Improving the Quality of Housing:

How public policy can promote multiple benefits

Motu PPS, May 2012

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Outline

- How poor housing leads to
  - poor health
  - high energy bills
  - higher carbon emissions
- Results of housing intervention studies
- NZ Insulation Fund Evaluation
  - energy, employment results
  - health results and sums up on CBA
  - summary

Pathways

- Cold indoor air is harder to heat
- Mould grows better in damp air
- Viruses survive for longer on cold surfaces
- Cold stresses immune system
- Blood (liquid) thickens when cold & more likely to form plaques
- When only 1 room heated in house, people crowd together

Kiwis pay for their cold comfort

By REBECCA TODD

PEOPLE ARE turning off heaters and jumping into bed to escape rising power bills after the coldest June in more than 30 years.

The average national temperature last month was a nippy 7.3°C, the lowest since 1972.

As the chill set in, Kiwis cranked up their heating and snuggled up indoors. Power usage was pushed to record highs – and power bills are now following suit.

Elaine and Fred Baker of Rotorua were forced to turn off their heater and stay in bed after receiving a bill for $147 when they usually pay about $80 to $90.

"We can't afford to have another power bill like that," Elaine said.

Millie Mitchell, 78, of Dunedin has been turning off her heating and going out during the day after receiving her biggest power bill ever of $240 for last month.

A brisk walk, trip to the gym or lunch in the warmth of the senior citizens' club is her tip for beating the chills and the bills.

Age Concern chief executive Ann Martin said: "We don't recommend staying in bed to save money. Activity is the key to keeping warm and healthy throughout winter."

Although Christchurch was the coldest main centre last month, Cantabrians Steve and Diane Garside say they're reaping the benefits of their decision last winter to convert to coal because of rising power bills. They have three children and estimate that if they had stayed with electric heating their June power bill would have been $330, instead of $180.

Temperatures in Omarama, North Otago, plummeted to a glacial all time low of –14°C last month. Locals Sue and Jim Harkin used a log burner with a wetback to combat the cold but even so were surprised to find their power bill jumped $40.

Even people in milder climates like Tauranga felt the pinch. Dawn Barber is in her seventies and lives alone in Bureta. Her June power bill was up $36 from the usual $100.

"It was quite a jump. It's probably the heaviest one I've ever had."

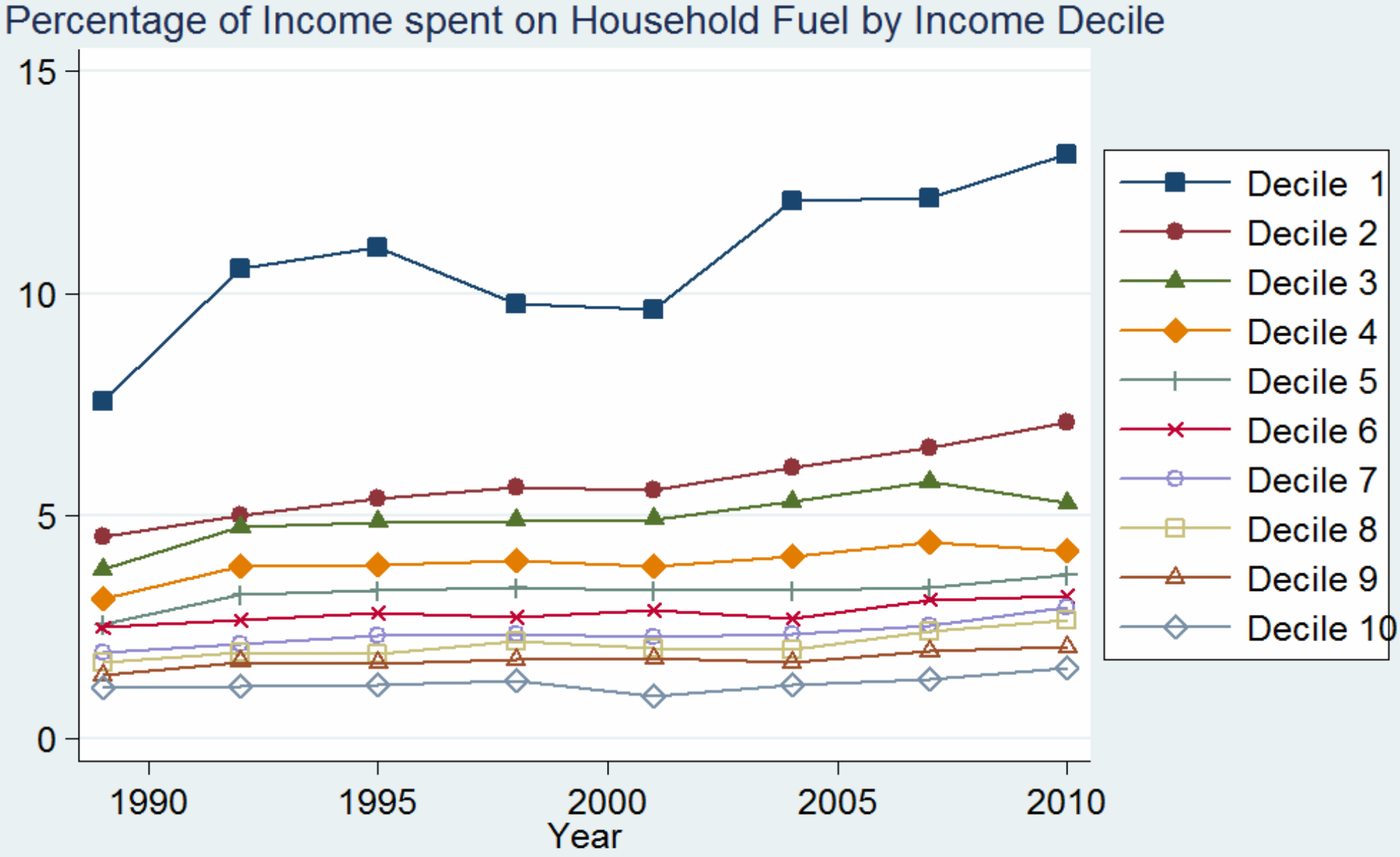
The warmest place to be in June was Kaitaia – where they had a relatively balmy average temperature of 11.3°C.

As the cold snap continues, July's bills could follow a similar pattern, but National Climate Centre principal scientist Dr Jim Salinger said the country should be thawing by the end of the month.

"We are expecting a cool July, frostier than usual, but a warm start to spring with average to above average temperatures for August and September."

The World Health Organisation recommends living areas are heated to 20°C. Less than 16°C puts people at higher risk of respiratory problems and under 12°C increases the danger of a heart attack or stroke.

■ **For information on how to keep your home warm and dry go to http://www.eeca.govt.nz.**



Source Data: Statistics New Zealand

After figure 34 'Market Design Review - Options Paper' Electricity Commission

Consequences

- Poor housing leads to other disadvantages that can affect income and health
- 1600 excess winter deaths from respiratory and circulatory problems
- Study linking NZ census & mortality data showed an increased risk of dying in winter among low-income people, those living in rented accommodation & those living in cities.

- Davie GS, Baker MG, Hales S, Carlin JB. Trends and determinants of excess winter mortality in New Zealand: 1980 to 2000. *BMC Public Health, 2007;7:263.*

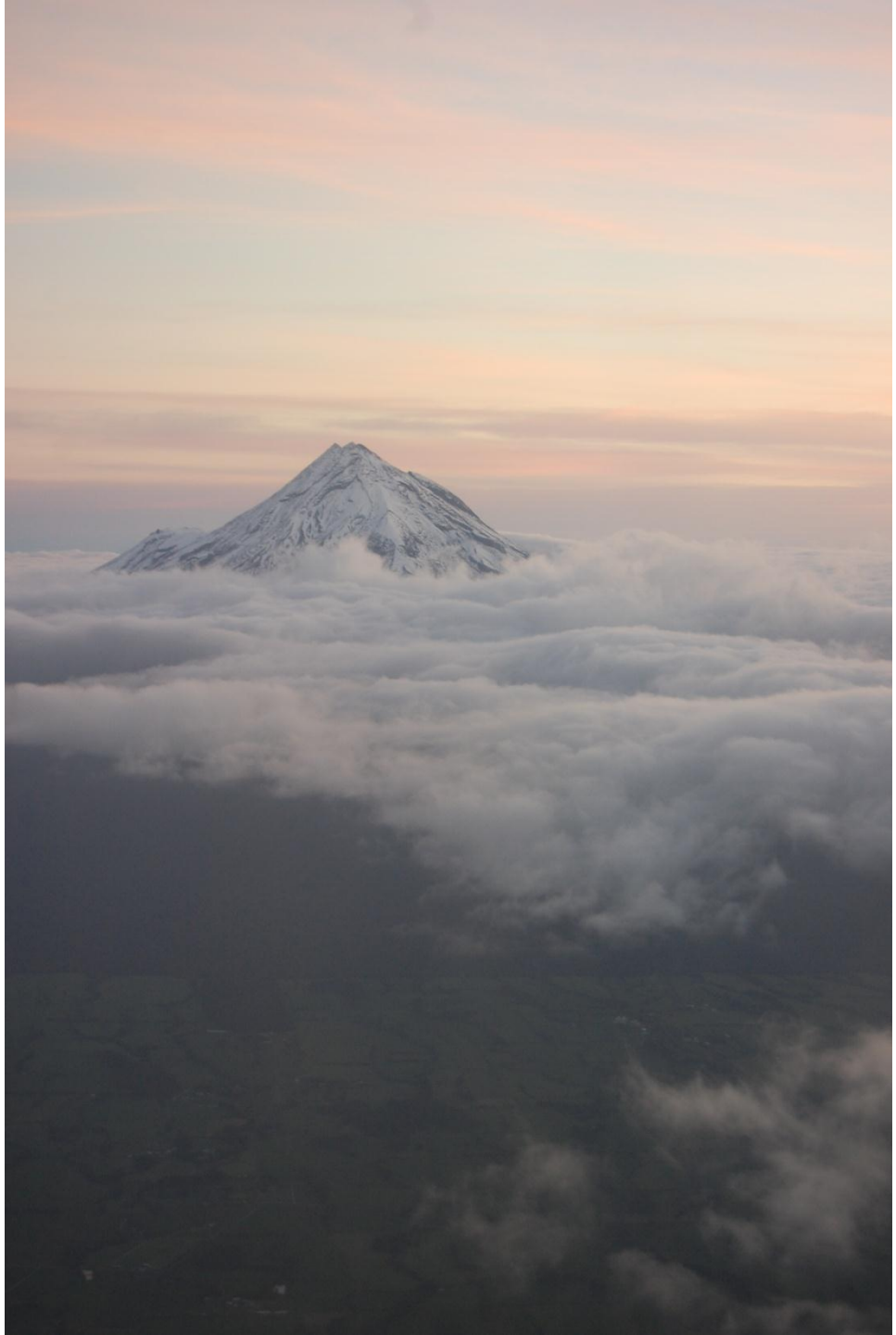
  Hales, S., et al., Seasonal patterns of mortality in relation to social factors. *Journal of Epidemiology and Community Health, 2010.* doi:10.1136/jech.2010.111864.

Robust community trials

- Housing, Insulation & Health Study
- Housing, Heating & Health Study
- Housing Injury Prevention Intervention
- Warm Homes for Elderly New Zealanders
- Housing, Crowding & Health Study

Housing, Insulation & Health Study

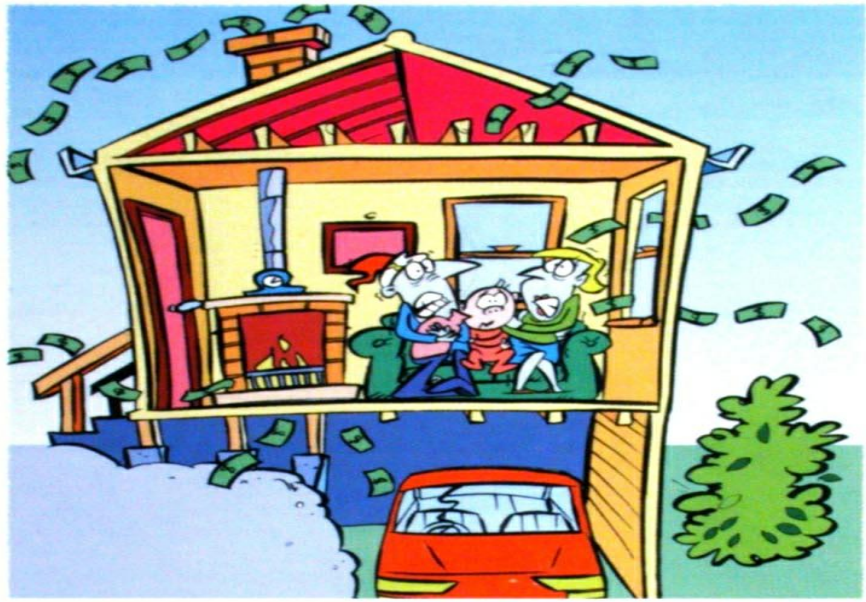
- 1400 households where one member had chronic respiratory symptoms
- Winter 2001 baseline measures taken
- Randomly assigned intervention houses insulated over summer
- Winter 2002 follow-up measures taken
- Control group houses insulated



Where does the heat go?

12%
through unblocked chimneys and draughts around doors and windows

10%
through the floor

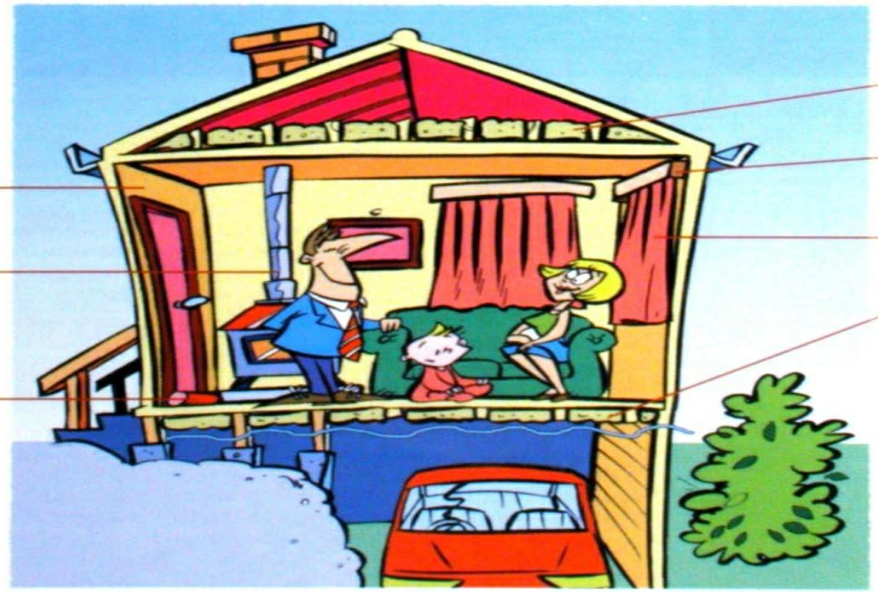


42%
through the ceiling

12%
through windows

24%
through walls

Winter heat savers



Wall insulation

Enclosed energy-efficient burner

Draught-stopper

Ceiling insulation

Pelmet

Well-fitting curtains

Underfloor insulation

Insulation also keeps the house cool in summer


FIRE EXIT

Significant results

- *Occupants in insulated houses used 23% less total energy (electricity, gas, wood)
- *Occupants of insulated houses exposed to cold temperatures (< 10^{o}C) for ¾ hour /day less
- *Occupants of insulated houses exposed to high humidity (> 75%) for almost 1 1/2 less per day

Better housing improves health

- *Improvement in self-reported housing conditions (less cold and dampness)
- *Fewer days off school and work
- *Fewer symptoms of wheeze and colds
- *Fewer hospital admissions

- Howden-Chapman, P., et al., Retrofitting houses with insulation to reduce health inequalities: aims and methods of a clustered, randomised trial in community settings. *Social Science and Medicine*, 2005. **61**: p. 2600-2610.
- Howden-Chapman, P., et al., Retrofitting houses with insulation to reduce health inequalities: results of a clustered, randomised trial in a community setting. *British Medical Journal*, 2007, 334, 460-464.

Cost-benefit analysis

- Co-benefits of improving housing on health, energy efficiency and carbon mitigation to reduce climate change
- Housing insulation ~2:1 benefits:costs

- Chapman R, Howden-Chapman P, Viggers H, O'Dea D, Kennedy M. Retrofitting housing with insulation: a cost-benefit analysis of a randomised community trial. Journal of Epidemiology and Community Health. 2009;63:271– 7

Importance of energy efficiency & climate change

- Halving of carbon emissions by ~ 2030
- Energy use in residential housing

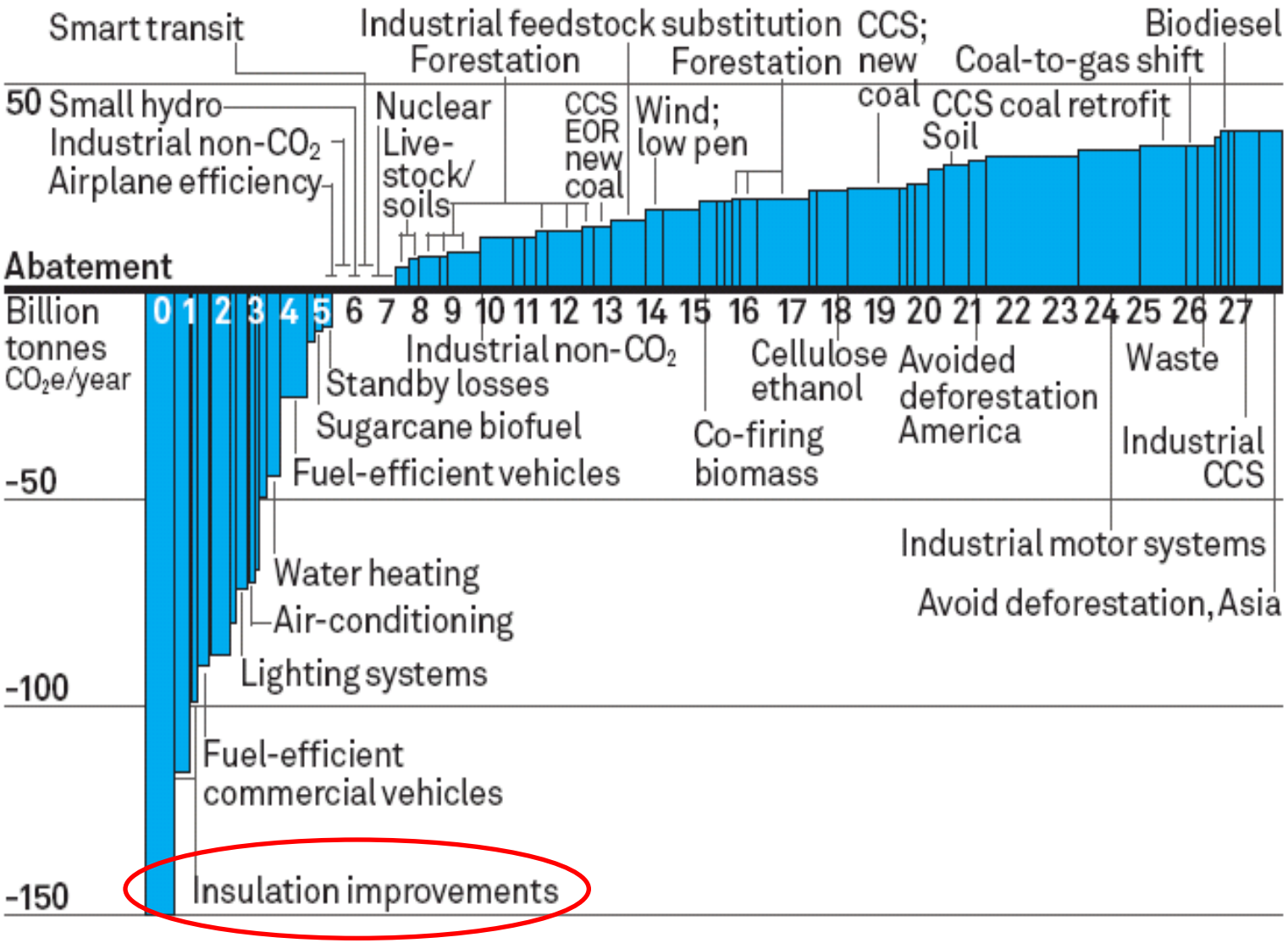
  <10% of NZ CO_2

  21.6% of USA CO_2 2009 (EPA)

  13 - 26% of UK CO_2
- Reductions possible through retrofits of existing buildings

WHO, *Health in the Green Economy: health co-benefits of climate change mitigation – housing sector. 2011*, World Health Organization: Geneva.

Exhibit 7



The cost curve provides a "map" of abatement opportunities
Cost of abatement, 2030, €/tonne CO_2e

Source: Enkvist et al. (2007)

LPG heaters

- Third of NZ households have UFGHs

- Exposure to NO_2 can reduce immunity to lung infections & increase the severity and duration of a flu episode

- NO_2 inflames the lining of the lungs, which can cause problems such as wheezing, coughing, colds, flu and bronchitis.

- NO_2 increases health risks from particulates
- 1 kg LPG = 1.6 kg H_20

Housing & Heating Study

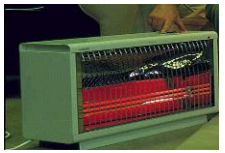
- 409 households in community trial
- Does non-polluting, more effective, home heating reduced children's asthma symptoms over winter?
- Households had choice of sustainable heaters

Intervention

Previous:

X electric heaters (2kW)

X unflued gas heaters (4kW)



Replaced with:

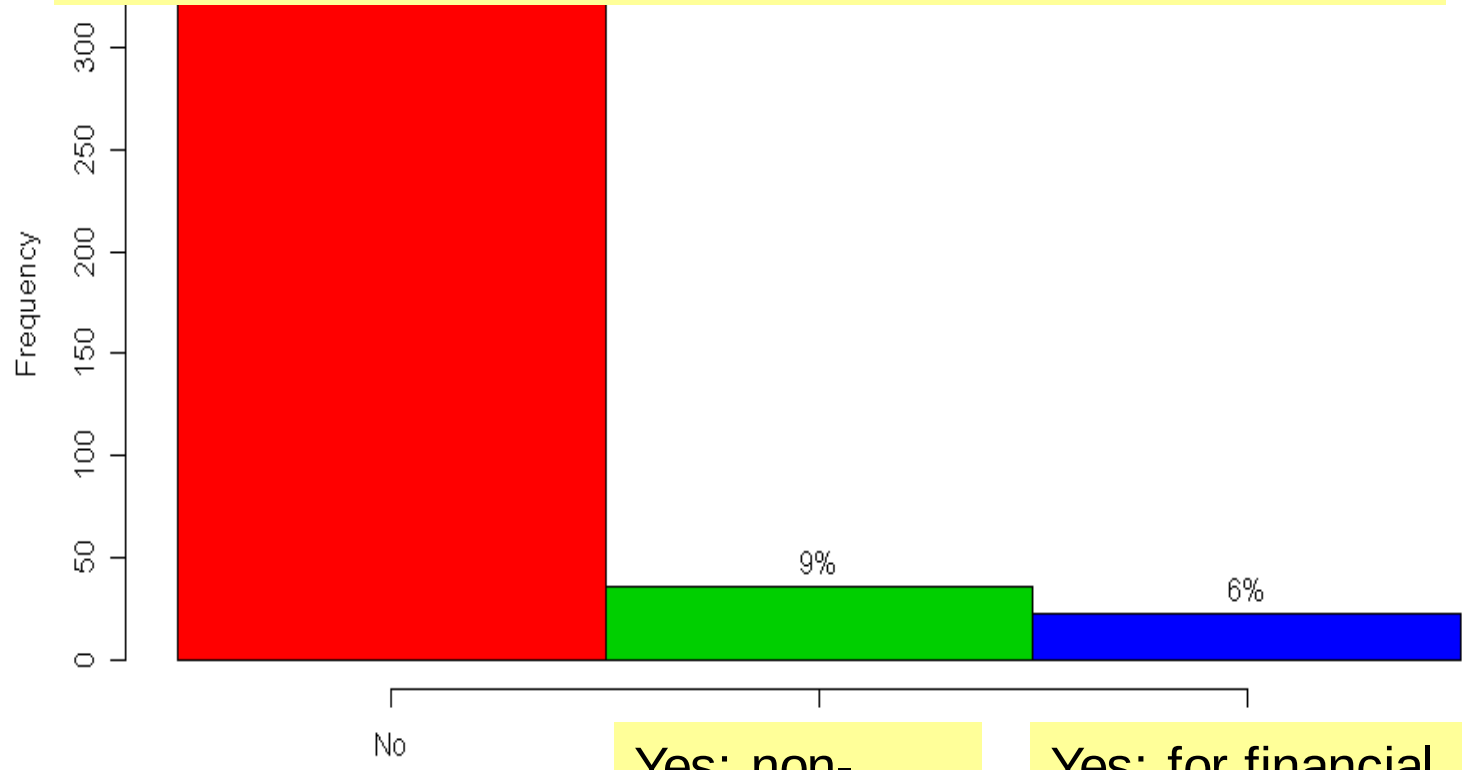
√ 320 heat pumps (4-7kW)

√ 55 wood pellet burners (10kW

√ 11 flued gas heaters

Baseline

Has your power been cut off in the last year?

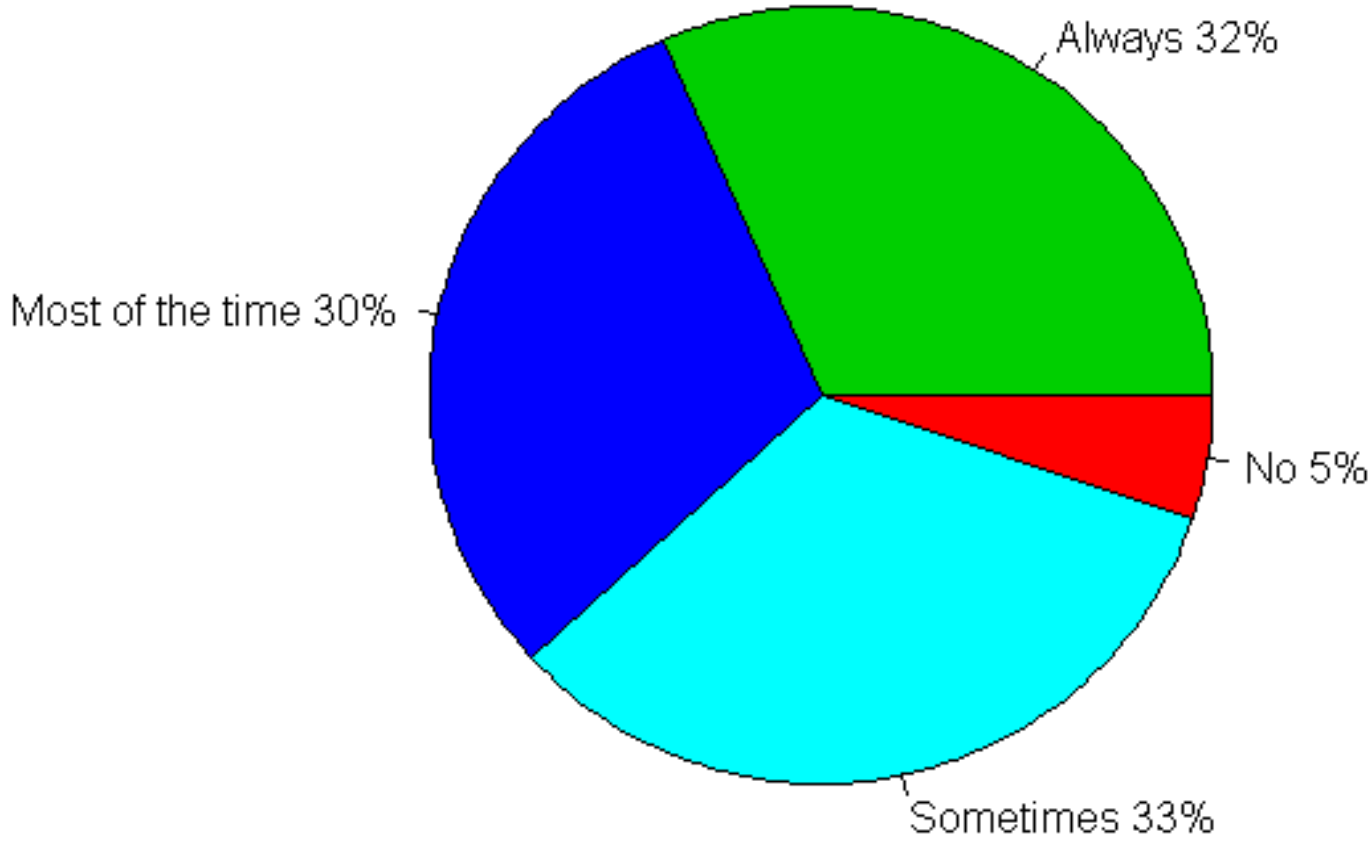


Yes: non-financial reasons

Yes: for financial reasons

Housing & Heating Study Baseline

Do you feel your house has been cold this winter?



Results

*Average living rooms 1.1°C warmer

*People felt warmer

*Condensation reduced

*Less mould and mouldy smells reported

*Levels of nitrogen dioxide halved

*Levels of wheezing & coughing halved

*Effects more marked in low-income families

*Two more days at school during winter

Howden-Chapman P, Pierse N, Nicholls S, Gillespie-Bennett J, Viggers H, Cunningham M, et al. Effects of improved home heating on asthma in community dwelling children: randomised community study. *British Medical Journal*. 2008;337:852-5.

Free S, Howden-Chapman P, Pierse N, Viggers H, Housing Heating and Health Study Research Team Study Team. Does more effective home heating reduce school absences for children with asthma? *Journal of Epidemiology and Community Health. 2009;doi:10.1136/jech.2008.086520*

Cost-benefit analysis

- Co-benefits of improving housing on health, energy efficiency and carbon mitigation to reduce climate change
- Space heating ~1.09:1 benefits: costs (for households with high proportion of children with asthma)
- Key health benefits: reduction in GP visits and days off school for asthmatic children

- Preval N, Chapman R, Pierse N, Howden-Chapman P. Evaluating energy, health and carbon co-benefits from improved domestic space heating: A randomised community trial. *Energy Policy* 2010.

Warm Houses for Elderly New Zealanders (WHEZ)

- 522 people over 60 with COPD
- Houses insulated beforehand
- Intervention $500 in electricity accounts
- “Heat is medicine”
- Wave design
- Outcomes: temperature and relative humidity, spirometry, diaries, hospitalisation, phaarmaceuticals
- Cost Benefit Analysis

WHEZ baseline

- Wave 1: 287 (24 known deaths); Wave 2: 235 (15 known deaths)

  Participants in Christchurch, Wellington & Whanganui:

  42% able to walk 100m or less on flat before needing a breather

  56% shivered inside at least once, during previous winter

  21% plug in medical equipment

Improving social housing & linking with primary health services: Healthy Housing Programme (HHP)

- Crowding linked to infectious diseases
- Cohort (SHOW) study links tenants to hospitalisations, 2004-2008
- After HHP, acute and arranged hospitalisations fell (27%) year after
- Fall in hospitalisations more marked (61%) for most intensive intervention

housing & health

www:sustainablecities.org.nz
www:healthyhousing.org.nz

Youtube Videos

Insulation Study

http://www.youtube.com/embed/wbObl3tnleA?rel=0

Heating Study

http://www.youtube.com/embed/U8EcY83W63U?rel=0

Evaluation of Warm up New Zealand: Heat Smart (New Zealand Insulation Fund)

- Evaluated effects of WUNZ:HS on:
  - Energy use
  - Hospitalisations, pharmaceutical impacts, life expectancy
  - Employment and industry effects
  - Overall benefit: cost outcomes
- Results to be released publicly late-May

Researchers, Funders & Data

- Research partners:
  - Motu
  - University of Otago
  - COVEC
  - Victoria University of Wellington
- Funder:
  - MED
- Data & other assistance from:
  - EECA, QVNZ, Genesis, Mercury, Meridian, Trustpower, PHARMAC, MOH

Healthy, Energy-Efficient Homes

- Examine insulation & clean-heat installation impacts
- Hypothesised to:
  - Warm up (and dry) houses
  - Reduce hospitalisations, lower pharmaceutical use & increase life expectancy
  - Reduce energy consumption
  - Have positive employment & industry effects
- Large-scale scheme compared with any previous studies

WUNZ: HS Scheme

- Launched July 2009
- $1,300 (or 33%) subsidy to retrofit **insulation**
- $500 subsidy for **clean-heat** source (e.g. heat pump)
- For houses built pre-2000
- No income threshold (extra funding for low incomes)
- Initial programme: 4 years; 188,500 houses
- Since extended

Treatment Categories:

Initial Houses (July 2009-May 2010)

Treatment Category	No. Houses Treated
Insulation Only	36,102
Heating Only (prior insulation)	3,611
Both Insulation and Heating	6,942
Total Houses	46,655

Research Design

- WUNZ:HS programme not randomised
  - though, conceptually, it could have been
- Evaluate ex post with quasi-experimental methods
- Compare 'treated' houses with 'control' houses
- Estimate difference before and after treatment of treated houses relative to their control houses
- I.e. a "difference in difference" research design

Research design

- Innovative approach informed by Lucy Telfar-Barnard's PhD thesis
- Addresses of WUNZ:HS participants (suitably anonymised) used to identify up to 10 control addresses
- Quotable Value carried out matching using matching protocol designed to identify controls as physically similar as possible to matched treatment homes

Telfar Barnard, L., *Home truths and cool admissions: New Zealand housing traits and excess winter hospitalisation,* PhD Thesis,. 2010, University of Otago: Wellington.

Research design: Matching criteria

QV variable	Definition	Maximum Points	Notes
Census area unit	Stats NZ defined areas – there are approx. 1860, of varying population sizes, covering the whole of NZ.	10	Mandatory match
Category	Residential/commercial/industrial etc.	10	
House Type	See Appendix 2	10	
Levels (single/multi-story)		10	
Decade	Decade in which the dwelling was constructed	10	Points variable
Floor Area		10	
Bedrooms	Number of bedrooms	5	
Main Roof Garages	Number of garages included under the main roof of the house (and therefore included in the floor area).	5	
Building	Wall material	10	
Roof	Roof material	10	
Modernised		10	

Choosing Control Houses

- For each treated house, chose controls based on:
  - Location (census area unit = “suburb”)
  - Age (decade of construction)
  - Dwelling/house type (e.g. bungalow);
  - No. levels
  - Floor area; no. bedrooms; garages under main roof
  - Construction material (wall/roof)
  - Whether modernised
  - Quality (building & roof condition)
- Matched 67% of treated houses to control houses

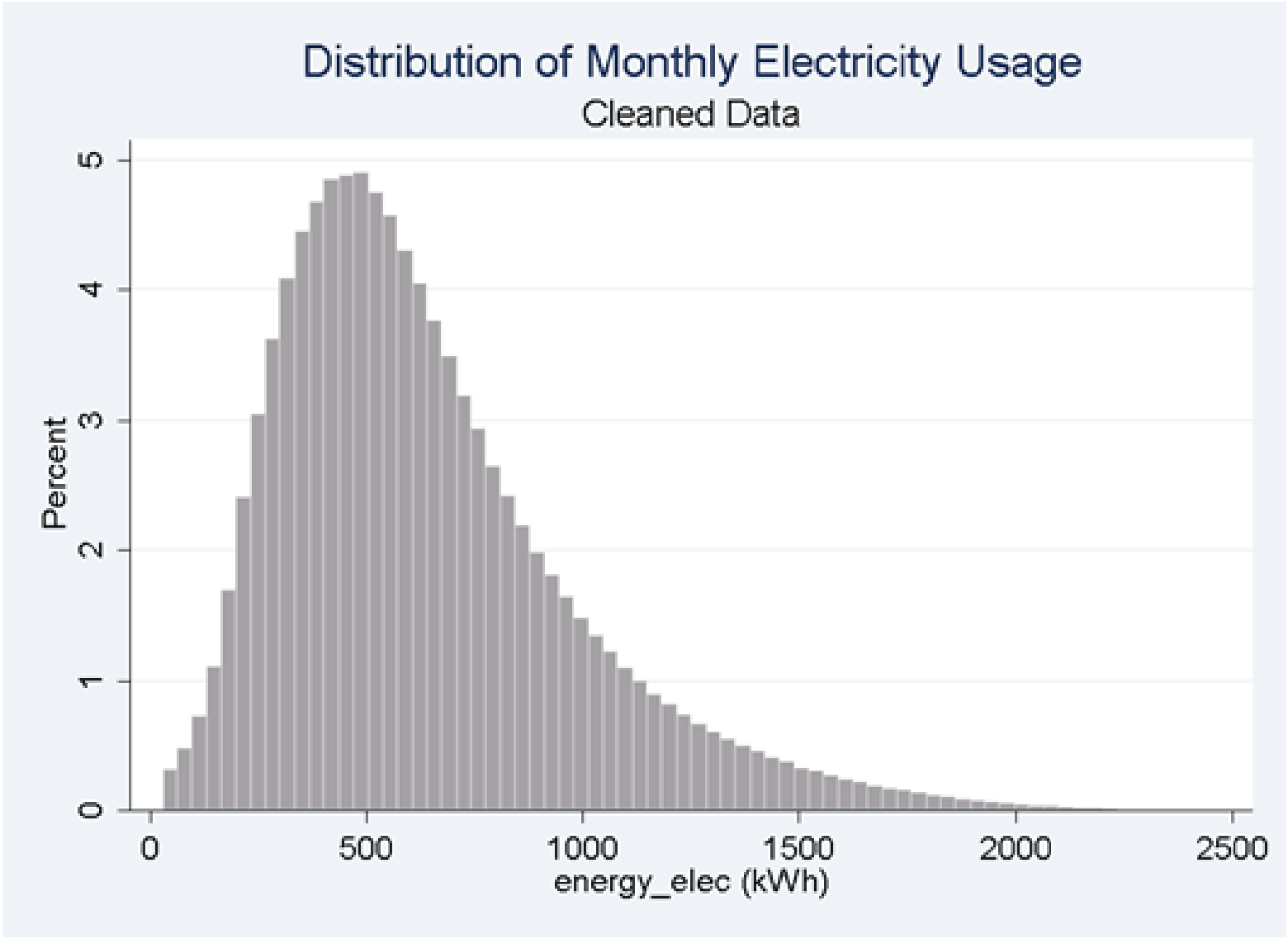
Design: Energy Data

- Obtained monthly energy use data from:
  - Genesis (electricity & gas)
  - Meridian (electricity)
  - Mercury/Mighty River (electricity & gas)
  - TrustPower (electricity)
- Missing:
  - Contact Energy (25% mkt), bottled gas, solid fuels
- Data available: Jan 2008 – Nov 2010
- Gas use converted to electricity equivalents

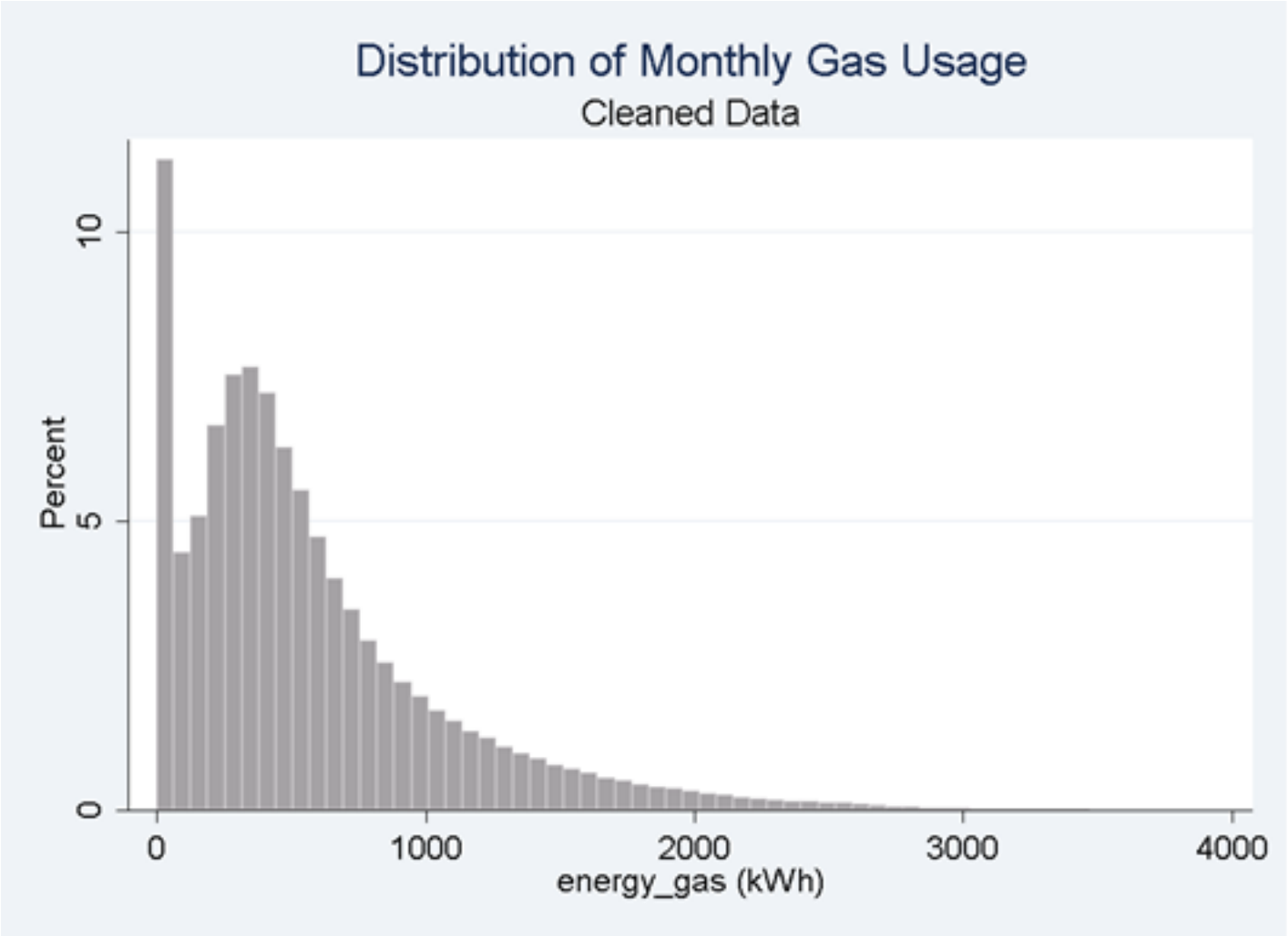
Energy data cleaning

- Houses matched to address (using ICP no.)
- Energy data obtained for ≅ 50% of houses
- Admin data meant data 'cleaning' required
  - Different samples with different degrees of cleaning
- Prior to treatment, treated houses had similar energy use as controls:
  - 97.4% (electricity)
  - 96.6% (total metered energy)

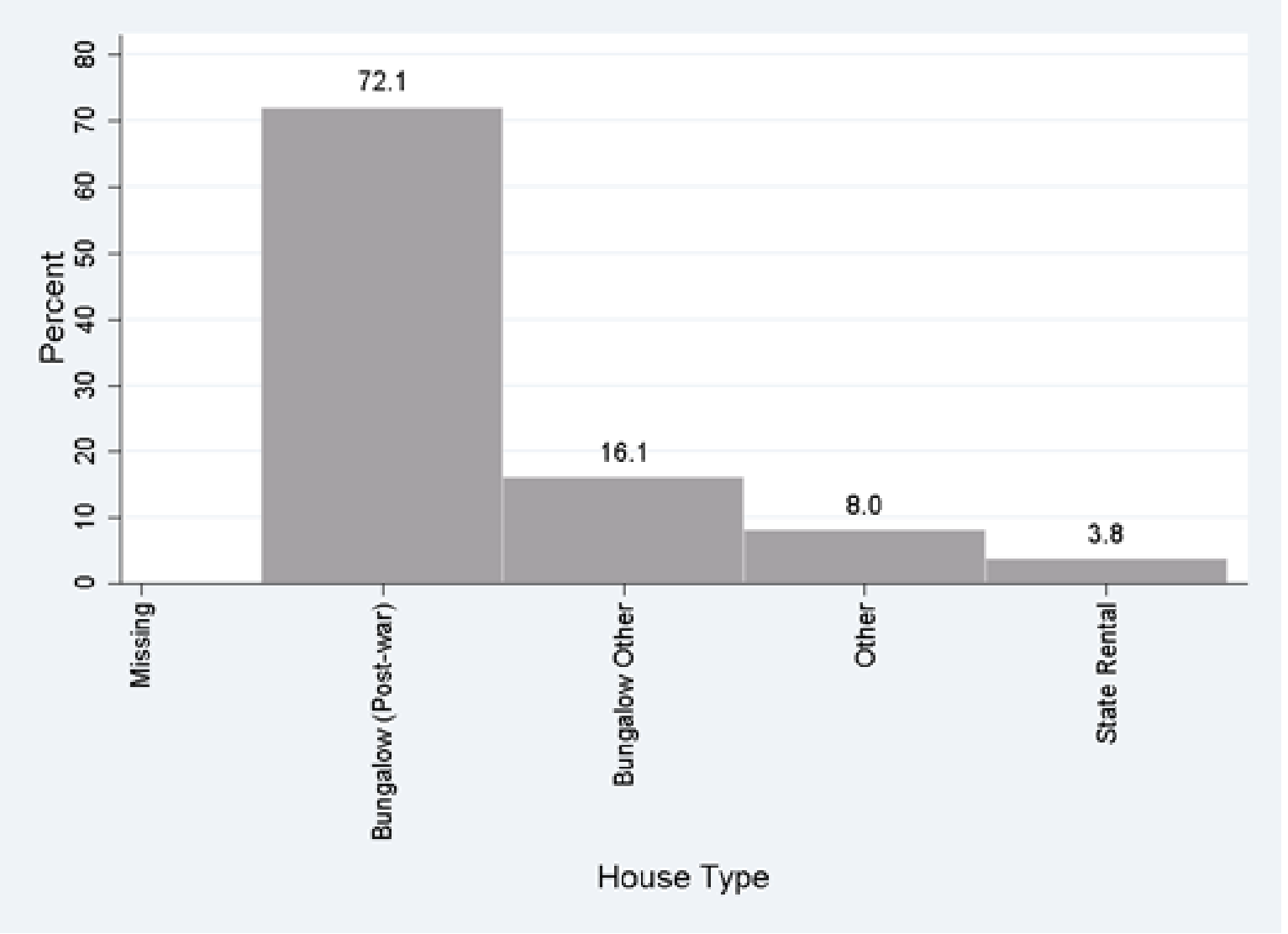
Cleaned Monthly Electricity Usage



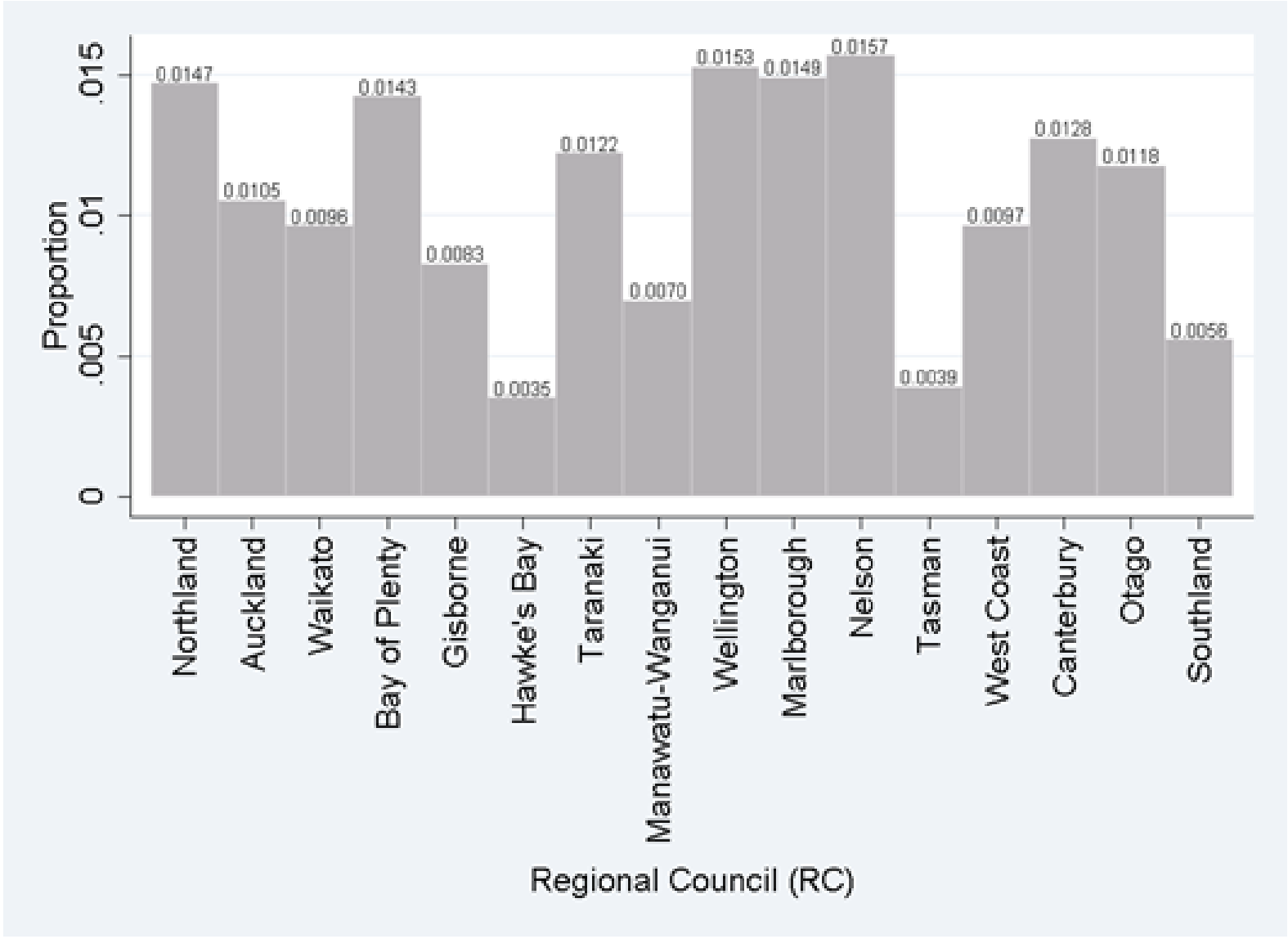
Cleaned Monthly Gas Usage



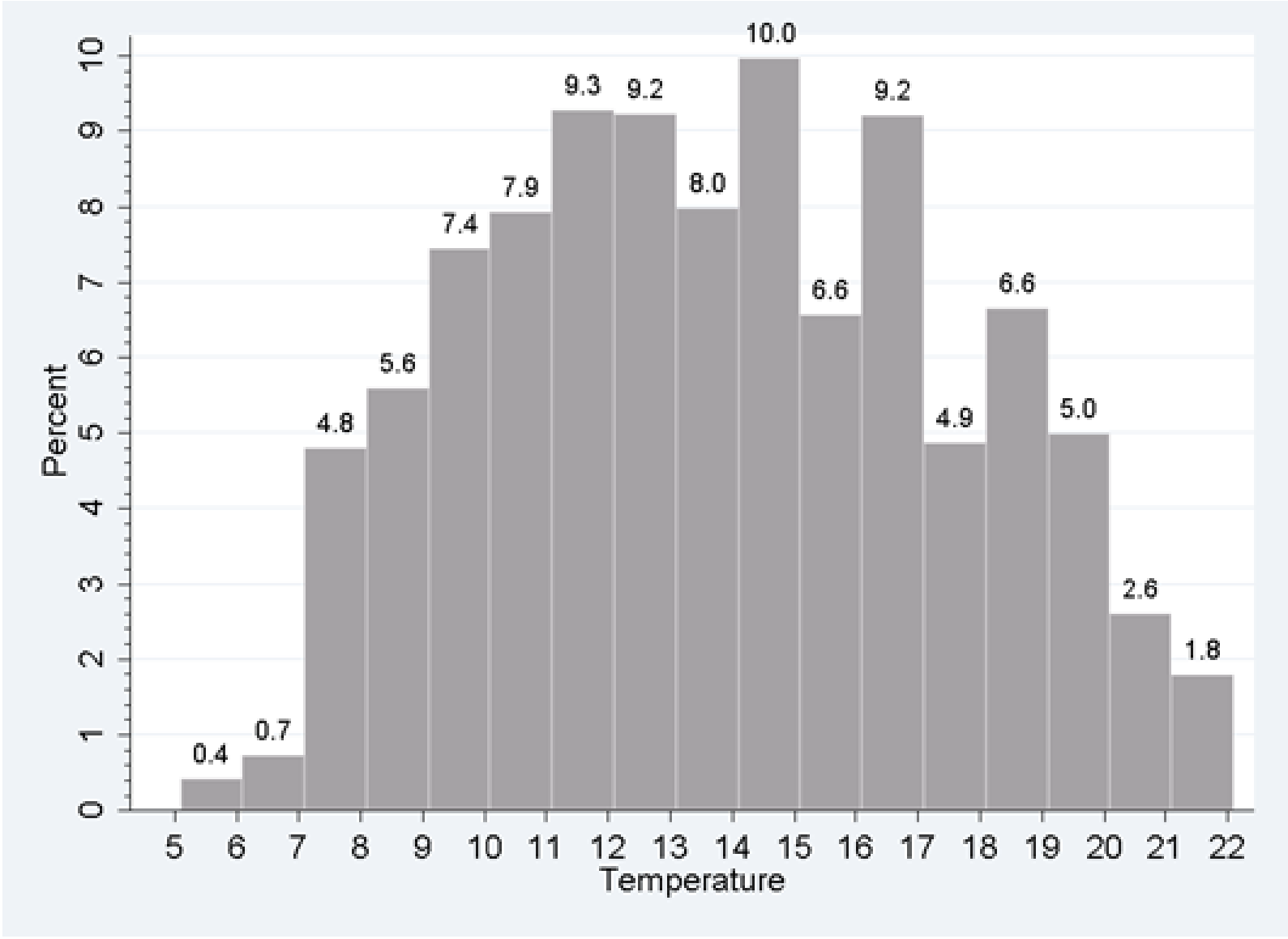
Treated Houses by Type



Treated houses/total houses by region



Mean Monthly Regional Temperature



Expected impacts: Insulation

- Reduced heat loss $\Rightarrow$ energy saving
- Effective energy cost reduction $\Rightarrow$ energy increase
  - Same rooms warmer
  - More rooms heated
- At very cold temperatures, there may be no energy change if previously using all available heating
  - But warmer house
  - So savings may be larger at cool rather than cold temp's

Expected impacts: Heat pump

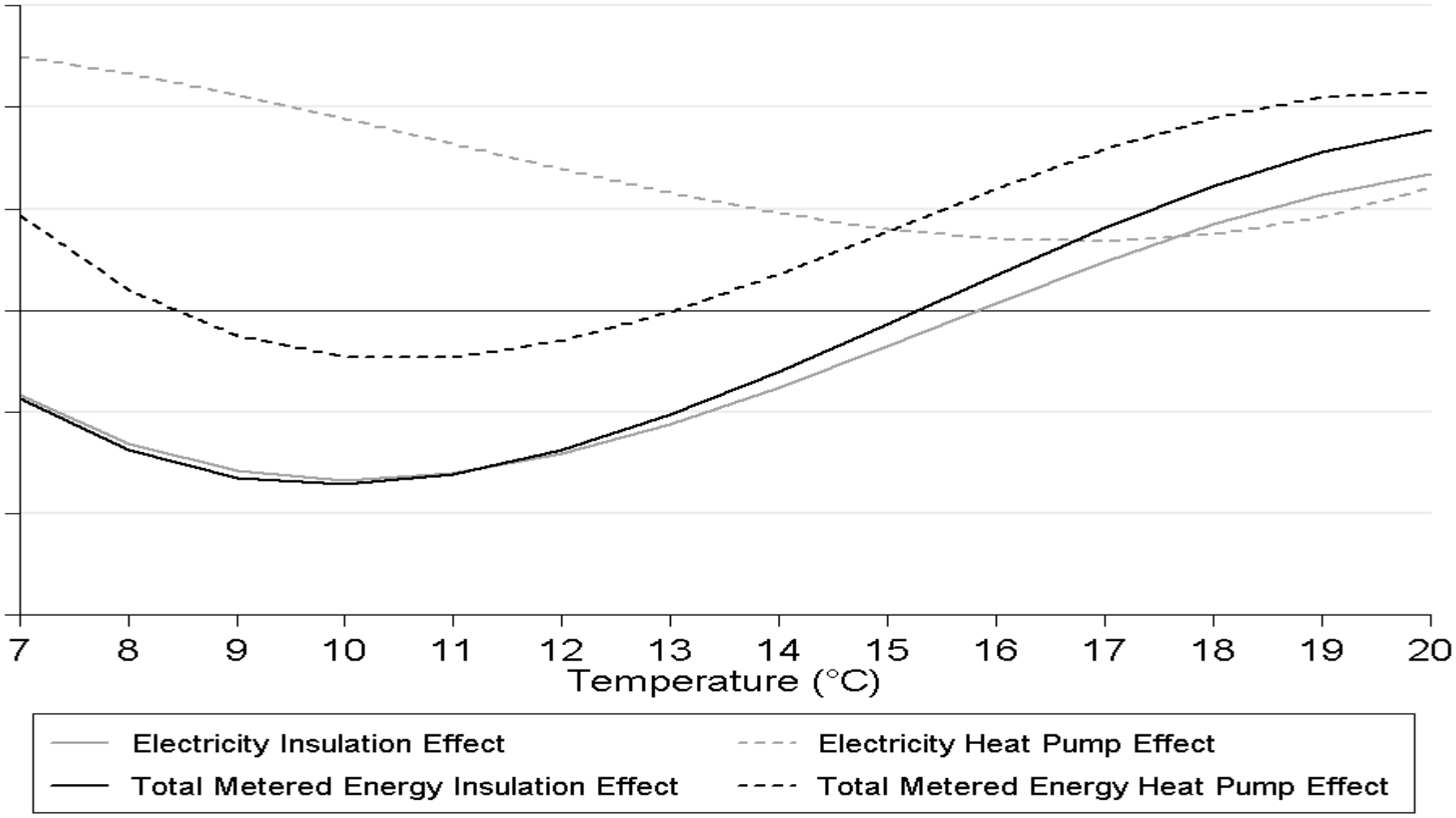
- Greater efficiency $\Rightarrow$ energy savings
- Lowered cost of heating $\Rightarrow$ energy increase
- Use in summer as air conditioner $\Rightarrow$ energy increase

- So energy effects of both retrofitted insulation and heat pump installation are ambiguous

Estimated metered energy impacts

- Some energy savings found for insulation
  - Effects are temperature dependent
  - Implies complex reactions reflecting expected effects
- Some energy increases found for heat pumps
  - Implies warmer houses were one result
  - Some evidence of air conditioner effect
  - Study doesn't explicitly include other heating sources

Illustration of energy saving effects (size depends on sample)



Industry & employment effects

- Programme introduced at height of recession
- Hence not all resources already fully utilised
  - Especially additional labour inputs possible
- Overall positive producer surplus:
  - total extra sales revenue > opportunity costs of production

Design: Health data

- Data for 973,710 individuals from 255,672 households
- Matched by National Health Index (demographic)
- National Minimum Dataset (hospitalisation)
  - Total stays, household costs
  - Cardiovascular, respiratory
- Pharms (pharmaceutical claims for subsidies by pharmacists)

Data: mortality

- Analysed vulnerable subgroups (over 65, recent hospitalisation)
- Significant result was lower mortality as a result of receiving treatment under WUNZ:HS for people over 65 who had been hospitalised with a circulatory illness in months prior to treatment

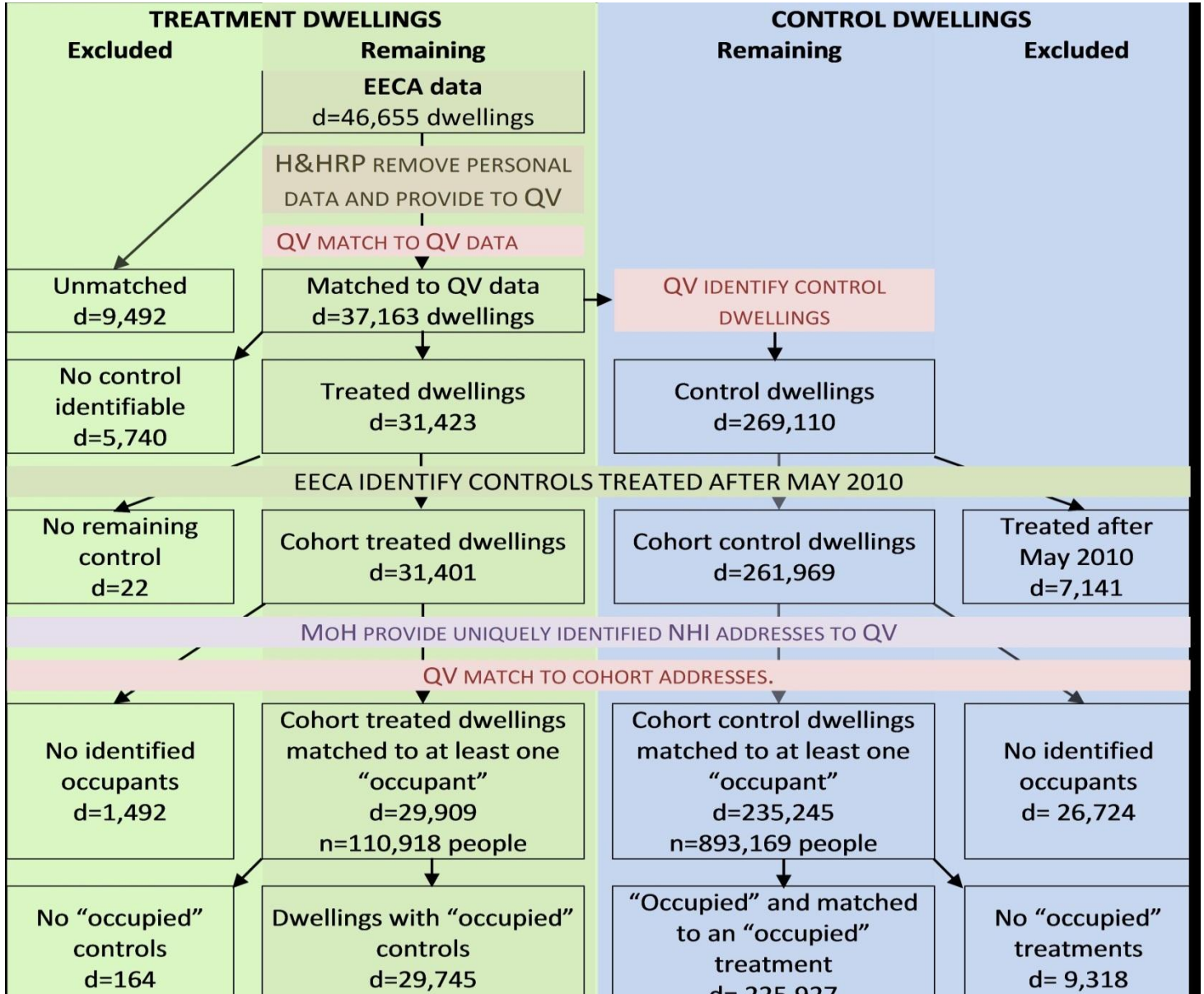
Final Cost Benefit Analysis

- Health benefits combined with:
  - Programme costs and installation costs
  - Energy savings
  - Deadweight cost of tax
  - Additionality (estimated on the basis of econometric analysis of sales of insulation)
- To produce a final estimate of benefits and costs for programme over four year period of operation

Overall benefit: cost

- Benefits arose through:
  - Health and life expectancy benefits (main estimated benefit)
  - Energy savings
  - Increased producer surplus
- Costs arose through resource costs of scheme
- Study assessed present value of benefits & costs
- Overall estimated B:C > 1
- Extended study will seek to obtain estimate of longer term health benefits

Study design: data protocol



Study design: data protocol