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Energy, Income and Well-being – Where is the Link?

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Energy, Income and Well-being – Where is the Link?

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Introduction

The dominant rhetoric in public policy in the new millennium has been around the need to work cross-sectorally, the need to be outcome-oriented, and the need to establish and persist with programmes and interventions that are evidence-based. Nowhere is the rhetoric less in evidence than in the intersect between energy policy and social policy.

In this paper, we explore three issues around the connection between energy policy and social policy. First, we focus on why the intersect between social and energy policy has been neglected. Secondly, we provide an overview of the Household Energy End-Use Project (HEEP) and comment on its potential to provide an evidence base for a much stronger and more effective integration of energy and social policy when addressing the needs of low income families in rural and urban contexts. Thirdly, we consider some of the potential connections between energy policy and social policy. Finally, we present some of the data emerging out of the HEEP study around households, their energy consumption, income and life cycle and the impacts of energy use.

Energy and social policy: a neglected interface

There are two examples in New Zealand where the connection between social policy and energy policy actively meet. The first is the retrofit insulation programmes partially subsidised by central Government through the Energy Efficiency and Conservation Authority (EECA), which in some regions uses the Community Services Card as a targeting mechanism. The second is in the benefit payment system where families facing extraordinary circumstances can apply for welfare assistance to meet household expenses.

The connection has largely been ignored, however. Neither social policy outcomes nor the energy policy outcomes have incorporated mutually reinforcing success measures. Nor, indeed, has there been a critical analysis of the extent to which energy policy outcomes and social policy outcomes are consistent or in tension with each other.

There are at least three key reasons for this:

- First, because energy is a universally consumed good in which the market is the primary mechanism of distribution, there has been little analysis of the differential access of households to energy. In effect, the interface between the social and energy policy has been too pervasive to become defined as problematic and incorporated into the rubric of social policy.

- Secondly, and connected to the first reason, social policy has had a history in New Zealand of being reduced to a focus on welfare policy. While there are, as we will see, strong connections between energy policy and welfare policy, to date these have been largely marginalised in the income adequacy debates which have seen adjustments in benefit levels as being the primary mechanisms to deal with deficient energy access among beneficiary households.

- Thirdly, energy policy has been preoccupied by supply issues and management, rather than issues of demand and demand management or the issue of household access to energy and the implications for households of their energy consumption.

While energy is seen as a fundamental requirement of our society, energy policy has principally focused on the supply of energy from a capital-intensive energy sector with a small number of major suppliers and usually large industry-based consumers. Energy supply is, thus, well understood, but the same cannot be said for energy demand, which is simply viewed as ever-increasing. Much of that demand for energy is within homes and represents a complex interaction between a dwelling and the households living in them.

The past 30 years have seen huge changes in both the technical and social aspects of the way houses are built and used, with largely unknown energy consequences. There have, for instance, been significant changes in:

- materials (e.g. large sheet particleboard for flooring has replaced strip flooring)
- the NZ Building Code (e.g. thermal insulation has been required since 1978)
- appliances (e.g. microwave ovens widely available from the late 1970s)
- electronic controls (e.g. TV remote controls require 'standby' electricity)
- work practices (e.g. retailing is now a seven-day-a-week operation)
- new forms of home consumption such as home offices (e.g. in 2001 nearly one half of NZ homes had a computer)
- household characteristics including household size, composition and the profiles of ethnicity in our households.

Understanding those changes, and what they mean for both energy consumption patterns and the impact on households of deficient access to energy or efficient energy use, requires a systematic and detailed understanding of energy consumption and the ways in which dwellings and households and behaviours interact at the household level. HEEP is designed to provide the platform on which that understanding can be built.

The Household Energy End-use Project (HEEP)

While the need to understand the impact of building technologies, behaviours and households was recognised and publicly discussed in the early 1980s, it was not until late 1995 that the Building Research Association of New Zealand Inc (BRANZ) started HEEP with a pilot study of 10 houses in Wanganui (Stoecklein et al. 1997). In the first three years a pilot study of 40 non-randomly selected houses was used to develop the selection, monitoring and analysis methodology, and to provide an estimate of the number of houses required to ensure a statistically acceptable result.

A statistical review of the pilot study data suggested a sample of about 100 houses would be required to estimate total annual household energy consumption with an error of less than 10% and with 90% confidence, and 375 houses to provide analysis of major end-uses by time-of-day. This was increased to a monitoring total of 400 houses, to allow for possible uncertainties in the pilot data and wastage (Bishop et al. 1998).

Random selection of houses started in 2000, with 41 houses being monitored. The following year only 17 randomly selected houses were monitored, with the remaining equipment used on a separately funded group of 11 pensioner houses. A sizable grant in 2002 provided equipment to monitor 100 houses. Eighty-six percent of the 400 randomly selected houses will have been monitored in the four-year period from 2002 to 2005 (Isaacs et al., 2003). Although the majority of monitoring has been spread over four years, it is believed that there has been no major change in the types of energy using equipment found in individual houses, or in legislation that might impact on patterns of house use. Annual HEEP reports have been published since 1997, providing feedback to funders and the wider community (Stoecklein et al. 1997, Bishop et al. 1998, Stoecklein et al. 1999, Camilleri et al. 2000, Stoecklein et al. 2001, Isaacs et al. 2002, Isaacs et al. 2003). In addition, executive summaries of these reports and conference paper reprints are available freely from the BRANZ website.

What does HEEP involve?

HEEP involves a mix of social surveying, dwelling assessment and monitoring of energy use within a dwelling. The energy monitoring involves identifying and measuring, at some point, all fuel types used in the household (electricity, natural gas, LPG, solid fuel, oil and solar energy use for water heating) and the end-uses or services they provide (space temperatures, hot water, cooking, lighting, appliances etc).

Although it is desirable to monitor all fuels and end-uses in all houses all the time, a trade-off had to be made between the equipment capital expenditure, the statistically acceptable sample size, the desired monitoring period and the types of analysis expected to be of value to the researchers, the NZ Government and the wider industry. Consequently some fuel types and appliances are monitored intermittently and some fuel end-uses such as barbeques ended up, after a brief experiment, not being monitored. Temperatures are monitored in three locations (two in the lounge and one in a bedroom).

It typically takes between two and four hours for a three-person team to instrument and survey each house, depending on its size, number of fuels, number of appliances and monitoring complexity. The energy audit involves a detailed inspection of the house, recording details of its location, presence of insulation, hot water system (including shower water flow rates and temperatures), and documentation on all appliances (whether connected or in storage). Each house is monitored for about 12 months (always including winter), with the following month set aside for equipment maintenance, calibration and the installation logistics.

Key characteristics of the monitored dwellings are also captured, including dwelling age, construction materials, floor coverings, and the type of window coverings. The dwellings are photographed and floor plan prepared. The capture of this information is important because the fabric and design of a dwelling potentially has direct impacts on energy use and can also moderate or shape energy use.

For instance, it would be reasonable to assume that the amenities provided by a particular dwelling moderate the choices and behaviours of households coming into particular dwellings with regard to heating irrespective of the tastes or preferences of those households. Similarly, dwelling size can be expected to be associated with, and be a determinant of, energy consumption patterns if for no other reason than larger households tend to occupy larger dwellings. The latter relationship is, of course, complicated for low income households in which overcrowding may be a response to limitations on their housing consumption or supply side problems in the housing market, as well as the recent trend for larger dwelling sizes and lower occupancy rates.

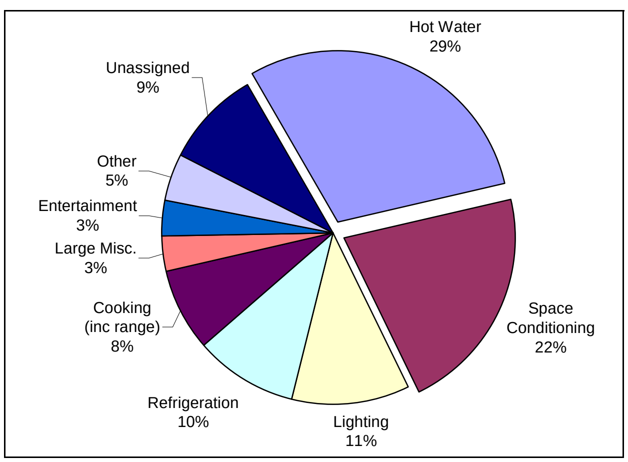
The final set of data captured through HEEP is by way of interview data relating to the occupants of the households themselves. This captured self-reports of appliance use and activities that involve energy consumption including bathing, cooking, sleep and daily occupancy patterns. Information about the socio-demographic characteristics of the occupants including age, sex, ethnicity, labour market position, educational qualifications and household income was captured. Information was also collected around dwelling tenure, period of occupancy, and the dwelling's location. Finally, a set of information was captured in relation to attitudes and perceptions related to energy, conservation and the environment that were seen as possibly determining or influencing energy use patterns. With regard to the latter, it is interesting to note that over 82% of household heads reported themselves as recycling households, with 77% reporting that they actively undertake energy consumption, although only 20% reported substituting car use by the use of public transport.

What does HEEP have to say about energy use?

Note that the results reported later in this paper are from the latest available data set. As data collection is ongoing, the results will continue to be revised.[1]

Figure 1 provides a breakdown by end-use for electricity and natural gas from the 200 house dataset. Work is proceeding to include energy used for LPG and solid fuel – both mainly used for space heating, although also used for water heating and cooking in some houses. No statistically significant regional difference has yet been found in the total energy use – the average for electricity and natural gas is equivalent to a 1154 ± 52 W continuous load.

Figure 1. Average Household Electricity and Gas by End-Use

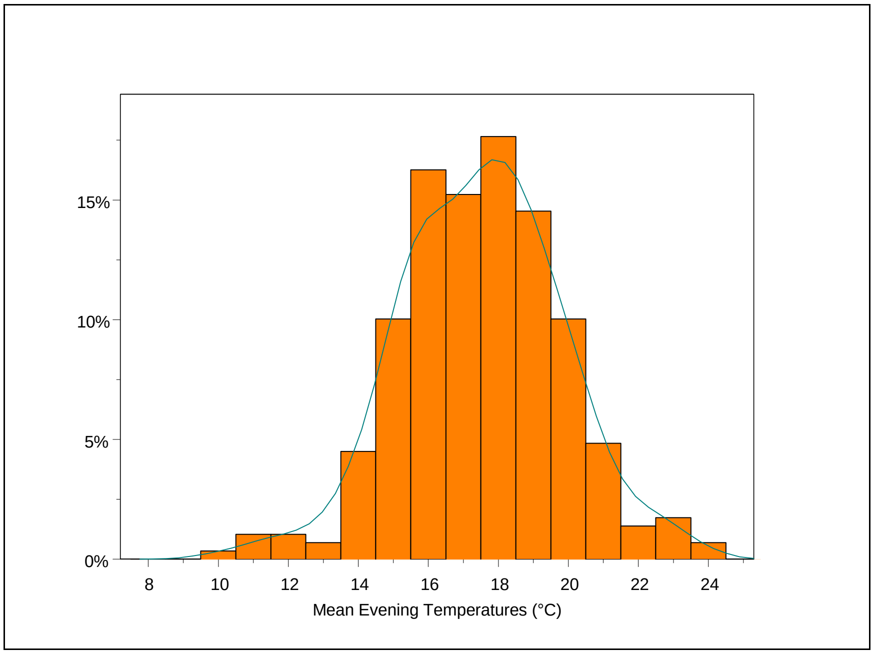


Analysis of heating and temperatures patterns suggest that the New Zealand winter heating season is the period between May and September (inclusive), and during this season the living room is heated in the evening between 17:00 and 22:50 hours.

[1] For the latest HEEP results, please see the BRANZ website: www.branz.co.nz/main.php?page=HEEP

Figure 2 provides an overview of the winter evening family room average temperatures for the 300 house dataset. It follows a normal (bell shaped) distribution, with an average temperature of 17.3°C and a standard deviation of 0.2°C – and shows that nearly 30% of the average winter evening living room temperatures are below the healthy minimum of 16°C (WHO 1987).

Figure 2. Winter Evening Family Room Average Temperature Distribution



Houses built since 1 April 1978 are required to have minimum component levels of thermal performance, generally achieved by the addition of thermal insulation, but in some cases provided as an intrinsic part of the construction technology. In general terms, the requirement is component R-values of at least: roof 1.9 m² °C/W; wall 1.5 m² °C/W; and floor 1.3 m² °C/W. Table 1 compares the family room and bedroom temperatures for pre- and post-1978 houses.

Table 1. Winter Temperatures and Energy Use by Insulation Level

House age group	Average winter evening family room temperature	Average winter overnight bedroom temperature
Pre-1978 (uninsulated)	17.3 ± 0.2°C	13.3 ± 0.2°C
Post-1978 (insulated)	18.3 ± 0.2°C	14.7 ± 0.2°C

Table 1 shows there is a very strong relationship between the age of the house and the winter temperatures, based on the 300 house sample. Currently, we can conclude that post-1978 houses are 1.0°C warmer on average, but that their winter evening energy use is not significantly different from the pre-1978 houses. This analysis does not yet include LPG or solid fuel heating. The HEEP data shows that New Zealand households seldom heat their bedrooms overnight, and thus the benefits of higher temperatures in the post-1978 houses are achieved at no additional energy cost.

Connecting energy policy and social policy

We believe that there are four critical questions around energy that can be illuminated by the HEEP data and connect energy policy to social policy. They are:

- First, the extent to which well-being outcomes are associated with differentials in access to and the efficient use of energy.
- Secondly, the determinants of differential household energy use and energy efficiencies.
- Thirdly, the extent to which the nation's 'energy efficiency' may be increased and energy consumption minimised through the targeting of households with different socio-economic and demographic characteristics.
- Fourthly, the extent to which income maximisation for low income households may be pursued through energy efficiency.

The first and second questions are intimately connected. In relation to well-being, the most obvious domain of well-being concern relates to temperatures. Compared to similar societies overseas, New Zealand households use relatively little energy (Schipper et al. 2000). One important reason for this is that New Zealanders appear unwilling to heat their houses to the levels considered comfortable and healthy by the World Health Organisation. Cold indoor temperatures are associated with damp and mould. Cold, damp and mould have been associated in the international literature with a wide range of health risks.

There are also safety concerns around energy use. Exposure to gases in domestic spaces due to unflued LPG heating, exposure to open flames, and exposure to high hot water temperatures are all risks associated with poor health and safety outcomes.

A variety of analyses are being undertaken in relation to temperatures and energy use to ascertain the extent to which differences between households account for differentials that may affect life chances, and to tease out the complex relationship between dwelling, household characteristics and behaviours. These include analysis of:

- The relationship between equivalised household income and temperature.
- The total energy use by households according to:
    - equivalised households income
    - dwelling characteristics
    - life event stage
    - labour market positioning
    - temperature outcomes.
- Dwelling characteristics and appliance profiles by household characteristics to establish whether lower socio-economic status households tend to:
    - access dwellings with lower levels of energy performance
    - use appliances with lower energy efficiencies.
- The differential exposure of households to health and safety risks associated with energy use.

In connecting social policy and energy policy it is important that the two separate preoccupations of each sector are recognised. For the energy sector, the question is the extent to which the nation's 'energy efficiency' may be increased and energy consumption minimised through the targeting of households with different socio-economic and demographic characteristics. For the social policy sector, especially but not only in the welfare context, the question is the extent to which income maximisation for low income households may be pursued through energy efficiency. In the context of cross-sectoral policy responses within a whole-of-government approach, the issue is to identify whether there are levers which can generate both energy outcomes and income maximisation/well-being outcomes.

While we still have a long way to go analytically on these issues, the analysis so far would suggest that the more appliances a household has the higher the energy use and the more heating they do. If those consumption patterns are connected with income, then it might be wise to target energy reduction interventions to high user households.

Moreover, it may be that we need different measures for energy programmes which recognise the needs of all households as well as the nation's energy conservation requirements. Retrofit insulation, for instance, might be an example in which the achievement of outcome is not only measured through energy use reductions, but relatively through increases in comfort and income optimisation.

There are, of course, some appliances that low income households use which are high energy use appliances or, in some cases, expose households to high levels of expensive energy use when there are cheaper alternatives. Old refrigerators and freezers are a case in point. Indeed, it might be argued that in general appliances at similar levels of functionality are becoming increasing energy efficient. Some 18% of refrigeration appliances (refrigerators, combined fridge/freezers, freezers) appear to have some form of problem. In about 10% the wastage is so large that there will be real benefits from replacement of the appliance.

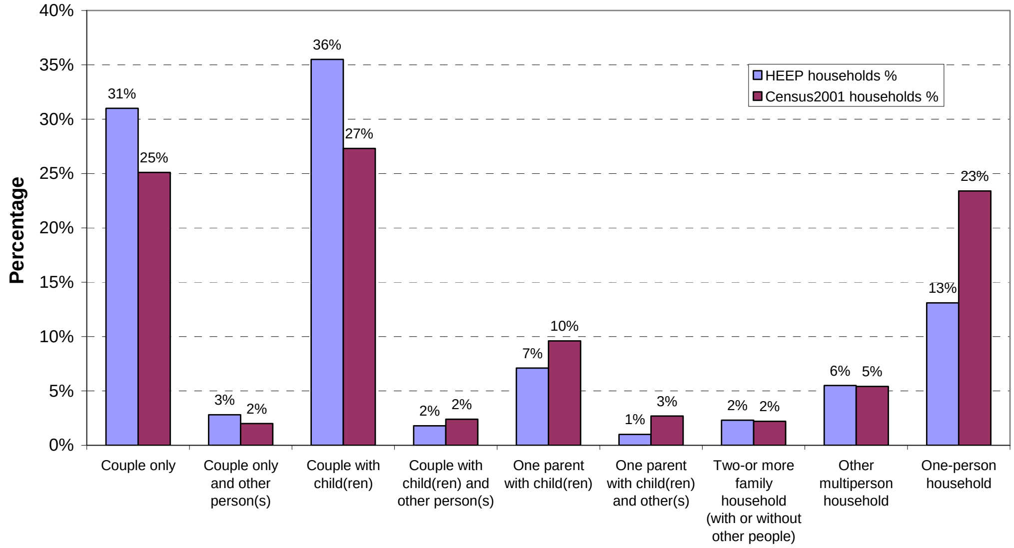
This has implications for both subsidised programmes directed at reducing energy consumption, as well as practices around benefit assistance, and even for the way in which our non-governmental support agencies assist households in need. The relative energy benefits, as well as the relative income optimisation benefits, might be greater if EECA subsidised the purchase of new efficient appliances for low income households along with or maybe instead of increasing the insulation of their dwelling. The tendency for beneficiaries or households in need to be 'sent' off to replace appliances, such as refrigerators and washing machines through the local second hand appliance dealer may be a less sustainable option, both environmentally and in terms of income maintenance, than ensuring that high energy performance appliances are purchased. Perhaps, even, in the spirit of the whole-of-government approach both the energy agency and welfare agencies could come together to facilitate the outcomes they both want.

Emerging social data from HEEP

HEEP provides us with socio-demographic information for 399 households that can been analysed in relation to indoor temperatures, energy use, energy consumption behaviours and, eventually, in relation to the energy performance of dwellings and relevant dwelling characteristics.

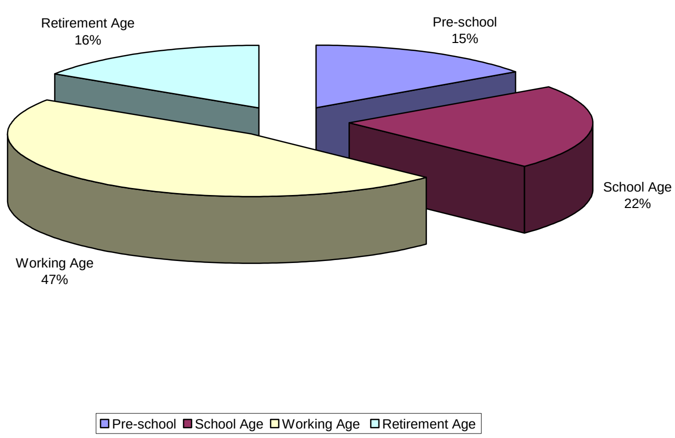
The predominant household compositional type among those households is the couple-with-children household. They make up 35.5% of the HEEP households followed by couple-only households (31%). One-person households make up 13.1% of the HEEP households. Figure 3 compares the household composition profile of the HEEP households with households as recorded in the 2001 census.

Figure 3. The Household Composition of HEEP Households and NZ Households 2001



Interestingly, about similar proportions of the HEEP households had members under five years of age (15.4%) or members 65 years or older (15.9%). Figure 4 sets out the profile of households in relation to critical life stages associated with the youngest household member.

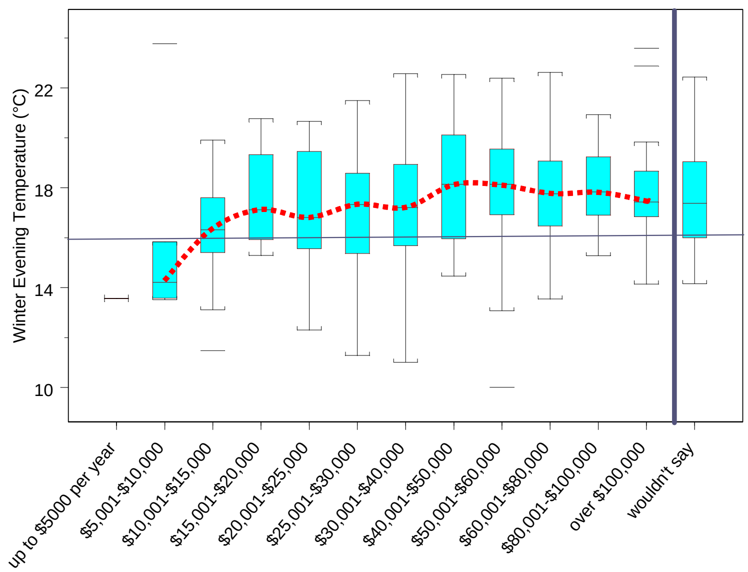
Figure 4. Age of Youngest Household Member – HEEP Households



Comfort

'Comfort' is generally considered to be a desirable benefit, and it was expected that in line with other countries New Zealand higher income groups would have a different temperature regime. Figure 5 provides a box plot of mean winter evening temperature against reported household income, for the 300 house sample. Note that as there are only small numbers of houses in the lowest two income groups, no conclusions can be drawn at present.

Figure 5. Winter Evening Temperatures by Household Income



Just over a quarter of the households had no adult member of the household in employment (25.2%), while 17.4% were households in which all the adult members were in full-time employment. The other largest category of households were households in which there was a mix of adults in full-time employment and adults not in employment. Using the Luxemburg method for calculating equivalised household income to control for household size effects, the quintile boundaries are:

- Quintile 1 – $1,118-$15,000
- Quintile 2 – $15,653-$24,597
- Quintile 3 – $24,749-$33,333
- Quintile 4 – $35,000-$45,000
- Quintile 5 – $49,498-$90,001.

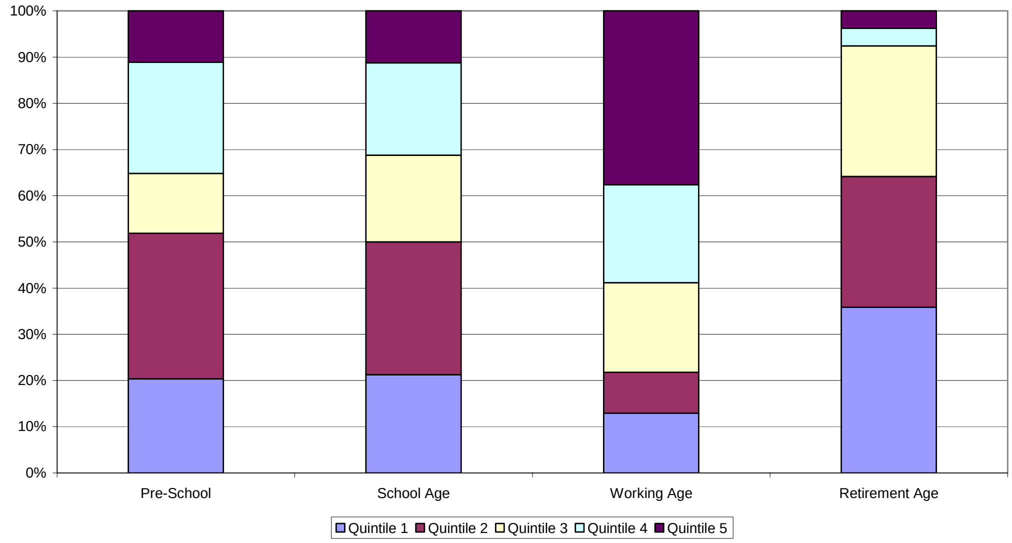
Preliminary analysis suggests that the following household types are over-represented among the lowest household income quintiles:

- one-person households
- other undefined multi-person households
- one-parent with children households
- multiple family households with children households
- couple-with-children plus others households
- couples-with-others households.

The latter are also over-represented in the highest income quintile. Couple-with-children households tend to be over-represented in quintiles 2, 3 and 4.

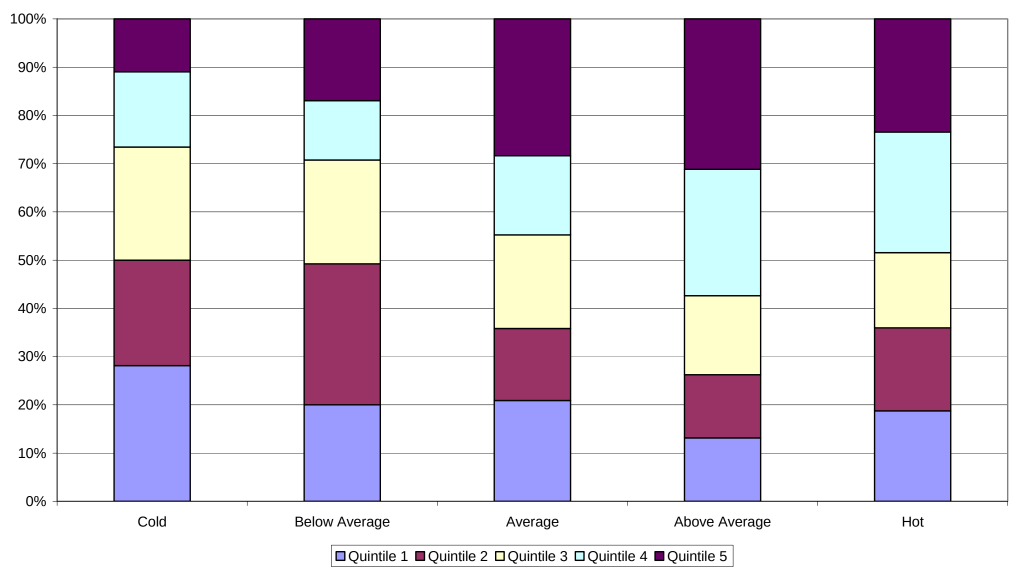
In relation to life stages, the situation in relation to income quintiles is somewhat more mixed. Figure 6 shows the quintiles for equivalised household income for households in each life stage calibrated by youngest household member. Retired person households tend to be over-represented among quintiles 1, 2 and 3. Households with pre-school and school age children tend to be over-represented in income quintiles 1 and 2. Households entirely made up of working age members tend to be over- represented in quintile 5.

Figure 6. Equivalised Household Distribution by Age of Youngest Household Member



Perhaps, most importantly, the emerging data from an analysis of equivalised household income appears to show some connection between household income and indoor temperature differentiations. This analysis is very preliminary and should not be regarded as definitive and may be subject to change. Nevertheless, when considering mean temperatures in living rooms in the evening, Figure 7 shows that low quintile groups are over-represented in those dwellings which might be described in comparison to other HEEP dwellings as ‘cold’ or ‘below average’. Conversely, quintiles 3 and 4 tend to be over-represented in dwellings with ‘hot’ (by comparison to other living rooms) mean evening temperatures. For the ‘average’ evening living room temperatures both quintile 4 and quintile 5 are over-represented.

Figure 7. Equivalised Household Income by Evening Mean Living Room Temperature



By contrast similar, but very preliminary analysis, suggests little association between household life stage and mean evening living room temperatures. Households with the youngest member in retirement appear to be slightly under-represented in the dwellings that are relatively cold and somewhat over-represented in the dwellings that are relatively hot. Similarly, households with the youngest member being a pre-school child tend to be slightly over-represented in relatively cold households and in households with above average mean evening living temperatures. They are, however, under-represented in dwellings that could be categorised as being relatively hot mean living room evening temperatures. These provide some tantalising insights into temperature outcomes. The opportunity now is to explore the way in which household behaviours and energy inputs and dwelling characteristics dynamically contribute to what might be broadly described as comfort outcomes for households with different life chances.

Conclusions

The HEEP research provides a unique integration of physical and social science. The detailed nature of the energy data, in itself, provides us with an unprecedented level of insight into the energy performance of dwellings and households. The social data is already generating a better understanding of the way in which the characteristics of dwellings moderate, or are moderated by, the social characteristics of households and their dynamic interface with the labour market, life events and lifestyles. Most importantly, the emerging HEEP data on the social aspects of energy consumption within domestic dwellings reads directly to a critical but largely ignored interface between energy policy and social policy.

By allowing us to explore the determinants of differential household energy use and energy efficiencies, and the implications of those differences for well-being, we believe that HEEP will assist in essential policy decisions around the extent to which the nation's 'energy efficiency' may be increased and energy consumption minimised while preserving the well-being of vulnerable households. Moreover, for practitioners in the arena of social policy and social services, the findings beginning to emerge from HEEP may allow us to identify opportunities to maximise the discretionary income of low income households through targeted energy efficiency interventions.

The preliminary analysis reported in this paper does not include all data from the full range of houses that form part of the research. National monitoring will be completed in early 2005, and then the final results and conclusions will become available.

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The HEEP team consists of:

- BRANZ Ltd (Data collection and analysis) – Lynda Amitrano, Michael Camilleri, Lisa French, Nigel Isaacs, Andrew Pollard
- CRESA (Social science) – Ruth Fraser, Kay Saville-Smith
- CRL Energy Ltd (Modelling) – Pieter Rossouw
- John Jowett (Statistical support).

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