

FUEL POVERTY IN NEW ZEALAND

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Abstract

The concept of fuel poverty emanated from grass roots environmental health movements in the United Kingdom and Ireland in the early 1980s. In recent years it has been taken on board by the British government in as much as they have committed to eradicate it by the middle of this decade. A household is in fuel poverty if it would need to spend more than 10% of the total household income on all household fuels to achieve a satisfactory indoor environment. A satisfactory indoor environment is defined as being at temperatures of at least 21°C in the living areas and 18°C in other parts of the house. The number of households in fuel poverty in the United Kingdom has been variously estimated at somewhere between one million and seven million, with a median acknowledged by the government of around three million in 2001. This number would mean some 14% of the population in the United Kingdom were in fuel poverty at that time. The present paper suggests that in New Zealand the number of households in fuel poverty in 2001, using the same definition of adequate indoor temperatures as for the United Kingdom, is very similar, with a range of between 10% and 14% of total households.

BACKGROUND

Fuel poverty is a concept that arose out of grass-roots energy action groups in the United Kingdom and Ireland during the early 1980s. This was a time when the oil price hikes of 1974 and 1979 produced fuel cost increases, which in turn led to large heating bills for residential consumers. The poorer consumers suffered more than others in terms of having to pay a larger percentage of their total income to keep warm.

The first definition of the concept was a fuzzy notion: "The inability to afford adequate warmth in the home", as given by Lewis in a submission for the National Right to Fuel Campaign in Bradford in the United Kingdom (Lewis 1982). Later, Brenda Boardman, in her doctoral thesis and her groundbreaking book on fuel poverty (Boardman 1991), expanded the concept to include the effect of energy-inefficient housing. The idea was

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roughly that households that would need to spend more than 10% of their income on all household energy fuels in order to achieve a satisfactory indoor heating regime were categorised to be in a state of fuel poverty (Clinch and Healy 2001). The key idea here is that the fuel cost is attributed to what people would need to spend, not what they actually spend.

The early definitions lacked precision in terms of both adequate economic parameters and the thermal parameters. Even today the definition is debated in terms of what constitutes an adequate thermal environment and what constitutes the total household income. Despite the definitional debates, fuel poverty has been taken on board by the British government in their current strategy to combat the health effects associated with cold homes (DEFRA and DTI 2001). The problem in the United Kingdom has been particularly politically sensitive due to historically poor levels of housing quality and their nearness to better-housed and cooler northern neighbours.

Household fuel poverty is currently defined in Britain (DEFRA 2003) as the need to spend more than 10% of annual household income on *all* household fuel use. The heating fuel component of the household fuel use should be sufficient to enable the home to achieve a satisfactory heating regime (see below). Household energy use excludes transport, lawn mowers, boats and other recreational energy uses not specific to that used within the residential building itself.

The British definition assumes that a satisfactory heating regime is one where the main living area is at 21°C, with 18°C in other occupied rooms. It is assumed that heating is available for 16 hours per day for households likely to have occupants home all day, and nine hours per day for households in work or full-time education. It is also assumed that the whole house is heated except where the household is “under-occupied”, when it is assumed that half of the house is heated (DEFRA 2003). This characterisation is consistent with the WHO recommendations on adequate indoor temperatures (WHO 1989). Under-occupied, in the British context, implies that the house has more than one unoccupied bedroom.

In Australia, which has a much warmer climate than either the United Kingdom or New Zealand, fuel poverty was investigated in the 1980s and was the subject of a number of research reports, including *Fuel Poverty in Victoria* (Energy Action Group 2002) and *Unequal Access* (Blackman et al. 1987). Due to the deregulation of the electricity sector in Australia and rising prices, especially in the more remote areas of the country, the problem has been recently resurrected, with lobby groups again questioning how market deregulation can sit with the provision of social equity (Energy Action Group 2002).

The economic parameters dealing with the British definition of household incomes are difficult to translate internationally, so are best considered in terms of current national

definitions. In this context, the household income is the income as reported by Statistics New Zealand from the 2001 census (Statistics New Zealand). Fuel poverty is commonly applied to developed countries and to cool climates that need heating for part (or all) of the year, but it has also been considered in terms of warm climates (cooling energy) and in developing countries with regard to the provision of fuel for cooking. In this paper, the concept is considered in terms of developed countries and for housing in cool climates, with Dunedin as a case study.

In terms of policy initiatives in New Zealand, reducing fuel poverty is consistent with the Ministry of Social Development's aims, as given in their recent *Statement of Intent 2005/06* (Ministry of Social Development 2005), among which are to:

... improve the overall wellbeing of New Zealanders. One way in which we do this is to reduce the inequalities experienced by disadvantaged groups. To be successful our work in reducing inequalities must focus on achieving sustainable improvements. (p.19)

Households that need to spend more than 10% of their income on fuels to keep warm and to service an adequate lifestyle would be deemed in most developed countries to be disadvantaged. The emphasis on "sustainable improvements" will be examined again at the end of this paper.

Fuel poverty was also discussed in the recent *Sustainable Energy* policy document produced by the New Zealand Ministry of Economic Development (2004b). Unfortunately this document gives a misleading interpretation of the British definition, because it refers to what New Zealanders *actually* spend on *heating* energy, rather than what they *would need to* spend on *all* household energy sources to achieve an adequate thermal environment (see earlier definition).

A recent International Energy Agency (IEA) report (Schipper et al. 2000) suggested 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 ... It seems unlikely in practice that comfort levels are so low in New Zealand. Possible data problems with wood may partly explain this apparent discrepancy.

The data they used are correct and comfort levels are indeed low. Residential energy use in New Zealand for 1995 was around 17 GJ/capita/annum compared to around 35 GJ/capita/annum in Australia, 30 GJ/capita/annum in Europe and 54 GJ/capita/annum in the United States.

The low values for New Zealand residential energy use reflect low levels of space heating. Houses in New Zealand are "energy efficient" in the respect that they use little

energy, but are poorly heated. In addition, with the population being mostly located in the north of the North Island the national average does not reflect conditions in the south, which has considerably greater house heating needs. For example, Auckland has around 1,150 heating degree days² compared to Christchurch at 2,400, Dunedin at 2,600 and Invercargill at 3,000 degree days (the base temperature used is 18°C) (New Zealand Meteorological Service 1978).

METHOD

The main difficulty in estimating the level of fuel poverty in a country relates to obtaining data on the thermal efficiency of residential housing and the corresponding heating necessary to meet the British fuel poverty definitions (as given above). The energy needed to maintain adequate indoor temperatures is, of course, highly dependent on the climate and the overall energy efficiency (including orientation and solar access) and size of the house. Because the target group comprises the poorer sections of the community, the type of housing can be narrowed to that occupied by such socio-economic groups.

To this end we have modelled a typical 90 m² three-bedroom brick-veneer house, as rented by Housing New Zealand Corporation to the public housing sector. The modelled house had a tiled roof and a suspended wooden floor with a window area of 25 m². This type of house has been monitored extensively as part of a concurrent research programme to determine the efficacy of energy efficiency upgrades being undertaken by the New Zealand government (Lloyd and Shen 2004). The building was modelled in different orientations, but no solar shading from external buildings or the topography was included.

The thermal modelling was undertaken using a commercial package marketed by a Scottish company as “Virtual Environment”. Verification of the model against actual temperature has been documented in an earlier paper (Taylor and Lloyd 2004). The modelling was undertaken initially for the Dunedin climate, which has an annual average ambient temperature of 11°C. For the indoor environment, we used the British definition of an adequate indoor temperature regime (21°C in the living area and 18°C elsewhere in the house). The analysis was then extended to other population centres in New Zealand, using the standard climate files as provided by the software vendor. These files were checked to ensure consistency with data from the National Institute for Water and Atmospheric Research.³

2 Heating degree days are a way to relate each day’s temperatures to the demand for fuel to heat buildings. This measure, computed with the average of a particular location’s daily high and low temperatures, can be used to compare how much more or less one might spend on heating a building between different parts of the country.

3 Data corresponding to the software weather files were purchased as a data file from the National Institute for Water and Atmospheric Research.

In terms of thermal insulation, the modelling was completed for both working occupants and unemployed occupants. A range of building fabric scenarios was modelled, including the house not being insulated at all, to it being insulated to the level of the upgrade undertaken by Housing New Zealand Corporation (i.e. an overall R value in the ceiling of R4.0, but no insulation in the walls) (Lloyd and Shen 2004). The same heating time definitions as used in the British definition were applied; that is, 16 hours per day for occupants at home all day and nine hours for working occupants. An occupancy level of 2.8 occupants per household was used and an air change rate of one per hour. Such housing and conditions would be typical for low-cost housing in Dunedin.

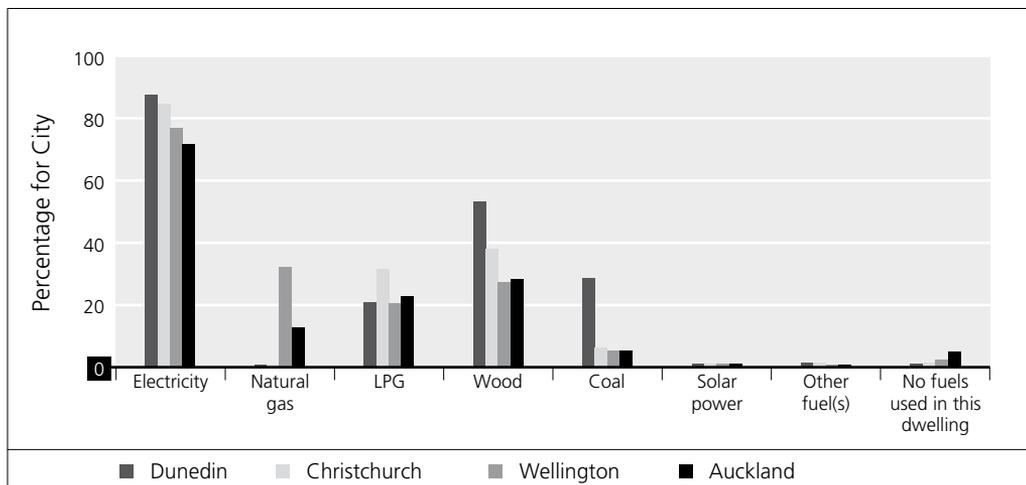
Statistics on income and energy use for the residential sector in New Zealand were obtained from the national data-gathering organisation, Statistics New Zealand, and from the Ministry of Economic Development's *Energy Data File 2004*. For the present research, these data were obtained at regional level with some aggregation to city level. To enable the percentage of households below a given income level to be calculated, the income data were plotted against the accumulated percentage of households. This curve was then modelled using a polynomial and the data interpolated to give the required percentage.

RESULTS

Although the data required to estimate the amount of heating needed to achieve an adequate indoor thermal environment (British definition) do not depend on the amount of heating actually used, we do need to know the types of heating used so that cost data can be estimated.

Data from the 1996 and 2001 censuses provide an outline of the fuel types used for New Zealand domestic heating. Although there was a slight decrease in the number of houses using electricity from 1996 to 2001, it was still the major means of home heating. (It is important to note that both electrical resistance heating and heat pump systems fall into this category although they have a factor of three difference in heating efficiency.) In contrast to electric heating, the use of gas (natural or LPG) has increased slightly from 1996 to 2001, while the number of houses using wood has remained relatively stable. Figure 1 shows the fuel-type data for 2001 as obtained from Statistics New Zealand.

Figure 1 Fuel Use for Heating, 2001



As can be seen, the most common form of space heating is electricity, mainly in the form of resistance heating. No data could be found on the number of heat pumps used for space heating in the domestic sector in New Zealand, but the number is likely to be very small in low-cost housing due to the high capital cost of the units. In our concurrent study of energy use in Housing New Zealand Corporation homes, no heat pumps were found other than in demonstration sites.

The 2001 Household Income Study revealed that nationwide 88% of households used electricity for house heating (Statistics New Zealand). The average consumption of electricity (all uses) for a Dunedin house is 9,417 kWh per annum. This is based on data from 9,664 houses in Dunedin City over the period of June 2002 to May 2003 and has been provided by one of the electricity power supply companies.⁴ The national average consumption is 20% lower, at around 7,800 kWh per household per annum (Ministry of Economic Development 2003). Our own data for the electricity consumption of the low-income sample (111 houses investigated in the Housing New Zealand Corporation upgrade programme) were close to the average for New Zealand at 7,700 kWh/household/annum (with a standard deviation in the mean of 360 kWh/household/annum).

The Building Research Association of New Zealand (BRANZ) is in the midst of a comprehensive Housing Energy Efficiency Project (HEEP) study which is investigating energy use in residential housing nationally. This study has found that only 20–30% of electricity and natural gas goes to space heating in New Zealand (BRANZ 2003). These

4 Trust Power, personal communication, 2003.

figures, however, exclude LPG and solid fuel heaters and include only Christchurch as a representative site in the South Island. Disregarding the exclusions, the share used for space heating would mean around 2,800 kWh/household/annum is presently used on average for house heating in Dunedin (electricity and LPG only). This value for space heating agrees well with our own data gathered for the Housing New Zealand Corporation upgrade survey: the data gave the seasonal component of electricity use (i.e. mostly space heating) of around 2,400 kWh per annum.

National statistics (Ministry of Economic Development 2003) attribute only 69% of residential energy use to electricity, with the remainder being taken up by natural gas, wood, geothermal, LPG and coal, as shown in Figure 1. This amounts to a national average of 11,600 kWh/household/annum for all energy use. This is slightly lower than the IEA value of 13,100 kWh/household/annum, probably due to the national statistics not accounting fully for non-commercial wood-fuel usage. The 2001 Housing and Incomes survey (Statistics New Zealand) found that \$1,246 was spent per household per annum on average for all household energy fuels.

The non-electricity fuels would be used predominantly for space heating (although some gas would be used for cooking and water heating). The data from our low-income Housing New Zealand Corporation houses indicated a value for total (net) household energy use (sample size = 111 houses) for Dunedin of 9,600 kWh/household/annum (± 510 kWh/household/annum). The net heating calculations used 100% thermal efficiency for electric and un-flued gas heating, 60% for solid fuel burners and 15% for solid-fuel burnt in open fires. The gross energy used for the same sample, however, would be closer to 11,000 kWh/household/annum and thus just under the national average energy use as determined from the values in the *Energy Data File 2003*. This agreement would suggest that in Dunedin, for the poorer sections of the community, the total net energy used for space heating would be between 3,800 kWh/household/annum (2,400 kWh electricity and 1,400 kWh other fuels) and 4,300 kWh/household/annum (2,400 kWh electricity and 1,900 kWh other fuels).

The fuel actually used by households, however, is irrelevant to calculate the numbers that may be subject to fuel poverty, because the definition is framed in terms of reaching adequate indoor temperatures. The energy needed to maintain adequate temperatures, going by the British definition, was obtained by modelling the typical 90 m², three-bedroom brick-veneer house for a range of installed insulation options and occupancies. This modelling suggested that the space-heating energy necessary to achieve an adequate thermal environment would be 13,000–16,000 kWh/household/annum for houses located in Dunedin. The lower value is for nine hours heating and R4 insulation in the ceiling; the higher value is for 16 hours heating and no insulation in the walls or ceiling. Other scenarios fell in between the lower and upper space-heating values given above.

At electricity retail rates of 9.5 cents per kWh (2001 prices from the *Energy Data File 2003*, including GST), the heating regime necessary to secure adequate indoor temperatures – that is, space heating of 13,000–16,000 kWh/household/annum – would cost \$1,240–\$1,500 per household per annum. The cost of LPG in Dunedin was similar to electricity at 8.9 cents per kWh (2001 prices from *Energy Data File 2003*, including GST). Then adding in the cost of the remainder of the electricity bill, being 6,600 kWh/household/annum, or \$630/household/annum, for water heating and other demands, this would give a total annual energy cost to the household of between \$1,900 and \$2,100 (resistive electric heating or LPG heating).

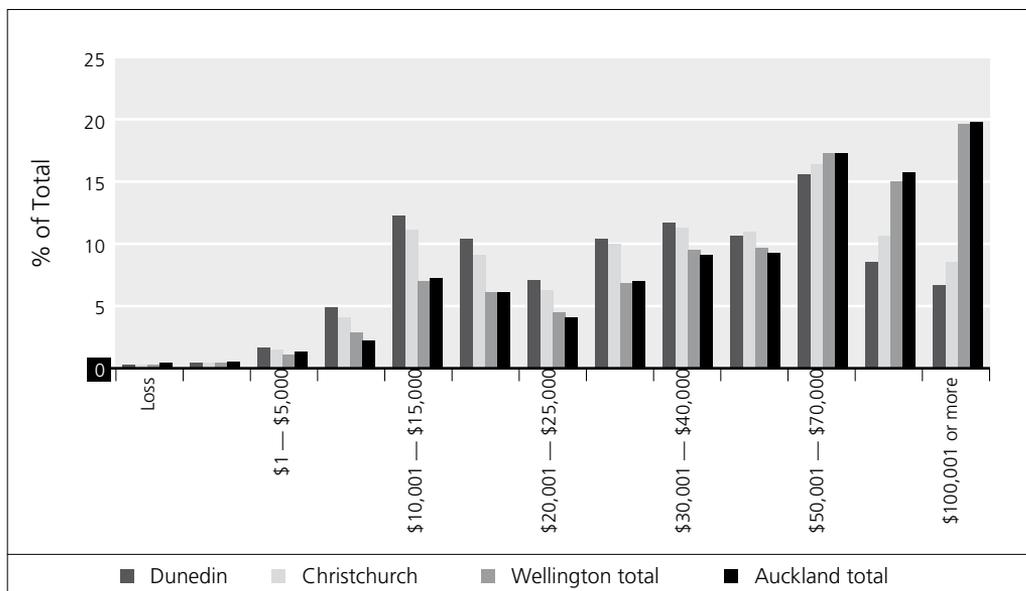
A household would then be deemed to be in a condition of fuel poverty if the total household earnings were below \$19,000–\$21,000 per annum (electricity and gas only).

The average income of people in Dunedin (for 2001) was somewhat lower than the national average; that is, an average annual income of \$14,500 per person in Dunedin, compared to \$18,500 per person nationally, and \$15,700 per person in the wider Otago area (Statistics New Zealand). In terms of household income, Figure 2 gives the breakdown for Dunedin and three other main centres. The percentage of households earning below a given dollar income was obtained by interpolation from graphs analysing cumulative percentages of households below a threshold income, as given in Figure 3. It should be noted, however, that one of the reasons for the relatively low income of people in Dunedin is due to the high proportion of a low-earning student population. Dunedin is a university town with a student population as high as 20% of the total resident population.

From these data it can be seen that in 2001 around 30% of households in Dunedin (that is, those that generate less than \$20,000 income per household per annum) would be highly likely to be in a situation of fuel poverty. To repeat, this assumes that the house is heated adequately to the British criterion for fuel poverty. The HEEP study (BRANZ 2003) and our own study of public housing (Lloyd and Shen 2004), however, made it clear that houses in Dunedin are not heated adequately and that temperatures considerably lower than WHO recommended levels are routinely experienced at all income levels. In Dunedin the estimated fuel used (for space heating only) for low-income families as surveyed in our sample of 111 Housing New Zealand Corporation homes was closer to 4,000 kWh/household/annum, or 27% of that needed to maintain an adequate indoor thermal environment, as defined by the British definition.

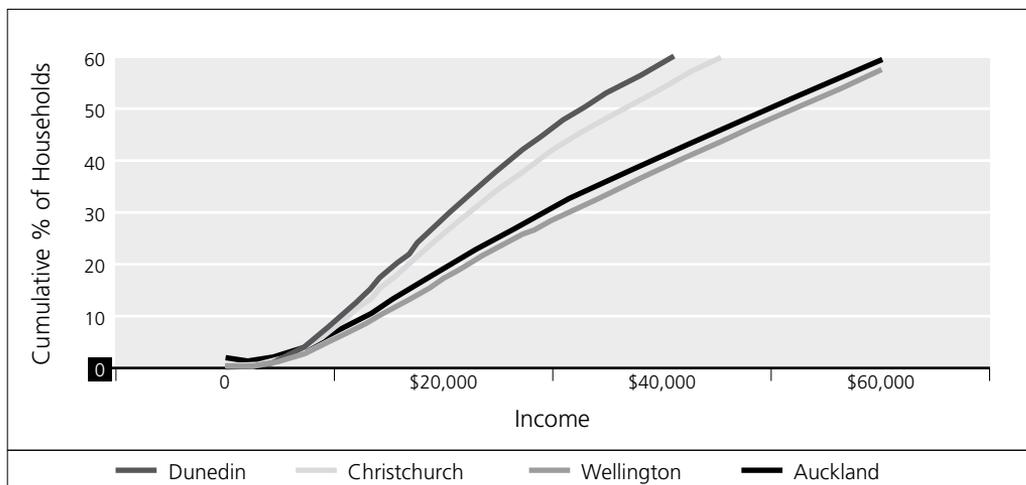
The same 90 m² brick veneer house was also modelled using the climate (including the same range of insulation levels and various orientations) for the other main centres in New Zealand. The energy needed reduced considerably as the location moved further north, as given in Table 1.

Figure 2 Income Distribution



Source: Statistics New Zealand.

Figure 3 Cumulative % of Households Below a Threshold Income



The results of this analysis are given in Table 1. Here, the Auckland data are for the five territorial authorities North Shore City, Waitakere City, Auckland City, Manukau City and Papakura City. Wellington comprises Porirua City, Upper Hutt City, Lower Hutt City and Wellington City. The total number of households likely to be in fuel poverty comes to between 65,000 and 89,000, or between 10% and 14% of the total population of the four main centres, which includes just under half (47%) of the total population of New Zealand.

Table 1 Fuel Poverty for New Zealand Households, 2001

	Auckland	Wellington	Christchurch	Dunedin	Total
Heating energy needed kWh/y	4,000– 6,000	8,000– 13,000	11,000– 15,000	13,000– 16,000	
Other electricity kWh/y*	5,500	5,900	6,200	6,600	
Total energy cost @ 9.5c/kWh	\$900– \$1,100	\$1,300– \$1,800	\$1,600– \$2,000	\$1,850– \$2,150	
Income thresholds	\$9,000– \$11,000	\$13,000– \$18,000	\$16,000– \$20,000	\$18,500– \$21,500	
% of city population in potential fuel poverty	6%–8%	9%–14%	18%–25%	26%–32%	10%–14%
No. of households	348,639	123,975	121,824	43,290	637,728
No. of households in potential fuel poverty	21,000– 28,000	11,000– 17,000	22,000– 30,000	11,000– 14,000	65,000– 89,000

* The higher costs for cooler climates reflect higher losses for hot-water heating

If the pattern is followed for the regions outside the main centres, as it well might because the rural areas in general have lower incomes than the main centres and follow a similar climate profile, then the analysis would suggest between 10% and 14% of the country's households, or some 400,000 people, could be in fuel poverty nationwide. It is likely that this estimate is in fact on the low side for several reasons, including that the modelling is based on a 90 m² house, which is at the small end of the housing market, and assumes no solar shading. In fact Dunedin in particular is afflicted with generally poor solar access (as is Wellington) due to the local geography. The average size of new housing has been rising in New Zealand from 127 m² in 1997 to 175 m² in 2003 (Statistics New Zealand). On the other hand the average number of residents decreased from 3.2 persons per dwelling in 1997 to 2.7 persons per dwelling by the end of 2004. The use of lower-cost fuels such as wood or coal on the other hand could lower the percentage of persons in fuel poverty.

DISCUSSION

The figure of 10–14 % in fuel poverty for New Zealand is very similar to that estimated for the United Kingdom, where according to the (British) government in 2001 some three million households or 14 % of the population (2001) were deemed to be in fuel poverty (DEFRA 2004). In Australia, Richardson and Travers (2002) conclude that for South Australia and Australia: “for lower income households, the typical share of fuel costs in total disposable income in South Australia (and Australia) is a little over 4%.” This would mean that almost no households would be in fuel poverty (in the British sense) in Australia, although these authors used fuel definitions and disposable income definitions somewhat different to the British definition.

There are several strategies that can ameliorate the inequalities introduced by having a serious proportion of the population in a state of fuel poverty, including regulation of supply costs, improving housing insulation levels and/or introducing specific subsidies to low-income households to pay some of the fuel costs.

Policy initiatives such as keeping electricity and other fuel costs low by regulation, however, would work across income levels and not necessarily reduce inequalities. In addition, the New Zealand Government has had an overall aversion to domestic commodity subsidies because they tend to distort the market and make substitution difficult to achieve. Indeed the long-term historically low cost of electricity in New Zealand, which in the days of a vertically integrated electricity sector provided a tax-payer-subsidised product, most likely contributed substantially to the relatively poor thermal housing standards in New Zealand. This situation occurred because energy-efficient improvements in the residential sector would not be cost effective compared with cheap electric heating. In recent years, as deregulation has evolved in the electricity supply sector, the supposedly self-regulating industry has not worked well, especially with regard to security of supply.

To remedy some of the supply-side problems the Government introduced a regulatory authority, the Electricity Commission, in 2004 to assist with the long-term provision of electrical energy to the country. The terms of reference for this commission, however, have been focused on security of supply and sustaining economic growth, including providing an electricity supply system that “is reliable and resilient, is environmentally responsible, delivers energy prices that are efficient, fair, and as competitive as possible consistent with these requirements” (Electricity Commission 2004).

The emphasis on economic growth and fair and efficient pricing has been attacked by social action groups such as the Association of Citizens Advice Bureaux, which submitted to an earlier version of the policy statement that: “there are some key parts missing from the Statement. Specifically we consider the Statement should address

issues around electricity as an essential service, vulnerable customers and their inability to pay for electricity, and fuel poverty” (Association of Citizens Advice Bureaux 2003). This concern was not addressed to any extent in the final policy document other than provision for a low-energy tariff for low-energy users. In addition, recent increases in electricity prices (since 2001) almost certainly mean that the percentage of people in fuel poverty in New Zealand is somewhat higher than that given for 2001 and will continue to rise as energy cost increases outpace income rises. Price control of other non-electricity energy supplies would have similar market distorting difficulties to electricity price regulation.

In terms of improving household insulation levels, this strategy is a government policy initiative included in the National Energy Efficiency and Conservation Strategy (Ministry for the Environment 2001), which is being administered by the Energy Efficiency and Conservation Authority of New Zealand (EECA). As part of this programme, a subsidy scheme is directed at low-income households, but the initiative relies on the householder, or organisation representing the householder, making a substantial contribution to the insulation upgrade. Another initiative in the same vein is being undertaken by Housing New Zealand Corporation, which has been upgrading state-owned houses since 2001.

However, strategies to combat the problem of high space-heating costs by housing insulation upgrades targeted mainly to introducing ceiling and under-floor insulation may not produce improvements in indoor temperatures sufficient to satisfy health criteria (Lloyd and Shen 2004). This study of ours shows that in the southern South Island of New Zealand, at least, many state-owned houses still exhibit temperatures seriously below WHO recommended levels. Improving the thermal standard of houses is thus difficult, especially in terms of retrofitting existing houses. In addition, Davie (2004) found that the level of seasonal mortality in New Zealand has not declined over the 20 years from 1980 to 2000, despite the introduction of thermal building standards requiring mandatory insulation levels in all homes built after 1978.

The question of how poor housing affects health in New Zealand, especially in terms of older inhabitants, has been extensively discussed by researchers from the Wellington School of Medicine (Howden-Chapman et al. 1999). These researchers address fuel poverty in terms of suggesting policies that will “improve the thermal performance of houses, especially existing ones, that address the cost of power for older people, and that result in the education of older people about the risks of cold homes”.

Thus, after considering and rejecting price control on energy supply and realising the difficulties and time that will be needed to improve the housing stock, at least in the short to medium term, we are left with the final policy alternative: selective subsidies. This strategy has the advantage that it could be targeted at low-income householders and could be specifically related to the climate zone and the thermal condition of the housing occupied.

Finally, the relatively low-cost strategy of providing information to vulnerable groups, especially the elderly, as to the health aspects of being exposed to low-temperature environments, has not been attacked aggressively enough by any New Zealand government health initiatives.

CONCLUSIONS

Our analysis of fuel poverty in New Zealand shows that the extent of the problem is much greater than is presently recognised by the Government. This difference is partly because of confusion over the British definition of the phenomenon. In the government review in the *Sustainable Energy* policy document (Ministry of Economic Development 2004b), the indicator used is what people actually spend on household fuels (5% for the lowest economic groups (p.49)) rather than what they would need to spend to attain a healthy indoor environment (10%–14% and rising to possibly as much as 32% in Dunedin in the lower South Island). That people actually use little fuel for space heating in New Zealand is reinforced by various studies showing relatively low indoor temperatures (Lloyd and Shen 2004, BRANZ 2003) in New Zealand and the apparent energy efficiency of the residential sector compared to other OECD countries (Schipper et al. 2000). It can also be concluded that recent increases in energy prices, especially electricity prices since 2001, will certainly exacerbate the situation and mean that a reassessment of the fuel poverty situation in New Zealand will need to be done within a few years.

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