PR105/1

Development of Beacon's National Scorecard

Final

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About This Report

Title
Development of Beacon's National Scorecard

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Abstract
This report proposes a structure/framework for a National Scorecard to measure change in the sustainability of houses at a national level. It sources publicly available national information for each indicator where possible, otherwise suggests national surveys.

Reference
Page, I. and Jaques, R. May 2006. Development of Beacon's National Scorecard.Report PR105/1 for Beacon Pathway Limited.

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1 Executive Summary

Introduction

The objective of this project is to provide a framework for Beacon to measure the influence it is having on the sustainability of houses at a national level. This framework is a first draft that will need to be tested over a period of time before being adopted. The measures are in keeping with Beacon's goals, and not the goals of other organisations, so Beacon keeps ownership of the Scorecard,. However, it is expected that compatibility will be found in many areas (e.g. reduction in energy use). The project also identifies a proposed method for defining a high level of sustainability at a house level.

For each indicator publicly available national information was sourced where possible. This was used to provide a measure and set targets in line with Beacon's goal. Where official information was not possible, national surveys have been used, or recommendations for new surveys have been provided. Two sets of indicators have been created, one for new houses and the other for existing houses. The reasons for this are twofold:

1) For new housing, built-in sustainability impacts, such as material use, are monitored.
2) Most official data used as indicators covers the existing stock rather than new housing.

Therefore the first measures are a measure of how successful Beacon has been in persuading new home builders to incorporate sustainability features in their houses, while the latter shows progress in retrofit of the existing stock.

The data for the new houses comes from two surveys:

- BRANZ Materials Survey (Page 1999) for new dwellings, a survey to builders and designers of over 1,200 dwelling units per year. Further details are in the Appendix.
- A yet-to-be-developed survey to owners of new dwellings focusing on sustainability questions. In brief, the survey will be a random selection of new dwellings identified from building consent lists published by Territorial Authorities.

The data for existing houses comes from a variety of official information including data on energy use, greenhouse gas emissions, security, water use, etc.

Measuring progress

There are three ways the National Scorecard can be used to measure progress: time series of individual indicators, a composite index, and objective weightings. The time series will provide trend lines for some of the indicators to determine if they are 'heading in the right direction'. The composite index is the best way to measure the overall performance across all the objectives, and the objective weightings will provide progress against each objective.

Figure 1: Sustainability index – existing housing stock

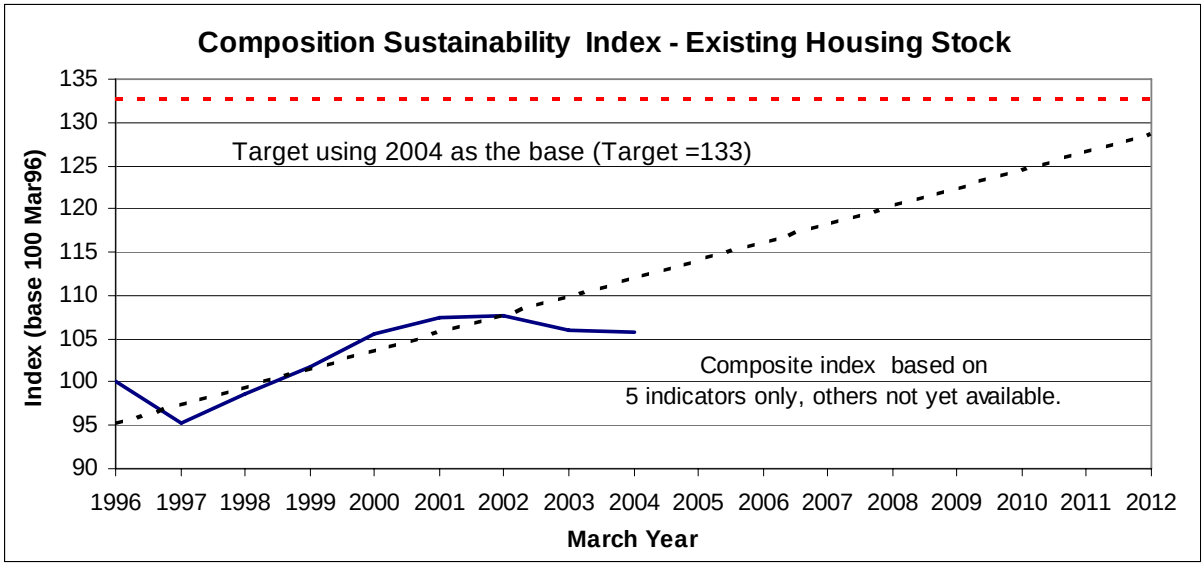
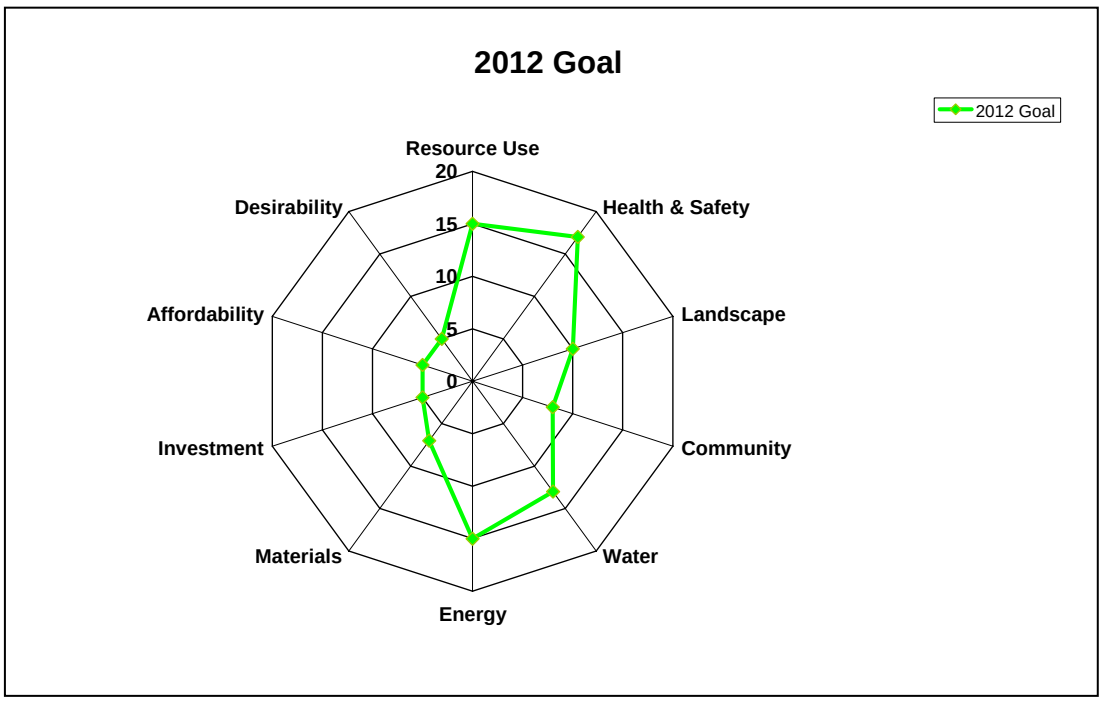


Figure 2: Spider diagram to measure progress of each objective or sub-objective for existing housing



Discussion and recommendations

The work completed in this report provides a starting point in developing Beacon's National Scorecard to monitor progress toward the Beacon sustainable housing goals. The proposed methodology is to monitor the existing housing stock and new housing separately. Published aggregate data will be used for the existing stock supplemented by a survey to owners. For new housing, either an addition to the existing BRANZ Materials Survey should be used or a new survey developed, depending on the outcome of a pilot survey.

Existing house survey

The indicators to be measured are those in Table 2 sourced from the House Condition Survey (HCS). A postal survey is proposed in which the owner fills out the form with a small incentive to encourage responses. The indicators are: composting bin, area for recycling storage, questions on health hazards (stairs, lighting, vents, poison storage, steps, handrails, mould etc), amount of impermeable surfaces, solar shading, rain water tanks, noise and air quality. Some questions are straightforward (yes or no), while others involve some choice judgement. As far as possible, checklists will be provided to help owners give accurate responses. It is proposed to carry out a pilot survey to assess the survey design, and in the pilot and the main survey some on-site checking will be needed.

New house survey

The indicators to be measured are denoted as New Survey in Table 3, namely, composting bin, area for recycling storage, questions on health hazards (stairs, lighting, vents, poison storage, steps, handrails, mould etc), fire safety (alarms, interconnected, other measures), security (lights, front door visibility etc), amount of impermeable surfaces, solar shading, rain water tanks, public transport distance (400 m to a stop and 800 m to a terminal), noise, air quality, window vents, solar shading (sill height and eaves width) and common service areas (for example, is the plumbing close together?).

Many of the questions have been trialled in the most recent HCS and generally useable responses were obtained in the survey. It is suggested the new questions are attached to the BRANZ Materials Survey (a postal survey filled out by the builder) as a trial (see Table 6 in the Appendix), but it may be necessary to develop a stand alone New House Survey. BRANZ has already included some of the required questions in the BRANZ survey, to start collating information on the response rate and the respondents' understanding of the questions.

It is believed the available statistics, supplemented by data obtained by new surveys, will be sufficient to adequately monitor progress toward the goals. Indicators have been identified for most of the nine Beacon objectives. It is recommended the indicators be combined into a composite index for each of new housing and the existing stock. The composite indexes are a weighted sum of indicators, and these weights were set by industry experts. The composite indexes will be calculated at regular intervals to check progress and two yearly intervals are recommended.

Discussion

This report proposes a structure/framework and methodology for Beacon to adopt as its National Scorecard. It is accepted that the Scorecard will need further refinement and the following outlines decisions that need to be made before any further amendments are made. For Beacon to adopt this Scorecard as their own, it is important for the following areas to be discussed and agreed steps to move forward are made:

- Are the proposed indicators in alignment with Beacon's needs?
- Core indicators – what is essential for Beacon to measure and why?
- Do these core indicators have a high level of sustainability?

National data sources

The data sources gathered for the development stage of the Scorecard were the best available, and while they are useful some do not align totally with Beacon's goals e.g. the Affordability Index, parts of the Healthy Housing Index (HHI), the Fire Safety and the Security Index. While these measures are possible at a national level and Beacon is interested in them, they do not provide the necessary measures to indicate if Beacon as an entity is successful. For example, the Affordability Index is related to house prices which the market dictates and will not provide information on the affordability of sustainable housing (i.e. a sustainable house over its lifetime costs no more than a non-sustainable house). With these indicators it is also likely other influences will have a greater impact on the measure than Beacon, so even if Beacon successfully meets the defined requirement it will not show up in the national indicator.

> **Recommendations: To remove the affordability and fire safety indices from the National Scorecard. To monitor the healthy housing and security indices for their effectiveness in capturing the essence of Beacon's objectives.**

Core indicators

The spider diagram in

Figure 2 clearly highlights the areas that are important to Beacon by the weightings. These core indicators are:

- Health and Safety
- Water Use
- Energy Use (note that Energy Use is measured under Performance but is also a surrogate for Resource Use in measuring greenhouse gas emissions)
- Resource Use.

Given Beacon's objectives and the finite short time-frame it is working within, it is essential to choose the best areas to put the greatest effort into. These core indicators highlight the areas where Beacon should be focused to gain maximum impact.

With the first iteration of the housing indicators it is now questionable how useful some of the original nine objective areas are towards Beacon's National Scorecard. This does not imply the

indicators should be reduced for all Beacon's research as it is important to recognise their use in the NOW Home protocols and design. However as Beacon progresses forward, objectives such as Desirability, when attempting to define and measure, are particularly subjective and therefore difficult to assess.

Recommendations: The following objectives are removed from the National Scorecard to concentrate on the core objectives:

- Investment Potential
- Desirability
- Affordability
- Future-proof.

The following objectives are kept in the National Scorecard but they are not considered to be core indicators:

- Landscape
- Community

High level of sustainability

The levels set to reach Beacon's sustainability goals are based on the modelling and estimates expected to be achieved by the NOW Home. These may or may not be accurate, and as monitoring progresses and a better understanding of what is achievable in a retrofit situation occurs, the targets at both a house and national level will need to refined. It is important to note this should not be done to make the goal easier to achieve.

Recommendation: As learning progresses the targets and house level goals (high level of sustainability) are adjusted and refined as necessary.

Testing the National Scorecard

To test the current Scorecard for its applicability, ease of use and to assist with the updates, the following should be completed in the current year:

- The indicators to be used, and their weights, are as shown in Tables 2 and 3.
- The target levels for each indicator are as shown in Tables 2 and 3.
- Two new surveys are developed to monitor progress – these must be undertaken every two years.
- The existing house survey should be a postal survey to home owners, selected randomly from a QVNZ database.
- The new house survey should be a postal survey to owners, randomly selected from building consent lists published by most Territorial Authorities, and this survey should be trialled as an addition to the existing BRANZ Building Materials Survey. Some new questions have already been included to check response rates and the respondent understanding. It may prove necessary to develop a separate survey for new houses.

- Pilot surveys for both new and existing houses should be first undertaken to ensure that the method is feasible, and some on-site inspections should be carried out to check for accuracy of the responses.
- It is likely that some indicators will be discarded as impractical and unreliable after the pilot surveys.

Recommendation: Test the Scorecard to check it meets Beacon's needs and adjust/refine if necessary.

2 Introduction

The objectives of this project is to provide a framework for Beacon to measure the influence it is having on the sustainability of houses at a national level. This is a first draft that will need to be tested over a period of time before being adopted. The measures are in keeping with Beacon's goals, and not the goals of other organisations, so Beacon keeps ownership of the Scorecard. However, it was expected that compatibility will be found in many areas (e.g. reduction in energy use). The project also identifies a proposed method for defining a high level of sustainability at a house level.

Beacon's goal is for 90% of New Zealand's homes to reach a high level of sustainability by 2012. The aim is to achieve 'outcomes' in terms of the nine Beacon objectives as defined in the following table (some indicators are in brackets):

Table 1: Beacon's objectives and goal definitions

Objective	Goal definition
Resource Use (CO_2 emissions, waste)	To reduce the amount of greenhouse gas emissions from the RBE sector caused by operating energy demand and kitchen waste, minimise construction waste and increase the use of recycled materials.
Investment Potential (re-sale price, conservative design)	To increase the investment potential from house price appreciation encouraging upgrading of existing stock, new housing investment.
Affordability (initial and running costs)	To increase the long-term affordability of housing, i.e. over its whole life (including operational, replacement and maintenance costs).
Personal Health/Safety (indoor environment, fire safety, security)	For people's health and safety to improve because of improved and healthier house conditions including warmth, air quality etc.
Desirability (supports lifestyle)	To make sustainable housing worth having, seeking or achieving and people realise its advantages.
Community (adjacent to facilities, noise)	The house embraces the surrounding community.
Performance (insulation, water efficiency)	For housing to perform to a high standard including the building envelope, water collection, noise levels, weathertightness and durability
Landscape (run-off, solar shading, water harvesting)	To maximise solar gain, minimise surface run-off, enhance privacy, where required.

Future-proof (flexible spaces, durability)	For housing to work effectively both short-term and long-term through good design and flexible living spaces.

Therefore to develop a Scorecard for Beacon, national data sources were identified and assessed for their suitability to provide useful indicators against each objective. Some objectives are easier to define and measure than others, and not all are applicable for both new housing and existing housing. To create the Scorecard the following process was used:

- Find data sources currently or potentially available that provide useful information to generate indicators for each objective.
- Assess the ease of accessing or developing the indicators, how reliable they are, and how often should they be updated.
- Define the target levels for the indicators and how they are combined to provide an overall assessment of progress.

It is proposed to have two Scorecards that are aligned, one for existing housing, and the other for new housing. The first measures progress in retrofit of the existing stock, while the latter is a measure of how successful Beacon has been in persuading new home builders to incorporate sustainability features in their houses.

For data sourcing requirements, housing has been defined as stand-alone houses plus low-rise (less than four levels) timber-framed multi-unit housing. Medium and high-rise residential units, which are approximately 2% of the housing stock, are not included in this report.

3 Indicators

Indicators have been developed for new housing and for the existing housing stock. The reasons for separate indicators are because the aggregate data that can be nationally sourced applies to the existing stock, and to monitor progress in new housing (i.e. housing built in the last year) different data sources are required.

There are various ways to choose a target and monitor progress. The approach outlined above consists of two main measures:

- First, ‘top-down’ measures, in which the units are aggregate data (e.g. average electricity or water consumption per household, domestic CO_2 emissions per household, regional/national Affordability Indexes, national crime housebreak statistics etc). The top-down approach is used for the existing housing stock, supplemented by data from the HCS (or equivalent).
- Second, the ‘bottom-up’ measures which are used when aggregate data is not available for measuring indicators. These are surveys to owners identified from building consent lists. Specific questions are asked on sustainability measures incorporated into the new house, or retrofitted into the existing house.

The advantage of 'top-down' methods are that aggregate data is readily available for some indicators from official sources. The disadvantages are:

- The change from year-to-year may record other factors than sustainability improvements. For example, household average energy consumption changes may be due to climate effects, or price changes, rather than improved efficiency/conservation of energy use. It is also affected by house size, persons per household, etc (see Figure 17 in the Appendix).
- The aggregate data includes both existing houses and newly constructed houses and there is no way of knowing how much each contributes to any change in the indicator. However with about 25,000 new houses per year, compared to a stock of 1.5 million houses, the effect of new additions on the aggregate data is small and any changes in national statistics will be largely due to upgrading of the existing stock.

The advantage of the 'bottom-up' approach is that the number of sustainable houses is directly measured, and existing houses and new houses can be separately surveyed and analysed. The disadvantages are:

- we are reliant on accurate responses from knowledgeable owners
- alternatively, if the survey is carried out on-site by professionals, it is expensive and time consuming.

Indicators have been allocated to only one objective so that the benefit of the same measure is not counted more than once. For example, Energy Use during occupation could be counted in Resource Use, Affordability and the Performance objectives, but is measured only in the latter objective.

In summary, the use of aggregate data from official sources, plus an existing house survey (more frequent than the HCS) is proposed for monitoring the existing housing stock, while for new houses a postal survey method is proposed. These surveys are discussed in section 5.

4 Data sources for indicators

The proposed indicators, their measures and identified data sources are discussed in detail below. There are many other indicators that could be used and these are discussed in the Appendix, Section 9.1, but these have been chosen as the most applicable and they can realistically be measured.

4.1 Existing housing stock benchmark indicators

4.1.1 Resource Use

Greenhouse gases (GHG). The measures are the numbers in the MED report *NZ Greenhouse Gas Emissions* (MED 2005) updated annually. It includes the CO_2 equivalent emissions by residential sector for gas, LPG and coal. The CO_2 releases associated with electricity use are not given and need to be derived from domestic electricity consumption obtained from the *MED Energy Data File* (Hein 2005) and a CO_2 tonnes/MWh factor for electricity generation. The 2012 target is 30% improvement in line with the Beacon 30% reduction in purchased energy.

Waste. Occupants will be asked if they compost their kitchen waste.

Recycling. Is a storage area under cover available for recycling household waste?

4.1.2 Investment Potential

No indicator is proposed as currently there are no appropriate data sources available, but see the Appendix for further discussion.

4.1.3 Affordability

There is no source of information that will provide Beacon's definition of affordability, that housing with a high level of sustainability is as affordable as current housing. It could be possible to survey with additional questions to the BRANZ building consent survey in the future with respect to price. However, it would be difficult to capture the 'whole of life cost' at the building consent stage, and possibly people's perceptions of affordability are more important than the actual costs given they will capture the non-tangible benefits.

However, the AMP Affordability Index is published quarterly, and represents the affordability of existing housing. The assumption is that affordability of housing in general is a sustainability issue, but see the Appendix for further discussion on this.

Given there are currently no other suitable sources of data this index has been included as an indicator, but future surveys could replace this with a more applicable data source. A 2012 target of a 10% improvement was used. The last 10 years have shown a static affordability trend.

4.1.4 Personal Health/Safety

Healthy Housing Index (HHI). A trial HHI is being developed in the Hutt Valley but there is no commitment as yet to develop a national index. However, the 2005 HCS recorded data that is useful for a national index, including data on mould, indoor stair safety, vents, ignition sources, poison storage, deck handrails, outdoor steps and glazing safety, and this has been used to develop an aggregate HHI (see the Appendix). The average value for all houses was 4.0 (scale 1= serious, 5= excellent).

Fire safety. The proposed measure is the annual number of domestic fire fatalities per household. These have declined by about 3% pa in the last 15 years, but are now flattening out and a 10% reduction target was chosen.

Security. The proposed measure is the number of domestic burglaries reported per household. These have declined by about 3% pa in the last 15 years, but have been flat in the last four years and a 10% reduction target was chosen.

Warmth. We use an insulation score developed in the HCS, in which 21% of households had a score of 5 (1=serious, 5= excellent), and the target is to significantly improve on this by 30% in line with Beacon energy saving targets.

4.1.5 Desirability

No suitable indicators that are amenable to measurement have been found.

4.1.6 Landscape

Water run-off. The percentage of the section that is paved or concreted in non-permeable materials was recorded in the 2005 HCS, but this ignores adjacent grassed common areas (parks, reserves etc).

Solar shading. The HCS records the degree of shading on a four point scale.

Water harvesting. The HCS records whether or not water is collected in a rain water tank.

4.1.7 Community

Noise. The data source is the HCS, where in the 2005 survey a five point scale for assessing noise was used.

Air quality. Six sources of pollution are listed in the 2005 HCS, and if any are found when checked the house fails this indicator.

Visibility. No measures are currently available and new questions to be developed will include one on front door visibility from the footpath.

4.1.8 Performance

Energy use. Annual national data on average domestic energy use per household is available from the Ministry of Economic Development. A 30% improvement by 2012 is the Beacon target.

Water use. Water consumption per household data is estimated by some local authorities but most do not appear to have robust information on the split between domestic and commercial/

industrial use. The estimates from authorities are not sufficiently accurate to monitor progress in conservation. Instead metered consumption from selected authorities may need to be used. A 50% reduction in consumption is the target.

Water meter. Is the house metered?

Weathertightness. Use the number of Weathertight Home Resolution Service (WHRS) new cases per year.

House condition. The HCS provides an average condition for houses on a five point scale. Rapid deterioration from one survey to the next (five years later) would be a major concern for the sustainability of the housing stock. It is an average of the condition of about 30 components, and this number of components is beyond the ability of the owner to assess. So it will need to be simplified to three or four questions on cladding and lining condition in the new survey.

4.1.9 Future-proof

There are no indicators that could be readily developed for regular monitoring of progress, but see the Appendix for further discussion.

4.2 New house benchmark indicators

4.2.1 Resource Use

Greenhouse gases (GHG). The measure is tonnes of carbon released in the construction of all dwellings during the year, divided by the number of new dwellings. The calculations will be based on the cladding, flooring and framing types, as obtained from the BRANZ Materials Survey. The average floor sizes are obtained from consent data, and material volumes per sqm of floor area are from quantity surveyor sources. This enables the total material volumes by type in all new housing to be calculated, to which the Alcorn carbon intensities are applied.

Embodied energy. The measure is in MJ for all new dwellings erected during the year. It uses the same data sources and methods as for CO_2 emissions.

Floor area. The rationale is that 'excessively' large houses are not sustainable due to their extra comfort and material maintenance requirements. The proposed method is based on the first NOW Home, with an adjustment for extra bedrooms and an office area. The range is from =1 (very resource efficient) to -9 (very resource inefficient). Analysis of recently constructed homes gives an average rating of = -2.1.

4.2.2 Investment Potential

There are no indicators that could be readily developed for regular monitoring of the investment potential, but see the Appendix for further discussion.

4.2.3 Affordability

New house Affordability Index. As for existing dwellings it is assumed that affordability of new housing in general is a sustainability issue. There is no established Affordability Index for new houses and one could be developed using three Statistics NZ indexes, namely the Labour Cost Index, Capital Goods Price Index (new housing) and mortgage interest rates. In addition, the

land price needs to be considered, and it is feasible that the QVNZ section price index be added into the new index. This composite index is easily developed, as shown in the Appendix, Section 9.4, however it was decided that an Affordability Index is not a core indicator nor should it be developed.

4.2.4 Personal Health/Safety

Healthy Housing Index, Fire Safety Index, and Security Index. The HHI is as described for existing houses. The development of the Fire Safety Index and the Security Index is described in the Appendix, Section 9.4.

4.2.5 Desirability

There are no indicators that could be readily developed for monitoring of Desirability.

4.2.6 Landscape

These indicators are obtained from the New Survey of new houses, and were trialled in the HCS.

Water run-off. Solar shade. *Water harvesting.* The same indicators as for existing housing are used.

4.2.7 Community

Infrastructure. The owner records whether the nearest transport stop is within 400m and a major transport terminal within 800m, which are the maximum distances the average person is prepared to walk according to experts.

Noise. Air quality. The same questions as for existing houses are asked.

4.2.8 Performance

Thermal insulation. The BRANZ Materials Survey currently records insulation R-values, double glazing and floor areas. Given this, a composite R-value for the house can be estimated.
Window vents. Built-in vents reduce cooling needs in summer while maintaining security.

Efficient heaters. Includes solar water heaters, heat pumps, storage heaters and double-burning wood burners, and a score is based on a count of these. This can be adjusted as new information comes along from Beacon reports e.g. TE102.

Water use. The BRANZ Materials Survey currently records low flow shower heads and dual flush toilets.

Orientation. Measures the house aspect for solar gains. The HEEP data provides a benchmark. The measure is the percentage of new houses totalling between 15% and 25% window to floor area on walls with a N, NE or NW orientation. This question may be too difficult for owners, as they need to measure window areas and know their orientation.

4.2.9 Future-proof

The BRANZ Materials Survey is used for these measures and the benchmarks are in the Appendix.

Flexible spaces. The measure is the incidence of roof trusses spanning between the exterior walls, so that internal layouts can be changed in the future.

Durability. The life span of the roof and wall claddings are rated on a five point scale, e.g. concrete roof tiles and clay bricks rate higher than steel roof tiles and uncoated cedar weatherboard.

Services. This measures the 'compactness' of the plumbing, and if the outlets (kitchen, bath and laundry) are near the hot water cylinder the rest of the house can be readily altered as required in the future. An additional benefit is that pipe heat losses are reduced.

5 Beacon's National Scorecard

It is proposed to have two sets of benchmarks, one for existing housing, and the other for new housing. The first measures progress in retrofit of the existing stock, while the latter is a measure of how successful Beacon has been in persuading new home builders to incorporate sustainability features in their houses.

We define housing as stand-alone houses plus low rise (less than four levels) timber-framed multi-unit housing. Medium and high-rise residential units, which are approximately 2% of the housing stock, are not included in this report.

5.1 Existing housing

The existing housing Scorecard is shown in Table 2. These indicators and their measures are generally available and most can be readily updated. An assessment of the indicator reliability, and the effort required to calculate or obtain this, is shown in the table. The weighting for each indicator is also shown, based on consensus opinion of experts.

Most of the Health/Safety, Desirability, Landscape and Community objective indicators have been trialled in the HCS (Clark 2005) which is only carried out every five years. It will be necessary to develop an alternative data source for these e.g. a scaled down existing house survey, possibly in the form of a postal survey to the owner, say every two years. The other indicators are available at yearly intervals (although often with 12 months delay).

- The HCS-sourced information has a weight of about 42% indicating that if we do not develop more frequently updated sources for this information we are ignoring significant impacts.
- Two of the heavily weighted indicators (Healthy Housing Index and Water Use per household) have a high difficulty of calculation, and the reliability of the latter is judged to be low due to poor Territorial Authority data. However, because of their importance it is considered necessary to attempt to measure these indicators at regular intervals.
- The 'impermeable surfaces' indicator has low reliability. It is difficult to calculate accurately, because to be done properly it should include consideration of nearby parks, reserves and roadside berms, which complicates the calculation. As it has only 3% in weight it could be omitted.

Most of the indicators for measuring progress in the existing stock are easily updated with low to moderate effort and good accuracy. The exceptions are the HHI and Water Use. The HHI may be developed by the Ministry of Health but is probably several years away, and the scoring difficulty has been assessed as high for a comprehensive index. It is suggested a simplified index be developed based on a few safety indicators such as mould, vents, handrail heights, poison storage and stair condition. This was done for the HCS data, as described later in Section 9.3.

For measuring Water Use per household, ideally, a national indicator should be developed, but of the many Territorial Authorities contacted, only a few (Auckland city councils, Nelson, Tauranga) have data on residential use, and only because they require domestic water meters for all households. This is not ideal since metered users have more incentive to use water efficiently than un-metered areas. However, it will probably be necessary to use these metered authorities to monitor changes in water use, as this is the only reliable data available.

The implicit assumption in monitoring these indicators is that the Beacon programme can bring about changes in each indicator. For most this is the case, although for some this will be easier than for others. The more difficult indicators to influence are affordability, personal security, noise and air quality since they are partly, or mainly, influenced by exogenous factors. However, at this stage it is considered they need to be included since they are measures of progress towards a more sustainable environment.

Table 2: Proposed National Scorecard for existing houses

Existing Housing Indicators									
OBJECTIVE	INDICATOR	MEASURE	UNITS	TARGET by 2012	DATA SOURCE	BENCHMARK (6)	RELIABILITY	DIFFICULTY OF USE/ ACCESS	Possible WEIGHT %
Resource Use	Greenhouse gases	CO2 emissions, residential sector	tonnes/yr / household	30% reduction	MED (EDF, GHG) (1)	44.6 tonnes CO2/HH	High	Low	15
	Kitchen waste use	Composting	% of households doing it	10% improvement	HCS (2)	Not yet recorded	High	Low	3
	Recycling	Recycling bin area	% of households doing it	20% improvement	HCS	Not yet recorded	High	Low	3
Investment potential	none								
Affordability	AMP Index, house sales	Index	Index	10% improvement	AMP website	Index = 21.01 (Feb04)	High	Low	5
Personal health/ safety	Heathy Housing Index	Stairs, glazing, vents, mould, etc.	Index	10% improvement	HCS - (4)	Index =4.0 (2005 HCS)	Medium	High	10
	Fire safety	Domestic fire fatalities	Number per household	20% reduction.	NZ Fire Service	13.9/million HH (Jun04)	High	Low	3
	Security	Residential break-ins	Number per household	20% reduction	Crime statistics.	24.4/000 HH (Jun04)	High	Low	3
	Warmth	Amount of Insulation	Insulation index	30% improvement	HCS	21% score excellent (HCS)	Medium	Medium	3
Desirability	None								
Landscape	Water run-off	Impermeable surfaces (3)	Impermeable sqm/ house	10% improvement	HCS	19.5% impermeable	Low	High	3
	Solar shading	Shading during winter	1-4 scale	10% improvement	HCS	3.7 (1-4scale, higher is better)	Medium	Low	3
	Water harvesting	Rainwater tanks	Number per household	50% improvement.	HCS	0.060	High	Low	3
Community	Noise	Level of noise	1-5 scale	10% improvement	HCS	1.9 (1-5 scale, lower is better)	Medium	Low	2
	Air quality	Adjacent to pollution sources?	Number of houses	90% of houses say No.	HCS	87% say No.	High	Low	2
	Visibility	Front door visble from footpath.	% of houses saying Yes.	10% improvement	HCS	Not yet recorded	High	Low	2
Performance	Energy use	Electricity & gas use	MJ/household/ year	30% improvement	MED (EDF)	8902kWh/HH (elect & gas)	High	Low	15
	Water use	Use of reticulated water	m3/ per household/ year	50% improvement	Local councils	(7)	Low	High	15
	Water meter	Existence of meter	% of houses saying Yes.	20% improvement	Local councils	Not yet calculated.	Medium	High	2
	Weather-tightness	Leaky homes notified to WHRS	Number of new cases/ year	90% improvement	DBH (5)	1177 (Dec04 year)	High	Low	3
	Physical condition indicat	HCS average condition	1-5 scale	10% improvement	HCS	3.99 (24 components)	Medium	Medium	5
Future proof	none								

(1) MED = Ministry of Economic Development, EDF = Energy Data File. GHG = NZ Energy Greenhouse Emissions 1990-04 June 2005.
(2) HCS = House Condition Survey carried out by BRANZ in 1994, 1999, and 2004/05, and every 5 years ahead.
(3) Impermeable surfaces. Need to average over several adjacent houses, to allow for parks/ reserves.
(4) Health Housing Index may be produced by the Ministry of Health, otherwise use the simplified index developed from the HCS data, and described later.
(5) DBH = Department of Building and Housing. WHRS = Weathertight Home Resolution Service.
(6) Benchmark is at March 2004 unless noted otherwise. HCS benchmarks are in the summer 2004/05.
(7) Councils appear unable to separate commercial/ industrial use from domestic use. Metered house data could be used, but possibly biased on low side.

Total %	100
Total excluding HCS indicators %	58
Total of Low diffculty indicators %	62

The target at 2012 is expressed in terms of percentage changes from the situation at the end of 2004. The difficulty of use/access is an assessment of how hard it is to adopt the data to the form required for measurement, and how hard it is to update the data.

5.2 New housing

Table 3 shows the suggested indicators for new housing, using the same objective areas as for existing housing.

The data comes from two surveys:

- BRANZ Materials Survey (Page 1999) for new dwellings, a survey to builders and designers of over 1,200 dwelling units per year. Further details are in the Appendix.
- A yet-to-be-developed survey to owners of new dwellings focusing on sustainability questions. In brief, the survey will be a random selection of new dwellings identified from building consent lists published by Territorial Authorities

Much of the required data is already available in the BRANZ Materials Survey, which now has a seven year history of building materials and other characteristics of new housing. However, not all of the data is currently available, and a new survey will be required for some indicators in most objectives. It may be preferable that the new survey be the sole source of the new house benchmarking data, or alternatively the BRANZ Materials Survey could be expanded to include the new questions. Most of these extra questions have already been trialled in the HCS and useful results were obtained, so we envisage few problems with obtaining useful indicators. The suggested additional questions are in the Appendix, Table 7.

Table 3: Proposed National Scorecard for new houses

New housing - Indicators for benchmarking

OBJECTIVE	INDICATOR	MEASURE	UNITS	TARGET by 2012	DATA SOURCE (1)	BENCHMARK	RELIABILITY	DIFFICULTY (of calculatn)	Possible WEIGHT %
Resource Use	Greenhouse gases (initial)	Material CO2 emissions	kg C per house	10% reduction	A Alcorn, BRANZ Materials Survey	Data is available	High	High	5
	Manufacturing energy intensity	Embodied energy	MJ per house	10% reduction	A Alcorn, BRANZ Materials Survey	Data is available	High	High	5
	House floor area (2)	Credits (+1 to -9 scale)	Credits	20% improvement	HCS, New Survey (3)	-2.1 credits (HCS)	High	Medium	5
	Kitchen waste	Composting	% of households doing it	30% improvement	New Survey	none	High	Low	1
	Recycling storage	Recycling bin area	% of households doing it	30% improvement	New Survey	none	High	Low	1
Investment potential	None								
Affordability	New house affordability index	Index	Index	10% improvement	Statistics NZ	Index = 87.6	Medium	Low	4
Personal health/ safety	Heathy Housing Index	Index	Index (scale 1 to 5)	20% improvement	HCS, New Survey	Index = 3.83	Medium	Medium	10
	Fire safety index	Index	Index (scale 1 to 5)	20% improvement	HCS, New Survey	Index =2.64	Medium	Medium	3
	Security index	Index	Index (scale 1 to 5)	20% improvement	New Survey	none	Medium	Medium	3
Desirability	None								
Landscape	Water run-off	Impermeable surfaces	% impermeable area	10% improvement	HCS, New Survey	22% (2005 HCS)	Low	High	4
	Water harvesting	Rainwater tanks	% of houses	10% improvement.	HCS, New Survey	8% (2005 HCS)	High	Low	4
	Solar shade	Shading during winter	4 point scale	10% improvement	HCS, New Survey	Index = 3.83	High	Low	3
Community	Infrastructure	Public transport terminal	m to bus and terminal	20% improvement	New Survey	none	Medium	Medium	2
	Noise	Level of noise	5 point scale	10% improvement.	HCS, New Survey	Index= 4.38	Medium	Low	2
	Air quality	Adjacent to pollution sources?	% of houses	5% improvement.	HCS, New Survey	90.4% nil pollutn	Medium	Low	2
Performance	Energy use	Thermal insulation	Whole house R value	30% improvement	BRANZ Materials Survey.	none	Medium	High	20
		Built-in window vents	Yes/ No	In 90% of houses	New survey	none	High	Low	3
		Efficient heating systems	Ave number per house	30% improvement	BRANZ Materials Survey.	) currently being	High	Low	5
	Water use	Dual flush/ low flow heads	Yes/ No	In 90% of houses	BRANZ Materials Survey.	) trialled.	High	Low	5
	Orientation	Living area windows face north	Yes/No	In 90% of houses	HEEP(4), New survey	% within 15-25% ban	Low	Medium	5
	Solar overheating	Overheating Index	Index (1 to 9 scale) (5)	10% improvement	New survey	none	Medium	Medium	2
Future proof	Flexible spaces	Trusses span to outside walls.	% of houses	10% improvement	BRANZ Materials Survey.	82%	Low	Low	2
	Durability	Wall/ roof cladding life	5 point scale	10% improvement.	BRANZ Materials Survey.	3.27	High	Low	2
	Services in common area	Rooms adjacent	Yes/ No	10% improvement	New Survey	none	Low	Low	2
									100

(1) A Alcorn is the embodied energy and CO2 emission coefficients established by Andrew Alcorn.
BRANZ Materials Survey is a survey of 1200 new dwellings and 400 alterarations/ additions per year, obtained from building consent lists.
(2) House floor area. Roman Jacques method giving debits to "excessive floor area" It adjusts for number of bedrooms, garage and office space. A house can earn up to 9 debit points. Benchmark is 2000 decade houses from the 2005 HCS.
(3) HCS = House Condition Survey carried out by BRANZ in 1994, 1999, and 2004, and every 5 years ahead.
New Survey = a new survey, yet to be devised, of randomly selected new houses, chosen from building consent lists published by territorial authorities. Use similar questions as in the 2005 HCS.
(4) HEEP = Household energy end use project, a sample of 48 post-1989 houses.
(5) Solar overheating index based on sill height and eaves overhang, developed by R Jacques.

6 Measuring progress

There are three ways the National Scorecard can be used to measure progress:

- time series of individual indicators
- composite index
- objective weightings.

All of these can be used to provide different levels of information from the same Scorecard. Using more than one measurement tool will assist in highlighting potential 'conflict' of some goals e.g. healthier with warmer internal temperatures and energy use. Each measurement option is discussed below.

6.1 Indicator time series

Currently there are aggregate time series data available for five indicators used in the proposed National Scorecard.

- greenhouse gas emissions residential sector
- electricity use by households
- fire safety – fatalities
- security – domestic burglaries.
- existing house Affordability Index.

Figure 3: Greenhouse gas time series

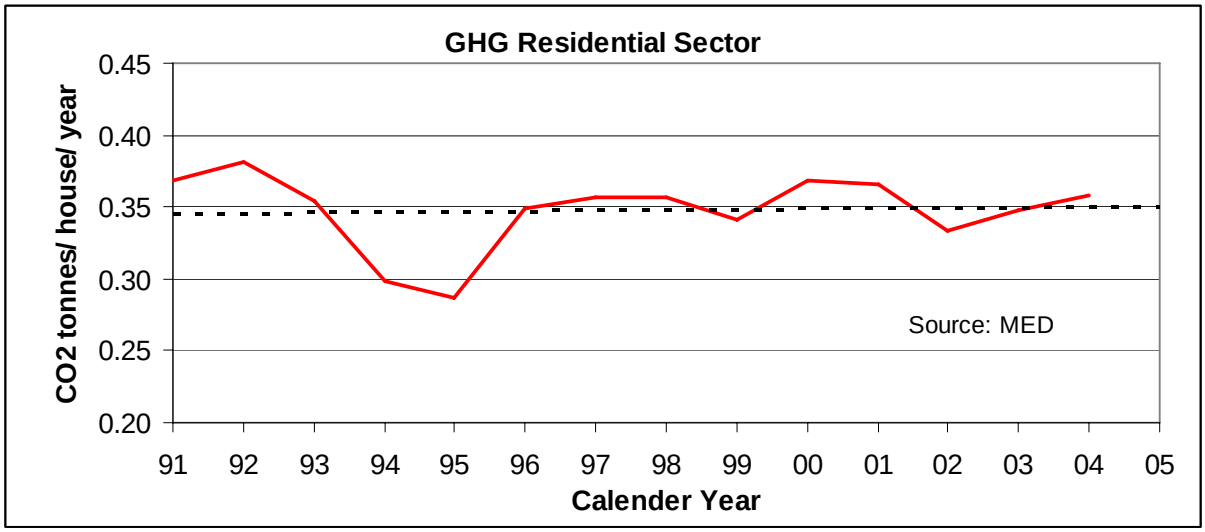
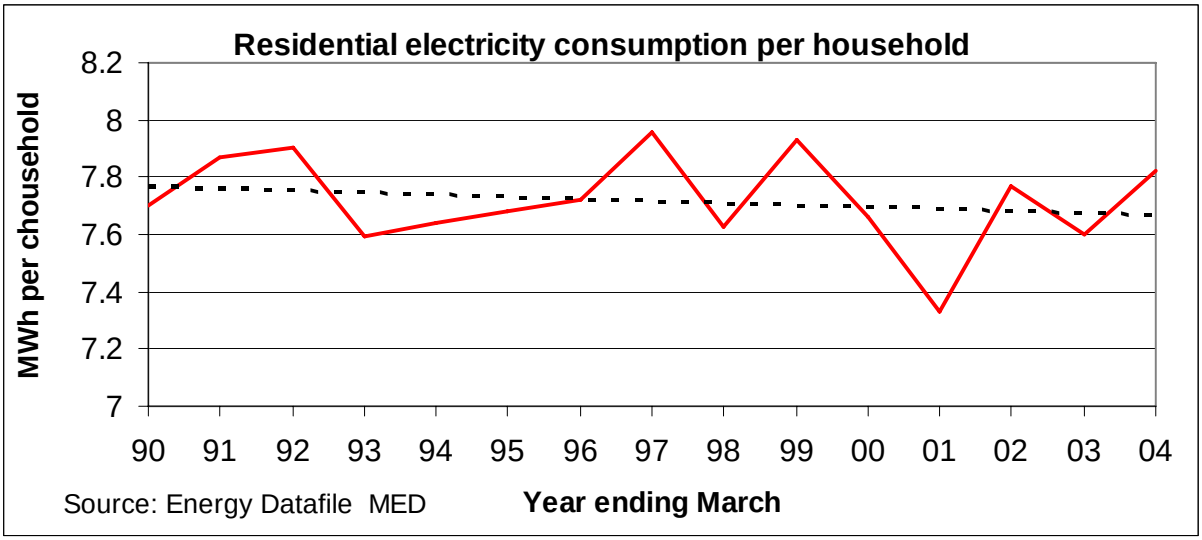


Figure 3 provides the amount of CO_2 emission for each house (average) annually. A downward trend would be expected if Beacon is heading towards achieving its goal. This has a direct relationship with the success of meeting the Resource Use objective.

Figure 4: Electricity consumption per household



Energy Use is a core indicator for sustainability in residential buildings so the electricity consumption time series provides another measure that relates strongly to Beacon's goal, in particular the Performance objective. It also has a positive relationship with the Resource Use objective. Once again a downward trend would show success to Beacon's goal.

Figure 5: Fire fatality rates

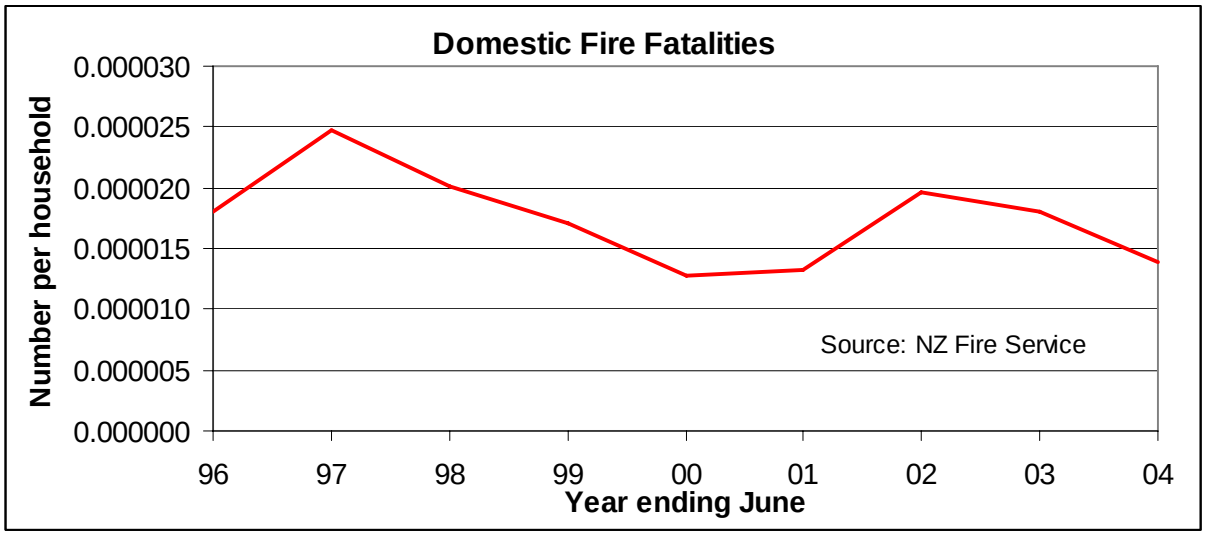


Figure 6: Domestic burglary rate

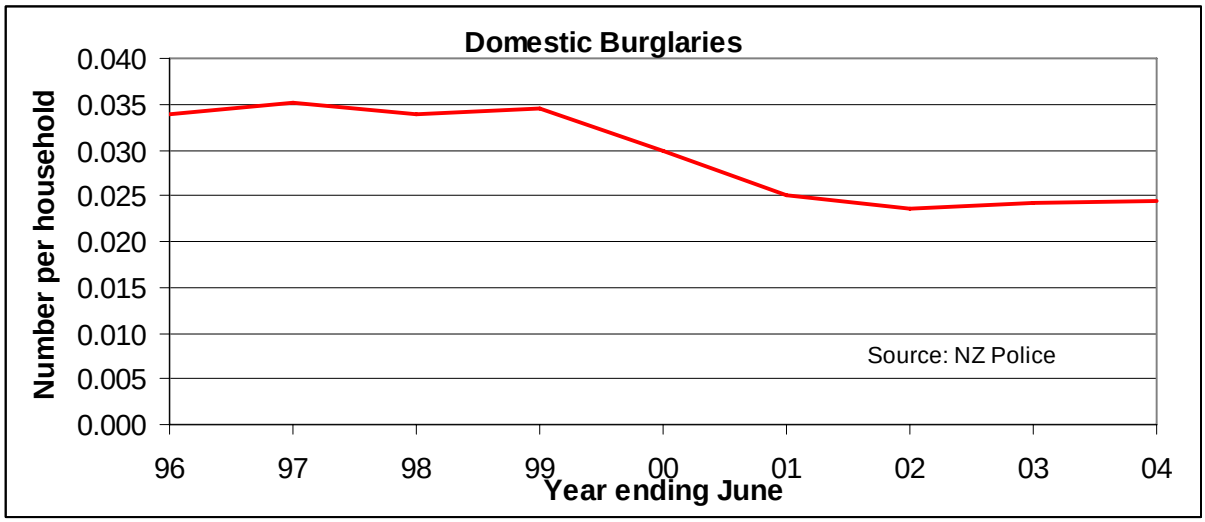
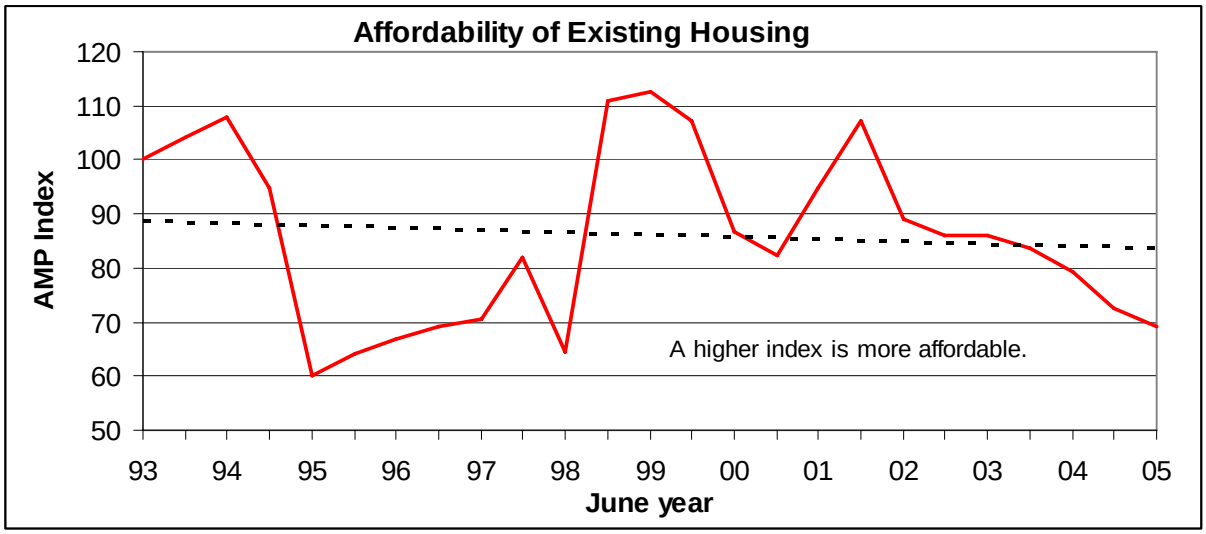


Figure 7: AMP Affordability Index



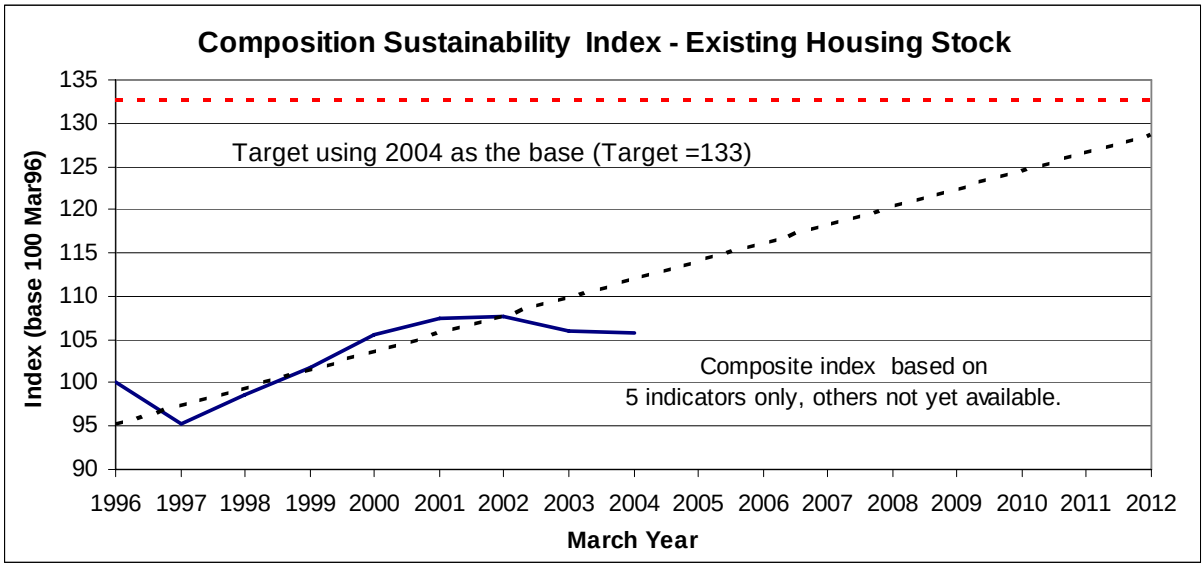
The last three time series (Figure 5–7) do not have as strong a relationship compared to the first two time series, but are useful when looking at trends for safety and affordability. The Affordability Index is much broader than Beacon's Affordability objectives, including the overall changes in house prices and is not a comparison between sustainable houses and standard housing,

6.2 Composite index for the existing stock

The most rigorous measure of progress is to combine the indicators into a composite measure using the weights in Table 2.

The indicators in Table 2 number 18 in total (omitting impermeable surfaces) and the above charts show aggregate data from official sources for five of them. The other 13 indicators are mainly from the HCS and there is only one year of data for most indicators. The five for which time series are available amount to about 41% of the weighting and a composite index for them was developed, as shown in Figure 8 to show past progress. The method used was to re-base all five indexes to 100 at March 1996 and then apply the weights to get the aggregate index year-by-year. If we apply the suggested 2012 targets in Table 2 to where we were in 2004, we get the dotted red line. The chart suggests that we are on target for 2012 for these few indicators for which we have a history. The purpose of Figure 8 is to demonstrate what a composite index will look like. As we develop measures for the other indicators the chart will change and may show we are tracking differently.

Figure 8: Sustainability Index – existing housing stock



It should be noted the target level (index =133) has no adjustment for the 90% of existing houses upgrade goal of Beacon and this will need to be included in the final version. Alternatively, Beacon could decide the Target column in Table 2 already allows latitude in meeting the goals, and further reduction in the target index (by 10% to Index= 130) is unnecessary.

6.3 Composite index for new housing

A benchmark index has not yet been developed for new housing, but the method will be the same as described above for the existing housing stock. Obviously it is not possible to develop a past time history, similar to Figure 8, since we have not recorded most of indicators for new housing year-by-year. The data from the new surveys, repeated every two years, will enable the composite index progress toward its goal to be graphed in future years.

6.4 Weightings

The weighting of the indicators can be expressed as spider diagrams (for new and existing) and progress along each objective scored as annual information is collected. So at 2005 for each objective, Beacon is at the beginning of its journey, point 0, and by 2012 to reach the Beacon goal would need to have progressed to meet the 2012 points (see Figure 9). The spider diagram immediately shows the importance of the indicators. The longer the radial line between the centre and the 2012 intersection, the greater the weighting and hence the importance. Because the Performance objective received a very high weighting it has been divided into three sub-objectives (materials, water and energy).

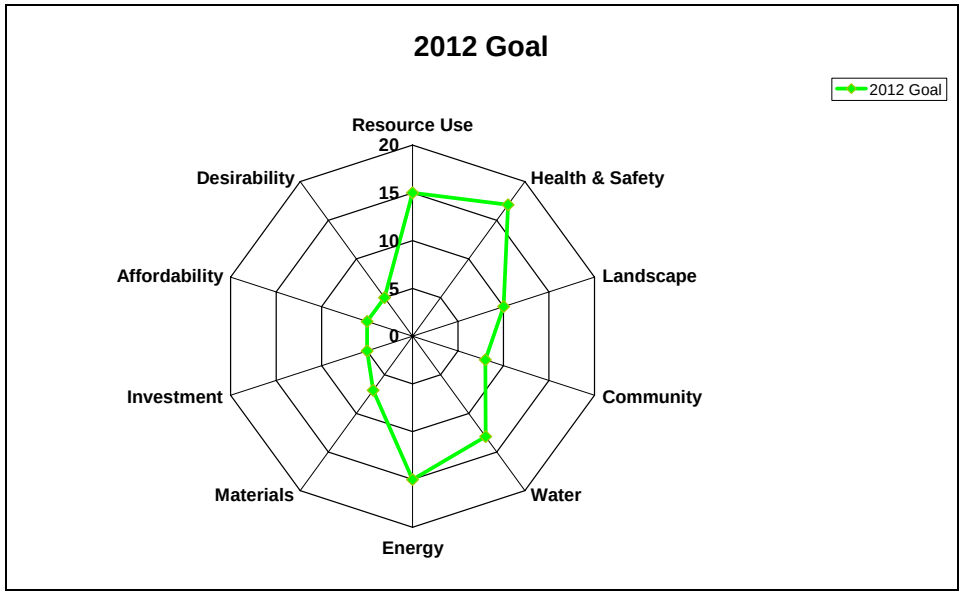


Figure 9: Spider diagram to measure progress of each objective or sub-objective for existing housing

7 High level of sustainability

The National Scorecard information provides a national picture of the improvements possible through meeting Beacon's 90% goal. This also needs to be brought down to a house level – what needs to be done for a house to get the 'tick' that it meets the Beacon 'high level of sustainability'.

To define this, the NOW Home can be used as the high level for new housing (this may need adjusting as results for the NOW Home monitoring are available in the next two years). Using the NOW Home as a base we can use any sustainability rating tool as the measure for each home. For example, the NOW Home received 63 points (a good rating) in the Green Home Scheme system. Therefore this can be the Beacon measure for new homes and a de-rating of $^1/_3$ for existing homes can be set at 42 points. Using the NOW Home as a base allows any new tools, or tools currently under development, to become a measure of Beacon's high standard of sustainability. It is anticipated that as learning from the monitoring projects (both the NOW Homes and the retrofits projects) progresses the high level of sustainability will become more defined.

It is also possible to include minimum levels for key areas where there are essential items. For example:

Table 4: Minimum and total points required using the Green Home Scheme

Minimum GHS points required in each area		
	New	Retrofit
Energy	20	10
Materials	6	0
Water	5	3
Indoor air quality.	5	3
Waste	3	3
Total points needed	63	42

8 Discussion and recommendations

The work completed in this report provides a starting point in developing Beacon's National Scorecard to monitor progress toward the Beacon sustainable housing goals. The proposed methodology is to monitor the existing housing stock and new housing separately. Published aggregate data will be used for the existing stock supplemented by a survey to owners. For new housing, either an addition to the existing BRANZ Materials Survey should be used, or a new survey developed, depending on the outcome of a pilot survey.

8.1 Existing house survey

The indicators to be measured are those in Table 2 sourced from the HCS. They are: composting bin, area for recycling storage, questions on health hazards (stairs, lighting, vents, poison storage, steps, handrails, mould etc), amount of impermeable surfaces, solar shading, rain water tanks, noise and air quality. Some questions are straightforward (yes or no), others involve some choice judgement. As far as possible checklists will be provided to help owners give accurate responses. It is proposed to carry out a pilot survey to assess the survey design, and in the pilot and the main survey some on-site checking will be needed.

8.2 New house survey

The indicators to be measured are denoted as New Survey in Table 3, namely, composting bin, area for recycling storage, questions on health hazards (stairs, lighting, vents, poison storage, steps, handrails, mould etc), fire safety (alarms, interconnected, other measures), security (lights, front door visibility etc), amount of impermeable surfaces, solar shading, rain water tanks, public transport distance (400m to a stop and 800m to a terminal), noise, air quality, window vents, solar shading (sill height and eaves width) and common service areas (is the plumbing close together?).

Many of the questions have been trialled in the most recent HCS and generally useable responses were obtained in the survey. It is suggested the new questions are attached to the BRANZ Materials Survey as a trial (see Table 7 in the Appendix), but it may be necessary to develop a stand alone New House Survey. BRANZ has already included some of the required questions are in the BRANZ survey, to start collating information on the response rate and the respondents' understanding of the questions.

It is believed the available statistics, supplemented by data obtained by new surveys, will be sufficient to adequately monitor progress toward the goals. Indicators have been identified for most of the nine Beacon objectives. It is recommended the indicators be combined into a composite index for each of new housing and the existing stock. The composite indexes are a weighted sum of indicators, and these weights were set by industry experts. The composite indexes will be calculated at regular intervals to check progress, and two yearly intervals are recommended.

8.3 Discussion

This report proposes a structure/framework and methodology for Beacon to adopt as its National Scorecard. It is accepted that the Scorecard will need further refinement and the following outlines decisions that need to be made before any further amendments are made. For Beacon to adopt this Scorecard as their own, it is important for the following areas to be discussed and agreed steps to move forward are made:

- national measurements in alignment with Beacon's needs
- core indicators – what is essential for Beacon to measure and why
- high level of sustainability.

8.3.1 National data sources

The data sources gathered for the development stage of the Scorecard were the best available, and while they are useful, some do not align totally with Beacon's goals e.g. the Affordability Index, parts of the HHI, the Fire Safety and the Security Index. While these measures are possible at a national level and Beacon is interested in them, they do not provide the necessary measures to indicate if Beacon as an entity is successful. For example, the Affordability Index is related to house prices which the market dictates and will not provide information on the affordability of sustainable housing (i.e. a sustainable house over its lifetime costs no more than a non-sustainable house). With these indicators it is also likely other influences will have a greater impact on the measure than Beacon, so even if Beacon successfully meets the defined requirement it will not show up in the national indicator.

> **Recommendations: To remove the affordability and fire safety indices from the National Scorecard. To monitor the healthy housing and security indices for their effectiveness in capturing the essence of Beacon's objectives.**

8.3.2 Core indicators

The spider diagram in Figure 9 clearly highlights the areas that are important to Beacon by the weightings. These core indicators are:

- Health and Safety
- Water Use
- Energy Use (note that Energy Use is measured under Performance but is also a surrogate for Resource Use in measuring greenhouse gas emissions)
- Resource Use.

Given Beacon's objectives and the finite short time-frame it is working within, it is essential to choose the best areas to put the greatest effort into. These core indicators highlight the areas where Beacon should be focused to gain maximum impact.

With the first iteration of the housing indicators it is now questionable how useful some of the original nine objective areas are towards Beacon's National Scorecard. This does not imply the indicators should be reduced for all Beacon's research as it is important to recognise their use in

the NOW Home protocols and design. However as Beacon progresses forward, objectives such as Desirability, when attempting to define and measure, are particularly subjective and therefore difficult to assess.

Recommendations: The following objectives are removed from the National Scorecard to concentrate on the core objectives:

- Investment Potential
- Desirability
- Affordability
- Future-proof

The following objectives are kept in the National Scorecard but they are not considered to be core indicators:

- Landscape
- Community

8.3.3 High level of sustainability

The levels set to reach Beacon's sustainability goals are based on the modelling and estimates expected to be achieved by the NOW Home. These may or may not be accurate, and as monitoring progresses and a better understanding of what is achievable in a retrofit situation occurs, the targets at both a house and national level will need to refined. It is important to note this should not be done to make the goal easier to achieve.

Recommendation: As learning progresses the targets and house level goals (high level of sustainability) are adjusted and refined as necessary.

8.3.4 Testing the National Scorecard

To test the current Scorecard for its applicability, ease of use and to assist with the updates, the following should be completed in the current year:

- The indicators to be used, and their weights, are as shown in Tables 2 and 3, except remove indicators for affordability, and fire safety, and remove all indicators under the Community and Future Proof objectives.
- The target levels for each indicator are as shown in Tables 2 and 3.
- Two new surveys are developed to monitor progress and these must be undertaken every two years.
- The existing house survey should be a postal survey to home owners, selected randomly from a QVNZ database.
- The new house survey should be a postal survey to owners, randomly selected from building consent lists published by most Territorial Authorities, and this survey should be trialled as an addition to the existing BRANZ Building Materials Survey. Some new questions have already been included to check response rates and the respondent understanding. It may prove necessary to develop a separate survey for new houses.

- Pilot surveys for both new and existing houses should be first undertaken to ensure that the method is feasible, and some on-site inspections should be carried out to check for accuracy of the responses.
- It is likely that some indicators will be discarded as impractical and unreliable after the pilot surveys.

Recommendation: Test the Scorecard to check it meets Beacon's needs and adjust/refine if necessary.

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10 Appendix One: Potential indicators

The potential indicators that were considered are in Table 5. The following is a discussion of those not included, and why they were omitted from the indicators.

10.1.1 Resource Use

Grey water reuse. These systems are believed to be quite expensive compared to other sustainability features and the uptake is likely to be low, and have a low incidence in any survey.

Green materials. Environmental Choice New Zealand has accredited a limited number of building products with an "eco-label". Currently only some paints (4 manufacturers) and some fibreglass insulation products (one manufacturer) are accredited. As the numbers of accredited products increase, this may become a usual indicator for the Resource Use objective but at present any change would have little meaning.

Construction waste. Territorial authorities are required by December 2005 to have methods for measuring the volume of landfill construction waste. The target as set by the NZ Waste Strategy is to reduce waste volumes to 50% of 2005 volumes by December 2008. The yearly volumes could be used as measure of progress of waste reduction but the disadvantage is that all construction waste (housing, other buildings) and demolition waste is included, and the Beacon project is mainly about housing sustainability. This is unlikely to be a reliable measure of trends in housing construction waste.

10.1.2 Investment Potential

Is investment potential a sustainability issue? Real price increases in housing encourage the building of new housing aiding the upgrading of the stock. Also housing is the major investment for most households and increases people's sense of participation in society. So it could be considered a sustainability issue. However expert opinion was that it should not be included. It would be preferable to monitor sustainable houses separately from the general stock, as discussed next.

Re-sale price. Turnover rates. Capital valuation. It is possible that "green" houses will achieve a re-sale price premium, compared to standard houses in the same area. Green houses would need to be identified, and QVNZ data used to compare their valuation with standard houses. As green house numbers build up, this method may be feasible, but it requires a method for identifying green houses, which is not easily formulated. One method may be to ask known "green" designers for a list of their houses. The same data source could be used to compare turnover rates and capital valuation with the hypothesis that "green" houses have lower turnover and higher valuations which improve their investment potential. This is a labour intensive indicator and is not recommended.

Maintenance requirements. This may be one indicator for the Investment Potential objective if we assume buyers are looking for low maintenance homes. The data source would be the BRANZ Materials Survey which would be used to monitor changes in the cladding types. This

is not recommended as an indicator as we believe that other factors have a greater influence on the investment potential.

10.1.3 Affordability

Is affordability a sustainability issue? The short answer is yes, because social/ cultural issues are included in sustainability, and providing affordable housing is a major part of the social and community fabric. We need to monitor movements in housing affordability and indexes for both existing housing (AMP Index) and new housing (see the new Index described in the Appendix). Existing house indexes are not totally appropriate because they largely record price movements of a financial asset rather than the underlying cost of provision of housing accommodation. The new house index is better in this regard because it includes a housing construction cost component, and land prices are also included.

The other aspect of affordability to be considered is whether the initial costs of achieving the Objectives in new and existing houses are "reasonable" in comparison to longer term benefits. It is not part of this project to quantify the benefits but it is likely that a number of the sustainability measures will have dollar benefits to off-set in part or completely the additional initial costs.

Despite the above, after consideration it was decided not to include any Affordability indicators.

Initial cost of new green homes. This indicator would be developed with the premise that "green" homes should not have an initial cost more than say 5% larger than standard new homes for the area. It would be a good indicator if it was possible to obtain reliable price data for green homes. As with the re-sale indicator we need to be able to identify green homes and carry out a random survey of their initial cost. The unit could be $/sqm and the target is that they cost no more than say 5% of standard houses (from consent lists) in the same area. This is a labour intensive indicator and is not recommended.

Maintenance and operating costs. The Household Economic Survey from Statistics NZ records expenditure by category including on house maintenance. We know from the HCS that there is a backlog of outstanding maintenance and we want to see this addressed. So an increase in maintenance expenditure could be considered a desirable trend. However at some point we are looking to see a declining trend as more durable materials are used. So the use of this indicator may give confusing messages and is not recommended. The HES also records expenditure on electricity, gas and other fuel sources. A possible indicator would be energy expenditure as a percentage of total household expenditure, with the expectation of a declining trend as houses became more sustainable. However relative price movements of energy compared to other household expenditure items may confuse this as a reliable indicator. The volume of energy used could be derived using an overall $/kWh rate however this would be an approximation and may not be accurate enough to pick up volume trends. Also it is double counting the benefits of energy efficiency measured in the Performance objective. Hence the inclusion of energy costs in the affordability objective is not recommended.

10.1.4 Personal Health/Safety

Respiratory illness. Ministry of Health has data on respiratory illness cases. The data is not ideal since other factors (e.g. anti-smoking campaigns, age structure of population) than the house environment affect the rate of illnesses. An ideal indicator would be the Healthy Housing Index (HHI) which currently being developed in the Hutt Valley area, involving inspection of 100 houses, and analysis of the medical records of the occupants. This is currently funded by the District Health Board, ACC, Hutt City Council, and Building Research. It is hoped to eventually develop a national survey, but its future is not certain at this time. The 2004 HCS asked many of the questions required for an index, and we have developed a trial index as described in the appendix.

10.1.5 Desirability

Private space. Through a survey, owners would be asked if they considered they had an outdoor space that was at least partially private. The sustainability benefits are not strongly obvious and, until densification increases, this indicator is not recommended.

House facilitating life style. Owners would be asked if the house facilitated their life style aspirations. Experience in the Canterbury region indicates that new owners almost always score high in these types of question. It is suspected the high score is biased because owners would be implying self-failure if they expressed dissatisfaction with their new house after a significant capital outlay.

10.1.6 Landscape

Water run-off, solar shading and water harvesting indicators are all recommended for measurement in existing and new housing. However it is acknowledged that the first (impermeable surfaces) is difficult to measure correctly because land adjacent to the section should also be considered in any assessment. Failing this, the impermeable surfaces within the section would be an approximate measure and probably adequate for monitoring progress. The recommendation is these indicators be retained, but not as core indicators.

10.1.7 Community

Nearest distance to facilities. The only access-to-infrastructure indicator recommended for consideration by the experts was for public transport.

Garaging. Fewer car spaces provided within the house or in any detached garaging are seen as positive for use of public transport. However there is also a need to remove vehicles parked at kerb side by providing space off-road. The experts decided this is a mixed message indicator and should not be included.

In the event it was decided not to proceed with any Community indicators.

10.1.8 Performance

Indicators were developed existing or new housing, but it was decided not to proceed with these.

10.1.9 Future-proof

Indicators were developed for new housing, but it was decided not to proceed with any Future proof indicators.

Table 5: Potential indicators

Potential Indicators of sustainable housing							
OBJECTIVE	**INDICATOR**	**MEASURE**	**UNITS**	**TARGET**	**DATA SOURCE**	**Recommended for**	
						New house	Existing hse
Resource Use	Greenhouse gases	CO2 emissions in manufacture	tonnes/yr /house	10% reduction in new houses	A Alcorn, BRANZ Materials survey	X	X
				5% reduction in existing houses			X
	Manufacturing energy intensity	Embodied energy	MJ per house	10% reduction in new houses	A Alcorn, BRANZ Materials survey	X	
	House floor area	Index (+1 to -0 scale)	Index	10% reduction in new houses	R Jacques method	X	
	Kitchen waste	Composting	% of households doing it	20% improvement	New Survey	X	X
	Recycling storage	Recycling bin area	% of households doing it	20% improvement	New Survey	X	X
	Grey water reuse	Installation of greywater systems	% of houses	In 90% of new houses	Survey		
			% of houses	In 90% of existing houses	HCS		
	"Green" materials	Sales of ECNZ approved materials	% market share	10% increase in market share.	BRANZ Materials survey		
	Landfill waste	Construction waste	Volume/ year	50% reduction	Regional councils		
Investment potential	Capital Valuation	QVNZ valuation all house sales	Index	Escalation 2% above CPI	Quotable Value New Zealand.		
	Resale price	Average "green" house resale price	$	5% better than market	Survey green houses cf QVNZ typical house.		
	Turnover	Average tenure "green" houses	years	10% increase	Survey green houses, cf all house sales data.		
	Capital Valuation	QVNZ valuation of "green houses"	$/sqm	10% higher than area	Survey of green houses, QVNZ data.		
	Maintenance requirements	Exterior envelope	5 point scale	10% improvement in new housing	BRANZ Materials Survey.		
Affordability	Affordability indexes	Index	Index	10% improvement	AMP, Statistics NZ.	X	X
	Initial cost of green homes	$/sqm "green houses"	$/sqm	<110% $/sqm of all houses.	Survey of green houses		
	Operating/ maintenance costs	$ expenditure	As % of total expenditure	10% reduction	HES		
Personal health/ safety	Health	Number of cases respiratory illness	Number per household	10% improvement	Ministry of Health.		
		Healthy housing index	Index number	10% improvement	Ministry of Health.	X	X
	Fire safety	Domestic fire fatalities	Number per household	20% reduction	NZ Fire Service		X
		Fire safety index	Index	20% improvement	Survey, HCS	X	
		Residential break-ins	Number per household	20% improvement	Crime statistics.		X
	Security	Security index	Index	20% improvement	HCS.	X	
Desirability	Privacy	Private outdoor space?	Yes/ No	90% new houses say Yes.	Survey, HCS		
	House facilitating lifestyle	Level of satisfaction	5 point scale	90% in top two levels	Survey, HCS		
Landscape	Water run-off	Permeable surface area	% permeable per house	10% improvement	Survey, HCS	X	X
	Solar shading	Shading during winter	4 point scale	10% improvement	Survey, HCS	X	X
	Water harvesting	Rainwater tanks	% of houses	10% improvement.	Survey, HCS	X	X
Community	Infrastructure	Nearest public transport terminal	kilometers	10% improvemt new subdivisions	Survey	X	
		nearest park/ reserve/ supermarket/	kilometers	ditto	Survey		
		primary health care/ education.	kilometers	ditto	Survey		
	Noise	Level of noise	5 point scale	90% in lower two noise levels	Survey, HCS	X	X
	Air quality	Adjacent to pollution sources?	% of houses	90% new houses say No.	Survey, HCS	X	X
	Visability	Front door seen from footpath	% of houses say Yes.	10% improvement	Survey	X	
	Personal transport	Garaging	Car spaces/ household	30% reduction	Survey		
Performance	Energy use	Thermal insulation	Whole house R value	30% improvement new houses	BRANZ Materials Survey	X	
		Electricity & gas use/household	MJ/household / year	20% improvement existing house	MED (Energy Data File)		X
		Energy efficient heating	Ave number/ house	30% improvement	BRANZ Materials Survey	X	
	Water use	Use of reticulated water	m3/ per household/ year	40% improvement	Territorial authority data		X
		Dual flush/ low flow heads	Yes/No	In 90% of houses	Survey, HCS	X	
		Water meters	Yes/No	% of houses saying Yes.	Local councils		X
	Solar orientation	Living area windows face north	Yes/No	In 90% of houses	HEEP, New survey	X	
	Solar overheating	Overheating Index	Index (1 to 9 scale)	20% improvement	New survey	X	
	Physical condition indicator	HCS average condition	1-5 scale	30% improvement	HCS, New survey		X
	Weather-tightness	Leaky homes	Number of new WHRS cases	Reduced by 90%	DBH		X
Future proof	Flexible spaces	Trusses span to outside walls.	% of houses	10% improvement in new housing	BRANZ Materials Survey.	X	
	Durability	Wall cladding life	5 point scale	10% improvement in new housing	BRANZ Materials Survey.	X	
	Services in common area	Rooms adjacent	Yes/ No	10% improvement	New Survey	X	
BRANZ Materials Survey is a survey of 1200 new dwellings and 400 alterarations/ additions per year, obtained from building consent lists.					QVNZ = Quotable Value New Zealand.		
Survey = a new survey, yet to be devised, of randomly selected new houses, chosen from building consent lists published by territorial authorities.					MED = Ministry of Economic Development		
HCS = House Condition Survey carried out by BRANZ in 1994, 1999, and 2004, and every 5 years ahead.					DBH = Department of Building and Housing		

10.2 BRANZ Buildings Material Survey

This survey is presented as an example of the type of postal survey that can be successful. It has been underway for 7 years and is a one page survey to builders and designers asking questions about a specific project identified from building consent lists published by territorial authorities. The survey form for new dwellings is shown in Table 4. The other side is addressed to the builder or owner, it identifies the building type and location, and it has Freepost back to BRANZ.

The response rate for new dwellings is about 30%, and a $6 lotto ticket or book voucher is offered as an incentive. Several of the questions are relevant to the indicators in Tables 2 and 3. These include floor types, framing types and claddings which enable embodied energy and the durability score to be calculated, and floor areas and insulation R values which enables the whole house R value to be calculated. The water and energy efficient appliances question are also relevant to the Beacon project. There is a question on roof framing which provides data for the flexible spaces indicator.

It would be feasible to add additional questions as shown in Table 7, though the survey would then extend to two pages. Alternatively a new survey could be developed independent of the BRANZ Materials Survey. In addition a new survey will be required for the survey of existing houses to supplement the 5 yearly HCS.

Table 6: BRANZ New Dwellings Materials Survey

NEW DWELLING

Please give this form to the builder or designer to fill out for the building consent listed over the page.

Number of dwelling units ☐ in this consent. Contract value of work (incl sub-trades) $ …… incl GST.

Floor areas Total floor area _____ Sq metres (include attached garage, exclude decks).

	Particleboard	**Plywood**	**Strip timber (not overlay, exclude decks).**	**Concrete**
Ground level	_____ Sq metres	_____ Sq metres	_____ Sq metres	_____ Sq metres
First level	_____ Sq metres	_____ Sq metres	_____ Sq metres	_____ Sq metres
2nd or more levels	_____ Sq metres	_____ Sq metres	_____ Sq metres	_____ Sq metres

If the floor is concrete is it Ribraft or similar (ie polystyrene formers) ? Yes / No (circle one)

Decks (above ground, not concrete patios) (circle one)
Includes a deck ? Yes / No (circle one or more)
Deck area_____Sq metres Deck surface material = radiata/ hardwood/ butyl/ tiles/ other/ pour-on.
Deck substrate = plywood sht/ fibre cement sht/ concrete/ timber joists.

Wall Framing (tick appropriate box)
Radiata ☐ Steel ☐ Douglas fir ☐ Other ☐ (state) ……
Was the wall framing precut or prenailed ? Yes / No (circle one)

Framing timber treatment	Untreated kiln dry	Untreated wet	H1.2	T1.2 (orange)	H3.1
Tick one or more	☐	☐	☐	☐	☐
State where used (eg outer walls, subfloor, etc)	……	……	……	……	……

Roof framing Trusses ☐ Timber rafters ☐ Other ☐
What framing is used ? ……(state)
If there are trusses, are they designed to span between exterior walls without support? Yes/ No (circle one).

Floor joists	None	Solid timber	Posistrut	Hybeam (I beam)	Steel	Twinaplate	Origin (I beam)	Other (state)
Tick one or more	☐	☐	☐	☐	☐	☐	☐	☐
Joist depth mm	……mm	……mm	……mm	……mm	……mm	……mm	……mm	……mm

Insulation (tick one or more)	Pink Batts	Bradford Gold	Premier Fibreglass	Blown FG Rocwool	Greenstuf (polyester)	Other polyester	Treated paper	Wool	R value of insulation
Wall insulation	☐	☐	☐	☐	☐	☐	☐	☐	……
Ceiling insulation	☐	☐	☐	☐	☐	☐	☐	☐	……

Installer (name) ……

Noise Control (circle one)
Have you installed noise control products? Yes / No What type? ……

Building wraps	Flamestop	Thermakraft	Bitumac	GIB underlay	Greencap	Pauloid	Other (state)
Roof wrap	☐	☐	☐	☐	☐	☐	☐

(tick one or more)	Flamestop	Tyvek	Thermakraft coverup	Flamegard II	Greenwrap	Fastwrap	Other (state)
Wall wrap	☐	☐	☐	☐	☐	☐	☐

Wall cladding State type
Type .....% area..... eg fibre cement sheet, 75%
Type .....% area..... clay brick, 15%
Type .....% area..... cedar 10%
(approx % wall coverage) plywood, stucco, plaster on polystyrene, plastered brick, concrete block, etc.

If fibre cement what type? - Harditex, Monotek, Linea, Hardiflex, Hardiplank, CSR, BGC, Prima, Eterpan, Titian,etc.
(circle one or more)

Roof cladding Type .....
eg metal tiles, prepainted corrugated, other steel profiles, concrete tiles, butyl, asphalt shingles, fibreglass shingles, etc. (circle one)

Wet wall linings (incl kitchen, bathroom, laundry)

(tick one)	Formica Aquapanel	Seratone	Hardies	GIB Aqualine	Other
	☐	☐	☐	☐	☐ ……

Energy effciency Tick if any of the following are being installed:

Double glazing	Solar water heaters	Dual flush toilets	Energy efficient lights	Heat pump	Low flow showers
☐	☐	☐	☐	☐	☐

Construction Delays
If you signed a contract with the owner now, how many weeks before on-site work would start? .....wks

Thank You. Please fold this form, tape or staple, and freepost. Sep-05

Table 7: New survey questions to ascertain sustainability features

NEW HOUSE FEATURES

Rooms

Number of bedrooms ☐ (Please enter the number.)

Please circle as many of the following you have: Family room, Formal lounge, Study, Games Room, Conservatory Attached garage, 2nd bathroom, 3rd bathroom, Seperate dining room.

Recycling and waste

Do you make compost from your kitchen waste? Yes/ No (circle one)

Do you have an area under cover for storage of recycled materials (paper, plastic, cans, etc)? Yes/ No (circle one).

Health and Safety

Please circle the appropriate condition below

Mould on inside walls/ ceilings. Heavy, Medium, Light, None.

What condition is the flooring covering on your inside steps? Good, Average, Poor, no floor covering.

Do you have mechanical vents in the kitchen ? Yes/ No (circle one)

Do you have mechanical vents in the bathroom? Yes/ No (circle one)

Do you have vents built-in to your windows? Yes/ No (circle one)

Do you use high cupboards to store detergents and cleansers? Yes/ No (circle one)

What height are your handrails above the floor or deck level ? (measure to top of rail) …….. mm.

Number of smoke alarms ☐ enter number

Are alarms battery powered or mains connected? (circle one)

Please circle as many of the following you have: fire extinguisher, hose reel inside, fire blanket, sprinklers.

Security

Do you have security lights Yes/ No (circle one)

Can you see the road footpath from the front door? Yes/ No (circle one).

Section

Approximately what percentage of your section is covered by your house, paved or concrete surfaced (i,e driveways, paths, patios, etc)?

(circle one box)

20 30 40 50 60 70 80 90 100 percent

Do you have a rain water tank (s) ? Yes / No (circle one). If Yes how large …….litres.

Do trees or buildings shade your house? (circle one)

Never/rarely, Late afternoon/early morning, Shaded in winter, Most of year all day.

Community

(circle below)

How many metres to the nearest bus stop? Less than 400 m / Greater than 400 m.

How many metres to a major transport terminal (train, bus depot)? Less than 800 m / Greater than 800 m.

How noisy is it outside your living areas? (circle one)

. Always quite, Mostly quiet, Moderate noise, Loud noise, Constant loud noise

House location. (circle one)

Adjacent to busy road, Adjacent to unsealed road, Close to petrol station, Close to polluting industries

House solar heating

Do the living area rooms (family room, dining) face the sun for most of the day? Yes / No ? (circle one).

For the north and west facing windows what height are the eaves above the bottom of the window? ……. mm.

For the north and west facing windows what width are the eaves? ……. mm.

Plumbing

Are the kitchen, laundry and bathroom next to each other? Yes / No. (circle one).

Thank You. Please fold this form, tape or staple, and freepost.

10.3 Benchmark indicators – existing houses

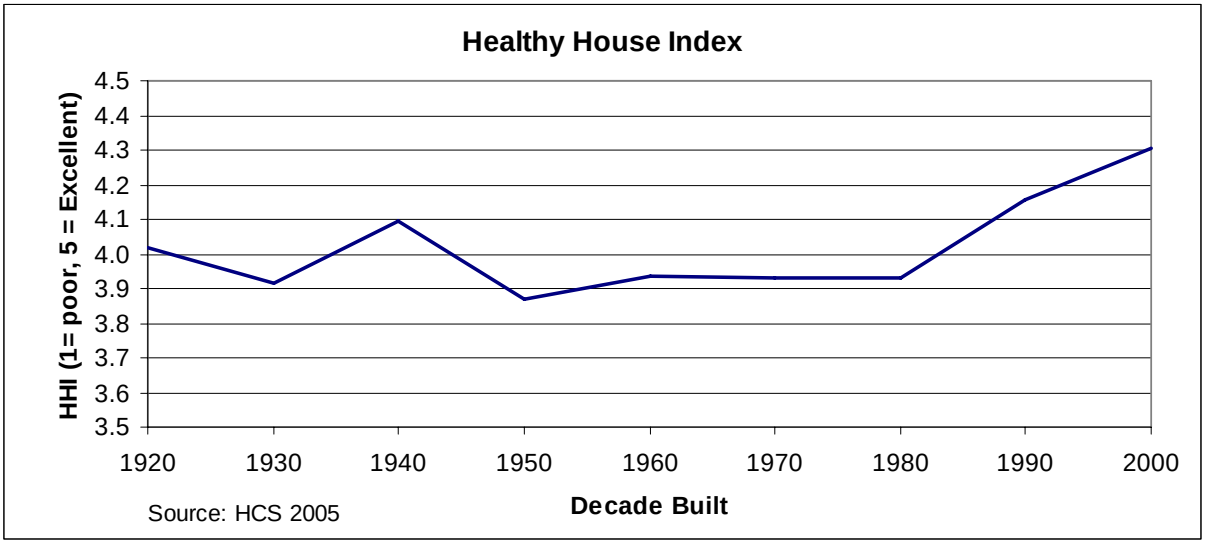
This section describes how selected indicators have been developed (for those not readily available from existing sources), and some additional data on trends is included. Where HCS data is shown by house age, it is suggested that the 2000 cohort be used as the benchmark, in the absence of more precise yearly data.

Greenhouse gas emissions by the residential sector were calculated as shown below.

CO_2 Emissions			
Residential sector		Hse stock numbers	
(Source MED Table E14)		(MarYr)	
Dec Yr	kt CO2	1300374	Ratio
91	485	1318243	0.37
92	509	1336111	0.38
93	479	1353980	0.35
94	409	1371848	0.30
95	399	1389717	0.29
96	494	1413229	0.35
97	512	1436741	0.36
98	521	1460254	0.36
99	507	1483766	0.34
00	555	1507278	0.37
01	561	1533041	0.37
02	519	1558805	0.33
03	551	1584568	0.35
04	576	1610332	0.36
05		1636095	

Healthy housing index. House shading, External steps condition, Handrail height, Poison storage cupboards, Internal stairs condition, Mould condition, and Alarms number/ condition were all scored on a 1 to 5 scale in the HCS, and equally weighted in the HHI. The index by age cohort is in Figure 10.

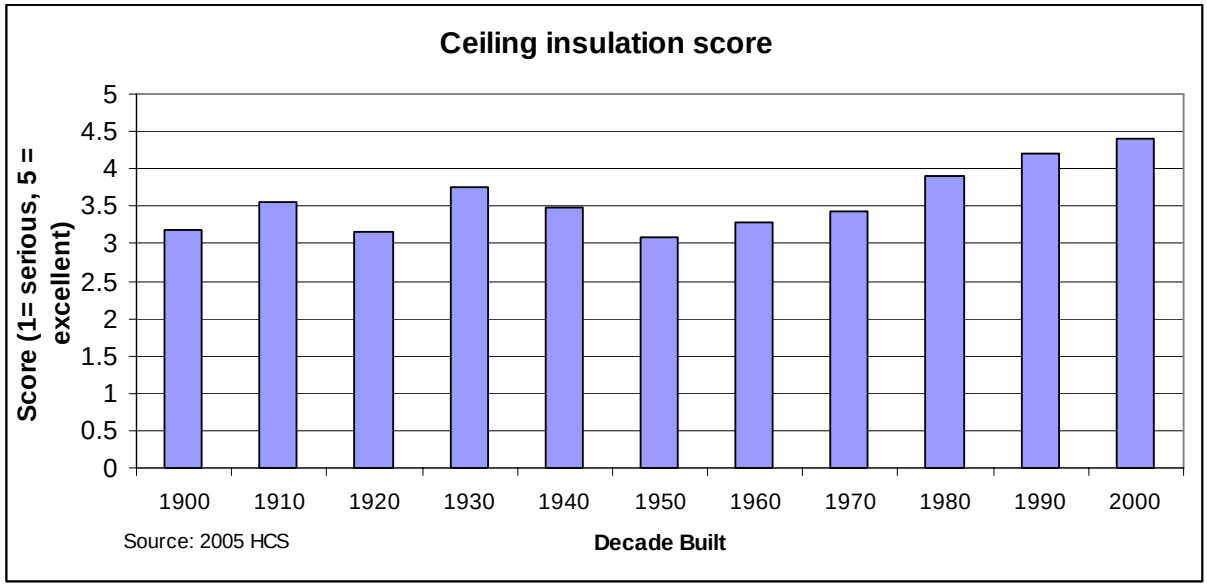
Figure 10: HHI by decade from the 2005 HCS



Warmth. The score for the insulation in the HCS was used as a proxy for the warmth indicator. The score method is shown below, and the score by age cohort is in Figure 11. As expected since the 1940s the younger houses have a better score than older houses. Significant retrofit has occurred in some older age cohorts (1910 and 1930).

Ceiling insulation condition score				
% insulation ceiling cover	Thickness mm	Condition Score	Count (houses)	%
nil		1	35	7
other		2	55	11
100	50	3	118	24
100	75	4	180	36
100	>75	5	106	21
>79	>50	3	494	100

Figure 11: Ceiling insulation score by house age



Impermeable surfaces. Figure 12 shows the percentage of impermeable surface around the house from the HCS, exclude the house area. There is a gradual upward trend in the percentage since the 1920s probably reflecting decreasing section sizes.

Solar shading. Figure 13 shows the solar shading score by age cohort from the HCS. The scoring appears to trend upward with younger houses, but some 1980s houses score poorly.

Water harvesting. The 1970s and 1980s cohorts have a high incidence of rain water tanks compared to other cohorts, and the reasons for this are not known, see Figure 14. Note the error margin is quite high, about ±7% at the 95% confidence interval, so the fluctuations between age cohort are not significant.

Figure 12: Impermeable surfaces by house age

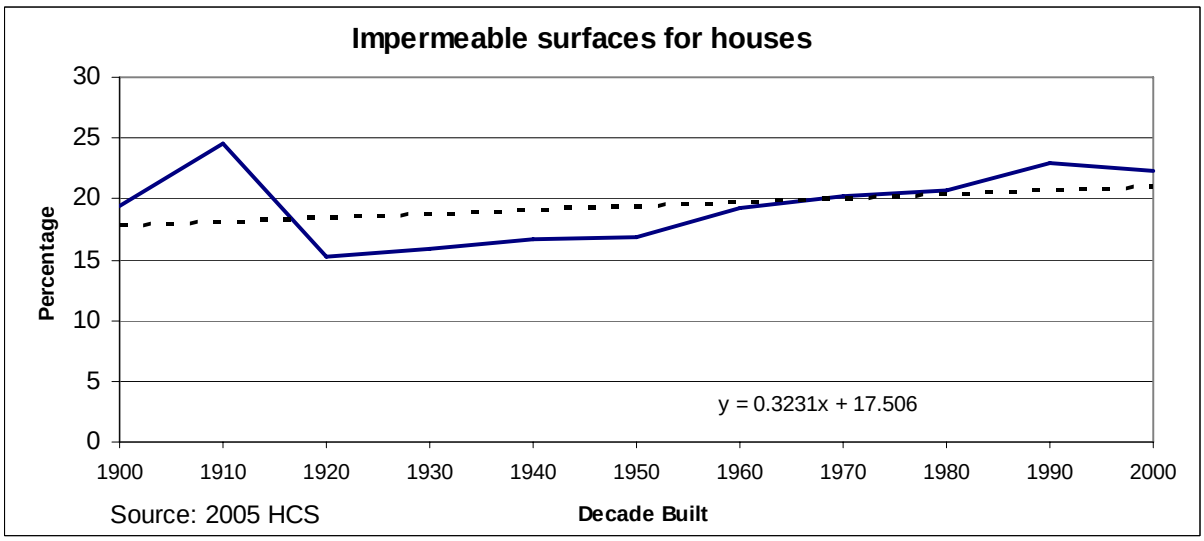


Figure 13: Solar shading by house age

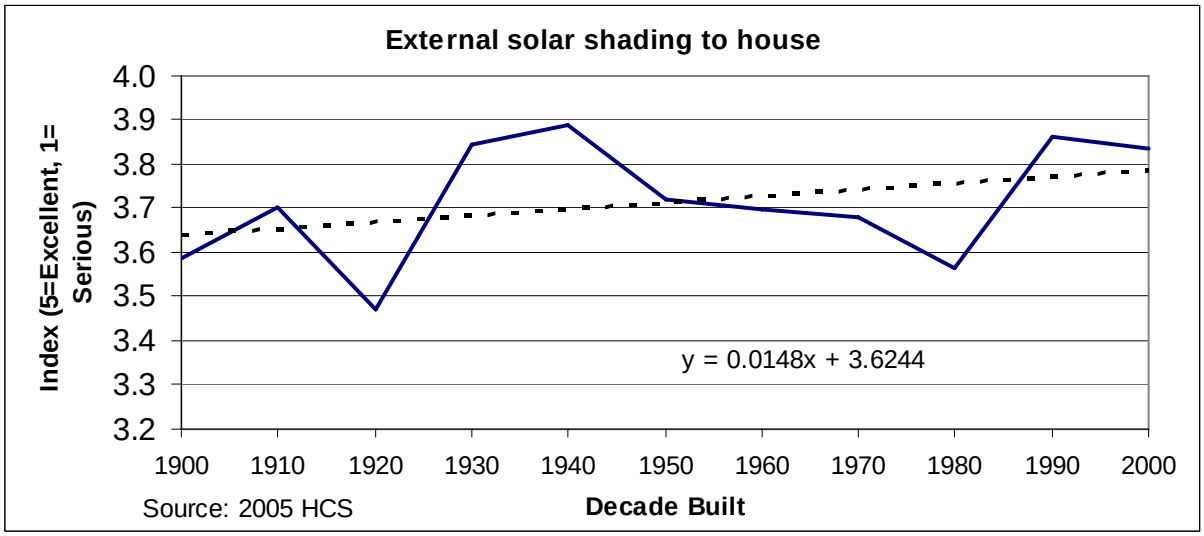
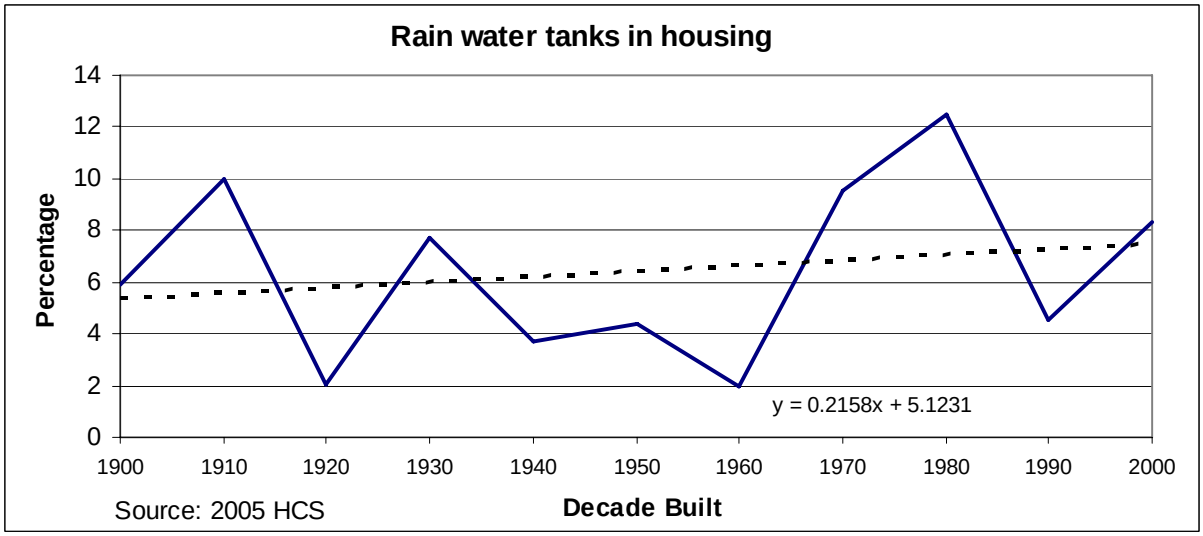


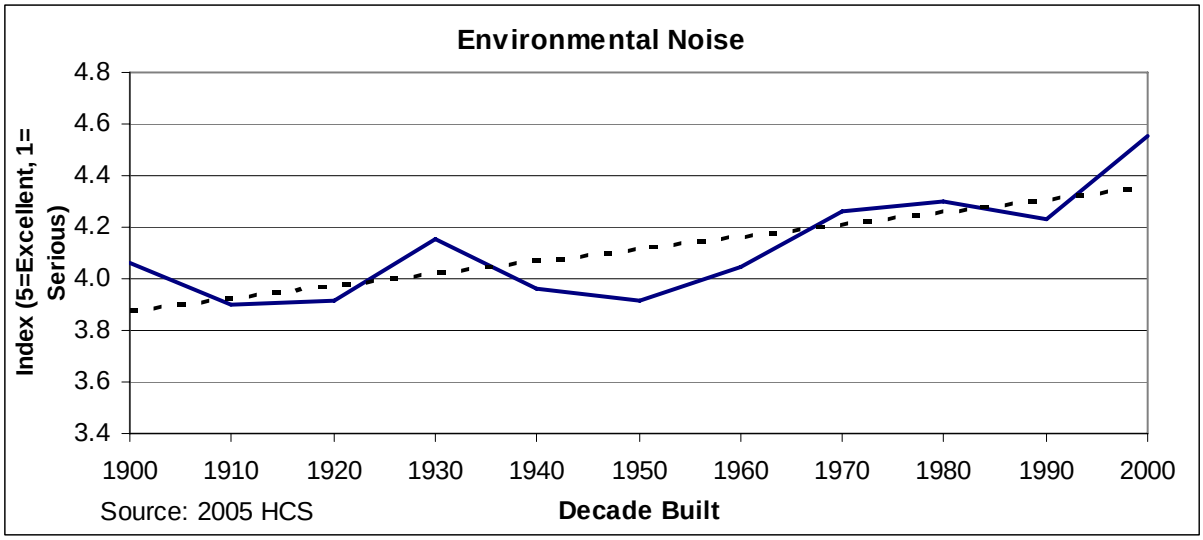
Figure 14: Rain water tanks by house age



Environmental noise. The noise score method, and the results from the HCS, are in the table below, indicating very few houses in the 2 worst categories. Figure 15 shows the results by age cohort, indicating an improvement with younger age.

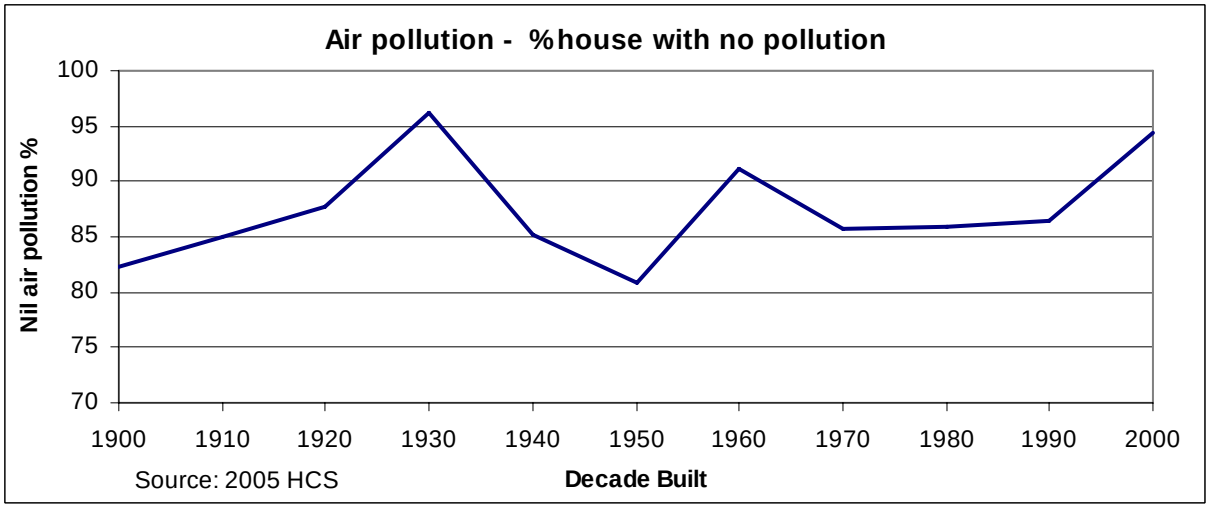
Environmental noise	count	%
always quite	195	35
mostly quite	251	45
moderate noise	109	19
loud noise	8	1
const loud noise	0	0
	563	100

Figure 15: Environment noise by house age



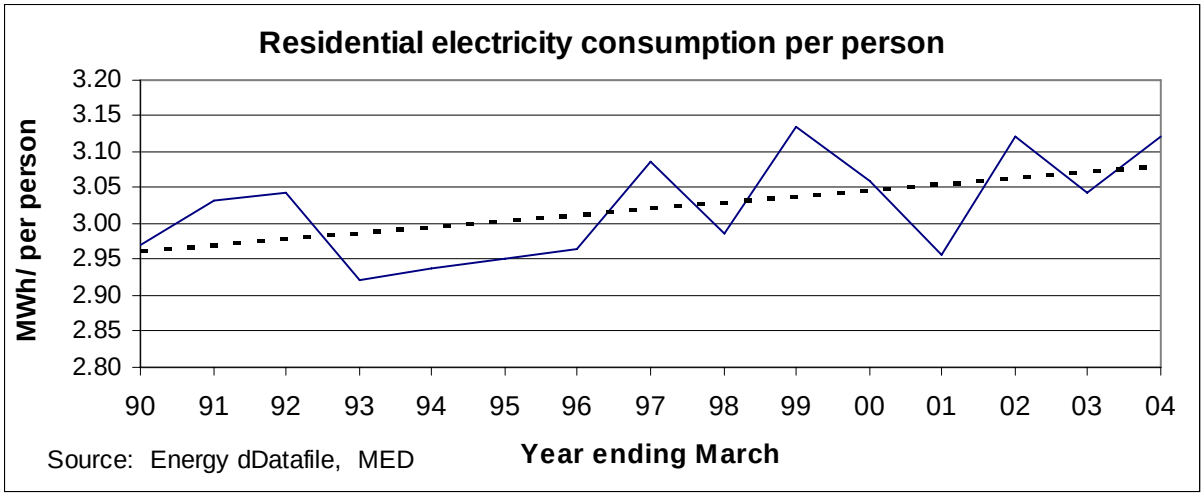
Air quality. The HCS listed possible sources of pollution (busy road, unsealed road, petrol station, polluting industry, and commercial orchards) and, if the house was "close" (undefined) to these, the inspectors would record positively. Figure 16 indicates that quite a high percentage of houses have no pollution sources.

Figure 16: Air pollution by house age



Energy use. An earlier section, see Figure 4, had energy use per household trending downward with time, as obtained from official information. One of the difficulties of this measure is that, if expressed in terms of energy use per person, the trend is upward, see Figure 17.

Figure 17: Energy use per person by year

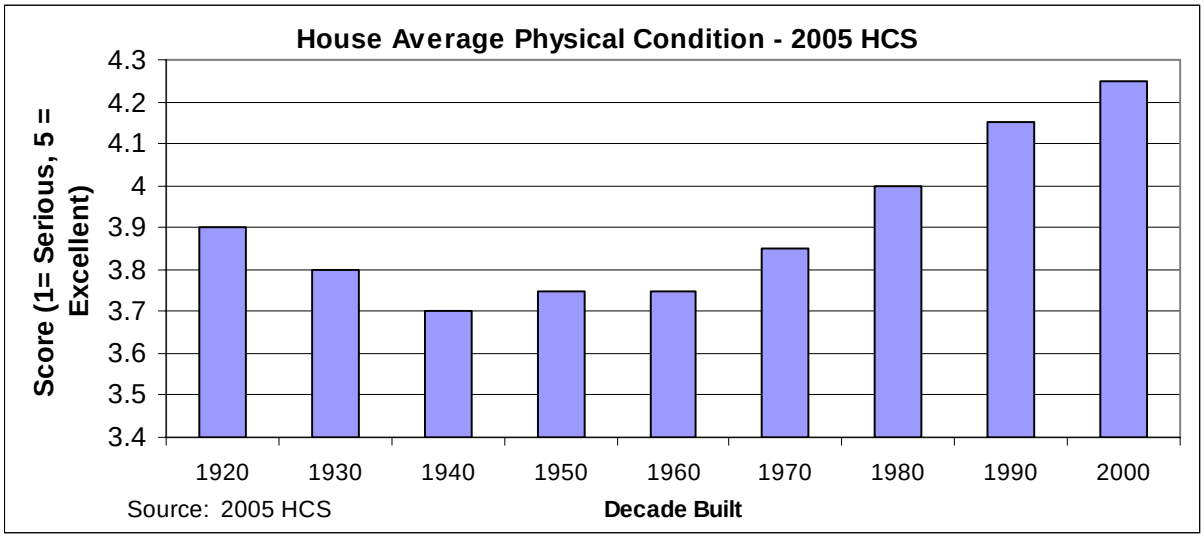


The Beacon project has an emphasis on houses rather than people's behaviour, though the latter is an integral part of persuading households to adopt sustainability. We aim to change houses and how they performance by physical measures, though hopefully the occupants' behaviour will also change to become more sustainable. At this stage consumption per household seems to be the correct indicator to monitor, rather than consumption per person.

Water use. Benchmarks are not yet available as we do not yet have reliable data on average domestic water consumption from territorial authorities. As described earlier it is likely Beacon will need to use meter consumption from selected authorities as the benchmark.

Physical condition indicator. The HCS condition by house age is in Figure 18, and the average for all cohorts and all 30 components (foundations, claddings, linings, fittings, etc) is 3.99. The new survey to owners needs to be reduced to only 3 or 4 components that they can easily assess, and the equivalent HCS average condition will need to be recalculated as the benchmark. This has not been done as yet.

Figure 18: Average physical condition by house age



10.4 Benchmark indicators – new houses

Some of the same indicators as described for existing houses are used in new houses, and it is proposed to use the post-2000 house age cohort in the 2005 HCS as the benchmark for some indicators for new housing.

Greenhouse gases and manufacturing energy. Data is available from the BRANZ Materials Survey of new houses (cladding types, frame types, flooring, floor area), and the Alcorn work, to calculate the embodied energy and CO_2 emission for various combinations of material types. The BRANZ survey tells us the market share of each material type and this can be scaled up using building consent data. The benchmark calculations have not been done as yet, and it is intended to produce cladding and frame type combinations which show embodied energy and CO_2 emissions per sq metre of floor area. With these, the aggregate values can be readily determined from time to time as market share changes.

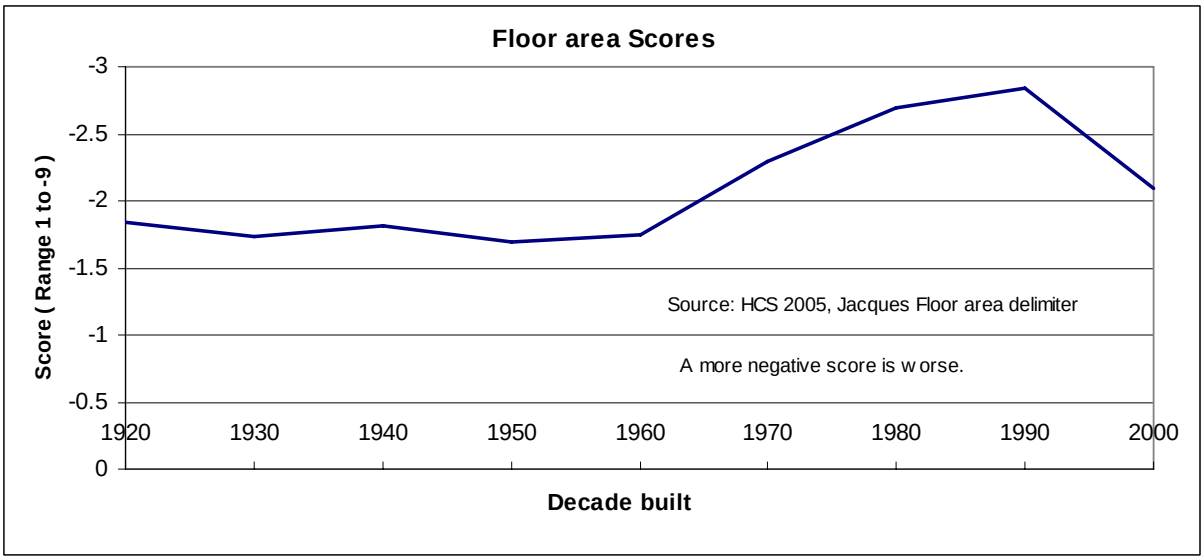
House floor area. It is considered that excessively large houses should be penalised compared to smaller houses, taking into consideration number of bedrooms and office space. A method developed by R Jaques, based on the Vermount approach, is shown in Table 8. The net effect is that one point is deducted for each 20 sqm of "inappropriate" floor space. This allows for 12 sqm per bedroom plus the home office, and garage space is not included. The arrows show the NOW Home.

Table 8: Floor area scoring

NET Floor Area (ex. office and unheated spaces)	Number of bedrooms					
	2	3	4	5	6	CREDITS
	88	102	116	132	150	1
	108	**122**	138	155	175	**0**
	127	142	159	177	198	-1
	146	162	180	200	222	-2
	165	182	201	222	245	-3
	183	202	223	245	269	-4
	202	222	245	270	296	-5
	221	242	267	297	331	-6
	239	262	288	322	360	-7
	258	282	310	347	386	-8
	274	302	335	375	416	-9

The method was applied to houses in the HCS, as shown in Figure 19. The range of score is quite small, between -1.6 and -2.8 and they scored less favourably the younger the house, though there was some improvement in the 2000 cohort.

Figure 19: Floor area scoring by house age



Affordability. A new house index was developed for this project, since the published indexes are for existing houses only, see Figure 20. The components are:

Affordability Index = Labour wages index / [((1-a) x CGPI + a x Section Price Index) x CAF(r/20 yrs)].

Where Labour wages index = Labour cost index, all industries all occupation, wages & salaries, from Statistics NZ.

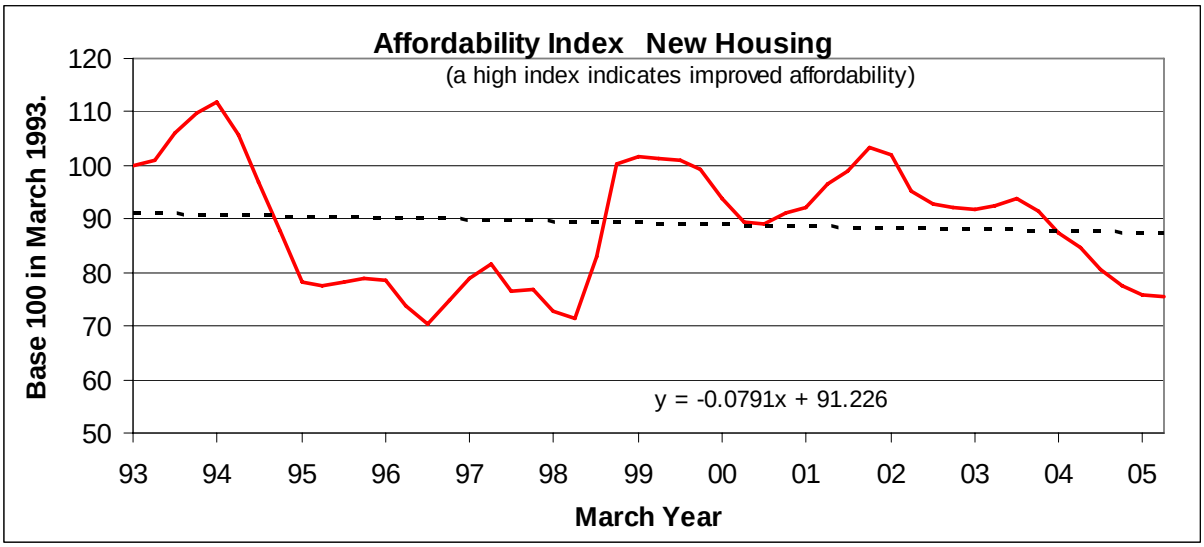
CGPI = Capital good price index (housing) from Statistics NZ.

Section Price Index is from QVNZ.

a is a ratio, currently 52%, the percentage of the total price that is the land cost.

CAF (*r*/20yrs) = capital recovery factor for interest *r* over 20 years, and is the factor used to calculate repayments of interest and principal.

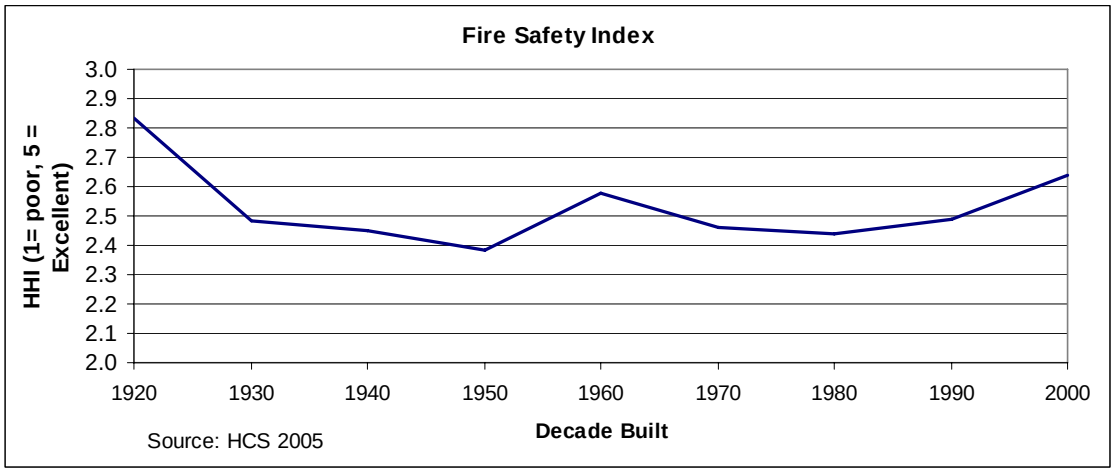
Figure 20: Affordability Index – new housing



In brief, the affordability index is wages divided by housing costs and interest rates. The results are in Figure 20 and have been based at an Index value of 100 in 1993. The affordability trend is downward recently, with escalating building costs and rising interest rates.

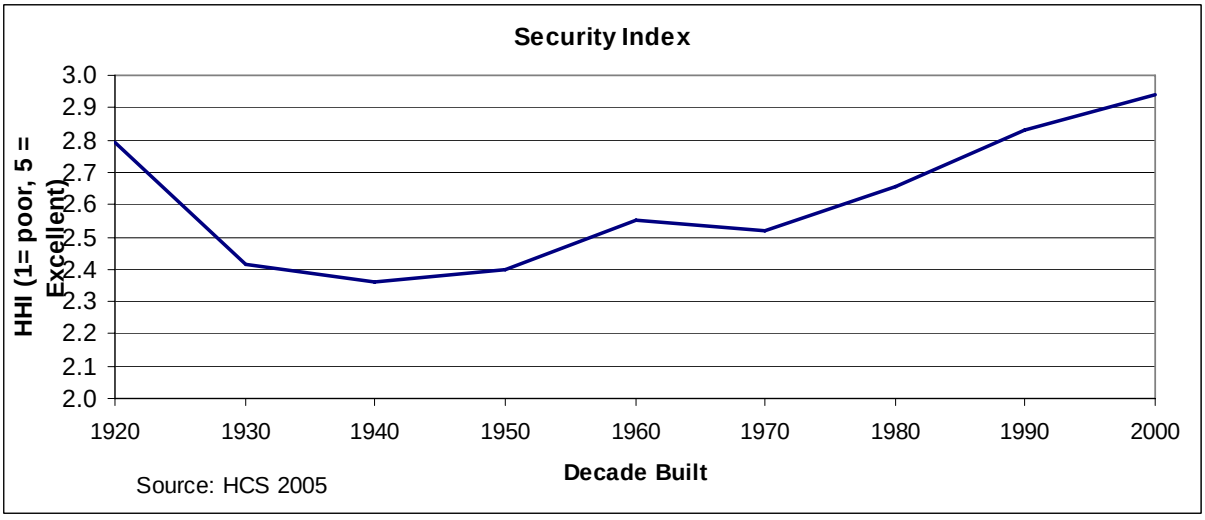
Fire safety. The HCS recorded smoke alarm numbers, other fire safety devices (blankets, hoses, sprinklers, extinguishers, etc), and sources of ignition and a method rating these occurrences on a 1 to 5 scale was developed, as shown in Figure 21. A similar approach could be used for new housing and the 2000 cohort used as a benchmark.

Figure 21: Fire safety index by house age



Security A security index was developed from HCS data, based on a count of security devices (alarms, lights, deadlocks, grilles, window stays, etc, the more the better) and scaled to a 1 to 5 scale, see Figure 22. However, experts have commented that increasing numbers of security devices is not necessarily a good indicator of a person's feeling of security, and that another security indicator should be investigated.

Figure 22: Security index by house age

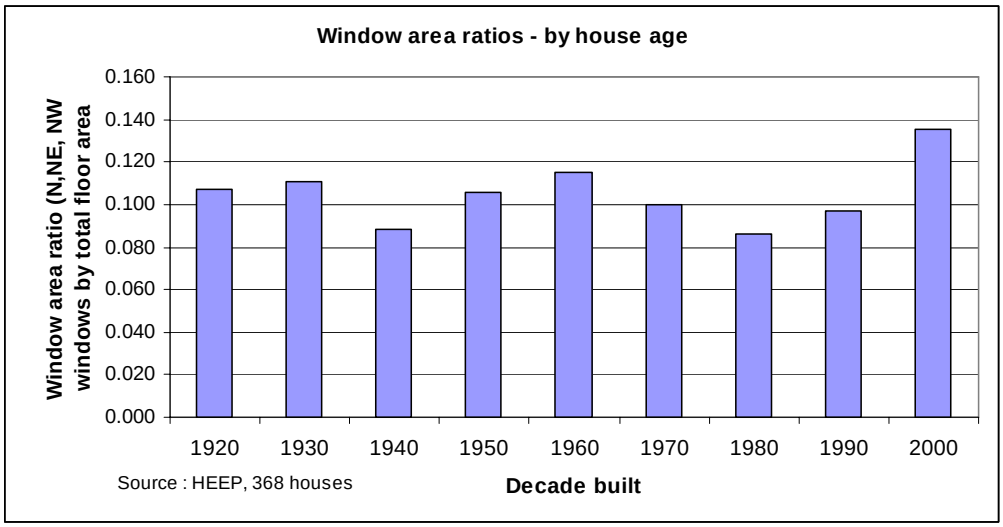


Thermal insulation. The BRANZ Materials Survey is currently collecting data on R values of insulation in new houses. The response rate for this question is fairly low, but is likely to be large enough to establish a benchmark for the whole-house R value.

Efficient heating systems. Water use. The BRANZ Materials Survey is collecting data on efficient appliances and water conservation devices (see Table 6), and a good response rate is being achieved for this question, enabling benchmarks to be clearly established.

Orientation. This indicator is to measure whether the house is appropriately oriented to achieve significant solar space heating gains. The measure is that north, NE and NW facing windows should have an area that totals between 10% and 20% of the total floor area. The current average is about 14%, see Figure 23. This question may be too difficult for owners, as they need to measure window areas and know their orientation. It is possible this indicator will be omitted, depending on the results of the pilot survey.

Figure 23: Window area ratios by house age



Solar overheating. A rating method developed by R Jaques and A Stoecklein checks window dimensions and eaves overhang for potential solar overheating. It requires the eaves width, window sill to eaves height, and an indication of whether exposed solar mass is available (exposed floors or mass walls). These question can be readily included in the New House Survey, and will provide a benchmark.

Flexible space, Durability, Common areas. The BRANZ Materials Survey is successfully recording truss spans which is a measure of flexible interior space. The same survey also records cladding types which are combined as shown in the table below to provide a durability score. The current benchmark score is 3.27.

	DURABILITY Points		
	Roof		
Wall	Concrete tile	Sheet metal	Metal tile/ butyl/asphalt
Brick/Conc	5	4	3
FC Sheet/ stucco	4	3	2
Weatherboard/ Ply sht/ EIFS	3	2	1
1-5 scale: 5= excellent durability,1 = poor durability.			

The Common area indicator is simply whether the laundry, bathroom and kitchen are adjacent so that plumbing runs are minimised. However it remains to be whether this will prove to be a useful indicator in the pilot survey, and it may be omitted in the full survey.