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Housing Typologies – Current Stock Prevalence

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About This Report

Title

Housing Typologies – Current Stock Prevalence

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Abstract

This report analyses the characteristics of the housing stock that affect the ability, opportunity and need to retrofit sustainability features. It covers such features as roof space and sub-floor space access, existing insulation levels, types of space heaters, chimneys, water cylinders, window and wall cladding condition, etc. The report confirms the typologies developed in earlier work are generally useful and numbers in each group are provided.

Reference

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1 Executive Summary

The typologies proposed in earlier work by Beacon (Ryan et al, 2008) are considered to be suitable. The categories are a generally recognisable set of housing eras, and each typology is suitable for a common package of retrofits. The typologies and number of houses are provided in Table 1. Stocks numbers are also provided for the three NZS4218 climate zones. The largest group is the 1940s to 1960s mass housing group and consideration was given to sub-dividing it. However in general the three decades looked fairly similar and their characteristics lend themselves to a common set of retrofits. Each typology was assessed for ease of retrofit based on a number of physical parameters, e.g. roof and sub-floor access and likely replacement of components. They were scored across a number of measures including existing insulation levels, roof and sub-floor access, chimneys, window and wall condition (for insulation retrofitting during replacement), and hot water cylinder age (for a solar water replacement). The best scoring in terms of retrofit favourability were the villas, 1920s bungalows and the 1940s to 1960s mass housing group.

Table 1: Typology number summary

Typology summary

Numbers as at March 2006

Number of dwelling units (000)

Villas	Bungalow 1920-36	Art Deco 1925-40	Mass housing 40s-60s	Multi units Pre-1960	Multi units 1960-70s	Mass housing 1970-78	Housing 1978-80s	Multi units 1980-90s	Housing 1990-96	Housing post 96	Multi units 2000s	Total
86	113	18	479	34	133	151	182	68	112	201	28	1606

2 Introduction

The main aim of this report is an analysis of the typologies of the housing stock and quantification of the numbers in various groups that are considered appropriate for energy saving retrofit projects. This report is in four main sections:

- Review of typologies developed in the draft Beacon Working Paper "Typologies to inform energy retrofit" (January 2008) and comparison with other Beacon market segmentation work.
- Review of databases that may assist in quantifying the stock numbers in each typology.
- Development of a method for estimating the numbers of different typologies.
- Development of a methodology for forecasting future stock profiles.

The research outlined in this report relating to typology and stock prevalence falls under work strand one (WS1) of Beacon's Energy Retrofit project. The key research questions for this work strand are:

- What housing typologies are easiest to retrofit, and what proportion of the overall housing stock do they make up?
- What energy efficiency gains are possible within the constraints of individual dwelling typologies? And,
- What parameters make a house not worth retrofitting and how can these be defined?

The main objective of WS1 is to establish the impact of house typology of existing dwellings on retrofit opportunities. The other two work strands are concerned with:

- Understanding energy use in homes by users and consumers (WS2); and,
- Developing optimised packages and tools for the market to stimulate energy retrofit (WS3).

Collectively, the three work strands underpin a decision-making framework so that a series of retrofit packages can be developed that will provide effective retrofit responses for the majority of New Zealand housing stock.

This report reviews and builds on an earlier piece of research that established a housing typology framework for Beacon (Ryan et al, 2008). That framework forms the basis of Beacon's advice to consumers, industry and government on how to retrofit existing homes to meet a HSS High Standard of Sustainability™. The intention is that these two reports are read together to provide an insight of the scale of the challenge for New Zealand in meeting Beacon's goals. The knowledge gained from this segmentation of the housing stock and an understanding of the prevalence by retrofit typology will help to prioritise Beacon's efforts in this area.

3 Method

3.1 Review typologies in the Working Paper

A literature review was undertaken of previous work for Beacon, and others, on the characteristics of the housing stock, and the types of retrofit measures that are used.

3.2 Review databases

Relevant databases were identified and examined for the detail available, including house types, house component details, existing retrofit information, and regional breakdowns.

3.3 Develop a method for estimation of numbers of different typologies

Each database was found to contain useful information including top-down and bottom-up information. The databases are discussed in the next section, but census data is the most complete; QVNZ data gives age profiles which is the starting point for developing typologies; the BRANZ House Condition Surveys and HEEP data provide good bottom-up data (e.g. types of components and their characteristics); and building consents give a good breakdown of new housing by storey type over the last 20 years. A framework, based on the QVNZ age profiles, was developed to utilise all of this data.

3.4 Methodology for forecasting future stock profiles

Stock inventory models used overseas were examined and are similar to that developed for the existing stock typologies. These include age profile models, e.g. Sartori et al (2008) for detached housing and Kohler et al (2007) for all building stock types. The age profile model can be adapted to allow for demolitions, renovations and new entries into the stock. A current BRANZ project on sustainable housing life cycles, including renovation and demolition modelling, was identified as having relevance to future profile modelling.

4 Results

4.1 Review of the Working Paper

The paper, hereafter referred to as the Working Paper categorises the stock into typologies which are based on house style. The housing categories are:

- Early housing (pre-1890)
- Villa (1880–1920)
- Bungalow (1920–1935)
- Art deco (1925–1935)
- State house and mass housing (1930–1970)
- 1960s multi-units
- 1970s house (pre-1978 insulation)
- 1980s house (1978–1989)
- Early 1990s (1990–1996 before code upgrade)
- Last decade (1996–2007, after code upgrade)

The Working Paper comments on the variability within each category and identifies some typologies that may need further sub-division, namely:

- Bungalow 1920–1935 (the two storey houses from this period have a different form to the more common one storey bungalows)
- State and mass housing 1930–1970 (may need to subdivide this large group e.g. semi-detached from detached)
- 1960s–1970s multi-unit housing (sub-divide one and two or more storey housing),
- Last decade (the considerable number of multi-units need to be a separate category).

The Working Paper notes that there are potentially some missing typologies, including baches which make up about 3% of the stock based on QV data.

The typologies are assessed in terms of their roof, wall and floor construction, solar orientation, windows, heating and hot water systems, plumbing location, and ventilation.

The types of energy saving retrofit identified as corresponding with these components are:

- roof, wall and floor insulation
- window double glazing
- effective space conditioning appliances and systems
- heat transfer systems
- water heating efficiency measures including solar panels, heat pumps and wetbacks.

The retrofit measures above cover the main energy saving measures, apart from energy efficient light bulbs and the need to integrate space condition, heat transfer and draught-proofing and ventilation. Retrofit of the efficient light bulbs is not dependent on the type of house to any significant extent, except that down lights and halogens are more common in post-1990s houses. Generally retrofit of efficient lights would be included in all retrofits as a matter of course. Solar cell electricity is not included because of the prohibitive costs, except for a few isolated cases.

The typologies largely follow decade construction groups with some overlap and/or mid-decade start or end dates. So using decade-built data will provide a good starting point for assessing typology numbers. The variability within typologies is an issue for some categories but it is believed various data sources can overcome this, as discussed later.

The main question for a reviewer is whether the house typologies are useful for quantifying packages of retrofit measures using three criteria. These are:

- What measures facilitate energy savings?
- Do they have net cost savings?
- Are the measures feasible to retrofit?

First, identification of the main retrofit measures to save energy have been well covered in previous work for Beacon in RF1 (Storey et al, 2004) and TE102 (Nebel et al, 2005) and include those measures listed above. Cost benefits have also been covered in TE106 (McChesney et al, 2006). The Working Paper has relevance to the third criteria, feasibility, as it identifies house characteristics that assist or restrict the ability to retrofit a house. These characteristics include:

- Ceiling space
- Skillion roofs
- Wall types
- Sub-floor access/floor type
- Window types
- Roof slope
- Heritage issues
- Room sizes/volumes for space/water heating
- Chimneys
- Orientation
- Later additions

This list appears to cover the major house characteristics affecting the ability to retrofit. The first four relate to insulation in the roof, wall and floor. Window types, roof slope and heritage issues affect the ability to double glaze or install solar panels. Room sizes determine whether efficient solid fuel/pellet heaters can be retrofitted and rooms' volumes, or stud height, determine the types of space heating needed. Presence of chimneys may enable the retrofitting of efficient heaters. Orientation may or may not be correlated to typology. Certain typologies have particular types of addition. If the additions are major and have occurred many years later (as most have) then the typology is mixed and suitable retrofits may be more complex to define.

In general, the typologies are considered to be useful for deciding on suitable retrofit packages from the feasibility viewpoint. There are many practical and cost considerations in the Paper that are linked to the typology, such as: retrofit of roof and floor insulation depends on access and some typologies tend to have more restricted access than other typologies. Space heating can be expensive in rooms with high studs (e.g. villas and bungalows) compared to the standard 2.4m stud height, and the costs and benefits of efficiency measures per square metre of floor area will vary. The need for hot water cylinder replacement is correlated with house age which affects the viability of solar water systems. The benefits of adding extra insulation in more recent homes can be marginal. Some typologies (e.g. villas, bungalows and state/mass housing 1930–1970s) are more likely to have fireplaces which may be suitable for an efficient wood or pellet burner. There are two considerations: firstly, whether the fire space is sufficient to accommodate a burner, and secondly, whether the existing chimney is normally retrofitted to the top with a metal flue.

These examples illustrate why the typologies are considered to be a useful breakdown.

4.1.1 Missing typologies

Table 1 of the Working Paper has identified potential missing typologies:

- Baches
- Solid timber wall
- State house split
- Group housing
- Pensioner housing
- Medium density housing.

Should baches be included as a separate typology? Baches amount to about 3% of the total stock according to QNVZ. That is about 50,000 dwellings which is not insignificant. The 2001 census (Statistics NZ) had a lower number of baches (0.7%) than QVNZ, and it appears their respective definitions are somewhat different.

The reasons for having a separate category include:

- Baches are usually poor performers from an energy efficiency perspective.
- An increasing proportion are rented out for extended periods and hence have close to full time occupancy rather than just summer or weekend use.

- There is a trend for baches to become permanent homes due to rising rents in the main city suburbs and because of the drift of the population to coastal and resort areas.

The reasons against are:

- Most baches are unoccupied by owners for most of the year so the energy and cost savings of retrofit may be low.
- They are often in a very poor physical state and if their occupancy changes to full time they are likely to have new additions on two or three sides and a significant upgrade of the existing building. In many cases the existing structure is almost totally rebuilt by new owners.
- Baches on prime sites are candidates for demolition and replacement by new housing.

On balance it is considered baches should not be introduced as a separate category.

Solid wood houses (e.g. Lockwoods, etc.) number approximately 3,000 only so we consider these can be ignored.

A split in state/mass housing 1930–1970 is worth investigation since this is a large group over four decades in span. The three main styles, in chronological order are stucco flat roof houses (not many of these were state houses), then square plan, weatherboard, hip roof houses, and lastly L plan, brick, gable roof houses. But all three types appear in all four decades and photos of houses in the 1940s, 1950s and 1960s are in the attachment to this report.

Group housing is mentioned as a potential typology. The term is taken to mean the fairly standardised designs from the major developers of the 1970s and 1980s. The Working Paper says the 1970s age group consists of these group houses (rectangular footprint, small rooms) and the rest showing a wide variety of variation in form. In the 1980s the group builders are building slightly larger houses, possibly L-shaped and open plan. The remainder are usually larger again and often two storey. There are quite large numbers in both decades so sub-division into the two decades is justified, particularly as the end of the 1970s saw the introduction of mandatory insulation.

Council housing is another category in the Working Paper. This is low-income older person housing originally provided by councils and now part privately owned. Most are single bedroom units and many are bed-sits. They vary in type, from units in multi-story apartment type buildings, to duplexes and stand-alone units. In total, councils provide approximately 14,000 of these units (Saville-Smith et al, 2007). Some councils are currently doing major upgrades of their stock including retrofitting insulation and other sustainability measures. Due to their low numbers, council rentals are not considered further.

Multi-unit housing is a recent cohort, from the 1990s ignoring the earlier HNZC units. The two main types are low rise housing, and medium to high rise buildings. Generally the former could be considered as candidates for retrofit as a large number of these are duplexes or single unit additions to existing houses.

4.2 Review of databases

This section considers the available databases of the housing stock and their usefulness for allocating the stock into typologies.

The databases considered are:

- BRANZ House Condition Survey (HCS)
- Quotable Value New Zealand (QVNZ)
- Home Energy Efficiency Project (HEEP)
- Census of Population and Dwellings, Statistics NZ (SNZ)
- Building Consents, Statistics NZ.

4.2.1 BRANZ House Condition Survey (HCS)

The HCS is carried out every five years, and was done in 1994, 1999 and 2004. (Surveyed numbers are 390, 465 and 565 houses respectively). The main purpose was to obtain a measure of the physical condition of typical New Zealand houses. Approximately 26 building components were assessed for condition on a 5 to 1 scale, where 5= Excellent condition and 1= Serious condition (needs immediate attention).

It was carried out in the main centres only (Auckland, Wellington and Christchurch) but includes some semi-rural areas such as Rodney District, Kapiti Coast and Waimakariri District, as well as the main cities. A range of house styles and ages were surveyed and the numbers in the survey for each group are in approximate proportion to the incidence of those groups in the whole population. Apart from physical condition a lot of other information was recorded, especially in the last two surveys. Data of interest to energy retrofits includes:

- Insulation in the ceiling (by thickness and percentage cover), walls and floors
- Double glazing
- Space heater types and systems
- Ventilation systems, e.g. DVS
- Hot water cylinder by type and age, second cylinder incidence. Wet back incidence.
- Solar water heaters
- Shower flow rates.

Other data collected and of relevance to retrofit are:

- House age and floor area
- Floor crawl space (mm height) – for retrofitting insulation.

- Roof slope (0–15 degrees, 16–30 degrees, >30 degrees) and skillion roof percentage — for insulation retrofit access, and for installing solar panels.
- Sub-floor vents — need for moisture control.
- Windows condition — likelihood of need for replacement.
- Chimneys — potential for efficient solid fuel heaters retrofits.
- Hot water pipe runs — (close, two rooms, >two rooms) — potential for lagging or re-plumbing.

4.2.2 Quotable Value NZ

This database is used mainly by territorial authorities (TAs) for assessing the council rates for property within their boundaries. Hence the data recorded has a bias toward what information is needed to assess the market value of a building. It includes:

- House valuation
- House decade and type. The main categories are: Rentals purpose built, Home and income (e.g. attached shop), Units single or multi-storey, Dwelling detached or semi-detached, and Converted house (now used as rental flats). The dataset has a number of dwellings in the nil category (about 2%) and another category described as mixed (3%) which refers to houses with large additions significantly different in appearance to the original house, and for which the original age has been lost.
- House area and site coverage (enables the incidence of two storey houses to be approximately identified).
- Multi-unit residential (number of units per building)
- Dwelling types are also classified into era type categories and are: Villa, Quality old, Pre-war bungalow, Cottage, Bach, Spanish bungalow, Post-war bungalow, State rental, and Contemporary). Since the 1980s it is thought most are listed as Contemporary and there are a large number of houses that have no type category.

Quotable Value no longer provide valuation data to several TAs including two of the larger, namely Auckland and Christchurch, cities. QV has agreements with the other valuation companies supplying to the TAs to obtain their data and add it to the QV database. However, some database fields are not recorded by the other companies (e.g. type of dwelling). About 20% of dwellings are not in the database, when compared to the total count from the Statistics NZ census count (see Table 2) and the reasons for this are not clear.

Table 2: QV database numbers and the census count

Comparison QVNZ and 2001 Census				
	Number of units		Census adjusted	
	QVNZ	2001 Census	to Dec03	Ratio
Houses	1,019,842	1,236,785	1,293,485	0.79
Flats/ apartments	235,444	265,225	278,025	0.85
	1,255,286	1,502,010	1,571,510	0.799
Note: QVNZ data is to Dec 2003				

The stock age profile in the Working Paper was derived from QV data, scaled up by approximately 20% as indicated in Table 2. The age profile chart has been updated using 2006 census data, as described in the Appendix. The numbers by cohort for the original chart and revised chart do not change greatly except for the 1970 and 2000 cohorts. The results and method are described in the Appendix.

4.2.3 Household end-use energy project (HEEP)

This project involved a survey of energy use by households for approximately 400 houses across New Zealand, not just in the three major regions. Data of interest to energy retrofits includes the same data as in the HCS, i.e.:

- Insulation in the ceiling (by thickness and percentage cover), walls and floors
- Double glazing
- Space heater types and systems
- Ventilation systems, e.g. DVS
- Hot water cylinder by type and age, second cylinder incidence. Wet back incidence.
- Solar water heaters
- Shower flow rates.

Other data collected and of relevance to retrofit are:

- House age and floor area
- All window sizes and orientation.
- Stud heights

4.2.4 Census of population and dwellings

The five yearly census provides a near 100% count of dwellings. Dwellings are recorded as:

- Detached, no storey information
- Separate house, one storey
- Separate house, two or more storeys
- Two or more flats/townhouses/apartments/houses joined together, no storey information

- Two or more flats/townhouses/apartments/houses joined together, single storey
- Two or more flats/townhouses/apartments/houses joined together, two or three storeys
- Two or more flats/townhouses/apartments/houses joined together, four or more storeys
- Private dwelling, not further defined

Data from recent censuses is shown in Figure 1. In 2006 the format changed and the previous breakdown for duplexes, baches and house plus business was dropped. The 2006 formats are shown in Figure 2. This is the dwellings part of the census and other information collected includes tenure (owned, mortgage, no mortgage, family trust), number of persons, household types, incomes, and other socio-economic data.

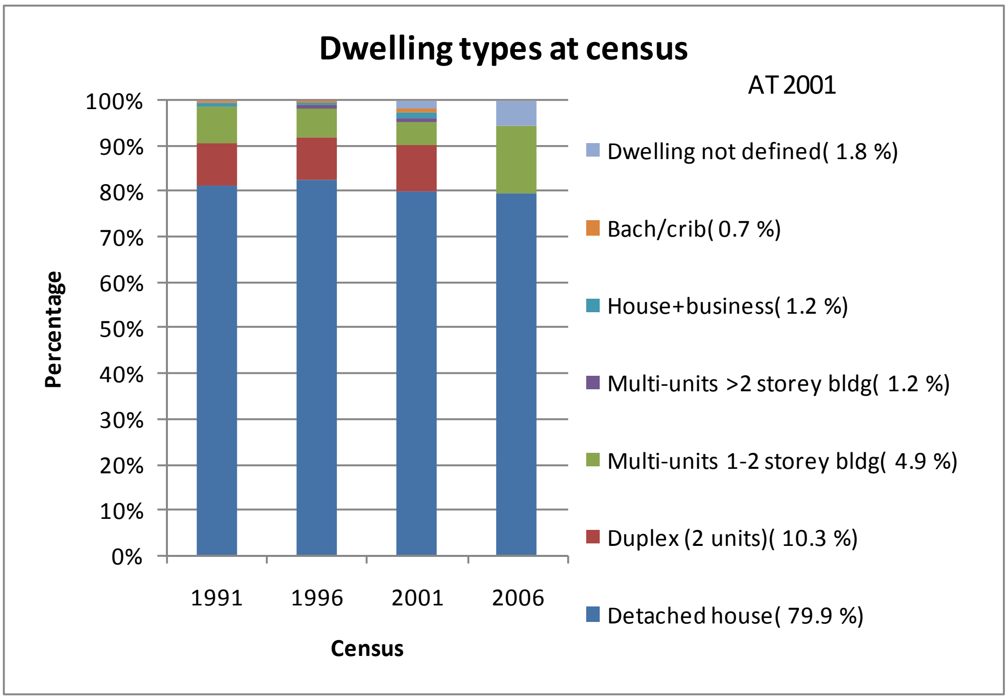

Figure 1: Census dwelling types

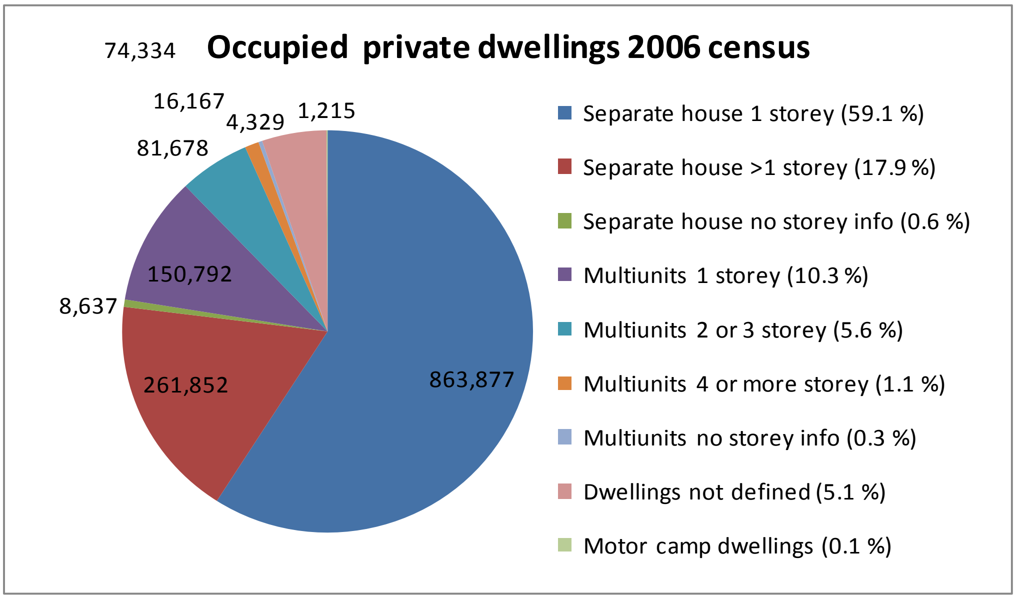

Figure 2: Occupied private dwelling types 2006 census

Unfortunately data in the same format as Figure 2 for unoccupied dwellings is not available from SNZ.

4.2.5 Building consents

Building consents are collected from the TAs by Statistics NZ and published in aggregate form. Individual consent data is not disclosed. The published data is:

- Number of consents, number of units, value and floor area of new dwelling totals
- By territorial authority
- By type (detached house, horizontally attached multi-units, vertically attached multi-units).

Disaggregated data is also available on request, e.g. number of houses in a specified floor area group, and number of buildings by specified numbers of units per building for multi-unit consents. The latter enables an analysis of the size of new apartment buildings.

A reliable count of number of new dwellings is available from about 1965 with the introduction of The Model Building Bylaw (NZSS1900) which for the first time required all building work to have a building permit (later called a "building consent"). Before that, starting in 1922, the larger municipalities developed their own by-laws and first began to issue building permits. In 1939 the municipalities switched to NZSS99 which was the first model building specification. From 1939 increasing numbers of rural authorities as well began to use NZSS99 and issue permits but in some rural areas the permitting was quite lax and incomplete until 1965 with the compulsory adoption of NZSS1900. Even after that time it took until the early 1970s before all TAs were picking up all consents and reporting them to SNZ.

In summary, building permit (consent) data is available back to 1922, but only from the early 1970s is it 100% reliable. After adjusting for some permit cancellations and demolitions it can be used to cross-check the QV derived decade numbers described above. There is no official information on cancellations or demolitions, though various estimates have been made by researchers e.g. (Johnstone, 1994, Page, 2007).

4.2.6 Summary of existing databases

The QVNZ database provides the distribution of houses by age group and it can also provide some breakdown by type (detached, multi-unit, single or multi-storey, etc.). It is not complete and it needs to be scaled up to match the census count of dwellings. Building consent data provides a check on the QV scaling up process from the 1970s, when the consent count became near complete. These sources were used in developing the house age group breakdown in Figure 1 of the Working Paper. That chart is based on the 2001 census and has been updated in the Appendix using the 2006 census numbers.

The housing characteristics recorded in the HCS are useful for investigating whether they affect the feasibility of various retrofits. The HEEP data has information on window orientations which is not available elsewhere. Consent data is a complete record of new housing and multi-unit numbers since the early 1970s and from 1997 onward provides a multi-unit horizontally attached, and vertically attached breakdown.

In summary all the databases are useful for quantifying the numbers in each typology.

4.3 Analysis of physical characteristics

This section describes the results of the data analysis undertaken to decide if it is feasible and/or necessary to further sub-divide the typologies, or possibly combine the typologies listed in the Working Paper. In this analysis a combination of prevalence and incidence characteristics have been used. Prevalence refers to overall stock numbers in broad categories such as detached houses, multi-units, single or multi-storey, age groups, and location. Incidence is related to particular characteristics of houses such as component characteristics (e.g. low floor clearance, existing insulation, etc.).

As a starting point the QVNZ categories are shown in Figure 3, where the most common type is the detached/semi-detached house group. Multi-unit housing numbers become significant from the 1960s.

The Working Paper suggests the 1920–1935 two storey houses are different from the bungalows of the period and may require a separate typology. The QVNZ database indicates 15% of

1920-1930 houses have an upper storey [1] (see Figure 4). This is only about 20,000 houses, i.e. 1.5% of the stock, and is probably not worth having as a separate typology.

The next group suggested as an additional typology was the large 1930–1969 mass house group, in particular separating out detached from semi-detached. The 1930s houses have been included under both the bungalow and art deco typologies (see Table 3). For the remainder, 1940–1969 houses, the semi-detached versus standalone breakdown is not available in the QV data. Likewise the census of population and dwellings in that period does not record this detail. So we do not know the relative numbers of detached and semi-detached. These three decades number about 550,000 units, and, if we assume 5% are semi-detached that is about 30,000 units or about 2% of the stock. From observation these semi-detached houses appear similar to detached houses of the same era in terms of roof slope, ground clearance, orientation, and cladding materials, so a separate category is not needed.

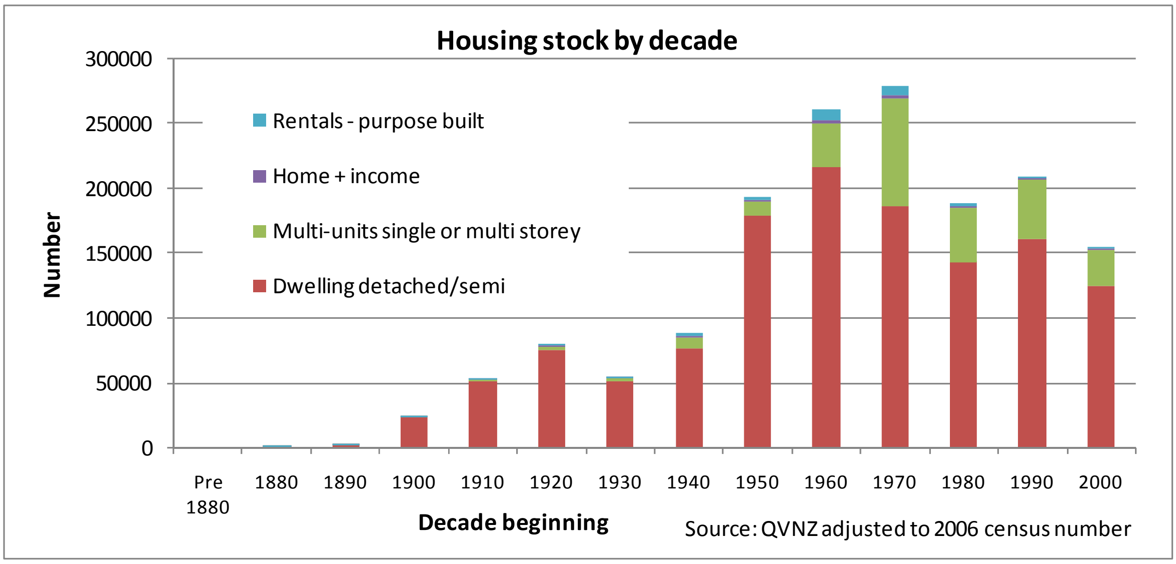

Figure 3: Decade groups by QV type

1 Some of these houses have a basement garage only in the lower level, and hence are similar to a single level house in terms of layout of living space. The number of these houses is not known.

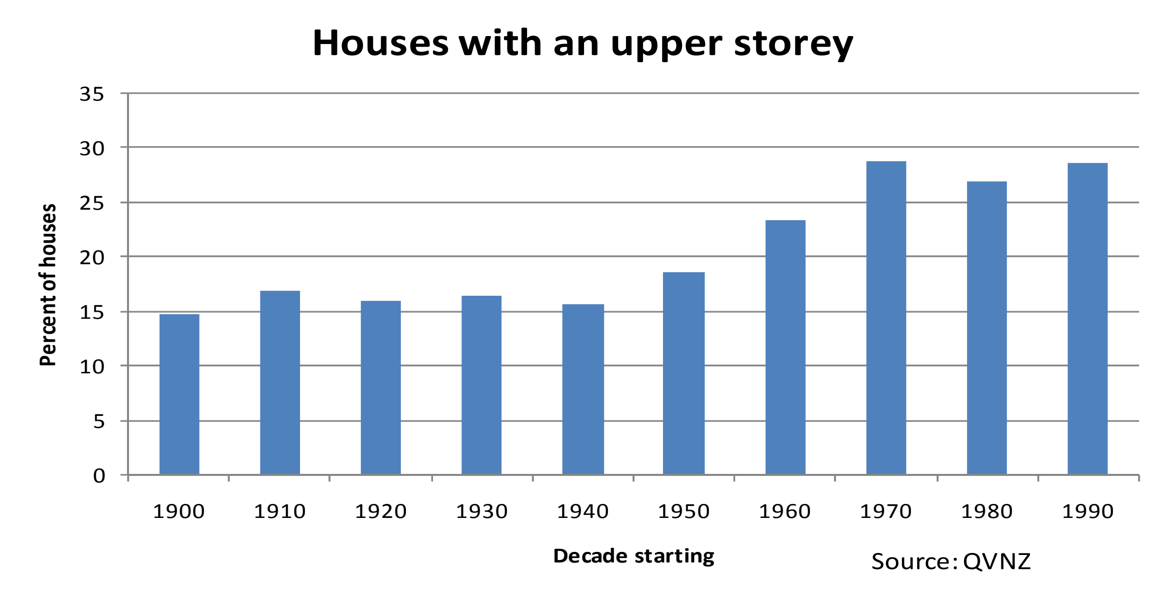

Figure 4: Upper storey incidence in houses

The main changes in the 1940–1969 group occur in floor clearance space, roof space, and the incidence of skillion roofs (see Figure 5, 6 and 7). In the 1940s houses the floor clearance is quite low on average and improves through to the 1960s. In contrast the incidence of low roof space increases from the 1950s, similarly for skillion roofs. The 1940s group has a number of flat roof houses (over 25% of houses have some flat roofs, mainly on lean-tos, according to the 2004 HCS), hence its high incidence of poor roof space. Even with quite low roof slopes it is still possible to retrofit ceiling insulation. However with a flat roof the retrofit is more costly because it is a skillion roof, i.e. the ceiling linings or roof cladding need to be removed to insert insulation. So for the mass housing group of 1940–1969 the 1940s could be a separate typology, but the 1950s and 1960s are similar in terms of sub-floor space and roof characteristics, and will have similar retrofit solutions.

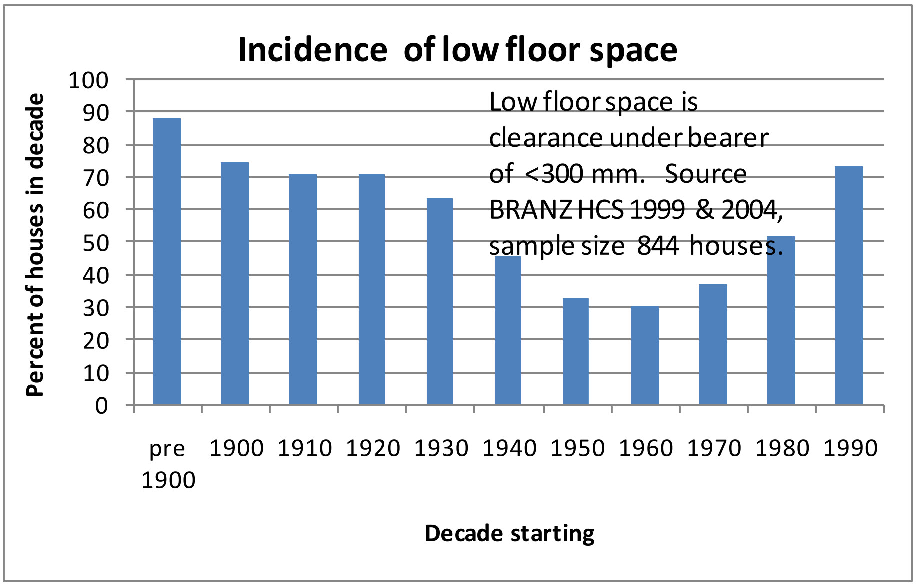

Figure 5: Low sub-floor space incidence by decade

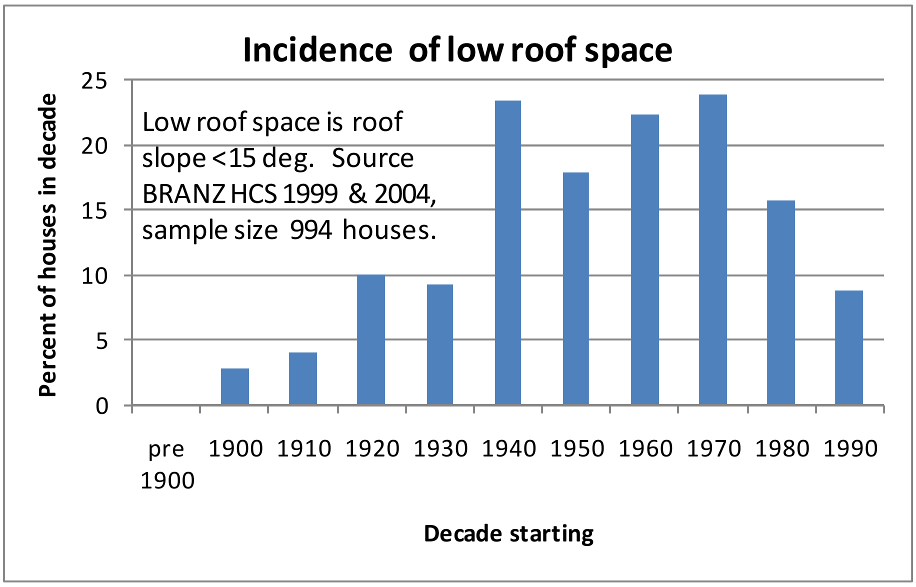

Figure 6: Low roof space incidence by decade

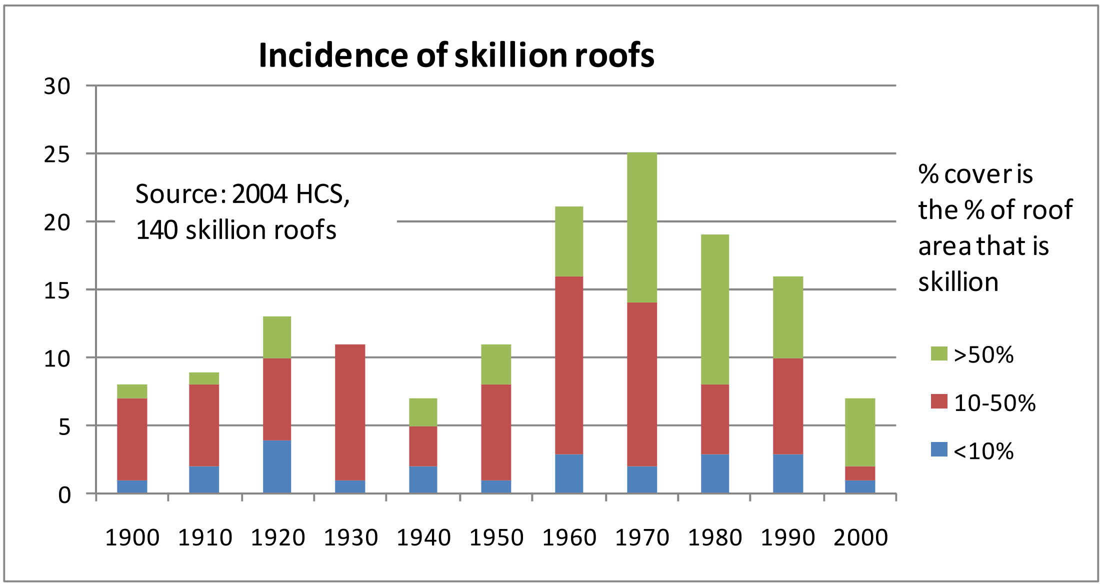

Figure 7: Skillion roof incidence by decade

The 1960s to 1970s multi-unit housing group numbers about 130,000 units and the Working Paper suggested they could be sub-divided into one storey and multi-storey typologies.

Figure 8 shows that the multi-storey component is quite low, about 15–20% of all units for the 1960s and 1970s group, or about 20,000 units. Many of these are state rentals, in two or three storey buildings, and are covered by HNZC retrofit programmes. However, it was decided to have multi-storey multi-unit 1960s and 1970s housing as a separate typology.

Figure 8 shows the percentage of multi-stories construction in multi-units, and is rising after 1970. The QV data indicates 30% of units are in a multi-storey building for the 1990 decade, but building consent data indicates an even higher percentage of about 60% in the 1990s (see the Appendix). In the 2000s the consent data indicates about 67% of new multi-units are in vertically attached units, and many of these will be in high rise buildings.

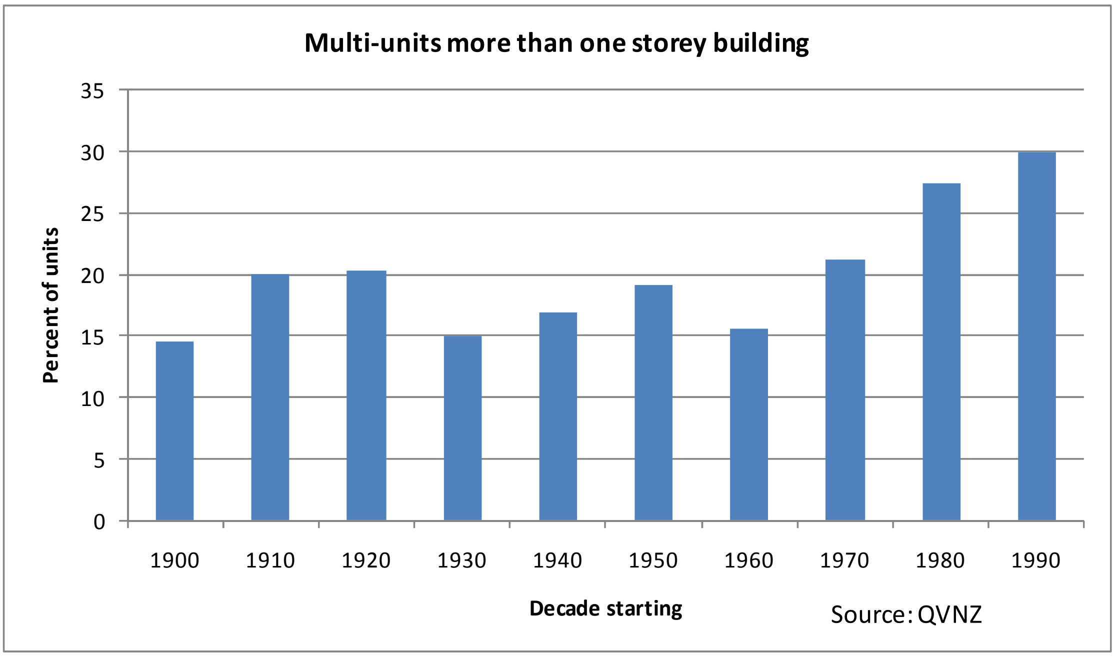

Figure 8: Incidence of upper storeys in multi-unit housing

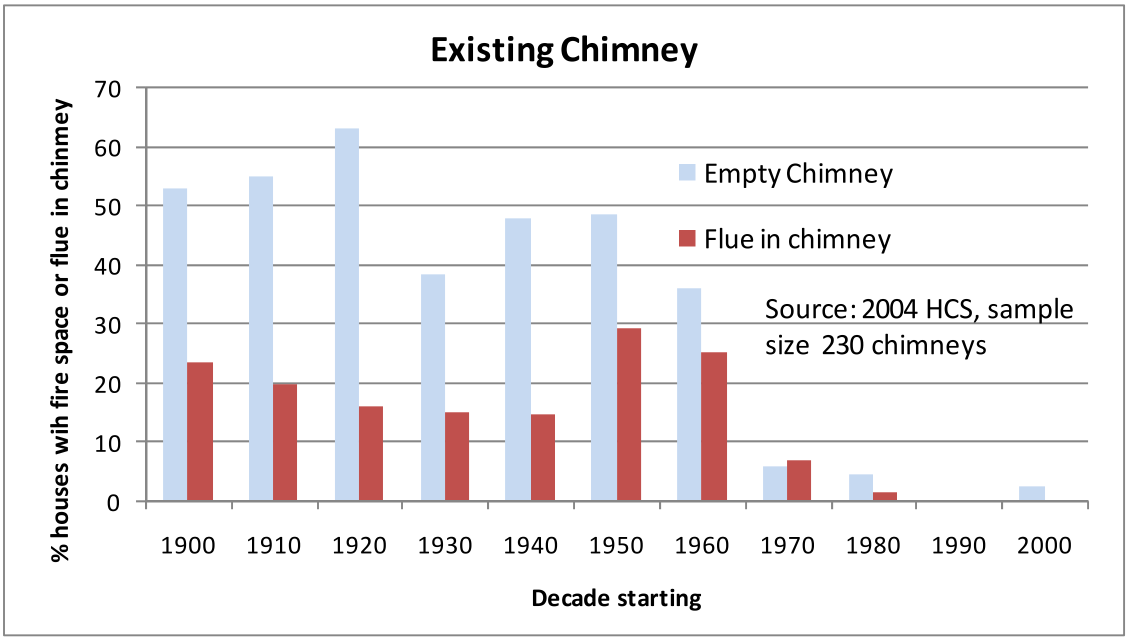

Figure 9: Incidence of chimneys

The incidence of chimneys indicates the potential to retrofit with efficient wood or pellet burners. Figure 9 shows that before the 1970s the incidence of fireplaces and chimneys is quite high. For example, in the 1920 cohort 78% of all houses have a chimney and 16 % of these houses have already been flued, leaving 62% of houses with the original chimney/fireplace. In many cases the fireplace will have been blocked off rather than remaining as an open fire, but it may be available for positioning an efficient burner and inserting a steel flue.

The HEEP data is useful for a number of reasons, including as the only source of data on house orientation, see Figure 10. The vertical scale is the average percentage of windows facing toward the sun (assumed to be within the 135 degree arc centred on due north). The percentage varies a little between decades, i.e. 37% to 48%, but the 1940s and 1980s groups are slightly less well oriented than the other decades. The window area to floor area percentage is also shown on the same scale. It does not vary much either, between 22% for the 1980s houses to 26% for the 1930s houses. This data suggests the 1940s and 1980s houses have a slightly greater problem than other decades in achieving solar gains, and the 1960s and 2000s houses are better off for solar gain. In some cases the solar gain can be a problem in summer, for example about 10% of 2000s houses have over 70% of their window area facing N, NW and NE. They may also have smaller eaves than other cohorts for shading. However, the variation between cohorts is quite small on average and effectively all age groups have the same ability to achieve solar gain through windows, on average.

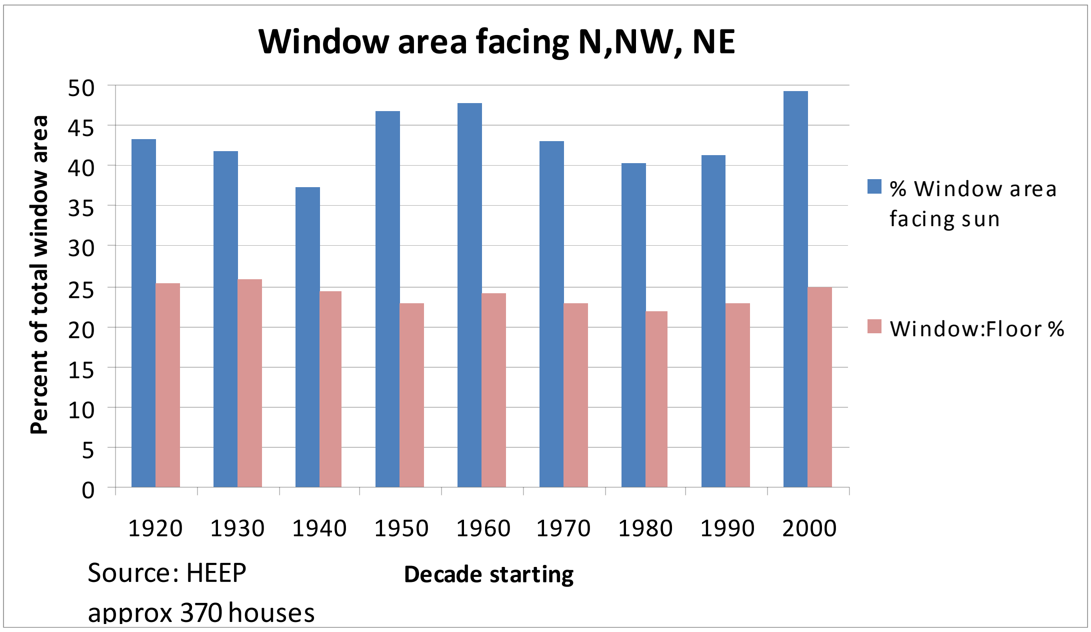

Figure 10: House/window orientation

The physical condition of windows is an indicator of the likelihood of replacement and hence the opportunity to use double glazing. Figure 11 shows windows in a serious or poor condition, from the 2004 HCS. Generally windows in houses from the 1930s and 1940s have the worst condition. The amount of retrofit of double glazing to date is low, see Figure 12.

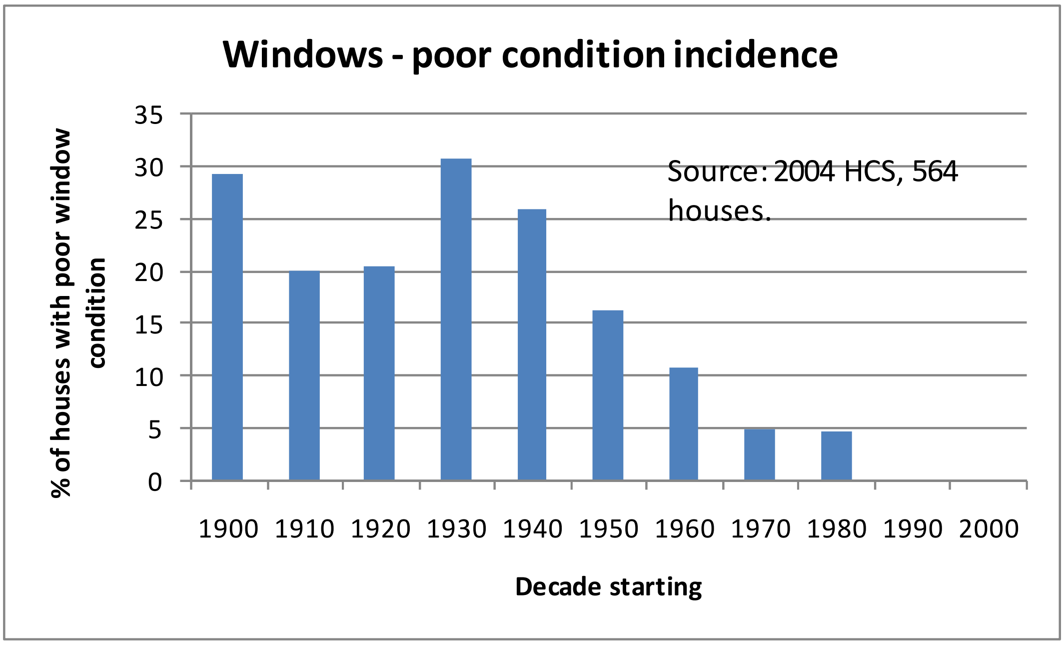

Figure 11: Poor window condition incidence

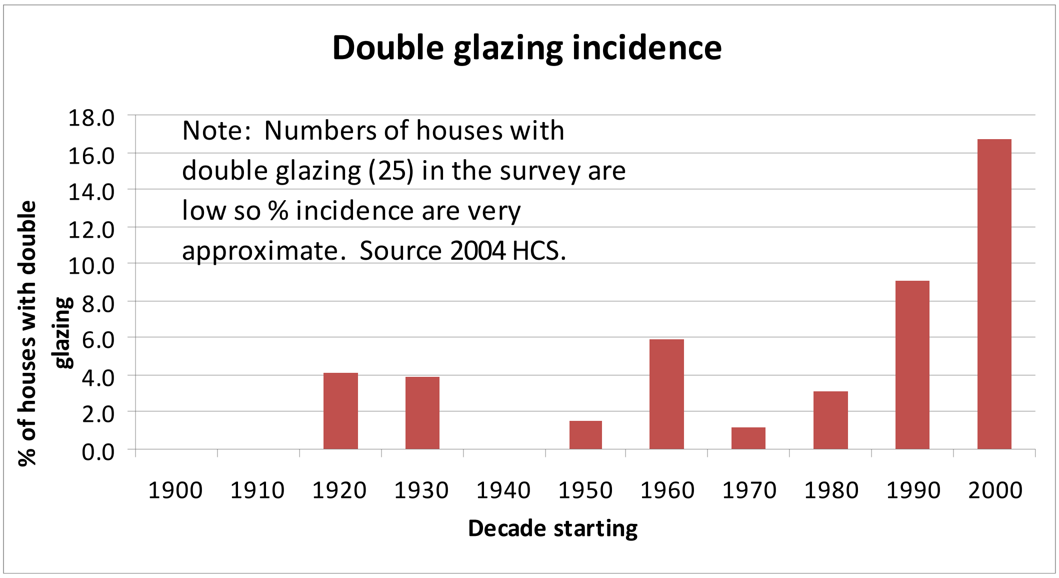

Figure 12: Double glazing incidence by decade

The condition of the wall cladding gives an indication of the likelihood of its replacement or major repairs, thereby allowing for insulation to be installed. Figure 13 indicates that the 1930s houses have the worst cladding condition, followed by 1910s and 1950s houses.

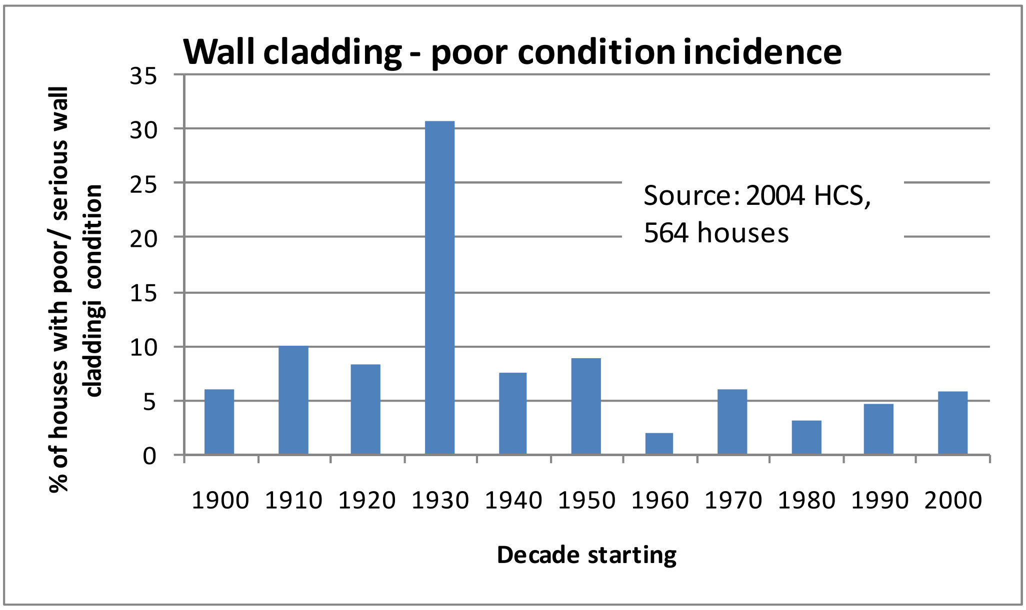

Figure 13: Poor wall cladding condition incidence

Other data available from the HCS includes hot water cylinder ages which may affect the decision to retrofit solar water heating. Figure 14 indicates that 1960s houses are prime candidates for replacement cylinders, and hence have potential for solar water retrofits.

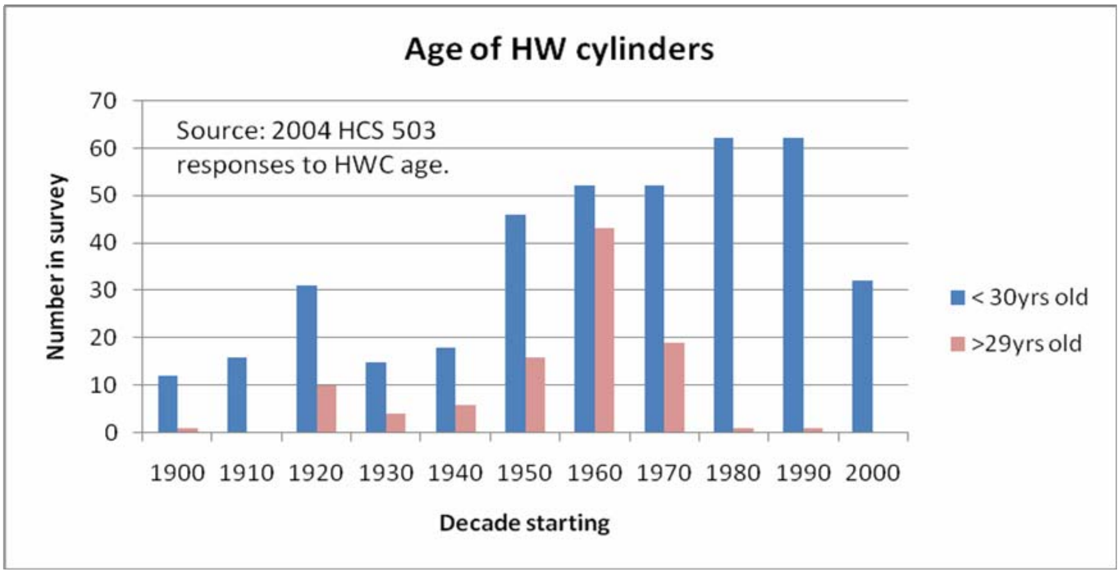

Figure 14: Hot water cylinder average age

Related to hot water systems are the delivery pipe runs. The 2004 HCS had a question on pipe run, but obtained only 50 responses, of which 86% had a short run (to an adjacent room). There were 12% with a medium length run (two rooms away), and 2% with a long run (more than two rooms away). None were wrapped so there is some scope for pipe wrap energy savings.

The next three charts show the amount of ceiling insulation in the three NZS4218 climate zones. This information helps decide which cohorts have poor or nil insulation and need to be retrofitted.

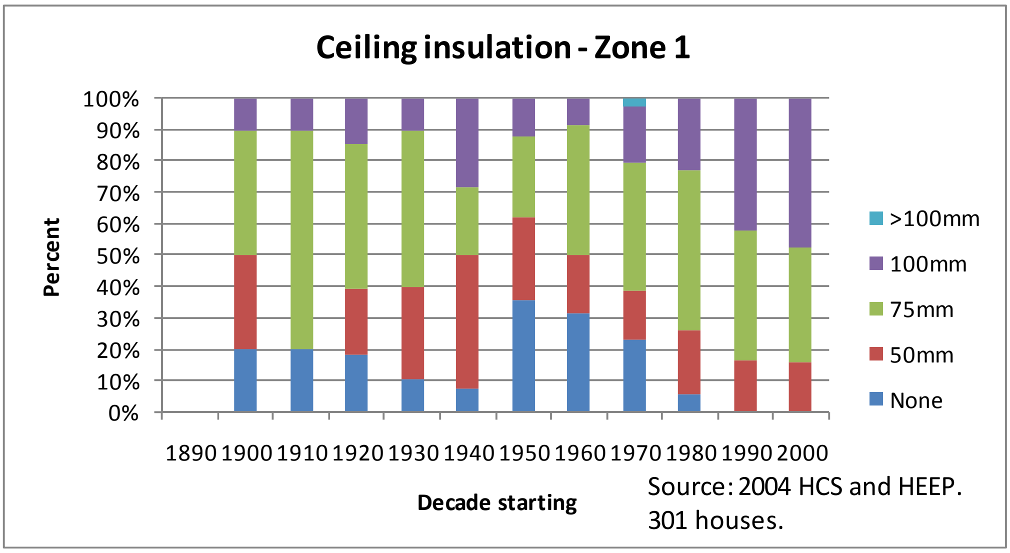

Figure 15: Ceiling insulation Climate Zone 1

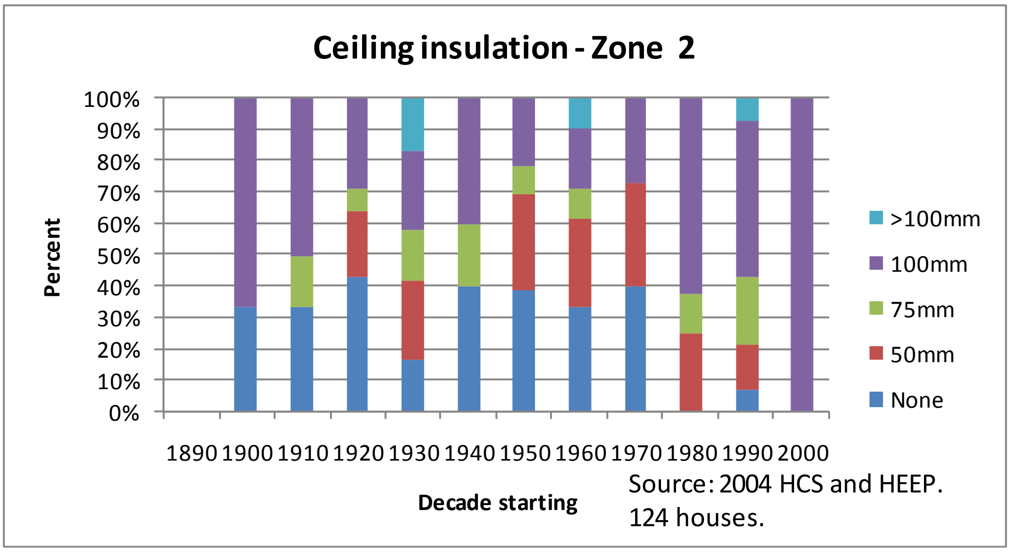

Figure 16: Ceiling insulation Climate Zone 2

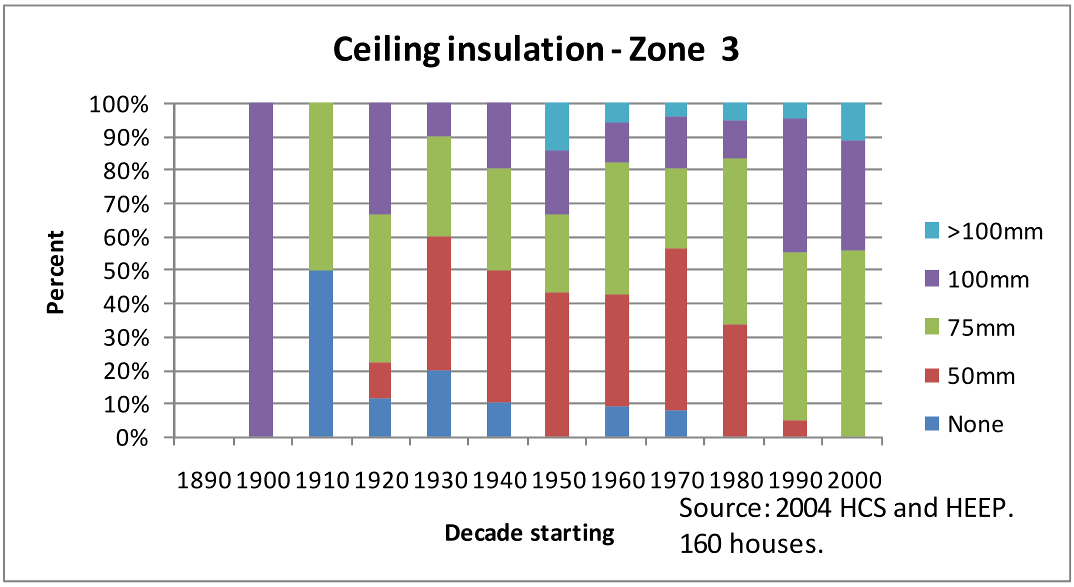

Figure 17: Ceiling insulation Climate Zone 3

The incidence of timber floor retrofit bulk insulation is low (see Figure 18) with only 32 houses with insulation out of 465 houses in the 2004 survey.

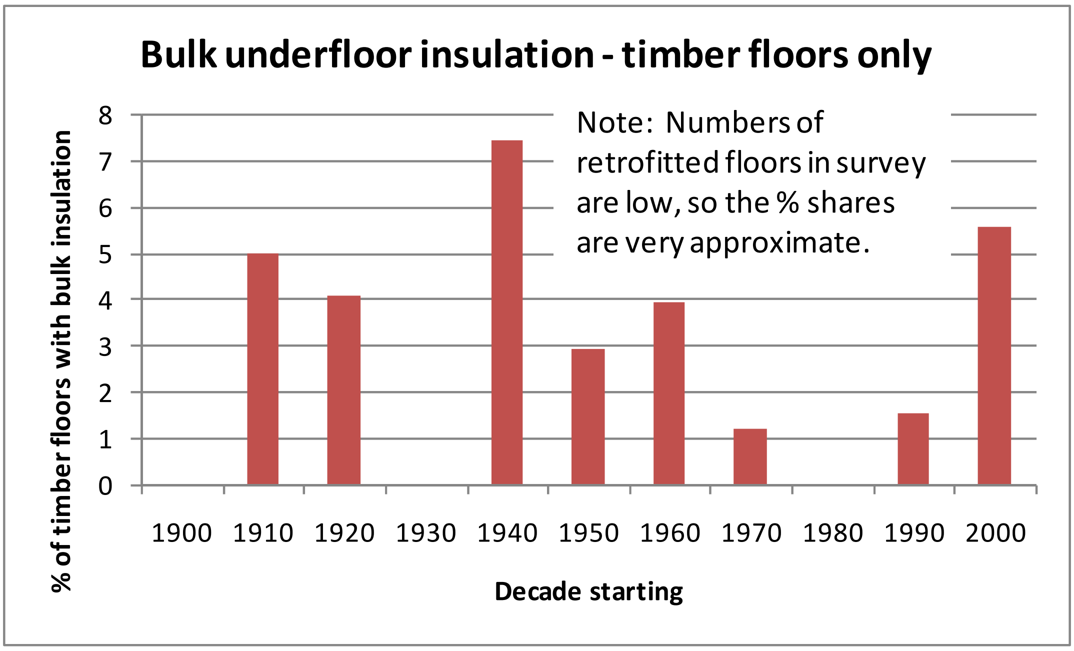

Figure 18: Retrofitted floor insulation

The types of space heaters are shown in Figure 19. Fixed electric heaters are resistant heaters of the panel, radiator or fan type and fixed to the wall. Portable electric heaters are the most common type and are usually the plug-in 2.4kW or less type. The incidence of heat pumps at the time of the HCS was low, but it is known from other work that these retrofits are now rising quickly.

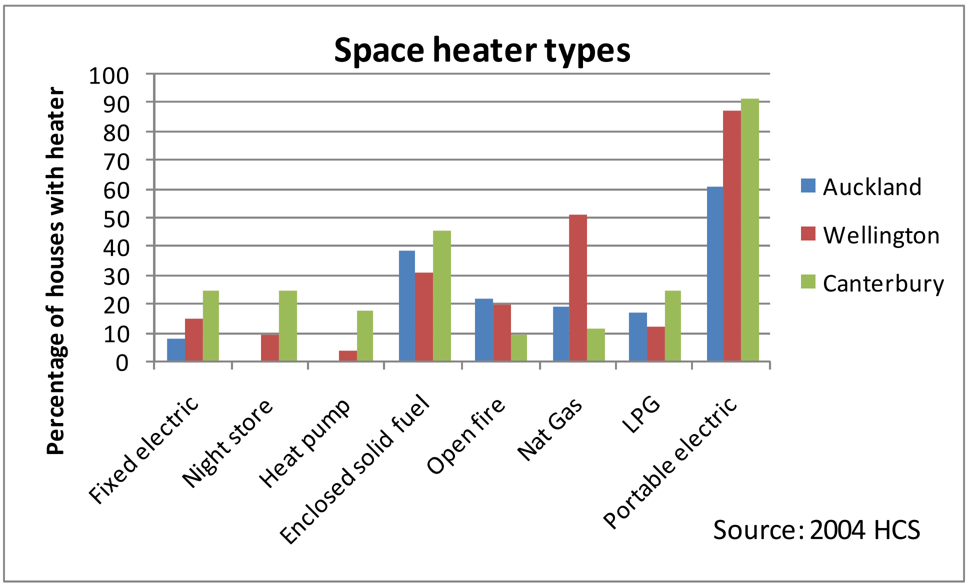

Figure 19: Space heater types

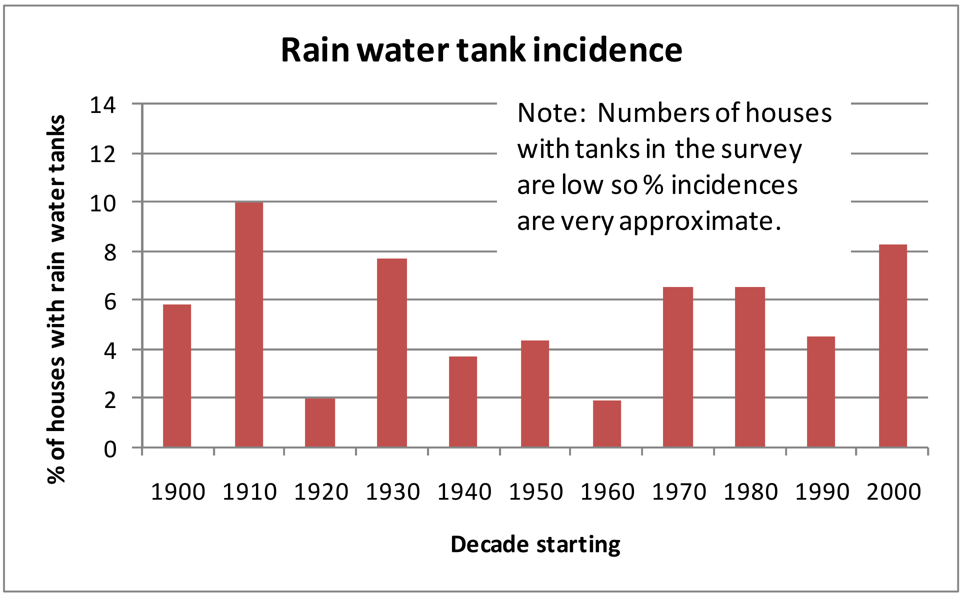

Figure 20: Rain water tank incidence

Other sustainability measures recorded in the HCS are rain water tanks (see Figure 20) and solar panels. Only two solar panels were found in the 2004 HCS (out of 465 houses). The number of tanks was 34, and 12 of these were in areas with a long established reticulation system. The others were in semi-rural areas such as Beachlands, Waiheke Island, Snells Beach, Stanmore Bay and Maraetai, i.e. areas without reticulated water.

Another useful characteristic is the average floor areas by age group (see Figure 21). This is based on QVNZ data and the floor area includes additions to houses after the original construction.

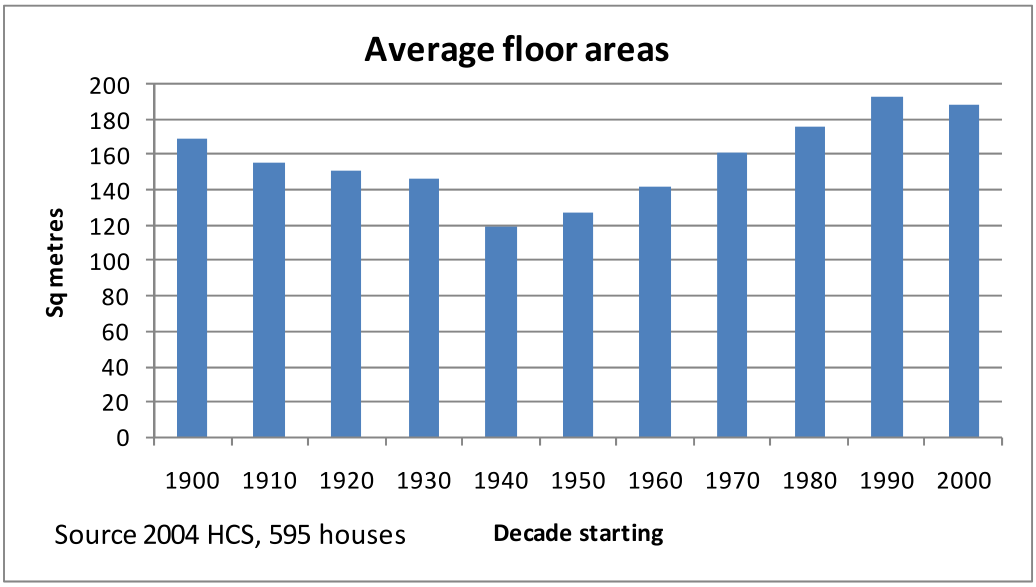

Figure 21: Average floor areas of existing houses by age group

The above covers most characteristics that affect the practical ability to retrofit efficiency measures. It has looked at components by decade rather than particular typologies because of the format of the data. The next section uses this data and matches it with the Working Paper typologies.

4.4 Component characteristics, typology, and numbers

The start point for estimating numbers by typology is the QV database. As it is incomplete it was scaled up to match the housing stock numbers from the 2006 census. The number of total permanent dwellings (both occupied and unoccupied) are in the Appendix. This total was spread to the age groups using the QV age profile, and the process is set out in the Appendix. The age profile was then used to assign the stock to the different house typologies, and the results are shown in Table 3.

It is suggested the typologies in this table are suitable for targeting retrofit programmes. In the main there is a direct translation from the age cohort to the typology, but some age groups are split between typologies. For example, mass housing 1970–1978 is assumed to be 80% of the 1970s cohort.

The individual component characteristics determine what can sensibly be retrofitted. The lower part of Table 3 scores the components for feasibility/ease of retrofit, based on the charts in the previous section. The scoring is on a 0 to 2 scale, and the more favourable the particular component characteristic in the age group, the higher the score. For example, large sub-floor clearances in the 1940s to 1960s houses, compared to other ages groups, gives these cohorts a high score for ability to fit floor insulation. Each component is given an equal weight (e.g. floor insulation is weighted equally with ceiling retrofit insulation, and chimney space for efficient heaters.) The component scores are added and the higher total scores indicate which typologies are the better ones to retrofit. These are the villas, the 1940s to 1960s mass housing, and the 1920–1935 bungalows.

This table is also available for each of the three climate zones of NZS4218 in the Appendix. The Working Paper mentioned some possible additional typologies:

- Mass housing 1940–1969, to be sub-divided
- Group housing in the 1970s and 1980s
- Multi-units in the 1960s and 1970s
- Multi-units in the 2000s.

The first group is large and its sub-division is discussed below. Group housing is not thought to be different from other housing of that period and the main distinction is the pre- and post-1978 insulation requirements and this division is in the table. Multi-units in the 1960s and 1970s are a large group and are separately identified in the table. For the 2000s multi-units consent data is available on horizontal and vertical attached units which will facilitate a split for this group (see the Appendix).

The 1940–69 mass housing group appear to have similar component characteristics as indicated by Figure 5–7 and Figure 9–17. The 1940s cohort possibly has fewer favourable characteristics to facilitate retrofitting than the other two decades and the decade is smaller in house numbers compared to the 1950s and 1960s, so it could be considered as a separate typology, numbering about 78,000 houses.

Table 3: Typology stock number estimates

House numbers by typology												
	Number of dwelling units to March 2006.											
	Dwelling unit numbers (000s) (1)											
Decade start	Villas	Bungalow 1920-36	Art Deco 1925-40	Mass housing 40s-60s	Multi units 1960-70s	Mass housing 1970-78	Housing 1978-80s	Multi units 1980-90s	Housing 1990-96	Housing post 96	Multi units 2000s	Total
pre-1900	6											6
1900	26											26
1910	54											54
1920		71	8									79
1930		42	10									52
1940				78								78
1950				182								182
1960				219	43							262
1970					91	151	38					279
1980							144	45				189
1990								23	112	75		209
2000										126	28	155
Total	86	113	18	479	133	151	182	68	112	201	28	1572
											Pre 1960s multi-unit numbers =	34
Component characteristics (2)											Total all dwelling units (000) at 2006 =	1606
0= Unfavourable,	1= Moderate		2 =Favourable									
Sub-floor clearance	0	0	0	2	1	1	1	1	0	0	0	
Roof space	2	2	0	1	1	0	1	1	1	1	1	
Chimney space	2	2	1	1	0	0	0	0	0	0	0	
Window condtn	1	1	2	2	1	1	0	0	0	0	0	
HW Cylinder age	0	0	0	2	1	1	0	0	0	0	0	
Existing insulation	1	1	1	2	1	2	1	1	1	0	0	
Wall cladding condtn	1	1	2	1	0	0	0	0	0	0	0	
Total (3)	7	7	6	11	5	5	3	3	2	1	1	

(1) The numbers are based on Working Paper Figure 1 age cohort numbers (revised, see appendix), and QVNZ breakdowns into multi-units and detached housing.
(2) Each decade is scored on a 3 point scale for the favourability or otherwise of retrofit of the component. See text.
(3) The higher the more favourable the decade is for retrofit. Each component is equally weighted, i.e scores are added.

4.4.1 Possible sub-division of the 1940s to 1960s mass housing group

A random sample of houses was taken from each of the three decades in the 1940–1969 mass housing group, using 2004 HCS photos. These are described in the Appendix in Table 6 and the photos are in the attachment to this report. The descriptions are taken from the five or six photos which accompany each house. Each decade had nine or ten houses selected from each, and there was no one particular house type within each decade, though the styles do slowly change from decade to decade. The 1950s group was slightly better in overall condition, as seen in the last column in Table 6. The changes between decades include: most stucco flat roof houses occur in the1940s; the floor plan layout moves toward more complex forms, i.e. from rectangular to L-shaped in the younger houses; there is a shift from weatherboard and stucco in the 1940s to clay brick and stucco in the 1950s and brick (often concrete brick) in the 1960s.

In summary, the house appearance for this large mass housing group slowly changes over the three decades, but apart from the flat roof houses the ability to retrofit does not change dramatically. Hence it is suggested the 1940–1969 mass housing group be treated as a similar typology, with a possible separate typology for 1940s houses, allowing for their high incidence of flat roof housing.

5 Discussion

The typologies generally follow the age group decades and the numbers in each age group are known with reasonable accuracy based on QVNZ data. There are two potential approaches for developing retrofit packages. One is to assess each house component for retrofit (i.e. ceiling, sub-floor, windows, chimney space, claddings, hot water system, etc.) and build-up a package for each component, house by house. This has the advantage that the solution is tailor-made for that particular house. The disadvantage is that it is time consuming and without a detailed inspection the owner will not know what can be done for his house, and the cost.

The other approach, adopted in the Working Paper, is to develop the general typologies, to which a package of retrofits is likely to apply. The advantage is that the cost and retrofit features are readily understandable to owners, as they can identify which typology applies to their house. The disadvantage is that there will be some variability within a typology and the complete package of retrofits will not be possible for all houses in that typology.

On balance the second approach seems more useful to owners, and where exceptions arise parts of the package can probably be modified. For example, it is known the amount of ceiling insulation already in place varies within a typology and it may be necessary to have two different insulation thicknesses for each typology, aside from any variation in insulation due to climate zone differences.

An attempt to prioritise the retrofits was made in Table 3 at the bottom. Here each typology was assessed by component for favourability of retrofit. It is an approximate assessment since not all components or potential retrofits are considered. Also, equal weight is given to each retrofit in totalling the score, whereas cost considerations may affect the weights. However, it is encouraging in that it indicates that the largest group, 1940s to 1960s, scores the highest, showing there is good scope to significantly improve the sustainability of the housing stock.

6 Conclusions

The typologies developed in the Working Paper are useful categories for developing packages of retrofits. The largest group is the 1940s to 1960s mass housing group and generally the characteristics that affect retrofitting are similar across the 30 years, though the house style changes slightly from small rectangular buildings to larger L-shaped floor plans. This group has several favourable characteristics that facilitate retrofits, likewise the villas and the 1920s bungalows. Other typologies will benefit from retrofits but the package of measures may be more constrained than those mentioned, because some of their characteristics are less accommodating for retrofit.

The numbers in each typology are as given in Table 3 and summarised in Table 1, and further regional breakdowns are in the Appendix.

7 References

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8 Appendix

This Appendix has five sections:

- Derivation of the housing stock age profile from census data and the QV database.
- 1940–1969 mass housing stock sample. The table needs to be read in conjunction with the separate document of photos of each sample house.
- Multi-unit dwelling consents for the last 18 years, broken into vertically and horizontally attached units.
- The age profile of the housing stock by territorial authority.
- Method for forecasting future stock profiles.

8.1 Housing stock numbers

The housing stock by age group chart in the Working Paper has been revised to match the 2006 census count (see Figure 22).

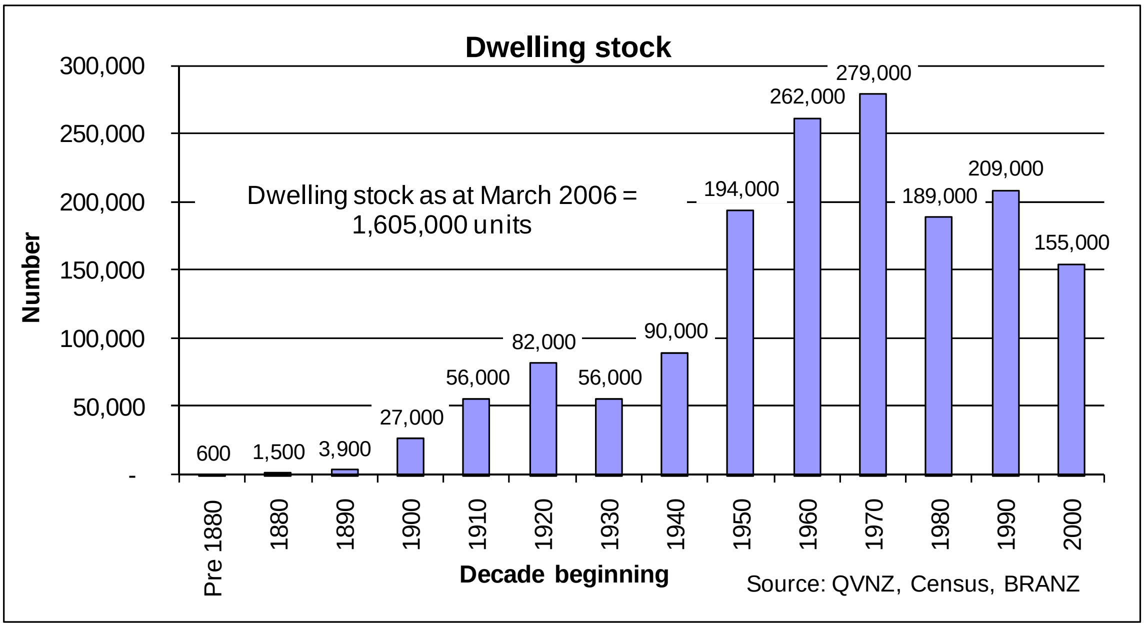

Figure 22: Dwelling stock by cohort matched to 2006 census

The derivation of the total stock number is shown in Table 4. The census provides the number of occupied permanent dwellings (excluding temporary shelters and motor camp cabins and caravans). Unoccupied dwellings are recorded in the census, but SNZ provides no breakdown of the types of these dwellings. We have assumed that 10% are non-permanent in nature, i.e. motor camp cabins/caravans and rough structures. The remaining 90% are permanent structures of a dwelling nature, though some are quite small one or two room structures.

Table 4: Total dwelling stock numbers at 2006 census

2006 census	
1,461,666	occupied permanent private dwellings (excl rough shelters and motor camp accomdtn)
159,273	unoccupied private dwellings (incl weekenders, temporary shelters/ motor camp cabins)
-15927	less 10% of unoccupied (temporary shelters, motor camp cabins , caravans).
1,605,012	= stock of permanent occ + unocc private dwellings, not temporary or motor cabins or caravans.

QVNZ data is used to spread the total stock number into the age cohorts. The QV count is only about 1,200,000 dwelling units, and many of their houses do not have an age group identifier, so adjustments and scaling are required, as shown in Table 5. The building consent data is reliable from the early 1970s and after allowing for some cancellations this consent data is used to set the 1970–2006 stock numbers. The residual from the census count is spread over the earlier decades in proportion to the numbers in the QV dataset.

Table 5: Derivation of dwelling stock numbers by age group

House stock number as at March 2006

	Mixed	Before 1920	Pre 1880	1880	1890	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000 (to Mar06)	No age	Total
Numbers in QVNZ database	34526	6284	471	1106	2876	19543	40862	60454	41475	66441	144004	194056	225044	156217	166810	-	23445	1183614
Spread pre-1920 (1)				108	281	1907	3988											
Spread Mixed, & None (2)								4791	3287	5266	11413	15379	17835					
Total (3)			471	1214	3157	21450	44850	65245	44762	71707	155417	209435	242879	156217	166810			1183614
Building consent units (4)													275359	193111	213619	156420		838508
Building consent cancellations % (5)													0	2	2	1		
Bldg consents less cancellations (6)													279359	189249	209346	154856		832809
Before 1970 scale-up (7)			589	1518	3946	26817	56071	81569	55961	89647	194301	261835						
Total stock numbers			589	1518	3946	26817	56071	81569	55961	89647	194301	261835	279359	189249	209346	154856		1605063

Notes:
1) Spread pre-1920 cohort in proortion to numbers in 1880, 1890, 1900, and 1910 cohorts.
2) Add Mixed and No Age cohorts and spread in the 1920s to 1960s cohorts in proportion to the numbers in those cohorts.
3) Totals by derived age group in the QV database, up to 2000.
4) Building consents for the decade ending in September 19x9, i.e allow 6 mths lag from consent to construction.
5) Cancelllations. Allow for consents that do not proceed.
6) These are the stock numbers for these cohorts based on building consents less cancellations. The 1970s cohort has an extra 4,000 added due to incompleteness of the consent records.
7) Approx 772,000 houses from pre 1970 are spread amoung the earlier cohorts in proportion to the numbers in line (3).

8.2 Mass housing 1940s to 1960s sample from HCS

Table 6: Random sample of 1940s, 1950s, and 1960s houses from the 2004 HCS

Christchurch only	2004 HCS Photo number	Roof slope 0=unfavourable 1=moderate 2=favourable	Roof Type	Roof cladding	Plan shape	Wall cladding	Foundation clearance 0=unfavourable 1=moderate 2=favourable	Windows	Chimney	General appearance 0=unfavourable 1=moderate 2=favourable	**Photo Comments**	HCS All component Score (5=Excellent 1= Serious)
1940s	1	1	hip	sht steel	L	stucco	1	Alum retrofit	Nil, steel flue	1	Cheap stucco house.	3
	2	2	gable	sht steel	Rect	WB	1	Alum retrofit	Nil, steel flue	2	Typical bungalow in 1920's California style, but cheap finishes.	3.6
	3	0	hip	sht steel	L	WB	0	Timber, repairs	Nil, steel flue	2	Typical hip roof, L shape, WB house.	3.6
	4	1	hip	metal tile rep	L	WB	0	timber poor	Brick	0	Typical WB hse, needs major cladding repairs	3.4
	5	0	hip	super 6	Rect	stucco	0	alum retrofit	Nil	2	Simple form, basic stucco house.	4.0
	6	2	gable	conc tile	Rect	WB	2	Alum retrofit	Nil	2	Flat roof additions2 sides.	4.2
	7	0	flat	?	Rect	stucco	1	timber	Nil steel fle	1	Typical rectangular stucco hse, parapets	3.3
	8	2	hip	conc tile	Rect	brick	1	Alum retrofit	brick	2	Typical near square brick, conc tile house.	3.2
	9	2	gable	conc tile	Rect	WB	2	timbwe	Nil, steel flue	1	Large windows at front	3.2
											Average=	3.5
1950's	10	0	gable	sht steel	Rect	brick, WB	0	alum retro	Nil, steel flue	2	Modern appearance	3.7
	11	2	hip	conc tile	Rect	stucco	1	alum retro	Nil, Heat pump	1	Mass house style, fairly cheap appearance.	4.1
	12	2	gable	sht steel	Rect	brick	2	timber	Brick	2	Cottage style, with lean-to addtion	4.0
	13	2	hip	conc tile	Rect	brick	1	timber	nil	2	Typical hip roof, brick WB, conc tile hse	3.5
	14	1	gable	conc tile	Rect	stucco	1	timber	nil	2	Tidy, "solid" looking, minor additions.	3.8
	15	1	gable	conc tile	L	brick	2	timber	nil	2	Tidy, Small lean to addition	3.4
	16	1	gable	conc tile	L	stucco	0	alum retro	concrete	1	Tidy, later additns in same style	3.7
	17	1	hip	sht steel	Rect	brick + WB	1	timber	nil	2	Tidy, brick WB mix is unusual.	3.7
	18	2	gable	conc tile	Rect	stucco	1	alum retro	brick	1	basic stucco house, maintained.	4.3
	19	2	hip	sht steel	Rect	WB	0	timb + alum	brick	2	Upper storey pop-top addition.	3.5
											Average=	3.8
1960's	20	0	mono slope	sht steel	Rect	conc masonry	on slab	timber	Nil, steel flue	2	Modern looking, painted conc 200mm blocks.	3.8
	21	0	gable	sht steel	L	brick (pale)	1	timber	concrete	1	Ugly bricks, lean-to addition	3.2
	22	2	hip	sht steel	L	brick	1	timber	Brick	2	Typical brick/ sht steel hip roof hse, large windows.	3.6
	23	0	hip	sht steel	L	conc brick	2	timber	Nil, steel flue	1	Rough texture concrete brick claddings, verandah enclosed.	3.6
	24	0	gable	sht steel	Rect	FC plank	0	timber	Concrete	1	Several lean-to additions. Looks cheap.	3.2
	25	1	gable	sht steel	Rect	brick	1	alum	brick, steel flue	1	Fibre cement gables above brick.	3.9
	26	1	gable	sht steel	Rect	conc brick	2	alum	Concrete	2	Painted conc brick cladding	3.7
	27	1	gable	metal tiles	L	conc brick	1	alum	Concrete	2	Painted conc brick cladding	3.7
	28	0	hip	metal tiles	L	conc brick	1	timber	nil	2	Tidy	4.4
	29	0	gable	sht steel	L	conc brick	0	timber	nil	2	Tidy	3.9
											Average=	3.7

Table 6 shows a random sample of 1940s–1960s houses from the 2004 HCS. The original survey sheets, with four to six photos per house, were examined and the physical characteristics from the photos were recorded in the table. The aim was to see if the house styles and forms changed significantly between the three decades. The main change was from a simple rectangular floor plan in the 1940s to more complex L-shaped floor plans and a switch to more brick cladding in later years. But apart from that the characteristics were similar, in terms of floor and roof clearances, timber windows, chimneys and claddings.

8.3 Building consents for multi-units

The building consents for multi-units are shown in Table 7. The breakdown is for horizontally attached units (i.e. at least one wall in common with an adjacent dwelling unit), and vertically attached units (at least one floor/ceiling in common with an adjacent unit). This breakdown is only available from 1991.

The horizontally attached units have a low average number of units per consent because most are either a single unit addition to an existing house, or a two or three unit new building.

Vertically attached units are in quite large buildings with a significant number each year having over 25 units per building.

Table 7 Horizontally and vertically attached units

Multi-unit building consents						
	Number of buildings		Number of units		Average number units per building	
	Horizontally attached	Vertically attached	Horizontally attached	Vertically attached	Horizontally attached	Vertically attached
Mar1991 Year						
1 to 6 units	16	716	32	1,063	2.0	1.5
7 to 25 units	0	2	0	26		13.0
>25 units	0	0	0	0		
	16	718	32	1,089	2.0	1.5
Mar1992 Year						
1 to 6 units	3	476	6	727	2.0	1.5
7 to 25 units	0	13	0	152		11.7
>25 units	0	0	0	0		
	3	489	6	879	2.0	1.8
Mar1993 Year						
1 to 6 units	9	372	18	567	2.0	1.5
7 to 25 units	0	10	0	144		14.4
>25 units	0	2	0	73		36.5
	9	384	18	784	2.0	2.0
Mar1994 Year						
1 to 6 units	6	375	12	588	2.0	1.6
7 to 25 units	0	13	0	194		14.9
>25 units	0	6	0	244		40.7
	6	394	12	1,026	2.0	2.6
Mar1995 Year						
1 to 6 units	26	383	52	642	2.0	1.7
7 to 25 units	0	40	0	502		12.6
>25 units	0	14	0	717		51.2
	26	437	52	1,861	2.0	4.3
Mar1996 Year						
1 to 6 units	18	236	37	422	2.1	1.8
7 to 25 units	0	22	0	302		13.7
>25 units	0	15	0	738		49.2
	18	273	37	1,462	2.1	5.4
Mar1997 Year						
1 to 6 units	1,299	75	2,321	161	1.8	2.1
7 to 25 units	21	36	164	507	7.8	14.1
>25 units	0	16	0	935		58.4
	1,320	127	2,485	1,603	1.9	12.6
Mar1998 Year						
1 to 6 units	1,638	39	2,841	112	1.7	2.9
7 to 25 units	40	86	314	1,199	7.9	13.9
>25 units	0	37	0	1991		53.8
	1,678	162	3,155	3,302	1.9	20.4
Mar1999 Year						
1 to 6 units	1,090	42	1,918	131	1.8	3.1
7 to 25 units	22	68	173	982	7.9	14.4
>25 units	0	34	0	1799		52.9
	1,112	144	2,091	2,912	1.9	20.2

Multi-unit building consents (continued)

	Number of buildings		Number of units		Average number units per building	
	Horizontally attached	Vertically attached	Horizontally attached	Vertically attached	Horizontally attached	Vertically attached
Mar2000 Year						
1 to 6 units	1,239	78	2,198	205	1.8	2.6
7 to 25 units	30	100	240	1,464	8.0	14.6
>25 units	0	48	0	2618		54.5
	1,269	226	2,438	4,287	1.9	19.0
Mar2001 Year						
1 to 6 units	884	63	1,563	178	1.8	2.8
7 to 25 units	14	60	107	875	7.6	14.6
>25 units	0	29	0	1314		45.3
	898	152	1,670	2,367	1.9	15.6
Mar2002 Year						
1 to 6 units	714	85	1,289	224	1.8	2.6
7 to 25 units	17	68	139	1,023	8.2	15.0
>25 units	0	37	0	2082		56.3
	731	190	1,428	3,329	2.0	17.5
Mar2003 Year						
1 to 6 units	982	102	1,746	300	1.8	2.9
7 to 25 units	24	99	190	1,381	7.9	13.9
>25 units	0	58	0	4539		78.3
	1,006	259	1,936	6,220	1.9	24.0
Mar2004 Year						
1 to 6 units	1,371	115	2,083	334	1.5	2.9
7 to 25 units	22	90	175	1,240	8.0	13.8
>25 units	0	52	0	4362		83.9
	1,393	257	2,258	5,936	1.6	23.1
Mar2005 Year						
1 to 6 units	1,138	128	1,915	291	1.7	2.3
7 to 25 units	32	98	251	1,294	7.8	13.2
>25 units	0	58	0	5062		87.3
	1,170	284	2,166	6,647	1.9	23.4
Mar2006 Year						
1 to 6 units	980	133	1,746	365	1.8	2.7
7 to 25 units	28	95	221	1,406	7.9	14.8
>25 units	0	32	0	2150		67.2
	1,008	260	1,967	3,921	2.0	15.1
Mar2007 Year						
1 to 6 units	1,013	88	1,967	259	1.9	2.9
7 to 25 units	35	90	271	1,291	7.7	14.3
>25 units	0	33	0	1709		51.8
	1,048	211	2,238	3,259	2.1	15.4
Mar2008 Year						
1 to 6 units	1,027	105	1,924	285	1.9	2.7
7 to 25 units	23	69	173	929	7.5	13.5
>25 units	0	23	0	1390		60.4
	1,050	197	2,097	2,604	2.0	13.2

8.4 Housing stock by Territorial Authority and Climate Zones

Stock number are broken into TA groups in Table 8 and Table 9, and can be used to find the stock numbers in the HERS Climate Zones.

Table 8: Dwelling stock numbers by TA — North Island

Dwelling stock numbers by TA

Decade starting	pre 1900	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000	Total
						NUMBER						to Mar2006	
Far North District	40	54	202	467	613	1091	2333	3279	4861	4854	4166	2320	24281
Whangarei District	14	70	324	1070	607	1494	3048	6374	6563	4581	3443	3611	31200
Kaipara District	15	66	195	375	279	574	1647	1364	1628	1156	773	876	8948
Rodney District	35	48	156	288	437	739	2970	4054	7264	7873	7722	6453	38037
North Shore City	27	178	1702	1908	739	1737	5449	14068	19726	10275	12740	7628	76179
Waitakere City	10	7	180	1055	642	1651	8009	11297	14489	9860	10479	7634	65313
Auckland City	0	5350	6461	12792	7738	13070	17219	19839	16255	12500	24655	20769	156648
Manukau City	12	12	186	937	504	1670	8421	20817	22954	13636	16368	13256	98774
Papakura District	1	8	60	221	85	263	1662	3133	3970	2637	1829	1616	15485
Franklin District	5	12	167	592	527	810	2593	3105	3799	3300	4047	2983	21941
Thames-Coromandel D	74	116	129	237	180	280	1532	2010	4711	5085	3884	2680	20919
Hauraki District	11	195	298	297	370	331	894	935	1417	1127	1061	520	7458
Waikato District	2	14	214	830	689	1360	2755	2352	3243	2122	853	1780	16215
Matamata-Piako Distri	2	6	144	738	635	827	2230	1887	2013	1611	1177	700	11969
Hamilton City	9	25	451	1620	1048	1975	5020	8941	9988	6473	7186	5599	48335
Waipa District	0	8	293	521	685	823	2473	2081	2922	2749	2096	1828	16479
Otorohanga District	2	1	31	187	226	315	831	627	586	358	207	200	3570
South Waikato District	1	4	17	128	163	298	2323	2593	2639	567	109	185	9027
Waitomo District	0	3	178	304	229	434	858	802	579	390	144	134	4055
Taupo District	0	0	8	22	137	685	1389	3749	3415	3407	2412	2020	17244
Western Bay of Plenty	0	5	42	188	384	459	2021	2172	3648	3880	2929	1933	17661
Tauranga District	0	11	45	78	331	774	3242	5088	7525	8382	11299	7236	44010
Rotorua District	8	4	49	215	439	1082	3471	5530	6493	4978	2282	1466	26018
Whakatane District	1	3	55	203	306	458	1996	2616	2839	2439	1299	740	12955
Kawerau District	0	0	0	0	0	5	797	594	767	406	16	16	2600
Opotiki District	2	9	89	149	182	229	583	592	639	847	344	194	3859
Gisborne District	0	305	844	1408	801	1276	3282	3157	2831	1441	1017	605	16967
Wairoa District	3	20	136	271	251	352	829	755	664	354	136	66	3836
Hastings District	19	86	823	1636	1253	1738	3723	4877	5670	3479	1719	1850	26874
Napier City	33	131	1260	1418	804	1129	3022	4182	4754	2361	2313	1325	22734
Central Hawke's Bay D	2	21	373	500	368	368	1070	719	813	640	293	329	5497
New Plymouth District	22	322	706	1921	1006	1814	4100	4176	6590	4027	2227	1455	28367
Stratford District	3	45	237	293	302	274	712	514	608	370	229	115	3704
South Taranaki District	13	189	1000	983	598	969	2112	1776	1869	882	479	266	11136
Ruapehu District	2	11	314	741	386	518	1059	1080	839	1067	316	199	6531
Wanganui District	65	353	1599	2561	393	1203	2886	2703	3048	1978	973	506	18269
Rangitikei District	5	0	539	678	262	515	1160	1344	930	531	260	138	6361
Manawatu District	32	173	513	552	494	640	2088	1597	2126	1480	1040	607	11342
Palmerston North City	29	284	693	1854	1235	2108	3955	4868	5647	3445	3113	1933	29165
Tararua District	43	178	542	771	495	681	1450	1019	1043	755	308	182	7467
Horowhenua District	16	113	352	409	337	1206	2773	2899	2312	1649	954	860	13879
Kapiti Coast District	2	49	128	339	507	733	2545	2983	4781	3911	3183	2776	21938
Porirua City	4	4	70	171	160	258	2706	4044	4081	2429	1391	858	16174
Upper Hutt City	2	10	133	341	349	934	2994	3106	4021	1221	742	949	14801
Lower Hutt City	5	246	1148	2751	2689	5955	4706	6789	6758	3034	2133	984	37197
Wellington City	1177	4772	3522	8455	4730	4210	5415	9676	10617	5595	7376	6752	72296
Masterton District	44	455	398	707	455	600	1747	1918	1643	914	603	588	10072
Carterton District	4	56	198	253	117	197	500	524	461	341	151	288	3087
South Wairarapa Distr	16	74	276	291	134	231	688	851	792	527	357	367	4605

Table 9: Dwelling stock numbers by TA — South Island

Dwelling stock numbers by TA (continued)													
Decade starting	pre 1900	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000	
						NUMBER						to Mar2006	
Tasman District	20	29	482	465	589	888	2218	2810	3044	2353	3699	2496	19091
Nelson City	119	198	558	560	679	1301	2386	2536	2800	2224	3135	1538	18035
Marlborough District	23	106	590	578	382	893	2023	2942	3900	2862	3149	2156	19605
Kaikoura District	3	5	31	21	68	137	259	309	350	196	211	218	1809
Buller District	1	7	823	387	488	658	584	297	586	373	315	287	4805
Grey District	5	17	736	608	995	675	629	440	672	401	419	271	5867
Westland District	0	4	18	393	365	337	421	225	1124	365	337	298	3887
Hurunui District	6	7	82	155	262	330	847	685	746	716	817	687	5339
Waimakariri District	22	109	373	387	383	575	1212	1755	3197	1876	3981	2591	16461
Christchurch City	344	2133	5153	8162	4725	8437	17760	21727	25521	14083	22553	12117	142714
Banks Peninsula District -- to Christchurch City													
Selwyn District	0	109	117	584	540	751	1020	1676	1630	1838	1581	2682	12528
Ashburton District	0	169	355	667	516	941	1142	2169	2177	1727	1089	927	11881
Timaru District	63	152	1374	1895	1169	1200	2928	2854	3706	1411	1180	868	18801
Mackenzie District	0	0	75	56	39	50	134	185	1364	137	176	309	2527
Waimate District	19	14	201	444	235	349	597	465	648	202	101	122	3398
Chatham Islands District													na
Waitaki District	250	200	494	969	513	622	2038	1640	1591	797	565	390	10070
Central Otago District	63	58	243	187	228	298	1176	1060	1804	1463	832	974	8386
Queenstown-Lakes Dis	8	8	87	37	60	70	502	1177	1577	2353	2699	3742	12321
Dunedin City	2000	2604	3570	4515	3435	3894	7035	6468	6638	2909	3129	1751	47948
Clutha District	250	314	437	492	509	365	1464	1386	1403	562	467	289	7939
Southland District	5	17	654	965	756	909	2043	2572	2462	1268	758	667	13074
Gore District	4	2	476	269	431	312	834	1065	1037	444	237	152	5265
Invercargill City	0	456	908	1438	1515	1610	2951	4145	4597	1991	1112	660	21383
Total NZ	5018	22726	47225	80879	57115	88883	195443	258005	302379	202458	209364	156567	1604611
Compare to Figure 20	6050	26801	56091	81889	55984	89649	193778	261961	279359	189249	209346	154856	1605012
Decade starting	**Pre 1900**	**1900**	**1910**	**1920**	**1930**	**1940**	**1950**	**1960**	**1970**	**1980**	**1990**	**2000**	

The numbers in Table 8 and Table 9 were derived from QV TA data. For each TA a similar method to that used in Table 5 for the total stock numbers was followed, i.e. the census count at 2006 for each TA was used, consent numbers between 2000 and 2006 were allocated, and the census remainder was spread between the age groups according to the QV age distribution for each TA individually. At the bottom of Table 9 a comparison is made between the totals of TAs and the numbers obtained in Table 5 for all New Zealand and the two sets agree fairly closely for the various age groups.

Note that the numbers for some TAs and age groups may not be very reliable. For example, the table shows zero pre-1900 dwellings in a number of authorities, including Auckland, Tauranga and Invercargill, which seems unlikely. It is likely the QV dataset is incomplete for these locations.

The breakdown by TA was used to proportion the typologies from Table 3 into the three climate zones of NZS4218 (see Table 10).

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Table 10: House typology by NZS4218 Climate Zones

House numbers by typology - Climate Zone 1

Number of dwelling units to March 2006.

Dwelling unit numbers (000s) (1)

Decade start	Villas	Bungalow 1920-36	Art Deco 1925-40	Mass housing 40s-60s	Multi units 1960-70s	Mass housing 1970-78	Housing 1978-80s	Multi units 1980-90s	Housing 1990-96	Housing post 96	Multi units 2000s	Total
pre-1900	0											0
1900	7											7
1910	12											12
1920		18	2									20
1930		9	2									12
1940				21								21
1950				52								52
1960				76	15							91
1970					32	53	13					99
1980							55	17				72
1990								10	49	32		91
2000										57	13	70
Total	19	27	4	149	47	53	68	27	49	90	13	546
											Pre 1960s multi-unit numbers =	11
											Total all dwelling units (000) at 2006 =	557

House numbers by typology - Climate Zone 2

Number of dwelling units to March 2006.

Dwelling unit numbers (000s) (1)

Decade start	Villas	Bungalow 1920-36	Art Deco 1925-40	Mass housing 40s-60s	Multi units 1960-70s	Mass housing 1970-78	Housing 1978-80s	Multi units 1980-90s	Housing 1990-96	Housing post 96	Multi units 2000s	Total
pre-1900	2											2
1900	10											10
1910	20											20
1920		30	3									33
1930		17	4									22
1940				33								33
1950				78								78
1960				86	17							102
1970					35	59	15					108
1980							56	17				73
1990								7	33	22		62
2000										38	9	46
Total	32	47	8	196	52	59	70	24	33	60	9	590
											Pre 1960s multi-unit numbers =	14
											Total all dwelling units (000) at 2006 =	604

House numbers by typology - Climate Zone 3

Number of dwelling units to March 2006.

Dwelling unit numbers (000s) (1)

Decade start	Villas	Bungalow 1920-36	Art Deco 1925-40	Mass housing 40s-60s	Multi units 1960-70s	Mass housing 1970-78	Housing 1978-80s	Multi units 1980-90s	Housing 1990-96	Housing post 96	Multi units 2000s	Total
pre-1900	4											4
1900	8											8
1910	22											22
1920		23	3									26
1930		15	4									19
1940				25								25
1950				52								52
1960				57	11							68
1970					23	39	10					72
1980							34	11				45
1990								6	30	20		56
2000										32	7	39
Total	35	38	6	134	35	39	44	17	30	52	7	436
											Pre 1960s multi-unit numbers =	9
											Total all dwelling units (000) at 2006 =	445

8.5 The future stock profile

The brief requested a methodology for forecasting the housing stock profile into the future. A model is suggested in Figure 23. The starting point is the current typologies, supplemented by models of demolitions and major renovations developed for each typology. The last component is the new additions into the future, based on various demographic based forecasts available from Statistics NZ.

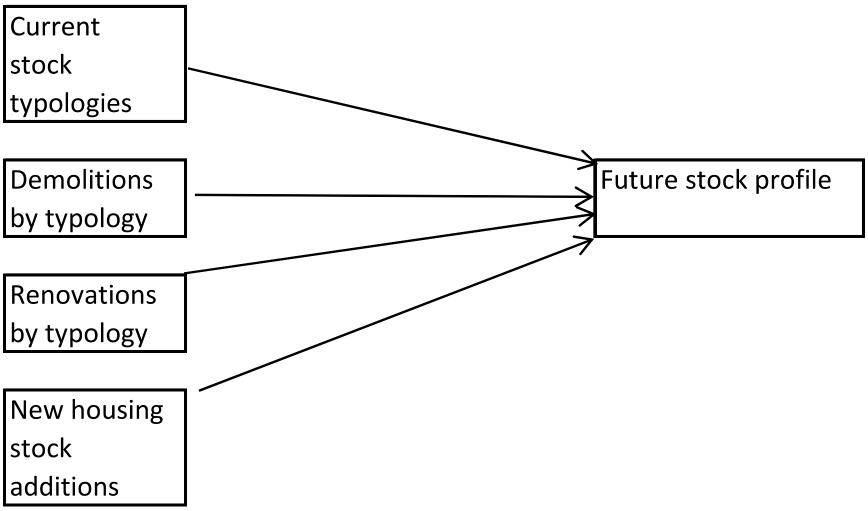

Figure 23: Future stock profile model

Most of the work is likely to be in developing models of demolitions and renovations. There is no complete official information on demolitions. A building consent is required for any demolition of a building. However these are often combined with the replacement building in the same consent application, and the consent application descriptor does not always include the demolition work. Also Statistics NZ does not record demolition consents when they are below $5,000 in value, nor is the building age included in the descriptor. In the last nine years SNZ has recorded 194 residential demolitions, an average of 22 per year, which is well below the true rate. Work by BRANZ (see the Reference section, Page (2007)), suggests the current rate of demolitions is about 2,000 per year, with another 3,000 being major renovations that significantly extend the life of the dwelling and thereby avoid physical failure and the need for a demolition replacement. Johnstone (1994) has also developed a model of demolition which predicts a rate of about 7,700 per year in the last few years.

BRANZ has recently begun a levy funded project called Sustainability and the Housing Life Cycle. Part of that project is to better understand the maintenance cycle in housing and the opportunities for incorporating sustainability features. The project now has underway a survey of builders/owners to investigate the reasons for demolition, the ages of demolished houses, and what replaces them. This survey data, available in late 2008, is likely to be relevant to any Beacon work on the future stock profile.