



*He Kainga Oranga/Housing and Health Research Programme*

**Housing, Heating and Health Study:  
2005/2006 Report Two**

**Home heating systems: preferences and trade-offs  
Report to Funders**

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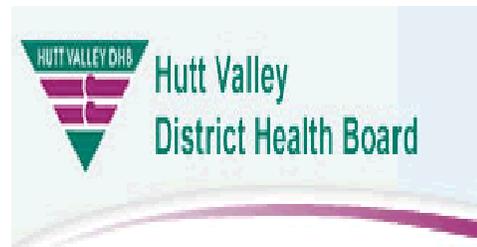


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## 1 Background

In New Zealand, around 11.5% of consumer energy is used in the residential sector (Ministry of Economic Development, 2005, p.11; 2003 data) and some 30% of this is used in residential space heating (BRANZ, 2004). With the rising price of energy, especially prices of fuel and electricity, and greater awareness of the need to constrain carbon dioxide emissions, the government and many households are looking to reduce energy demands and costs, and associated emissions.

At the same time, New Zealand houses remain poorly insulated and heated, in part because New Zealand's temperate climate was traditionally viewed as insufficiently extreme to warrant investing in insulation and heating systems, except in colder parts of the country, such as in the south of the South Island.

New Zealand is not a high-income country by OECD standards, and New Zealanders are not extravagant with home heating. Low indoor temperatures are common. An International Energy Agency report notes that "By 1995, New Zealand had the lowest space heating intensity (measured as energy per square meter per degree day) of all the countries studied, even including Japan and was about half of Australian levels." (Schipper et al 2000). According to the 2001 New Zealand Census, three percent of people used no heating at all (Statistics New Zealand, 2006) and almost a third of households had an average winter temperature below the WHO recommended minimum of 18°C (World Health Organisation, 1987). In some southern cities, heating standards are particularly poor (Shannon et al, 2003; Mill and Lloyd, 2004).

As New Zealanders' incomes have grown, however, there has been a gradual move towards improving housing insulation, and heating. Recently, central and local government programmes to encourage better insulation and more efficient heating have been expanded or introduced, particularly that of the Energy Efficiency and Conservation Authority and the Ministry for the Environment's Warm Homes project. There is also a growing awareness that an adequate temperature in the home is important for health, and that there are health risks associated with low indoor temperatures during winter (Wilkinson et al 2001). Cold housing in New Zealand has been associated with avoidable excess winter mortality among people 65 or older (Isaacs and Dunn, 1993).

However, there is relatively little research, either in New Zealand or overseas, on the effectiveness in terms of health benefits of introducing more efficient heating systems into houses (Howden-Chapman, Crane et al, 2005) and there is an associated paucity of comprehensive studies on households' preferences for different types of heating system. A typical US survey of retrofitting of multi-unit housing (DeCicco, Smith et al, 1994), for example, identified attractive payback periods for various retrofits, some as low as 6 years, depending on

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<sup>5</sup> Howden-Chapman et al, *Housing, Heating and Health Study: 2005/2006 Report One*. Wellington, HHRP, 2006

the sort of building characteristics involved but, while mentioning comfort, did not identify health improvements. Another North American study identified significant benefits, but this was based on extrapolating ambient air pollutant emission savings from energy use simulations (Levy et al, 2003).

A recent Irish modeling study analysed the returns on domestic energy conservation opportunities and concluded that a home retrofit programme thermal efficiency would result in a 3:1 benefit:cost ratio (including both energy savings, health benefits and reduction in avoidable mortality) (Healy, 2004, p5). All these studies, however, are based on modelling.

Against this background, the Housing and Health Research Programme at the Wellington School of Medicine and Health Sciences, New Zealand, undertook an empirical study to assess whether installing more efficient, sustainable heaters in New Zealand houses has any impact on the occupants' health or the energy they use. The study was based on the premise that housing is potentially an important determinant of the health of at least some New Zealanders and this may be especially the case for lower-income households occupying dwellings with poor insulation and heating. The study focussed in particular on households in which one child aged between 7 and 12 had asthma.

Potentially, health benefits of installing better heating can accrue in a number of ways, such as a reduced number of visits to general practitioners, hospitalisations, days off school, and days off work. These benefits could accrue simply through the general effect of greater warmth and dryness on respiratory health, or through specific mechanisms such as reduced moisture, mould and allergens in the house.

Households with improved heating equipment may be able to achieve both greater comfort and energy savings, since more efficient equipment can achieve a given temperature in the home with less expenditure on heating. Some households may take the benefits from more efficient heating in greater comfort, rather than making energy expenditure savings. The relative magnitude of these various benefits and the costs of achieving them is of interest, not only to health and energy researchers, but to a range of policy advisers.

From a policy viewpoint, the questions addressed in this study are significant because of imperfections in the housing market (Le Grand et al, 1992; Allen Consulting Group, 2002, p(iv)). Such imperfections often reflect lack of information. For example, house buyers may not be aware that the health and energy benefits of better heating systems may more than outweigh the additional upfront costs of the heating system, and building professionals such as builders and architects may not specify efficient heating systems because of uncertainty about whether the upfront costs will deter customers. Tenants are likely to be even less informed than house buyers, and landlords have weaker incentives to have regard to heating equipment and house comfort than buyers, and thus may exert little influence on the actions of house builders and developers. Other imperfections reflect 'externalities': better heating, to the extent it does generate better health outcomes, provides spillover benefits to the wider community in the same way that an effective public health system generates social benefits. To the extent that more efficient heating lowers energy use, it has the potential to generate environmental benefits (less air and water

pollution and lower greenhouse gas emissions) and again, such benefits accrue to the wider community.

This paper focuses on the factors influencing New Zealand households' choice of new heating systems, and their willingness to pay for improved space heating in their houses.

The underlying expectation is that a better picture of these 'values' may assist in the formulation of better housing, health and environmental policy. Details of other aspects of the 'base' study are provided elsewhere.<sup>5</sup>

The heater choices studied took place within the context of a larger study, the "Housing Heating and Health" study, that links household space heating with the health of children in those households. The principal aim of the study is to examine the effects of the indoor environment on children's health. The study focuses on asthmatic children and their families and is taking place over the New Zealand winters of 2005 and 2006.

Every household that stays in the study until its end will be given a new heater, and the household's dwelling is also having insulated installed if necessary. The new heaters are new-generation energy efficient heaters that make it cheaper to heat a substantial part of house. The study design is such that the researchers are able to compare the health and energy consumption behaviour of an intervention group with the behaviour of a control group.

## 2 Method

To summarise the overall study method, the study was a single-blinded, clustered, randomised trial of the retrofitting of new heaters, to determine whether this intervention improved the health of children with asthma in the study households.

Households were asked about their **heating system preferences**, both in respect of the current main form of heating, and the heating they would prefer. Questions explored householders' views on the indoor environment and perceived health impacts. In addition, households were asked to identify how they would 'trade off' energy savings and indoor warmth, and their willingness to pay for a heater, together with reasons.

Households were randomised into two groups, with the intervention group being the first group to gain a new, more efficient and sustainable heater that heats more of the house and gives off no indoor emissions. These heaters were installed over the summer 2005-06.

Households had a choice of a heat pump, a wood pellet burner, or a flued gas heater. Over the winter of 2006, follow-up measures are being taken and then the control households will receive their choice of new heaters in the following year.

People living in the houses were asked to record their breathing symptoms over winter, and at the end of both winters will fill in a questionnaire. Some houses have had their air quality intensively monitored for a part of the winters.

### 3 Results

Initial findings about household heater choices are now available. Final results will be available in 2007.

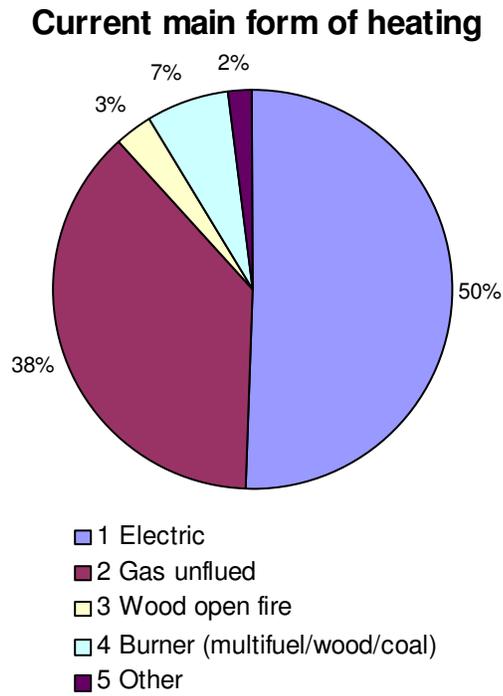
#### 3.1 Findings on 'baseline' heating system

The first set of findings relate to the **baseline** heating system (i.e. the heating system in the house before the intervention). Heads of household were asked about why that heating system had been chosen (although in some cases the choice had not been the household's – for example, in rented accommodation, it was typically the heating system in place when the household moved in – and these cases are excluded from the findings reported here).

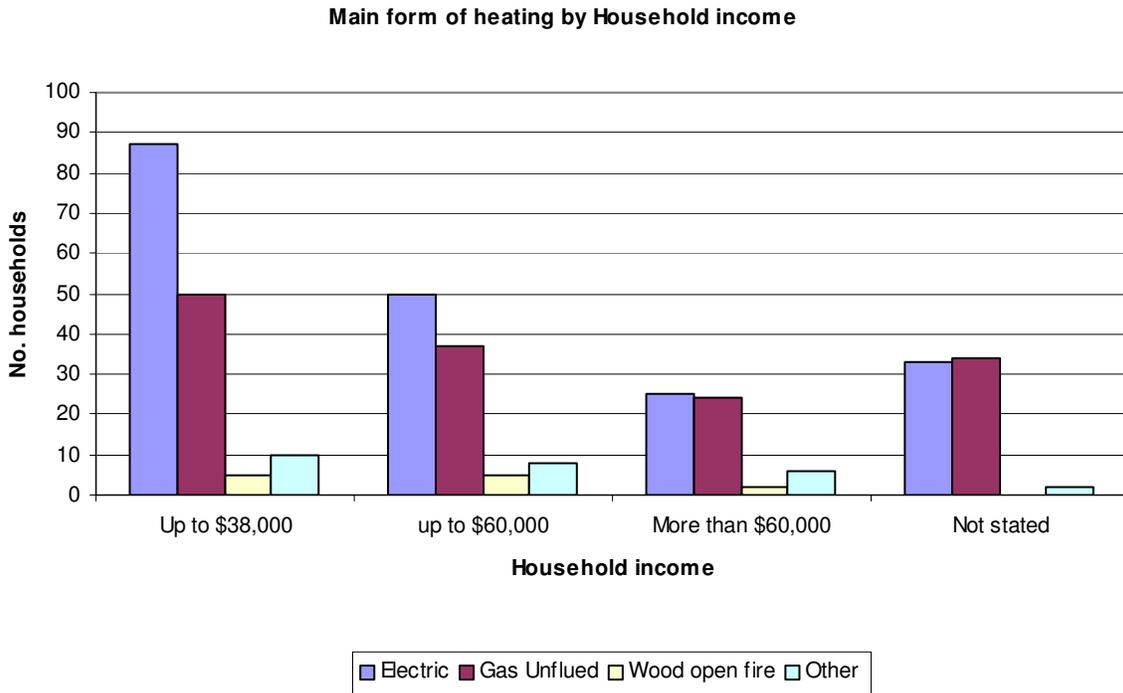
- Electric heating systems were the most common (50%) among respondents, followed by unflued gas heaters (38%); some form of solid fuel burner (wood, coal or multi-fuel) accounted for 7% of respondents; 3% used a wood open fire; and 2% of respondents reported other systems
- Both electric and unflued gas heating were used across all income groups
- Electric heating systems were more common among the low-income group in the study (households were grouped into three income levels based on reported income)
- Safety and affordability were the most common considerations in choosing heaters
- Health considerations were fairly important in choosing heaters
- Environmental considerations less often “mattered” in heater choices
- Among those with flued gas heaters, households more often reported feeling their house was cold; this was least likely among those with solid fuel burners ( $p < 0.01$ )
- Asked the reasons why their house was colder than they liked, households on low incomes more often indicated that cost was the reason (suggesting fuel poverty); among those on high incomes, ‘preference’ (rather than cost or ineffectiveness of heating) was most often cited ( $p < 0.10$ )

Graphs illustrating these findings are as follows.

**Graph 1: current (baseline) main form of heating**

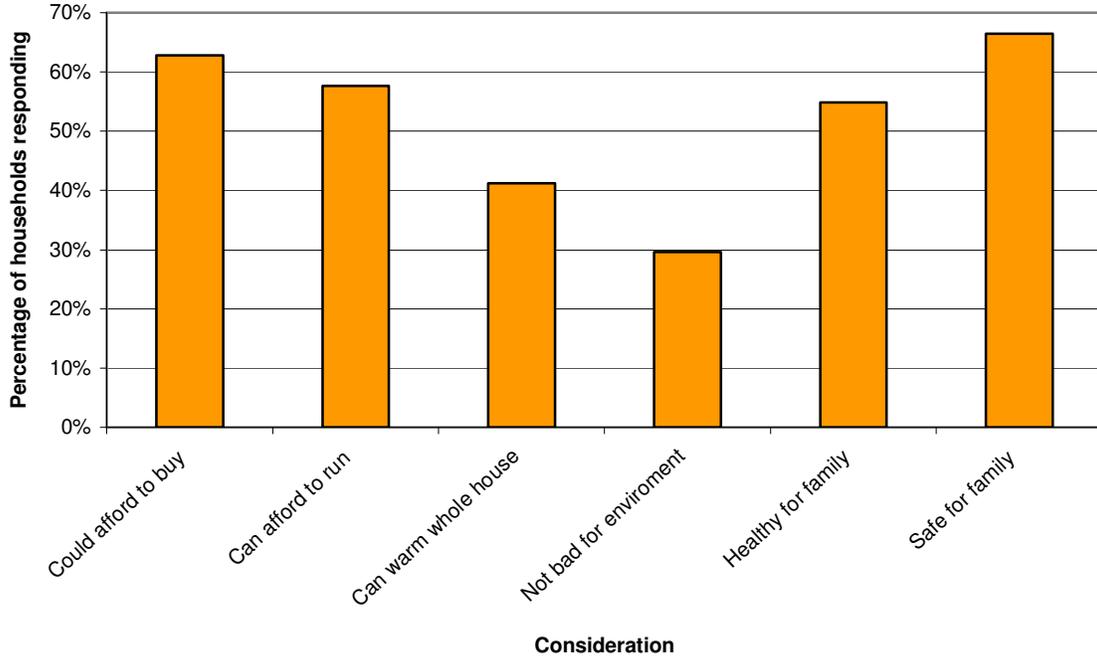


**Graph 2: main form of heating (baseline) by household income**



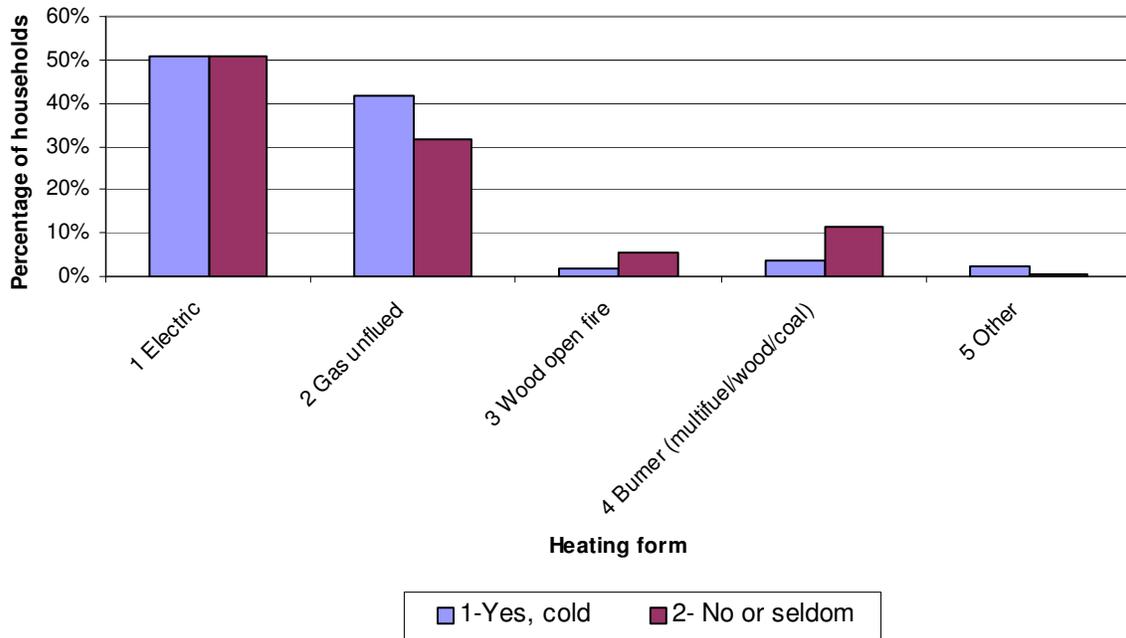
**Graph 3: What considerations mattered in choice of heating (baseline)?**

**Table 5: What mattered in choosing main heating? (%)**

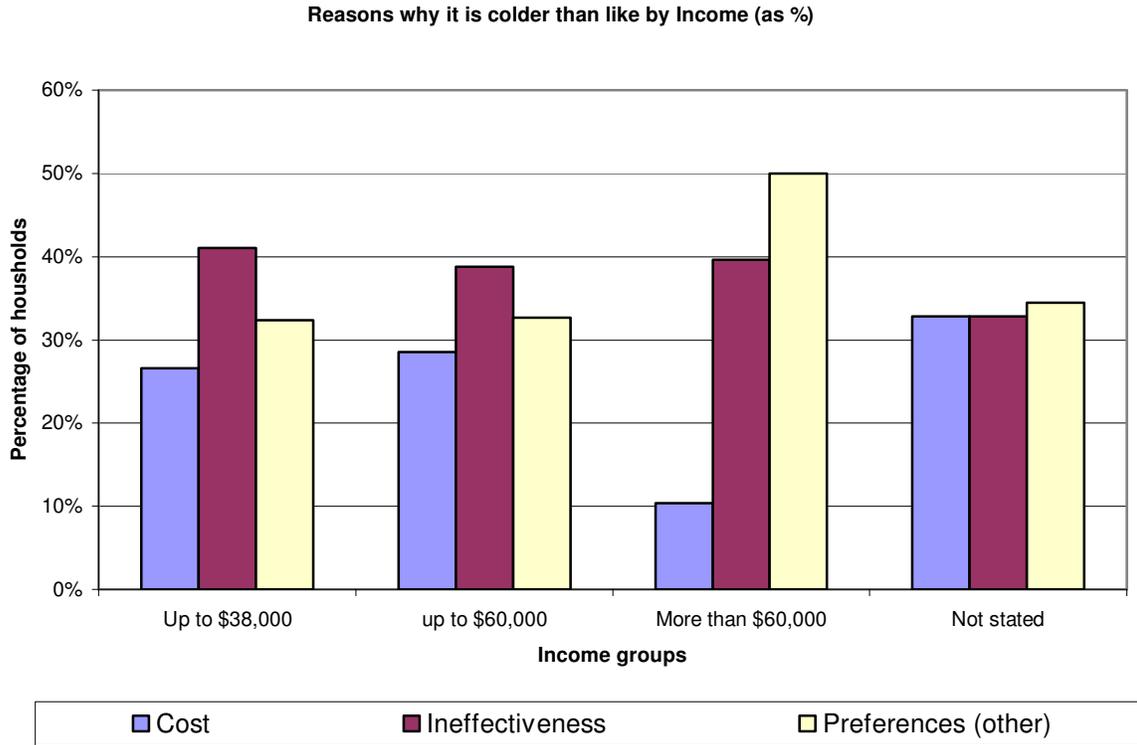


**Graph 4: Main form of heating (baseline) by subjective coldness**

**Main form of heating by subjective winter coldness of dwelling (as %)**



**Graph 5: Reasons why colder than like, by household income (baseline)**



### 3.2 Findings on heater preferences (hypothetical choices)

The second set of findings relate to households’ **hypothetical** choices about what sort of heater they would like in principle, i.e. they were asked to consider hypothetically what their ideal heating system would be. They were reminded that in the Study, they would not have to pay for the heater being installed, although the range of heater types in the Study was limited – for example, central heating was not an option. Moreover, some households’ first choices might not be reflected in the heater chosen in the Study where the landlord was making the choice. The purpose of the question on hypothetical choices was thus to gain an understanding of household heating system preferences irrespective of actual heater choices in the more constrained environment of the Study itself.

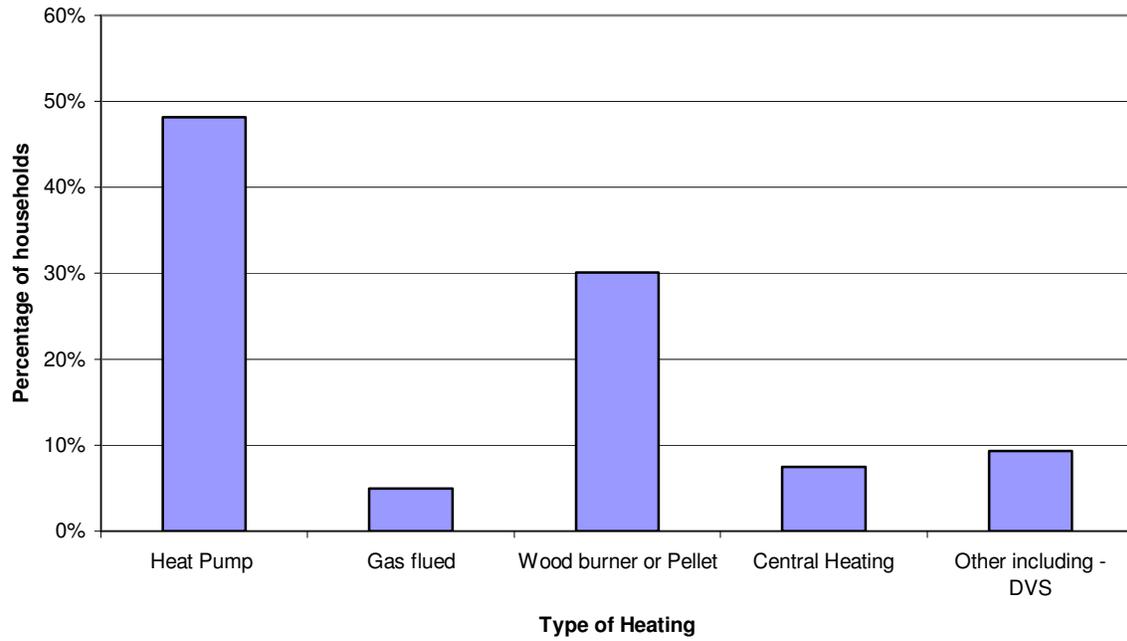
Households were also asked what balance they imagined they would strike between heating efficiency gains (financial savings) from a new heater, and improvements in comfort. Main findings were:

- Heat pumps were most popular (48%) as the household head’s hypothetical choice of heating system; wood burners or pellet burners were also relatively popular (30%)
- When asked about what sort of choice they would make in terms of the efficiency gains from a new heater, households generally (60%) indicated a preference for taking a mix – i.e. some financial savings and some gains in comfort
- This preference for a mix was fairly consistent across income groups.

Graphs illustrating the findings are as follows.

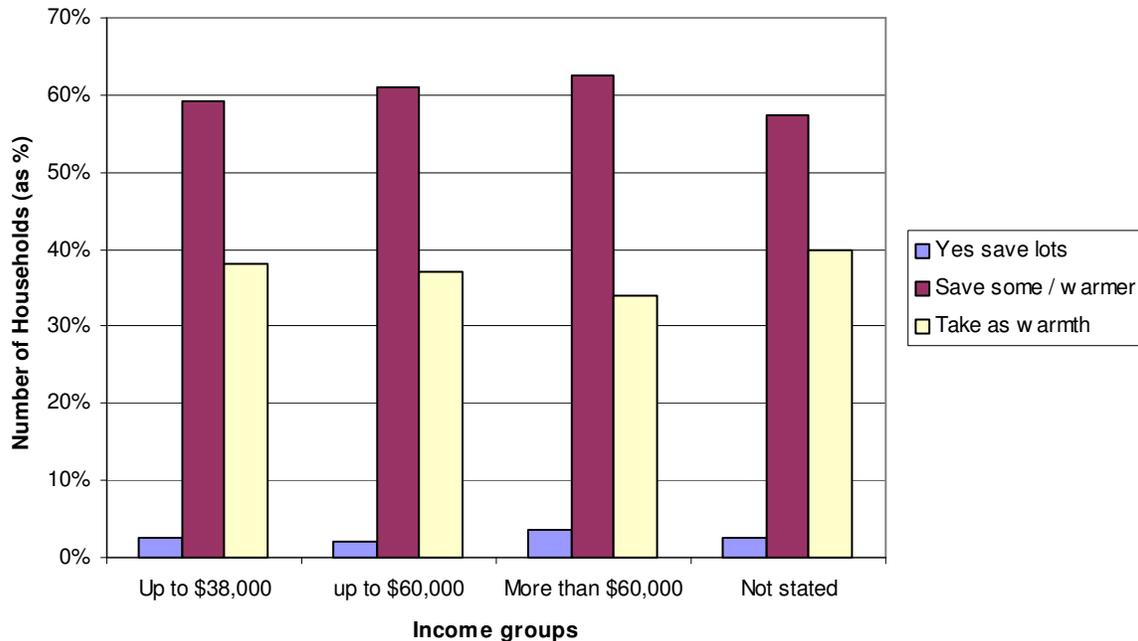
**Graph 6: What heating system do you prefer (hypothetically)?**

What heating would you most like to have?



**Graph 7: hypothetical trade-offs between savings and comfort, by income**

**Table 9: Anticipated trade-offs by Income**



**3.3 Findings on ‘willingness to pay’**

The third set of questions related to household willingness to pay (WTP) for a new more efficient heater. WTP is a standard economic (contingent valuation) concept, reflecting the respondent’s stated view of how much he or she would be prepared to pay to purchase a good. In this case, the question was asked to provide a comparison with the value of the heaters to be installed by the Study at no charge to the household.

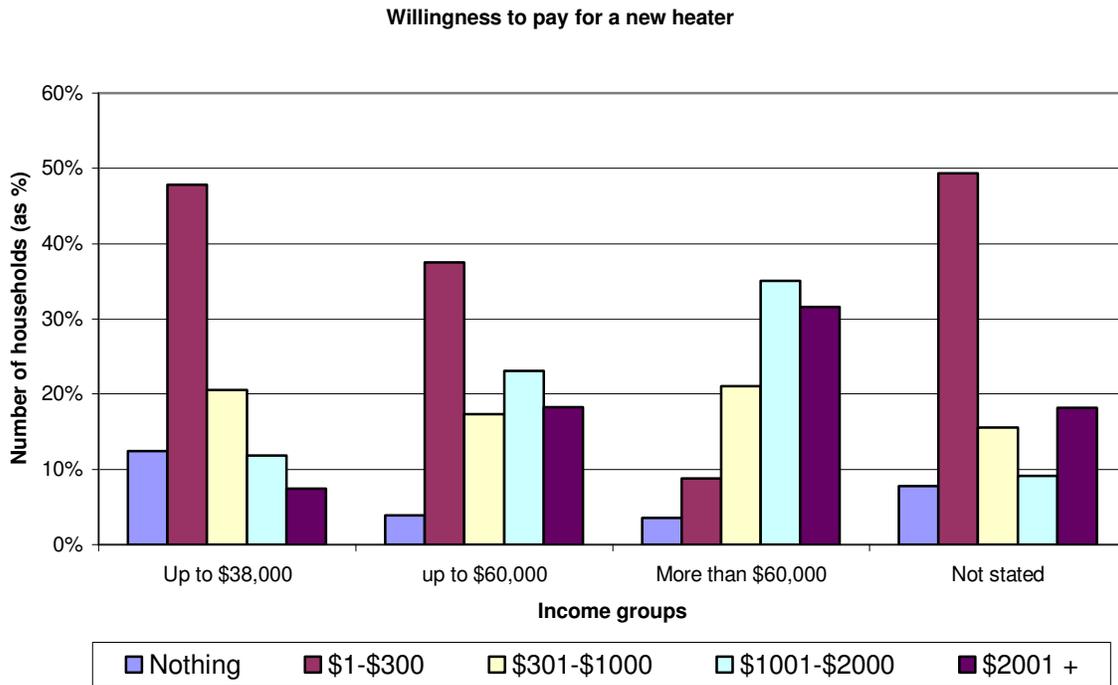
It is generally expected that WTP will rise with income (i.e. the demand for heaters is income elastic), and that the number of households willing to pay a *low* price for a new heater would be greater than the number willing to pay a high price (i.e. the demand for heaters exhibits the normal downward sloping curve).

Graph 8 below shows that both these expectations were met. Findings can be summarised as:

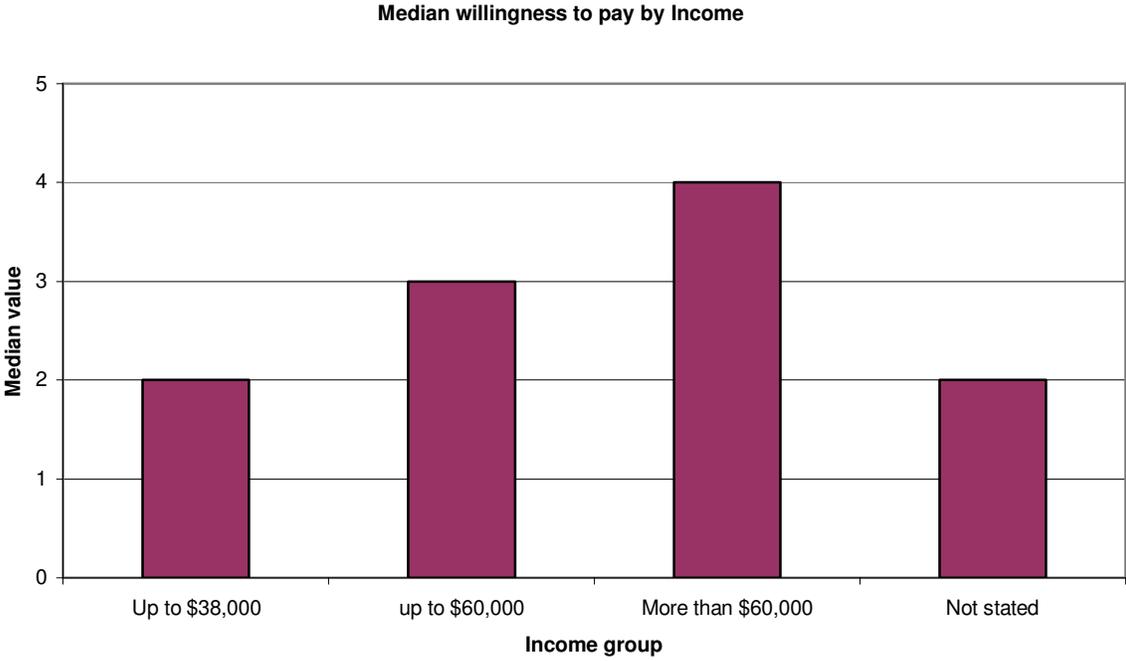
- Expressed hypothetical “willingness to pay” for heaters varies strongly with income
- For the low income group, median WTP is under \$300
- For the high income group, median WTP is between \$1001 and \$2000
- Median willingness-to-pay is greater for the high income group (p<0.01)
- The main reason given for limited willingness to pay, i.e. “as much as could afford”, varied by income group, with the low-income group most often giving this (p<0.01)
- The high income group was more likely to say “other things matter” in explaining their WTP for heating.

In interpreting Graph 9 below, WTP of level 2 means that the median household was willing to pay in the second band (\$1-\$300), while WTP of level 4 means the median household was willing to pay in the \$1001-2000 band.

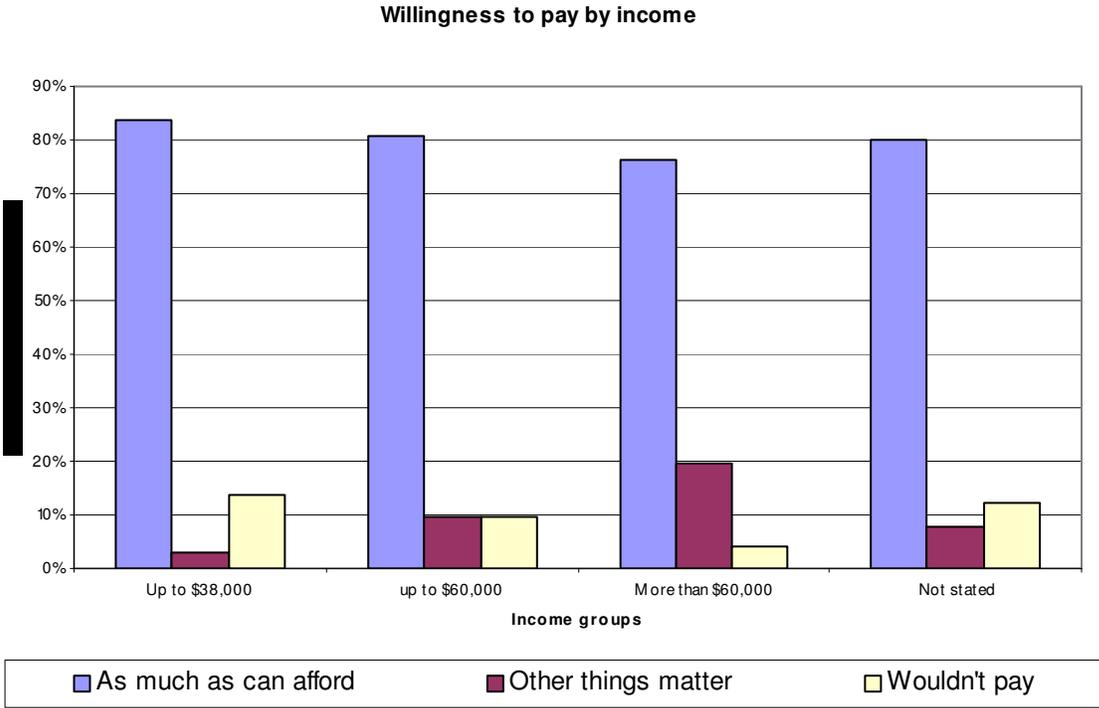
**Graph 8: Willingness to pay for a new (more efficient) heater, by household income**



**Graph 9: Household willingness to pay for a new heater, by household income**



**Graph 10: Willingness to pay reason, by income**



### **3.4 Findings on participants' choice of heaters for Study to install**

Households in the Study were asked to choose a type of heater for the Study to install. In the case of rented dwellings, the landlord made the choice (but landlords were asked to consider tenant preference). The social housing landlord in the Study (Housing New Zealand) chose not to install any pellet burners, but instead opted for heat pumps.

Overall, the breakdown of heater choices across the households in the Study was as follows:

- 319 heat pumps
- 30 wood pellet burners
- 11 flued gas heaters.

## **5 Summary of key results**

Key results in respect of baseline heater choice and household heater preferences were as follows:

- The Study group (the selection of which was based on the presence of a child with asthma) were fairly typical of the wider population in terms of tenure balance (owning/renting), while showing a rather higher number of tenants than the general New Zealand population
- A majority of households in the Study kept houses uncomfortably cold, prior to the intervention, despite evidence of the effects of cold such as damp on walls
- Value for money / operating costs and convenience were important consideration in choice of current heater; environmental considerations were not high on households' list of considerations
- Expressed hypothetical "willingness to pay" for more efficient heaters varies strongly with income, and median willingness-to-pay is higher for the high income group
- Willingness to pay is, however, consistently lower than actual purchase costs of either a heat pump or pellet burner
- Households express preference for taking the efficiency gain from a more efficient heater as a mix of financial savings and greater comfort
- When asked to choose a heater in the Study's free heater upgrade, households in the Study showed strong a preference for heat pumps over pellet burners (next) and flued gas heaters (last).

## **6 Discussion**

The results presented in this paper are initial results relating to household heating arrangements and heater preferences expressed by the households involved in the Housing, Heating and Health Study. This community trial involves 400 families and is being implemented by a multi-disciplinary team, across several urban areas in New Zealand. The heater choice analysis presented here is complementary to the wider analysis of impacts of heater choice on the health

of asthmatic children and (potentially) household energy use and sustainability. The underlying hypothesis is that heater choice makes a difference to the indoor environment and hence households' health, and perhaps to energy use. It is too early to comment on whether this hypothesis is valid.

The purpose of collating these initial findings on heating systems is to give a greater understanding of heating preferences (current and hypothetical) among households in the Study. Key points for discussion and further investigation are as follows:

- We can predict from their expressed views that households are generally likely to take the benefits of greater heater efficiency as warmth rather than energy savings
- Greater environmental sustainability was not a prominent consideration in households' choice of existing heater, and is unlikely to be prominent in their choice of a more efficient heater
- The most important considerations in the choice of a more efficient heater are likely to be safety, operating cost and perceived health effects

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