Auckland Regional Council
TE RAUHĪTANGA TAIAO

Auckland Sustainable Homes Assessment

Part 1: Insulation and Clean Heat Appliances

November TR 2009/052

Auckland Regional Council
Technical Report No.052 November 2009
ISSN 1179-0504 (Print)
ISSN 1179-0512 (Online)
ISBN 978-1-877483-39-4

Reviewed by:

Name: Kevin Mahon
Position: Manager,
Air Quality Policy
Organisation: Auckland Regional Council
Date: 13 November, 2009

Approved for ARC Publication by:

Name: Alastair Smaill
Position: Group Manager,
Environmental Policy & Planning
Organisation: Auckland Regional Council
Date: 13 November, 2009

Recommended Citation:

Parfitt, B.; Kuschel, G.; Sridhar, S. (2009). *Auckland Sustainable Homes Assessment. Part 1: Insulation and Clean Heat Appliances.* Prepared for Auckland Regional Council. ARC Technical Report No 2009/052.

Auckland Sustainable Homes Assessment Part 1: Insulation and Clean Heat Appliances

Bonnie Parfitt
Gerda Kuschel (Emission Impossible Ltd)
Surekha Sridhar (Auckland Regional Council)

Prepared for

Auckland Regional Council

Emission Impossible Ltd
116c Marsden Avenue, Balmoral, Auckland
PO Box 96 086, Balmoral, Auckland 1342, New Zealand
Phone +64-9-629 1435, Mob +64-21-270 0639
www.emissionimpossible.co.nz

Contents

Peer Reviewed by:

Name: Janet Petersen

Date: 13 November 2009

Acknowledgements

This work was funded by the Auckland Regional Council (ARC).

A number of people contributed to the success of this programme including:

- Kevin Mahon, ARC
- Bruce Forbes, ARC

And many others from a number of organizations, who provided valuable input and assistance, including:

- EcoWiseWest
- Energy Efficiency Conservation Authority
- Housing New Zealand Corporation
- Manukau City Council, and
- Waitakere City Council

Executive summary

This report assesses the sustainability of the Auckland housing stock in terms of minimum levels of insulation and clean and efficient home heating appliances. It is a response to the Auckland Sustainability Framework (ASF), which aims to help our region secure a better quality of life, and create a better future socially, culturally, economically and environmentally. As part of this, the Auckland Regional Council (ARC) is investigating the role that a "Sustainable Homes" programme could play to implement the ASF and address the challenges of climate change, unsustainable natural resource use, population growth, social disadvantage, and degraded air quality.

Quality, sustainable housing will play an important role in ensuring a sustainable future by assisting Auckland to reduce the region's ecological footprint, build community resilience, and contribute towards the long-term goal of carbon neutrality. However, there is a lot of work to be done to improve the current state of Auckland houses. Auckland is home to over a third of the national population and many presently live in homes that:

- Have indoor environments that are cold, damp, mouldy and/or poorly ventilated;
- Use high polluting heating appliances; and
- Are poorly insulated and use inefficient methods of domestic home heating.

In this report, work has been undertaken to:

- Assess the current condition and quality of the region's housing in relation to insulation and home heating;
- Identify existing programmes and future interventions that could be applied to improve sustainability in homes in Auckland; and
- Undertake a preliminary evaluation of the costs and benefits of improving energy efficiency and clean heating in homes.

The following is a summary of the key findings contained in the body of the report. These findings have been based on an analysis of recent studies and surveys, including the 2006 census, to build up a picture of the state of Auckland's housing stock and identify opportunities for intervention.

Current state of the Auckland region's housing stock

Age profile of Auckland homes

The age of the house is an important factor in establishing insulation levels and the types of heating devices a house may have but it varies across the Auckland region, due to historical land development patterns. Older houses are also more likely to be cold, damp, and mouldy, lack sun, and have polluting heating devices and poor insulation.

- As at 2006, there were 439,080 houses in the Auckland region and approximately 60 per cent of these were built before 1978 (when the first insulation standard was introduced).
- Most territorial authorities have less than 10 per cent of their housing stock built before 1930, except for Auckland city which has over 15 per cent.
- Papakura district, Manukau city, North Shore city, Franklin district and Waitakere city all have over 50 per cent of their housing stock built between 1950 and 1980.
- Rodney, Franklin and Papakura districts all have younger housing stock on average as a result of relatively recent development and growth.
- It is estimated that 70 per cent of the houses expected in the Auckland region in 2030 already exist.

Design of Auckland homes

The design of homes is important as it affects the ability to retrofit cleaner and more energy efficient options, such as improved insulation, particularly in cases where dwellings are attached.

- Stand alone or separate houses account for 71 per cent of all housing in the Auckland region but this varies considerably with territorial area. Only 58 per cent of Auckland city houses are defined as separate houses whereas considerably higher proportions are found in Franklin (86 per cent) and Rodney (82 per cent) districts.
- Joined or attached dwellings account for 24 per cent of the Auckland region's housing stock with Auckland city recording the highest proportion (35 per cent) and Franklin district the lowest (seven per cent).

Tenure of Auckland homes

Tenure affects the ability of households to improve the condition of their dwelling. Those with the least ability are renters who cannot upgrade their houses appreciably without the permission of their landlords.

- In the Auckland region, 64 per cent of households own the dwelling, or hold that dwelling in a family trust. The remainder (36 per cent) rent the home they live in.
- Rental properties comprise nearly 28 per cent of separate houses in the region but over 61 per cent of multi-unit dwellings.
- Older, colder houses are more likely to be rental properties.
- Rates of major renovation and demolition are generally low in New Zealand. Therefore the condition of our housing stock improves slowly.

Level of insulation in Auckland homes

The first standard for house insulation in New Zealand was introduced in 1977, requiring all houses built after 1978 to meet minimum ratings for insulation in ceilings, walls, and floors. In October 2007, the New Zealand Building Code was changed to require improved thermal performance in all new houses and major extensions to existing homes. This change came into effect in Auckland in September 2008 and also includes a new requirement for double-glazing.

- Up to 27 per cent of the houses in the region (118,550 homes) are likely to have little or no insulation.
- Household energy use in Auckland has been steadily increasing but many homes are still not meeting the World Health Organisation's (WHO) recommended minimum indoor temperature of 18°C during winter.

Heating methods used in Auckland homes

Space heating consumes approximately 34 per cent of total household energy on average in Auckland. Emissions from solid fuel heating contribute towards Auckland's poor ambient air quality in urban areas, producing up to 39 per cent of fine particle emissions which are responsible for the most serious health effects. There are issues relating to the increased use of unflued gas (LPG or natural gas) heating devices as these also have adverse effects on indoor air quality and health.

- There are still a significant number of households (29 per cent) using solid fuel, such as wood or coal, for heating.
- People in older homes are more likely to use solid fuel or portable heating appliances. Houses over 50 years old are twice as likely to have an open fire.

- Gas heating (reticulated or LPG bottles) is used in approximately 35 per cent of houses, with estimates suggesting that up to two thirds of these homes use gas in an unflued appliance.

Opportunities for intervention

There are several established programmes in the region to help improve energy efficiency in homes and as of March 2009, nearly 15,000 homes in the region had received energy efficiency upgrades. Many of these programmes are jointly funded and are provided by more than one agency. However, based on the current level of funding, it would take 50 years to address the sustainability of the worst housing in Auckland and other initiatives are required if more substantial and swift progress is to be made. Any additional intervention should also support existing programmes.

Households that are the worst affected by cold, damp housing are those with children, elderly people and occupants with poor health/disabilities. Households with limited income, those living in rental properties, or home owners with low disposable incomes also have the least ability to improve the conditions of their housing without assistance. These are the types of households that would gain the most benefit from schemes to improve the sustainability of the housing stock.

Approaches that could be undertaken in the region to promote improved energy efficiency and clean heating include:

- Education, advice and information,
- Partnerships,
- Financial support and assistance,
- Incentives and disincentives, and
- Regulation.

A range of complementary tools is available within each approach and more than one of these can be used together. Based on experience in other regions, regulation is the mechanism most likely to deliver swift and efficient improvements to the 439,080 homes in Auckland. All options require a component of education.

Many councils in New Zealand have proposed regulatory changes as part of their action plans to meet the National Environmental Standards for Air Quality (AQNES). In Auckland, the installation of new solid fuel appliances is already regulated through the Proposed Regional Plan: Air, Land and Water and the AQNES. Two additional intervention points which could be considered in Auckland are:

- At "point of sale". Between 1500 and 3000 houses are sold in the region each month. If a mix of incentives, regulation and education were introduced requiring homes to have a clean heating appliance and a minimum level of insulation at time of sale then all of Auckland's housing stock could potentially be upgraded within 12 to 23 years.

- Targeting rental properties. Nearly 30 per cent of Auckland's housing stock (131,120 homes) comprises rental properties. Most of the publicly owned properties have been or are on schedule to be upgraded. However, the privately owned stock (98,400) is presently not targeted.

Benefits and costs

The extent of the overall benefits achieved in a particular situation will typically depend on the measures installed and on the pre-existing conditions in the home. There is general agreement that a holistic approach – combining building envelope and hot water cylinder insulation with clean heat appliance upgrades – will achieve the greatest improvements.

The primary benefits associated with improving insulation and clean heating are energy savings, healthier households and better air quality. An investment of $1,800 for insulation and $4,000 for a cleaner more efficient heating device could deliver the following per household benefits:

- energy savings of $275 per annum, based on a saving of 1570 kiloWatt hour (kWh) through insulation, hot water cylinder wraps and better heating efficiency,
- healthier home benefits of $180 per annum, through fewer days off work/school, and reduced GP/hospital visits,
- air quality benefits of $2,017 per annum, resulting from reduced mortality and illness caused by air pollution.

Assuming all improvements continue to deliver benefits for at least 20 years, the present value of the primary benefits per household is $30,806, resulting in a benefit cost ratio of 5.31 (i.e. $5.31 benefit for every $1 spent).

Insulation and clean heat improvements also contribute to reducing greenhouse gas emissions, reduce the need for greater investment in energy generation (i.e. fewer power stations), increase tenure and property values, and can add economic stimulus through job creation. Estimates suggest that a regional upgrade programme in Auckland could deliver co-benefits in the order of:

- $0.925 million per annum in carbon credits
- $300 million one-off saving on a 240 MW power station
- $31.1 million per annum in savings on tenure costs for rental properties
- $151.4 million per annum in additional jobs created.

The costs and benefits presented here are indicative only and would need to be re-calculated for the specific details and timing of any proposed upgrade programme.

Summary and recommendations

Substantial improvements could be made to the energy efficiency status and heating standards of the region's homes. Insulation and clean heat programmes should be the first steps towards creating homes that contribute to a healthy, resilient, and sustainable region. However, many households are unable to make improvements owing to constraints such as lack of ownership, limited tenure or low-income. Central and local government intervention is necessary to assist households who are not able to make improvements, or to encourage those who can to act.

Future work is recommended to identify the policy options that should be taken forward to improve the sustainability of the Auckland housing stock. The assessment undertaken in this report should also be extended to other aspects of household sustainability in Auckland, such as solar water heating, rainwater tanks and grey water use.

Even from the preliminary benefit cost analyses undertaken in this report, there is a compelling case for the ARC and other stakeholders to collaborate on a coordinated and accelerated programme of action which will deliver a suite of benefits to Aucklanders.

1 Introduction

Auckland is home to over a third of the national population and many presently live in homes that:

- Have indoor environments that are cold, damp, mouldy and/or poorly ventilated, resulting in increased, otherwise avoidable illness of the occupants;
- Use high polluting heating appliances, resulting in unacceptably high outdoor and indoor air pollution; and
- Are poorly insulated and use inefficient methods of domestic home heating.

Despite space heating consuming approximately 35 per cent of total household energy on average in Auckland, many homes are still not meeting the World Health Organisation's (WHO) recommended minimum indoor temperature of 18°C. Emissions from solid fuel heating contribute towards Auckland's poor ambient air quality in urban areas, producing up to 39 per cent of fine particulate emissions which are responsible for the most serious health effects. In addition, there are issues relating to the increased use of unflued gas (LPG or natural gas) heating devices which produce high levels of indoor air pollution and moisture.

Concerns about energy use and housing quality have been topical for some time in New Zealand. Energy use in homes was first addressed in legislation following the oil crisis in the 1970s and this resulted in some improvements being made. Poor health has long been associated with substandard housing and many actions have been taken to improve the situation, such as sanitation, building regulations and technological solutions. Measures to address these issues were sufficient at the time, but are not enough to address the challenges in housing today. Technological advances also mean that we have more methods available to address these problems than before.

The extent and effects of unsustainable homes have become more apparent as research results have accumulated. There has also been renewed government interest in addressing related issues over the past 10 years. A number of government and non-government programmes have been established in attempts to improve the quality and sustainability of New Zealand homes. However, most of these have focused on the colder climates of New Zealand and application to the Auckland housing stock has been limited.

Insulating homes has been shown to make them warmer, drier and more comfortable. Clean heat appliances improve both indoor and ambient air quality as well as reducing fuel use. When insulation and clean heat appliances are installed in conjunction, winter indoor temperatures increase, energy use decreases and the health of occupants improves markedly. The incentives to act on these issues are compelling. Improving the housing stock across the region will help to deal with the challenges of energy security and price volatility, poor air quality, climate change, socio-economic disparities and unsustainable resource use.

This report has been prepared as part of designing a potential Sustainable Homes programme for the Auckland region. This assessment focuses on providing an overview of the Auckland housing stock in terms of insulation and home heating and is structured as follows:

- Section 2 summarises the major policies and pieces of legislation that dictate the level of insulation and heating practices in Auckland homes;
- Section 3 reviews previous studies and explains physical building conditions, demographic influences and other factors that have shaped the current condition of Auckland houses;
- Section 4 outlines existing energy efficiency and clean heat programmes and highlights the options available for intervention; and
- Section 5 analyses the costs and benefits of insulation and clean heat upgrades.

This report is part of a suite of technical work has been undertaken by the ARC on domestic home heating. For additional information, please refer to the Auckland Regional Council at www.arc.govt.nz or phone the Air Quality Policy team on (09) 366 2000.

2 Developments in policy and legislation

As the adverse consequences of unsustainable homes have become more widely understood, the New Zealand government has moved to strengthen legislative and policy responses to address these concerns. The following section provides an overview of the relevant strategies at a national level. It also sets out legislative requirements and targets that would need to be met by any sustainable homes, clean heat or insulation programmes.

2.1 Insulation standards and housing regulations

2.1.1 1977-1990

The first standard, NZS 4218P: 1977 for house insulation was introduced in 1977 as a response to the oil crisis and problems with electricity generation (CBPR, 1993). All houses built after 1978 were required to meet this standard, which specifies minimum ratings (r-values[1]) for insulation in walls, floors and roofs as shown in Table 2.1.

The standard came into effect under the Local Government Amendment Act 1978 and was enforced and administered by local authorities as part of their building permit issuing function (CHRANZ, 2006).

2.1.2 1991-2003

In 1991, the first national regulations controlling the building industry were introduced as part of the Building Act 1991, administered by the newly created Building Industry Authority. Prior to this, buildings had been regulated under various local government and public health legislation. The key features of the legislation included:

- The Building Act 1991 which set out the law on building work; and
- The Building Regulations 1992 which contained a mandatory New Zealand Building Code, which set out performance standards that all new building work must meet.

The 1977 insulation standard was formally incorporated into the 1992 Building Code as part of Clause H1 - Energy Efficiency, which was designed to facilitate efficient energy use in buildings and ensure that buildings were safe and comfortable.

In 1996, a new insulation standard was published. However, the changes were relatively minor and there were no changes in the minimum ratings required for Auckland houses. The main change was a shift to a "climate-based" approach

[1] The r-value is a measure of the thermal resistance used in the building and construction industry. Higher r-values indicate better insulation effectiveness.

whereby the level of insulation required is determined by the location of the dwelling within the climate zones. The revised Building Code specifies three climate zones in New Zealand, which are based on average temperatures and boundaries set in accordance with territorial authority jurisdictions. Auckland is in Climate Zone 1, which is considered to be mild and temperate (DBH, 2006). This change took full effect after 2001 and all new homes built since then were required to meet the standard NZS 4218: 1996 (CHRANZ, 2006).

2.1.3 2004 to date

The Building Act 2004 replaced the Building Act 1991 and came into full effect in April 2005. The new act sets out the law on building work and applies to the construction of new buildings, as well as the alteration and demolition of existing buildings, and incorporates a number of changes as follows:

- The Building Industry Authority has been dissolved and administration is now undertaken by the Department of Building and Housing (DBH – formerly the Ministry of Housing), which was established in November 2004. However, additional functions and duties, such as issuing building consents and monitoring, are carried out by local authorities.
- The Building Regulations 1992, and subsequent Amendments, were made under the Building Act 1991 but are now treated as if they were regulations made under the Building Act 2004. However, the majority of the 1992 Regulations were revoked on 31 March 2005 by the Building (Forms) Regulations 2004. The only part of the 1992 Regulations continuing in force is Schedule 1 containing the Building Code, which sets out the minimum performance standards for building work (DBH, 2008a).
- The Building Code has been fully reviewed, resulting in significant improvements especially in energy efficiency.

In October 2007, Clause H1 of the Building Code was changed to require improved thermal performance (insulation) in all new houses, non-residential buildings smaller than 300m^2, and in alterations to both. New houses and major extensions to existing houses need to use 30 per cent less heating energy to achieve healthy indoor temperatures than previously. The changes incorporate the latest insulation standard, NZS 4246: 2006[2], which increases the minimum ratings for roof and wall insulation as well as introducing a new standard for double-glazing (see Table 2.1). In addition to energy efficiency requirements, a number of other clauses in the Building Code exist that set out requirements for indoor temperature, hot water cylinders, ventilation and space heating (DBH, 2006).[3]

[2] Full standards are available from Standards New Zealand at www.standards.co.nz
[3] For further details refer to the DBH website at www.dbh.govt.nz

Table 2.1 Minimum insulation standards for Climate Zone 1 which includes Auckland

Type of Insulation	r-value of 1978 - 2008 Standard	r-value of new Standard (effective 2008)
Roof (ceiling)	1.9	2.9
Walls	1.5	1.9
Floor	1.3	1.3
Vertical glazing (windows)	-	0.26
Skylights	-	0.26

Source: DBH, 2007

The changes have been effected in stages across New Zealand. The last area for implementation (on 30 September 2008) was Climate Zone 1, which covers the northern parts of the North Island including Auckland.

Under the current Building Act, a building consent is required for installing heating devices including solid fuel burners. Insulating a house is exempt from consent requirements.

It should be noted that although minimum insulation standards have existed in New Zealand for more than 30 years, not all houses built after 1978 will necessarily meet the applicable standard. The condition and effectiveness of insulation is dependent on the type of product used, on how it is installed and maintained, and also on how it deteriorates over time. Conversely, home owners and builders can choose to build and insulate to higher standards than those specified in the code. This should be encouraged whenever practicable, as higher standards can invariably be attained more economically during initial construction than from retrofitting.

2.1.4 New Zealand Housing Strategy 2005

The New Zealand Housing Strategy (NZHS) 2005 sets out the government strategy on the direction of the housing sector until 2015. The overarching vision is: "All New Zealanders have access to affordable, sustainable, good quality housing appropriate to their needs." (HNZC, 2005).

The programme of action outlined in the document is led by Housing New Zealand Corporation (HNZC). The strategy aims to address concerns in the housing sector, including affordability, quality and sustainability. It is linked in to other government strategies, including the New Zealand Energy Efficiency and Conservation Strategy (NZEECS). There are 10 areas of action, each of which sets out priorities over a short to long-term period including Area 4 - Developing the rental sector and Area 5 - Improving housing quality.

There are four work streams under Area 5 to achieve the vision:

- Implementing Building Act changes and reviewing the Building Code;
- Reviewing current building standards with a view to implement new healthy housing standards;
- Improving the energy efficiency of housing; and
- Encouraging good design and innovation in the building sector.

In order to inform any work done to improve the quality of housing, HNZC, Statistics New Zealand and DBH are scheduled to design and carry out a national housing quality survey by 2015.

2.2 Air quality standards and public health issues

2.2.1 National Environmental Standards for Air Quality 2005

In 2004, 14 National Environmental Standards for Air Quality (AQNES) were set by the Ministry for the Environment (MfE) to improve air quality and associated health outcomes (MfE, 2004b). These standards were developed under section 43 of the Resource Management Act 1991 (RMA). Regional councils and unitary authorities are responsible for enforcement and monitoring of the standards.

There are five ambient (outdoor) air quality standards for contaminants, including one for emissions of fine particles (PM_{10} - particles less than 10 micrometres in diameter) emissions and one design standard for new woodburners in homes.

The design standard for woodburners came into effect in September 2005. From this date, all woodburners[4] installed in dwellings on properties that are less than two hectares in area must achieve a thermal efficiency standard of at least 65 per cent according to Australian/New Zealand Standard AS/NZ 4012:1999 and emit less than 1.5 grams of PM_{10}[5] for each kilogram of dry wood burnt as measured by Australian/New Zealand Standard AS/NZ 4013:1999.

Ambient air quality standards for contaminants are set out in schedule 1 of the AQNES (see Appendix 1). The threshold concentration for PM_{10} emissions is 50 micrograms per cubic metre expressed as a 24-hour average and this must not be exceeded more than once in a 12-month period.

In Auckland, PM_{10} concentrations exceed the limits on a regular basis. In 2007, Auckland exceeded the standard on seven occasions and recorded the second highest 24-hour average concentration of PM_{10} in New Zealand, after Otago (MfE, 2009).

[4] The definition of woodburner does not include: open fires, multifuel heaters, pellet burners, or stoves heated by wood that are used for cooking (MfE, 2004b).

[5] The Proposed Auckland Regional Plan: Air, Land and Water includes a wider requirement for all new solid fuel appliances (including woodburners, multifuel burners and open fires) installed in urban, coastal marine, and industrial air quality management areas to emit no more than 4.0 grams PM_{10} per kilogram of fuel.

Annual PM_{10} emissions in the Auckland region would need to be reduced by 53 per cent (based on 2005 levels) to meet the standard by 2013. Emissions from domestic sources, including home heating, account for about 39 per cent of the annual Auckland PM_{10} total (ARC, 2006a).

2.2.2 Health and Air Pollution in New Zealand Report 2007

The Health and Air Pollution in New Zealand (HAPINZ) study was commissioned, in 2003, by the Health Research Council of New Zealand, the Ministry of Health and the Ministry of Transport with in-kind support from regional councils. The study aimed to:

- Identify effects of air pollution throughout New Zealand and to link the health effects to various sources of pollutants;
- Confirm preliminary research that concluded New Zealanders are suffering significant adverse health effects because of exposure to outdoor air pollution;
- Incorporate up-to-date air quality monitoring, health data and exposure modelling;
- Refine existing analysis techniques and apply new techniques to produce more accurate results;
- Carry out economic impact assessments and develop potential policy options to improve health; and
- Assess potential effects in previously unstudied areas.

The study examined 67 urban areas and included 73 per cent of New Zealand's population. The results, published in June 2007, show that anthropogenic air pollution is associated with approximately 1100 cases of premature mortality per annum, with more than a third of these caused solely by exposure to domestic fire emissions (Fisher *et al*, 2007). It is estimated that the effects from air pollution occur throughout New Zealand – not just in the main cities. The primary sources are home heating nationally, vehicles in Auckland, and industry.

Other illnesses caused by air pollution include:

- 1500 extra cases of bronchitis and related illnesses;
- 700 extra hospital admissions for respiratory and cardiac illnesses; and
- 1.9 million restricted activity days (RADs - days on which people cannot do the things they might otherwise have done if air pollution was not present).

The bulk of effects are associated with pollution from PM_{10}, but there are also effects associated with other pollutants, such as nitrogen dioxide (NO_2), carbon monoxide (CO) and volatile organic compounds (VOCs).

The total economic costs of air pollution in New Zealand (from both premature deaths and adverse health impacts) are estimated to be $1.14 billion per year or $421 per person. However, this figure is based on very conservative estimates and the real figures could be double this value. In addition, the report only covered New

Zealanders aged 30 years or more and therefore missed the effects on children's morbidity that other studies have shown, such as impaired lung development, asthma, and infant mortality.

For the Auckland region, HAPINZ estimates that at least 520 Aucklanders die prematurely every year from air pollution.[6] However, because of the study timing, the estimates were based on the 2001 census data. The authors acknowledge significant population growth has occurred nationally since but that the latest figures were not available in time to be incorporated.

Using the 2006 census data, the Auckland Regional Council (ARC) has updated the calculations to better determine the real impact on Aucklanders and estimates that domestic fire emissions alone are causing 165 premature deaths and 332,300 days being lost region wide every year due to illness or poor health – especially in the young, the elderly and people with heart disease, respiratory disease, asthma and bronchitis (ARC, 2009b).

2.3 Energy and sustainability strategies

2.3.1 Auckland Sustainability Framework 2007

Creating a sustainable future is a significant challenge facing the Auckland region. The Auckland Sustainability Framework (ASF) aims to help our region secure a better quality of life and create a sustainable future socially, culturally, economically and environmentally. It takes a 100 plus year view and provides direction so that our local authorities and central government agencies can work together with a common purpose. This will help us to embrace the opportunities and face the challenges associated with developing a truly sustainable region.

The ASF was ratified by all of the Auckland councils on 5 September 2007 (RGF, 2007) and is built around eight interrelated and long-term "goals":

- A fair and connected society;
- Pride in who we are;
- A unique and outstanding environment;
- Prosperity through innovation;
- Te Puawaitanga o Te Tangata: Self sustaining Mäori communities;
- A quality, compact urban form;
- Resilient infrastructure; and
- Effective, collaborative leadership.

---

[6] Including both anthropogenic (man-made) and background (natural) sources.

Achieving these long-term goals will enable Auckland to take a sustainable development approach to responding to the following forces of change: climate change, unsustainable natural resource use, global economic change, population pressures and demographic change and social disadvantage.

In order to achieve these goals, major "shifts" must occur in our social values and expectations, and systems and processes as follows:

- Put people at the centre of thinking and action;
- Think in generations, not years;
- Value Te Ao Mäori;
- Activate citizenship;
- Create prosperity based on sustainable practices;
- Reduce our ecological footprint;
- Build a carbon neutral future; and
- Integrate thinking, planning, investment and action.

All major policy documents and implementation programmes in Auckland are now required to be evaluated using a "sustainability lens" to highlight how well they are performing against the agreed ASF shifts and goals (RSDF, 2008).

2.3.2 New Zealand Energy Strategy 2007

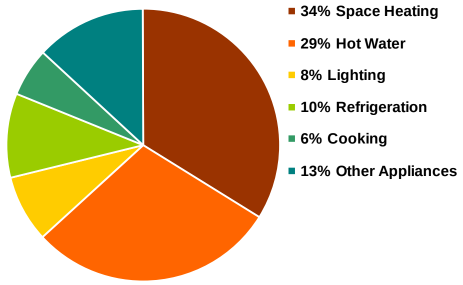
The New Zealand Energy Strategy (NZES) 2007 sets out a vision for energy use in New Zealand to 2050 (MED, 2007). It is part of the government's response to climate change, sustainability and meeting growing energy demands in New Zealand. Development of the strategy has been led by the Ministry of Economic Development (MED). Implementation and action is carried out across government agencies and in partnership with stakeholders in the energy sector.

The strategy outlines an overarching set of actions which emphasises reducing emissions and encouraging efficient energy use. There are six broad areas for action including;

- Resilient, low carbon transport;
- Affordable and accessible energy;
- More efficient energy use;
- A secure electricity supply;
- Low emission power and heat; and
- Sustainable technology and innovation.

One of the affordability and well-being objectives of the NZES is to ensure that "every household in New Zealand should be able to heat and light their home". In order to achieve this, energy use in homes must be more efficient. As seen in Figure 2.1, approximately 63 per cent of current household energy is used for heating hot water or living space in New Zealand homes.

Figure 2.1 Total energy use in households by end use



Source: BRANZ Study Report (BRANZ, 2006)

The NZES encourages insulation retrofitting in houses and the use of renewable clean energy sources for home heating. The goal is that efficient homes will also help to curb growing energy demands, reduce pressure on electricity supply and further reduce harmful and greenhouse gas emissions. Particular targets for homes are detailed in the NZES.

2.3.3 New Zealand Energy Efficiency Conservation Strategy 2007

The second New Zealand Energy Efficiency Conservation Strategy (NZEECS) was completed in October 2007 (EECA, 2007a). It replaces the 2001 Strategy and outlines a detailed action plan for accelerating energy efficiency, conservation and renewable energy programmes across the economy to deliver against the vision set by the New Zealand Energy Strategy. The Energy Efficiency and Conservation Authority (EECA) is the lead and supporting agency.

The NZEECS targets action in five areas:

- Energywise homes;
- Energywise business;
- Energywise transport;
- New Zealand's efficient and renewable electricity system; and
- Public sector leading the way.

The overarching goal of the Energywise homes programme is to "create warm dry homes, improved air quality and reduced energy costs", with success measured against five high-level objectives as follows:

- Improving the performance of existing homes;
- Better products;
- Improving the performance of new homes;
- Better information; and
- Increasing the uptake of household renewable energy.

The 2001 strategy set an objective to retrofit all pre-1977 housing stock with energy efficient measures by 2016 (EECA, 2001b). The updated strategy does not specifically target pre-1977 houses as the previous strategy did. It now aims to upgrade a set number of houses each year. The main actions for the Energywise homes programme and their respective funding organisations are summarised in Table 2.2.

Table 2.2 Energywise homes actions

Action	Details	Delivery
65,000 insulation retrofits for low-income families by end 2012	Energywise Home grants - 12,000 insulation retrofits per annum.	EECA funded
4,000 clean heating upgrades for low-income families in areas of poor air quality by end 2012	800 clean heat upgrades per annum.	EECA funded
15,000 – 20,000 solar water heating systems by end 2010	In the form of information and financial assistance.	EECA funded
Accelerate state house retrofit programme to complete retrofits on 21,000 homes by end 2013	A subsequent decision was announced in May 2008[7] to fast-track the original programme to complete retrofits on the outstanding homes within five years. Retrofit includes insulation of floors and ceilings, hot water cylinder wraps ad pipe lagging	HNZC funded
Minimum Energy Performance Standards (MEPS)	Investigate MEPS for new and existing homes – especially rental properties, at change of occupancy. To be reported on by end 2009.	DBH
Home Energy Rating Scheme (HERS)	Voluntary scheme that came into effect at the end of 2007. Aims to provide incentives to all home owners to make energy efficiency improvements and drive market demand for homes with a high rating. Assessments are carried out by the Association of Building Sustainability Assessors, who retains the findings of the assessments. The scheme may become compulsory in the future.	DBH/EECA
Building code amendments for thermal performance and hot water systems by end 2008	New standards have been written and came into full effect by end 2008[8].	DBH

Source: EECA, 2007a

[7] Media release by Housing Minister Maryan Street, *State House Insulation Programme Fast-tracked*, 15 May 2008, available from www.beehive.govt.nz
[8] These came into effect in Auckland on 30 September 2008.

In May 2009, the government announced an increased funding allocation of $323.3 million over four years for an accelerated campaign to fit homes with insulation and clean heat appliances (EECA, 2009b). The Warm Up New Zealand: Heat Smart programme started on 1 July 2009, and aims to retrofit more than 180,000 New Zealand homes over the next four years. It will be run by EECA, and will replace existing EECA home insulation programmes. More than 180,000 New Zealand homes built before 2000 will have access to grants of up to $1,800 to go towards ceiling and under floor insulation as well as installation of clean heating sources. The programme aims to retrofit 27,500 homes by the end of June 2010, another 40,500 homes in the 2010/11 year, 52,000 in 2011/12, and 60,500 in 2012/13.

Important note: EECA has now expanded the scope of its residential programme to include houses built before 1 January 2000. This followed a programme review and recommendations from funding and installation partners. The Energywise™ funding programme previously only applied to houses built before 1978, when insulation requirements for new houses were introduced. Research showed, however, that a number of post-1978 houses had no or poor insulation, particularly those built in the late-1970s and early-1980s (when the insulation requirement was still relatively recent). Houses with no insulation from the mid-1990s were also identified as needing improvement. About 1.2 million of the 1.6 million homes in New Zealand were built before 2000. One third of these have inadequate insulation.

All home owners with homes built before 2000 are eligible and can get funding assistance to install:

- Ceiling and underfloor insulation, up to a required standard. Both must be installed, if possible, to qualify for funding.
- A clean, efficient heating device in the primary living space, if the primary living space does not already have a heating device that meets current standards. Home owners are only eligible for funding for the installation of clean heating if their home's insulation meets the required standards.
- The following energy efficiency measures where necessary: a hot water cylinder wrap, pipe lagging, draught-stopping, and a ground moisture barrier.

EECA provides funding to the levels outlined below:

- All owners of houses built before 2000 are eligible for 33 per cent of the total cost of insulation up to $1,300 (including GST) and $500 (including GST) towards a clean heat appliance.
- Home owners who hold community services are eligible for a grant up to 60 per cent[9] of the total cost of insulation and $1,200 (including GST) towards a clean heat appliance.

[9] In some regions, the total finding given to Community Services Card holders may be higher, where third party funding from charities, lines companies or councils is provided. EECA advises home owners to ask their local provider what they offer.

- Landlords with tenants who hold community services are eligible for a grant up to 60 per cent of the total cost of insulation and $500 (including GST) towards a clean heat appliance.

In the first month of operation of the scheme – July 2009 – 3282 homes had been retrofitted, with a quarter of these being in Auckland.[10]

[10] Article by Anne Gibson, NZ Herald, *North Warms to Subsidised Insulation*, 20 August 2009, available at www.nzherald.co.nz/nz/news/article.cfm?c_id=1&objectid=10591850

3 Features of the Auckland housing stock

There are many factors that interact to determine the warmth, energy efficiency and heating method in a home including:

- The climate of the area,
- The type of housing,
- The maintenance of the house,
- The tenure of the occupant,
- The architectural style and construction of the house,
- The age of the dwelling,
- The occupant's socio-economic status,
- The occupant's behaviour.

This section explains how these factors have influenced the profile of housing stock across the Auckland region and what this means in terms of insulation levels, home heating methods, energy use and environmental effects. Section 3.1 outlines the sources of data used in this analysis. Sections 3.2 and 3.3, respectively, look at the physical and socio-economic influences affecting the quality of housing in the Auckland region. Section 3.4 looks at the effects of cold homes and inefficient heating on the region's residents.

3.1 Data sources used in this report

There is no single source of information available to establish the insulation levels and heating appliances in houses in the Auckland region. In New Zealand, most recent studies and surveys on housing condition, heating and insulation have not had very large sample sizes. Nationwide studies have only included a small number of Auckland houses, which limits the understanding of the condition of the Auckland housing stock. Nevertheless, by using a range of data sources a general idea of the status of insulation in Auckland houses can be gained.

The largest datasets available are the censuses conducted nationally on a five-yearly basis (Statistics NZ, 2009). The latest census - Census 2006 - did not specifically ask about housing quality or condition, but the information that was useful in understanding living conditions and associated trends in New Zealand. Respondents were asked to specify the type of dwelling they live in, what types of fuel are used in the household and a range of questions about household type, income and tenure.

The ARC undertook a comprehensive study of heating in Auckland homes in 2007 (ARC, 2009a). The Auckland Home Heating Survey 2007 aimed to provide detailed understanding of the factors influencing home heating emissions in order to develop management strategies to improve Auckland's wintertime air quality, particularly in order to meet the National Environmental Standards for Air Quality (AQNES). Approximately 7200 households across the region were surveyed and asked a range of questions about fuel types, heating habits and attitudes, as well as a question about the age of the dwelling.

The Building Research Association of New Zealand (BRANZ) have carried out a Housing Condition Survey - firstly in 1994, then 1999 and most recently in 2005 (BRANZ, 2005a). Assessors inspected 306 privately owned, stand-alone houses in areas covered by four territorial authorities (TAs) of the Auckland region – Auckland city, Manukau city, Waitakere city and Rodney district. There are some limitations to the data collected. Firstly, the demographics of the groups in the BRANZ survey did not match the demographics of the groups in the 2001 Census. Secondly, assessment of the house condition was based on the assessor's subjective judgement. Nevertheless, the survey does provide a good overview of the general condition of housing. The results can be compared with previous survey findings and other studies.

The findings of the BRANZ Household Energy End-use Project (HEEP) were also used in this report. The HEEP study is into its tenth year. The project involves monitoring of energy use and temperatures in approximately 400 privately owned houses nation-wide (BRANZ, 2006). Insulation levels and age of houses in the project are used to compare the energy use in pre and post 1978 houses.

As part of the Warm Homes Project, the Ministry for the Environment (MfE) carried out a phone survey of 151 households in December 2004 (MfE, 2005a). However, there are some limitations in collecting data on insulation levels from occupants as often they do not know or cannot tell if there is insulation in the dwelling so caution needs to be applied when comparing results from these surveys with others involving inspection.

The Housing and Health programme, He Kainga Oranga, is a research group dedicated to examining the links between housing and health. It is part of the University of Otago's Wellington School of Medicine and Health Sciences. The two studies referred to in this report are the Housing, Heating and Health (HHH) Study and the Housing, Insulation and Health (HIH) Study.

The HIH Study was carried out over winter 2001/02. The study involved 1400 households in seven areas nationwide, including Otara (a suburb in south Auckland). All households were monitored during the first winter, and then half were given insulation upgrades in the following winter. The study showed improvements in indoor temperatures and the health and well-being of occupants (Howden-Chapman *et al,* 2007).

The HHH Study was carried out over 2005/06 and involved 412 households with asthmatic children selected from the initial 2001/02 study. All households had insulation and were monitored during the winter of 2005. An intervention group was then given clean heat upgrades and monitored again over winter 2006. The study found further improvements in indoor temperatures and reductions in the frequency of asthma attacks, hospitalisation and the numbers of days off school (Howden-Chapman, 2006).

Quotable Value New Zealand (QVNZ) collects a range of information about housing in order to determine its rateable value. Building age information is usually included and this is now available for just over half the dwellings in the region (QVNZ, 2009). This information has been used to map the age of houses across the region to identify where large areas of pre-1978 houses exist, that may not have adequate insulation and/or may be using open fires which are inefficient and pollute more.

The Real Estate Institute of New Zealand (REINZ) provides an online service which generates statistics on sales and property prices in New Zealand. This service has been used to generate tables showing the number of sales in the region and the location of sales shown in Appendix 4 (REINZ, 2009).

There are a number of existing programmes being run in the Auckland region to retrofit housing with insulation and other energy efficiency measures. Data have been collected from these organisations (where possible), to indicate the number of pre-1978 houses that have received upgrades.

EECA has provided statistics for this report regarding the number of houses in the Auckland region that have been insulated by the Energywise programme. They have provided information on the total number of retrofits to end March 2009, with detailed information available for the period mid 2006 to end 2008 in terms of socio-economic factors, tenure, and health referrals.

The Ecomatters Trust in Waitakere is one of the providers of insulation retrofits in the region. They are partly funded by the Energywise programme. They have provided a further breakdown of retrofits completed between 2004 and 2007.

HNZC has provided information about the age of state owned housing in the region and the number of houses insulated to March 2009 under their programmes. Good quality data have been difficult to obtain owing to changes in data collection methods.

The idea of housing quality is subjective and difficult to measure. The physical condition of a dwelling is often referred to when discussing housing quality. This measurement is based on the dwelling's age, maintenance and whether or not the construction meets a set of standards. This gives quantifiable results, but other aspects of housing quality are about experience, perceptions and behavioural responses to the house environment. These are more difficult to measure but are equally as important.

A Dunedin survey of private rental housing established a set of reasonable and tolerable standards to measure housing quality (Presbyterian Support Otago, 2005). These were based on the English and Scottish House Condition Surveys.[11] The four sets of standards were Safety, Soundness, Value and Suitability.

[11] The English House Condition Survey can be found at www.communities.gov.uk/housing/housingresearch/housingsurveys/englishhousecondition/ and the Scottish House Condition Survey can be found at www.scotland.gov.uk/Topics/Statistics/SHCS

The standards for Soundness were:

- weather tightness
- no signs of internal dampness
- all rooms have adequate ventilation
- living areas can maintain a healthy temperature
- some energy efficiency measures are in place, and
- thermal comfort is provided in the form of carpets and thermal drapes (Presbyterian Support Otago, 2005).

It is useful to consider the various understandings of what constitutes quality in housing when considering current housing condition.

3.2 Physical influences on housing condition in Auckland

Many physical factors influence the condition of local housing such as the harshness of the climate, improvements in housing design and construction, and settlement patterns. An understanding of the types of housing and construction forms in the region is important, as it can indicate the ability and need to improve them.

3.2.1 Climatic conditions

Climate is one of the main deciding factors in the heating and cooling requirements of a house and the physical condition of a house. Houses in cooler climates will need more heating than those in warmer climates. Climate should determine how a house is constructed, including levels of insulation, solar energy use, ventilation and glazing.

Auckland has warm humid summers with mild winters. The average summer temperature ranges between 22 and 26°C. The winter temperature range is 12 to 17°C. In winter, Auckland is five to seven degrees warmer than the South Island. June, July and August are usually the coldest and wettest months. The prevailing wind is south-westerly in winter and turns north-easterly in summer. Auckland is slightly more humid than other parts of the country. The maximum winter rainfall is about 130mm, usually in July (NIWA, 2007).

3.2.2 Architectural style

Architectural style refers to the classification of buildings according to their appearance, structure, materials, and historic period.

Different architectural styles provide different levels of thermal resistance. Other important variables that influence heat loss and warmth are the number and type of doors and windows, orientation, size and volume. These factors affect the level of intervention required to make a house warm and dry and the effectiveness of any retrofits.

A range of architectural styles can be found in Auckland and the location of these is a reflection of the historical growth and development of the region. The oldest houses in the region are villas built between the 1890s and 1910s (Figure 3.1).[12] Owing to the local climate, ventilation was considered to be important so they are not usually airtight. These houses are typified by their all timber construction, high stud height, suspended wooden floors (designed to be carpeted), and lack of orientation towards the sun. Open fires provided heating in these houses. Villas and cottages were not built with insulation and the materials used have low r-values. This is why these houses are often cold and damp.

Figure 3.1 Example of an Auckland villa built in the 1900s

Source: B. Parfitt

Between 1910 and 1930, bungalows became the popular house building style (Figure 3.2). Construction methods are similar to the villa, although in Auckland some were built of masonry and finished in plaster. Ceilings are typically lower in bungalows (Cooke, 1972). Due to their construction, villas and bungalows are usually quite easy to retrofit with insulation.

Figure 3.2 Examples of Auckland houses built in the 1920s and 1930s

Source: B. Parfitt

[12] There are older houses than this, mostly cottages, but they are not very common.

In the 1930s and 1940s house style became more diverse. Construction was simplified and houses became smaller as a result of the depression and material shortages during World War II (WWII). The use of concrete and stucco became popular. In Auckland, many blocks of flats were built in this style. The 1930s also marked the beginning of the state housing programme. Large suburbs of state houses, such as those in Orakei, Glen Innes and Mt Roskill were constructed across Auckland. Most were either stand alone or semi-detached houses.

In the 1950s, post WWII, housing design was influenced by modernist architecture (Figure 3.3). Orientation towards the sun, size and scale became important. Around this time, there was some improvement in fireplace technology and awareness about insulation began to grow. Insulation was available in the form of slag wool (or loose fill) which could be installed in the roof cavity and walls (Rosenfeld, 1953). However, insulation was not widely used and where it has been used the condition has often deteriorated over time.

Figure 3.3 Examples of Auckland houses built between the 1950s and 1970s prior to the 1978 insulation standard

Source: B. Parfitt and K. Mahon

The majority of houses in New Zealand and Auckland were built after WWII between the 1950s and 1970s (CHRANZ, 2004a). The peak building period was the 1970s (BRANZ, 2007a), just prior to the introduction of the national insulation standard. Nearly a third of dwellings in the 1960s and 1970s were multi-unit dwellings (BRANZ, 2007a). This reflected key socio-demographic changes that occurred in New Zealand in the 1960s and 1970s.

By the 1960s, home building technology had advanced greatly. A greater variety of home heating options were available and there were several different types of insulation available, including loose fill, aluminium foil and fibreglass Batts®. As insulation was not compulsory at this time, it is difficult to quantify the number of pre-1978 homes with insulation. In general, these houses are found to be reasonably warm and dry, in part due to construction methods and design. From the late 1960s, concrete slab floors became more common but these were not usually insulated. Technology and new building standards continued to improve housing quality in the 1970s and 1980s (Figure 3.4).

Figure 3.4 Examples of Auckland houses built in the 1980s and insulated to the 1978 standard

Source: B. Parfitt

The introduction of monolithic cladding in the early 1990s gave rise to the 'leaky building syndrome' and has meant that many houses built during this period also have problems with cold, mould and dampness. Construction of new houses peaked in the 1990s (BRANZ, 2007a). Since the advent of leaky buildings together with increasing concerns about energy efficiency, house construction has started to improve again.

The average floor area of new houses has increased (BRANZ, 2007a). Despite this, they are noticeably warmer as a result of better orientation, insulation and heating. The quality of houses today is still variable, even though much higher standards of construction are expected. It does not always follow that newer houses will be warmer or use better heating devices. Factors such as preferences in heating, design, quality and cost of construction and other topographical and climatic variables will also determine the warmth of a new home.

Technological improvements and availability of products have not been enough to drive energy efficiency or green building improvements (MfE, 2005b). This may be because of costs, lack of awareness and understanding of the issues around home heating, warmth and sustainability. Consequently, concerns about housing quality and energy use have led to tighter building controls and the need for government intervention.

3.2.3 Settlement patterns

Settlement patterns can indicate where different types and ages of houses can be found. The oldest settlements have the oldest (and often coldest) houses (HNZC, 2005). In Auckland the volcanic topography meant that early house building occurred on the less sloping parts of Auckland, such as Ponsonby, Mt Eden, Arch Hill and Onehunga. Housing development continued to grow outwards as rapid passenger transport networks improved.

Post WWII saw dramatic growth and change in the region. New housing occurred along motorway corridors built in response to the increase in private vehicle ownership. Areas such as Papakura and Waitakere experienced rapid growth over the following 20 years. The harbour bridge also opened large areas of land for housing development on the North Shore. Although new house construction has slowed in the last 20 years, the Auckland region is still experiencing high growth. Nationally, building trends show that more new residential building has occurred in warmer climates post 1978 and this is expected to continue (CHRANZ, 2004a). This is reflected in the high growth rates in parts of the Auckland region. Most new growth is still directed to "green field" developments. Nevertheless inner city living has become popular again and this has led to the renovation of many inner city buildings and houses as well as the construction of new apartment and townhouse buildings.

In New Zealand, 29.6 per cent of housing is located in the Auckland region. From Census 2001 to Census 2006, the number of occupied dwellings in the Auckland region increased by 11.2 per cent (an extra 44,265 houses) to 439,080 in total as shown in Table 3.1. Auckland and Manukau cities experienced the greatest increase in actual numbers. But the fastest growing areas were Rodney district, followed by Franklin district. As new houses have to comply with higher standards for energy efficiency, these areas will have a higher proportion of houses with energy efficiency measures.

Table 3.1 The change in total occupied dwellings across the Auckland region from 2001 to 2006

Territorial Area	2001	2006	Change 2001 to 2006 in numbers	Change 2001 to 2006 in %
Auckland City	132,933	145,572	12,639	9.5
Manukau City	83,826	95,121	11,295	13.5
Waitakere City	56,172	62,355	6,183	11.0
North Shore City	66,609	72,762	6,153	9.2
Rodney District	28,668	33,444	4,776	16.7
Franklin District *	17,730	20,421	2,691	15.2
Papakura District	13,560	14,934	1,3741	10.1
Auckland Region	394,815	439,080	44,265	11.2

* These figures are for the whole of Franklin district which is split between the Auckland and Waikato regions.

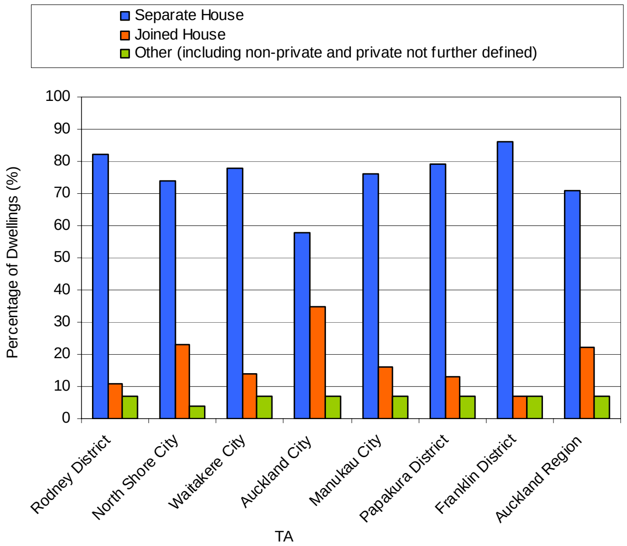
Source: ARC, 2007

3.2.4 Housing type

The type of dwelling determines the ability or need to retrofit. It can also signal the type of heating and level of insulation that may be found therein. Stand-alone houses are generally easier to retrofit than joined houses.

Stand-alone or separate houses account for 71 per cent (311,109 dwellings) of all housing in the Auckland region from the 2006 Census. Although separate houses are the dominant housing type for all areas, the proportion varies by TA. Only 58 per cent of Auckland city houses are defined as separate houses. Whereas the highest number of separate houses are found in Franklin (86 per cent) and Rodney (82 per cent) districts (Figure 3.5).

Figure 3.5 Dwelling type across the Auckland region

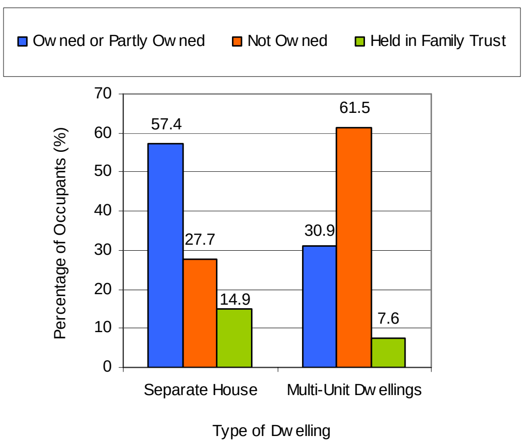


Source: 2006 Census – Statistics NZ

Joined dwellings account for 23.9 per cent (98,457 houses) of the Auckland region's housing stock. Auckland city has the highest proportion of attached houses (35 per cent). This is accounted for by inner city intensification including the growth in the number of high-rise apartment buildings. Franklin district had the least number of attached dwellings (seven per cent).

Intervention can be more difficult where houses are attached. There are two reasons for this. Firstly, the construction methods of purpose-built attached housing typically differ from separate houses. Shared walls and roofs can make it difficult to divide costs and get permission from occupants to undertake upgrades. Secondly, attached houses are more likely to be rental properties (Figure 3.6).

Figure 3.6 Tenure by dwelling type in Auckland



Source: 2006 Census – Statistics NZ

The way houses are attached also determines the need and ability to retrofit. Attached houses have fewer external walls. Medium and high rise housing in particular may only have one external wall and an internal roof. Therefore there is little need or ability to retrofit these houses.

The number of storeys is a good indicator of the age of a building and how much of the building envelope may be exposed. In the Auckland region, 52 per cent (approximately 50,000) of attached houses are one storey (Table 3.2). This includes older homes converted in flats, purpose-built flat blocks and townhouses, and houses attached to shops.

Table 3.2 The 10 Auckland census area units (CAUs) with the highest number of attached dwellings in one storey buildings

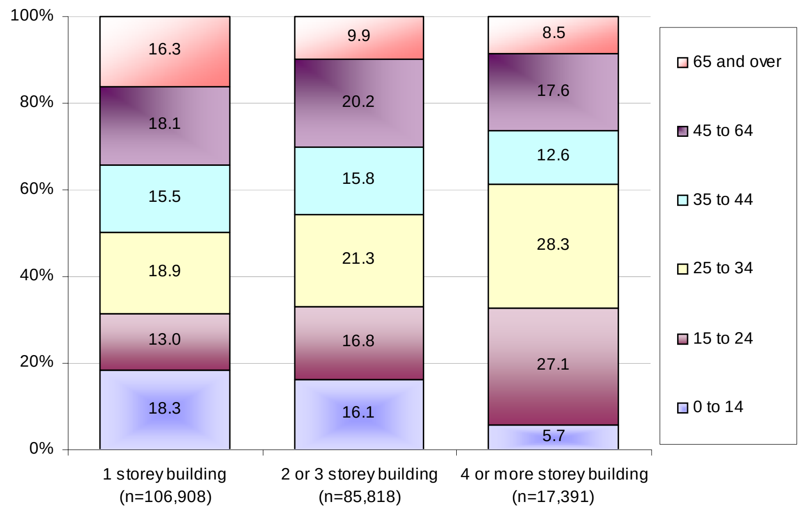
Census Area Unit	No. of One Storey Attached Buildings
Mt Wellington North	762
Onehunga North West	654
Papatoetoe Central	597
Westlake	582
Orewa	561
Lake Pupuke	471
Ellerslie North	459
Papatoetoe North	438
Onehunga North East	429
Balmoral	420
Three Kings	390
Sandringham West	387

Source: ARC, 2008a

One storey attached houses tend to be in more established areas, which implies that they are likely to have been built before 1978. A large number of one storey multi-unit dwellings were built in the 1970s prior to the introduction of the insulation standard (BRANZ, 2007a).

One storey flats and apartments also have the highest proportion of children and older people living in them (ARC, 2008a). As can be seen in Figure 3.7, 16.3 per cent of occupants living in one storey flats and apartments are aged 65 and over and 18.3 per cent are under the age of 15.

Figure 3.7 Occupant age breakdown by housing type, for all those living in flats and apartments in the Auckland region

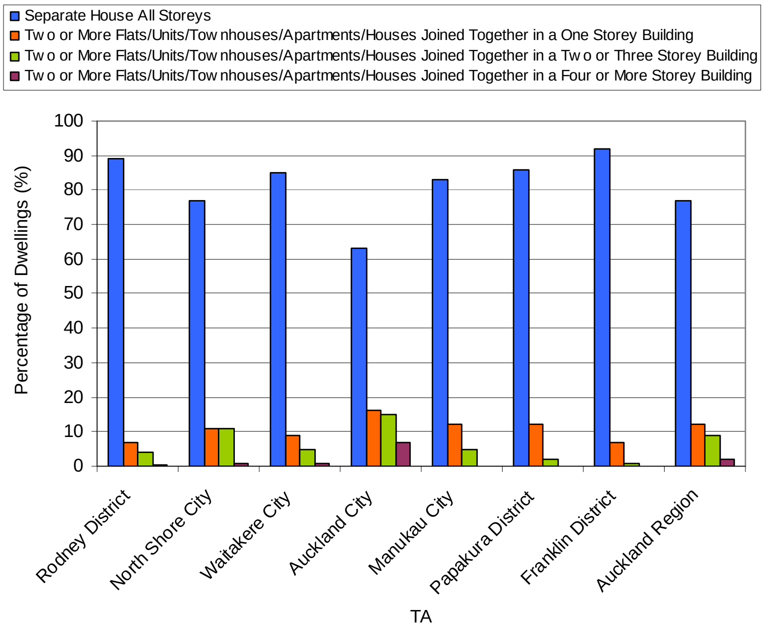


Source: 2006 Census – Statistics NZ

Two or three storey buildings constitute 37 per cent (36,558) of attached housing. These are a mixture of ages and styles, depending on where they are located. Where houses are attached vertically, not horizontally, i.e. one house per storey, they are more difficult to retrofit. However, houses which are attached horizontally (i.e. two or more stories per house) and are built prior to 1978 are usually candidates for retrofitting. The majority of these multi-storey dwellings are found in Auckland city (19,602 dwellings). North Shore city has the second highest number (7875 dwellings). These are mostly found in developments built in the 1990s and 2000s, such as Albany and North Cross, and therefore they should have good levels on insulation.

Figure 3.8 shows that only two per cent (9876 houses) of the Auckland housing stock are high-rise (four storeys or more) multi-unit housing. Of these, 89 per cent are located in Auckland city. As these are associated with recent intensification, they should meet the minimum insulation standard and therefore they are not candidates for insulation retrofits.

Figure 3.8 Private occupied houses by type across the Auckland region



Source: 2006 Census – Statistics NZ

3.2.5 Dwelling age

The age of a house is an important factor in establishing insulation levels and the types of heating devices a house may have. Most pre-1978 houses do not have full insulation and are likely to be using a polluting heat source, such as an open fire.

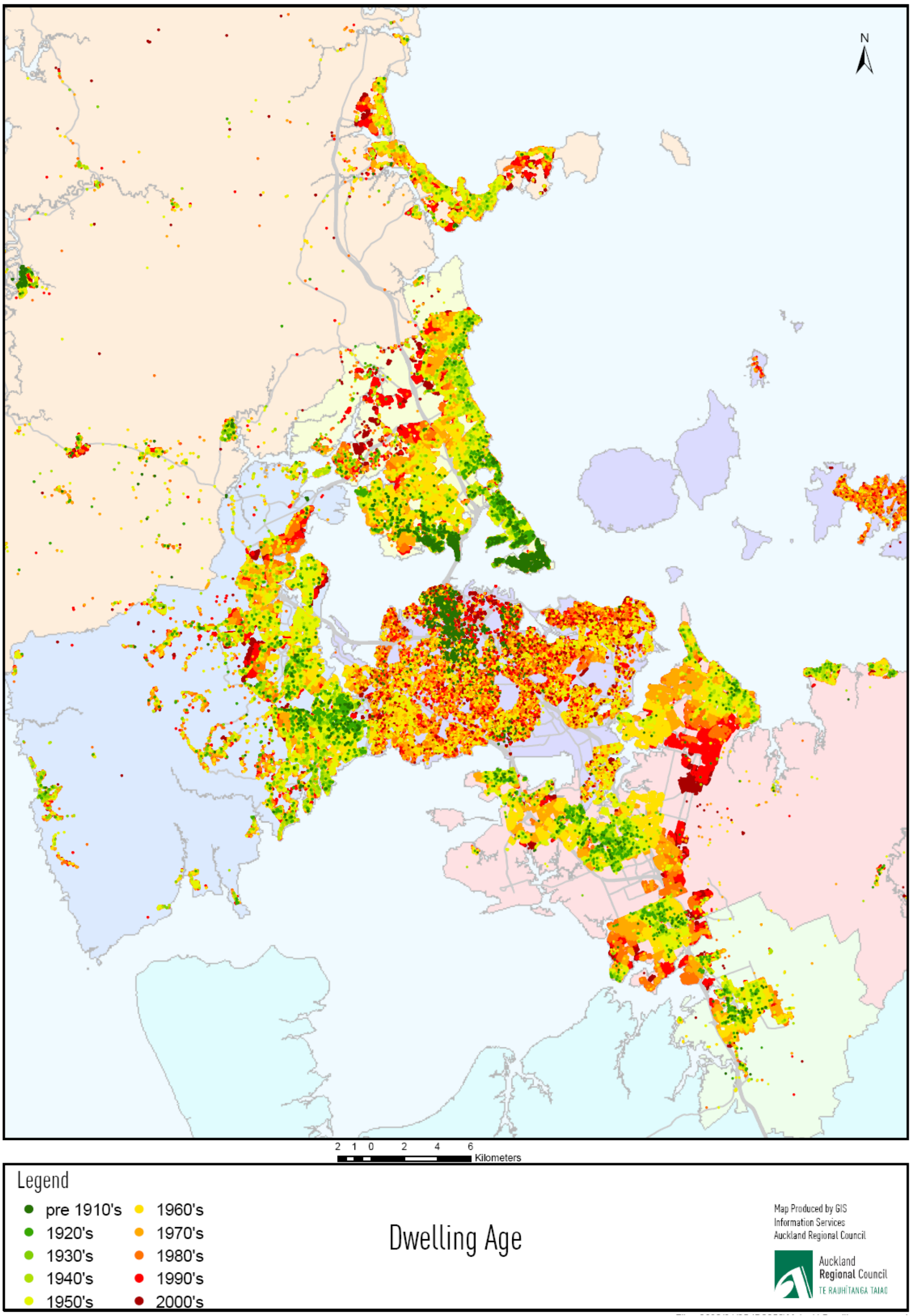
Papakura district, Manukau city, North Shore city, Franklin district, and Waitakere city all have over 50 per cent of their housing stock built between 1950 and 1980 (see Figure 3.9). Most TAs in the Auckland region have less than 10 per cent of their housing stock built prior to 1930. The exception is Auckland city, which has over 15 per cent of houses that are this old (CHRANZ, 2004a). In Rodney district, nearly 60 per cent of housing was built after 1980. Franklin and Papakura districts also have a younger housing stock as a result of relatively recent development and growth (CHRANZ, 2004a).

Generally, the condition of a house steadily decreases as it ages (BRANZ, 2005a), until it gets to the point where the house is demolished or renovated. Notwithstanding this, the oldest houses are not always those in the worst condition. Renovating older houses has been popular pastime for New Zealand home owners. These, changes are often limited to interior improvements and external maintenance (CHRANZ, 2004a). Energy efficiency upgrades are often overlooked.

The demolition and major refurbishment rate for Auckland houses has been estimated by BRANZ to be 1606 houses in 2007 (BRANZ, 2007a). This is expected to increase to 2253 in the next 10 years. Major refurbishment usually applies to the oldest housing stock (BRANZ, 2007a).

Figure 3.9 Dwelling age across Auckland region

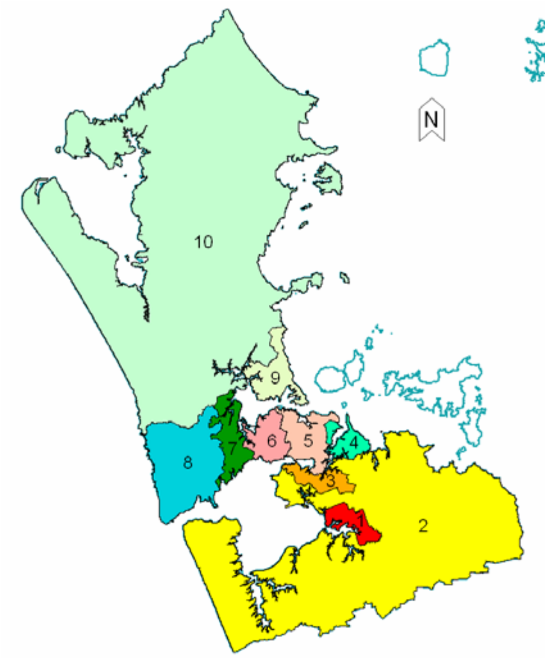
Excludes: Mixed age (defined as houses that have been altered and built date is no longer relevant) and age unknown.



Source: QVNZ rates database

The Auckland Home Heating Survey 2007 surveyed 7200 household across the Auckland region regarding home heating habits, levels of insulation and also dwelling age (ARC, 2009a). The region was broken down into 10 areas as shown in Figure 3.10.

Figure 3.10 Map of areas surveyed in the Auckland Home Heating Survey 2007 (ARC, 2009a)



Key to Areas

1 Papakura District - PD

2 Franklin District - FD

3 Manukau City South West - MC (SW)

4 Manukau City North East - MC (NE)

5 Auckland City East - AC (E)

6 Auckland City West - AC (W)

7 Waitakere City East - WC (E)

8 Waitakere City West - WC (W)

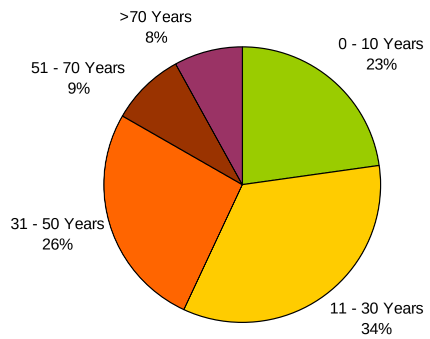
9 North Shore City - NSC

10 Rodney District - RD

Note: ARC Home Heating Survey 2007 areas do not align exactly with the TA boundaries but are considered representative of the housing of their designated area.

The survey found that 43 per cent of respondents lived in houses that were built prior to the 1978 insulation standard, with 26 per cent living in homes built between 1957 and 1977 (see Figure 3.11).

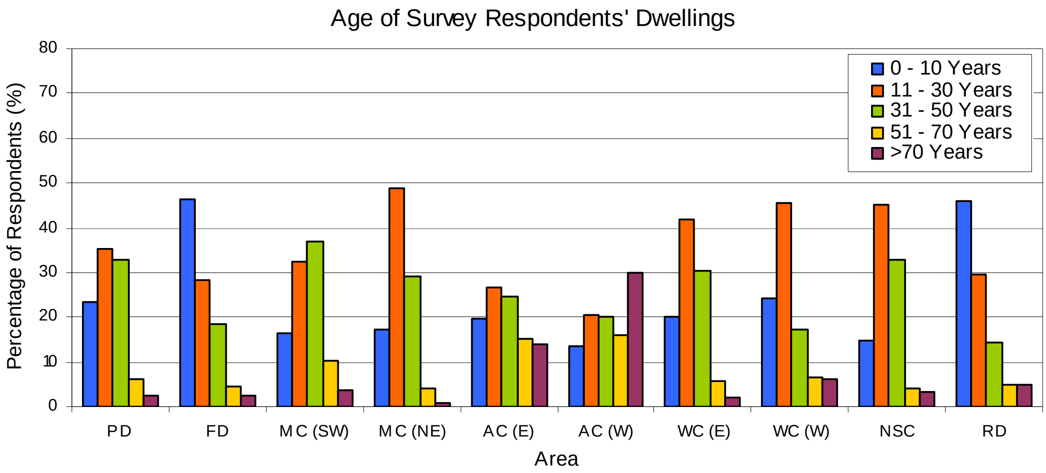
Figure 3.11 Age of Auckland dwellings in 2007



Source: ARC, 2009a

The highest proportions of houses aged 31 years or more (that is built pre-1978) were found in survey areas 5 and 6 – Auckland city (see Figure 3.12). The highest numbers of new houses were found in areas 2 and 10 – Franklin and Rodney districts.

Figure 3.12 Age of dwellings across the Auckland region in 2007



Source: ARC, 2009a

3.3 Socio-economic influences on housing condition in Auckland

Many socio-economic factors influence the condition of local housing and the subsequent impact on energy use, such as changes in the population, household size, occupant age, income and tenure (MfE, 2002).

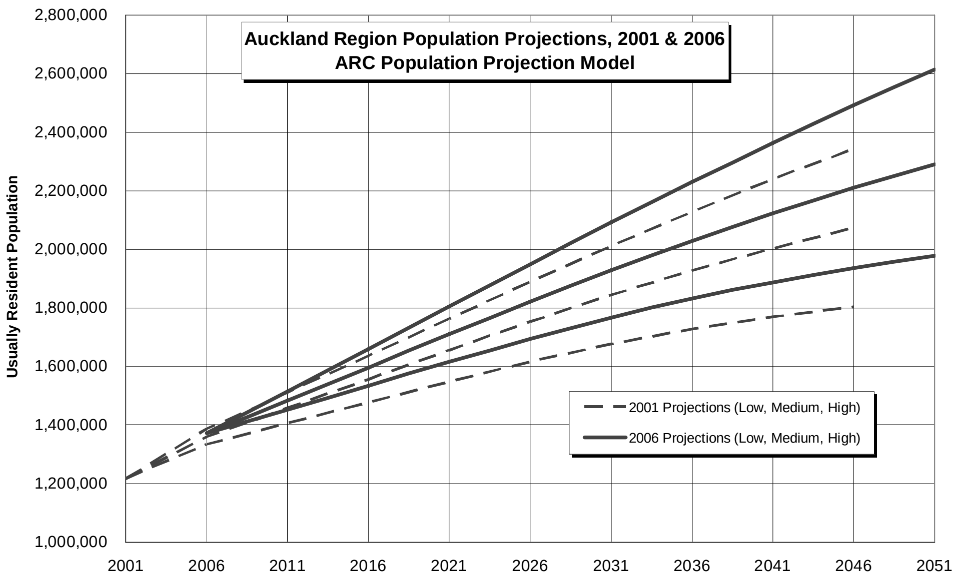
3.3.1 Population growth and housing demand

It is predicted that energy use will rise due to population growth and demographic changes (CHRANZ, 2006). Based on current projections, the Auckland region's population is estimated to increase from 1.3 million to 2.3 million people by 2051 (as shown in Figure 3.13). The population growth will bring with it an additional 350,000 dwellings, 1.2 million jobs and, undoubtedly, a correspondingly significant increase in energy demand.

Trends in the Auckland housing market suggests that demand is outstripping supply in housing (CHRANZ, 2007). Regional growth trends, affordability issues and housing shortages may result in an increase in the life-span of older houses. If these houses are not in good condition, they will have a negative impact on the health of communities and energy efficiency in the Auckland region.

It is reported by social agencies that when there is a short supply of accommodation, people are more willing to take whatever is available (Presbyterian Support Otago, 2005). For low-income earners, limited ability to compete in the housing market means that they are more likely to end up in poor quality housing.

Figure 3.13 Population projections for the Auckland region



Source: ARC

3.3.2 Occupant age and income

Low-income earners, children and elderly people are most vulnerable to health problems resulting from living in cold homes. In addition, households with children and elderly occupants usually have the highest energy use (Wilson, 2006) and it is these household types that are increasing in Auckland.

The population of Auckland is aging. However, due to migration and a slightly higher proportion of younger people, Auckland's population is aging differently to the rest of New Zealand (Table 3.3).

In the Auckland region, only 9.9 per cent of the population is aged 65 years and over. However, the region has the highest number of residents over 65 years of age (ARC, 2007). Older people are usually on fixed incomes. This limits their ability to maintain or improve the warmth of their house (BRANZ, 2007d).

The Auckland region has a slightly higher percentage of children aged 0-14 years than the rest of New Zealand. Manukau city has the highest proportion at 26.2 per cent (ARC, 2007). Households with children are the highest energy users (Wilson, 2006). In the Auckland region, 65.2 per cent of households have children (46.3 per cent are couples with children and 18.9 per cent are single parent with children households).

Table 3.3 Proportion of Auckland's population by age group and area

Territorial Area	Total Population (number)	0-14 years (%)	15-64 years (%)	65 years plus (%)	Total (%)
Rodney District	89,562	21.9	63.2	14.9	100
North Shore City	205,614	19.8	69.3	10.8	100
Waitakere City	186,444	23.7	67.0	9.3	100
Auckland City	404,655	18.8	71.6	9.6	100
Manukau City	328,980	26.2	65.4	8.3	100
Papakura District	45,174	25.0	64.9	10.1	100
Franklin District *	58,935	24.6	65.0	10.5	100
Auckland Region	1,303,062	22.1	68.0	9.9	100
New Zealand	4,027,953	21.5	66.2	12.3	100

* These figures are for the whole of Franklin district which is split between the Auckland and Waikato regions.

Source: ARC, 2007

Maori and Pacific Island children living in Auckland have high rates of asthma, bronchitis and pneumonia (ARFNZ, 2006). Cold, damp and mouldy housing has been cited as a leading cause of asthma and other respiratory problems.

Income is a key factor in the ability of a household to create a warm, dry and healthy home. Nevertheless it does not necessarily follow that higher income households are warmer. The warmth of higher income homes is influenced by preference, rather than necessity (MfE, 2005b). For lower income households, income and expenditure on energy are more closely linked. Poverty affects both indoor and outdoor air pollution, because low-income households rely on cheap fuel and heating methods, which are usually unclean (Wilson, 2006).

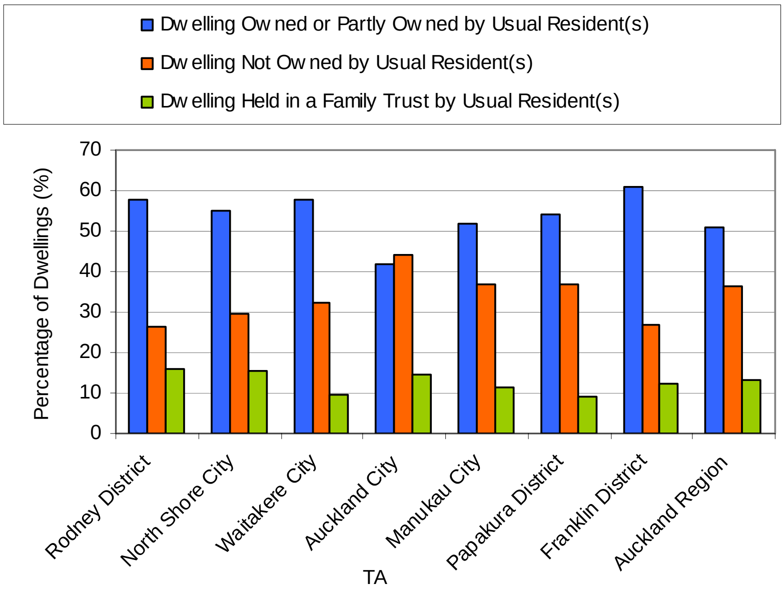
Children in lower socio-economic households are more at risk from the health effects of cold, damp housing (Howden-Chapman, 2004). Approximately 29 per cent of New Zealand children are living in poverty (ARFNZ, 2006). This percentage would be considerably higher in parts of the Auckland region which have high levels of social deprivation (see Appendix 2).

3.3.3 Tenure

Tenure affects the ability of households to improve the condition of their dwelling. Those with the least ability to change their house conditions are renters, who cannot change their houses much without the permission of their landlords, and home owners on low or fixed incomes.

Tenure patterns are changing in the Auckland region, with fewer households owning the house they live in. Most Aucklanders (63.8 per cent) still own or partly own the house they live in.[13] The Census 2006 found that 36.2 per cent of residents did not own the house they live in. In the past 10 years home ownership has dropped by 10 per cent. Ownership patterns vary across Auckland as shown in Figure 3.14.

Figure 3.14 Tenure of dwellings across the Auckland region



Source: 2006 Census – Statistics NZ

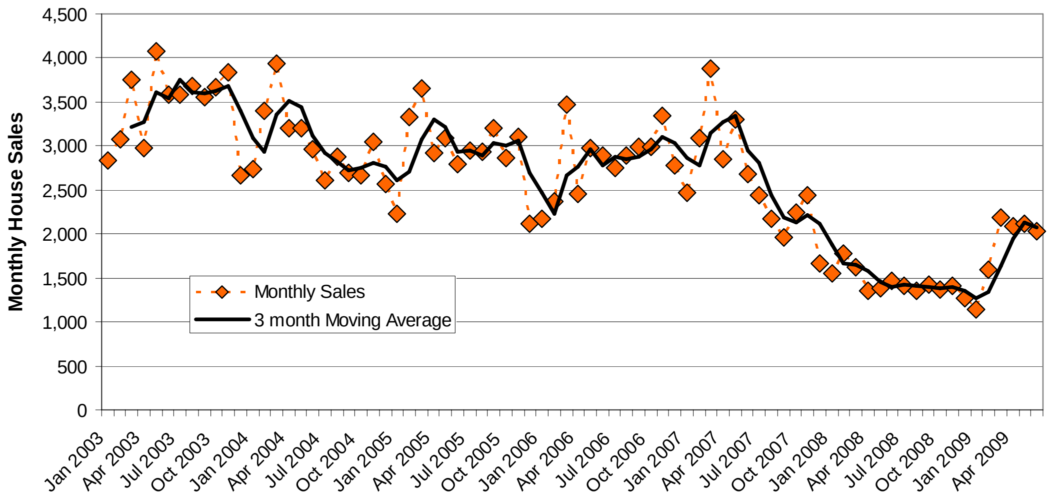
Increasing house prices have meant that recent home owners have more capital tied up in the purchase of their house and less left over for improvements. The rapid rise in interest rates from 2003 to early 2008 reduced disposable household income and limited the ability of first time buyers to enter the market. Since peaking in mid-2008, rates have fallen dramatically and it is expected that housing affordability will improve and there is already anecdotal evidence that housing improvements are on the rise as people choose to stay put and invest their money in their current property, making it more liveable.[14]

The numbers of sales in the Auckland region varies month by month as shown in Figure 3.15 (REINZ, 2009).[15] Annual sales fell from a peak in 2003 of 41,288 homes to average around 34,000 homes for the period 2004 to 2007. The housing market then experienced a sharp drop in 2008 in response to the economic recession with sales levelling off at 17,384 homes per year (see Appendix 4 for detailed sales data breakdown by area). The latest figures for 2008 translate into a turnover of 4.0 per cent of the total Auckland housing stock per annum, which is just over half of the trend of 7.7 per cent recorded for the period 2004 to 2007. Recent months have shown a rebound in the housing market but numbers appear to be holding stable at around

[13] The question about tenure in the Census was changed in 2006, to include homes owned in trusts.
[14] NZ Herald (2008). *Renovations likely to boom in gloom*, 4 December 2008, available at www.nzherald.co.nz/house-building/news/article.cfm?c_id=228&objectid=10546413
[15] This does not include private sales, only those through REINZ members and may count some properties twice due to turnover.

2000 sales per month – up from the trough of 1500 sales per month but still substantially down on the peak of 3500 per month. It is likely that the turnover rate will remain at current levels for the coming year at least before it gradually recovers.

Figure 3.15 Monthly house sales in Auckland 2003-2009



Source: REINZ, 2009

The rental sector has been identified as "pivotal to success of the warm homes project" (MfE, 2005b). The condition of rental properties is generally not as good as owner-occupied houses. Many landlords rent out older properties that they intend to eventually demolish or redevelop, so they are often not interested in upgrading.

The 2004 national survey of private landlords found that 58.3 per cent of the rental houses were over 30 years old.[16] Only 12.6 per cent were built in the past 10 years (CHRANZ, 2004b). Stand-alone dwellings accounted for 66 per cent of the rental properties in the survey, 32 per cent were purpose built apartments, flats or units and two per cent were dwellings divided in to flats.

Approximately 45 per cent of rental properties are owned by private landlords (see Table 3.4). Most private landlords are small investors, who own rental property for income. This may make intervention easier, as many landlords may only need to undertake one upgrade.

[16] 818 landlords were surveyed. A range of ownership types were represented but it is not known how many were in Auckland.

Table 3.4 Landlords of rented private occupied dwellings in Auckland

	Auckland City	Manukau City	Franklin District*	Rodney District	North Shore City	Papakura District	Waitakere City	Auckland Region **
Private Person, Trust or Business	39,399	18,546	3,408	6,261	15,405	3,135	12,249	98,403
Local Authority or City Council	105	420	90	57	375	57	267	1,371
Housing New Zealand Corporation	9,351	7,071	219	75	1,023	915	2,217	20,871
Other State-Owned Corporation or State-Owned Enterprise or Government Department or Ministry	318	273	66	45	408	72	495	1,677
Not Elsewhere Included	3,774	1,998	261	354	1,080	330	1,002	8,799
Total	52,947	28,308	4,044	6,792	18,291	4,509	16,230	131,121

* These figures are for the whole of Franklin district which is split between the Auckland and Waikato regions.

** The figures for the Auckland region include all of Franklin district and are therefore likely to be slightly over-estimated.

Source: 2006 Census – Statistics NZ

Most landlords surveyed (69.1 per cent) did not have a budget for improvements or maintenance and work done tended to be unplanned. Although some maintenance carried out on properties seemed to be relatively regular (24.6 per cent reported doing maintenance every six months), given the limited budget of most landlords, it is unlikely that this work is more than minor repairs and general maintenance carried out between tenancies (CHRANZ, 2004b).

Anecdotal evidence suggests that about 77 per cent of renters have periodic leases (CHRANZ, 2004b) and that average rental periods are between seven and nine months (MfE, 2005b). Ministry of Housing[17] research (2003) showed that over 50 per cent of tenancies lasted less than 10 months, with 33 per cent ending within six months and 13 per cent being less than three months. Leases tend to be shorter for lower income tenants (HNZC, 2005).

HNZC owns and manages approximately 21,000 houses in the Auckland region. About 57 per cent (about 12,000 houses) of these were built before 1978 (HNZC, 2008).

[17] Now known as the Department of Building and Housing

Auckland and Manukau cities have the highest number of households in publicly owned housing.

3.4 Resulting impact on Auckland housing stock and surrounds

The latest census counted a total of 439,080 occupied dwellings in the Auckland region (Census, 2006).[18] The Auckland housing stock has evolved based on the physical and socio-economic influences outlined in the previous two sub-sections with subsequent impacts on the insulation levels, home heating methods in use, and energy consumption of the homes themselves and the indoor and outdoor quality of their surroundings.

3.4.1 Insulation levels

The perceptions of what constitute warmth and comfort differ between people. Notwithstanding these differing perceptions, linkages between colder and damper houses and poor health outcomes are now well established.

The World Health Organisation (WHO) recommends a minimum indoor temperature of 18°C during winter. For older people, children and other vulnerable groups a higher temperature of 20 to 21°C is recommended (DBH, 2008b). Temperatures below 16°C can hinder respiratory function, strain is placed on the cardiovascular system below 12°C and the risk of hypothermia is increased below 6°C. Risk is higher for vulnerable groups and if exposure to low temperatures occurs over an extended period of time (BRANZ, 2006).

From QVNZ data, approximately 60 per cent of the Auckland housing stock was built before the introduction of the 1978 insulation standard. Based on the 2006 Census figure of 439,080 homes across the region, this translates to 262,810 homes Auckland wide.

Levels of insulation have been estimated in a range of studies as follows.

The Building Research Association of New Zealand (BRANZ) Housing Condition Survey in 2005 assessed the condition of 306 privately owned, stand-alone houses in the Auckland region across four territorial authority areas – Auckland city, Manukau city, Waitakere city and Rodney district (BRANZ, 2005a). The main findings were:

- Ceiling insulation is the most common type where 69 per cent had fully insulated ceilings, 19 per cent had some level of ceiling insulation and six per cent had none at all (seven per cent were not able to be accessed to inspect).
- 56 per cent of houses had wall insulation.
- 36 per cent had floor insulation.

[18] Variations in data occur due to the way census questions are formulated – see Statistics New Zealand website at http://www.statisticsnz.govt.nz for more details.

- Not all insulation met the relevant standard. Inadequate thickness was the common problem.
- A range of defects were found where ceiling insulation was installed including, gaps, damage, and problems with it not being fitted properly.
- Only three per cent of homes with insulation had it installed at best practice levels.

The BRANZ Household Energy End-use Project (HEEP) involved monitoring of energy use and temperatures in approximately 400 privately owned houses nation-wide (BRANZ, 2006). Insulation levels and age of houses in the project are used to compare the energy use in pre- and post-1978 houses. Key findings of the study were:

- 73 per cent of pre-1978 homes had some insulation, but the extent and quality of the insulation varied. Although many homes did have whole roof coverage, in most cases the insulation would not meet building code standards.
- Mandatory insulation since 1978 can be linked to warmer homes that use less space heating.
- Pre-1978 houses were more likely to have solid fuel appliances than those built post 1978.
- The coldest houses were built between 1910 to 1920 and 1930 to 1940s.

As part of the Warm Homes Project, the Ministry for the Environment (MfE) carried out a phone survey of 151 households in December 2004 (MfE, 2005a). The main findings of houses surveyed in the Auckland region were:

- 55 per cent of the houses surveyed had ceiling insulation.
- 44 per cent had wall insulation.
- 77 per cent had varying levels of insulation, with ceiling insulation being the most common.
- 23 per cent had no insulation at all.

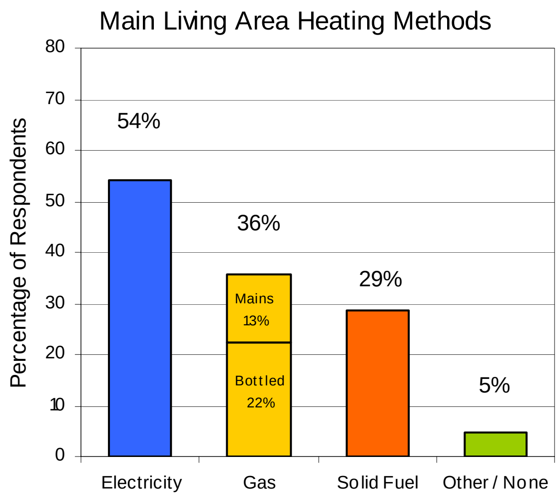
Based on these studies, it is likely that up to one third of homes in Auckland have little or no insulation whatsoever – equating to as many as 146,000 homes across the region. These homes will comprise mainly pre-1978 homes, which were built without insulation before the first standard was introduced, but also some dwellings built after 1978 where the installation or degradation of the insulation has rendered it essentially ineffective.

3.4.2 Home heating methods

Space heating is the main user of household energy at 34 per cent of the total (BRANZ, 2006). In Auckland, over 50 per cent of Auckland households use electricity for heating their main living areas as shown in Figure 3.16 (ARC, 2009a). Although electricity is the most common form of space heating, solid fuels and gas heating are also very popular as they are considered to be efficient and cheap.

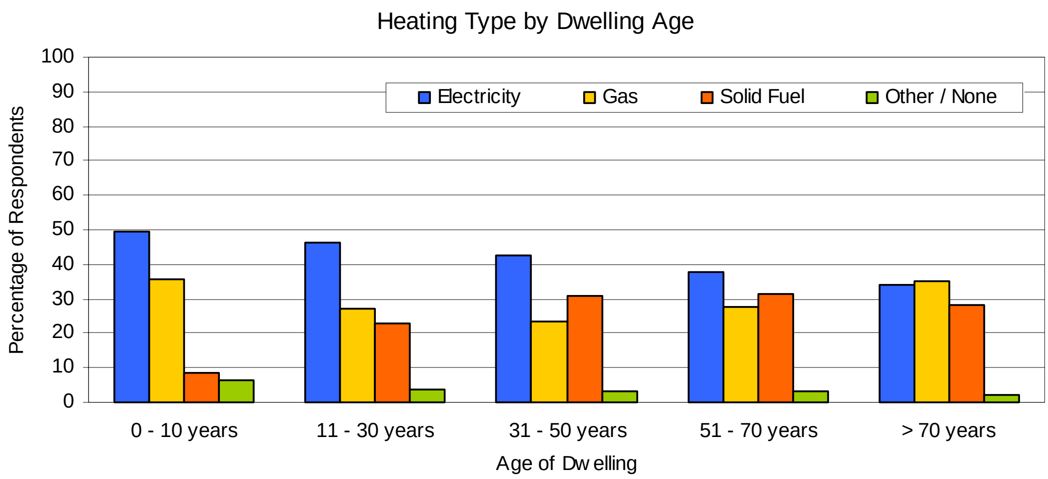
The proportion of homes using various heating methods varies with dwelling age as seen in Figures 3.17. Newer homes opt for electricity and gas over solid fuel heating whereas older homes have a more even split between the fuel types.

Figure 3.16 Method used to heat the main living area of Auckland homes in 2007



Source: ARC, 2009a

Figure 3.17 Heating method by dwelling age in Auckland in 2007

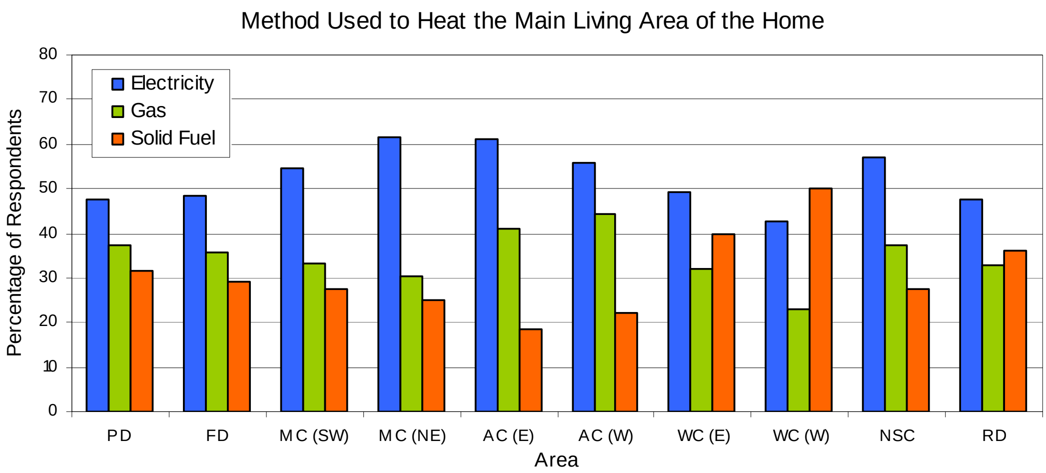


Source: ARC, 2009a

The ARC Home Heating Survey 2007 found that 29 per cent of households surveyed used solid fuel heating in their homes (ARC, 2009a). Of the households using solid fuel heating, 23 per cent reported using an open fire and 72 per cent reported using a woodburner, with 38 per cent of all solid fuel appliances being older than 15 years.

Use of open fires was found to be highest in areas 5 and 6 - Auckland city (see Figure 3.13) - which were also found to have the oldest houses in the survey. The frequency of overall solid fuel heating was highest in areas 7 and 8 - Waitakere city. Over 80 per cent of these respondents used woodburners, which is probably a reflection of the age of the housing stock and the availability of fuel (Figure 3.18). The abbreviations used in the figure relate to the survey areas shown in Figure 3.10.

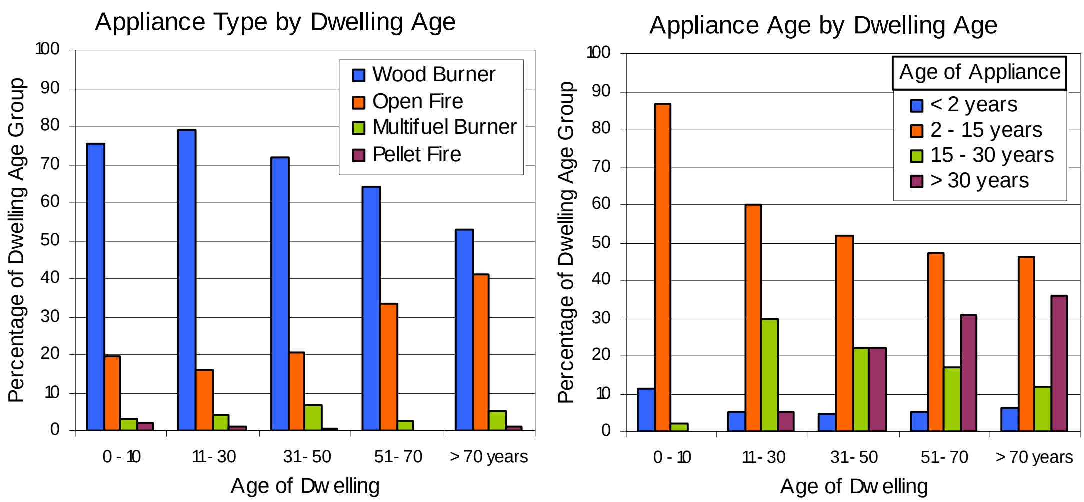
Figure 3.18 Method used to heat the main living area of homes by territorial area across the Auckland region in 2007



Source: ARC, 2009a

Figure 3.19 further illustrates the link between dwelling age and the type and age of solid fuel appliances being used. The most polluting appliances – open fires and older woodburners – are far more prevalent in homes older than 50 years, which represent 17 per cent of the total Auckland housing stock.

Figure 3.19 The age and type of solid heating appliance by dwelling age group in Auckland in 2007



Source: ARC, 2009a

Reports show an increase in the use of unflued gas heating in New Zealand, despite related safety concerns regarding impacts on indoor air quality, dampness and exposure to unguarded flames (Wilson, 2006). Census 2006 data show that 24 per cent of Auckland households use bottled gas[19] for heating areas of their homes, with about 80 per cent of these being used in stand-alone dwellings.

3.4.3 Energy consumption and fuel poverty

Energy consumption in New Zealand houses has been steadily increasing and accounts for about 12.6 per cent of national consumer energy use (MED, 2007). Despite this, our houses are still cold. There are a number of factors that account for the increase in energy use, including an increase in new and average house sizes, lifestyle changes, higher expectations of comfort in the home and increased use of electrical appliances.

Electricity and household gas prices have increased significantly in recent years (Statistics NZ, 2008a). This trend is likely to continue if the international price of petroleum continues to rise. In addition, the investment costs of preparing energy production and distribution infrastructure for combating global warming, together with emissions trading costs will inevitably be passed on to end users (MED, 2007). Rising energy prices to end-users do not do much to reduce energy use, except in very low-income households. These are the ones with the most to lose from reduced consumption (MfE, 2005b).

Sales of electric climate control systems, such as heat pumps and other Heating Ventilation and Air-Conditioning (HVAC) systems, have increased dramatically in the past five years or so. Although no accurate statistics are available, it is estimated that 7.5 per cent of New Zealand households now have heat pumps (BRANZ, 2007c). While these systems are very energy efficient if installed correctly, they have increased electricity use in homes, in particular when used as cooling devices in summer.

The sale of dehumidifiers has also increased (to about 45,000 per annum). Dehumidifiers can enhance energy efficiency of home heating if used correctly. However, in New Zealand, they are more commonly used at colder temperatures and are often used to remove moisture in older homes or resultant condensation from unflued gas heating (EECA, 2005). Healthy housing studies (Howden-Chapman, 2006) have found that bottled gas (used in portable unflued gas heaters) is used in low-income households as a way of limiting the cost of heating. This is probably an indicator of fuel poverty.

In Auckland, energy consumption is about 10,660 kW per house per annum (all fuel types). Electricity use has been estimated to be about 7970 kW per house per annum (BRANZ, 2006). This is about 500 kW higher than the national average and is partly explained by the higher use of electricity for home heating in Auckland. Hot water heating is the second biggest energy user in homes. Auckland households use about 30 per cent of their total energy to heat water.

---

[19] Not all of this gas will be burnt in unflued appliances but it is likely that a significant proportion will be.

The HEEP survey reported that lower-income houses were spending a large proportion of their incomes on heating while still not achieving the recommended indoor temperature. It was estimated in 2001 that around seven per cent of Auckland households (28,000 homes) were potentially experiencing fuel poverty (MSD, 2006). The 2006 HEEP study found that the top 20 per cent of households monitored (by energy use) used 36 per cent of the total energy, while the bottom 20 per cent used only nine per cent of the total energy (BRANZ, 2006). This may also be an indication of fuel poverty.

Direct carbon dioxide (CO_2) emissions from the residential sector only accounts for approximately two per cent of the energy sector's total emissions. However, if emissions from electricity generation for the residential sector are included, this increases to about eight per cent. Direct CO_2 emissions in the residential sector have remained fairly steady over time, but related emissions from electricity generation have increased by about 50 per cent since 1990 (CHRANZ, 2006). This suggests that the key to significantly reducing overall CO_2 emissions from household space heating lies in reducing the emissions from the associated electricity generation.

Irrespective of any ambient temperature increases that may result from global warming, the demand for energy to heat and cool homes is likely to continue to increase. Greenhouse gas emissions from the residential sector will need to be reduced to help meet targets set under the Kyoto Protocol. Any reductions in household energy use through efficiency measures will reduce greenhouse gas emissions, costs to consumers and improve supply security (MED, 2007).

3.4.4 Indoor air quality and indoor air temperature

As the majority of people's time is spent indoors, the quality of indoor air is important. The main causes of poor indoor air quality are:

- Heating devices with poor fuel combustion
- Damp or humid house conditions resulting from construction defects or from unflued gas heaters
- Inadequate ventilation
- A combination of some or all of the above.

Heating devices such as open fires, unflued gas heaters and inefficient woodburners contribute to high levels of carbon dioxide (CO_2), carbon monoxide (CO) and nitrogen dioxide (NO_2). An unflued gas heater can release up to half a litre of water per hour into the room, in the form of water vapour (EECA, 2008).

As warm, moist air cools, the water vapour condenses onto colder surfaces. Damp or humid conditions lead to the growth of mould and fungi. Dust mites also proliferate in damp humid conditions. These bio-contaminants exacerbate existing health problems such as asthma and increase the prevalence of allergies, sinus congestion and related irritations.

When there are multiple types of pollutants, these interact and accumulate which can lead to poor health outcomes. Minor complaints, such as headaches, dizziness, nausea, and drowsiness, are often associated with poor indoor air quality. More serious ailments, such as respiratory illness, neurological problems, stunted lung development in children and pulmonary oedema, are also associated with poor or inadequate heating (BRANZ, 2008).

The use of inappropriate heating leads to poor indoor and outdoor air quality, which in turn contributes to high rates of asthma in the region. Respiratory infection has been found to be 1.4 times higher in homes with unflued gas heaters (Wilson, 2006). Switching to better heating devices has been shown to decrease asthma rates and improve general health over winter (Howden-Chapman, 2006).

Research has linked increased rates of hospitalisation and GP visits to seasonal variations in temperatures (NIWA, 2006). During the New Zealand winter, mortality rates are 18 per cent higher than non-winter rates and two per cent higher than rates in comparable countries (Davie *et al*, 2007). Winter mortality from respiratory illness is 66 per cent higher than non-winter mortality (Table 3.5). It is not the cold weather itself that causes health problems, but rather the additional stresses on the body and the way that these are addressed. Living in a cold, damp and mouldy home without adequate ventilation increases the risk of fatal illness, particularly in the elderly and children (ARPHS, 2005).

Table 3.5 Seasonal variations in mortality in New Zealand for 1996-2000

Mortality from all causes			Mortality from respiratory illness		
Rate per 10,000 people	Winter*	Non-Winter	Rate per 10,000 people	Winter*	Non-Winter
All	8.0	6.7	All	9.4	5.5
Age (years):			Age (years):		
0-4	1.7	1.5	0-4	0.9	0.4
5-14	0.2	0.2	5-14	0.0	0.0
15-29	0.9	0.9	15-29	0.1	0.1
30-59	2.5	2.4	30-59	1.1	0.7
60-79	25.1	21.2	60-79	29.8	17.5
80+	122.8	97.2	80+	180.2	103.6

* Winter is defined as June – September

Source: Davie *et al*, 2007

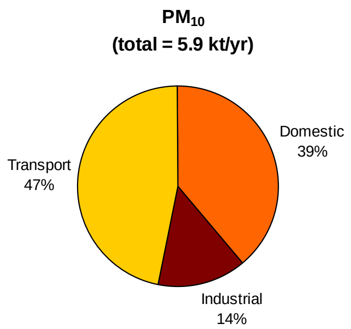
Summer temperatures are just as important to health as winter temperatures. Extreme summer temperatures can also increase mortality. Elderly people are particularly sensitive to extreme variations in temperatures. Without insulation and shade protection, house temperatures can easily exceed the WHO recommended range (18 to 25°C). Houses without insulation have been found to be about 1°C warmer in summer (BRANZ, 2000).

The Royal Commission on Environmental Pollution in the United Kingdom estimate that 25,700 extra deaths occurred in the period December 2005 to March 2006 due to winter climate factors and at least 2000 extra deaths resulted from a heatwave in the summer of 2003. These figures compare with estimates for premature deaths from air pollution in Great Britain at 24,000 per annum (Royal Commission, 2007).

3.4.5 Ambient air quality

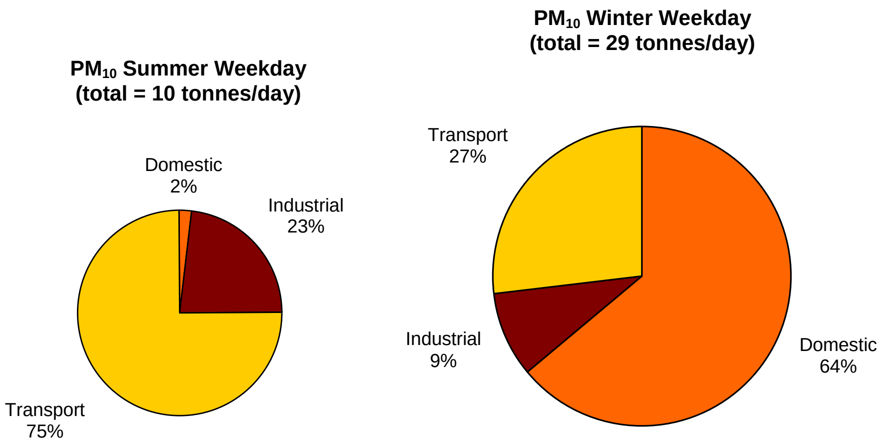
Domestic fires are a significant source of air pollution. In Auckland, fine particle (PM_{10}) concentrations regularly exceed allowable levels (see Section 2 for further details on national standards). Domestic sources account for about 39 per cent of the Auckland PM_{10} emissions annually (see Figure 3.20) but up to 64 per cent of emissions in winter (see Figure 3.21), due to seasonal variations (ARC, 2006a). Smoke from domestic fires also contains carbon monoxide (CO), and volatile organic compounds (VOCs) which contribute to poor air quality.

Figure 3.20 Breakdown of annual PM_{10} emissions by source for the Auckland region in 2004



Source: ARC, 2006a

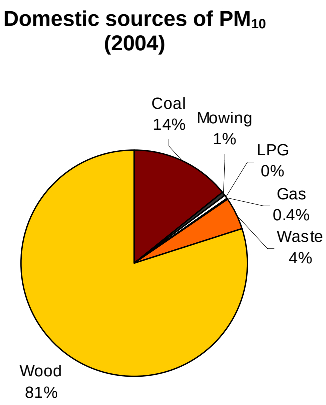
Figure 3.21 Seasonal variation in typical daily PM_{10} emissions in Auckland in 2004



Source: ARC, 2006a

The majority of domestic PM_{10} emissions comes from home heating with the combustion of solid fuels (wood and coal) accounting for 95 per cent of all annual emissions (see Figure 3.22) (ARC, 2006a).

Figure 3.21 Relative contribution of various sources to annual domestic PM_{10} emissions in Auckland in 2004



Source: ARC, 2006a

The ARC Home Heating Survey 2007 found that the oldest and least efficient burners were found in older urban areas (ARC, 2009a). Although these homes are also more likely to use electricity for heating, the relatively high density of houses with fires means that the cumulative effect of PM_{10} emissions is more noticeable.

For the Auckland region, the current health costs of air pollution from all sources are estimated to be at least $548 million per annum with 165 Aucklanders dying prematurely each year due to domestic fire emissions alone (ARC, 2009b). As well as the premature deaths, domestic fire pollution results in 332,300 days being lost region wide due to illness or poor health – especially in the young, the elderly and people with heart disease, respiratory disease, asthma and bronchitis.

Asthmatics are particularly sensitive to poor air quality and Auckland has one of the highest rates in the world, with a prevalence of one child in four (25 per cent) and one adult in six (17 per cent). Asthma is the most common cause of hospitalisation in children and rates have more than doubled in the past 30 years. The cost of asthma in New Zealand is conservatively estimated at $825 million per year, with $125 million from direct medical expenses and $700 million due to disability and premature deaths (Asthma Foundation, 2009).

Inequities in exposure to air pollution by deprivation have been demonstrated in Christchurch (Pearce *et al*, 2006), and similar inequities are likely to exist in Auckland. As the population of Auckland grows, a greater number of people will become vulnerable to the effects of PM_{10} and other harmful emissions. This will in turn further increase the burden on the health system.

4 Opportunities for intervention

Nationally, programmes for upgrading existing housing stock have been in existence since 1996. This chapter reviews the current programmes operating in the Auckland region and their impact to date, outlines other initiatives being undertaken by other regions, highlights the priorities for future programmes in Auckland, and outlines approaches that could be undertaken in Auckland to promote improved energy efficiency and clean heating in homes.

4.1 Current initiatives in Auckland

There are several programmes already established in the Auckland region that aim to create warmer, healthier and more energy-efficient homes (Table 4.1). Many of these are jointly funded and are provided by more than one agency. There are two types of programmes: "educative" programmes that aim to change householders' behaviour by providing information and advice on energy use in the home; and "passive intervention" programmes that change houses physically but not householders' behaviour. Not all programmes provide both of these aspects.

Colder climates in southern parts of the country have meant that more of the initial effort has been directed towards upgrading houses in these areas. As these programmes near completion, the focus will shift to more northerly areas, including Auckland. As of March 2009, approximately 15,000 houses in the Auckland region have undergone insulation retrofits. Clean heat upgrades have also been undertaken in some homes. These have mostly been in publicly owned housing. No comprehensive data are available on how many households have completed energy efficiency upgrades as a result of education programmes. As awareness grows, it is expected that more households will respond to this type of initiative.

Based on the current levels of funding, these programmes would take 50 years to address the worst housing in Auckland and would therefore need to be supplemented by other initiatives if substantial and swift progress was to be made.

Table 4.1 Current programmes and number of houses insulated in the Auckland region.

Providers and Programmes Offered	No. of Houses Insulated*	Location
EECA Energywise Grants Programmes (from 1996 to March 2009)	7,500	Auckland Region
EcoWiseWest (EcoMatters Environment Trust, WCC, EECA, WDHB, MSD)		Waitakere City
Te Whare Ahuru O Manukau (Tamaki ki Raro Trust, EECA, MCC, ProCare)		Manukau City
Warm n' Well (Eco Charitable Trust, EECA, Eco Insulation, WCC, NSCC, RDC, ARPHS, WDHB, Tihi Ora MaPo)		Waitakere City, North Shore City and Rodney District
Snug Homes for Auckland (ASB Community Trust, EECA, Eco Insulation, Mercury Energy, Starship Foundation, ACC, MCC, ProCare Network, ADHB)		Auckland City, Manukau City, and Papakura District
Huntly Energy Efficiency Trust (HEET) with EECA		Franklin District
Housing New Zealand Corporation (HNZC) Programmes (from 2001 to March 2009)	7,133	Auckland Region
HNZC Energy Efficiency Retrofit Programme	4,168	Auckland Region
Healthy Homes Programme (HNZC and ARPHS)	2,965	Auckland Region
Local Council Housing (to March 2009)	356	Auckland Region
Waitakere City Council	110	Waitakere City
Franklin District Council	30	Franklin District
Manukau City Council	216	Manukau City
Estimated Total No. of Houses Insulated*	14,989	Auckland Region

*All numbers are approximates only

NB: To see the number of retrofits by programme where further information is available, see Appendix 4.

4.1.1 EECA funded programmes

EECA is the main government organisation responsible for providing funding, education to households and energy efficiency retrofitting projects. It is also responsible for the Home Energy Rating Scheme (HERS). Most EECA funding programmes have targeted low-income households.[20] Nevertheless, interest free loans or one-off grants are available to all home owners to assist them in making energy efficiency upgrades.

EECA has undertaken retrofits in partnership with various organisations to deliver retrofits across the Auckland region with the major ones shown in Table 4.1.

The Warm n' Well programme is a joint project between the Waitemata District Health Board, EECA, Waitakere City Council, North Shore City Council, Rodney District Council, Auckland Regional Public Health Service (ARPHS) and the Eco Charitable Trust. It offers a free home visit by a nurse to identify unmet health or social needs and free insulation to eligible families with children aged 14 years and under.

The Snug Homes programme has been extended to include incentives for landlords of low-income tenants in the form of 55 per cent discounts to the prices of Eco Insulation products (EECA, 2007b).

Approximately 7500 houses have been insulated in the Auckland region through EECA's Energywise grants programme since its inception in 1996 until the end of March 2009 (EECA, 2009a). In the past three years, the retrofit rate has averaged approximately 1400 Auckland homes per annum.

In May 2009, the government announced an increased funding allocation of $323.3 million over four years for a campaign to fit homes with insulation and clean heat appliances (EECA, 2009b). More than 180,000 New Zealand homes built before 2000 will have access to grants of up to $1,800 to go towards ceiling and under floor insulation as well as installation of clean heating sources. The programme aims to retrofit 27,500 homes by the end of June 2010, another 40,500 homes in the 2010/11 year, 52,000 in 2011/12, and 60,500 in 2012/13. Based on Auckland's proportion of previous EECA funding, this new programme will substantially increase the annual retrofit rate from 1400 to nearly 6000 Auckland homes per annum, resulting on a further 24,000 homes being retrofitted by mid 2013.

4.1.2 Public housing programmes

In the Auckland region, about seven per cent of all houses are owned by the Housing New Zealand Corporation (HNZC). In response to the New Zealand Housing Strategy, HNZC is administering a number of programmes to improve energy efficiency in public housing as shown in Table 4.1.

As part of the Energy Efficiency Retrofit programme, insulation and a range of other energy savings measures are being installed in all HNZC houses over a 10 year period (HNZC, 2008). To the end of April 2009, 4168 homes in Auckland had been retrofitted in this programme with the remaining 7470 retrofits due to be completed by June 2013.

[20] Low-income households are usually defined as those who qualify for a community services card.

In addition, a Healthy Housing Programme is being undertaken jointly between HNZC and the Counties Manukau and Auckland District Health Boards (ADHB). Established in 2001, it aims to improve the health of HNZC tenants through reducing risks associated with poor housing conditions (HNZC, 2006). Improvements have been made to houses in Mangere, Point England, Tamaki, Otara, Onehunga, Glen Innes and Wiri. The level of intervention varies, but many houses have received insulation upgrades as part of the programme.

Other public landlords in the region include local councils, many of which have also undertaken upgrade programmes as shown in Table 4.1.

HNZC administers a Housing Innovation Fund that provides councils with interest-free loans for housing programmes. Franklin District Council has used the fund to upgrade 30 housing units for the elderly, including retrofitting insulation and carpet.

Over the next six years from 2007, Manukau City Council will be upgrading the 515 units it owns for the elderly. About 400 of these were built prior to 1978. As well as insulating the pre-1978 houses, all units will receive energy efficiency measures and heating appliance upgrades.

Waitakere City Council also has an upgrade programme for its social housing. Of the 336 units Waitakere City Council own for elderly tenants, around one third (110) had been upgraded by the end of 2008 with a further 110 due to be upgraded by the end of 2009.

4.1.3 Education programmes and other initiatives

Waitakere and Auckland City Councils have contributed funding to the EcoWise Energy Advice Programme (EEAP) run by the EcoMatters Trust. EEAP has completed energy audits in over 600 homes in Waitakere City and Auckland city. The EcoMatters trust is working to expand all of its sustainable homes programmes in Auckland city.

Programmes and initiatives are not limited to those funded by government organisations. Some organisations have established their own programmes for varying reasons. These support the work being done by government organisations.

In July 2007, Westpac bank introduced a green loan scheme for their home loan customers, which included discounts on insulation, solar heating systems and clean heat devices (Westpac, 2008). They subsequently replaced this programme in October 2008 with an online EcoShop for Westpac customers to enable recording of the uptake.

New Zealand Insurance (NZI) has introduced an insurance policy which allows an extra $20,000 to provide eco-features for home owners who need to re-build their houses (NZI, 2008).

One of the most significant new developments is the announcement by Waitakere City Council in their long-term council community plan (LTCCP) to secure funding for a widespread retrofitting programme (WCC, 2009). The Retrofit the City initiative aims to upgrade 20,000 homes in Waitakere by 2020, not only in terms of insulation but also in terms of energy, water, and waste efficiency and travel planning. Around one third of the 62,000 homes in Waitakere city were built before requirements to insulate homes and many have inadequate insulation by current building standards. The Retrofit the City programme aims to:

- Improve living conditions with better insulation, and more efficient energy and water use to make homes warm, dry and healthy environments;
- Help Waitakere city meet its targets to reduce water demand and greenhouse gas emissions;
- Provide business, employment and training opportunities.

The Waitakere City Council has agreed to support this initiative in conjunction with EECA funding for insulation and home heating. The council has made provision for residents to apply for a loan to retrofit their home and meet those costs beyond what is currently funded by central government's initiative. All costs associated with this loan scheme will be met by the approved home owners. This may be recovered as a target rate from those properties.

Following the May 2009 budget announcement for the government's accelerated insulation retrofit and clean heating programme, all of the major trading banks in New Zealand have agreed to scrap their fees for householders who borrow money to take advantage of the scheme (EECA, 2009c).

4.2 Other regional councils' regulations and programmes

Many councils in New Zealand have proposed regulatory changes as part of their action plans to meet the national environmental standards for air quality (AQNES). These action plans have become imbedded in Regional Plans and Long Term Council Community Plans (for example HBRC, 2009). Some of the actions considered by those councils include:

- Banning the installation of new open fires in new homes;
- Banning the installation of new solid fuel burners (even burners that meet the AQNES woodburner standard) in new homes or existing homes (unless they are upgrading from an older solid fuel burner to an approved cleaner burning option);
- Prohibiting the use of existing open fires or 15 year old solid fuel burners;
- Reducing the emission limit for all new woodburners sold in their region to 0.7g PM_{10} per kg wood burnt (vs. the AQNES standard of 1.5g PM_{10} per kg wood);
- Requiring all homes to be fitted with an approved clean heating appliance at "point of sale" (i.e. when sold).

Many of these changes have also been proposed with a co-requirement for improved insulation to minimise the amount of fuel or energy used, irrespective of the heating appliance efficiency or cleanliness.

The Tasman District Council has introduced new woodburner rules in the Richmond airshed[21] under its Resource Management Plan.[22] The rules came into effect in January 2007. These state that if a house changes ownership, the new occupants will no longer be able to use non-compliant woodburners and that new or existing houses cannot install non-compliant woodburners (TDC, 2008).

Nelson City Council has implemented a programme to meet PM_{10} emission targets by 2013. Key actions include:

- Banning the use of open fires, effective 1 January 2008.
- A compulsory phase-out of older enclosed burners and pot belly stoves, which is to be completed by 2010.

These actions are written into the council's Air Quality Plan. The 'Clean Heat Warm Homes' programme (also known as the 'Pay as you heat' scheme) assists home owners in preparing for the bans. Interest free loans are provided to home owners to switch heating methods. Insulation must be installed as part of the upgrade and the cost of this can be covered by the loan. Loans are paid back through rates. Low-income home owners may qualify for a rates rebate. In February 2008, it was announced that Nelson City Council would receive $2.3 million from EECA to help fund the Clean Heat Warm Homes programme (NCC, 2008).

Environment Canterbury established the 'Clean Heat Project' in 2003, partly funded by EECA. The aim is to reduce PM_{10} emissions and improve ambient air quality. The project offers financial assistance to Christchurch home owners (and landlords) to insulate and upgrade heating appliances in homes with open fires and solid fuel burners. There are four types of assistance available:

- Full assistance (for low-income participants)
- Subsidies for home owners
- Interest free loans (paid back through rates)
- Subsidies for landlords.

Insulation upgrades are only done in conjunction with clean heat upgrades. Eligibility and the type of intervention are decided on by an independent assessor. The programme is not income targeted, but more benefits are given to low-income households. Assistance is not available for houses that are in serious disrepair or are structurally unsound (ECan, 2007a). To the end of June 2008, 13,450 homes (of a total 26,460 homes to be assisted) had been upgraded. This has resulted in a significant reduction in the number of winter nights with high air pollution (ECan, 2007b).[23]

[21] A geographic area established to manage air pollution within the area as defined by the AQNES. The concept of an airshed is to recognise that different areas will need different management approaches. This depends upon the effects of air pollution that occur within the area and the emissions that cause these effects.
[22] Tasman District Council is a unitary authority and as a result they have different powers than other councils.
[23] Refer to the Clean Heat website for more information: http://www.cleanheat.org.nz/

4.3 Prioritising future programmes in Auckland

A review of current programmes, policy objectives and strategies indicates that there are areas where interventions could be prioritised. While the aim should be to ensure that all housing stock in the region is in good condition, it is evident that some areas and populations have a greater need for improvement than others. Also, any interventions should support worthwhile existing programmes.

About 262,810 houses were built in the Auckland region before the 1978 insulation standard was introduced. Many of these will now have some level of insulation. Table 4.2 shows the potential number of houses in the Auckland region with little or no insulation. This has been estimated using the findings of previous surveys. Estimates and findings from these surveys vary greatly due to wide variations in sample sizes and survey methods.

Tables 4.3 and 4.4 outlines where early intervention is likely to be most effective, based on what is known about the current condition of the houses, socio-economic factors and environmental issues.

Table 4.2 Potential number of houses with little or no insulation in the Auckland region

Territorial Authority (TA)	No. of houses from the 2006 Census	Percentage built before 1978 **	No. of houses built before 1978	BRANZ House Condition Survey found 20% of all houses are without full insulation	HEEP study findings found 27% without insulation	MfE estimated that 23% have no insulation	EECA estimated 33% built before 1978 without insulation
Auckland	145,572	67.0	97,530	29,110	39,300	33,480	32,190
Franklin *	20,421	57.0	11,640	4,080	5,510	4,700	3,840
Manukau	95,121	58.0	55,170	19,020	25,680	21,880	18,210
North Shore	72,762	61.0	44,380	14,550	19,650	16,740	14,650
Papakura	14,934	64.0	9,560	2,990	4,030	3,440	3,150
Rodney	33,444	40.0	13,380	6,690	9,030	7,690	4,410
Waitakere	62,355	55.0	34,300	12,470	16,840	14,340	11,320
Auckland Region Total	439,080	59.9	262,810	87,810	118,550	100,990	86,730
Less 15,000 houses insulated through retrofit programmes to end March 2009			247,810	72,810	103,550	85,990	71,730

* These figures are for the whole of Franklin district which is split between the Auckland and Waikato regions.

** These percentages are based on QVNZ data, which are calculated by decade, so they actually represent the percentage of houses built pre-1980. However, these numbers will only be slight over-estimates and will not impact greatly on the overall potential number of houses.

Table 4.3 Households that could be targeted

Households living in pre-1978 houses who:	Why:	Potential Number of Households
Are low to middle income earners	These households are most likely to reduce heating to meet other household expenditure needs and are less likely to be able to make the energy efficiency upgrades they require due to income restrictions.	206,040 based on Census 2006 for income less than $50k in Auckland
Have children aged 14 years and under	The impact of cold, damp housing has a long-term effect on the health of children. Early intervention can prevent future health problems.	137,770 based on Census 2006 for subset of families with children in Auckland
Have occupants aged over 65	The number of people over the age of 65 continues to increase. This is likely to have a significant impact on the health system, especially when they live in cold housing. Without intervention it is likely that the quality of housing for the elderly will not improve and may even get worse (BRANZ, 2007d).	26,020 based on Census 2006 for % population over 65 yrs in Auckland
Have occupants with disabilities and/or pre-existing medical conditions	People with disabilities and pre-existing medical conditions need more help to keep warm and are more susceptible to ill health. They may also be on limited incomes.	44,680 based on Disability Survey 2006 for % population in NZ affected
Live in areas with high levels of social deprivation (see Appendix 2)	Households in these areas are more likely to live in old, cold houses and have little ability to change them.	57,820 based on Census 2006 for % households in Auckland with SDI* of 9 or 10
Are tenants who fall into any of the preceding categories	Tenants have reduced control over the houses they live in. Landlords often have limited financial incentives to improve rental properties, especially if they are older or have short-term leases. A growing number of families with children live in rental accommodation.	95,140 based on Census 2006 for tenure in Auckland

*Social Deprivation Index

Table 4.4 Houses that could be targeted

Houses that are:	Why:	Potential Number of Houses
Built pre-2000	Many of these houses were not required to have insulation and where insulation does exist it may be in poor condition.	338,090 based on Auckland Home Heating Survey 2007 for dwellings older than 2000 (ARC, 2009a)
Are maintained and structurally sound	For insulation to be most effective the house needs to be structurally sound and in good condition. Poor sub-floor conditions are common in older houses. Consideration needs to be given to the economic efficiency of changes made to pre-1978 houses.	364,440 based on NZ 2005 House Condition Survey assuming good plus moderate for Auckland (BRANZ, 2005a)
Have a heat source that is considered to be unsafe or polluting	These need to be removed due to their contribution to poor health and pollution issues. They are particularly bad when they exist in combination with a lack of insulation.	184,600 based on Auckland Home Heating Survey 2007 percentages for bottled gas plus non-compliant woodburners (ARC, 2009a)
Are in urban areas with poor winter air quality that results from domestic emissions	Insulation will reduce the need to heat, resulting in fewer emissions from burners. Clean heat appliances will substantially improve ambient air quality.	375,810 based on Census 2006 data for Auckland, North Shore, Manukau and Waitakere cities only
Post 2000 houses with non-complying woodburners	Post-2000 dwellings that use older woodburners are good candidates for clean heating upgrades, as they already have the level of insulation required to make upgrades efficient.	14,640 based on Auckland Home Heating Survey 2007 for dwellings younger than 2000 assuming 29% burning solid fuel and half of these installed with non-NES woodburner (ARC, 2009a)
Are separate houses or joined in a way that makes them easy to retrofit	Low and medium rise multi-unit dwellings should be included, as many are home to elderly people, children and low-income households.	390,780 based on Census 2006 for detached or one storey attached dwellings in Auckland

4.4 Approaches for improving energy efficiency and clean heating

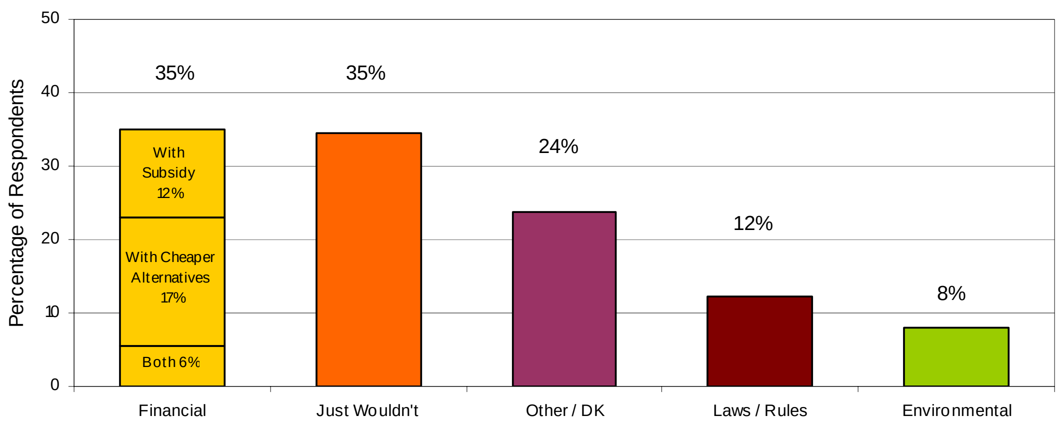
The five main approaches that could be undertaken in Auckland to move towards improved energy efficiency and clean heating in homes are:

- Education, advice and information,
- Partnerships,
- Financial support and assistance,
- Incentives and disincentives, and
- Regulation.

A range of complementary tools is available within each approach and more than one of these can be used together. All approaches have limitations and challenges. For these reasons, consideration needs to be given to how these should be best applied in various circumstances. The following sections discuss the possible approaches in more detail.

As an example of why a range of approaches should be considered, Figure 4.1 (ARC, 2009a) shows the circumstances under which people who currently use solid fuel for heating would consider changing to a clean heating alternative. Thirty-five per cent of current solid fuel users would not be prepared to change regardless of the situation. Of the remaining 65 per cent, many different factors can influence change ranging from a desire to use a more environmentally friendly heating option through to the need to comply with tighter rules and regulations.

Figure 4.1 Reasons to change from solid fuel use, given by the 2007 survey respondents who burn wood and/or coal.



Source: ARC, 2009a

4.4.1 Education, advice and information

Lack of understanding, knowledge and information has been identified as some of the key inhibitors to improving energy use in homes (MfE, 2005b). Behaviour is an important factor in efficient energy use and in some ways this is more difficult to change than physical housing conditions. The BRANZ house condition survey found that there was a clear gap between perception and reality with respect to housing conditions. Many home owners' perceptions of the condition of their houses were much more positive than those of the assessments of the survey (BRANZ, 2005a).

MfE has found that a wide range of information sources (including those from regional councils) and media can help to spread appropriate messages (MfE, 2005b).

As every household is different, tailored advice is a good way of ensuring that home owners make the most appropriate changes. An in-home assessment is one way of establishing the changes that are needed. It can also encourage home owners to initiate these changes themselves.

4.4.2 Potential partnerships

There are a number of organisations that have already established regular contact with home owners, landlords and tenants. Working with these organisations could help to inform the Auckland public about regulations or programmes that are available to households to improve energy use.

Existing programme providers:

- Energy Efficiency Conservation Authority (and programme providers)
- Non-Governmental Organisations (NGOs) e.g. Beacon Pathways Ltd, Eco Matters Trust
- Housing New Zealand Corporation
- Ministry for the Environment
- Industry
- Local Councils

Organisations that have regular contact with home owners:

- Department of Building and Housing
- Real estate agents
- Public health providers
- Age Concern and Grey Power
- Property managers

4.4.3 Financial support and assistance

In some cases passive intervention (changing the physical condition of the house) is the most effective way of improving energy efficiency. Loans, grants, subsidies and discounts are the most common forms of assistance provided. All financial assistance provided should be made in conjunction with home inspections, to ensure that the changes are carried out and products installed properly.

Interest free loans with easy pay-back options (such as through rates payments) are the most successful. These are more likely to be used by households that have some financial resources, but lack sufficient incentive or are restricted by other spending priorities. Grants are most appropriate for low-income households.

The Big Clean Up programme (previously run by the ARC) offered discounts to participants for 'green' products. A revised discount programme approach could be implemented which included discounts on insulation and/or clean heat appliances. The councils also have the ability to potentially offer rates rebates for households that complete clean heat and energy efficiency upgrades.

4.4.4 Incentives and disincentives

The introduction of EECA's Residential Rating Tool provides home owners with a direct incentive to ensure their home scores a positive rating for energy use. The Home Energy Rating Scheme (HERS) is an assessment of the energy efficiency performance of a home. It includes the building itself, and the two biggest energy users in a home - the room heating and the water heating systems. A qualified assessor evaluates the home then generates a report containing star ratings showing the energy performance of the home, and professional recommendations on the most appropriate actions to improve the home's rating.

The Green Star scheme run by the New Zealand Green Building Council, has a broader focus on the greening of buildings by working with the property industry. The Green Star scheme rates buildings based on energy efficiency, indoor air quality, land use, ecology, waste and water management. It may be feasible to incorporate aspects of the Green Star scheme at the household level.

4.4.5 Regulations

Regulations have long-term effects and, in all instances, need to be carried out with a range of other measures that help to support households in meeting any requirements.

In the Auckland region, the Proposed Regional Plan: Air, Land, and Water already has a rule prohibiting the installation of new solid fuel appliances in new or existing homes that do not meet an emission limit of 4.0g PM_{10} per kg fuel burnt in all areas.[24] This

[24] The more stringent AQNES woodburner emissions standard of 1.5g PM_{10} per kg wood overrides ARC rule 4.5.5 in situations where it applies, i.e. for any home with a section of less than two hectares, irrespective of whether it is in the urban or rural area. However the AQNES does not currently address emissions from multi-fuel or coal burning appliances and these are covered by the ARC rule.

rule (4.5.5) essentially bans the installation of pot bellies, coal ranges, and brick open fireplaces which cannot comply with specified emission limit (ARC, 2008b).

Two additional intervention points which could be considered in Auckland are:

- At "point of sale", when houses are sold.
- Targeting rental properties for upgrades.

Between 1500 and 3000 homes are sold in the Auckland region each month (see Figure 3.15). If homes sold in the Auckland region were required to be fitted with approved clean heating appliances and to meet a minimum level of insulation (equating to a minimum Home Energy Rating value) then all of Auckland's housing stock could potentially be upgraded in 12 to 23 years. The potential costs of $5-10k for the necessary upgrades could be accommodated relatively easily as part of the transaction, given that the average house price is around $500k. This requirement would not prevent low-income home owners from securing grants through schemes such as the Energywise homes programme for additional financial assistance.

Nearly 30 per cent of Auckland's housing stock (131,121 homes) comprises rental properties (see Table 3.4). The largest individual landlord is Housing New Zealand Corporation (HNZC) which owns 20,871 properties. However, HNZC has already completed retrofits on 4168 homes and has pledged to complete retrofits on the remainder by June 2013. Similarly, local councils have also commenced renovating their social housing stock with all of their properties due to be upgraded by 2013. The balance of rental stock is principally in private hands, with approximately 98,400 homes owned by individuals, trusts or businesses. Applying a minimum clean heating and insulation requirement to rental properties, comparable to that suggested for "point of sale", could certainly accelerate the achievement of more sustainable housing stock for Auckland.

5 Evaluation of improvements – benefits and costs

There are a variety of measures available to improve energy efficiency and clean heating. The effectiveness of these measures is dependent on how they are applied, the extent to which they are installed and the pre-existing physical conditions of the house. This chapter reviews the options available, summarises the typical primary costs and benefits of each, and lists additional co-benefits.

Please note that all analyses undertaken in this section are intended to be indicative only of the potential costs and benefits of various measures and are subject to the assumptions that are highlighted.

5.1 Improvement options

A Beacon Pathways study (Beacon, 2007) has shown that the strongest case can be made for passive[25] interventions such as ceiling insulation, double glazing, space heating upgrades, and hot water cylinder wrapping.

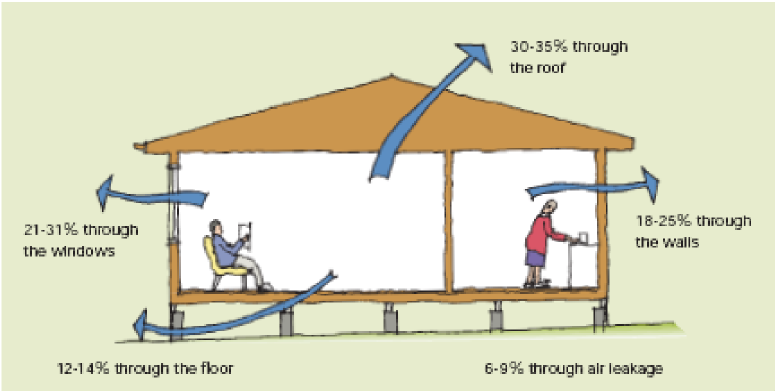
There is general agreement that a holistic approach provides the best benefits.[26] To achieve the greatest improvements in warmth and energy efficiency, building envelope insulation should be done in conjunction with double glazing, clean heat appliance upgrades and hot water cylinder insulation.

5.1.1 Heat loss minimisation

Without proper insulation heat loss is high. In these cases heating main living areas takes longer and heating needs to remain on at a higher temperature to maintain heat gains. This has a direct impact on amount of energy used. Most heat loss in homes is through the roof and windows (Figure 5.1).

[25] A "passive" intervention is one that does not require a change in behaviour of the occupant in order to be effective, such as retrofitting ceiling insulation.
[26] Otago University Healthy Housing study found that houses with insulation and clean heat upgrades had better results (Howden-Chapman, 2004). Informants in research done by Wilson (2006) all agreed that a holistic approach to heating in Auckland is needed.

Figure 5.1 Heat loss in an un-insulated house



Source: BRANZ, 2007b

Comparing two houses with the same construction materials, but different levels of insulation, the house with insulation to the 1978 standard would have half the heat loss of the house with no insulation (BRANZ, 2006). A house insulated to the new 2008 standard would perform even better, with only 35 per cent of the heat loss of the house with no insulation.[27]

Research done by EECA estimates that a high thermal mass (or well insulated) house in the Auckland climate would on average need only six kilowatts (kW) (3 x 2 kW heaters) to heat the whole house to an appropriate level. An un-insulated house would need up to 18kWs, or nine heaters (EECA, 2001a).

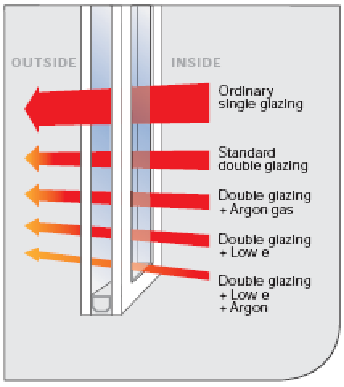
Insulation typically improves the indoor temperature by one to 1.3°C (BRANZ, 2006). This is not usually sufficient to bring the temperature up to 18°C as recommended by the WHO. The effectiveness of insulation is dependent on the size, orientation, ventilation and location of the house. For example, improvements in a sunny north facing house will be greater than those in a south facing house.

Options available for reducing heat loss and improving energy efficiency include ceiling insulation, thermal lined curtains, double glazing, wall insulation, carpet, under floor insulation, draught stopping, and hot water cylinder wraps.

Double glazing, in particular, is very effective because it is passive and the behaviour of the household cannot negate its benefits. For example, if the occupants do not have any window coverings at all or do not have thermal lined curtains or they do not draw the curtains when the sun goes down, the heat loss from the house will still be inhibited by the thermal insulation of the double glazing as shown in Figure 5.2.

[27] Homes that are built to the 2008 standard are required to use 30 per cent less energy than was previously necessary to stay at a comfortable indoor temperature.

Figure 5.2 Heat loss reduction through glass



Source: DBH, 2007

Insulating the hot water cylinder is a simple and affordable form of insulation that is not always considered when upgrades are made to homes. Cylinders have different levels of insulation, depending on when they were installed. Cylinders installed in homes before the 1988 standard came into effect have lower levels of built-in insulation. Heat loss from even a well-insulated cylinder is still around two kW per day, due to standing heat loss (DBH, 2008c).[28] A cylinder wrap is a very affordable method of insulation and can result in worthwhile energy savings (see Table 5.1).

The new insulation standards that came into effect in September 2008 require higher r-values. These will add to the cost of insulating both new or existing houses (see Table 2.1 for r-values). Pay-back periods for households may be increased, owing to the higher initial costs. However, the benefits will include reductions in heating costs and warmer houses.

It has been found that it is generally more effective to properly insulate a small number of houses, than to partially retrofit a large number of houses (Lowe, 2002). It is not economically viable for local or central government to provide funding for every house in Auckland to be upgraded to the 2008 insulation standards. Therefore optimum balance will need to be found between partially funding retrofits for a large number of houses (together with providing incentives for additional changes) and fully funding retrofits for a small number of houses, each of which will derive the maximum benefit from the changes.

5.1.2 Ventilation

In a well insulated house, heating and cooling become a delicate balance of factors. Ventilation has an important role to play in maintaining temperature, minimising energy use and ensuring good indoor air quality.

In houses with unflued heating appliances, poor ventilation will compound the build-up of indoor air pollutants. This becomes problematic when a house is well insulated, relatively air-tight and the appliances are in use.

[28] For any type of hot water storage, energy is lost through the walls of the cylinder even if no hot water is being used. This is called 'standing loss' (DBH, 2008c).

Over-heating in summer is a common problem in both under-insulated and well insulated houses with inadequate ventilation (typically newer houses in the latter case). This can lead to increased reliance on cooling systems and thus more energy use.

Passive cooling in the form of shading by planting, eaves, blinds, pergolas, effective ventilation and good insulation is preferable to using cooling devices such as fans or air-conditioners. Insulation and thermal mass in walls and the roof provide barriers to external heat and help to maintain a stable and cooler temperature indoors.

5.1.3 Heating

The appropriate heating type depends on the house's conditions and heating requirements. Some households may heat the whole house, others only living rooms and bedrooms. Heating options that would suit most retrofitting situations (regardless of insulation) are heat pumps, flued gas heating, pellet burners or low emission woodburners.

Significant energy savings are possible by switching to a heat pump. The best heat pumps can provide up to five kW of heating for every kW of electricity used. Some models are not as efficient, especially if they are larger units or when outside temperatures drop below 5°C.

Gas heaters are up to 90 per cent efficient and are relatively cheap to run, especially if they use reticulated natural gas rather than LPG. Prices of the heaters and their installation are usually significantly more than for electric heating, especially if a connection to a gas main is required. All gas heating must be properly installed and vented to reduce health and safety risks to acceptable levels.

Woodburners, when used correctly, are efficient and cheap to run. Unfortunately, even when used properly they contribute significantly to winter ambient air particulate pollution.

Pellet burners are also efficient and are less polluting than woodburners. They are slightly more expensive to run than a woodburner, as they use both electricity and specially re-constituted wood pellets.

Consumer Magazine recently compared the prices for home heating options and found that the cheapest to run are woodburners and heat pumps, with the most expensive being an unflued LPG heater running off a 9kg cylinder (Consumer, 2009).

5.1.4 Summary of typical cost and payback periods

Table 5.1 summarises the typical costs, benefits and payback periods for a range of energy efficiency measures in homes, based on data supplied by EECA and Meridian Energy (EECA, 2001a), (Meridian, 2008).

Table 5.1 Indicative costs and benefits of energy efficiency measures in homes based on upgrading a 120m^2 home

Measure	Cost *	Benefits / Effect	Energy Savings per annum	Payback Period **
Ceiling insulation with r-value of 2.9 ***	Average of $11 per m^2 ($1,320 for whole house)	Reduces heat loss by up to 34%, increases indoor temperature.	$180-400	3 - 7 years
Thermal Lined Curtains	Variable ($4,500 on average)	Can reduce 21-31% heat loss through windows.	Up to $250	18 years
Wall insulation with r-value 2.0 ***	$6-10 per m^2 ($720-1,200 for whole house) excluding relining the walls	18-25% heat losses reduced.	Up to $300	2.5 - 4 years
Double glazing	Approx. $500-750 per 2m² window ($5,000-7,000 for whole house)	Expensive but, 47% more effective than standard glass at insulating and also effective in reducing noise. 10-15% energy savings.	Up to $250	20 - 28 years
Underfloor insulation with r-value of 1.3 ***	$16 per sq metre ($1,920 for whole house)	12-14% heat loss reduced.	Around $165	11 - 12 years
Carpet	Variable ($4,800 on average)	12-14% heat loss reduced.	Around $165	29 years
Draught stopping	Up to $200	Reduces heat loss by 6-9%	Up to $250	10 months
Hot water cylinder wrap	$80-100	Heat loss can be up to 40%. With wrap between 5-25% can be saved depending on usage.	Up to $140	7 - 9 months

* Based on a 120m² house.

** Assuming that the rate of energy price increases matches the discount rate for cash

*** r-values based on new building code standard (effective 2008).

5.2 Primary benefits

The primary benefits associated with improving insulation and clean heating - energy savings, healthier households and better air quality – are covered in this subsection.

Other benefits such as reductions in greenhouse gas emissions, improved security of supply, increased tenure and property values, and added economic stimulus through job creation are dealt with in the following subsection on co-benefits.

5.2.1 Energy savings

There are considerable savings to be made by reducing household energy use. The extent of these will depend on the amount and quality of insulation the physical characteristics of the houses, climatic conditions and household occupants' behaviour (Table 5.2). EECA estimates that medium to low cost insulation measures alone could reduce total annual residential consumer energy use by up to eight per cent (EECA, 2001b).

Table 5.2 Potential savings in annual household energy use for space and water heating compared to an uninsulated home

	Total Energy Use in Households (kWh)	Energy Used for Space Heating * (kWh)	Potential Space Heating Savings (kWh)	Energy Used for Water Heating ** (kWh)	Potential Water Heating Savings (kWh)	Total Energy Use after Savings (kWh)	Total Potential Savings (kWh)
Saving of 5% (as estimated by HEEP report)	10,660	3,624	180	3,091	770	9,710	950
Saving of 6-22% - with better insulation (as estimated by EECA)	10,660	3,624	220 - 800	3,091	770	9,090 - 9,670	990 - 1,570
Saving of 65% (new homes built to 2008 standards)	10,660	3,624	2,355	3,091	770	7,535	3,125
Saving of 81% (best practice ***)	10,660	3,624	2,935	3,091	770	6,955	3,705

* Based on 34 per cent of total household energy used for space heating (BRANZ, 2006).

** Based on 29 per cent of total household energy used for water heating (BRANZ, 2006)

*** Best practice is when insulation and energy efficiency measures are installed beyond the code minimum to the highest level available in products

EECA also estimates that six per cent to 22 per cent space heating energy savings per household could be made by insulating timber framed houses to 1978 code levels; and up to 81 per cent if the house is insulated to best practice levels (EECA, 2005). The savings are likely to be lower in Auckland houses, owing to the milder climate and the higher proportion of newer houses compared to other regions. The HEEP report suggests that an overall saving of about five per cent is more likely (BRANZ, 2006).

While significant energy savings are possible when insulation is at least code compliant, "takeback" by households can reduce the actual overall energy savings. "Takeback" is when a household's expectations of comfort increase. This counteracts energy savings as more energy is used to meet the new expectations (CHRANZ, 2006).

From Table 5.2, an investment of $1,800 for improved insulation and a cylinder wrap can result in energy savings of up to 1570 kWh, which equals $275 per annum.[29]

5.2.2 Healthier households

In households with vulnerable occupants, the health benefits of well insulated homes are usually greater than the energy savings benefits. The University of Otago Housing and Health research programme has shown that living in cold, damp houses increases the risk of respiratory problems, psychological stress and prolongs colds and flues. Hospitalisation and sick days taken from school and work were also found to be higher in households living in cold damp houses (Howden-Chapman, 2006). There are also flow-on effects to the rest of society. Sub-standard housing impacts on social cohesion, inequalities, the economy and costs to the health system.

Health improvements from insulating homes are:

- Fewer days off work and school;
- Fewer GP and hospital visits;
- Reduced medication costs;
- Reduced number of attacks for asthma sufferers;
- Reduced winter mortality;
- Improvement in self-reported mental health and well-being - as a result of reducing the stress of living in a cold, mouldy house, less social stigma, and reduced affects of neighbourhood noise through better insulation.

Further benefits were found when homes were insulated in conjunction with clean heat upgrades. Self-reported health was improved, occupants had fewer days off school and work, and GP visits and hospitalisations were reduced as shown in Table 5.3 (Chapman *et al*, 2004).

[29] Assuming a variable electricity price of 0.175c per kWh.

Table 5.3 Reduction in days off work and school resulting from insulating homes

	Control Group Days Off School	Intervention Group Days Off School	Reduction in Days Off School
Children aged 6-12	1,094	923	171
Teenagers aged 12-18	498	301	197
Total (school age children)	1,592	1,224	368
	Control Group Days Off Work	Intervention Group Days Off Work	Reduction in Days Off Work
Adults aged 19-64	1,029	632	397

Source: Chapman *et al*, 2004

The present value[30] of these benefits to households was calculated to be $3,110 excluding GP visits for an insulation investment of $1,800 per household (Table 5.4). This was based on an annual health benefit of $202.10 per household assuming a five per cent discount rate over 30 years.

Table 5.4 Health benefits and energy savings resulting from insulating homes

	Reduced GP Visits [self-reported]	Reduced Hospital Admissions	Reduced Days Off School	Reduced Days Off Work	Energy Savings	Total Benefits Excluding GP Visit Savings
Annual Benefits per Household ($)	[$46.50]	$71.60	$10.00	$51.30	$69.10	$202.10
Present Value of Benefits per Household ($)	[$715]	$1,100	$150	$790	$1,060	$3,110

Source: Howden-Chapman, 2004b

The benefit calculations were based on a number of conservative assumptions. Firstly the reduced GP visits were excluded from the total benefits as they were self-reported and were therefore deemed to be potentially biased. Secondly, the assumption was made that the price of electricity would experience a zero real price increase (even though energy prices had increased by over four per cent per annum in the years

30 Present value is the value on a given date of a future payment or series of future payments, discounted to reflect the time value of money and other factors such as investment risk. Present value calculations are widely used in business and economics to provide a means to compare cash flows at different times on a meaningful "like to like" basis. For example, if the discount or investment rate is 10%, $100 now can be turned into $110 one year from now. Thus, $100 now and $110 a year from now have the same value.

preceding the study). In addition, having children living in warm, healthy homes will also reduce the long-term consequences of childhood illness which are not factored into the above figures.

Based on Table 5.4, an overall benefit-cost ratio is close to two[31] means that the benefits accruing over time, in terms of health gains and energy savings, are a comfortable margin in excess of the costs of installing insulation in the house in the study.

However, it likely that benefit-cost ratio is considerably higher. Combining the results in Table 5.4 with those in Table 5.2, an insulation investment of $1,800 can return energy savings of $275 per annum and health benefits of $180 per annum (if GP visits are included). [32] This would result in a present value of $5,670 over 20 years, yielding a total ratio of 3.15.

5.2.3 Improved air quality

Around two-thirds of New Zealanders live in areas that suffer from poor air quality, most of which is due to high winter levels of fine particles (PM_{10}) from the burning of wood or coal used for home heating. Regional councils are required to bring PM_{10} levels in their airsheds to within the National Environmental Standards for Air Quality (AQNES) by 2013 (MfE, 2004b).

The Ministry for the Environment (MfE) has estimated that meeting all of the AQNES would:

- Save up to 625 lives to 2020;
- Return a saving of $429.2 million (present value) in benefits due to reduced mortality and illness on an investment of $110.8 million (present value) in terms of woodburner replacements, ambient monitoring and other costs;
- Yield a benefit-cost ratio of 3.87.

The estimates are based on the period 2004 to 2020, using a discount rate of 10 per cent, and show that the achievement of the AQNES is efficient and economically justified (MfE, 2004a).

In Auckland, PM_{10} concentrations regularly exceed allowable levels in the national standard and the ARC estimate that annual emissions from both motor vehicles and domestic fires in the urban airshed need to reduce by 58 per cent over 2005 levels in order to meet the PM_{10} standard by 2013 (ARC, 2006b). Using the HAPINZ data (Fisher *et al*, 2007) updated for the 2006 Census (ARC, 2009b), it is possible to estimate the health benefits accrued by meeting the standard and compare them with the likely costs of implementing cleaner heating appliances as shown in the following example (see Appendix 5 for more details):

[31] Benefit ($3,110) / Cost ($1,800) = 1.73

[32] Based on total benefits of $202.10 less energy savings of $69.10 but including reduced GP visits of $46.50.

Health benefits: The Auckland urban airshed can be assumed to cover the four centrally-located TAs of North Shore city, Waitakere city, Auckland city and Manukau city which together have a combined population of 1,143,120 according to the 2006 Census. Scaling the estimates from HAPINZ, the health effects in the Auckland urban area in 2006 resulting from domestic fire pollution are shown in Table 5.5.

Table 5.5 The cost of health effects from domestic fire pollution in the urban area of Auckland for 2006

Health Effect in 2006	No of Cases	Cost per Case	Total Cost
Deaths due to PM	157	$750,000	$117.7 million
Deaths due to CO	9	$750,000	$7.0 million
Cancer	7	$750,000	$5.3 million
COPD/Bronchitis	267	$75,000	$20.0 million
Cardiac Admissions	41	$3,675	$0.15 million
Respiratory Admissions	80	$2,700	$0.22 million
Restricted Activity Days (RADs)	330,525	$92	$30.4 million
Total Health Effects in 2006			$180.9 million

Source: Fisher *et al*, 2007 and ARC, 2009b

If the PM_{10} standard is met by 2013 through annual emissions being reduced by 58 per cent then the health costs in 2013 reduce to $76.0 million. Assuming this saving is realised following a straight line path from 2006 to 2013 and that the benefits persist out 20 years to 2025 then the present value of accrued benefits would equal $989 million.[33]

Implementation costs: Based on the Auckland Home Heating Survey 2007, there are 87,000 domestic fires in the urban area that do not currently comply with the AQNES woodburner standard (Metcalfe, 2009). However, the use of woodburners is declining in the Auckland region.

Assuming that only 52,000 non-compliant woodburners would need to be replaced with clean heating appliances[34] in order to achieve the 58 per cent reduction and that each replacement would cost approximately $4,000 for the appliance and any associated installation costs, the total replacement cost would be $308.0 million. Spreading the replacements evenly between 2006 and 2013 following a straight line path, the present value of accrued costs would equal $168 million.[35]

Benefit-cost ratio: From the previous calculations, this example of a clean heat upgrade programme in the Auckland urban area would return a benefit-cost ratio of 5.89.

[33] Based on 2006, a discount rate of 0.05, and for accrued benefits out for 20 years.
[34] Heat pumps, pellet burners, AQNES woodburners and flued gas heaters all qualify as clean heating appliances.
[35] Based on 2006, a discount rate of 0.05, and for accrued benefits out for 20 years.

Please note that this example is intended to indicate the potential benefits of this type of initiative only. It does not consider the benefits resulting from reduced child morbidity and infant mortality, warmer indoor environments, and reduced fuel costs through higher efficiency appliances nor the effect of increasing population and current trends. It is also calculated for a base year of 2006.

5.2.4 Estimate of combined primary benefits

Based on the analyses in the previous sections, it is possible to estimate the potential combined benefits and costs of an insulation and clean heat initiative per household. Assuming all improvements will deliver benefits for at least 20 years, with a discount rate of five per cent, the benefits and costs per household upgrade are shown in Table 5.6.

Table 5.6 The combined primary benefits and costs for an insulation and clean heat upgrade per household

	Present Value	Assumptions
Energy Savings	$2,243	Based on $275 pa, taken from Table 5.2 EECA savings of 1,570 kWh pa due to improved insulation and cylinder wrap
Healthier Homes	$3,427	Based on $180 pa, taken from HIH Study combining all health benefits incl. reduced GP visits less energy savings
Better Air Quality	$25,136	Based on $2,017 pa, taken from HAPINZ Study scaling for the Auckland urban area in 2006 for all health effects benefits*
Total Primary Benefits	$30,806	
Insulation plus Cylinder Wrap	$1,800	Based on HIH Study
Clean Heat Appliance	$4,000	Based on $2,000 per appliance plus an additional $2,000 for installation costs including consent fees
Total Primary Costs	$5,800	Overall Benefit/Cost Ratio=5.31

*Note this benefit will be realised by more than just the household undergoing the upgrade

Source: Howden-Chapman, 2004, Fisher *et al*, 2007, and ARC, 2009b

5.3 Co-benefits

Following on from the assessment of primary benefits, this subsection discusses other benefits that could potentially be realised from an insulation and clean heat upgrade programme.

5.3.1 Reduced greenhouse gas emissions

The residential energy sector in 2007 accounted for 12.6 per cent of New Zealand's energy (MED, 2008a) and 1.7 per cent of New Zealand's greenhouse gas emissions[36] (MED, 2008b). It has been estimated that every one per cent reduction in energy use in homes nationally would result in a 0.1 per cent reduction in national CO_2 emissions. Such reductions would also reduce the cost of applicable carbon emissions trading impositions (BRANZ, 2003).

Any programme improving insulation will reduce the energy needed to heat a household. If the upgrade includes a clean heating appliance, further energy savings will be possible as the newer appliances perform considerably better than older appliances.[37] The potential savings that can be realised are illustrated in the following example.

Example: From Table 4.2, there are approximately 15,000 homes in the Auckland region that have undergone major insulation and clean heat upgrades, leaving approximately 79,000 un-insulated homes[38] and 345,000 homes insulated but below the 2008 standard.

If 52,000 of the most poorly insulated homes (corresponding to those homes with non-compliant woodburners that would need to be upgraded to achieve the AQNES) underwent a major upgrade that resulted in a 30 per cent improvement in their home's heat loss combined with a further 30 per cent reduction in the amount of energy required to heat their home plus received a cylinder wrap, then each home could potentially reduce their annual energy bill by 2795 kilowatt hour (kWh) (a saving of 27.9 per cent overall).

If the remaining homes (372,000 households) underwent a lesser upgrade that resulted in a 10 per cent improvement in their home's heat loss combined with a further 25 per cent reduction in the amount of energy required to heat their home plus received a cylinder wrap, then each home could potentially reduce their annual energy bill by 2070 kWh (a saving of 19.4 per cent overall).

Greenhouse gas emissions from the New Zealand residential sector in 2007 were 572 kilotonnes $CO_{2\text{-}e}$. (MED, 2008b). Scaling for population, Auckland's share of this total would be close to 185 kilotonnes $CO_{2\text{-}e}$. A 20 per cent reduction in Auckland's residential energy use (equivalent to the example above) would reduce this total by 37 kilo tonnes $CO_{2\text{-}e}$ and would be worth \$0.925 million in carbon credits[39] per annum.

[36] As carbon dioxide equivalents ($CO_{2\text{-}e}$).
[37] A typical heat pump has a coefficient of performance of 4 versus a bar heater at 1, therefore a heat pump using 1 kW of electricity will produce four times as much heat. Similarly an open fire has a thermal efficiency of around 15 per cent versus an AQNES woodburner that must be at least 65 per cent efficient so more than four times the amount of wood would be needed for the open fire to maintain the same indoor temperature as an AQNES burner.
[38] Averaging the BRANZ< HEEP, MfE and EECA figures for the remainder.
[39] At a carbon price of \$25 per tonne $CO_{2\text{-}e}$.

5.3.2 Improved security of supply

In addition to the energy savings and greenhouse gas emissions benefits, an insulation and clean heat upgrade programme would also improve security of supply.

In the example used previously, the regional energy savings would be 1,630 million kWh. Assuming that 60 per cent of the energy saving would be in electricity[40], the combined energy savings would total more than 978 million kWh. This would be equivalent to the output of a 240 megawatt (MW) power station during the winter period (when most of the load would arise).

This would improve the security of supply and would save the cost of building a new power station at over $300 million.[41]

5.3.3 Increased tenure and property values

An analysis of the economic benefits of insulation in rental properties, using a Whakatane case study, found that tenancies lasted longer in houses with insulation. This resulted in savings for landlords, as they did not have to find new tenants as often. The cost for insulation and hot water cylinder wraps was calculated at $3,150 per house, with a typical floor area of 150m² (BRANZ, 2005b). Savings to the landlord were about $290 per annum (see Table 5.7). This means that the pay back period is about 10 years, which may be too long for many landlords. A rent increase of about $60 per week would be required to achieve pay back in one year. A $12 per week rent increase would achieve a five year pay back.

Table 5.7 Estimates of benefits of insulation and hot water cylinder wraps in rental properties

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

Source: BRANZ, 2005b

In Auckland, there are approximately 107,200 privately-owned rental properties (see Table 3.4). If all of these properties were upgraded to an appropriate insulation standard, the regional savings to landlords would tally $31.1 million per annum.

[40] Based on the proportion of space heating and water heating provided by electricity.
[41] Based on the costings for the 480 MW Rodney Power Station, which is expected to cost over $500 million to build, with a further $117 million required for gas infrastructure.

Under the Warm Up New Zealand: Heat Smart programme run by EECA,[42] landlords qualify for grants towards the cost of insulation and heating depending on the socio-economic status of their tenants as follows:

- Landlords with tenants who hold community services are eligible for a grant up to 60 per cent of the total cost of insulation and $500 (including GST) towards a clean heat appliance.
- For the remaining landlords, all owners of houses built before 2000 are eligible for 33 per cent of the total cost of insulation up to $1,300 (including GST) and $500 (including GST) towards a clean heat appliance.

For home owners, insulation and clean more efficient heating appliances may also add to the resale and rental values of the property. This becomes more likely as energy efficiency becomes better understood and more valued in the housing market. This is already underway through education and programmes such as the Home Energy Rating Scheme (HERS), launched at the end of 2007. The economic effects of facilitating upgrades need to be considered in relation to the location and scale of the initiatives. There could be significant increases in the market values of houses in areas that are targeted for upgrades.

Under the Warm Up New Zealand: Heat Smart programme, home owners qualify for grants towards the cost of insulation and heating depending on their socio-economic status as follows:

- Home owners who hold community services are eligible for a grant up to 60 per cent[43] of the total cost of insulation and $1,200 (including GST) towards a clean heat appliance.
- For the remaining home owners, all owners of houses built before 2000 are eligible for 33 per cent of the total cost of insulation up to $1,300 (including GST) and $500 (including GST) towards a clean heat appliance.

5.3.4 Economic stimulus through job creation

The residential sector is a large source of employment, with the house building and renovation industry worth in excess of $12.0 billion annually and directly employing about eight per cent of the workforce (Beacon, 2008).

Beacon Pathway Ltd undertook an analysis of the economic benefits of a large scale renovation programme for the Jobs Summit held in February 2009. They estimate that a standard 1940-1960 home[44] renovated for improved performance would require an estimated 277 hours of labour split between a variety of sub trades. For every 1000

[42] Applies to all houses built before 2000.
[43] In some regions, the total finding given to Community Services Card holders may be higher, where third party funding from charities, lines companies or councils is provided. EECA advises home owners to ask their local provider what they offer.
[44] These homes were picked due to the ease with which retrofits can be undertaken and research undertaken by BRANZ indicates that there are a total of 479,000 of these houses throughout New Zealand.

homes retrofitted, a total of 151 full time equivalent jobs would be required for the delivery of the retrofitting services alone (Beacon, 2009).

In Auckland, around nine per cent of the housing stock is in the 1940-1960 age category (see Figure 3.11) so there would be just over 39,500 homes as candidates for such a scheme. Based on Beacon's figures and assuming 4000 retrofits could be undertaken each year for 10 years, a renovation programme involving only these homes would keep at least 600 full time equivalents employed for 10 years. Assuming an average regional weekly income of $728 (Statistics NZ, 2008b), this would translate to $151.4 million per annum.

It should be noted that the Beacon programme incorporates considerably more than the installation of improved insulation and clean efficient heating devices. Their programme also covers a ground polythene vapour, a heat transfer system, solar water heating, low flow water devices and low flush toilets, a rainwater tanks, extraction fans in the kitchens and bathrooms, and double glazing retrofitted into existing timber window frames. The likely cost for materials and labour for the Beacon proposal would be in excess of $20,000 per household, whereas the example used in Table 5.6 was based on an investment of $5,800 per household. Regardless, there would still be considerable employment benefits from a programme that only focussed on insulation and clean heating.

5.3.5 Estimate of combined co-benefits

It is not possible to estimate the potential combined co-benefits of an insulation and warm home initiative per household as the benefits and cost will hinge on the timing and design of the programme. Notwithstanding, a regional upgrade programme could deliver co-benefits in the order of:

- $0.925 million per annum in carbon credits;
- $300 million one-off saving on a 240 MW power station;
- $31.1 million per annum in savings on tenure costs for rental properties;
- $151.4 million per annum in additional jobs created.

6 Conclusions

6.1 Key findings

This report has used a range of information sources to assess the current state of the region's housing in relation to insulation and energy efficiency. It has found that;

- of the 439,000 houses in region, approximately 60 per cent were built before the 1978 insulation standard came into effect;
- houses built before the standard came into effect are more likely to be cold, damp and mouldy;
- surveys suggest that up to 27 per cent (118,550) of houses in the region have little or no insulation;
- approximately 15,000 homes have received insulation retrofitting through EECA and HNZC programmes in the region.

Despite technological improvements and growing awareness of energy efficiency, many houses are still not meeting WHO recommended indoor temperatures. Furthermore, the use of inefficient, polluting heating devices is contributing to poor household health and breaches of the National Environmental Standards for Air Quality (AQNES).

- There are still significant numbers of households (29 per cent) using solid fuel, such as wood or coal, for heating.
- Gas heating is used in approximately 35 per cent of houses, with estimates suggesting that up to two thirds of these homes use gas in an unflued appliance causing serious health risks to occupants.

The region's stock of un-insulated houses with polluting heating devices is contributing to;

- high rates of asthma and other respiratory illness, which increase the burden on the health system;
- increased air pollution during winter, at levels which breach air quality standards set to protect human health;
- loss on economic output through days taken off work and school.

Substantial improvements could be made to the energy efficiency status and heating standards of the region's homes. Many households are unable to make improvements owing to constraints such as lack of ownership, limited tenure or low-income. Central and local government intervention is necessary to assist households who are not able to make improvements, or to encourage those who can to act. The region faces the following challenges:

- Demographic change, including increases in the numbers of elderly and children. These groups are more vulnerable to the effects of cold, damp housing and poor air quality.
- Unsustainable resource use, including increasing household energy consumption.
- Climate change and the associated need to reduce CO_2 emissions.
- Social disadvantage, such as the issue of fuel poverty.
- Maintaining air quality where it is good and improving it in areas where it is now degraded.

Moving towards sustainable homes will help to address these challenges and will contribute significantly to the health and well-being of the region's population and improve the security of energy supply.

All programmes should take a comprehensive approach to retrofitting, rather than focusing on 'quick fix' methods. The best way to improve the energy efficiency and the warmth of homes is to deal with all of the factors that contribute to these. Although this will be initially more expensive, it will produce better results and significant savings over the longer term. A holistic approach should be taken because energy use is influenced by both household behaviour and the physical state and characteristics of the house concerned.

To date there have been limited and uncoordinated efforts towards improving the warmth of Auckland's homes. This is probably because most government programmes have prioritised regions with colder climates, more noticeable winter air pollution problems or older houses.

EECA funding has now been substantially increased, which should provide additional opportunities to develop and extend relevant programmes in Auckland.

This seems to be an opportune time to vigorously address the issue of the region's air quality and at the same time improving the energy efficiency, warmth and heating of Auckland's housing.

6.2 Summary and recommendations

Even from the preliminary benefit cost analyses undertaken in this report, there is a compelling case for the ARC and other stakeholders to collaborate on a coordinated and accelerated programme of action for insulation and clean heat upgrades which will deliver a suite of benefits to Aucklanders.

This report has also shown that it is important to continue to regularly collect and evaluate information, such as home heating surveys. There are many additional analyses that could be undertaken on the ARC Home Heating Survey 2007. For example, data collected from that survey on dwelling ages, heating devices and insulation could be mapped to help identify areas where intervention would be most beneficial. This information could also be cross-referenced with socio-economic data.

Future work is recommended to identify the policy options required to accelerate the sustainability of the housing stock. This should include extending the assessment to other aspects of household sustainability in Auckland, such as solar water heating, rainwater tanks and grey water use.

7 References

ARC (2001). Housing Demand and Supply: the impact of socio-economic change in the Auckland region. Prepared by L. David for Auckland Regional Council.

ARC (2006a). *Auckland Air Emissions Inventory: 2004*. Prepared by J. Metcalfe, G. Fisher, M. Sherman and G. Kuschel for Auckland Regional Council, ARC Technical Publication No. 292.

ARC (2006b). *PM_{10} Emissions Reduction Targets and Strategies by Sector Needed to Meet the AQNES in Auckland*, Report prepared by G. Kuschel and G. Hill for Auckland Regional Council Environmental Management Committee, 9 October 2006.

ARC (2007). 2006 Census Series: Overview of Results for the Auckland. Prepared by Auckland Regional Council.

ARC (2008a). Higher Density in the Auckland Region – Visiting Bill Randolph's Australian Findings. Prepared by A. Reid for Auckland Regional Council.

ARC (2008b). *Proposed Auckland Regional Plan: Air, Land and Water*. Prepared by Auckland Regional Council, notified 23 October 2001 and highlighted to indicate provisions appealed to May 2008.

ARC (2009a). *Auckland Home Heating Survey 2007*. Prepared by Auckland Regional Council, ARC technical report In preparation.

ARC (2009b). *A Review and Update of HAPINZ for the Auckland region*. Prepared by K. Mahon for Auckland Regional Council, In preparation.

ARFNZ (2006). *Trying to Catch Our Breath - The Burden of Preventable Breathing Diseases in Children and Young People*. Edited by I. Asher and C. Byrnes for Asthma and Respiratory Foundation of New Zealand.

ARPHS (2005). *Housing and Health in Auckland – A Summary of Selected Research*. Prepared by J. Rankine for Auckland Regional Public Health Service.

Asthma Foundation (2009). New Zealand asthma statistics. [Online]. Available: www.asthmafoundation.org.nz/in_new_zealand.php, 15 July 2009

Beacon (2007). National Value Case of Sustainable Housing Innovations – Making the Case for the National Benefit to be Gained by Transforming the New Zealand

Housing Stock – Both New and Existing – to Improve Sustainability. Prepared by Allen & Clarke Policy and Regulatory Specialists, Infometrics, Eco$ense, and M. Jenkins for Beacon Pathways Ltd, October 2007.

Beacon (2008). Briefing prepared by Beacon Pathways for the Minister for Construction, November 2008, p7.

Beacon (2009). *Large Scale Renovation is BIG on Job Creation*, Briefing prepared by Beacon Pathway Ltd for the Jobs Summit held in February 2009.

BRANZ (2000). *A Draft Climate Change Sustainability Index for Houses*. Prepared by M. Camilleri for Building Research Association of New Zealand, BRANZ Study Report No. 95.

BRANZ (2003). *Energy Use in New Zealand Households: report on Year 7 of the Household Energy End-use Project (HEEP)*. Prepared by Building Research Association of New Zealand, BRANZ Study Report No. 122.

BRANZ (2005a). *2005 House Condition Survey*. Prepared by S. Clark, M. Jones, and I. Page for Building Research Association of New Zealand, BRANZ Study Report No. 142.

BRANZ (2005b). *The Value of Low Energy Technologies for Occupant and Landlord*. Prepared by A. Stoecklein, Y. Zhao, L. Christie, and L. Skumatz for Building Research Association of New Zealand, BRANZ Conference Paper No. 112.

BRANZ (2006). *Energy Use in New Zealand Households - report on the Year 10 of the Household Energy End-use Project (HEEP)*. Prepared by N. Isaacs, M. Camilleri, L. French, and A. Pollard of BRANZ Ltd, K. Saville-Smith and R. Fraser, of CRESA, P. Rossouw of CRL Ltd and J. Jowett for Building Research Association of New Zealand, BRANZ Study Report No. 155.

BRANZ (2007a). *Assessment of the Need to Adapt Buildings in New Zealand to the Impacts of Climate Change*. Prepared J. Bengtsson, R, Hargreaves, and I. Page for Building Research Association of New Zealand, BRANZ Study Report No. 179.

BRANZ (2007b). *House Insulation Guide – 3rd Edition*. Prepared by G. Tims for Building Research Association of New Zealand.

BRANZ (2007c). *National Impacts of the Widespread Adoption of Heat Pumps in New Zealand*. Prepared by N.R. Buckett for Building Research Association of New Zealand, BRANZ Study Report No. 169.

BRANZ (2007d). *Changing Housing Needs – Ageing Population Creates New Demands*. Prepared by T. Davies for BRANZ Build Magazine, Building Research Association of New Zealand.

BRANZ (2008). Common Airborne Pollutants. [Level Website Online], Available: www.level.org.nz/passive-design/controlling-humidityair-quality/common-airborne-pollutants/

CBPR (1993). *Thermal Efficiency in New Zealand Buildings – A Historical Overview*. Prepared for Centre for Building Performance Research, School of Architecture, Victoria University of Wellington.

Chapman, R.; Howden-Chapman, P. and O'Dea, D. (2004). *A Cost-Benefit Evaluation of Housing Insulation: Results from the New Zealand 'Housing, Insulation and Health' Study*. Prepared for Wellington School of Medical and Health Sciences, University of Otago.

CHRANZ (2004a). *Changes in the Structure of the New Zealand Housing Market*. Prepared by DTZ Research for the Centre for Housing Research Aotearoa New Zealand.

CHRANZ (2004b). *National Landlords Survey: Preliminary Analysis of the Data*. Prepared by K. Saville-Smith and R. Fraser of CRESA for the Centre for Housing Research Aotearoa New Zealand.

CHRANZ (2006). *The Impact on Housing Energy Efficiency of Market Prices, Incentives and Regulatory Requirements*. Prepared by I. McChesney, N. Smith, J. Baines of Taylor Baines and Associates for Centre for Housing Research Aotearoa New Zealand.

CHRANZ (2007). *Housing Supply in the Auckland Region 2000-2005*. Prepared by A. Grimes, A. Aitken, I. Mitchell and V. Smith of Motu Economic and Public Policy Research for Centre for Housing Research Aotearoa New Zealand, Department of Building and Housing and Housing New Zealand Corporation.

Consumer (2009). *Keep Warm for Less: 2009 Update of Home Heating Running Costs*, Article written by B. Whitely for Consumer Magazine, April 2009.

Cooke, M.B. (1972). *The Age of Houses Illustrated*. Farm Management and Rural Valuation Department, Lincoln College, New Zealand.

Davie G.; Baker, M.; Hales, S. and Carlin, J. (2007). Trends and Determinants of Excess Winter Mortality in New Zealand 1980-2000. *BMC Public Health*, United States of America, September 2007; 7: 263. Available: www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2174476#id2660008

DBH (2006). Compliance Document for New Zealand Building Code, Clause H1, Energy Efficiency. 3rd Edition. Prepared by the Department of Building and Housing.

DBH (2007). *Your Guide to $marter Insulation*. Prepared by the Department of Building and Housing.

DBH (2008a). *New Zealand Building Regulations*. [Online]. Department of Building and Housing. Available: www.dbh.govt.nz/building-regulations

DBH (2008b). *Indoor Climate*. [Online]. Department of Building and Housing. Available: www.dbh.govt.nz/bcr-part5-type2-indoor-climate

DBH (2008c). *Water Heating*. [Online] Smarter Homes. Available: www.smarterhomes.org.nz/energy/water-heating/

EECA, (2001a). *Designing Comfortable Homes: Guidelines on the use of Glass, Mass and Insulation for Energy Efficiency*. Prepared by M. Donn for Energy Efficiency and Conservation Authority and Cement and Concrete Association of New Zealand.

EECA (2001b). *National Energy Efficiency and Conservation Strategy – Towards a Sustainable Energy Future*. Prepared by Energy Efficiency and Conservation Authority and Ministry for the Environment for the New Zealand Government.

EECA (2005). Getting Warmer by Degrees. A Home Owner's Guide to Energy Savings and Comfortable, Healthier Living. Prepared by Energy Efficiency and Conservation Authority.

EECA, (2007a). New Zealand Energy Efficiency and Conservation Strategy –Making it Happen. Action Plan to Maximise Energy Efficiency and Renewable Energy. Prepared by Energy Efficiency and Conservation Authority for the New Zealand Government.

EECA (2007b). *Landlords and Low-income Tenants to Benefit from 55 percent Insulation Subsidy*. [Online Media Release 29 October 2007]. Energy Efficiency and Conservation Authority. Available: www.eeca.govt.nz/news/media-releases/insulation-subsidy-for-landlords.html

EECA (2008). *Natural Gas Heating*. [Online] Energywise. Available: www.energywise.org.nz/yourhome/heating/natural-gas-heating.html

EECA (2009a). Data on Energywise Homes grants for Auckland region provided by M. Whittaker, April 2009.

EECA (2009b). *Boost for Warmer, Drier, Healthier Kiwi Homes.* [Online Media Release 28 May 2009 by the Minister of Energy and Resources]. Energy Efficiency and Conservation Authority. Available: www.eeca.govt.nz/node/3109. [28 May 2009]

EECA (2009c). *Banks Waive Fees for Home Insulation Scheme*. [Online Media Release 18 June 2009 from New Zealand Prime Minister]. Energy Efficiency and Conservation Authority. Available: www.eeca.govt.nz/node/3107. [18 June 2009].

ECan (2007a). *Clean Heat Project*. [Online]. Prepared by Environment Canterbury. Available: www.cleanheat.org.nz/CHBooklet.pdf.

ECan (2007b). *Clean Heat Project Makes Inroads to Winter Air Pollution*. [Online Media Release by Environment Canterbury 10 July 2007]. Available: www.cleanheat.org.nz/MediaRelease.aspx?id=936.

Fisher G.; Kjellstrom T.; Kingham S.; Hales S. and Shrestha, R. (2007). *Health and Air Pollution in New Zealand*, Report prepared for Health Research Council of New Zealand, Ministry for the Environment, and Ministry of Transport.

HBRC (2009). *Draft Ten Year Plan 2009-2019*. Long term council community plan prepared by Hawke's Bay Regional Council.

HNZC (2005). *Building the Future: New Zealand Housing Strategy*. Prepared by Housing New Zealand Corporation for the New Zealand Government.

HNZC (2006). *The Healthy Housing Programme: Report of the Outcomes Evaluation (Year Two).* Prepared by J. Clinton, F. Mahony, R. Irvine, C. Bullen and R. Kearns for Housing New Zealand Corporation.

Howden-Chapman, P. (2004). *Housing and Health: Research, Policy and Innovation*. Edited by P. Howden-Chapman and P. Carroll, Wellington: Steele Roberts Ltd.

Howden-Chapman, P. (2006). *Housing, Heating and Health Study: 2005/2006 Report One, Aims and Methods*. Prepared by P. Howden-Chapman and the Housing and Heating Research Team, Wellington School of Medical and Health Science, University of Otago, Wellington.

Howden-Chapman, P.; Matheson, A.; Crane, J.; Viggers, H.; Cunningham, M.; Blakely, T. *et al* (2007). Effect of Insulating Existing Houses on Health Inequality: Cluster Randomised Study in the Community. *British Medical Journal* doi: 10.1136/bmj.39070.573032.80, February 2007.

Lowe, L. (2002). *Do Housing Retrofits Improve Health and Conserve Energy? The Resident's Perspective*. Masters thesis prepared by L. Lowe, University of Auckland.

Meridian Energy (2008.) *For Your Home – Energy Costs and Savings Start Here.* [Online]. Meridian Energy Available: www.meridianenergy.co.nz/YourHome/Energy+and+cost+savings/At+home/

Metcalfe J. (2009). *Domestic Emission Policy Evaluation.* Progress report prepared for Auckland Regional Council, 7 April 2009.

MED (2007). *New Zealand Energy Strategy to 2050, Powering Our Future, Towards a Sustainable Low Emissions Energy System*. Prepared by Ministry of Economic Development for the New Zealand Government.

MED (2008a). *New Zealand Energy in Brief.* Prepared by Ministry of Economic Development for the New Zealand Government.

MED (2008b). *New Zealand Energy Greenhouse Gas Emissions 1990-2007.* Prepared by Ministry of Economic Development for the New Zealand Government.

MfE (2002). *Reducing Emissions from Domestic Home Heating.* Prepared by P. Millichamp and E. Wilton for Ministry for the Environment. MfE Air Quality Technical Report No. 26.

MfE (2004a). *Proposed National Environmental Standards for Air Quality, Resource Management Act, Section 32. Analysis of the Costs and Benefits*. Prepared by Ministry for the Environment. MfE Report No. 514.

MfE (2004b). *Resource Management (National Environmental Standards Relating to Certain Air Pollutants, Dioxins, and Other Toxics) Regulations 2004 SR 2004/309 and Amendments*. Prepared by Ministry for the Environment.

MfE (2005a). *Warm Homes Technical Report: Home Heating Methods and Fuels in New Zealand*. Prepared by E. Wilton for Ministry for the Environment. MfE Report No. 701.

MfE (2005b). *Warm Homes Technical Report: Social Drivers – Phase One: Interim Progress Report*. Prepared by Taylor Baines Associates for Ministry for the Environment, MfE Report No. 702.

MfE (2009). *Air Quality (Particulate Matter – PM_{10}) Environmental Report Card*. [Online]. Ministry for the Environment. Available: www.mfe.govt.nz/environmental-reporting/report-cards/

MoH (2003). *Housing and Health*. Prepared by the Ministry of Housing (now the Department of Building and Housing).

MSD (2006). *Fuel Poverty in New Zealand*. Prepared by B. Lloyd for the Ministry of Social Development in Social Policy Journal of New Zealand - Issue 27.

NCC (2008). *Clean Heat Warm Home Programme*. [Online]. Nelson City Council. Available: www.nelsoncitycouncil.co.nz/environment/air_quality/clean-heat-warm-homes-main.htm

NIWA (2006). Climate and Health. How is Climate Linked to Respiratory Infections in Auckland. Prepared by A. Gosai, and J. Salinger for the National Institute of Water and Atmospheric Research, *Water and Atmosphere* 14 (4) 2006.

NIWA (2007). *The Climate of New Zealand – Northern New Zealand, Kaitaia, Whangarei, Auckland, Tauranga*. [Online] National Institute of Water and Atmospheric Research. Available: www.niwa.cri.nz/edu/resources/climate/overview/map_north

NZI (2008). *NZI Home Insurance – Bringing Sustainability to Your Replacement Home*. [Online] Prepared by New Zealand Insurance. Available: www.nzi.co.nz/upload/Sustainability%20Home%20Fact%20Sheet.pdf

Pearce, J.; Kingham, S. and Zawar-Reza, P. (2006). Every Breath You Take? Environmental Justice and Air Pollution in Christchurch, New Zealand. *Environment and Planning A*, 38(5): 919-938. DOI:10.1068/a37446

Presbyterian Support Otago (2005). *Old, Cold, and Costly? A Survey of Low Income Private Rental Housing in Dunedin 2004*. Prepared by D. Povey and U. Harris for Presbyterian Support Otago.

QVNZ (2009). *Essential Property Guide*. [Online]. Quotable Value New Zealand datasets and reports. Available: www.qv.co.nz/onlinereports/default.htm

REINZ (2009). *Market Trends and Market Facts Graphs*. [Online] Real Estate Institute of New Zealand. Available: www.reinz.co.nz/reinz/public/market-information/market-information_home.cfm

RGF (2007). *Auckland Sustainability Framework: An Agenda for the Future*, Regional Growth Forum.

RSDF (2008). *Auckland Sustainability Framework: Tool Kit*, Regional Sustainable Development Forum.

Rosenfeld M. (1953). *The New Zealand House*. 3rd Edition, Wilson and Horton.

Royal Commission (2007). *The Urban Environment*. The 26th Report of the Royal Commission on Environmental Pollution. [Online], Royal Commission on Environmental Pollution. Available at: www.rcep.org.uk/reports/index.htm

Statistics NZ (2008a). *New Zealand Energy Statistics: September 2007 Quarter*. Revised 14 January 2008. [Online]. Statistics New Zealand. Available: www.stats.govt.nz/products-and-services/hot-off-the-press/nz-energy-statistics/new-zealand-energy+-statistics-sep07qtr-revised-hotp.htm

Statistics NZ (2008b). *New Zealand Income Survey: June 2008 Quarter*. Revised 17 October 2008. [Online]. Statistics New Zealand. Available: http://www.stats.govt.nz/products-and-services/hot-off-the-press/nz-income-survey/nz-income-survey-jun08qtr-hotp-revised.htm?page=para005Master

Statistics NZ (2009). *Census*. Datasets and additional information. [Online]. Statistics New Zealand. Available: www.stats.govt.nz/census/default.htm#2006census

TDC (2008). *Domestic Fires – New Rules for Wood Burners*. [Online] Tasman District Council. Available: www.tasman.govt.nz/index.php?DomesticFires

WCC (2009). *Best for the West – Waitakere's 10 Year Plan 2009-2019*. Long term council community plan prepared by Waitakere City Council.

Westpac (2008). *Going Green with Your Home Loan*. [Online]. Wespac. Available: www.westpac.co.nz/olcontent/olcontent.nsf/Content/Green+home+loan+booklet

Wilson K. (2006). *Healthy Heating for Auckland: A Health Impact Assessment of the Options*. Masters thesis prepared by K. Wilson, University of Auckland.

Data received from organisations

Energy Efficiency and Conservation Authority (EECA)

Housing New Zealand Corportation (HNZC)

EcoWiseWest

Manukau City Council

Waitakere City Council

8 Glossary

Terms	
Airshed	A geographic area established to manage air pollution within the area as defined by the AQNES.
AQNES	National Environmental Standards for Air Quality
ASF	Auckland Sustainability Framework
Building Code	A national, mandatory set of standards for Building Work, forming part of the Building Regulations made under the Building Act.The Building Code is "performance based", that is, it specifies the performance required of a building rather than the particular materials, methods etc. to be used in construction.
Best Practice	As outlined in the New Zealand Standards for insulation, best practice is when insulation is installed beyond the minimum r-value required. For example, if roof r-value is R1.9, better practice is R2.6 and Best Practice is R3.3.
CAU	Census Area Unit
CO	Carbon monoxide, a type of air pollutant
CO_2	Carbon dioxide, a type of greenhouse gas
EEAP	Ecowise Energy Advice Programme run by Ecomatters Trust in Waitakere.
Fuel Poverty	When a household is unable to meet the cost of heating their home or when a household would need to spend 10 per cent or more of their budget to heat their home properly.
HAPINZ	Health and air pollution in New Zealand
HEEP	Home Energy End-use Project, a project run by BRANZ which monitors and analyses energy use in homes.
HERS	Home Energy Rating Scheme, a new scheme run by EECA.
HHH	Housing, Heating and Health Study conducted by the Housing and Heating Research Team, Wellington School of Medical and Health Sciences, University of Otago
HIH	Housing, Insulation and Health Study conducted by the Housing and Heating Research Team, Wellington School of Medical and Health Sciences, University of Otago
HVAC	Heating, Ventilation and Air-Conditioning
Joined or attached dwellings	A dwelling that is attached either horizontally or vertically to another dwelling or commercial unit, such as an apartment, flat or townhouse.
LTCCP	Long Term Council Community Plan
MEPS	Minimum Energy Performance Standards. These set out compulsory energy efficiency standards for some products, such as hot water cylinders and air conditioners.

NO_2	Nitrogen dioxide, a type of air pollutant
NZEECS	New Zealand Energy Efficiency Conservation Strategy
NZES	New Zealand Energy Strategy
NZHS	New Zealand Housing Strategy
NZS	New Zealand Standards
PM_{10}	Fine particles less than 10 microns in diameter, a type of air pollutant
RADs	Restricted Activity Days are days on which people cannot do the things they might otherwise have done if air pollution was not present.
RGS	Regional Growth Strategy
RMA	Resource Management Act
r-value	A measure of the thermal resistance used in the building and construction industry. Higher r-values indicate better insulation effectiveness.
SDI	Social Deprivation Index combines a range of socio-demographic factors to estimate an overall score of material and social deprivation for a particular area, on a scale of 1 (least deprived) to 10 (most deprived or experiencing considerable hardship).
Stand-alone dwellings	A dwelling that is not connected in any way to another dwelling.
Takeback	'Takeback' is when a household's expectations of comfort increase. This counteracts energy savings as more energy is used to meet new comfort expectations.
TA	Territorial Authority
Thermal mass	Materials that absorb solar energy and then radiates the heat out as temperatures cool. Examples are concrete and bricks. Works best if insulated.
Thermal resistance	The resistance of a building material to heat loss.
Total thermal resistance	Refers to the heat flow of the whole building envelope.
VOC	Volatile Organic Compounds, a type of air pollutant

Organisations

ADHB	Auckland District Health Board
ARC	Auckland Regional Council
ARFNZ	Asthma and Respiratory Foundation of New Zealand
ARPHS	Auckland Regional Public Health Service
BRANZ	Building Research Association of New Zealand
CHRANZ	Centre for Housing Research Aotearoa New Zealand. Established by HNZC.
CRESA	Centre for Research Evaluation and Social Assessment
DBH	Department of Building and Housing (formerly the Ministry of Housing)
EECA	Energy Efficiency and Conservation Organisation
HEET	Huntly Energy Efficiency Trust
HNZC	Housing New Zealand Corporation
IPCC	Intergovernmental Panel on Climate Change
MED	Ministry of Economic Development
MfE	Ministry for the Environment
MSD	Ministry of Social Development
NIWA	National Institute of Water and Atmospheric Research Ltd
NZI	New Zealand Insurance
QVNZ	Quotable Value New Zealand
REINZ	Real Estate Institute of New Zealand
WHO	World Health Organisation

9 Appendix 1 – Ambient Air Quality Standards

Schedule 1 of AQNES - Ambient air quality standards for contaminants (MfE, 2004b).

1-hour mean

(a) means a mean calculated every hour on the hour for the preceding hour; and

(b) in relation to a contaminant at a particular location for a particular hour, means the mean of not more than 10-minute means, collected not less than once every 10 seconds, for the contaminant at that location during that hour.

24-hour mean

(a) means a mean calculated every 24 hours at midnight for the preceding 24 hours; and

(b) in relation to a contaminant at a particular location for a particular 24-hour period, means-

(i) the mean level at which the contaminant is recorded in the air, by continuous sampling of the air at that location, throughout that 24-hour period; or

(ii) the mean of the 1-hour means for that contaminant at that location for the preceding 24 hours.

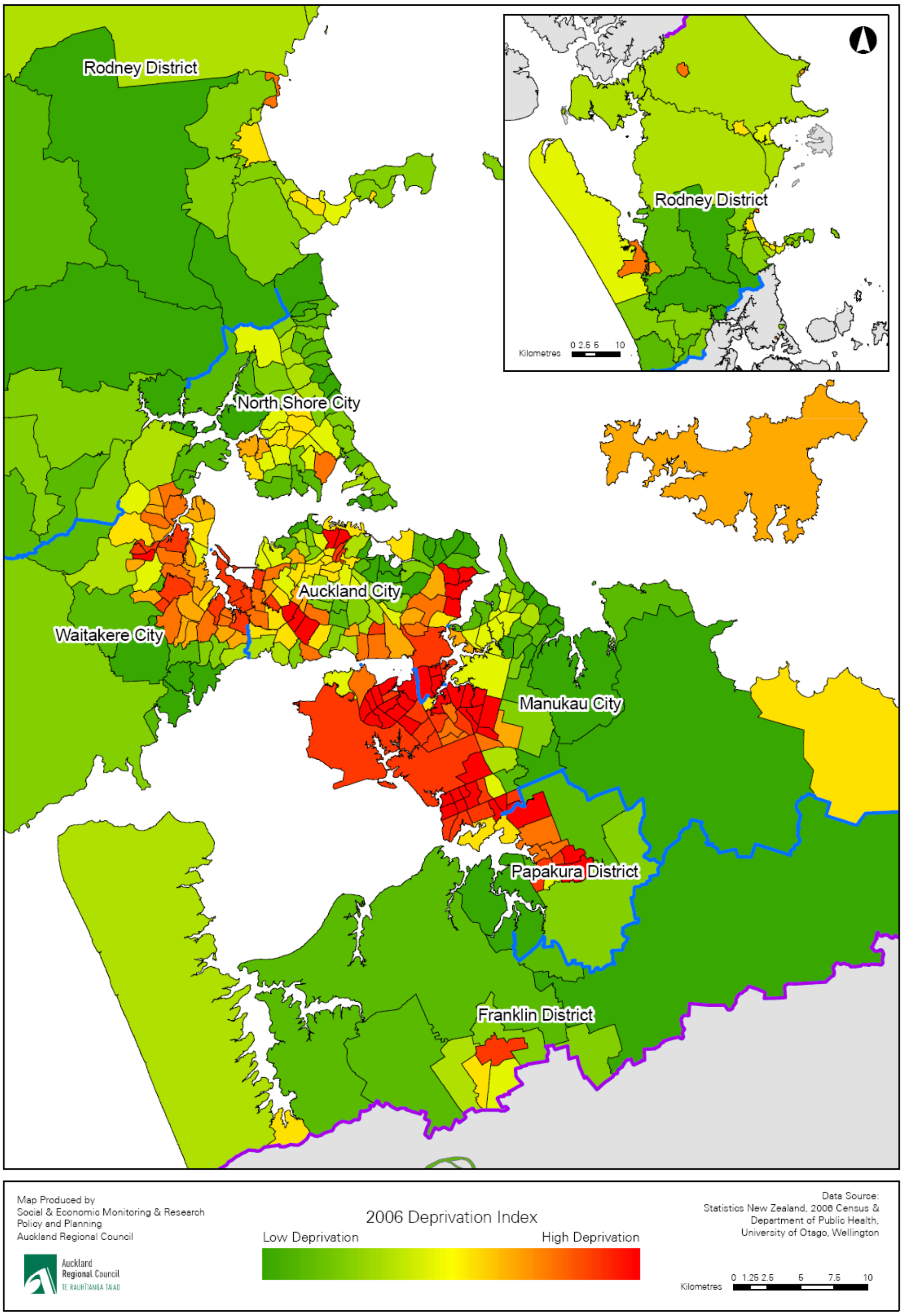
running 8-hour mean

(a) means a mean calculated every hour on the hour for that hour and the preceding seven hours to give one running 8-hour mean per hour; and

(b) in relation to a contaminant at a particular location for a particular hour, means the mean of the 1-hour means for that contaminant at that location for that hour and the preceding seven hours.

Contaminant	Threshold concentration	Permissible excess
Carbon monoxide	10 milligrams per cubic metre expressed as a running 8-hour mean	One 8-hour period in a 12-month period
Nitrogen dioxide	200 micrograms per cubic metre expressed as a 1-hour mean	9 hours in a 12-month period
Ozone	150 micrograms per cubic metre expressed as a 1-hour mean	Not to be exceeded at any time
PM_{10}	50 micrograms per cubic metre expressed as a 24-hour mean	One 24-hour period In a 12-month period
Sulphur dioxide	350 micrograms per cubic metre expressed as a 1-hour period mean	9 hours in a 12-month period
Sulphur dioxide	570 micrograms per cubic metre expressed as a 1-hour any time mean	Not to be exceeded at any time

10 Appendix 2 – Map of Social Deprivation Index



11 Appendix 3 – House sales across Auckland 2006-2008

Area	JanFeb Mar	AprMay Jun	JulAug Sep	OctNov Dec	2006 Total	JanFeb Mar	AprMay Jun	JulAug Sep	OctNov Dec	2007 Total	JanFeb Mar	AprMay Jun	JulAug Sep	OctNov Dec	2008 Total
Albany	198	259	237	248	942	265	251	199	185	900	118	140	136	130	524
East Coast Bays	362	413	421	475	1671	481	436	329	283	1529	247	222	207	207	883
Glenfield Area	340	342	361	342	1385	411	347	251	218	1227	189	171	134	143	637
Birkenhead Area	190	215	192	244	841	226	172	125	158	681	116	99	102	103	420
Milford / Takapuna	119	189	165	180	653	201	173	135	102	611	89	89	81	78	337
Devonport Area	102	97	100	134	433	90	106	64	72	332	49	49	51	56	205
Upper Harbour	89	70	91	93	343	94	95	49	60	298	50	50	37	43	180
Waitakere Area	20	11	10	15	56	26	8	7	9	50	10	8	4	6	28
Henderson Area	582	582	671	745	2580	739	706	502	447	2394	335	278	335	271	1219
Glen Eden Area	248	253	277	254	1032	300	299	207	227	1033	174	115	137	129	555
Titirangi	120	143	151	134	548	152	112	80	88	432	73	59	61	84	277
Mt Roskill Area	340	347	323	379	1389	462	426	281	303	1472	219	210	194	183	806
Mt Albert	171	255	212	233	871	227	205	161	185	778	119	125	111	117	472
City / Pt Chev	854	849	813	759	3275	724	768	677	586	2755	433	424	379	409	1645
Mt Eden /Epsom Area	351	382	446	416	1595	384	351	253	333	1321	217	256	268	225	966
Eastern Suburbs	491	540	510	569	2110	595	563	366	424	1948	291	275	287	277	1130
Ellerslie / Panmure	125	148	157	171	601	176	151	130	123	580	89	82	71	67	309
Onehunga / Penrose	278	276	276	274	1104	298	317	245	207	1067	173	144	117	95	529
Islands of Bay	89	77	64	100	330	100	88	54	59	301	53	39	19	35	146
Eastern Beaches	715	776	783	836	3110	909	827	554	571	2861	453	401	421	389	1664
Manukau Rural	4	8	10	8	30	15	4	3	4	26	5	2	3	1	11
Papatoetoe	510	485	579	627	2201	612	611	499	380	2102	345	211	234	244	1034
Manurewa Area	471	434	519	527	1951	516	518	427	350	1811	281	170	188	182	821
Papakura Area	299	262	336	285	1182	309	310	217	215	1051	160	114	120	131	525
Rodney North	170	164	184	218	736	222	193	129	143	687	126	77	97	70	370
Hibiscus Coast	306	296	309	335	1246	317	291	257	245	1110	182	142	138	150	612
Franklin	232	258	262	290	1042	332	303	243	210	1088	170	136	148	117	571
Total Auckland Region	7776	8131	8459	8891	33257	9183	8631	6444	6187	30445	4766	4088	4080	3942	16876

Source : REINZ, 2009

12 Appendix 4 – Insulation retrofits undertaken in Auckland

Statistics on retrofit from programme providers in the Auckland region. Variations in data collection methods vary; therefore all numbers should be treated as estimates only.

12.1 EECA statistics for Energywise home grants

No of Houses Insulated in the Auckland Region	2006/07	2007/08	To end Dec 2008
(a) By Territorial Authority			
Auckland City	384	494	344
Waitakere City	438	395	293
North Shore City	280	132	71
Papakura District	39	116	36
Franklin District	10	0	1
Manukau City	196	262	166
Rodney District	0	0	2
Total	1347	1399	913
(b) By Tenure			
Number of owner-occupied dwellings	1219	1236	620
Number that are rentals	128	163	293
Total	1347	1399	913
(c) By Income			
Low-income (i.e. eligible for community services card)	900	1265	872
Not low-income	447	134	41
Total	1347	1399	913
(d) By Health Referral			
Yes	731	1142	691
No	616	257	222
Total	1347	1399	913
Auckland Region Total	1347	1399	913
Houses insulated by Energywise in Auckland from 1996 to end March 2009		7500	

12.2 EcoMatters Environment Trust

Figures for houses insulated from August 2004 to December 2007

All houses are in Waitakere city or on the border between Auckland and Waitakere cities

All have been insulated under an EECA contract with funding from EECA, Waitakere City Council, Waitemata DHB and, in one year, additional monies from Genesis so that a subsidised service could be offered.

	No. of Houses per year				
Household defined as	2004/05	2005/06	2006/07	To end Dec 2007	Total
Low-income	178	305	321	109	913
Renters (Low-income)	10	21	18	8	57
Non-low-income	17	83	83	5	188
Households with respiratory health problems	195	203	250	91	739
Type of retrofitting received					
No. given ceiling insulation	154	295	249	78	776
No. given underfloor insulation	160	386	382	119	1047
No. given hot water cylinder insulation	101	187	154	51	493

12.3 Housing New Zealand Corporation

Figures for housing retrofits from 2003 to 2007 completed by programme providers.

No. Completed	2003/04	2004/05	2005/06	2006/07	To end Dec 2007	Total
Central Auckland	177	150	151	104	53	635
Manukau	15	0	0	0	0	15
South Auckland	212	160	150	103	26	651
West & North Auckland	218	205	238	100	50	811
Total	622	515	539	307	129	2,112

13 Appendix 5 – Benefit cost example for a clean heating replacement initiative

Based on HAPINZ methodology updated with 2006 Census data by ARC

Attributable to DFs in Urban Area 2006

Health Effect	No of Cases	Cost per Case	Total Cost
Deaths due to PM	157	$ 750,000	$ 117,735,688
Deaths due to CO	9	$ 750,000	$ 6,989,947
Cancer	7.1	$ 750,000	$ 5,347,308
COPD	267	$ 75,000	$ 20,014,918
Cardiac Admissions	41	$ 3,675	$ 151,279
Respiratory Admissions	80	$ 2,700	$ 216,730
RADs	330,525	$ 92	$ 30,408,292
All Health Effects			**$ 180,864,162**

Assuming achieve a 58 percent reduction in domestic fire PM10 emissions by 2013

Attributable to DFs in Urban Area 2013

Health Effect	No of Cases	Cost per Case	Total Cost
Deaths due to PM	66	$ 750,000	$ 49,448,989
Deaths due to CO	4	$ 750,000	$ 2,935,778
Cancer	3.0	$ 750,000	$ 2,245,869
COPD	112	$ 75,000	$ 8,406,266
Cardiac Admissions	17	$ 3,675	$ 63,537
Respiratory Admissions	34	$ 2,700	$ 91,027
RADs	138,820	$ 92	$ 12,771,483
All Health Effects			**$ 75,962,948**

Not accounting for population increase

Mortality/Morbidity Calculations assuming straight line path to compliance in 2013

Date	Year	PM+CO Deaths	RADs	Cancer	COPD	Respiratory	Cardiac	Total Costs	Benefits
2005	0	166	330,525	7.13	267	80.3	41.2	$ 180,864,162	$ -
2006	1	154	306,562	6.61	248	74.5	38.2	$ 167,751,511	$ 13,112,652
2007	2	142	282,599	6.10	228	68.6	35.2	$ 154,638,859	$ 26,225,304
2008	3	130	258,636	5.58	209	62.8	32.2	$ 141,526,207	$ 39,337,955
2009	4	118	234,673	5.06	189	57.0	29.2	$ 128,413,555	$ 52,450,607
2010	5	106	210,710	4.55	170	51.2	26.2	$ 115,300,903	$ 65,563,259
2011	6	94	186,747	4.03	151	45.4	23.3	$ 102,188,252	$ 78,675,911
2012	7	82	162,784	3.51	131	39.5	20.3	$ 89,075,600	$ 91,788,562
2013	8	70	138,820	2.99	112	33.7	17.3	$ 75,962,948	$ 104,901,214

Present Value Calculations assuming 52,000 non-compliant burners replaced at $4,000 each and 5% discount rate

Date	Year	Benefit	Cost	PV Benefit	PV Cost	0.05
2005	0					
2006	1	$ 13,112,652	$ 26,000,000	$ 12,488,240	$ 24,761,905	
2007	2	$ 26,225,304	$ 26,000,000	$ 23,787,123	$ 23,582,766	
2008	3	$ 39,337,955	$ 26,000,000	$ 33,981,605	$ 22,459,778	
2009	4	$ 52,450,607	$ 26,000,000	$ 43,151,244	$ 21,390,264	
2010	5	$ 65,563,259	$ 26,000,000	$ 51,370,529	$ 20,371,680	
2011	6	$ 78,675,911	$ 26,000,000	$ 58,709,176	$ 19,401,600	
2012	7	$ 91,788,562	$ 26,000,000	$ 65,232,418	$ 18,477,715	
2013	8	$ 104,901,214	$ 26,000,000	$ 71,001,271	$ 17,597,823	
2014	9	$ 104,901,214	$ -	$ 67,620,258	$ -	
2015	10	$ 104,901,214	$ -	$ 64,400,246	$ -	
2016	11	$ 104,901,214	$ -	$ 61,333,567	$ -	
2017	12	$ 104,901,214	$ -	$ 58,412,921	$ -	
2018	13	$ 104,901,214	$ -	$ 55,631,354	$ -	
2019	14	$ 104,901,214	$ -	$ 52,982,241	$ -	
2020	15	$ 104,901,214	$ -	$ 50,459,278	$ -	
2021	16	$ 104,901,214	$ -	$ 48,056,455	$ -	
2022	17	$ 104,901,214	$ -	$ 45,768,052	$ -	
2023	18	$ 104,901,214	$ -	$ 43,588,621	$ -	
2024	19	$ 104,901,214	$ -	$ 41,512,973	$ -	
2025	20	$ 104,901,214	$ -	$ 39,536,164	$ -	
				$ 989,023,735	**$ 168,043,532**	**Benefit Cost ratio = 5.89**