EN6570/9

New Zealand House Typologies to Inform Energy Retrofits

Final

A report prepared for Beacon Pathway Limited
November 2008

The work reported here was funded by Beacon Pathway Limited and the Foundation for Research, Science and Technology

About This Report

Title

New Zealand House Typologies to Inform Energy Retrofits

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Reviewer

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Abstract

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Reference

Ryan, V., Burgess, G. and Easton, L. November 2008. New Zealand House Typologies to Inform Energy Retrofits.Report EN6570/9 for Beacon Pathway Limited.

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1 Executive Summary

Beacon's aspiration is to bring about a significant and substantial improvement in the sustainability of the residential built environment in New Zealand. It recognises that improving the standards of our existing stock is key to meeting that vision. This means retrofitting the vast majority of our poorly performing housing — but not just any sort of retrofitting. It means retrofitting our houses to a HSS High Standard of Sustainability® (HSS®) with the best standards of insulation, energy efficient water and space heating, energy efficient lighting, water efficiency and solutions to improve the indoor environmental quality.

As part of Beacon's programme of work in this area, an analysis of house typology has been undertaken. This work has been informed through a workshop analysing house typologies that was held at the end of November 2007 and followed up with input from architecture and retrofit experts. The purpose of the workshop was to harness the skills and experience of gathered experts to consider whether our modal house types in New Zealand — that is the house types that dominate our housing stock — are amenable to retrofit to meet Beacon's HSS High Standard of Sustainability® and, if so, what sort of retrofit packages may be required.

This report summarises the findings from the workshop and provides an analysis of typologies within the framework of Beacon's retrofit programme.

2 Beacon Strategic Context

Beacon's vision is to "create homes and neighbourhoods that work well into the future and don't cost the Earth". To reach this vision we are guided by two goals:

- 90% of New Zealand homes will be sustainable to a high standard by 2012; and,
- Every new subdivision and any redeveloped subdivision or neighbourhood from 2008 onwards will be developed with reference to a nationally recognised sustainability framework.

The research is managed under six streams: Energy, Water, Indoor Environment Quality, Materials, Sustainable Homes and Neighbourhoods. The Board approved Energy strategy has three research targets:

1) 90% of New Zealand homes use energy efficient systems for water heating, space heating, lighting and appliances, and have a high standard of insulation (to maintain a minimum temperature of 18^{o}C) by 2012, thus reducing the demand on reticulated energy from homes by 40%.
2) All homes will have a minimum net 50% of their energy supplied from local renewable sources and have a minimum temperature 18^{o}C by 2020; AND all energy into all homes/neighbourhoods will be supplied by renewable sources by year 2040.
3) All new homes and consented renovations will be designed to reduce total energy requirements through active management of the passive solar and thermal performance by 2012.

Beacon has prioritised research that addresses existing homes — by 2012 these will make up 80% of the predicted housing stock. This programme of work addresses the retrofit aspects of the first energy target. Research into options to reduce energy from new builds will be addressed in the Homes stream, particularly the Home*Smart* Homes[1] programme.

[1] ***Formerly the NOW Home® programme***

3 Research context

Beacon's energy research will trial and establish best practice to reduce the energy demand within existing homes. It will enable Beacon to meet one of its overriding milestones that by 2008, a framework for decision making on how best to retrofit for energy efficiency will have been developed. This research has three work strands:

1) Energy retrofit options for existing homes by house typology (*this report forms part of this work strand*)[2]
2) Energy retrofit options for targeted users and consumers
3) Retrofit intervention packages and options to deliver to the market.

This report relating to descriptions of basic New Zealand house types falls under Work Strand One of the Energy Retrofit project described above. 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, if any, make a house not worth retrofitting and how can those be defined?

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

(a) understanding energy use in homes by users and consumers; and,

(b) developing optimised packages and tools for the market to stimulate energy retrofit.

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 (Ryan et al., 2008) provides the background for a companion report (Page et al., 2008) which sets out prevalence of house typologies in New Zealand. 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.

To date, Beacon has drafted a housing typology with inputs from universities, industry, research organisations and others. The intention is that this typology will be used to form the basis of our advice to consumers, industry and government on how to retrofit existing homes to meet a HSS High Standard of Sustainability®. This report has been developed to help Beacon

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[2] ***Further work in this work strand includes an overview of prevalence of the suggested modal house types within New Zealand. This is currently being undertaken by BRANZ and will help to inform Beacon's final list of house typologies.***

understand the main characteristics of the basic house types outlined and issues that will be pertinent to the provision of retrofit solutions.

The typologies below have been set out to provide a framework for tackling retrofit solutions for our housing stock. The aim is that within each typology the basic descriptions of the systems and characteristics cover 80% of the houses falling within that typology. There are undoubtedly variations within each era, and the exceptions that prove the rule, but for the majority of cases the characteristics provided below will enable us to state that "most houses of this type will be like this".

Even though New Zealand has a wide range of climatic conditions and topography from the top to the bottom of the country, the same basic housing types from each period of history were used throughout the country for mass housing. In the main, these were timber framed houses with metal roofs and little or no insulation. As shifts in society and culture occurred, including updates to the building regulations, changes appear in house typology. However, within the typologies set out below there remain very little regional variations between these changes in styles that are anything more than minor.

The following draft typologies are considered to capture 80% of New Zealand's housing stock:

1. Early housing (pre-1890)
2. Villa (1880–1920)
3. Bungalow (1920–1930/40)
4. Art Deco (1925–1935)
5. State House and Mass Housing (1930–1970)
6. 1960s Multi Unit Housing
7. 70s House (1970–1978 pre-insulation)
8. 80s House (1978–1989)
9. Early 90s (1990–1996 pre-revamped Building Code)
10. Last decade (1996–2007 post-insulation upgrade)

3.1 Typologies workshop

To assist in developing the main typologies a workshop was held in November 2007 and was attended by over 20 participants from a range of backgrounds including architects, retrofit specialists, academics and researchers. A full list of attendees is provided in Appendix A. The workshop was arranged as two main exercises with a summary session at the end. The two main sessions were themed as follows:

- **Session One:** The aim of the first session was to work out what the modal houses are in the current New Zealand housing stock and what features of them classify them into particular "typologies". The groups filled out predesigned templates gathering data about the main construction features such as age, era, style, condition, systems such as walls, floors etc.

- **Session Two:** The second session concentrated on establishing for each of the modal houses outlined from the first session, whether they represent particular retrofit needs or challenges. The aim was to develop a preliminary, albeit expert view, on the sorts of retrofit packages suitable to different modal houses (including a brief analysis of these between different climate zones).

Each session was designed to answer a set of key questions as follows:

- ***Session One Key Questions:***
  - Can we identify a defined list of modal housing types that are representative of the New Zealand housing stock?
  - Do these modal house typologies have distinct sub-typologies that make further segmentation necessary?
  - Can we reach consensus on a list of modal house typologies and the main features of each of those typologies?
  - If it is possible to ratify a series of modal house typologies, is data available to develop an understanding of prevalence of different types of houses — and can we identify any trends in terms of regionality?

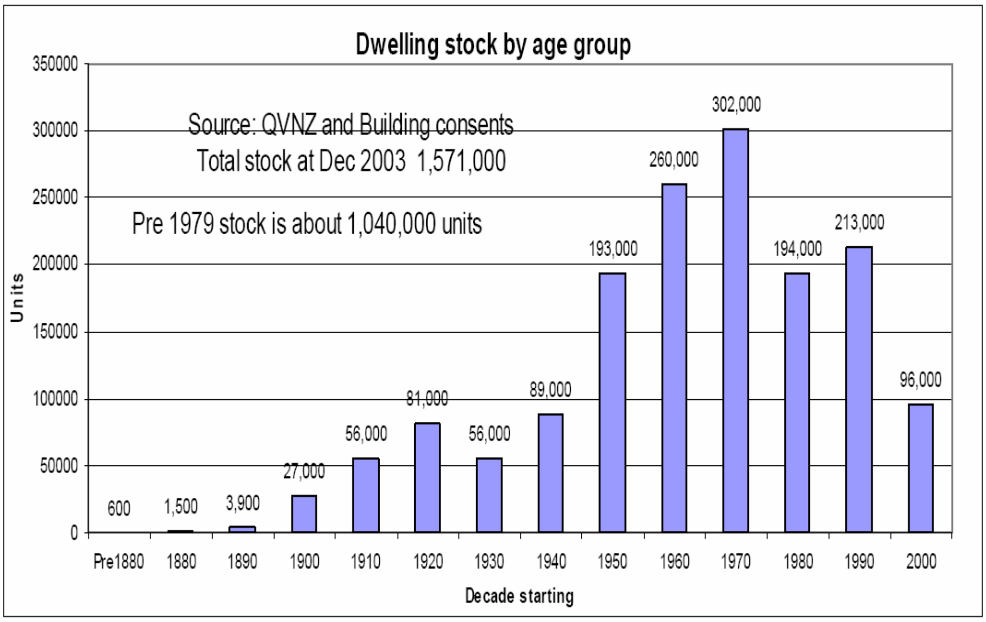
- ***Session Two Key Questions:***
  - What energy efficiency gains are possible within the constraints of individual house types?
  - Can we identify those aspects of house type that make retrofit easy?
  - Can we identify those aspects of house type that make retrofit necessary?
  - Can we identify those aspects of house type that make retrofit impossible?
  - What parameters make a house not worth retrofitting — how can those be defined?
  - What is the interaction between climate, house typology and retrofit solutions and how can this be represented?

3.2 Existing research

Despite the large body of research in New Zealand looking at housing, and in particular the thermal performance of houses, there is little in the way of existing research that splits out New Zealand's house types in terms of a readily identifiable typology. Work conducted by BRANZ including HEEP (Isaacs et al., 2006) and the NZ House Condition Survey (Clark et al., 2005) typically categorises houses for analysis based on the decade of construction. This provides a useful criteria for analysis on many levels, but in terms of understanding the physicality of the house for Beacon's retrofit programme it does not, for instance, distinguish a bungalow built in 1929 from an art deco house constructed in the same year.

Figure 1 indicates the numbers of houses by age group in New Zealand. Whilst this data does not align itself neatly alongside a set of different typologies based on physical characteristics of housing (e.g. bungalow vs state house), it does provide some understanding about where Beacon's focus needs to be. In some cases, as with the early housing, it can assist Beacon in determining prevalence of certain modal housing types.

Figure 1: New Zealand's dwelling stock by decade age group (Storey et al., 2004 as quoted in Amitrano et al., 2006)



Where the existing research concentrates on the thermal performance of New Zealand's housing stock, it tends to focus on the provision of different levels of insulation as one of the defining characteristics of different house types. Therefore much of this data splits houses into pre-1978 and post-1978 (when insulation became mandatory), as well as defining houses between 1978 and further revisions to the New Zealand Building Code in later years. This analysis, based on insulation levels, is one of the key inputs for Beacon's programme of work. However, Beacon also needs to understand a level of detail relating to the physical characteristics of basic house type and features of the house that go beyond this criterion.

Preparatory discussions with EECA indicated that BRANZ had been commissioned to undertake some work aimed at identifying a range of house types that could be used with the newly introduced HERS scheme. This study (Buckett et al., 2007) provided useful background to the workshop and Beacon's retrofit programme, particularly in relation to defining the draft typologies outlined below. The workshop and subsequent programme of energy retrofit work utilises the typologies identified by BRANZ in the EECA work and seeks to develop these further in relation to retrofit interventions.

3.3 Development of the draft typologies

Prior to the workshop a series of draft typologies were developed as a starting point for discussions. These were based on the typologies suggested in the EECA commissioned BRANZ report, "*EC1390 EECA HERS Houseplans*" (Buckett et al., 2007). This was done primarily so that the results of the workshop and subsequent research could be aligned with the recently launched HERS scheme. One of the aims of the EECA commissioned research was the development of a set of "typicals" that would be relatively representative of the New Zealand housing stock. In the resulting report BRANZ identified that the available datasets (including HEEP and the NZ House Condition Survey) do not readily lend themselves to the development of a set of typical features based on house form, construction type, floor type, etc. Instead a set of categories are developed in the report and it is these that formed the basis for the typologies that Beacon used in the workshop as outlined below.

3.3.1 Draft Typologies

1. Early housing (pre-1890)
2. Villa (1880–1920)
3. Bungalow (1920–1935)
4. Art Deco (1925–1935)
5. State House and Mass Housing (1930–1970)
6. 1960s Multi Unit Housing
7. 70s House (1970–1978 pre-insulation)
8. 80s House (1978–1989)
9. Early 90s (1990–1996 pre-revamped Building Code)

10. Last decade (1996–2007 post-insulation upgrade)

Although these typologies are indicative of different eras of housing within New Zealand they can, and do, show huge variation within each typology. This issue is central to the development of a series of standardised packages for Beacon. If New Zealand's one million plus underperforming houses are to be brought up to a HSS High Standard of Sustainability® by 2012 we do not have the time to develop a million individual solutions.

4 Typologies discussion and analysis

The following section summarises some of the main findings from analysis of the different typologies in relation to retrofit suitability. Much of this information is gleaned from input provided at the typologies workshop. This information was captured on worksheets, the detail of which is provided in the main typologies templates available in the Appendices. This information was then developed further utilising input from heritage architects and retrofit specialists. It is important to note that the following analysis restricts the discussion to the range of typologies analysed at the workshop. Further work is being undertaken at the time of writing to ascertain the prevalence of these modal housing types and it is expected that this may broaden the typologies categories. This issue and an analysis of potential "missing typologies" is discussed later in this report.

4.1 Early housing (pre-1890)

4.1.1 Main characteristics

This category describes the simple early housing that was built in New Zealand before then end of the 19th century. The majority of these houses were timber framed, clad in plain or shiplapped weatherboards, with metal roofs. There are some examples of brick and stone being used. The main house form is based on a rectangular plan with a gabled roof and most are single storied. Most had an open veranda facing the street and a fireplace. More prosperous houses of the period also utilised the roof space. These upper floor rooms are fitted into the attic space of the roof with low walls and sloping ceilings. Houses from this era were built with no insulation. The age of these houses means that those that remain have often undergone a significant number of renovations and alterations including reorientation of rooms, conversion to open plan living, new kitchens and extensions and insulation added in the attic space. From the single rectangle the most basic additions are lean-to roofs to the rear, or additional gabled rooms added behind or as return wings.

4.1.2 General description of era and construction types

This category describes the simple early housing that was built in New Zealand before the 1890s. The majority of these houses are very simple wooden workers' cottages, often based on a single gabled room. Houses were small in scale and plain in finish. These houses were built before industrially produced materials were readily available and their size reflects the cost of goods and labour at that time. Typical house size is 80 m^2. Houses are generally on flat sites in the earliest areas of settlement, both in cities, small towns and as farmhouses and rural workers' dwellings.

4.1.3 Variability of typology

There is a degree of variation within this typology, with some early dwellings being two storeys and rather grand compared to simple workers cottages. However, for the purposes of retrofit solutions much of the construction is carried out using similar techniques and materials. Notable variants are brick masonry or stone with a few cob structures still in existence.

4.1.4 Solar orientation — including within the neighbourhood

These houses were generally built facing the street regardless of solar orientation. Living space will be located at the front of the house, bedrooms on one side and service areas (kitchen, laundry, bathroom) at the rear. Very few intact examples remain as most houses from this period have been enlarged and the configuration of functions within the house will vary. Due to the form of the roof in most instances there will be at least one side with good northern solar access suitable for solar water heating.

4.1.5 Roof system — materials, form, construction and access

Roofs of houses from this period were gabled with lean-to roofs over the verandas and service areas. The gable roofs are pitched at 30–45º with lower pitched roofs to the lean-tos. When first built, shingles were the most readily available roofing material, with corrugated iron also available. Few, if any, shingled roofs remain. The ceilings of these houses in the main area are flat, except on the smallest and the upper floor areas of the larger houses where the ceilings follow the roof line, leaving no cavity between ceiling and roof, except at the apex where there is a flat section of ceiling. The roof and ceilings are often framed with 100 x 50 rafters. The ceilings are generally finished in timber sarking.

4.1.6 Wall system — materials, form, construction and access

Most houses from this period are clad in wooden weatherboards over timber frame with no dwangs or building paper. The interior of original houses is timber sarking covered in hessian and wallpaper. There is no insulation and no access to the wall cavity without removing cladding or linings. Houses of this era generally exhibit an 8–10 ft (2.4–3 m) stud.

4.1.7 Floor system — materials, form, construction and access

These houses have timber strip flooring on a timber subfloor. The subfloor space is generally low (less than 300 mm) rising up to one metre. Access to the underfloor space is variable. The flooring is, in most cases, kauri tongue and groove. The floors have no underfloor insulation.

4.1.8 Windows and glazing systems — materials, form and construction

Most joinery was standard wooden double hung sash windows of a standard size. The joinery profiles are finer than contemporary joinery. Due to the age of the houses, most joinery will have been replaced or repaired over time.

4.1.9 Heating system — type and location

All houses from this period had at least one open fire. In larger homes coal or wood burning ranges were fitted in kitchens although few of these will remain, with even fewer in use.

4.1.10 Hot water system — type and location

Most of these houses have low pressure, small hot water cylinders which are reaching the end of their lives. Where they have failed they have often been replaced by high pressure systems. Hot water cupboards with space for a large cylinder (e.g. 250 l) are generally located next to the bathroom. Often, particularly in rural areas, there may be a wet back system attached to the fireplace or the range.

4.1.11 Plumbing — general system, location of bathroom and laundry

Plumbing systems are old and often patchily repaired. Generally the original kitchen, bathroom and laundry are close to each other to minimise plumbing. Bathrooms and laundry were located to the rear of the house regardless of solar orientation.

4.1.12 Ventilation characteristics

These older houses rely on double hung windows for ventilation. The plan area is generally small. The service areas will often have only an awning or casement window for ventilation. Due to the age of the houses draughts under doors and from windows are very common, as are holes and cracks in the floorboards.

4.1.13 Likelihood and impact of previous renovations on typology and systems

Most early housing will have been added to or otherwise altered to improve functionality and layout. As many early houses were built without indoor bathrooms a significant number now have lean-to additions to accommodate this feature. Additions can usually be found at the back of the house although some extensive remodelling has occurred in some early houses. Conversions of open fires to inset wood burners and the installation of unflued wall gas heaters in urban areas is common.

4.1.14 Heritage issues, section sizes and other planning constraints

These houses are a limited resource. Over time many have been demolished or altered to the point where they are no longer period houses. These houses from before 1890 have a unique character that can easily be lost or destroyed. They have a cultural significance to our whole society because of what they represent and their rarity. Having an understanding of their particular qualities and character is important. This is recognised by many Territorial Authorities and the protection of heritage character has become a planning issue, with heritage overlays and zoning giving some protection to these houses.

Houses from this period were often built on very small sites. As a consequence, pre-1890s houses may be sited close together, facing the road, or with houses from later periods being constructed very close by. Generally they are sited very near to the street.

4.1.15 Characteristics and links to regionality, geographic areas or typography

These houses were built in the centre of towns, usually just outside the commercial area as it developed and in rural areas as farm houses or workers' cottages. There are some distinct areas where these houses are still the predominant house type, in the Aro Valley and Grahamstown in Thames, for example. In general, they remain as scattered remnants in the villa suburbs.

4.1.16 Suitability for retrofit

These are not necessarily a good candidate for standard retrofit packages and successful retrofit will depend largely on the individual situation of each house including access and other characteristics. Adding additional insulation can be done if there is space in the ceiling and provided access under the floors is possible. However, floor access can be problematic as many of these dwellings are built near to the ground (less than 300 mm). Some of the two storey houses in this typology exhibit skillion type roofs making additional ceiling insulation difficult to retrofit. Character windows in these older houses are hard to double glaze and may be restricted by heritage regulations. These dwellings can be good candidates for heating retrofits and solar water heating (SWH) is possible, given decent pitch of the roof on most of these houses (although obviously orientation will be an overriding factor and heritage restrictions may be an issue).

The limited number of houses of this type (40–60,000) as indicated in Figure 1 and the essential nature of the heritage characteristics suggest that this category of housing is not a priority for Beacon.

4.2 Villa (1880–1920)

4.2.1 Main characteristics

Relatively speaking, villas show little variation within their category compared to other housing typologies. They are typically constructed in native timbers, square in plan with a gabled corrugated iron roof. Notable variants are twin brick and masonry villas with a few cob structures still in existence. Interior walls are typically sarked unless renovated and floors are usually of the suspended native timber tongue and groove variety. These houses were built with no insulation. Many villas have a high stud of 10–12 ft. The windows are typically wooden joinery and single glazed. Sash windows are common and are rarely a standard size, indicating that retrofitting double glazing will be problematic. As many villas were built without indoor bathrooms a significant number now have lean-to additions and additions to accommodate this feature and increase the size of the house. A typical villa roof is high pitch with a large cavity above the ceiling. Open fires were common in villas. As with early housing, the age of these structures means that any remaining have often been highly renovated, added to or altered since they were first built. This will add a layer of complexity to any standardised retrofit solution.

4.2.2 General description of era and construction types

The villa was the first mass housing style in New Zealand. The earliest villa style houses were constructed in the 1880s, however it was during the period of strong immigration in the 1890s that the villa suburbs grew. By this time there were established industries delivering standard components to the construction industry. The components and often house plans were taken from industry pattern books. At this time public transport systems were opening new areas of cities for development and the villa suburbs follow the tram lines of the era. Builder developers would buy several sections in a row and then construct matching houses as can still be seen clearly in some intact streets of identical villas.

The villa period began at the end of the 1880s and reached a peak by the turn of the century. The first villas were plain in form and finishes and they became more ornate and complex during the 1890s culminating in the “bay villa”. The most ornate villas were built in wealthy areas, and close to the tram routes that commonly ran along ridge lines. From around 1910 the detail of the villas began to change, incorporating more features of the bungalow style that followed. The houses from this period are sometimes called transitional villas.

4.2.3 Variability of typology

Villas follow a clear typology with ample variation within that theme. The basic house is almost square in plan with a central hall running from the front to the back, and two rooms each side of the hall. On one side of the house there is generally a chimney between the rooms with a fireplace on one side and the coal or wood fired range on the other. More affluent houses had more than one chimney. All villas were built with a veranda to the street. The main roof of the villa is generally hipped. At the back of the house there is commonly a lean-to extension. Variations on this include, square front villa, wrap around verandas, the addition of a front bay (bay villa), double bays enclosing a central veranda, side bays, etc. Some villas were also built with gable roofs.

There are occasional examples of two storied villas. The form of the house in these examples is simply raised making these houses very strong clear forms that relate well to the surrounding townscape. Almost all villas are built of timber with weatherboard cladding. Brick, plastered brick, stone and concrete villas were built, but examples are rare.

4.2.4 Solar orientation and house layout — including within the neighbourhood

These houses were generally built facing the street regardless of solar orientation. At the front of the house one room was used as a parlour for receiving guests. The other front room was the main bedroom. The back room of the house was the kitchen/scullery. The laundry and toilet were usually housed outside in sheds, many of which still remain in the backyard of existing houses.

In villas today the back of the house is often opened to form a living area with service rooms to the side. The core of the villa itself is usually left in its original form with the rooms used as bedrooms or living rooms. Because of the form of the roof, generally there will be at least one side with good northern solar access.

4.2.5 Roof system — materials, form, construction and access

Villas generally have roofs with a pitch of 30º. On later villas the pitch often dropped to 24–27º as the bungalow style evolved. Villas have flat ceilings and clear ceiling spaces over the main roof area. In lean-to areas the ceilings are generally timber sarked and follow the pitch of the roof. During the high period of villa construction ceilings did become very ornate in elaborate villas. Most villa ceilings are board and batten with a moulded cornice around. In elaborate villas the ceilings can be of moulded plaster or pressed metal, with the decoration expressing the function of each space (fancy in entertainment areas, and getting plainer as the functions become less public).

4.2.6 Wall system — materials, form, construction and access

The majority of villas were timber framed, built of machine cut 4 x 2 inch kauri. Villa walls typically have no horizontal intermediate framing (nogs or dwangs). The exterior is generally clad in machine dressed kauri weatherboards, and the interior lined with timber sarking, hessian and wallpaper. They predate the use of building paper and insulation.

4.2.7 Floor system — materials, form, construction and access

Villas have kauri floors on a timber subfloor structure. There is generally 500 mm or greater clearance under the floor and access is typically good.

4.2.8 Windows and glazing systems — materials, form and construction

The standard villa window is the double hung timber sash. These were standard units produced in joinery factories. Double hung windows generally have thin profiles. Due to age and depending on maintenance, many will require some repair or other attention.

4.2.9 Heating system — type and location

All villas were built with open fireplaces. Typically these were between the two front rooms of the house.

4.2.10 Hot water system — type and location

Most of these houses have retrofitted low pressure, small hot water cylinders; many of which will be reaching the end of their lives. Where they have failed they have often been replaced by high pressure systems, in main centres often with instant gas. Hot water cupboards with space for a large cylinder (e.g. 250 l) are generally located next to the bathroom. In some instances, particularly in rural areas, there may be a wet back system attached to the fireplace or the range.

4.2.11 Plumbing — general system, location of bathroom and laundry

Plumbing systems are old, and often patchily repaired. Generally the original kitchen, bathroom and laundry are close to each other to minimise plumbing. Bathrooms and laundry are generally located to the rear of the house regardless of solar orientation and most will have been added since the original construction.

4.2.12 Ventilation characteristics

Villas rely on double hung windows for ventilation. There may be fan lights on more elaborate villas. The service areas will often have only an awning or casement window for ventilation. Due to the age of the houses draughts under doors and from windows are very common, as are holes and cracks in the floorboards.

4.2.13 Likelihood and impact of previous renovations on typology and systems

Most villas will have been added to or otherwise altered. As many villas were built without indoor bathrooms a significant number now have lean-to additions and additions to accommodate this feature. They are very adaptable houses with generously proportioned rooms. Most additions will be at the back of the house, and recent additions will generally be to provide for living areas and service functions. Renovations are unlikely to have significantly impacted on wall or floor systems. Alterations and additions carried out in the last 20 years will be insulated.

Villas did not have garages; as a result these have generally been added — often in the 1970s. In many localities the narrow sections mean that garages and carports have been built at the street frontage, often in front of a bedroom, restricting solar access.

Conversions of open fires to inset wood burners were a popular renovation in the 1970s, as was the installation of wall mounted unflued gas heaters in those areas with reticulated gas.

4.2.14 Heritage issues, section sizes and other planning constraints

These houses are a limited resource. Over time many have been demolished or altered to the point where they are no longer period houses. The houses of the villa period have a unique character that can easily be lost or destroyed. Villa suburbs have a cultural significance to our whole society because of what they represent and the fact that they are a finite resource that is vulnerable to change. Having an understanding of their particular qualities and character is important. This is recognised by many Territorial Authorities and the protection of heritage character has become a planning issue, with heritage overlays and zoning provisions giving some protection to these houses.

4.2.15 Characteristics and links to regionality, geographic areas or typography

These houses were built in the expanding suburbs of New Zealand towns as these areas developed along tram lines and other public transport routes. The villa was a universal style. They were built as mass housing, as farm houses, for the wealthy and the humble, indeed for any housing. The style was used by architects as well as builders and developers.

4.2.16 Suitability for retrofit

Villas are generally known for having "good bones". They exhibit a simple structure, with lots of ceiling cavity space and often good crawl space under suspended timber floors. Solar orientation is usually reasonable although the majority of houses were oriented to the street. Gabled roofs usually provide at least one north facing aspect suitable for solar panels. With an absence of nogs or dwangs, there are possibilities for adding wall insulation although the absence of building paper in the walls means that condensation issues need to be considered. Many have large rooms and a high stud which can make retrofitting insulation expensive but definitely feasible. Insulation under the floor is crawl-space dependent, but if done will make an appreciable difference to the thermal performance of the house. Retrofitting for solid fuel heating is relatively easy within this housing type as many already had open fires and their layout and chimney arrangements can make the addition of wet backs suitable.

Many villas are prized for their heritage value and, due to the strong native timbers, are surprisingly robust. Villas are often found in the older and more established neighbourhoods throughout New Zealand (which may indicate owners with a higher socio-economic background).

The simple structure of these houses makes them good candidates for retrofit in most systems with the exception of double glazing of windows which can be limited due to the suitability of window frames and in some areas, heritage restrictions.

4.3 Bungalow (1920–1930/40)

4.3.1 Main characteristics

The typical New Zealand bungalow is a relatively simple plan, single storey, gabled home built primarily from native timber and with a corrugated steel roof. A subvariant which may require further research is the English Cottage Style which has 1½ storeys typically and with a large garage or basement underneath. Floors are generally suspended native timber lifted off the ground by more than 500 mm. Wall construction is usually wooden weatherboard with no insulation and no building paper. Some renovations in the 60s and 70s saw the application of brick veneer cladding although solid brick bungalows are rare. The stud height is typically lower than that of villas, commonly being around 2.8 m. Glazing is single in the majority of cases and enclosed in timber joinery except where these have been replaced by single glazed aluminium as part of renovation. Insulation, which was not a requirement at the time of construction, is typically poor throughout although some may have been retrofitted with paper cellulose or older batts in the roof. Almost all bungalows have chimneys unless these have been sealed, with open fireplaces typically in living rooms and sometimes kitchens. Unflued wall heaters are common in areas with reticulated gas. Older style, smaller hot water cylinders are likely to be present in a significant number of these houses presenting an opportunity for retrofit with more efficient cylinders linked to solar or heat pump hot water heating. Bungalows are often oriented to the street rather than the sun. There are pockets of bungalows in neighbourhoods as many of these were built as developer subdivisions.

4.3.2 General description of era and construction types

The bungalow style that became the predominant housing type of the 1920s and 1930s was based on the Californian Bungalow of that same period. These houses are plainer and less ornate than villas. The bungalow was also a mass housing style and many houses were often built by the same developer builder from the same plan. Most bungalows have a 24–27º pitch gabled roof with projecting gables over front rooms or porches and a few have hipped roofs. Bungalows have porches, not verandas. They are almost square in plan but do not have a central hallway. The bungalow hall is often “L-” or “T-” shaped. They were also predominantly built of timber with metal roofs. There are brick bungalows, particularly in towns such as Huntly where there was a brick industry. This was a period of experiment with new cladding types, such as fibrolite and chicken mesh stucco, although these anomalies are not common.

4.3.3 Variability of typology

Bungalows were built from standard pattern books often imported from California. They were all single storied. The two storied buildings from this period were a different style, the "English Cottage" style. The style known as "Moderne" or "Art Deco" from this period is essentially a variation of bungalow in plan but is very different in its roof form.

4.3.4 Solar orientation and house layout — including within the neighbourhood

These houses were generally built facing the street regardless of solar orientation. Bedrooms will be located at the front of the house, with the laundry and bathroom area typically placed at the back with living rooms and kitchen between. Due to the form of the roof, there will generally be at least one side with good northern solar access.

4.3.5 Roof system — materials, form, construction and access

Roof pitches are gentler than villas with angles of 24–27º being common (although some may be down as low as 18º). Roofing materials are mostly iron although some are tiled and some utilise asbestos sheet in tile or corrugated form. There is typically a large cavity between ceiling and the roof which is commonly framed with 100 x 50 mm rafters. The rafters are generally expressed on the overhanging soffits. Bungalow ceilings are flat, often with planted beams and plaster panels. These houses were built with no insulation.

4.3.6 Wall system — materials, form, construction and access

The majority of bungalows were timber framed, built of machine cut 4 x 2 inch rimu. Bungalow walls typically have no horizontal intermediate framing (nogs or dwangs). The exterior is generally clad in machine dressed cedar weatherboards, and the interior lined with plasterboard or woodboard. They predate the use of building paper and insulation.

4.3.7 Floor system — materials, form, construction and access

Bungalows have matai or rimu floors on timber subfloor structure. There is generally 500 mm or greater clearance under floor providing reasonable access.

4.3.8 Windows and glazing systems — materials, form and construction

The typical bungalow window is the casement. These were standard timber units produced in joinery factories. Fan lights are common. Due to age and depending on maintenance, many of these will require some repair or other attention.

4.3.9 Heating system — type and location

Most bungalows were built with open fireplaces. These are frequently located on external walls, mainly of the main living area. By the 1920s and 1930s, electric heating was becoming more common. In rural areas coal or wood burning ranges were generally installed.

4.3.10 Hot water system — type and location

Most of these houses have low pressure, small hot water cylinders which are reaching the end of their lives. Where they have failed they have often been replaced by high pressure systems, in main centres often with instant gas. Hot water cupboards with space for a large cylinder (e.g. 250 l) are generally located next to the bathroom. Often, particularly in rural areas, there will be a wet back system attached to the fireplace or the range.

4.3.11 Plumbing — general system, location of bathroom and laundry

Plumbing systems are old, and often patchily repaired. Generally the original kitchen, bathroom and laundry are close to each other to minimise plumbing. Bathrooms and laundry are typically located to the rear of the house regardless of solar orientation.

4.3.12 Ventilation characteristics

Bungalow windows are made of timber, typically in the form of casement sashes, often with fan lights above. The service areas also have casement windows for ventilation. Due to the age of the houses draughts under doors and from windows are very common, as are holes and cracks in floorboards.

4.3.13 Likelihood and impact of previous renovations on typology and systems

Most bungalows will have been added to or otherwise altered. In typical cases additions will be at the back of the house, and recent additions will generally be to provide additional living and service areas. Renovations are unlikely to have significantly impacted on wall or floor systems. Alterations and additions carried out after 1978 should be insulated, but standards may vary widely.

The bungalow period falls at the beginning of private car ownership in New Zealand. Some were built with basic "car sheds" in the rear or side yards. Most garages have been added — often in the 1970s. In many localities the narrow sections mean that garages and carports have been built at the street frontage, often in front of a bedroom, restricting solar access.

Conversions of open fires to inset wood burners were a popular renovation in the 1970s, as was the installation of unflued wall gas heaters in urban areas.

4.3.14 Heritage issues, section sizes and other planning constraints

Like pre-1890s housing and villas these houses are now recognised as a limited resource. The houses of the bungalow period have a unique character that can easily be lost or destroyed. Bungalow suburbs have a cultural significance to our whole society because of what they represent and the fact that they are a finite resource that is vulnerable to change. Having an understanding of their particular qualities and character is important. This is recognised by many Territorial Authorities and the protection of heritage character in bungalow suburbs has become a planning issue, with heritage overlays and zoning provisions giving some limited protection to these houses.

4.3.15 Characteristics and links to regionality, geographic areas or typography

Following the First World War bungalow suburbs grew at the margins of the villa suburbs, or in the gaps left by topography, valleys and less accessible areas within villa suburbs. They were often built in areas ignored by the developers of the villa suburbs, or as new suburbs developed along public transport routes. The bungalow was generally a builder/developer house style.

4.3.16 Suitability for retrofit

Bungalows are relatively easy to retrofit to a high standard. There are issues insulating walls due to the absence of building papers which can lead to condensation. Provision of adequate ventilation is therefore important. As with villas, there may be issues with heritage restrictions in certain neighbourhoods making interventions such as fitting double glazing or providing solar hot water panels more complicated. The provision of solar water heating and photovoltaic panels may also prove problematic due to the pitch of the roof and orientation to the sun — an individual analysis is likely to have to be made for each house. Provision of additional insulation in the ceiling and under the floor can be achieved comparatively easily. Bungalows would also be relatively easy to retrofit with more renewable heating options such as efficient wood burners or pellet burners combined with a heat transfer system.

4.4 Art Deco (1925–1935)

4.4.1 Main characteristics

Art deco houses are similar in size and layout to the bungalow though they are constructed using quite different materials and techniques. Typical house size is less than 110 m^2 and most face the street. The majority are constructed with wooden frames although some are built in brick. Claddings are typically stucco (estimated to be 70%) with a smaller proportion brick (estimated to be 15%) and the remaining in timber (estimated to be 10%) and fibrolite (estimated to be <5%).[3] The roof is a key feature of the art deco style, typically featuring a parapet with a flat roof behind. Materials used include steel, mathoid and tile. Failures of the roofing system mean that a significant number of these houses have a new roof installed over the old one. Inside the house the ceilings are often a feature and exhibit ornate plaster work. Heating in the majority of cases will be supplied by plug in electric with few having open fires and wood burners. In terms of regionality many of these houses are located in the Hawkes Bay and in neighbourhoods carved out in the 1930s.

4.4.2 General description of era and construction types

The Art Deco or Moderne style is essentially a variation of the Bungalow style. It came about as a result of builder/developer interpretation of the modernist architecture that was developing in Europe during this era. The Moderne style was also imported in the plan books and magazines from America.

These houses have similar plans to the bungalow but are startlingly different in appearance and construction. The skillion roof is hidden behind parapets and curved and horizontal planes are used to give the effect of architectural modernism, without embracing any of its substance.

These houses are frequently finished in plaster to create large smooth surfaces that emphasise the sculptural forms of the house. This may be on brick or expanded mesh. Weatherboards were also used, as was brick and fibrolite.

4.4.3 Variability of typology

Most art deco houses are single storey. Very few are two storied; however the form easily allows a simple upward extrusion and, unlike bungalows, there are examples of two storied art deco houses.

[3] ***Percentages were estimated at the typologies workshop and have not been verified due to lack of available data.***

4.4.4 Solar orientation — including within the neighbourhood

These houses were generally built facing the street regardless of solar orientation. Bedrooms will be located at the front of the house, the laundry and bathroom area at the back with living rooms and kitchen between. In many cases, due to the skillion roof behind the parapet, it may be possible to set up solar panels oriented to the north.

4.4.5 Roof system — materials, form, construction and access

Art deco houses have mono pitch roofs with a low angle and generally clad in corrugated iron. The roof will typically be framed with 100 x 50 mm rafters. The ceiling space reduces from the front to the back of the house. These houses were built with no insulation.

4.4.6 Wall system — materials, form, construction and access

The majority of art deco houses are timber framed and built of machine cut 4 x 2 inch rimu. The walls typically have no horizontal intermediate framing (nogs or dwangs). The exterior is generally clad in stucco plaster or machine dressed cedar weatherboards, and the interior lined with plasterboard. Some less common examples are constructed out of brick. They predate the use of building paper and insulation in the walls.

4.4.7 Floor system — materials, form, construction and access

Art deco houses have matai or rimu floors on timber subfloor structure. There is generally 500 mm or greater clearance under floor although in some instances the perimeter wall encompassing the floor may restrict access to the underfloor cavity.

4.4.8 Windows and glazing systems — materials, form and construction

Timber casement windows are standard and were typically produced in joinery factories. Fan lights are common. Due to age and depending on maintenance, many of these will require some repair or other attention.

4.4.9 Heating system — type and location

Most art deco houses were built with fireplaces. These are frequently located on outside walls. By the 1920s and 1930s electric heating was becoming more common. In rural areas coal or wood burning ranges were generally installed.

4.4.10 Hot water system — type and location

Most of these houses have low pressure, small hot water cylinders which are reaching the end of their lives. Where they have failed more recently they may have been replaced by high pressure systems. Hot water cupboards with space for a large cylinder (e.g. 250 l) are generally located next to the bathroom. In some cases, particularly in rural areas, there may be a wet back system attached to the fireplace or the range.

4.4.11 Plumbing — general system, location of bathroom and laundry

Plumbing systems are old, and often patchily repaired. Generally the original kitchen, bathroom and laundry are close to each other to minimise plumbing. As with other examples of early housing, bathrooms and laundry are generally located to the rear of the house regardless of solar orientation.

4.4.12 Ventilation characteristics

Art deco house windows are typically casement sashes. Fan lights as seen in bungalows are rare. The service areas also have casement windows for ventilation. Due to the age of the houses draughts under doors and from windows are very common, as are holes and cracks in floorboards. However, due to the higher use of plasterboard linings and stucco these houses have the potential to be more airtight than the houses of the preceding eras.

4.4.13 Likelihood and impact of previous renovations on typology and systems

Some art deco houses will have been added to or otherwise altered. Most additions will be at the back of the house, and recent additions will generally be to improve living areas and to provide additional service areas. Renovations are unlikely to have significantly impacted on wall or floor systems. Alterations and additions carried out since 1978 should have insulation although the levels and standards of installation may vary.

This period (1925–39) was at the beginning of private car ownership in New Zealand. Some were built with basic “car sheds” in the rear or side yards. Most garages have been added — often in the 1970s. In many localities the narrow sections mean that garages and carports have been built at the street frontage, often in front of a bedroom, restricting solar access.

Conversions of open fires to inset wood burners were a popular renovation in the 1970s, as was the installation of wall mounted unflued gas heaters in urban areas with reticulated gas.

4.4.14 Heritage issues, section sizes and other planning constraints

As with earlier examples of housing, art deco houses are now recognised as a limited resource with unique character that can easily be lost or destroyed. They have a cultural significance to our whole society because of what they represent and the fact that they are a finite resource that is vulnerable to change. Having an understanding of their particular qualities and character is important. This is recognised by many Territorial Authorities and the protection of heritage character of art deco houses in many suburbs has become a planning issue, with heritage overlays and zoning provisions providing some protection to these houses.

4.4.15 Characteristics and links to regionality, geographic areas or typography

Art deco houses were built throughout the country although some regions show a particularly strong influence such as Napier where art deco houses are comparatively common. In the main this was due to their form being fashionable at the time of rebuilding following the Napier earthquake.

4.4.16 Suitability for retrofit

Importantly, only a small fraction of houses are art deco (estimated at less than 4%). This makes this a somewhat insignificant subset in terms of the wide application of retrofit solutions, and a difficult one in relation to their walls, floor and ceiling systems. The ceiling/roof can be difficult to retrofit because of the nature of the skillion roof and the general construction including the presence of the stepped parapet (often coated in bitumen). In addition to this there may be several renovated layers put over the top due to the failure of the original roof system, making retrofit near impossible. The relatively complicated cladding and stucco systems make retrofitting insulation in walls difficult. Despite these difficulties the art deco style is highly valued and important to the development of New Zealand's housing stock from a heritage perspective. For these reasons, sympathetic owners may go the extra mile (and additional expense) to retrofit them.

4.5 State house and mass housing (1930–1970)

4.5.1 Main characteristics

The New Zealand state house is typically small (less than 100 m^2) and has a simple square plan. Many state houses show an orientation to the north with living spaces designed to capture the sun as opposed to the early colonial housing which typically faces the street. Roofs are usually hipped and typically have a reasonable pitch (30–40º). Manufactured concrete block starts to appear more commonly as a construction material although the majority of houses are timber framed with either wooden cladding (estimated to be 40%) or brick (estimated to be 40%). The remaining cladding being stucco (estimated to be 15%) and fibrolite (estimated to be <5%). It is unlikely that there will be insulation or building paper in the walls unless retrofitted.

Floors are typically of the suspended wooden variety utilising rimu and matai flooring of good quality. State houses have variable ground clearance, in most cases over 600 mm. Ceilings are of a standard 2.7 m stud height, usually utilising Pinex with additional features such as cornicing. In many cases insulation is present in the ceiling, although this is typically of poor quality (i.e. old Insulfluff).

Glazing of early state housing is smaller than the later bigger windows of the 1950s and in most cases is wooden framed single glazing with good eaves. A wide variety of heating types exist from electric through to a large number of unflued gas heaters fixed to walls. An estimated 20% of these houses still use the open fires located in the living rooms. Some examples exist of state houses being built as duplexes and terraces with no sound insulation between walls. State houses are often built on hills and other “leftover” land at the edge of bungalow suburbs, or in some cities exist as whole suburbs (e.g. Palmerston North). Those state houses built after the 1950s show more variation in typology than earlier examples.

4.5.2 General description of era and construction types

The most commonly known state house was developed in the 1930s by the first Labour government. These houses were designed by the Public Works Department. State houses were built throughout New Zealand generally in groups. Whole suburbs of state houses were developed with a variety of housing types used: free standing houses, semi-detached houses, row houses and apartments. The construction of state housing established the Fletcher brothers, who gained contracts to develop state housing suburbs, as a dominant force in the construction industry as between the Great Depression and the commencement of the Second World War state houses were almost the only houses constructed.

The classic state house is a small neo-Georgian styled building, almost square in plan. They are plain, well built and well designed houses, formal in plan and appearance. Most have pyramid hip roofs with some, as illustrated, with gabled roofs, and generous flat soffits. The walls are finished in a flat frieze above the window heads. The joinery is timber casements. Permanent materials are common, tiled roofs, brick or plastered brick walls.

State houses were built to standard plans produced by the Public Works Department (later the Ministry of Works and the Housing Corporation). Living areas were on one side of the house with bedrooms and bathroom on the other. The materials specified in state houses were of a very high standard as these houses were expected to have a long life.

The state house was so successful that it was almost immediately emulated by private housing developers and the form of the state house became the model for standard housing in New Zealand until the 1960s.

4.5.3 Variability of typology

Most houses are square in plan, single storied, with a pyramidal hipped roof. Some were gabled, as illustrated. The majority are individual houses on their own sections. They were also built as semi-detached houses or in blocks and as apartments. A potential subtype of the "50s Classic" has also been identified both during the workshop and later in discussions with experts. Whilst similar in construction methods to state houses of the time they are larger and well designed houses, formal in plan and appearance. These houses, built predominantly between 1950 and 1970 have variable ground clearance, in most cases over 600 mm. Glazing is usually larger than the standard state house. The potential variant of the 50s Classic will be explored in more detail as part of the prevalence work currently underway.

4.5.4 Solar orientation — including within the neighbourhood

Most of these houses were generally built facing the street but with a layout that made use of good solar orientation. Due to the form of the roof and the thought that went into orienting these houses to the sun, there is generally at least one side of the house with good northern solar access.

4.5.5 Roof system — materials, form, construction and access

The preferred roof pitch for the state house is 30º. Most were built with pyramidal hipped roofs and the main roofing used was concrete tiles. The other most common roof form is the plain gable. The ceilings are flat, creating an accessible area within the roof. The ceilings are sheet plasterboard with tongue and groove timber sometimes used in porch areas. These houses were built with no insulation in the ceiling.

4.5.6 Wall system — materials, form, construction and access

The majority of state houses were timber framed and clad in weatherboards. State house framing has both studs and nogs/dwangs. They generally have no building paper or insulation.

The interior linings are standard plasterboard sheet. Brick clad state houses are standard brick veneer on a structural timber framework. The stud height varies from 2.4–2.7 m.

4.5.7 Floor system — materials, form, construction and access

State houses typically have suspended timber floors on concrete piles and timber bearers. The flooring is generally quality native timbers such as heart rimu or matai tongue and groove. These houses were built with no insulation under the floors. In most cases these houses have 500 mm or greater clearance under floor with good access. In some cases the perimeter wall of the house may restrict access to the underfloor space through a small hatch in the floor or wall.

4.5.8 Windows and glazing systems — materials, form and construction

State houses were designed as a mass produced housing type. The windows are typically side hung casements built with timber and of a standard size and type. The material and detail specification for the joinery was high and if maintained the joinery should be in good condition. The windows were not double glazed.

4.5.9 Heating system — type and location

Most state houses have open fires. Where available gas fires were installed. Electrical radiators had become common by the 1930s and were beginning to be widely used. The fireplace was in the living room. The stove was generally electric.

4.5.10 Hot water system — type and location

The hot water system is typically a low pressure electric supplemented in some situations by wet back systems built into the fireplace.

4.5.11 Plumbing — general system, location of bathroom and laundry

The houses were planned to keep plumbing to a minimum with kitchen, laundry and bathroom close together. The pipework is of a high standard, generally seamless copper with hessian lagged hot water pipes. Hot water cylinder cupboards may be small, making the addition of cylinder wrap problematic in some cases.

4.5.12 Ventilation characteristics

Windows are the only form of controlled ventilation. There was no specific kitchen or bathroom ventilation. Due to the age of the houses there are likely to be draughts under doors and from windows, as well as possibly holes and gaps in floorboards.

4.5.13 Likelihood and impact of previous renovations on typology and systems

In areas where state houses have been privately sold they have often been altered beyond recognition. State houses that have remained in state ownership are less likely to have been substantially altered. Some upgrading of service areas may have been undertaken and basic levels of insulation may have been installed in the ceiling space. The open fires are often converted to enclosed fireboxes. In urban areas the fireplaces may have been converted to gas.

4.5.14 Heritage issues, section sizes and other planning constraints

The state house could be described as the "wallflower" of heritage housing. It was a remarkable innovation which transformed the appearance of New Zealand suburbs. These houses were designed by architects who were committed to creating a form of popular mass housing that suited New Zealand in terms of culture and climate. The houses were more than a stand alone type and were also significant as groupings. This significance has been recognised in places such as Savage St in Palmerston North where the character of the entire area is recognised as deriving from the group significance of that state housing development. In other parts of the country such as Auckland City and Auckland's North Shore City blanket heritage controls give protection to any houses built before 1940.

4.5.15 Characteristics and links to regionality, geographic areas or typography

State houses were built throughout the country, generally in groupings, some consisting of a few houses, some of much larger developments. State houses were typically built at the edges of cities and towns or as infill within the existing suburbs.

4.5.16 Suitability for retrofit

The potential for retrofitting classic state houses for more efficient energy use is good. Cavities both in the ceiling and under the floor make these houses relatively easy in terms of access. However, in many cases the trapdoor leading to the ceiling cavity is located in a wardrobe or in the laundry so the size of the insulation product used in the ceiling may be an issue in relation to access. The lack of building paper in the walls could raise issues of condensation when considering wall insulation. The small floor plan may make the addition of a stand alone wood burner or pellet burner difficult to retrofit unless provided as an inset heater in an existing fireplace. As with other typologies, a heat transfer system would be required to heat the whole house (particularly the SE bedrooms). Heat pumps may provide a more simple solution for this house typology. The pitch of the roof and orientation to the sun of the main living spaces provides good opportunity to maximise solar gain and install solar hot water systems. As the state house in New Zealand is emblematic of a period of New Zealand history there may be growing issues with heritage legislation, particularly if this typology is located in a state housing area.

In terms of retrofit systems, the "50s classic" is a good typology to start with. They have "good bones", good orientation, and good levels of access to renovation areas that will all facilitate a high chance of success in bringing these houses up to meet Beacon's HSS High Standard of Sustainability®.

4.6 1960s and 1970s Multi Unit Housing

4.6.1 Main characteristics

1960s multi unit housing has a typical rectangular house form. Almost all are constructed as light frame concrete block wall on concrete slab, with some brick units evident in some areas. Most are in original condition and rarely have additions or extensive renovations been made. Walls are almost exclusively uninsulated. Roofing is either corrugated iron or fibrous cement/asbestos incorporated in a skillion roof system. Many units will have textured ceilings of asbestos or Pinex tiles with low cavity space. Flooring usually consists of 4 x 6 inch rimu floorboards. Windows are typically single glazed and are usually modular in design, indicating that suitable double glazing solutions could potentially be standardised across the units. Timber frame joinery is used throughout with some aluminium beginning to be used in the later years. Electric night store heating systems are common with additional portable and reticulated gas systems in some areas. These multi unit developments are common in Auckland, Christchurch, Wellington and provincial centres.

4.6.2 General description of era and construction types

The "sausage flats" of the 1960s and 1970s were generally constructed as rental accommodation by property investors. The 1960s and 1970s were a time when the older areas of cities were considered to be in decay and available for redevelopment. Inner city suburbs were run down and in many cases considered to be cheap real estate as the older houses were not perceived to have any value as young professionals and business people moved to the outer suburbs.

Multi unit housing was constructed as cheaply as possible and was generally built on the sites of villas or bungalows which were demolished to make way for this type of development. The buildings were a product of very limited design input that aimed to construct functional rather than aesthetic housing. Their primary function was to bring in as much rent as possible for the least outlay.

The form of these buildings is basic, a long rectangular form with typically a flat or sometimes low pitched gable roof. There are both single storied and two storied varieties and are commonly laid out to provide the minimum space allowed by planning controls. The two storied units often have a single stair at one end with a walkway running the length of the upper storey on one side. Some were built with garages below and living above.

They are predominantly painted concrete blockwork to achieve some degree of fire rating. The earlier buildings of this type will have timber joinery. However, as soon as aluminium joinery became available it was widely employed in this type of housing. These houses were built cheaply in terms of the materials used and construction detail.

4.6.3 Variability of typology

Many are two storied, some with garaging below, some split into separate units above and below. A large number are also single storied. The variation between the two may require further research from a retrofit point of view, as well as research to determine the prevalence of one and two storied split within this typology.

4.6.4 Solar orientation — including within the neighbourhood

Solar orientation played very little part in the planning of these buildings. They are typically sited to gain maximum site coverage and are planned as simply as possible to fit on their sites. The occasional example of positive solar orientation is probably more by chance than intention.

4.6.5 Roof system — materials, form, construction and access

The roofs of these buildings are generally low pitched, often mono pitch, metal tray or skillion roofing. They generally have no accessible roof space. They were built before any requirement for insulation and may or may not have building paper as a moisture barrier. The stud height within the buildings is generally 2.4 m, the lowest permissible at the time they were built. The ceilings are sheet plasterboard.

4.6.6 Wall system — materials, form, construction and access

Most of these units are constructed of concrete blockwork, with some a combination of blockwork and timber framing finished in sheet fibrolite or other cheap materials. Some may be clad in weatherboards. The blockwork units are unlined and may only be partially reinforced. The areas of timber framed walls will not have any insulation but may have some building paper. Interior linings are generally plasterboard with minimal sized mouldings to edges and openings.

4.6.7 Floor system — materials, form, construction and access

With few exceptions these units have a reinforced concrete ground floor, sometimes carpeted or finished in vinyl. The slab will not be insulated. The upper floor areas will be strip timber flooring for the older units and as sheet particle board flooring became available in the 1970s this replaced timber boards to become the standard flooring material. These floors will not be insulated.

4.6.8 Windows and glazing systems — materials, form and construction

Early units of this type will have timber joinery. The quality of the joinery will vary but will generally be at the low end of quality standards. Aluminium joinery, usually of the cheapest kind, became the material of choice as soon as this product became available to the mass market at the beginning of the 1970s.

4.6.9 Heating system — type and location

No heating systems were installed. It was considered the responsibility of the tenant to provide a heating solution and this invariably resulted in plug in electric heating and later unflued gas heaters being used.

4.6.10 Hot water system — type and location

The hot water systems generally used are low pressure cylinders fitted into hall cupboards.

4.6.11 Plumbing — general system, location of bathroom and laundry

Plumbing systems will be medium quality copper pipework. Wastes may be lead, copper, mild steel, wrought iron, cast iron or copper and later became PVC. The kitchens and bathrooms are generally side by side.

4.6.12 Ventilation characteristics

Provision of adequate ventilation was not well considered in these houses. The primary form of ventilation is via the windows, although in some units extract fans were installed in kitchens. The concrete floors common to this typology reduce the levels of draughts from the subfloor compared to earlier housing types.

4.6.13 Likelihood and impact of previous renovations on typology and systems

These buildings are unlikely to have been substantially altered or upgraded unless they have been unit titled and sold.

4.6.14 Heritage issues, section sizes and other planning constraints

These buildings generally maximise site coverage. They may not comply with current zoning controls, particularly controls on bulk and location such as height in relation to boundary or site coverage controls. As they are a form of infill housing these buildings may also be in a zone that has heritage controls and any proposed changes to the building may have to be considered in relation to those controls.

4.6.15 Characteristics and links to regionality, geographic areas or typography

These buildings were primarily built as infill in the older inner city suburbs.

4.6.16 Suitability for retrofit

1960s multi unit developments are problematic in relation to retrofit although they do provide some interesting possibilities in relation to their neighbourhood context. Built typically on an uninsulated concrete slab they exhibit high thermal mass which due to the lack of insulation can lead to poor thermal performance. The lack of ceiling cavity in the roof, skillion construction and the typically low stud heights makes retrofitting insulation in this area problematic. Similarly, timber floors are likely to be too low to the ground in terms of crawl space to be easily retrofitted for insulation. Existence of common walls between each of the units, and the generally small sizes of dwellings should result in less energy being required to heat the space. In terms of space heating the small footprint of the units restricts the use of solid fuel heating devices, indicating that heat pumps may provide the most effective solution. The concrete block walls present difficulties in relation to adding insulation, particularly in respect to the small dimensions of the units as adding insulation to the internal wall will reduce living space inside the property. 1960s multi units are typically low capital value houses (although built on large sections which may be worth considerable amounts). They are often pensioner and community owned units which raises multiple issues including health, affordability and provision of adequate housing.

Despite these shortcomings, there are some positive aspects of this typology which may assist certain retrofit interventions. Firstly, the standardised nature of the unit design, both within developments and also between them, means that any retrofit solution that works for one of the units is likely to be able to be successfully employed for others. For instance, the modular windows have the potential for successful double glazing retrofit interventions with a reduced cost if carried out over the whole multi unit development. In addition, the implications of the multi unit design in terms of “neighbourhood” should not be overlooked. Retrofitting an entire multi unit development as part of the same project may provide substantial cost savings and other benefits. In particular opportunities for shared renewable energy generation and bulk water retrofitting across the units may counter some of the downsides encountered with thermal performance.

4.7 70s House (1970–1978 pre-insulation)

4.7.1 Main characteristics

From the 1970s onwards significant variation in both the design and materials used across the housing stock starts to appear. In the period of 1970 through to the introduction of basic insulation standards in 1978, houses in New Zealand were predominantly of timber and chipboard construction with a growing number of examples of concrete construction. Split levels start to appear to delineate between living spaces. Estimates from the workshop indicate that 95% of this house type may be single storey with the remainder being two storeys. The first "A" frame houses start to appear at this time. Skillion roofs with exposed ceiling rafters are common in this era and although roofs are typically pitched there is a wide degree of variation of angles and orientations. Roofing and cladding materials also show marked variability. The most common materials for roofing included corrugated iron, long run steel, and concrete/clay tiles. Analysis from the EECA/BRANZ report indicates that a wide variety of cladding materials are common including asbestos fibre cement, manufactured timber products, stucco, concrete, plastics, weatherboard, concrete blocks and bricks (Buckett et al., 2007). Single glazed aluminium window frames start to appear, as do examples of floor to ceiling sliding doors, also known as "ranch sliders". In some houses there is limited roof and wall insulation with occasional regional pockets of insulation based on bylaws as was the case with Christchurch where insulation was mandatory from 1973 (Buckett et al., 2007). Heating devices became a "feature" and enclosed wood burners start to replace open fires within this typology compared to earlier house types.

4.7.2 General description of era and construction types

The stand alone low income developer housing of the late 1960s through to 1978 is very plain. These houses were constructed as part of the expanding suburban development of that period. The houses are simple rectangular boxes, generally with a low pitched gabled roof. Most are full timber frame construction, some were built on concrete slabs.

These houses utilised the cheapest available products of that time and were built to a limited range of designs all with living rooms at one end and bedrooms at the other. They were built at a time when the land at the edge of cities was inexpensive and hence the properties are more generous in size.

4.7.3 Variability of typology

These houses were built by large property development companies such as Neil Homes and Reidbuilt, and were built from standard plans. With few exceptions they are single storied.

4.7.4 Solar orientation — including within the neighbourhood

These houses were not sited with a great deal of concern for solar orientation and furthermore did not generally have a formal relationship to the street. They are typically sited close to the street as this reduced the costs of construction and reticulation of services; however the living room of the house may appear at either end regardless of solar orientation.

4.7.5 Roof system — materials, form, construction and access

The roof form of most of these houses is the plain gable. Most are metal roofed with a few with metal tiles. The roof pitch is low, and in most cases is less than 20º. The roofs of these houses were built using trusses. There is a small amount of space in the roof. These houses were generally built with no insulation but there may be building paper present.

4.7.6 Wall system — materials, form, construction and access

These houses were preframed with the frames delivered to site and then erected. They were factory built and assembled on site. Most are clad in weatherboards, with earlier houses clad in timber weatherboards and later houses generally clad in fibrolite weatherboards. A few were clad in brick or concrete masonry veneer. The walls are typically 2.4 m stud. They will not generally be insulated and may or may not have building paper. The linings will be plasterboard with minimum size mouldings to the edges and openings.

4.7.7 Floor system — materials, form, construction and access

Generally these houses have a timber subfloor and will have particle board flooring. The floors are usually carpeted with vinyl flooring in the wet areas. These houses are typically built very low to the ground, less than 500 mm. On sloping sites they may have concrete block bases and will have a reasonable area underneath them, which may be utilised for storage or an informal area such as a rumpus room or tool shed.

4.7.8 Windows and glazing systems — materials, form and construction

Very early examples of these houses will have painted casement style or awning timber joinery. As soon as aluminium joinery became readily available this became standard.

4.7.9 Heating system — type and location

Some of these houses have open fires or wood burners. Most relied on electric heating.

4.7.10 Hot water system — type and location

These houses were constructed with basic low pressure water systems. The hot water cylinder is generally boxed into the corner of the kitchen or in a hall cupboard.

4.7.11 Plumbing — general system, location of bathroom and laundry

The hot and cold water pipes will be copper. The wastes will generally be PVC with some metal wastes on older houses. The kitchen, bathroom and laundry are generally located close together.

4.7.12 Ventilation characteristics

The only ventilation in these houses is through opening windows. Some may have an extract fan in the kitchen.

4.7.13 Likelihood and impact of previous renovations on typology and systems

As these houses are generally in less affluent areas they are not substantially altered, if at all. Some will have had better heating systems installed, enclosed fires or gas where this is available.

4.7.14 Heritage issues, section sizes and other planning constraints

There are no major constraints beyond consideration of general planning controls.

4.7.15 Characteristics and links to regionality, geographic areas or typography

These houses were constructed as large developer subdivisions on the edge of New Zealand cities from the late 1960s through to the end of the 1970s.

4.7.16 Suitability for retrofit

In some respects 1970s housing could be thought of as a split typology. The two groups would be those that exhibit the wide degree of individual variation found at this time and a 1970s mass housing type which is more uniform in construction and materials. A small percentage of 1970s housing is also architecturally designed and these examples typically present more challenges in relation to standardised retrofit solutions. An approach that identifies suitable retrofit solutions for the 1970s mass house type may assist in retrofitting a selection of these houses. The wide variation amongst other 1970s houses indicates that providing a standard retrofit solution may be more difficult for this split typology. As a broad generalisation of 1970s housing it could be said that heating is relatively easy to retrofit, but insulation is more difficult. The main challenge provided by this housing type is the roof form and where applicable, the concrete floors. “A” frames are very difficult to retrofit and may be more suitable for demolition if they are underperforming.

4.8 80s House (1978–1989)

4.8.1 Main characteristics

1980s houses exhibit a similar variability to 1970s houses. Many of the houses built in this period appear in Auckland and in high growth areas in the north of New Zealand. Typical construction consisted of timber frame utilising treated pine with cladding in wood weatherboard, fibreboard, fibre cement or brick veneer. Insulation, which is mandatory from 1978, starts to appear in houses although not to a particularly high level. Iron roofs are common and metal tile roofs are also evident. Suspended floors are still utilised in this era with reasonable access provided underneath the house. Single glazed aluminium windows are common. Larger rooms are evident, certainly in comparison to the 1970s and often designs are more open plan, maximising space inside the dwelling.

Buckett et al. (2007) provides a useful analysis of 1980s housing, splitting houses into two main styles: the "Beazley box" and the large suburban house. Beazley box houses tended to be of lightweight construction with suspended timber floors, simple rooflines and of open plan rectangular or L-shaped forms. The houses were designed to be low maintenance, clad in fibre cement weatherboards with corrugated iron roofs and aluminium windows. The large suburban houses were often two storeys with multiple living rooms. Cedar and brick cladding, aluminium windows and metal tile roofs were common (Buckett et al., 2007).

4.8.2 General description of era and construction types

The outward appearance of most of these houses does not vary greatly from the pre-1978 house. The developer houses of this period were also constructed as prefabricated homes built to standard plans on subdivisions at the edges of cities and towns. They follow a similar typology to the pre-1978 house although the new insulation standards which came in 1978 create a distinction in relation to thermal performance and retrofit interventions.

4.8.3 Variability of typology

These houses were built by large property development companies such as Neil Homes and Reidbuilt, and were built from a series of standard plans. They are largely single storied although as is the case with 1970s houses, those built on slopes sometimes were able to provide a garage underneath the living area.

4.8.4 Solar orientation — including within the neighbourhood

As with the houses of the proceeding decade, 1980s houses were not sited with a great deal of concern for solar orientation and furthermore did not generally have a formal relationship to the street.

4.8.5 Roof system — materials, form, construction and access

The roof form of the majority of these houses is the plain gable. The roof pitch is low at less than 20º and most utilise standard metal roofing materials with a few constructed with metal tiles. The roofs of these houses were again built using trusses leaving only a small amount of accessible space in the roof. Limited levels of ceiling insulation start to appear and there is usually also building paper.

4.8.6 Wall system — materials, form, construction and access

In terms of materials and construction the mass housing of this period follows a similar pattern to 1970s houses with framing built in factories and then delivered on site. Most houses are clad in weatherboards made of a range of materials from wood through to fibre cement and fibrolite. A few were clad in brick or concrete masonry veneer. The walls are typically a 2.4 m stud. In most cases walls will generally be insulated and will have building paper. Some may have no insulation except for foil lined plasterboard. The linings are typically plasterboard with minimum size mouldings to the edges and openings.

4.8.7 Floor system — materials, form, construction and access

Generally these houses have a timber subfloor and will have particle board flooring. The floors are usually carpeted with vinyl flooring in the wet areas. These houses are typically built very low to the ground, less than 500 mm. On sloping sites they may have concrete block bases and will have a reasonable area underneath them, which may be utilised for storage or an informal area such as a rumpus room or tool shed. Some later examples may have draped foil over the joists, and some of this may be in need of repair and maintenance.

4.8.8 Windows and glazing systems — materials, form and construction

A few examples of these houses will have painted casement style or awning timber joinery although the majority of the houses will have relatively cheap aluminium joinery as this became widely available. During this period construction standards slipped and some houses from this period may not have adequate window flashings causing deterioration in the building fabric.

4.8.9 Heating system — type and location

Some of these houses have open fires or wood burners. Most rely on electric heating.

4.8.10 Hot water system — type and location

These houses were constructed with basic low pressure water systems. The hot water cylinder is generally boxed into the corner of the kitchen or in a hall cupboard.

4.8.11 Plumbing — general system, location of bathroom and laundry

The hot and cold water pipes will be copper in older houses with polybuteline becoming standard at the start of the 1980s. The wastes will generally be PVC. The kitchen, bathroom and laundry are usually located close together.

4.8.12 Ventilation characteristics

The only ventilation provided for in these houses is through opening windows. Some may have an extract fan in the kitchen.

4.8.13 Likelihood and impact of previous renovations on typology and systems

As these houses are generally in less affluent areas they are not substantially altered, if at all. Some will have had better heating systems installed, enclosed fires or gas where this is available.

4.8.14 Heritage issues, section sizes and other planning constraints

There are no major constraints beyond consideration of general planning controls.

4.8.15 Characteristics and links to regionality, geographic areas or typography

These houses were constructed as developer subdivisions on the edge of New Zealand cities from the late 1970s.

4.8.16 Suitability for retrofit

Some insulation should exist in all of the houses built from 1978 onwards. However, it may have been poorly installed, inadequate, or in need of replacement. It may also be the case that some houses were approved before the standards for insulation became mandatory, so the assumption that all houses built after 1978 will have insulation may be incorrect. The relatively low pitch of the roofs from this era means that ceiling access is difficult and the angle of the roof is not sympathetic to solar water heating. Underfloor access is generally good where suspended timber floors exist so the addition of floor insulation is possible. There may be a need for more active ventilation of these houses in order to improve the indoor environmental quality (IEQ). This is a result of the combination of the materials used (including asbestos and MDF) and the more airtight standards of construction. Aluminium windows in these houses are more amenable to double glazing retrofit than wooden varieties, although performance of the aluminium frames as well as flashings may require consideration of full window replacement. A relatively easy retrofit option for these houses includes space heating upgrades utilising both heat pumps and solid fuel heating. Care will be required in renovation due to the possibility of some asbestos problems.

4.9 Early 90s (1990–1996, pre-revamped Building Code)

4.9.1 Main characteristics

Variation between houses becomes more widespread in this era of construction leading to the possibility of several subtypologies. This may require additional research to develop an understanding of the level of relevant detail and how that might affect the application of retrofit interventions. However, as with other varied typologies, some generalisations can be drawn. Houses from this era are predominantly timber frame. Roofing is predominately metal, with some concrete tiles and sheet shingles (asphalt). Flat roofs utilising butyl rubber and bituminous torch on membranes are also a common feature of this typology. Floors are typically concrete slab on flat land and particle board suspended floors on sloping sites. Brick veneer tile predominates as the cladding material with other materials commonly used such as Insulclad® and polystyrene plaster systems with direct fixing to studs. Few houses from this era have fixed internal heating devices and most will have a standard electric hot water cylinder that is between 10 and 20 years old. A high percentage of glazing typifies 1990s housing — with as much as 40% or more in the main living areas (drawn from estimates discussed at the workshop). Most of this is single glazed aluminium with no louvres and minimal eaves — leading to poor thermal performance including heat loss in winter and overheating in summer. Garages either under or connected to the house are a common feature of this period.

4.9.2

4.9.3 General description of era and construction types

The form and style of most of the mass housing from the early to mid 1990s does not vary largely from the previous descriptions for houses from the 1970s and 1980s. These are also prefabricated houses built to standard plans on mass housing subdivisions. The key differences are diminishing section sizes, more use of manufactured materials such as fibrous cement cladding, aluminium joinery and PVC, and other construction cost driven change such as the use of 75 x 50 mm studs.

4.9.4 Variability of typology

Almost all of these houses are stand alone, simple rectangular boxes. Most will be on flat sections. They are low in height as a consequence of low stud height and will generally have low pitched gable or hipped roofs.

4.9.5 Solar orientation — including within the neighbourhood

These houses are generally sited to minimise construction costs and maximise developer profits. The houses are often built close to the street and the arrangement of the rooms within the house will relate to the choice of standard plan used with little regard to solar orientation.

4.9.6 Roof system — materials, form, construction and access

The roof system typically used on these houses is standard corrugated metal roofing on an engineered truss roof. The majority of the roofs from this era are low pitched, typically constructed with building paper and are insulated in most instances with R2.0 fibreglass insulation. Ceilings are typically flat, at 2.4 m stud height, and there is usually reasonable ceiling access.

4.9.7 Wall system — materials, form, construction and access

Most of the houses built in this period will be timber framed and in most cases that timber will be H1 Boric or H3 copper chrome arsenic treated (as compared with later years). Most will be clad in fibre cement sheet weatherboards (as opposed to asbestos which was phased out in the late 1970s). Some may have masonry or brick veneer, and some utilise timber weatherboards. Walls are typically constructed with building paper and will have the equivalent of R1.8 insulation, generally fibreglass. This was also the period in which polystyrene cladding systems such as Insulclad® were marketed, although these systems were not widely used. The more common systems of this monolithic type were the fibre cement sheet cladding systems marketed by James Hardies and these also became more common at this time. Walls were lined with plasterboard with minimum sized mouldings to the edges and openings.

4.9.8 Floor system — materials, form, construction and access

Most houses of this period are built with timber on concrete block foundations and are relatively low to the ground. The flooring is sheet particle board with carpet in living areas and bedroom areas and vinyl flooring to the wet areas. Where concrete slabs are used the floor finishes are the same.

4.9.9 Windows and glazing systems — materials, form and construction

Almost all houses from this period will have aluminium joinery. A greater range of colours in aluminium had become available by this stage as a consequence of the growth of the powder coating industry, hence window colours vary from the earlier bronze silver and black.

4.9.10 Heating system — type and location

Most houses of this period relied on plug in electric heating. Some will have gas wall heaters where this is available (in many cases unflued) and a few houses may also have wood burners.

4.9.11 Hot water system — type and location

Available types of water heaters improved in this period. Some still have low pressure electric systems but most will have high pressure electric with gas heating where gas is available.

4.9.12 Plumbing — general system, location of bathroom and laundry

Almost all these houses are plumbed in polybuteline with wastes utilising PVC. Generally the service areas are situated close together.

4.9.13 Ventilation characteristics

Windows still are the primary form of ventilation although bathroom and kitchen fans are common. Many of the smaller bathroom fans run at a high rate and have a limited life and therefore may be candidates for a more suitable replacement.

4.9.14 Likelihood and impact of previous renovations on typology and systems

These houses are unlikely to have been renovated.

4.9.15 Heritage issues, section sizes and other planning constraints

These houses are not generally found in heritage areas. General planning and building controls apply.

4.9.16 Characteristics and links to regionality, geographic areas or typography

In the main these houses are clustered together in new suburbs on the edges of cities and towns throughout New Zealand.

4.9.17

4.9.18 Suitability for retrofit

Houses of this era are often developer built and cheaply built to minimal Building Code standards. There may be cases of poor construction and multiple building errors, as well as a high potential for weather tightness issues. This presents a problematic set of circumstances for retrofit. Most of the houses are poorly oriented, make little use of thermal mass and are therefore cold. Those that employ a concrete slab may potentially be candidates for retrofit around the concrete perimeter — but this will depend on soil and site variables. The low (or flat) roof pitches of many of these houses make it difficult to add insulation to them. In addition, the Building Code in place at the time of construction means that basic levels of insulation are already in place. The relative benefits of additional insulation compared to the costs of installation tend to indicate a long payback time that would make retrofitting additional insulation unviable[4]. Overall these houses are not considered a priority for retrofit — except where renovation is occurring to correct or improve the building fabric due to poor construction techniques and faulty specification of materials.

[4] ***Analysis of insulation undertaken by Beacon suggests that the first 75 mm of insulation in a building provides the majority of the benefits in energy and cost savings (McChesney et al., 2008).***

4.10 Last decade (1996–2007, post-insulation upgrade)

4.10.1 Main characteristics

Houses built in the last decade were, in the majority of cases, built as part of large subdivisions and developments. Most could be said to be airtight and well insulated — but a significant number are also prone to leaky building syndrome. Orientation of these houses is typically toward the street — in most cases, to provide vehicle access to large garages that are common throughout. This era sees the onset of multi unit residential and higher densities. This change of development style will undoubtedly require a separate typology which is beyond the scope of this report to address. In terms of construction, many of the houses from this era are timber frame (some steel frame) with a small number built of concrete. Poly and monolithic claddings are common with many being constructed from flat sheet products. Aluminium joinery predominates with some limited double glazing evident, although thermally broken frames are rare.

4.10.2 General description of era and construction types

Mass housing by the major construction companies, that is individual houses built on subdivisions, still does not vary substantially in construction type or form from that housing of the previous three decades. However, this period did see a new type of housing in terms of infill apartments built at the margins of commercial and industrial areas. This was typically encouraged by councils as a means to intensify housing densities and many of these units were also built by property developers. Multi unit apartments were generally built in blocks of two storied units, with some developments of five stories.

The standard form of construction for the majority of housing in this era was timber framing, with plaster board systems used to achieve fire rating. Following the problems encountered with the failure of untreated timber and the low standards of construction this shifted to tilt slab and masonry construction.

4.10.3 Variability of typology

Stand alone housing varies little from the previous typologies in the early 1990s. However, multi unit housing is very different. This is a style of intensive housing based on stacked joined units. As with the majority of other housing built by developers the primary drivers of this type of housing are profit margins and cost control. They are generally small in size and repeated to form blocks.

4.10.4 Solar orientation — including within the neighbourhood

As with the previous typologies, solar orientation is not generally a factor that appears to have been given consideration in the siting and planning of these houses. For the multi unit developments of the period orientation is simply a factor of maximising the number of units built on site.

4.10.5 Roof system — materials, form, construction and access

Stand alone houses exhibit similar construction systems as houses built earlier in the 1990s. Multi unit houses developments will typically have mono-pitch roofs, with no roof space. Roofs will have building paper or building wrap, and will be insulated to Code requirements. Timber framed roofs from the period 1996–2003 are most likely built with untreated Radiata pine and unless these roof spaces are kept dry and well ventilated they may be subject to rot.

4.10.6 Wall system — materials, form, construction and access

The walls of these buildings are generally timber framed. The period 1996–2003 brought with it the problems of leaky buildings constructed with untreated timber. These walls are generally clad in manufactured products. Sheet material claddings were not required to have a cavity before 2004 and much of the construction between 1996 and 2004 may be subject to rot or mould unless the wall cavity has been kept extremely dry and well ventilated. The Building Act of 2004 upgraded the requirements of E2 External Moisture (Department of Building and Housing, 2004). Since that time new systems have been introduced to the construction industry to ensure that walls breathe and to reintroduce timber treatment for framing timber.

4.10.7 Floor system — materials, form, construction and access

Refer to comments regarding timber above. The flooring systems used on stand alone houses of this period are similar to those described for the previous housing types.

On the multi unit housing the ground floor is typically concrete, and the upper floors generally will be timber framed with particle board flooring. Some will have suspended concrete floors above. As with the previous typologies most will have carpet in living rooms and bedroom areas and vinyl in the wet areas. Some will have tiles.

4.10.8 Windows and glazing systems — materials, form and construction

Aluminium windows are standard. Up until 2004 the windows may not be adequately flashed.

4.10.9 Heating system — type and location

Built-in heating is not commonly provided in these houses. In areas where gas is available some gas wall heaters will be used (including portable unflued heaters). Fires are not common. In some later houses research suggests that heat pumps are being installed at time of construction, with larger ducted systems becoming more common (French, 2008).

4.10.10 Hot water system — type and location

Most will have an internal system, high pressure electric cylinder. Some will have an external demand hot water system. Later buildings may have external storage type cylinders. External cylinders will be both electric and gas.

4.10.11 Plumbing — general system, location of bathroom and laundry

Most will have polybuteline supply and PVC wastes. Service areas will be located close together.

4.10.12 Ventilation characteristics

Opening windows, and fans in bathrooms, kitchen and laundry. Due to construction techniques houses from this era are comparatively more airtight than previous decades.

4.10.13 Likelihood and impact of previous renovations on typology and systems

These buildings are unlikely to have been renovated except those that have failed as a consequence of water tightness issues.

4.10.14 Heritage issues, section sizes and other planning constraints

The stand alone houses on subdivisions will not generally impact on heritage character. Where these are built as infill housing in heritage zones this will be a factor. General planning controls will also apply.

The multi unit housing developments may have heritage issues as they may be adjacent to an area of high heritage value. These units were frequently built on sites that were not zoned for housing. Zoning rules have been changed in response to the development and new work may be required to meet new controls.

4.10.15 Characteristics and links to regionality, geographic areas or typography

The stand alone houses are generally in new housing developments at the edge of towns and cities.

The multi unit developments are generally at the edge of commercial centres on properties that were light industrial or similar, often close to railway lines. The development rules that apply to these areas were very open, allowing developers to build very densely.

4.10.16 Suitability for retrofit

In terms of meeting Beacon's HSS High Standard of Sustainability®, ventilation and IEQ may be the biggest issues that require addressing in these houses. Similar issues arise in these houses as per the previous decade related to the presence of adequate levels of insulation limiting the cost effectiveness of additional insulation interventions. Provision of an efficient heating source and solar hot water may be more cost effective. There may be some potential to examine the case for retrofit of down lighting in these houses. The provision of down lights is a common feature of last decade housing and their use interferes with the thermal effectiveness of ceiling insulation.

Importantly, the construction techniques employed during this decade of building coupled with the use of untreated timber indicates that there is a significant potential to reveal leaky homes issues when retrofitting. This alone may make retrofitting of these houses an urgent task, but a potentially hazardous one.

5 Missing typologies

The draft typologies described above present a framework for assessing individual housing types within New Zealand's residential built environment. The aim was to utilise this framework to capture 80% of the existing housing whilst allowing for some degree of variability within each standardised typology. During the course of the research and analysis it has become clear that in addition to the typologies outlined above there are a range of "other" house types which may need to be considered in relation to retrofitting 90% of New Zealand's housing stock.

The next phase of this research is to utilise the information gathered to date to develop an understanding of the prevalence of these modal housing types. As part of this analysis, Beacon has examined a range of data sources in order to identify any significant house types that may be missing from the analysis. The following table presents an indication of the house types that have required additional investigation as part of the next phase of the research. Further discussion of the findings is outlined in the report *Housing Typologies – Current Stock Prevalence* (Page et al., 2008).

Table 1: Potential missing typologies

Typology	Comment
The bach	Data available from the QVNZ database suggests that baches make up around 4% of our housing stock. However, they are likely to show a very high degree of variability in terms of construction and materials and many will follow the typologies outlined above.
Lockwood homes and solid timber construction	The next phase of the research may give us a better understanding of the numbers of Lockwood and other solid timber homes in existence. If there are significant numbers identified then further work will be required to provide an indication of their thermal performance and retrofit suitability.
State housing split	The state house typology represents a large sector of houses which evolved over a significant period of time (1930–1970). Within this band it may be necessary to redefine sub-typologies based on different styles of construction. Suggested breakdown of subtypes may follow the following pattern: 1930–1950 original state houses; the 50s classic house; and then the 60s/70s mass house. This will be explored in more detail as part of the prevalence work.
Group housing	This has been highlighted as a potential typology that has not yet been recognised in the draft typology framework. This will be studied in more detail as part of the prevalence work.

Typology	Comment
Pensioner housing	This has been highlighted as a potential typology that has not yet been recognised in the draft typology framework. This will be studied in more detail as part of the prevalence work and if significant numbers are identified this may require additional research to identify suitable retrofit solutions.
Medium density housing and apartments	This is obviously a significant and growing subset of New Zealand housing. However, it represents a form of unit development which will have its own complexities in terms of sub-typologies. In addition, many of these dwellings are more recently built and should therefore perform better than the majority of our older housing. Undoubtedly, if Beacon's goal is 90% of housing stock, then further analysis of retrofit solutions for multi unit development will be required. Although addressed in the last decade housing typology provided above, a full analysis is outside of the scope of this piece of work.

6 The interaction of energy systems within housing typologies

For each of the “modal” houses outlined in the typologies framework Beacon is seeking to understand the main retrofit barriers, challenges and opportunities. The following tables outline these for each typology in reference to the main systems utilised in a house that have implications from an energy perspective. These include:

- Insulation
  - Ceiling insulation
  - Wall insulation
  - Floor/underfloor insulation
  - Double/triple glazing
- Space heating system
  - Heat pump
  - Low emission wood burner
  - Pellet burner
  - Heat transfer systems
- Water heating system
  - Solar hot water systems
  - Heat pump hot water systems
  - Wet back hot water systems

The data in the tables that follow is derived in the main from comments and input gathered at the typologies workshop. In places this has been supplemented by additional input from retrofit experts. Some interpretation has been included to aid understanding of the short points captured at the workshop. The benefit of a matrix in this format is the ease of comparison between different typologies in relation to both the system being looked at and the implications for renovation.

6.1 Insulation system

Typology	Ceiling insulation	Wall insulation	Floor/underfloor insulation	Double/triple glazing
Early housing (pre-1890)	- Comfortable cavity to work in - Problems with lean-tos and attics (opportunity at re-roofing stage)	- Good opportunity when refurbishing and replacing plasterboard or external weatherboards - Need to be careful about moisture issues in relation to lack of building paper - Potential with weatherboards — but age is a constraint (as they split)	- If good access under the floor (greater than 400 mm and suitable sized access door) then this is possible - Due to modification polystyrene blocks difficult (different distances between joists) — polyester rolls would be easier	- Character/heritage is a constraint - Secondary glazing has more potential than replacing whole windows - No standard — more expensive - Plastic film glazing may be suitable for windows that are in less noticeable parts of the house (e.g. back bedrooms)

Typology	Ceiling insulation	Wall insulation	Floor/underfloor insulation	Double/triple glazing
Villa (1880–1920)	- Easy — no limitations for main house although additional lean-tos may be problematic - Lowered ceilings; recessed wardrobes - Dormers roofs, skillion roof portions may throw up issues - Overall good option	- Easy if renovating and willing to lose sarking - No dwangs but no building paper either — condensation may be an issue - Sash window weight cavities difficult — thermal hole? - Foam or blown insulation from inside the walls an option (but somewhat untested and lack of building paper might create issues) - Deal to draughts around windows and external doors	- Easy if underfloor space is enough - Highly effective to stop draughts/infiltration	- Heritage timber joinery throws up issues? - Some windows with stained glass etc. - Sash windows have weight issues - Heritage controls - Bay windows can be problematic - Big range of options in bay window situation — very individualised

Typology	Ceiling insulation	Wall insulation	Floor/underfloor insulation	Double/triple glazing
Bungalow (1920–1930/40)	- Not a problem — similar to villa as above	- In cold climates have to insulate walls or wasting time - Rot and Bora may throw up structural issues - Small sections of timber — lots of thermal breaks — also have to upgrade wall - No building paper so condensation an issue - Have to get rid of internal moisture first	- Not a problem — similar to villa as above	- Heritage issues — too expensive to retrofit double glazing into wood - For effective solution need to use thermally broken panes - Removing draughts in windows a key issue
Art Deco (1925–1935)	- Flat roof very tricky - Plasterboard ceilings desirable - May have secondary roof	- Difficult to replace external cladding so unlikely to get access from outside - Inside decoration and features may require protection (heritage and character)	- Lower to ground so access may be an issue - Have concrete piles	- Unlikely solution as windows a feature - Thermal curtains and pelmets may provide the best solution

Typology	Ceiling insulation	Wall insulation	Floor/underfloor insulation	Double/triple glazing
State house (1930–1970)	- Typically few issues of concern - Relatively easy access and good opportunities for retrofit of additional insulation - May have has some insulation retrofitted already	- Additional wall insulation could be problematic as these have dwangs/nogs - Fewer maintenance issues indicate wall linings would need pulling off. So less opportunity to insulate while renovating - Biggest constraint to energy retrofitting - In cold climates have to insulate walls to significantly upgrade performance - Rot and Bora may throw up structural issues - Small sections of timber — lots of thermal breaks — also have to upgrade wall - No building paper so condensation an issue - Have to get rid of internal moisture first	- Typically access OK and floor relatively easy to insulate	- Double glazing good option — timber framed - If have aluminium frames <10 years old and can easily retrofit double glazing - Similar issues with bungalows (although not so much a heritage issue) - Removing draughts from windows a key issue to achieve better thermal performance
1960s Multi unit housing	- Cavity issues - Skillion or low roof difficult	- Concrete block end walls no space options - End walls offer thermal mass/insulation options	- Concrete slab issue, perimeter insulation is an option but veranda difficult - Timber floor probably too close to ground.	- Yes, modular windows but wooden joinery not easy - Cost benefit of overall retrofit may make this unviable

Typology	Ceiling insulation	Wall insulation	Floor/underfloor insulation	Double/triple glazing
70s House (1970–1978, pre-insulation)	- Possible in cavity but not in skillion roof systems	- Major retrofit requirements to increase performance — good opportunity	- Height of floor sometimes an issue - Controlling dampness important - Basements in this typology problematic — often need to address drainage problems	- Double glaze into existing aluminium frame — can do on site - Low cost secondary glazing options available in South Island (but installation is key) - Thermal drapes/pelmet an effective option
80s House (1978–1989)	- More difficult access to ceiling cavity in many cases - Blanket insulation works better to cover thermal breaks	- Should already have some wall insulation but some will not	- Draped foil already installed but often in bad condition - Might be worth upgrading with bulk insulation	- Replace the aluminium windows with other double glazed (preferably thermally broken) - Different approach with cedar - Add pelmet/shading against summer sun to prevent overheating
Early 90s (1990–1996, pre-revamped Building Code)	- If no space between ceiling and roof options are limited	- Major job (presence of ants in Auckland may complicate this procedure) - All should have building paper - Foil plasterboard walls may be the only ones worth retrofitting	- Expensive - May be more cost effective in colder climates - Can retrofit perimeter insulation (not common) - Depends on ground - Have to flash and use extruded polystyrene	- Potential to replace the aluminium windows with other double glazed (preferably thermally broken)

Typology	Ceiling insulation	Wall insulation	Floor/underfloor insulation	Double/triple glazing
Last decade (1996–2007, post-insulation upgrade)	- Should already have sufficient although down lights may reduce performance considerably	- Some may exhibit leaky building syndrome — so insulation may be water logged and in need of replacement	- Too late - If it is there under slab only - Need to develop perimeter insulation solutions (1m)	- Slimline — too late — often design for blinds - Pelmets may assist performance but not the “look”

6.2 Space heating system

Typology	Heat pump	Low emission wood burner	Pellet burner	Heat transfer systems
Early housing (pre-1890)	- Very few issues - Noise? (in close proximity neighbourhoods)	- Floor plan and space availability - Floor strength	- Floor plan and space availability - Floor strength	- Roof cavity available to be used
Villa (1880–1920)	- Heritage issues depending on where external unit located - Ducted or multiple systems may be required - Sized correctly important (as with all houses of any age)	- Should be easy inside existing fire place	- Similar for wood burner	- Easy but air volume issues - Central heating using radiators or underfloor ducting options could also be explored
Bungalow (1920–1930/40)	- Similar to villa	- Similar to villa	- Similar to villa	- Similar to villa
Art Deco (1925–1935)	- Reasonable solution	- Space issues could restrict options	- Space issues - Aesthetic issues	- Could do for part of the house but lack of access to ceiling void difficult

Typology	Heat pump	Low emission wood burner	Pellet burner	Heat transfer systems
State house (1930–1970)	- Not dependent on typology — must insulate first - Reasonable solution	- Floor space issue in some homes if smaller - watch regional air shed requirements (common to all houses — i.e. not dependent on typology)	- Small rooms — noise from fans may be an issue - Space in small homes - Probably require a heat transfer system to fully warm the house beyond the single room	- Easy roof space — good option, great solution if original closed plan still existing - Good option because of smaller room size
1960s Multi unit housing	- Yes — single and correctly sized unit	- Not enough space	- Not enough space	- Not useful nor space in cavity
70s House (1970–1978, pre-insulation)	- Easy	- Easy if fireplace existing (replace flue) - Relatively cheap	- Easy if fireplace existing (replace flue)	- Easy to do low wattage - Should use insulated ducting (applies to all houses, not dependent on typology)
80s House (1978–1989)	- No issues — prime candidates - Noise issues if close to neighbouring properties	- Replace existing wood burner if present (probably needs replacing and may not be efficient)	- Replace existing wood burner if present	- Sometimes not enough space — not possible in skillion roof - Focus on the middle part of the house
Early 90s (1990–1996)	- Reasonable solution if required	- Reasonable solution if required	- Reasonable solution if required	- Not possible in skillion roof

Typology	Heat pump	Low emission wood burner	Pellet burner	Heat transfer systems
Last decade (1996–2007, post-insulation upgrade)	- Are efficient in some climates but not necessarily all (applies to all typologies) - In Auckland the high humidity may lead to extra costs	- No problem	- No problem	- Barrier may be size of house

6.3 Water heating system

Typology	Solar hot water systems	Heat pump hot water systems	Wetback hot water systems
Early housing (pre-1890)	- Pitch of the roof beneficial - Square house, good choice of roof orientation - Structural problems — strength of roof - Aesthetics — heritage buildings - Likely to have smaller cylinder and potentially issues with its location	- Possibility - Having enough space and the correct layout may be an issue	- Existing fireplace cavity may not be appropriate (sometimes it has been filled in) - May need too many bends to achieve efficient layout - Should be undertaken together with other refurbishments
Villa (1880–1920)	- Depends on orientation for hip roofs; potential shading mature trees and surrounding two or three storey buildings - Basically good potential - If refurbishing kitchen, bathrooms etc. good easy wall access and ceiling access - Aesthetics and heritage issues	- Heritage aesthetics - Noise proximity to neighbours - Suit larger households 3+ people (applies to all typologies)	- Originally had wet backs; generally good option as solid fuel common
Bungalow (1920 – 1930/40)	- Heritage issues in some zones (e.g. North Shore won't get planning permission)	- As per villa	- As per villa
Art Deco (1925 – 1935)	- Roof pitch — can be problematic (generally too low) - Dependant on orientation - View from the street important — heritage and aesthetic issues	- Should work well - Outdoor unit should be situated next to kitchen and requires space outside close to service areas (applies to all typologies) - Kitchen/bathroom + plumbing/piping	- Space main issues - Less likely to have wood burners than earlier housing

Typology	Solar hot water systems	Heat pump hot water systems	Wetback hot water systems
State house (1930–1970)	- Typically roof pitch OK - Orientation may be incorrect - May require strengthening in roof for hot water cylinder - Has roof space for cylinder - Efficiency a function of locality - Difficulties with installation on tiles (safety issues as tiles can not take weight) - In some areas low number of sunshine hours may make SHW unviable (applies to all typologies) - Small HW cupboard may make internal cylinder replacement problematic	- Needs space outside close to service areas - Good option as kitchen and bathrooms close - No specific typology issues - HW cylinder has to be outside house as is generally quite large (applies to all typologies)	- Space and layout are the main constraints - Hard to retrofit a wet back in because of small room sizes - May be an option if cylinder close to wood burner
1960s Multi unit housing	- May be an opportunity to provide water from a single unit to a number of dwellings (but complicated by ownership issues) - not cost effective for single units	- Not big enough to warrant these	- No space for solid fuel burners

Typology	Solar hot water systems	Heat pump hot water systems	Wetback hot water systems
70s House (1970–1978, pre-insulation)	- To be effective cylinder likely to need replacing. This will mean a bigger cylinder but difficulties locating this in previous cylinder space - Potential gain 50–60% hot water or 15% total energy (from workshop estimates) - To use thermosyphon system an engineers report on roof structure may be required - Barriers include aesthetics, consent fees and payback periods (applies to all typologies)	- Has to go outside the house — close enough to hot water use to be effective - Upgrade low to high pressure provides a barrier which is partly technical and partly cost driven (applies to all typologies)	- Proximity of cylinder to heat source will be a constraint - Height in relation to distance between cylinder and wet back an issue — ratio of 7:1 required
80s House (1978–1989)	- Flatter roofs than is optimal - Orientation issues for many houses - Aesthetics could be a barrier - Roof construction may be able to hold bigger cylinders than previous typologies	- No issues (dependent on space availability) - More space in this typology (large suburban sites)	- Cluster of cylinder and heating - A number might already have a system installed - Retrofitting wet backs into existing wood burners is problematic
Early 90s (1990–1996, pre-revamped Building Code)	- No issue with installing on these houses	- No issues	- Requires appropriate air shed restrictions not to be a barrier

Typology	Solar hot water systems	Heat pump hot water systems	Wetback hot water systems
Last decade (1996–2007, post insulation upgrade)	- More problems — roof spaces more complex - Cylinder requires right insulation and to be sized correctly - Consent costs and delays are barriers	- No issues	- EE wood burners + wet back component an option - Requires appropriate air shed restrictions not to be a barrier — models should be selected carefully

7 Conclusions

This report summarises the main findings of Beacon's current research into New Zealand house typologies. This initial piece of research has identified a series of typical houses that dominate our housing stock both in terms of overall plan and look and also in terms of their constituent housing systems (walls, floors, roofs, windows, etc.).

Additional research continues in respect to identifying the prevalence of these modal housing types, as well as the development of an understanding of the range of thermal performance and energy use across different typologies. The prevalence work is presented in a companion report (*Housing Typologies - Current Stock Prevalence*, Page et al., 2008) to be read alongside this report. This includes a review of the house typologies outlined in this report, as well as a discussion of those typologies which may require adding to the framework or conversely being grouped together.

Further research has been identified in the following areas:

- The prevalence of the typologies contained in this report and the proportion of the housing stock that they make up.
- An analysis of potential missing typologies and their significance within the make up of the residential housing stock.
- Analysis of HERS ratings based on typologies, including an assessment of the energy efficiency gains possible within the constraints of each typology.
- Identification of the parameters that make a house not worth retrofitting and a framework for defining this.

The research is providing a framework on which to look in more detail at the opportunities and challenges of renovating these different house types to meet Beacon's HSS High Standard of Sustainability®. This report captures many of the learnings necessary to develop this framework and assists in the development of the next phases in Beacon's energy retrofit work. From this point further work will be undertaken to identify the types of retrofit packages that may be required to improve the overall performance of New Zealand's different typologies. Beacon's work on typologies was intended to answer a number of key questions that would assist further research and inform the Home*Smart* Renovations project.

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Appendices

Appendix A — Groups and workshop participants

Appendix B — Typology datasheets

Appendix C — Beacon HSS High Standard of Sustainability™ synopsis (provided as background to the workshop)

Appendix D — Workshop invitation and briefing notes

9 Appendix A — Groups and workshop participants

Group	Name	Typology
Group 1	Nick Collins, Beacon Pathway Ltd Jane Cuming, Placemakers Matthew Cutler Welsh, Energy Mad Robin Schmidt, DBH	Last decade housing 1970s
Group 2	Lois Easton, Beacon Pathway Ltd Jo Hunt, Energy Options Graeme Burgess, Burgess Treep Architects Bob Lloyd, University of Otago	Bungalow Early 90s houses State houses
Group 3	Ian McChesney, EECN Christchurch Alison Handley, DBH Martin Barry, EECA Marta Karlik-Neale, URS	Simple early housing 80s houses
Group 4	Lynda Amitrano, BRANZ Robin Skinner, Victoria University Mike O'Connell, ECAN Vicki Cowan, Beacon Pathway Ltd	Art deco State houses (50s classic)
Group 5	Kay Saville-Smith, CRESA Phil Hancock, Energy Smart Barbara Nebel, Scion Norman Smith, Rocky Mountain Institute	Multi unit 60s houses Villas

10 Appendix B — Typology datasheets

10.1.1 Early housing (pre-1890)

<table>
<tr><td>House Type
Simple Early Housing
</td><td colspan="3" rowspan="2">Basic description
• Principal material — wood (hard timbers)
• Large number of modifications homes (e.g. additions, change in lay-out, reorientation of rooms, e.g. moving lounge and bedrooms, open plan living)
• Often orientated to road etc., rather than sun</td></tr>
<tr><td>Era/age
Late 19th century</td></tr>
<tr><td rowspan="2">House Form
• Originally square
• Some have attics
• Verandahs

(Most common example — square box with verandah in front and lean-to at the back)</td><td colspan="3">Main construction type/materials
• Timber frame
• Suspended floors — replaced with concrete piles
• Roof cavity usually good, but little or none in the lean-tos)</td></tr>
<tr><td colspan="3">Estimated percentage
Number of storeys</td></tr>
<tr><td>Location
• Mostly rural and small towns</td><td>1 storey
most houses</td><td>2 storey —
some houses</td><td>3 storey</td></tr>
</table>

<table>
<tr><td>Main system features</td><td>Significant variations
(if significant then add to possible subtypes below)</td></tr>
<tr><td>Floors
• Timber floor
  ➢ low to the ground
  ➢ good quality hard wood (often exposed)
• Sloping sections (!), majority on flat (?)
• Underfloor access can be difficult depending on section</td><td></td></tr>
<tr><td>Walls
• Timber frame
  ➢ sarking, serim still present
  ➢ plasterboard retrofit (?)
  ➢ more upright framing
  ➢ a lot of modifications
  ➢ different distances between joists
• External cladding
  ➢ wood
  ➢ sometimes extensive patching</td><td></td></tr>
<tr><td>Ceilings
• Plaster/sarking/some ornate</td><td></td></tr>
</table>

• Wood or plaster	
Glazing • Sash windows • Single glazed/timber • Small panes	
Roof • With cavity — some with attics	
Insulation None originally — some later retrofited	
Heating system • Originally fireplace and coal range — now different types of replacements	
Other (e.g. garage under house common)	
Can we say anything in relation to climate and/or region?	
Can we say anything in relation to ease of retrofit to Beacon HSS™? • Energy • Water • Waste • IEQ • Materials	
Potential subtypes based on variations	Significant? Estimated % of stock

10.1.2 Villa (1880–1920)

<table>
<tr><td rowspan="4">House Type
Villa
</td><td colspan="3">Basic description</td></tr>
<tr><td colspan="3">House Form
Square and simple</td></tr>
<tr><td colspan="3">Main construction type/materials
Iron and native timber some thermal mass in chimneys</td></tr>
<tr><td colspan="3">Estimated percentage
Number of storeys</td></tr>
<tr><td>Era/age
1900–1920</td><td>1 storey
most</td><td>2 storey
some</td><td>3 storey</td></tr>
</table>

Main system features Solid structure, highly adaptable, serious architectural features	Significant variations (if significant then add to possible subtypes below)
Floors 6 inch or wider floorboard	
Walls Sarked unless renovated; hallway lined	Some high thermal mass, twin brick, cob, pebble
Ceilings 12 ft stud	Cowed ceilings difficult to insulate
Glazing Wooden joinery, single glazed, sash = complicated Multipane = non-retrofittable	
Roof Iron; large cavity; high pitch; inbuilt	
Insulation Roof and renovated walls? No building paper	
Heating system Complete gamet; unlikely to be only electric; solid fuel common; heat transfer	
Other (e.g. garage under house common)	2 storey often converted into multiple flats
Can we say anything in relation to climate and/or region? Large range of current condition/states	
Can we say anything in relation to ease of retrofit to Beacon HSS™?	
• Energy	

• Water Likely to be replumbed therefore high pressure hot water	
• Waste Compost + space for options	
• IEQ Excellent	
• Materials Native; non-toxic; high value	
Potential subtypes based on variations 2nd storey additions/turned back to front; built in verandas; always renovated for bathrooms; ownership options; split houses	Significant? Estimated % of stock

Additional notes (from Phil)
Highly renovatable
Infiltration
10–12 ft stud
No dwangs
Sarking (kauri)
Pressed ceilings
Shingles on attic walls
Window shades
Open fires (sometimes two)
Coal ranges

Probably highly renovated
Bathrooms
Lowered ceiling to 8 ft stud
Very poor wall/floor linkage re thermal performance
All replied
Large verandahs
Underfloor
Large wall cavity
Sash windows (double hung) with weight cavity
Wooden joinery

10.1.3 Bungalow (1920–1930… 40?)

<table>
<tr><td rowspan="4">House Type
Bungalow
</td><td colspan="3">Basic description
Single story gabled home.
There is a subvariant, the English Cottage Style, which are all 1½ stories with generally a garage/basement underneath</td></tr>
<tr><td colspan="3">House Form</td></tr>
<tr><td colspan="3">Main construction type/materials
Wooden weatherboard (rimu), wooden floors (rimu or matai), corrugated steel roof</td></tr>
<tr><td colspan="3">Estimated percentage
Number of storeys</td></tr>
<tr><td>Era/age
1915–1930</td><td>1 storey
99%
bungalows</td><td>1½ storey
99% of
English
Cottage style</td><td>3 storey</td></tr>
</table>

Main system features	Significant variations (if significant then add to possible sub types below)
Floors Always have a suspended timber floor. Mainly greater than 600 mm and often very high underneath (for Dad's shed)	
Walls Wooden weatherboard, no insulation, no building paper. Some now clad in brick veneer as a result of 60s and 70s renovations; brick bungalows are rare, as some with stucco over chicken wire and fibro cement	
Ceilings Stud height around 2.8, originally cast plaster ceilings with pseudo beams. Cavity ceilings and roofs framed with 100 x 50 rafters	
Glazing Wooden joinery with casement windows and fanlights above, in the 60s and 70s these were often replaced with aluminium windows single glazed	
Roof Pitched roof 24–27º (can be down to 18º), mostly steel, some tiled and some asbestos sheet in tile form or corrugated form	
Insulation Paper mache in ceiling or early batts common, walls uninsulated, underfloor insulation uncommon	
Heating system All have chimneys (mostly in living room, sometimes in kitchen also), wall	

gas heaters are common in reticulated areas of the North Island	
Other (e.g. garage under house common) Garages independent, popped tops from 80s onwards common, lean-tos not that common	
Can we say anything in relation to climate and/or region? Always oriented to the street not the sun Built as developer subdivisions as population centres expanded, so whole neighbourhoods of bungalows	
Northern parts of the country wood burners with wet backs are common, many areas wood burners retrofitted into chimney space	
Can we say anything in relation to ease of retrofit to Beacon HSS™?	
• Energy — relatively easy to insulate underfloor and ceiling — main issue is underfloor access if less than 400 mm, often get slumped floors; big issue for retrofit is draughts through windows — requires fiddly draught stopping and draught stopping products are poor quality • Sashes of windows won't take the weight of double glazing • Insulating does result in drying of floorboards and gaps resulting (lino can lift and bubble) • Lots of DIY wiring under houses — health and safety risk for stapled foil products but OK for batts and polystyrene • Is a concrete foundation under the chimney and sometimes for setdown porches and these areas are uninsulatable • If insulate walls the architects consider should put in building paper otherwise will create a condensation point in walls and create rot — ventilation and removal of moisture from within home would address this issue • Open fires are commonly used, and wet backs are common in rural areas • Old small electric hotwater cylinders (low pressure) are still common — can be 50 years old	
• Water	
• Waste	
• IEQ	
• Materials	
Potential subtypes based on variations English Cottage Style – 1½ storey	Significant? Estimated % of stock

10.1.4 Art Deco (1925–1935)

<table>
<tr><td rowspan="4">House Type
Art Deco
</td><td colspan="3">Basic description
Similar size and layout to a bungalow
3–4 bed, have curves!</td></tr>
<tr><td colspan="3">House Form
<110m^2 curved, face the road</td></tr>
<tr><td colspan="3">Main construction type/materials
Wooden frame majority (minor brick)
Stucco 70%, brick 15%, timber 10%, fribrolyte (<5%)</td></tr>
<tr><td colspan="3">Estimated percentage
Number of storeys</td></tr>
<tr><td>Era/age
1931–1939 Traditionally seen as a Spanish style (curved front)
1931–39, 1934–40 depression, war</td><td>1 storey
90</td><td>2 storey
10</td><td>3 storey</td></tr>
<tr><td colspan="2">Main system features
Whole house poorly orientated. Poor internal layout</td><td colspan="2">Significant variations
(if significant then add to possible sub types below)</td></tr>
<tr><td colspan="2">Floors
Suspended timber strip (high value wood matai), concrete piles</td><td colspan="2"></td></tr>
<tr><td colspan="2">Walls
Wooden frame (majority), rest brick. Stucco 70%; timber 10% /panels fibrolight 5% /brick 15%. Difficult to access for insulation</td><td colspan="2"></td></tr>
<tr><td colspan="2">Ceilings
Ornate plaster. High stud 8–9 ft</td><td colspan="2"></td></tr>
<tr><td colspan="2">Glazing
No eaves, <20% of wall area, leadlight features.
Pelmets fashionable (70–80%)</td><td colspan="2"></td></tr>
<tr><td colspan="2">Roof key feature
Parapet with x-flat roof behind (80%)
- steel
- mathoid
- tile
Failures mean some have a new roof built over existing — difficult/impossible to insulate because of air gap
Hipped roof (20%)</td><td colspan="2">Christchurch reroofed over fouled mathoid (with ventilation gap so insulation useless)</td></tr>
<tr><td colspan="2">Insulation
40% no ceiling insulation; <5% floors; <2% walls</td><td colspan="2">Ceilings — ornate plaster; people want to keep</td></tr>
<tr><td colspan="2">Heating system
Plug in electric — 68%   Open fire — 15%
Wood burner — 10%   Heat pumps — 7%</td><td colspan="2"></td></tr>
<tr><td colspan="2">Other (e.g. garage under house common)
Garages if home built on hills</td><td colspan="2"></td></tr>
</table>

Can we say anything in relation to climate and/or region? Streets of deco suburbs countrywide. High % in Hawkes Bay	
Can we say anything in relation to ease of retrofit to Beacon HSS™?	
Energy retrofit within style floors, windows flat roof HARD	
Water — equivalent to bungalow	
Waste — equivalent to bungalow	
IEQ — equivalent to bungalow	
Materials — equivalent to bungalow	
Potential subtypes based on variations These are subsets of bungalows — with a flat roof! But great marketing opportunities for "deco pack" For those on flat — 50%(?) difficult to retrofit	Significant? Estimated % of stock <5%

Additional flip chart discussion points

1931–39–1934–40 depression – war
Similar size and layout to a bungalow
3–4 bedrooms
High stud 8–9 ft
Single storey
Traditionally seen as a Spanish style (curved front)
Curves
Walls — stucco 70%; timber 10%/panels fibrolight 5%/brick 15%
Could be part of bungalow group
Flooring — timber stripped floors — matai
Concrete piles
For those on flat — 50%(?) difficult to retrofit
Glazing : <20% wall area
    Leadlight features
    Pelmets fashionable (70–80%)
Roof: key feature — parapet
    x-flat roof behind (80%)
        - steel
        - mathoid
        - tile
Failures mean some have a new roof built over existing — difficult/impossible to insulate because of air gap 1:1 roofs
Hipped roof
Insulation — 40% no ceiling insulation; <5% floors; <2% walls
Ceilings — ornate plaster; people want to keep
Heating system
    Plug in electric — 68%
    Open fire — 15%
    Wood burner — 10%
    Heat pumps — 7%
Region — Hawkes Bay
But nationally small pockets and streets (suburbs)
Retrofit — bungalow with flat roof

10.1.5 State House (1930–1970)

Please note that this is a combined table of findings from groups 2 and 4

<table>
<tr><td colspan="2" rowspan="4">House Type
State House
(1 group suggested two typologies which included early state housing and another subtype which could be branded the “50’s classic”)
</td><td colspan="3">Basic description</td></tr>
<tr><td colspan="3">House Form
<=100m^2, detached
Hipped roof, square single story home
Small homes — average size 87m^2</td></tr>
<tr><td colspan="3">Main construction type/materials
New Zealand materials (aim to minimise inputs). “Sound bones”</td></tr>
<tr><td colspan="3">Estimated percentage
Number of storeys</td></tr>
<tr><td colspan="2">Era/age
1937–1965 (the classic). State houses built till now
This picture covers houses pre-1950. After >1950 more variation in typology.
1930–1950 [note this era of house is the subject of extensive work by Bob Lloyd]</td><td>1 storey
75%
(some discrepancy between groups with one group estimating 100% 1 storey)</td><td>2 storey
25%</td><td>3 storey</td></tr>
<tr><td colspan="3">Main system features
Orientation/layout can be constraining especially with private state house “typology”
Architectually designed, oriented to the sun with living areas facing north</td><td colspan="2">Significant variations
(if significant then add to possible sub types below)</td></tr>
<tr><td colspan="3">Floors
Suspended wooden (good quality), suspended timber rimu and matai, variable ground clearance norm over 600 mm</td><td colspan="2">Nil</td></tr>
<tr><td colspan="3">Walls
Timber framing: cladding timber (40%), brick (40%), fibrolite (<5%), stucco (15%)
Timber framed typically weatherboard but some brick and some stucco over chicken mesh, no building paper, no insulation</td><td colspan="2">Nil</td></tr>
<tr><td colspan="3">Ceilings
Pinex standard stud, some with features such as cornices
2.7 m ceiling, mostly insulfluffed,</td><td colspan="2">Nil</td></tr>
<tr><td colspan="3">Glazing
Smaller windows in earlier (saving imported glass), later “50s classic” bigger windows), wooden frames
Wooden framed single glazed windows, 15–20% glazing with good eaves</td><td colspan="2">Nil</td></tr>
<tr><td colspan="3">Roof</td><td colspan="2">Nil</td></tr>
</table>

Steep pitch, concrete tiles, high pitch 25–30º. Good cavity	
Insulation Good chance most were insulated to some level by state ceiling only, normally insulfluff	Nil
Heating system Fireplace, electricity, heat Very hard to heat as small rooms, and SE bedrooms often very cold — 20% still use open fires which were located in living rooms, lots of unflued gas heaters (fixed to walls)	Nil
Other (e.g. garage under house common) Originally no garage/fences (against the "rules") Sometimes built as duplexes and terraces with no sound insulation between walls Some with water tanks in ceiling for h/w or with tight h/w cupboards for small electric cylinder Often built on hills and other "leftover" land at the edge of bungalow suburbs, or in some cities (e.g. Palmerston North), whole suburbs	Lots extensions decks, extra rooms (skillion, roof, lean-to), sleepouts and garages
Can we say anything in relation to climate and/or region? Built in pockets, or neighbourhoods	
Can we say anything in relation to ease of retrofit to Beacon HSS™?	Problem can over capitalise. Retrofitting the additions
• Energy — excellent • Access to ceiling often through a wardrobe or through laundry so size of product is an issue. Cavity is sufficient for good insulation in ceiling and underfloor • Need for heat transfer systems to adequately heat the whole house • Really hard to retrofit with pellet burners or stand alone wood burners as rooms are so small – takes up a lot of room • Insulfluff often with unwholesome biota so no fun to retrofit in ceilings	
• Water — easier, good roof structure, land for tank	
• Waste	
• IEQ	
• Materials	
Potential subtypes based on variations There are art deco "look-a-likes"	Significant? YES Estimated % of stock 40%

10.1.6 1960s Multi Unit Housing

<table>
<tr><td rowspan="4">House Type
1960s multi unit
</td><td colspan="3">Basic description</td></tr>
<tr><td colspan="3">House Form
Rectangular, no additions</td></tr>
<tr><td colspan="3">Main construction type/materials
Concrete block, concrete slab; timber frame joinery; rimu floorboards 4–6 inch; iron roof</td></tr>
<tr><td colspan="3">Estimated percentage
Number of storeys</td></tr>
<tr><td>Era/age
1960s</td><td>1 storey
All 100%</td><td>2 storey</td><td>3 storey</td></tr>
</table>

Main system features Non-renovatable/adaptable	**Significant variations** (if significant then add to possible subtypes below)
Floors Low underfloor height if timber Concrete slab common	
Walls Block (8 inch) between units; light frame concrete block wall	Some firewalls go into ceiling cavity — some stop at 8 ft
Ceilings Textured ceilings (asbestos) or pinex tiles	
Glazing Wood; single glazing; modulised	
Roof Corrogated iron/corrogated F Cement/asbestos low cavity space if any	
Insulation None and difficult	
Heating system Some gas; electric night store; portable gas	
Other (e.g. garage under house common) No garage	
Can we say anything in relation to climate and/or region? Auckland, Christchurch and Wellington + provincial centres (i.e. not villages)	
Can we say anything in relation to ease of retrofit to Beacon HSS™?	
Energy Gas	
Water Low pressure; bath and showers; single flush; copper pipes; rotary clothes line; no lagging or HWC wraps	
Waste	
IEQ Humidity and cold	
Materials	

Potential subtypes based on variations ½ storey; fibrelight; ownership potential = community Potentially high thermal mass Good dwelling size to occupant ratio	Significant? Estimated % of stock

Additional notes (Phil)
Skillion 8 ft stud
Uninsulated slab or low floor boards
Lead nails and asbestos roofs
Sprayed textured ceilings
Ownership — community/council owned/pensioner units
Very low capital value
Ceiling rafters 75 mm
Elect low pressure good quality hot water system
2 storey concrete wall both storeys
Minimal materials throughout
1–3 person units

10.1.7 70s House (1970–1978, pre-insulation)

<table>
<tr><td rowspan="4">House Type
1970s house
</td><td colspan="3">Basic description</td></tr>
<tr><td colspan="3">House Form</td></tr>
<tr><td colspan="3">Main construction type/materials</td></tr>
<tr><td colspan="3">Estimated percentage
Number of storeys</td></tr>
<tr><td>Era/age
70s House (1970–1978, pre-insulation)</td><td>1 storey
95%</td><td>2 storey
5%</td><td>3 storey</td></tr>
</table>

Main system features	Significant variations (if significant then add to possible subtypes below)
Floors Predominantly timber/chipboard — some concrete	
Walls Light timber frame, foil backed Gib, concrete block	Foil backed Gib a problem
Ceilings Skillion roofs have sarked ceilings	
Glazing First aluminium, some glazing floor to ceiling, sliding doors	
Roof Predominantly pitched, some skillion	
Insulation Little insulation	May find some limited retrofit attempts
Heating system Fires, the first log burners appear, night store heaters, panel heaters	
Other (e.g. garage under house common)	
Can we say anything in relation to climate and/or region? Regionally and budget dependent — brick weatherboard and fibro cement	
Can we say anything in relation to ease of retrofit to Beacon HSS™?	A frames are pigs and should be demolished — Beacon to supply counselling...
Energy Underfloor OK except for concrete Skillions problematic	

Water	
Waste	
IEQ	
Materials	
Potential subtypes based on variations	Significant? Estimated % of stock

General comments captured on flip chart:

Simple roof form
% rafter — load bearing walls
% truss?
% skillion — partial skillion split level
A frame
Large # std design — state advance/state house
Smaller # architect leading edge — new ideas/products (skylights)
Light timber frame
Block basements — some concrete floors
Aluminium windows
Chipboard replaces timber flooring

10.1.8 80s House (1978–1989)

<table>
<tr><td rowspan="4">House Type
1980s house
</td><td colspan="3">Basic description
• Timber frame maximising space
• Larger rooms — more open plan
• Little style — diversity</td></tr>
<tr><td colspan="3">House Form
1. Beazley box
2. Large suburban house
3. Mediterranean</td></tr>
<tr><td colspan="3">Main construction type/materials
• Timber frame — pine (treated)
• Cladding ––wood fibreboard, brick veneer
• Roof — iron</td></tr>
<tr><td colspan="3">Estimated percentage
Number of storeys</td></tr>
<tr><td>Era/age
1978–1989 (post insulation upgrade in Building Code)</td><td>1 storey
most houses</td><td>2 storey
very few</td><td>3 storey
very few</td></tr>
</table>

Main system features	Significant variations (if significant then add to possible sub types below)
Floors • Custom wood floors • Some pine • Vinyl and asbestos backing • Suspended floors with fair access	
Walls • Timber frame cavity — insulation in some (not all — but required!) • GIB-lined • Insulation insufficient	
Ceilings • Plasterboard	
Glazing • Single glazed aluminium windows	
Roof • Difficult access/small cavity	
Insulation	
Heating system • Generation 1 wood burners (closed, Kent) • Sometimes no fix heating • Night store • Convection • Underfloor heating	
Other • Garage — attached to the house • Move away from eaves and other protection from houses • Overheated? • Conservatories • Large windows — often problem with glare	

Can we say anything in relation to climate and/or region? • A lot of these houses are in Auckland and high growth areas to the north	
Can we say anything in relation to ease of retrofit to Beacon HSS™? • **Energy** — better underfloor/difficult ceilings, aluminium glazing — ready to retrofit, upgrade of heating system • **Water** — dual flush toilets retrofits • **Waste** — asbestos • **IEQ** — asbestos, MDF (?), no active ventilation, more tight • **Materials** — more petroleum-derived materials	
Potential subtypes based on variations	Significant? Estimated % of stock

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10.1.9 *Early 90s (1990–1996, pre-revamped Building Code)*

House Type 1990s house — 1990–1996, pre-insulation changes to Code 	**Basic description** **House Form** Incredibly variable **Main construction type/materials** Predominantly timber frame [untreated timber] Usually concrete slab on flat land, sometimes particle board floor on hills, predominantly metal roofs, some concrete tiles and sheet shingles (asphalt) and butyl rubber on flat roofs and bituminous torch on membranes on flat roofs **Estimated percentage** **Number of storeys**

Era/age	1 storey	2 storey	3 storey
1990–1996			

Main system features	**Significant variations** (if significant then add to possible subtypes below)
Floors Mostly concrete slab on flat land (uninsulated), sometimes suspended particle board on hillsides, suspended floors have foil draped underneath	
Walls Three main types: brick veneer, fake weatherboard (e.g. lineaboards) and monolithic cladding (Insulclad® and polystyrene plaster system direct fixed to studs common, these are leaky buildings)	
Ceilings Small ceiling cavity, tiled ceilings common in BOP	
Glazing Often 40% glazing in living areas, single glazed in aluminium windows, no louvres or overlights, minimal eaves	
Roof Generally low pitch and low ceiling stud (2.4 m) or trussed ceilings with small roof spaces	Whole subdivisions in Auckland and BOP of brick veneer and tiled homes
Insulation To Code — sometimes a foil lined Gib product was used in walls — which is already failing; where suspended floors have foil draped underneath which is often failing	
Heating system Generally in northern parts of the country no in built heating systems.	
Other (e.g. garage under house common) Often multi level. Generally have electric hot water cylinders, but in	

Auckland can have instant gas or gas storage	
Can we say anything in relation to climate and/or region?	
Can we say anything in relation to ease of retrofit to Beacon HSS™?	
Energy — hard to retrofit insulation into ceiling due to lack of space, concrete slab floors relatively hard to retrofit, often a hazard of rot encountered during retrofits — these are often leaky buildings; orientation for the sun was not a consideration for these homes, therefore are often poorly oriented and cold	
Water	
Waste	
IEQ — generally have ventilation fans, these are often broken now	
Materials	
Potential subtypes based on variations	Significant? Estimated % of stock

10.1.10 Last decade (1996–2007, post-insulation upgrade)

<table>
<tr><td rowspan="4">House Type
Last decade housing
</td><td colspan="3">Basic description
Large and leaky; subdivisions; airtight; well insulated; orientation toward street; onset of multiunit residential</td></tr>
<tr><td colspan="3">House Form
Complete roof; multiple cladding</td></tr>
<tr><td colspan="3">Main construction type/materials
Timber framing; poly/mono claddings — flat sheet; cavity construction; aluminium joinery</td></tr>
<tr><td colspan="3">Estimated percentage
Number of storeys</td></tr>
<tr><td>Era/age
1996–2007 (post-1996 insulation upgrade)</td><td>1 storey
40%</td><td>2 storey
50%</td><td>3 storey
10%</td></tr>
</table>

Main system features	Significant variations (if significant then add to possible subtypes below)
Floors Concrete mostly; midfloor timber; particle board	
Walls Timber frame; steel frame; small number concrete; some lightweight timber frame	
Ceilings Ceilings with holes (downlights); only 90% insulated due to penetrations/timber	
Glazing Aluminium, double glazing in south; not thermally broken; no longer have pelmets	
Roof Truss; metal claddings; some flat	
Insulation Well insulated — though lots of penetrations; uninsulated slab; downlights means not so effective insulation; no insulation in garage but mostly lined	
Heating system Many types; lpg; some underfloor; minimal pellet burners; heat pumps; A grade water cylinders	A grade water cylinders
Other (e.g. garage under house common) Garage facing street and attached	
Can we say anything in relation to climate and/or region? Designs not site-specific	
Can we say anything in relation to ease of retrofit to Beacon HSS™? Big potential to reveal leaky homes issues when retrofitting	So many variants that it is difficult to know what you are dealing with
Energy Size of houses requires large appliances needed	
Water	

Large roof	
Waste Large kitchen and large garage with in sink waste disposal	
IEQ Ventilation is critical	
Materials	
Potential subtypes based on variations	Significant? Estimated % of stock

Additional issues captured on flip charts

1990s big leakers — retrofit may reveal bigger issues — nightmare
More research on healthy houses? (for modern houses)
Over heating in summer
Assume well insulated
Air tight/poorly ventilated
Formaldehyde
Complex software generating roof structure
Double garage and standard (integral)
Enclosed decks (over living)
Covenants in subdivision — large subdivision — gated communities
No eaves/parapets/integral gutter/internal of fascia gutter
Concrete landscape
Light steel frame (6%)
Sealed not ventilated
Non thermal break aluminium joinery
$$ on visible parts of house
Garage faces street
Large openings
Monolithic cladding/kiln dried untreated timber frame
Large number of downlights
High pressure hot water
Lots of appliances
Underfloor heating/concrete floor
Top soil removed from site
Two lounge rooms
Level entry — high ground level
Uninsulated garage/lined
Plethora of materials/junctions/complexity

11 Appendix C — HSS High Standard of Sustainability® synopsis

11.1.1 Beacon's HSS High Standard of Sustainability®

In order to provide a framework for Beacon to measure the influence it is having on the sustainability of houses at a national level, and to provide a useful benchmark against which individual households can evaluate their home's performance, Beacon has developed benchmarks for a HSS High Standard of Sustainability® in homes (Easton, 2006). These benchmarks have focused on five key aspects of dwelling sustainability:

- Energy use
- Water use
- Indoor Environment Quality
- Waste
- Materials

Underpinning these five technical aspects of dwelling sustainability are the issues of affordability and future proofing.

The benchmarks set represent:

- a 25% reduction in energy use in new homes
- a 15% reduction in energy use in existing homes
- a 25% reduction in water use in both new and existing homes
- indoor environment temperatures which meet the World Health Organisation standards of 18^{o}C in living areas and 16 ^{o}C in bedrooms
- adequate ventilation without excessive draughts
- provision for waste minimisation during construction, renovation and operation of homes
- consideration of sustainability issues in the choice of materials used for construction or renovation of homes.

The percentage reduction in energy and water use are attributable to the design and features of the home and have been set acknowledging the particular attributes of New Zealand housing stock. For example home energy uses is lower than in countries such as Australia, the United States and the United Kingdom (McChesney, Smith and Baines, 2006), and New Zealand homes are significantly underheated. It is also expected that occupier behaviour modification could see further significant improvements in the efficiency and healthiness of the homes.

11.1.2 Features to achieve a HSS High Standard of Sustainability®

A number of key features have been identified which would enable homes to be built to meet the HSS High Standard of Sustainability® measures. While occupant behaviour will affect the actual outcome in terms of energy and water use, and the quality of the indoor environment, houses with these features can inherently be operated in a more sustainable manner. These features can be grouped into low, moderate and high categories which reflect both their impact on the sustainability of a home and the amount of capital investment required to be put in.

Basic low cost measures which will have a modest impact on the sustainability of the home include measures such as:

- Low flow shower head
- Compact fluorescent light bulbs
- Dual flush toilet
- Outdoor clothesline
- Hot water cylinder wrap and pipe lagging
- Draught stopping
- Ventilated fridge space (in northern areas)
- Opening windows
- Mechanical venting of bathroom and kitchen
- Incorporation of passive solar design into new homes and extensions to existing homes
- Provision of space for recyclables storage
- Provision of facility for collection and composting of organic waste
- Use of materials for new homes and alterations to existing homes which have been selected with reference to a sustainability checklist
- Elimination of unsustainable features such as — air conditioning; in sink waste disposal units; and unflued gas heaters.

Moderate cost features which will have a significant impact on the sustainability of a home include the following measures:

- Ceiling, external wall and underfloor insulation to meet “better” recommended values for each climate zone
- Rainwater tanks supplying the garden
- Windows with passive venting
- Thermal curtains and pelmets;
- Water and energy efficient appliances.

Depending on the type of home (new or existing, efficient or inefficiently designed) some higher cost features such as solar hot water systems, insulation levels to meet “best” recommended values for each climate zone, double glazing, greywater reuse or rainwater tanks supplying non potable uses may be required to fully meet Beacon’s HSS High Standard of Sustainability®.

Depending on whether the home is new or retrofitted, a combination of basic and moderate features with one or two higher cost features will enable a home to achieve the HSS High Standard of Sustainability® in relation to energy, water and waste. Further work is underway by Beacon to determine the most efficient and effective means of achieving a high quality indoor environment and ways in which to determine what are the most sustainable building materials available in New Zealand.

12 Appendix D — Workshop invitation and briefing notes

12.1.1 Energy Retrofit Housing Typologies Workshop

27 November 2007 12.15pm – 4.45pm (with drinks afterwards)

Venue: Brewery Bar and Restaurant, Corner of Taranaki and Cable Streets on the Waterfront, Wellington

Workshop

Beacon's aspiration is to bring about a significant and substantial improvement in the sustainability of the residential built environment in New Zealand. It recognises that improving the standards of our existing stock is key to meeting that vision. This means retrofitting the vast majority of our poorly performing housing — but not just any sort of retrofitting. It means retrofitting our houses to a HSS High Standard of Sustainability® with the best standards of insulation, energy efficient water and space heating, energy efficient lighting, water efficiency and solutions to improve the indoor environmental quality.

Purpose

The purpose of this meeting is to use your skills, experience and expertise to consider whether our modal house types in New Zealand — that is the house types that dominate our housing stock — are amenable to retrofit to meet the HSS® and, if so, what sort of retrofit packages may be required.

What we want you to do

We want you to help us by working progressively through two exercises.

- First, we want to try and work out what the modal houses are in our current stock and what features of them classify them into these "typologies" (so we might be looking at main construction features, age, era, style, condition, systems such as walls, floors, etc.)
- Second, we want you to help us establish for each of those modal houses whether they represent particular retrofit needs and we want you to provide a preliminary, albeit expert view, on the sorts of retrofit packages suitable to different modal houses in different climate zones.

Key questions

Key questions are:

- Can we identify a defined list of modal housing types that are representative of the New Zealand housing stock?
- Do these modal house typologies have distinct sub-typologies that make further segmentation necessary?

- Can we reach consensus on a list of modal house typologies and the main features of each of those typologies?
- If it is possible to ratify a series of modal house typologies, is data available to develop an understanding of prevalence of different types of houses — and can we identify any trends in terms of regionality?
- What housing typologies are easiest to retrofit, and what proportion of the overall housing stock to they make up?
- What energy efficiency gains are possible within the constraints of individual dwelling typologies? And
- Can we identify those aspects of typology that make retrofit easy?
- Can we identify those aspects of typology that make retrofit necessary?
- Can we identify those aspects of typology that make retrofit impossible? (i.e. what parameters make a house not worth retrofitting and how can those be defined?)
- What is the interaction between climate, house typology and retrofit solutions and how can this be represented?

12.1.2 Expected outcomes

We hope at the end of this workshop, we will have identified:

- A series of typical houses that dominate our housing stock both in terms of overall plan and look but also in terms of their constituent housing systems (walls, floors, roofs, windows, etc.).
- The opportunities and challenges to bring these different house types to a HSS®.
- The types of retrofit packages that may be required to improve the house performance of different house types under different climate zones.

12.1.3 Preparation

The best outcome will be achieved by participants spending a little time before the workshop thinking about the issues and gathering any sources of data that they would like to have at the tip of their tongue during the workshop. We have asked you to attend as you are an expert in this area and have a wealth of knowledge about these issues. Some of you will have papers, books, research documents, pictures, diagrams, ideas — please bring whatever you can to throw into the mix — or that you feel you might want to refer to on the day.

For more information please contact:
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Typologies workshop agenda

DATE: 27 November 2007

Venue: Brewery Bar and Restaurant on the waterfront, Wellington

Time: 12.15pm - 4.45pm

27 Nov 2007		Comments
12.15 pm - 12.45 pm	Arrival / registration	light lunch
12.50pm - 1.00pm	Welcome	Scope of the day and brief introductions from participants
1.00pm - 1.20 pm	Introduction	Beacon's Energy Research Beacon Retrofit1000 project
1.20pm - 1.30pm	Process	
	Introduction to HSS	Beacon's High Standard of Sustainability
1.30 - 3.00pm	Workshop Session 1	New Zealand's Typical Houses
3.00pm - 3.10	Comfort break	
3.10 - 4.40	Workshop Session 2	Retrofitting typical houses
4.40pm - 4.45pm	Summary and close	
4.45pm finish	Drinks	