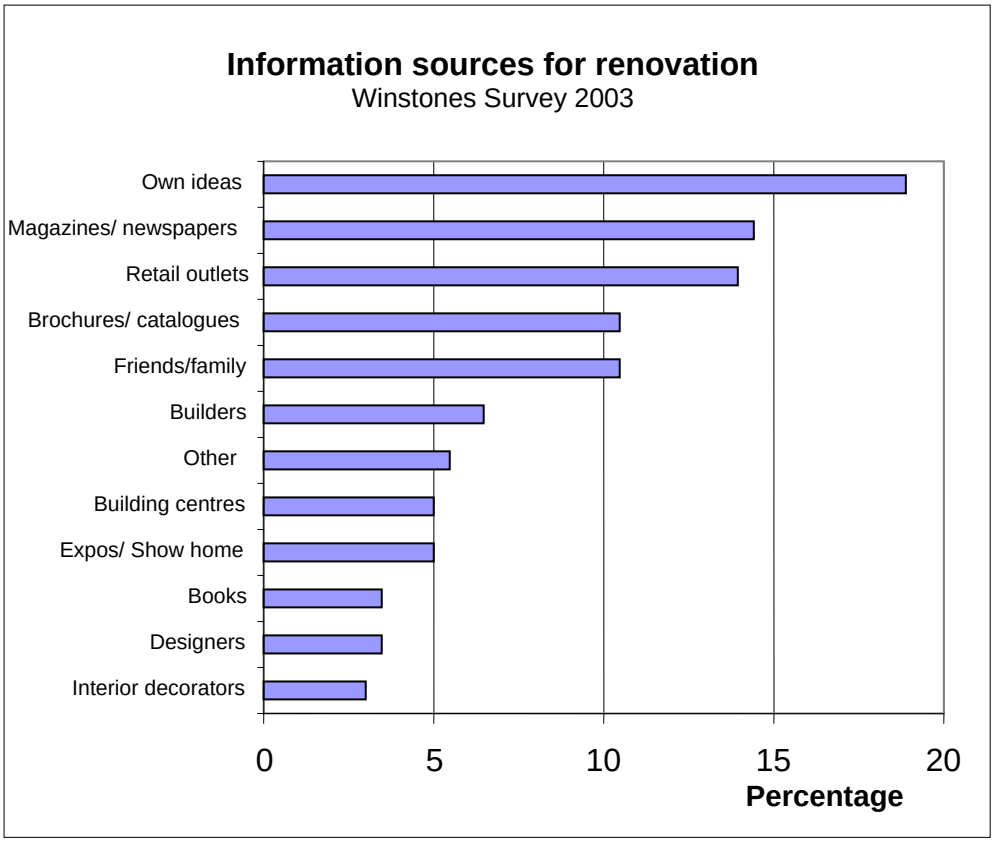
Figure 13 shows information on the financing of renovations. The most obvious, and rather startling, fact is that about 86% of respondents did not take out a loan to finance their renovation work. In other words carrying out the renovation did not add to their debt burden. **This is seen as an opportunity for Beacon.**

In the recent Krehl survey of 100 Bay of Plenty homes[18], the following budget limits were set by respondents for a makeover of their property: 15% $0-1,000; 45% $1,000-10,000; 25% $50,000-90,000; 2% $90,000-130,000. These are surprisingly high. Many of the retrofit measures discussed could be covered by these amounts of money, if the occupants could be persuaded of the merits of performance enhancing interventions. The Bay of Plenty and in particular Tauranga are affluent areas by NZ standards. It would be dangerous to extrapolate these figures to cover the whole country without a more widely based piece of research.

[18] Krehl, T. 2004. Retrofit Survey. Preliminary findings, Unpublished, Forest Research, Rotorua. Based on a survey of 100 homeowners in the Bay of Plenty.

Information Sources

Figure 14 Information sources



The most common source of information identified in the Winstone Survey of recently completed renovations is the owners own ideas, but these are likely to have been informed by the items next on the list, namely, magazines, brochures, catalogues and retail displays. The figure of 3.5% for designers is in itself a commentary on the very limited extent of the involvement of architects, architectural designers and interior architects in the whole area of renovation, including the $800M plus consented additions and alterations market.

Experience in Renovation

No general information was found on the extent of homeowners undertaking DIY for retrofitting, but a Forest Research survey[19] found that over 80% of respondents had some experience in renovation, and about 8% had a great deal of experience in renovation. There may be an opportunity here to encourage DIY interventions provided good clear information and instructions were made available.

Alterations and additions requiring a building consent usually involves trade professionals but this only accounts for about 15% of the total renovation market. Plumbing, drainage, gas fitting and electrical work of all types must be certified by a registered tradesperson. A good deal of non-consented work is also carried out by tradespeople but the extent of this is again unknown.

[19] Krehl, T. 2004. Retrofit Survey. Preliminary findings, Unpublished, Forest Research, Rotorua. Based on a survey of 100 homeowners in the Bay of Plenty.

POTENTIAL

Opportunity

At the time of writing there are estimated to be 1.6 million[20] houses in New Zealand. Currently about $5,300M is spent on renovating this housing stock each year. From the information previously given in this report, it can be see that $3,200M of that total could be potentially related to performance improvements of various kinds. Currently however, most of this money goes into appearance related renovation (60%) and most of the rest into improving functionality.

Of the four fields of sustainability related retrofit established in this report, energy, materials, water and health, only energy related retrofitting has received any serious attention in New Zealand to date. Even here the interventions have been very modest except in relation to the provision of thermal insulation in ceiling cavities. In this instance roughly 651,000 or 63% of pre-1979 have been retrofitted with pre-2000 levels of ceiling insulation. This means that about 382,000 houses in New Zealand have nil or inadequate ceiling insulation. Only the 530,000 or so houses built after 1979 have ceiling, wall and underfloor thermal insulation or 33% of the housing stock. It is estimated that 5-15% of post-1979 houses have poorly installed insulation which significantly reduces its performance. Only about 120,000 or 7.5% of the housing stock of these are fitted with the higher levels of insulation called up in the revised energy efficiency regulations that came into force in 2000. Only about 18% of cylinders in houses are fitted with cylinder wraps according to the HCS. In 1999 only about 2% of houses were fitted with double glazing. Currently 69% of new houses in the South Island and 6% of new houses in the North Island incorporate double glazing, which sounds encouraging but in overall terms it is unlikely that more than 3% of the housing stock is currently fitted with double glazing.

In all other energy efficiency/conservation aspects, in so far as they are known, sustainability related features seem to be fitted in around 1-1.5% of the total housing stock. It is not known what percentage of these elements are incorporated in new houses and which have been retrofitted into existing houses.

Some water authorities have introduced metering and metering based charging in their areas but this information and its effect on water use do not seem to be available centrally. It is known that native hardwood timbers from demolished buildings find a ready market and that many other components such as recovered doors and windows are incorporated into alterations of houses built at the same period as the recovered components. Figures on the amount of this waste diversion are not centrally available.

Health is a very evocative subject and there is considerable anecdotal evidence that many New Zealand houses do not provide healthy living conditions. The work being carried out currently by the Wellington School of Medicine tends to verify the anecdotal contentions but the research is far from complete. What seems to be emerging is a higher degree of certainty that warmer, drier houses are healthier homes, and that many New Zealand homes are neither warm nor dry enough to be healthy.

The market potential is therefore enormous as we are virtually starting from a baseline of about 1% in most areas of sustainability related retrofit apart from some areas of insulation. We know that about $3,200M is spent annually on renovation. The challenge is how to convince homeowners to spend this money on improving the performance of their properties rather than on improving or maintaining its appearance or its functionality.

Barriers

The main barrier to sustainability performance upgrading is the apparent indifference of the population at large to the issues. Perhaps this is due to lack of knowledge, perhaps it is because the effects of the lack of attention we pay to the sustainability of our built environment have had less impact on our life style and well being in New Zealand than in most other parts of the world. It is presumed that this factor has been a major focus of CON1. If not then Beacon needs to conduct a major research

[20] 1,571,000 December 2003 QVNZ+ Building Consents plus about 30,000 new houses in 2004 minus about 2000 demolitions.

programme to establish the reasons for the lack of take-up of available technologies and techniques in this area. Once we know the reasons, we can design a remediation programme.

There are many minor barriers which inhibit sustainability take up, many of which have been identified already in this report along with suggested ways to address the issues however unless this fundamental issue is addressed then all the other measures are unlikely to succeed in transforming the situation in the way the Beacon programme demands.

APPENDICES

1 USEFUL WEBSITES

Austin Energy, United States
Austin Energy is a community-owned electric utility and a department of the City of Austin. They provide free energy efficient home improvements for low to moderate-income families and their Green Building Program provides homeowners with information to help incorporate health, energy efficiency and the environment when building new or retrofitting existing homes. Austin Energy also runs a series of workshops to inform home owners of the benefits of green design and have a range of green resources.
http://www.austinenergy.com/

Building Sustainability Index (BASIX), Australia
BASIX is a web-based planning and mandatory compliance tool that measures the potential performance of new residential dwellings against a range of sustainability indices: Energy, Water, Thermal Comfort, Stormwater, and Landscape. Compliance certificates for alterations to all types of residential development will be introduced to the programme in October 2005.
www.basix.nsw.gov.au

Building America, U.S. Department of Energy, United States
Building America is a private/public partnership that develops energy solutions for new and existing homes and the equipment, components, and systems within them. The program supports R&D activities and provides tools, guidelines, training, and access to technical and financial resources.
www.buildingamerica.gov

Building Research Association of New Zealand Incorporated (BRANZ Inc), New Zealand
The BRANZ Inc and its associated companies provide innovative and creative solutions to the industry by means of research, testing, consultancy and information transfer. Their website includes a range of articles and research based on domestic retrofits for improved energy efficiency.
www.branz.org.nz

Centre for Housing Research Aotearoa New Zealand (CHRANZ), New Zealand
CHRANZ is committed to investing in and promoting housing research that provides an evidence base for policies and practices that meet New Zealand's housing needs. The website's database contains various articles related to retrofits.
www.chranz.co.nz

Community Energy Action (CEA), New Zealand
CEA is a charitable trust that provides services and information on energy efficiency. To date they have installed floor and ceiling insulation, hot water cylinder wraps and a range of other energy efficiency measures in well over 5000 Christchurch homes to make them warmer, drier and more energy efficient. Subsidies are available for homeowners of older properties, community services cardholders and landlords of low-priced rentals.
www.cea.co.nz

Department for Environment, Food and Rural Affairs (Defra), United Kingdom
Defra works for the essentials of life - food, air, land, water, people, animals and plants. Their remit is the pursuit of sustainable development - weaving together economic, social and environmental concerns. Defra endorses the Energy Efficiency Commitment for 2002 to 2005 (EEC), in which electricity and gas suppliers are required to achieve targets for the promotion of improvements in domestic energy efficiency. Suppliers encourage and assist their domestic consumers to make

energy savings - through installing measures such as cavity wall and loft insulation and energy efficient boilers, appliances and light bulbs.
http://www.defra.gov.uk/environment/energy/eec/

Department of Planning and Development (DPD), United States
The Seattle DPD develops, administers, and enforces standards for land use, design, construction, and housing within the city limits. The department develops policies and codes related to environmental protection, development, housing and community standards. HomeWise Weatherization grants is a service provided by the department to help lower-income families improve the energy efficiency of their houses by recommending a conservation package based on an energy analysis. They also run free Home Improvement Workshops.
www.ci.seattle.wa.us/dclu

Department of the Environment, Transport and the Regions (DETR), Materials Information Exchange, United Kingdom
This exchange allows the construction industry to buy and sell used, second hand and un-utilised construction materials over the Internet.
http://cig.bre.co.uk/waste

Energy & Environmental Building Association (EEBA), United States
EEBA promotes the awareness, education and development of energy efficient, environmentally responsible buildings and communities. The site contains a number of retrofit and energy efficiency related articles.
www.eeba.org

Energy Efficiency and Conservation Authority (EECA), New Zealand
EECA encourages, promotes and supports the uptake of energy efficient initiatives and new renewable energy by providing the necessary tools and information to make changes. The website provides a number of articles relating to energy efficient retrofitting programmes around the country, and energy wise tips and schemes.
www.eeca.govt.nz

ENERGY STAR, United States
ENERGY STAR is a government-backed program helping businesses and individuals protect the environment through superior energy efficiency. The website contains home improvement suggestions for increased energy efficiency.
http://www.energystar.gov/

Green Home Remodel, Seattle Sustainable Building, United States
The City of Seattle has developed the Green Home Remodel series, which covers common remodelling topics, giving helpful hints on materials and strategies to create a home that's healthy, saves money, and is easy on the environment. They also offer incentives and assistance to residents to conserve resources (water, energy and materials) and save on utility bills.
http://www.ci.seattle.wa.us/sustainablebuilding/greenhome.htm

Housing Corporation of New Zealand (HCNZ), New Zealand
Housing New Zealand Corporation provides access to decent homes, helping New Zealanders manage their own circumstances and contribute to community life. They undertake housing research and retrofit existing stock and the website includes published development guides for social housing, a database of substandard housing, and a national survey of housing.
http://www.hnzc.co.nz/

Office of Energy Efficiency (OEE), Canada

The OEE's mandate is to renew, strengthen and expand Canada's commitment to energy efficiency. They play a dynamic role in helping Canadians save millions of dollars in energy costs while addressing the challenges of climate change. EnerGuide for Houses offers Canadians individualised professional advice and encouragement on how to improve the energy performance of their houses.
http://oee.nrcan.gc.ca/energuide/index.cfm

Salvo, United Kingdom
Salvo is a website dedicated to architectural salvage, garden antiques and reclaimed building materials. It contains for sale and wanted ads, dealer directories, reproduction services, restorers and is eco-friendly and green.
http://www.salvoweb.com/

SunPower Design, Australia
SunPower Design specialises in designing comfortable homes with integrated sustainable features, and has designed more than 300 new buildings and renovations. The website contains a number of case studies relating to eco-renovations carried out and provides links to green building information and news.
http://www.sunpowerdesign.com.au

Sustainable Buildings Industry Council (SBIC), United States
SBIC is an independent, non-profit organisation whose mission is to advance the design, affordability, energy performance and environmental soundness of America's buildings. They provide a number of resources including software, guidelines and green building workshops for architects, contractors, remodelers and homebuyers.
http://www.sbicouncil.org/

Sustainable Homes, United Kingdom
Sustainable Homes promotes awareness of sustainable development issues and good practice, and encourages housing associations to adopt sustainable policies and practices. The site contains a number of case studies and resources related to retrofits.
http://www.sustainablehomes.co.uk/

The Ecohome, United Kingdom
This website contains detailed information about an eco-renovation project of a typical urban house.
http://www.msarch.co.uk/ecohome/

Trade Me, New Zealand
Trade Me is New Zealand's number one website for buying and selling goods online, and has sections dedicated to house & garden and building & trade goods, suitable for retrofit projects.
http://www.trademe.co.nz/

U.S. Department of Energy, United States
The Weatherization Assistance Program enables low-income families to permanently reduce their energy bills by making their homes more energy efficient.
http://www.eere.energy.gov/weatherization/

U.S. Green Building Council (USGBC), United States
The USGBC is a coalition of leaders from across the building industry working to promote buildings that are environmentally responsible, profitable and healthy places to live and work. They are well known for their LEED (Leadership in Energy and Environmental Design) Green Building Rating System®. The LEED for Homes programme is being developed by the USGBC and is a voluntary initiative promoting the transformation of the mainstream home building industry towards more

sustainable practices. At present it does not include retrofit projects but valuable information can still be applied and utilised.
www.usgbc.org

Western North Caroline (WNC) Green Building Council, United States
The WNC Green Building Council is a non-profit organisation whose mission is to promote environmentally responsible and health conscious building practices through community education. The site contains a retrofit case study and other useful resources.
http://www.wncgbc.org/
Your Home, Australian Greenhouse Office, Australia
Your Home is a suite of consumer and technical guide materials and tools developed to encourage the design, construction or renovation of homes to be comfortable, healthy and more environmentally sustainable.
http://www.greenhouse.gov.au/yourhome/

2 OECD TABLES

Current situation of government policies for the reduction of the CO_2 gas emission

Target of the reduction	Point of intervention	Required improvements	Approaches	Policy instruments	Australia	Belgium	Canada	Czech Republic	Denmark	Finland	France	Germany	Greece	Italy	Japan	Korea	Netherlands	New Zealand	Norway	Sweden	Switzerland	Turkey	United Kingdom	United States	TOTAL
Reduction of the CO_2 gas emission from the building sector in general			General policy instruments	Support for R&D																					12
				Support for technology diffusion, etc.																					12
				Voluntary instruments																					5
Use stage	Design and construction stage	Energy Efficiency of building envelopes	Regulatory	Standards for thermal insulation	*1	*2	*3							*5										*6	19
				Standards for airtightness	*1	*2	*3		*4					*5										*6	18
				Standards for transparent elements	*1	*2	*3							*5										*6	19
			Economic	Capital subsidy programmes																					6
				Tax exemption schemes																					2
				Premium loan schemes																					6
				Energy tax (environmentally related tax)																					5
			Information	Mandatory energy labelling							*7												*8		5
				Voluntary environmental labelling for buildings														*10							7
				Voluntary comprehensive labelling for buildings							*11														4
				Environmental labelling for building materials																					2
				Recommended standards, guidelines, etc.																					10
		Energy Efficiency for appliances	Regulatory	Standards for H/C appliances	*1	*2	*3																		14
				Standards for lighting appliances							*13												*14		7
			Economic	Capital subsidy programmes																					7
				Tax exemption schemes																					3
				Premium loan schemes								*9													5
			Information	Mandatory energy labelling							*7												*8		6
				Voluntary environmental labelling for buildings														*10							5
				Voluntary comprehensive labelling for buildings							*11														3
				Environmental labelling for building materials																					4
				Recommended standards, guidelines, etc.																					8

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Current situation of government policies for the reduction of the CO_2 gas emission *(cont.)*

Target of the reduction	Point of intervention	Required improvements	Approaches	Policy instruments	Australia	Belgium	Canada	Czech Republic	Denmark	Finland	France	Germany	Greece	Italy	Japan	Korea	Netherlands	New Zealand	Norway	Sweden	Switzerland	Turkey	United Kingdom	United States	TOTAL
Use stage	Design and construction stage	Use of renewable energy	Regulatory	Standards, etc.																					0
				Obligations for utilities companies																					1
			Economic	Capital subsidy programmes																					7
				Tax exemption schemes																					4
				Premium loan schemes																					3
			Information	Mandatory energy labelling							*7												*8		4
				Voluntary environmental labelling for buildings														*10							5
				Voluntary comprehensive labelling for buildings																					1
				Environmental labelling for building materials																					1
				Recommended standards, guidelines, etc.																					6
	Use and refurbishment stage	Energy Efficiency of building envelopes and appliances	Regulatory	Standards																					1
				Obligation for utilities companies																					2
			Economic	Capital subsidy programmes																					6
				Premium loan schemes																					4
			Information	Mandatory energy labelling																					3
				Voluntary environmental labelling for buildings																			*15		4
				Energy audits programmes																					5
				Recommended standards, guidelines, etc.																					3
Construction stage	Design and Construction stage	Embodied energy	Regulatory	Standards, etc.																					0
			Economic	Capital subsidy programmes, etc.																					0
			Information	Mandatory labelling																					1
				Recommended standards, guidelines, etc.									*16												2
		Service life	Regulatory	Standards, etc.																					0
			Economic	Premium loan schemes																					1
				Capital subsidy programmes, etc.																					0
			Information	Voluntary comprehensive labelling for buildings											*16										1
				Voluntary environmental labelling for buildings																					1
				Recommended standards, guidelines, etc.																					0

Current situation of government policies for the reduction of the CO_2 gas emission *(cont.)*

Target of the reduction	Point of intervention	Required improvements	Approaches	Policy instruments	Australia	Belgium	Canada	Czech Republic	Denmark	Finland	France	Germany	Greece	Italy	Japan	Korea	Netherlands	New Zealand	Norway	Sweden	Switzerland	Turkey	United Kingdom	United States	TOTAL
Construction stage	Use and refurbishment stage	Embodied energy	Regulatory	Standards, etc.																					0
			Economic	Capital subsidy programmes, etc.																					0
			Information	Recommended standards, guidelines, etc.																					2
		Service life	Regulatory	Standards, etc.																					0
				Provision of a service handbook																					1
			Economic	Premium loan schemes																					0
				Capital subsidy programmes, etc.																					0
			Information	Voluntary comprehensive labelling for buildings																					0
				Voluntary environmental labelling for buildings																					0
				Recommended standards, guidelines, etc.						*17															1

*1. In two states only.
*2. Dwellings and hospital etc; in Flanders and Wallonia regions only.
*3. Several provinces and cities only.
*4. Dwellings only.
*5. Dwellings only.
*6. Many states and municipalities.
*7. Dwellings only.
*8. Dwellings only.
*9. Owner-occupied dwellings only.
*10. Dwellings only.
*11. Dwellings only.
*12. Dwellings only.
*13. Commercial building only.
*14. Commercial building only, physical durability and reparability.
*15. Office only.
*16. Physical durability and reparability.
*17. Maintenance manual.

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Current situation of government policies for the minimisation of C&DW

Target of the minimisation	Point of intervention	Required improvements	Approaches	Policy instruments	Australia	Belgium	Canada	Czech Republic	Denmark	Finland	France	Germany	Greece	Italy	Japan	Korea	Netherlands	New Zealand	Norway	Sweden	Switzerland	Turkey	United Kingdom	United States	TOTAL
Waste minimisation in the building sector in general			General policy instruments	Support for R&D																					10
				Support for technology diffusion, etc.																					12
				Voluntary instruments																					8
Demolition waste	Upstream stages (design and construction)	Recycling and reuse	Regulatory	Standards for the choice of materials																					0
				General obligation without specific standards																					4
			Economic	Capital subsidy programmes																					0
				Tax exemption schemes																					0
				Premium loan schemes																					1
			Information	Voluntary environmental labelling for buildings																					1
				Voluntary comprehensive labelling for buildings																					1
				Voluntary labelling for building materials																					1
				Recommended standards, guidelines,, etc.																					1
		Service life	Regulatory	Standards, etc.																					0
			Economic	Premium loan schemes																					0
				Capital subsidy programmes, etc.																					0
			Information	Voluntary comprehensive labelling for buildings											*1										2
				Voluntary environmental labelling for buildings																					2
				Recommended standards, guidelines, etc.																					1
	Upstream stages (use and refurbishment)	Service life	Regulatory	Standards, etc.																					0
				Provision of service handbook																					1
			Economic	Premium loan schemes, capital subsidy programmes																					0
			Information	Voluntary comprehensive labelling for buildings																					1
				Recommended standards, guidelines, etc.						*2															2

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Current situation of government policies for the minimisation of C&DW *(cont.)*

Target of the minimisation	Point of intervention	Required improvements	Approaches	Policy instruments	Australia	Belgium	Canada	Czech Republic	Denmark	Finland	France	Germany	Greece	Italy	Japan	Korea	Netherlands	New Zealand	Norway	Sweden	Switzerland	Turkey	United Kingdom	United States	TOTAL
Demolition waste	Demolition stage	Recycling and reuse	Regulatory	Ban on landfill																					5
				Mandatory separation			*5								*6										8
				Mandatory delivery		*3									*6										4
				Demolition permission																					4
				Mandatory reporting			*5																		4
				Standards for recycled products		*4																			2
				License system		*4																			6
			Economic	Landfill tax																					10
			Information	Waste information exchange																					3
				Guidelines for the management of C&DW																					4
	Downstream stage	Recycling and reuse	Regulatory	Standards for recycled products		*4																			3
				General obligation without specific standards																					4
			Economic	Aggregate tax																					4
				Capital subsidy for recycling facilities, etc.																					2
				Premium loan scheme																					1
			Information	Voluntary environmental labelling for buildings														*7						*8	4
				Voluntary comprehensive labelling for buildings																					0
				Voluntary labelling for building materials																					6
				Guidelines for the management of C&DW																					3
				Recommended standard for recycled products																					2
				Certificate scheme for recycled products		*4																			1
Construction waste	Design and construction stage	Reduction of quantity of materials, etc.	Regulatory	Standards, etc.																					0
			Economic	Capital subsidy programmes, etc.																					0
			Information	Recommended standards, guidelines, etc.																					3

Note: Policy instruments targeted at the demolition waste and implemented at demolition stage are usually applied also to construction waste.
*1. Physical durability and maintainability.
*2. Maintenance manual.
*3. Certain types of non-contaminated C&DW in Brussels region only.
*4. Flanders region only.
*5. Ontario province only.
*6. Concrete, asphalt, lumber.
*7. Dwellings only.

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Current situation of government policies for the prevention of indoor air pollution

Points of intervention	Required improvements	Approaches	Policy instruments	Australia	Belgium	Canada	Czech Republic	Denmark	Finland	France	Germany	Greece	Italy	Japan	Korea	Netherlands	New Zealand	Norway	Sweden	Switzerland	Turkey	United Kingdom	United States	TOTAL
Prevention of indoor air pollution in general		General policy instruments	Support for R&D																					8
			Support for technology diffusion, etc.																					9
			Voluntary instruments																					1
Design and construction	Minimisation of pollutant sources	Regulatory	Standards for building materials					*1	*2		*3											*4		6
			Standards for the release of pollutants		*6			*6		*7									*8			*9		6
			General obligation on materials																					8
		Economic	Capital subsidy programmes																					1
			Tax credit schemes																					0
			Premium loan schemes																					1
		Information	Mandatory labelling for buildings																					1
			Voluntary environmental labelling for buildings														*10							4
			Voluntary comprehensive labelling for buildings																					2
			Voluntary labelling for building materials																					7
			Target value, guidelines, etc.																					13
	Adequate ventilation	Regulatory	Standards for ventilation system																					15
		Economic	Capital subsidy programmes																					1
			Tax credit schemes																					0
			Premium loan schemes																					1
		Information	Mandatory labelling for buildings																					1
			Voluntary environmental labelling for buildings														*10							4
			Voluntary comprehensive labelling for buildings																					1
			Target value, guidelines, etc.																					13

*1. Formaldehyde.
*2. Formaldehyde etc. .
*3. Formaldehyde and VOC.
*4. Formaldehyde (urea formaldehyde foam).
*5. CO, CO_2, carcinogens.
*6. Radon, NO_2.
*7. Radon.
*8. Radon.
*9. Methane, Radon and CO_2.
*10. Dwellings only.

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3 RETROFIT COSTINGS

1. Hot water cylinder wraps (typical range $60-$100) estimated cost saving per annum $18-$68, payback 1-2years[21]).
2. Pipe lagging (typical range $100-$200, depends on access).
3. Weather stripping (up to $100).
4. Draught proofing ($100-$130[22]).
5. Low flow shower heads ($45-$90, estimated cost saving per annum $32-$65, payback 1-2 years[23]).
6. Compact fluorescent light bulbs replacing incandescent ($6-$15cost, saving $12 per year each[24]).
7. Undercover laundry line. ($10 -$100 depending on type).
8. Water saving fittings such as shower heads, taps and dual flush cisterns, if used when fittings are being replaced generally cost very little extra to normal fittings.
9. Reused components/materials can be cheaper or of equivalent cost to new products.

Other retrofit enhancements are more expensive but can result in significant energy, water or health benefits

10. Ceiling insulation (typical range $500-$2,000[25], depends on access. (Estimated cost saving per annum $106-$289, payback 1-7years[26]).
11. Under-floor insulation (typical range $100-$1000[27], depends on access).
12. Under-floor moisture barriers (typical range $300-$900[28], depends on access).
13. Heavy curtains. Good quality curtains that seal well can achieve 80% of the performance of double-glazing[29] with pelmets and edge seals.
14. Energy management glass[30]. E.g. Pilkington ComfortPlus™ (about $200/m²)
15. Double glazing (Plastic double glazing range $50 to $300 for a standard bedroom window depending on system. Glass retrofit to double-glazing costs depends on many factors.)
16. Wall insulation. It will cost about $15,000 -20,000 to retrofit exterior wall insulation in an average 3 bedroom light timber frame house[31].
17. Solar water heater. Cost $3500 - $7000 to save about 60 - 70% of hot water energy. At current rates of power charging, payback would be somewhere between 10 and 20 years.

[21] EnergyWise News April1998, p.11.
[22] EECA, A homeowner's guide to energy savings and healthier living. June 2004 www.energywise.org.nz.
[23] EnergyWise News April1998, p.11.
[24] EECA, A homeowner's guide to energy savings and healthier living. June 2004 www.energywise.org.nz.
[25] R1.8 bats $7.50 to $9.3/m2 fitted, R2.4 $8.95 to $10.5/m2 fitted. Lower value ITM Pink Fit®, higher value NZ Building Economist
[26] EnergyWise News April1998, p.11.
[27] Estimated cost $950 for 120m^2 house. EECA, A homeowner's guide to energy savings and healthier living. June 2004 www.energywise.org.nz.
[28] Estimated cost $600 for 120m^2 house. EECA, A homeowner's guide to energy savings and healthier living. June 2004 www.energywise.org.nz.
[29] Cement and Concrete Association of New Zealand. 2001. Designing Comfortable Homes, p.21.
[30] U-Value of 6mm clear glass = 5.7, 6mm ComfortPlus™= 3.6 and double-glazing clear = 2.8 and double-glazing with ComfortPlus™=1.8. The lower the U-Value the better. ComfortPlus™ costs about $200/m^2.
[31] According to GIB Living Solutions Renovators Guide for established homes, August 2002, it costs about $1,655 to replace linings and adding insulation to externals walls in one 4.2m x 3.6m (15.12m^2) room or $109.45/ m^2 floor surface area. As most rooms in a house are smaller than 15.12m^2 and if all wall linings are removed and replaced the cost will be close to $15,000. The GIB estimate includes adding 2 extra power points and a phone outlet ($210).

4 JOURNALS AND MAGAZINES

While there are no specific magazines published in New Zealand dealing with renovation or retrofit, the following journals and magazines include occasional articles and sources of information useful to people undertaking renovation.

Architecture New Zealand: Specialist architectural magazine. Targeted audience architects and Architectural Designers

BUILD: BRANZ magazine provides up-to-date advice and information on a wide range of building-related issues.

Building Today: Official journal of the Registered Master Builders' Federation of New Zealand

Home and Entertaining: Popular home magazine

INFO-LINK: Advertising magazine which enables subscribers to obtain trade information on advertised materials and products either though the post of through a website. www.info-link.co.nz

Interior DETAIL(S): Interior DETAIL(S) is a trade magazine with a residential interiors focus

Landscape New Zealand: Landscape New Zealand is a dedicated publication for professionals in the landscaping industry.

New Zealand Property Magazine: Targeted at the serious real estate investor and home of the Property Investors Federation.

NZ HOME & GARDEN: Popular home and garden magazine.

Progressive Building: Trade magazine for the building industry.

Trends Homes: Popular magazine for the housing fashion.

Trends Kitchens and Bathrooms: Popular magazine for kitchen and bathroom fashion

URBIS: Design and architecture magazine

URBIS DESIGN ANNUAL: Design magazine for both professionals and consumers

URBIS LANDSCAPES: Focuses on the spaces between buildings.
URBIS SPACES: Focuses on Kitchens and Bathrooms.