

## ENVIRONMENT CANTERBURY CLEAN HEAT PROJECT – AN AIR QUALITY IMPROVEMENT PROJECT FOR THE URBAN ENVIRONMENT

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### ABSTRACT

The Clean Heat Project has been developed as a result of new rules for home heating proposed in the air chapter of the Proposed Canterbury Natural Resources Regional Plan. The focus of the Project is on meeting the 2013 National Environmental Standard for air quality. The consequence of not reducing air pollution will have significant impacts not only on health but also on industry growth, the quality of social services provided for Christchurch people, and ultimately people's standard of living. Not meeting this standard will significantly limit the ability of the Regional Council to issue new resource consents for discharge into the air after 2013, the impacts of which will be experienced by community services as well as industry.

Through the Clean Heat Project, Environment Canterbury provides incentives and assistance to assist homeowners in Christchurch using old, inefficient and polluting solid fuel home heating appliances to change to cleaner forms of heating and to upgrade home energy efficiency. The aim of the project is to assist the conversion of 26,464 homes over an 11-year period between 2003 and 2014. Through this approach, the development of the Clean Heat brand has raised community awareness of the negative health effects of pollution and the acceptance of the role the community plays in the use of domestic solid fuel heating. As of 2007, nearly one-third of targeted homes have been successfully retrofitted under the parameters of this project.

Alternative heating appliances that are considered to be 'Clean Heat' approved are offered to participants and consist of a range of technologies and fuel types in reflection of the Christchurch airshed's capacity to handle resultant emissions. Selection of such appliances by participants must be balanced with an approximate 60% of conversions to be of very little to no emissions (gas, electrical, diesel fuel types) heating appliances with the remaining 40% available for ultra-low emission solid fuel burning appliances and some remaining existing solid fuel burners.

Depending on eligibility, homeowners with existing open fires and older solid fuel burners may qualify for one of four programme options with differing levels of assistance and subsidies of heating appliance conversion and installation of energy efficiency measures. Participation is on target as far as meeting project conversions and budget, however, the conversion rate in Christchurch will need to be increased whilst maintaining airshed capacity through voluntary conversions, or other mechanisms, in order to meet the 2013 deadline.

### KEYWORDS:

Air; appliance; fuel; particulate; residential

### INTRODUCTION

A number of urban centres in Canterbury are subject to the long existing problem of periods of reduced wintertime air quality due to high (ca. 80%) relative proportion of fine particulate matter (PM<sub>10</sub>) emitted from residential home heating appliances. Elevated concentrations of particulate matter are associated with a range of health issues from minor irritation of the eyes to exacerbation of existing cardiac and respiratory conditions. High pollution events normally occur on cold, clear and still nights in winter and tend to coincide with increased residential electricity demand (see Figure1).



**Figure 1** Typical high wintertime pollution event experienced in a Canterbury settlement

The National Environmental Standards for Air Quality (NESAQ) have set a national standard that Canterbury needs to meet by 2013, with the standard ( $50 \mu\text{g}/\text{m}^3$ ) not to be exceeded more than once per year. Research indicates that coal and wood burning for domestic home heating contributes 80% of the particulate  $\text{PM}_{10}$  emission loading in Christchurch's winter heating season (nominally May to August). This standard has in recent times been exceeded by as much as 30 - 40 times per year<sup>1</sup>. To meet the NESAQ a major decrease in  $\text{PM}_{10}$  emissions from domestic heating is required. If the NESAQ standards are not met, Environment Canterbury (ECan) will be severely restricted in its ability to issue air discharge consents to the industrial and commercial sector which has the potential to cause impacts on the region's business and economic activity.

ECan has a responsibility under the Local Government Act (2002) to deliver upon community expectations under the main implementation tool of that legislation; the council's Long-Term Council Community Plan 2006-2016 (LTCCP). Outcomes are based on community views of the region's social, cultural, environmental and economic well-being. Levels of Service (LoS) are the council's contribution to community outcomes and one of these is '*Converting to cleaner forms of home heating to reduce the most significant source of  $\text{PM}_{10}$  emissions*', with a measure of the success of this LoS being the number of conversions undertaken annually by the Clean Heat Project (CHP – [www.cleanheat.org.nz](http://www.cleanheat.org.nz)).

The CHP thus forms an integral part of the Air Quality portfolio at ECan<sup>2</sup>. Via a targeted community rate, the Project accounts for approximately 75% of the portfolio's budget of \$10.6M in 2007/08. As a result of new rules in the air chapter of the Proposed Canterbury Natural Resources Regional Plan (NRRP), and more recently required under NESAQ, the CHP has developed an environmental focus.

There is a second aspect to this problem: that many New Zealand houses are cold and damp and hard to heat in winter. The CHP, as an incentives and assistance project, is primarily designed to encourage and assist homeowners who are currently using solid fuel domestic heating appliances to change to cleaner forms of home heating. As it is a targeted programme specific for this purpose, the CHP has not been designed as a 'home heating/energy solution'.

This paper discusses primarily the CHP, its objectives, principles, barriers / challenges, processes and outcomes. However, there are other issues around housing energy efficiency, which are briefly discussed. Approximately 70% of contributing ratepayers derive no direct benefit other than cleaner

<sup>1</sup> In the 2007 season, this has been around 10 breaches of the NES for  $\text{PM}_{10}$ .

<sup>2</sup> Environment Canterbury is the trading name of the Canterbury Regional Council, one of 12 regional councils in New Zealand who have responsibility for the sustainable management of resources which includes air quality.

air from their contribution because they remain ineligible under the conditions of Clean Heat funding yet face substantial difficulties as a result of poor building energy performance (an issue which is nationwide, not Canterbury-specific).

**THE CLEAN HEAT PROJECT**

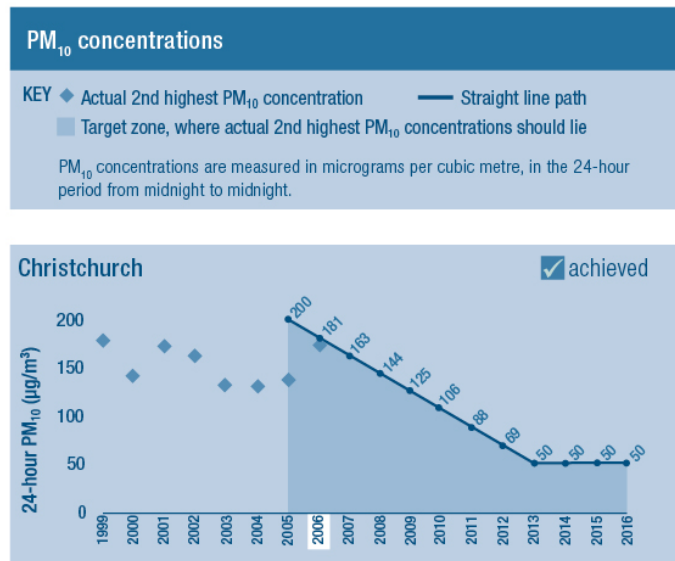
**Objectives**

The CHP is a voluntary method of financial incentives and assistance, to enable and encourage households to comply with the new air quality rules. The primary objective of the project is to improve air quality in Christchurch by facilitating conversion from old, inefficient and polluting home heating appliances to cleaner and more efficient alternative appliances. The project began in 2003 and targets 26,464 Christchurch households, offering a variety of financial assistance programmes and follows on from work done by the Christchurch City Council’s Clean Air and Energy Efficiency Programme in the years 1997-2002.

The Local Government Act 2002 (LGA) requires that local authorities describe their activities in terms of the service levels they propose to meet for the contributions required under LTCCP. The LTCCP enables the project as a key voluntary tool for improving wintertime air quality throughout the Canterbury region to:

- meet the ambient air standard as outlined in the NESAQ;
- encourage and assist homeowners to replace open fires and solid fuel burners with Clean Heat approved heating appliances;
- keep assistance costs within the budget provided in the LTCCP, and;
- encourage and assist homeowners to install insulation that makes better use of home energy.

Notwithstanding favourable meteorological conditions and other technical and behavioural factors, the impact of the CHP can in part be measured by a second LoS, ‘Meeting National Environment Standards for PM<sub>10</sub> concentrations to protect human health’, is measured by the second highest PM<sub>10</sub> concentration to be above ECan’s straight line path (a steady annual increase to 50 µg/m<sup>3</sup> by 2013) for PM<sub>10</sub> concentrations (see Figure 2).



**Figure 2** Level of Service performance measure for ECan’s Air Quality portfolio, 2006-07

## Principles

Key project principles include:

- providing the greatest level of assistance to those on low incomes (who are more likely to find it hard to make the conversions without assistance);
- assistance provided for home heating conversions in residential homes that currently use solid fuel as their main source of heating in their main living area;
- replacement of inefficient heating appliances and technologies with those that are Clean Heat approved;
- ensuring that the project provides warm homes in accordance with current codes and standards in terms of energy efficiency measures, including insulation;
- specifications of new appliance sized to adequately to heat the main living area in which the existing appliance is situated;
- removal of the fireplace or rendering inoperable of the solid fuel appliance being replaced.

A combined efficiency/heating appliance package appears to provide a much better set of multiple outcomes (e.g. environmental outcomes and comfort gains) than a basic energy efficiency package alone (typically ceiling insulation, underfloor foil and draught-proofing doors), especially in colder parts of the country (McChesney and Amitrano, 2006). When measured by environmental outcomes and householder perceptions, the CHP ably demonstrates the impact that a combination package of insulation and heating appliance home retrofitting can be more effective than an 'insulation-only' approach (McChesney and Amitrano, 2006).

## Barriers and Challenges

Unlike most other projects of its kind, the CHP is funded by a special targeted rate by Christchurch City ratepayers. Initially, many residents were opposed to such rate increases primarily through lack of understanding of what the NRRP proposed and the reasons behind regulation. The community raised a variety of concerns ranging from outright rejection of the imposition of regulation and perceptions of uncertainty in scientific analysis to a series of emotive and economic impacts on the home environment. These 'acceptance' barriers may have been overcome to a greater degree in Christchurch but similar issues are being faced for similar proposed programmes for other urban centres

From the outset of the Project, ECan has worked very closely as the primary leader with community stakeholders in establishing project requirements and guidelines in advance of regulatory measures. All income-brackets, rather than only targeting low income sectors, are able to participate. A high level of transparency has been required.

The CHP was not designed to provide a home heating solution. The fact that it has succeeded as well as it has offers real hope for the success of a dedicated 'home heating solution' programme (a programme that will likely need funding levels an order of magnitude greater than the CHP to make an impact on the energy inefficiency of New Zealand's residential housing stock).

## Processes

Only heating appliances that are approved by ECan to comply with the CHP eligibility standards and installation requirements may be considered. Heating appliances offering environmental or efficiency benefits, such as ultra-low emissions or very high levels of energy efficiency, have priority and must meet specified laboratory testing and Building Code Standards. All technologies must then be installed

in accordance with manufacturers' specifications. Competitive prices have been negotiated for installation of technologies. Participants (home owners or landlords) can elect to have the work project managed, or arrange installations themselves using approved registered organisations.

As the Clean Heat Project is in the public domain, it cannot be seen to recommend, endorse or provide advice about any particular technology option. The availability of all fuel type options is presented to customers in a manner that enables them to make an informed choice. The various companies are responsible for the promotion of their particular product.

The NRRP as it stands allows customers to select pellet burner technology but it is not entirely clear if this choice (or resource consent granted to manufacturers/suppliers) will remain the case when the plan becomes operative in 2007/08<sup>3</sup>.

The CHP provides four main incentive options. The options target different groups with different levels of subsidy or assistance.

- **Full Assistance:** is provided for low-income owner-occupiers who are expected to have the greatest difficulty funding the conversion to cleaner forms of heating. Full Assistance provides for the full cost of the conversion to be funded and is provided to homeowners who have a current Community Services Card<sup>4</sup>;
- **Subsidy:** a subsidy programme (discount on ceiling/underfloor insulation costs; discount on appliance cost) is available for owner-occupiers who do not qualify for Full Assistance;
- **Loan:** a ten-year interest-free loan is offered as an alternative to the subsidy. It enables participants to pay for the conversion by an advance of the capital cost. The loan principle is repaid over ten years through the rating system on the householder's property (10% per annum over ten years);
- **Landlord Subsidy:** is provided to encourage landlords to participate by offering a higher level of subsidy (40% of the cost). It is available for residential property organisations or landlords for their tenants.

While the CHP has the principal objective of providing cleaner air, it also considers options that make better use of home heating energy. Therefore, it is a requirement of participation that energy efficiency measures are installed as part of the project. The project also requires the removal (and destruction) of, or rendering unusable, the existing solid fuel burner or open fire, and either meets those costs, or subsidises them.

The policies and implementation of the CHP are reviewed annually, and that review considers, among other things:

- the level of uptake of the project incentives, compared to that budgeted for;
- the assumptions underlying the forward projections;
- the progress towards the reduction of PM<sub>10</sub> air pollution;
- the extent of choice of low emission woodburners as a replacement option; and
- the qualifying emissions standard for additional heating appliances to be included in the project.

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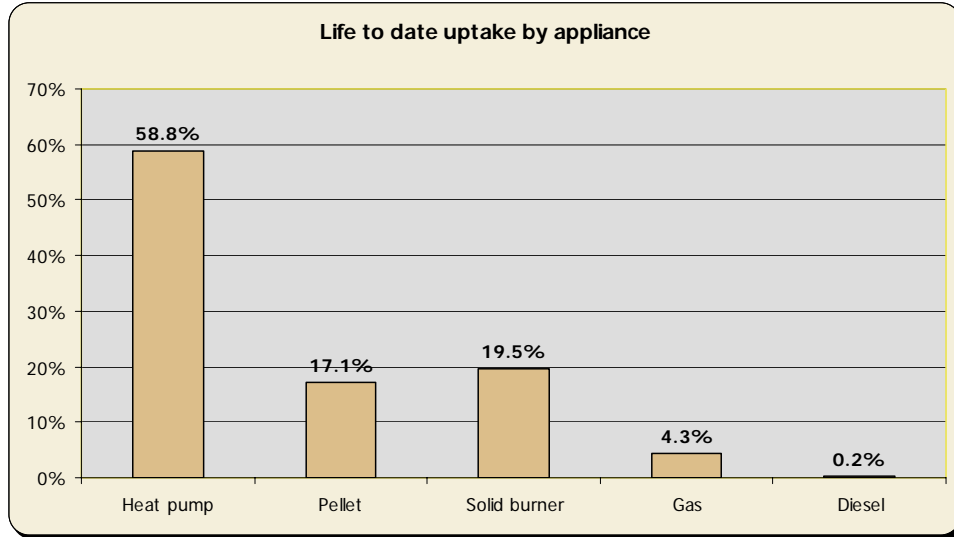
<sup>3</sup> There are three active global consents granted by ECan which allow a total of 1505 pellet burners in new homes in the Christchurch airshed.

<sup>4</sup> A Community Services Card is a means of providing a subsidy on a variety services to certain individuals or families if their annual income is below a certain threshold.

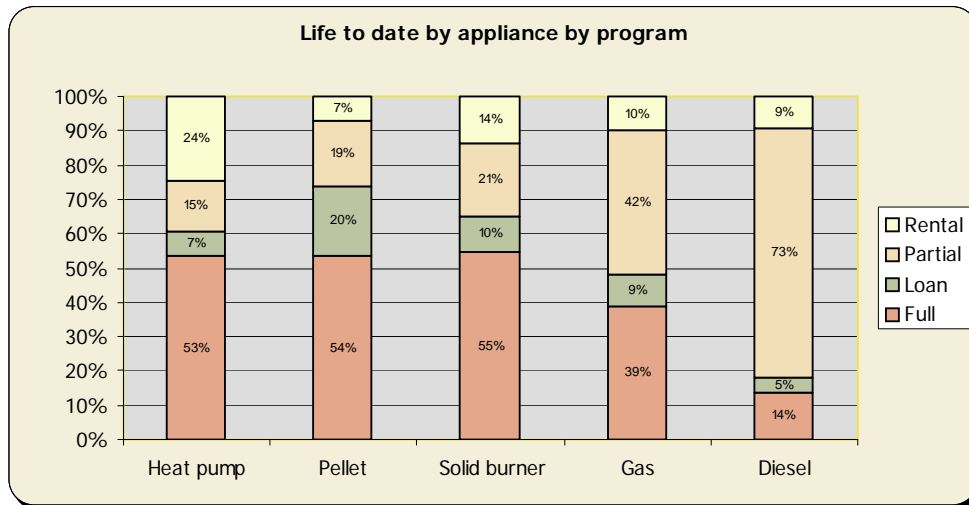
**Outcomes**

The project maintains a comprehensive database and is able to provide reports and statistics on monthly and annual targets and what has been achieved, and specific monitoring of the progress of individual assessments and project installations (see Figures 3 and 4).

Despite being an additional cost to ratepayers, the project has been well received and is getting good traction. Continued improvements to the project have paid off, with a recent independent Customer Satisfaction Survey indicating 97% of the survey sample is 'very satisfied' or 'quite satisfied' with the Clean Heat process (Opinions Market Research, 2006).



**Figure 3** Proportion of conversions by appliance type



**Figure 4** Proportion of conversions by appliance type and incentive option

Incentive grants are offered as a discount towards the installed costs of the chosen technologies as offered. A wide range of fuel types and a limited range of high performing brand and models of the technologies are offered depending on the incentive option available to the homeowner and reflect energy efficiency and environmental concerns.

A trained independent assessor determines and verifies eligibility for each participant and agrees with the homeowner on the technology that needs to be installed. Heating technology selection is at the homeowner's prerogative based on objective information provided by the assessor covering the capital costs, operating costs and efficiencies of each available option. Assessors must be professional and unbiased in presenting information that enables the participant to make an informed choice. ECan does not endorse or promote any technology or organisation.

## **HOUSING ENERGY EFFICIENCY**

### **Energy policy**

ECan is increasingly active regionally regarding energy policy. 'Existing Homes' has been identified, via the Regional Energy Strategy, as a key priority area for action in the 2007/08 financial year (ECan, 2007). Key reasons include:

- The residential sector, while a relatively low user of consumer energy (though a significant electricity user), is where most people spend most of their time and a major area of concern in terms of social inequity
- Some 80,000 homes in Canterbury are incapable of providing minimum comfort and healthy indoor temperatures for their occupants in a manner that is affordable (CEA, 2007)
- Central government support for regional investment in funding, implementing and monitoring energy efficiency programmes is insufficient and lacks clarity of purpose (McChesney et al, 2006)
- Current home retrofit packages are inadequate and effectively limited to insulation
- Existing home / housing initiatives do not cover all socio-economic groups which can lead to perverse outcomes.

Lack of a clear purpose has been cited as a key reason for hindering progress in improving nationwide household energy efficiency (McChesney et al, 2006). As described earlier, the NES for air quality by 2013 is an important development but much remains to be done. Other areas that could provide specific outcomes include CO<sub>2</sub> emission reductions (e.g. the Communities for Climate Protection programme), healthy indoor temperatures and (regional) energy security (e.g. the CRESF project (CREF, 2007)).

While the CHP seeks to address air quality issues in Canterbury, there are associated energy issues that are less well understood or debated. These include the trend toward lower use of wood as a residential fuel in favour of increasing use of electricity. Regional energy survey data serve to illustrate the overall trend of increasing, rather than stabilising or decreasing regional energy use (ECan, 2006 – also see Figure 5).

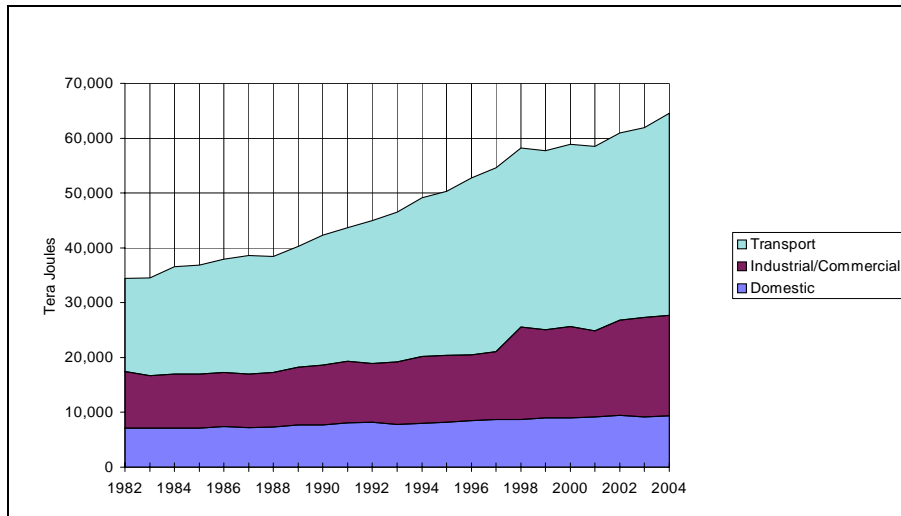
Demand trends show big opportunities for residential electricity substitution plus substitution of approximately 20PJ of coal by wood for space heating (Melhuish, 2007). In the residential sector, the use of firewood for space heating is undoubtedly common and more significant than previously recognised (Isaacs et al, 2007). Its share of (input) energy for Canterbury households is estimated to have increased from around 17% of consumption in 1982 to some 22% in 2004 (ECan, 2006).

There is an on-going debate about how best to utilise the region's wood as a residential fuel. Pellet fuel alternatives, while cleaner burning (and in reality the only woody fuel available as a Clean Heat option for new dwellings<sup>5</sup>) are generally more expensive than competing technologies. There is future potential for non-pellet wood burners to be installed in new dwellings, however, aspects such as higher

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<sup>5</sup> New dwellings in greater Christchurch but not including Banks Peninsula settlements amalgamated in 2006 such as Lyttelton.

technology standards and emission testing methodology need to be re-examined before this can take place.



**Figure 5** Canterbury energy consumption by sector to 2004 (ECan, 2006)

As described earlier, around 59% of CHP conversions have been to heat pumps. This has the effect of reducing the consumption of firewood but it increases the consumption of electricity, the latter effect particularly impacting on the important aspect of peak electricity loading, especially in the winter season. Increased electricity demand in summer from using heat pumps in reverse cycle mode (as an air conditioner) has not been quantified in Canterbury in a region where use of irrigation pumps is of greater concern. Summer time heat pump usage is regarded as a less important issue in comparison to what other regions might experience (e.g. the warm, humid summer climates in the North Island).

One way forward that can potentially address both air quality and energy demand concerns is, rather than increasing electricity generation, ensuring a better matching of fuel type with the desired household energy services (Isaacs et al, 2007). Anecdotally, recipients of the CHP have provided feedback stating their electricity consumption has reduced because resistant heating has not been used in preference to lighting the woodburner for short term heat.

There are deeper air quality – energy cross-over issues here that need further investigation, for example, the impact of the approximately 70% of homes not covered by CHP and the choices those occupants will make between appliances (ever more expensive electricity tariffs vs. pellet burners); or those ‘holding on to the bitter end’, that is, using inefficient appliances until being made forcibly to change heating forms in 2013. These issues are important but are beyond the scope of discussion in this paper.

### **Equity issues**

The CHP is an excellent model, which demonstrated how multiple objectives (clean air and warm homes) can be integrated through a single package of measures. While the Project cannot be expected to provide every household (the expense would be far too great for local ratepayers), there are some equity issues around what the project cannot deliver.

The CHP is forecast to cost \$58 million over the 10 years of the programme, the vast majority of which will be derived from ratepayers (rather than external grants). However, approximately 70% of contributing ratepayers will derive no direct benefit from their contribution because they currently remain ineligible under the conditions of Clean Heat funding. Yet within that majority group of

Christchurch households, there are many that face substantial difficulties, and who do not qualify for assistance (CEA, 2007).

For example, take the case of two randomly selected neighbouring, low income households. For a low-income household whose home is heated with solid fuel, Full Assistance (100% subsidy for both insulation and heating) is available. However, the next door neighbour who is heated by an unflued LPG heater and electric heaters cannot access Clean Heat assistance. This house would not qualify for any assistance to get its unhealthy, polluting but non-particulate emitting heater replaced. Moreover, based on the results from BRANZ's Household Energy End-use Project (HEEP), the latter house can be expected to be substantially colder and less healthy (Isaacs et al, 2006)<sup>6</sup>.

The unintended consequence of Clean Heat implementation is that there has been an increased awareness for the need of healthy and warm homes in Christchurch. This is a difficult problem to address either nationally or regionally. Under the NESAQ, the air quality limit of one exceedence per annum must be achieved by September 2013. For Christchurch, achievement of the standard will likely mean a large-scale shift in home heating from open fires and older solid fuel burners to low emission (solid and liquid fuel) burners and electricity. There will be consequences (prominently financial) in achieving the 2013 standard, as householders may bring forward appliance changes that would have occurred over a much longer timescale.

The funding of these changes also raises concerns over social equity. At the same time, socially responsible policy solutions should also ensure that 'cleaner homes' do not lead to 'colder homes'. Furthermore, solid fuel burners in Canterbury are largely wood burning. A shift to include more electricity, oil and gas in the appliance mix also raises questions regarding regional energy security and efforts to mitigate greenhouse gas emissions. These concerns will be investigated more closely in the council's forward work programme of the energy portfolio.

## **CONCLUSION**

Over time there may well be regionally closer integration of air quality and energy efficiency measures to address 'policy gaps' currently much in evidence. However, the CHP is widely acknowledged as the country's most successful practical programme of its type and serves as a useful structure for related and/or associated programmes nationally. The combination of insulation and heating retrofits provided by the Clean Heat Project demonstrates how multiple objectives (cleaner air and warmer homes) can be integrated through a combined energy efficiency / heating appliance package. .

## **ACKNOWLEDGEMENTS**

The assistance of Sandra Barns, Environment Economist at Environment Waikato, is appreciated in relation to preparation of material relating to the Clean Heat Programme.

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<sup>6</sup> LPG heaters are a health issue in their own right; they are a significant form of household heating identified in the HEEP studies yet they emit harmful nitrogen oxides emissions.

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