

Background & Overview

Household Energy End-use Project (HEEP)

Nigel Isaacs, BRANZ Ltd.

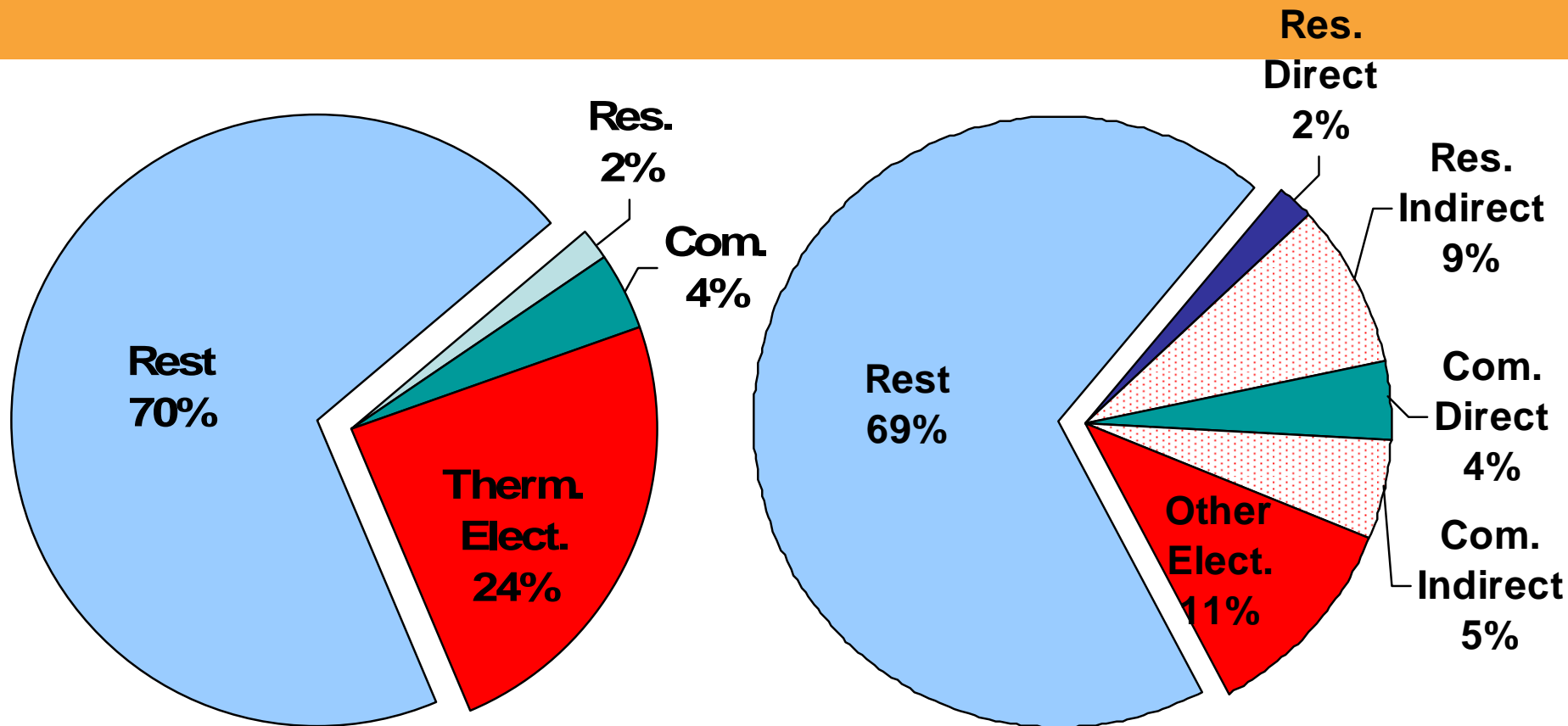
- **BRANZ Ltd – Brief Introduction**
- **Built Environment & Greenhouse Gases**
- **HEEP – What is it? Start? Funding?**
- **Houses – Selection**
- **Monitoring – Design & Equipment**
- **Overview of Results & Some Useful Facts**
- **Value to Policy Development**

- **Head Office: Judgeford, Porirua**
- **Other offices:**
 - NZ: Hamilton
 - Australia: Sydney
- **Work: NZ, Australia, Asia, Pacific**
- **Established 1969**
- **100 mainly technical staff**
- **Owned by building industry**
 - Building Research
- **Independent provider of**
 - Research, Testing & Consulting
 - Information Services

www.branz.co.nz



NZ Energy GHG 2005



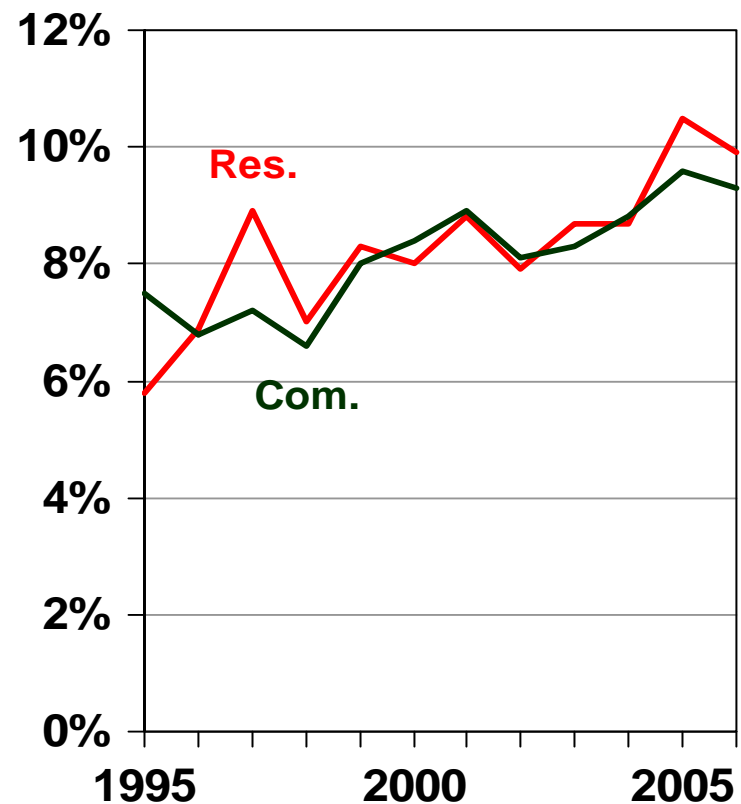
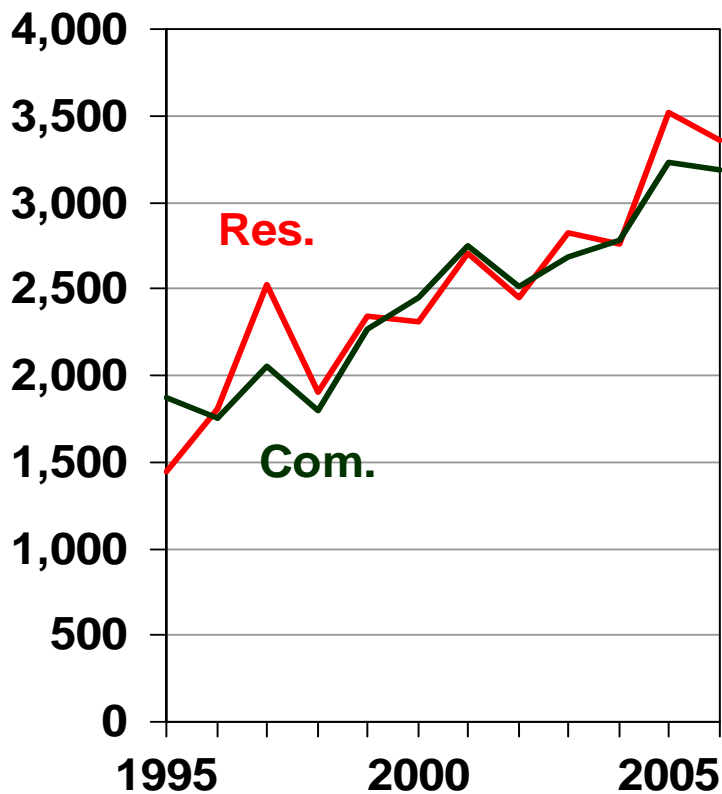
Direct GHG
(Thermal electricity unallocated)

Direct & Indirect GHG
(Thermal Electricity allocated to users)

Growth in GHG Emissions

kt CO₂ equiv. GHG Emissions

% of Energy GHG Emissions



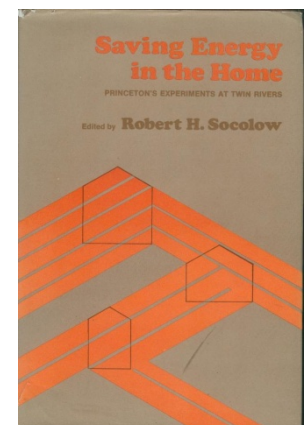
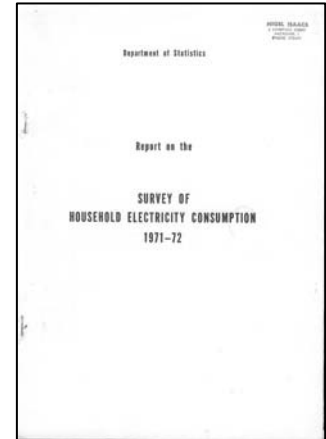
Large growth in GHG
– both **absolute** & **% of energy** GHG

What is HEEP?

- **H**ousehold **E**nergy **E**nd-use **P**roject
- Understand hows, whys, wheres & whens of residential sector energy use
- No change in behaviour or technologies
- Interested in all fuel types
 - Electricity, natural gas, LPG, solid fuel, solar water
- **And the energy services they provide**
 - e.g. space temperatures, hot water, television, radio, refrigeration, washing, drying, lighting, cooking, spa ...

HEEP – origins [1]

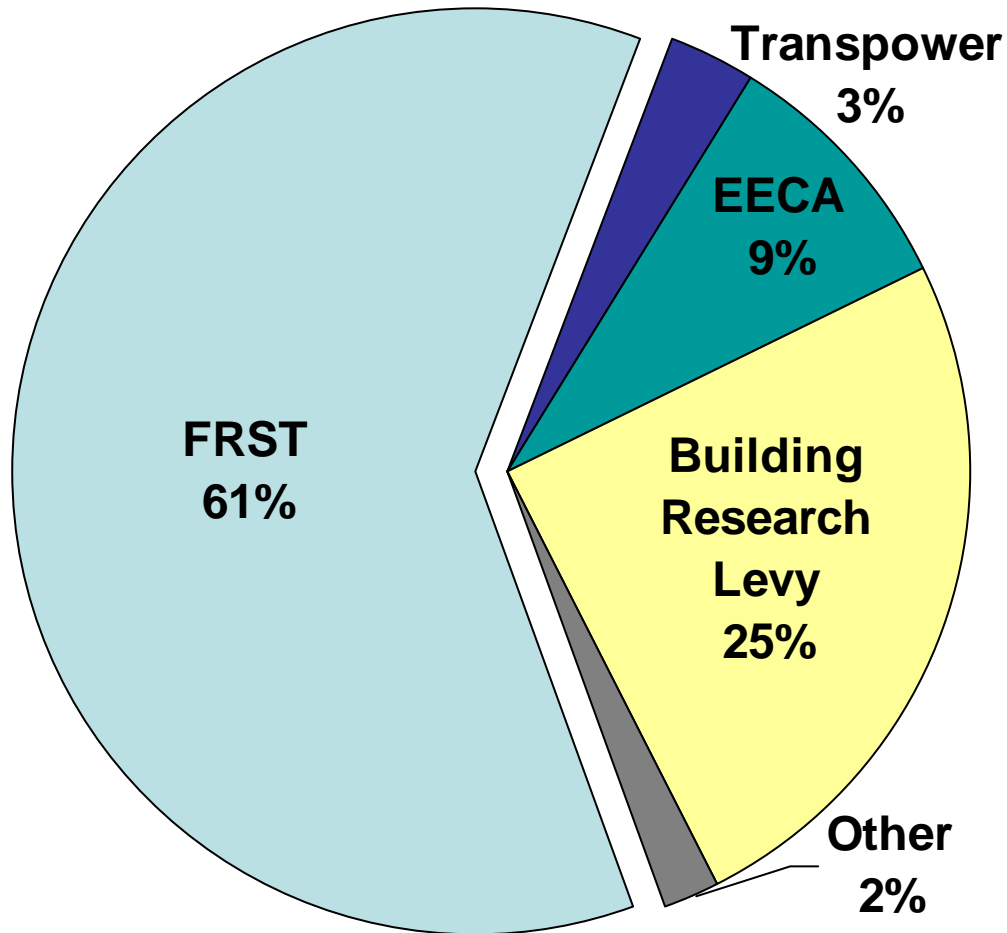
- **1969 National Development Conference**
 - Examine “cost effectiveness of heat insulation”
 - To “reduce fuel use & cost of new power stations”
- **1971/72 Household Electricity Study**
 - 1,651 houses, **electricity only**
 - 29% only electric heating (HEEP = 23%)
 - 63% electric + other fuel heating (HEEP = 64%)
 - 8% only other fuel (HEEP = 13%)
 - 75% houses were uninsulated
 - Cooler than insulated & used less space heating
 - Lower income, unknown other differences
 - Cost \$100,000 (about \$1 million 2007)
- **1978 Twin Rivers Study published**
 - Electricity & gas use in new housing development



HEEP – origins [2]

- **1980 NZ Electricity planned survey – Never happened**
- **1983 Official Review of Energy Statistics – Supported**
- **1984 NZERDC – Did not pick it up**
- **1988 CBPR proposal to Min. of Energy – Not accepted**
- **1992 Dr. Garth Harris promoted new survey – No funders**
- **1993 EECA proposed new survey – Support but no funds**
- **1996 BRANZ started HEEP**
 - Key support from Frank Pool, EECA
 - EECA, FRST & Building Research funding
 - Mark Bassett, Andrew Pollard & Albrecht Stoecklein
 - April 1996: Wanganui monitoring (10 all-electric (?) houses)

HEEP Funding 1999-2007

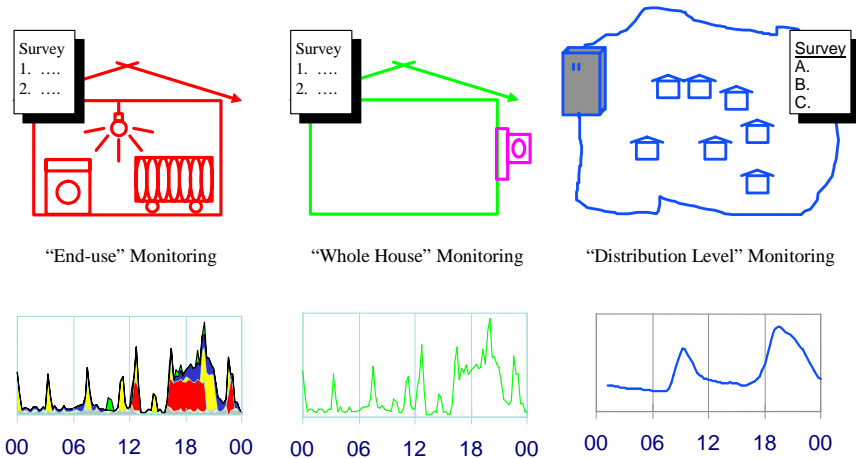


Thanks to:

FRST
Building Research
EECA
Fisher & Paykel Appliances Ltd
Ministry of Social Development
PowerCo, Wanganui
TransAlta NZ Ltd
TransPower NZ Ltd
WEL Energy Trust

Costs: \$16,000 + GST per random monitored house
\$4.17 + GST per NZ house

Monitoring Design



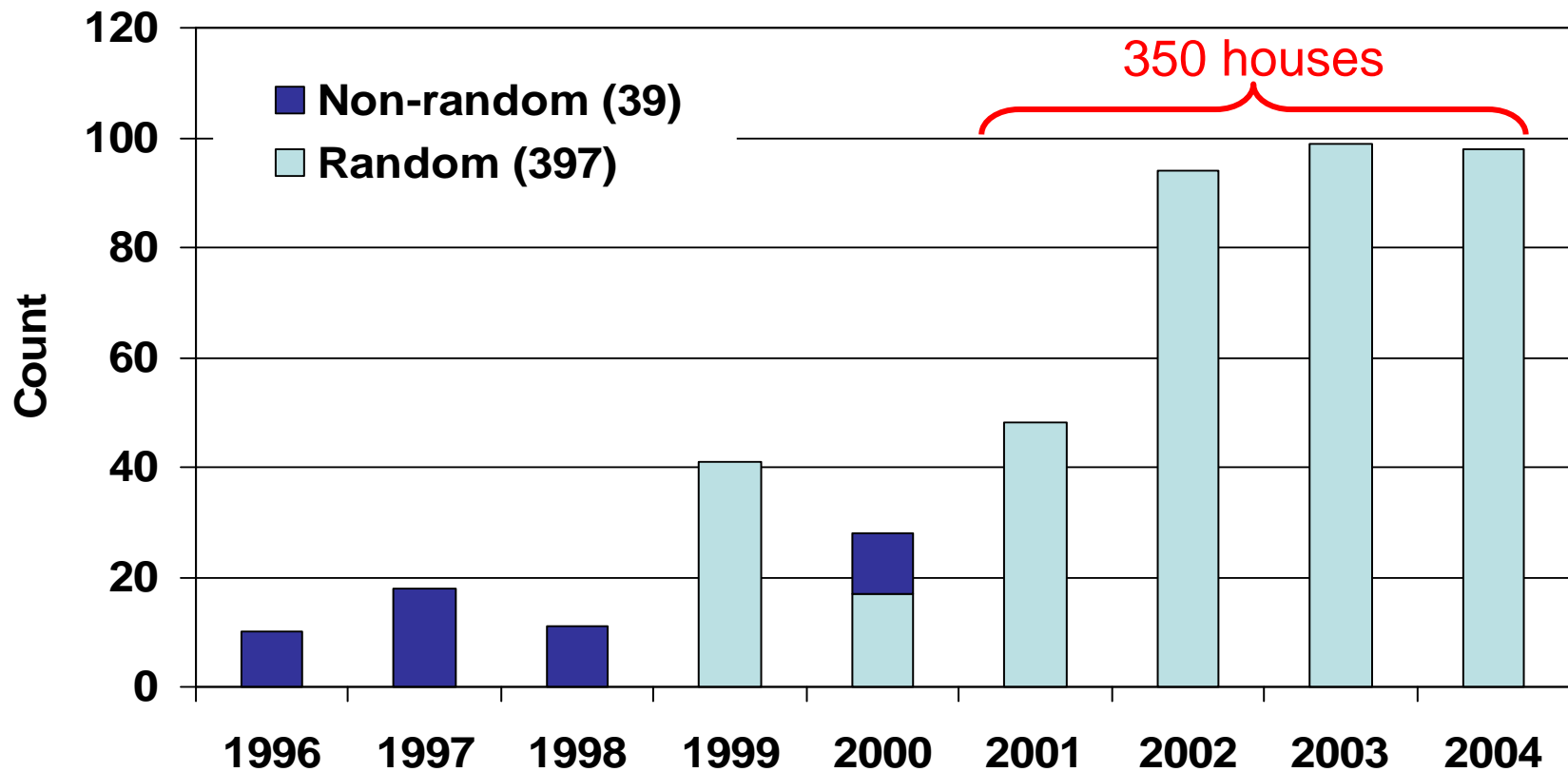
Early approach (Year 1)

- **'End-use' (lots \$)**
 - Detailed monitoring
 - Appliance or circuit
 - All end-uses
- **'Whole House' (less \$)**
 - All fuels
 - Heating / Non-heating
- **'Distribution Level' (few \$)**
 - Up to 50 houses
 - Street transformer
- **Maintained through HEEP**

Monitoring Design

- **Pilot study explored variability**
 - Space heating sample required = 375
 - Estimate with $< 10\%$ error & 90% confidence
- **Monitoring period**
 - Pilot explore 6 month
 - 12 months monitoring used
- **Contact by letter, phone or person**
 - 1,687 households contacted
 - 24% participation rate
 - Over 400 participated (some dropped out)

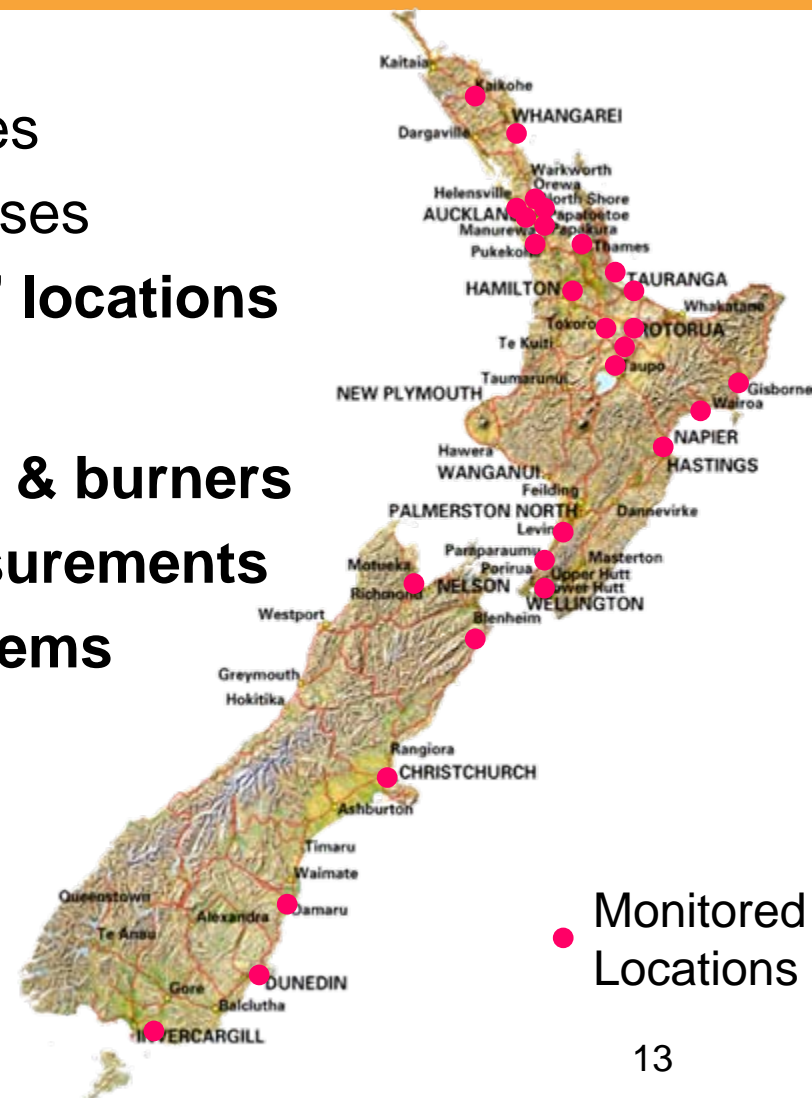
BRANZ HEEP Monitoring



HEEP numbers

Year	Random Houses
1999	43
2000	17
2001	48
2002	100
2003	100
2004	100

~400 random houses
 62 non-random houses
1,200 'temperature' locations
850 dataloggers
255 solid fuel fires & burners
14,000 power measurements
440 hot water systems
175 LPG heaters



12 month monitoring

- **Purpose built dataloggers**
- **Electricity**
 - Electronic meters with pulse
 - Power line carrier systems
- **Natural Gas**
 - Conventional meter with pulse output
- **LPG (invented by BRANZ)**
 - Thermocouples monitor 'discrete' panels
- **Sold fuel (wood, coal) (Invented by BRANZ)**
 - Thermocouple monitor flue temperature
- **Other 'fuels' (invented by BRANZ)**
 - Diesel, Solar Water Heater, 'Wet back' water heater



Installation surveys

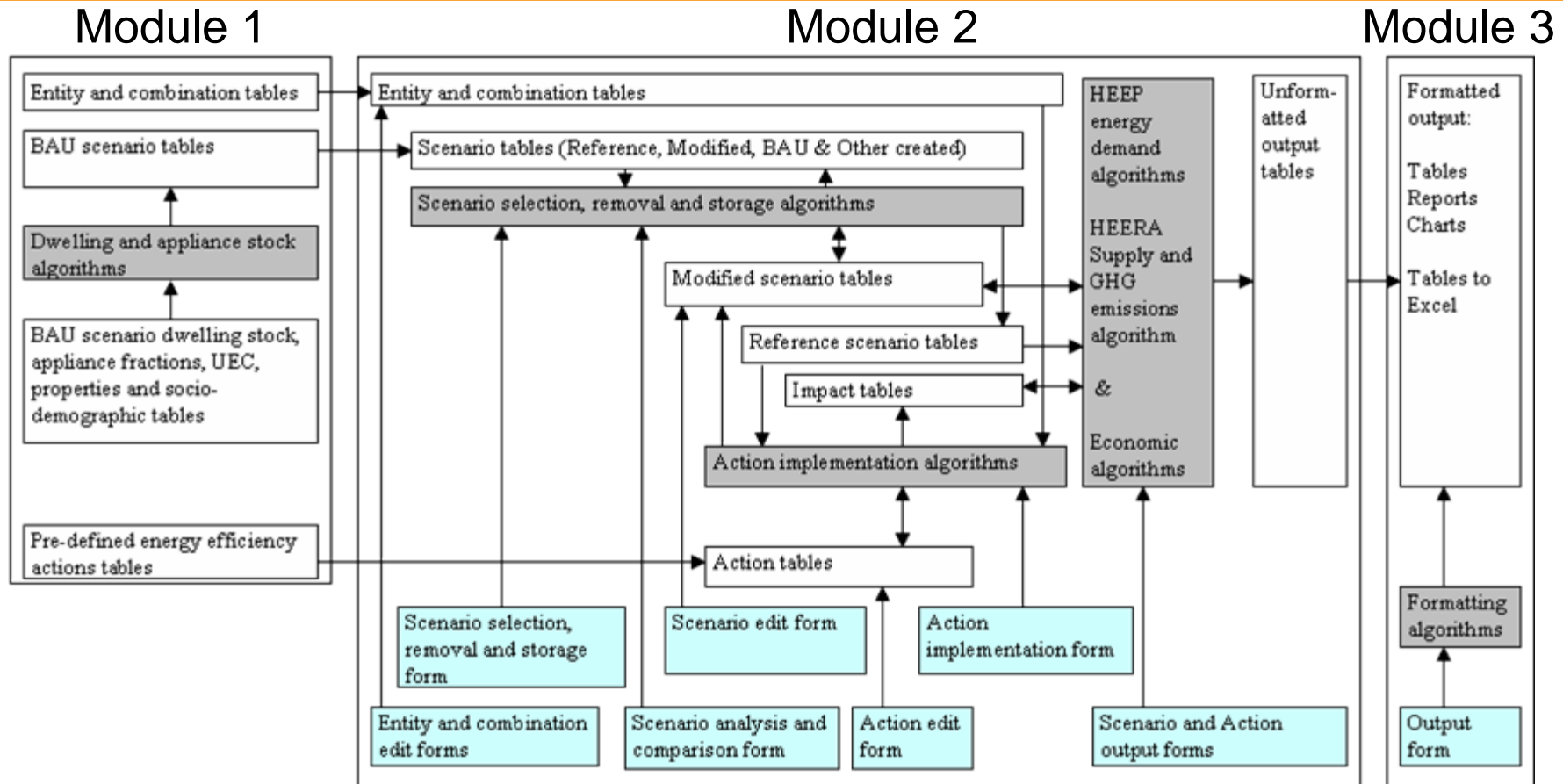
- **House occupants**
 - Household characteristics
 - Building use
 - Energy bills
 - Background, behaviour and attitudes
 - Use of energy & services
- **Physical house**
 - Floor plans, construction, insulation
 - Water system (inc. temperatures)
- **Appliances**
 - Standby, 'on' or 'off', plugged in?



HEERA Model

- **H**ousehold **E**nergy **E**fficiency **R**esource **A**ssessment
- **A modelling framework to**
 - construct NZ residential sector energy use scenarios
 - analyse and compare the scenario energy use
 - develop energy-efficiency actions and estimate effect
- **Built around Business-As-Usual case (BAU)**
 - Scenario(s) change number, growth, per unit energy use, etc
- **Three modules**
 - Module 1: MS-Excel Model & Database
 - Module 2: MS-Access Model & Database
 - Module 3: Output Processor & Database
- **Expert use**
 - Requires understanding of reality, not just plugging in numbers

HEERA Model Structure



- **Algorithms developed from HEEP data (and modified by scenarios)**
 - Stock: appliance numbers and change-by-year
 - Energy: use by area/appliance

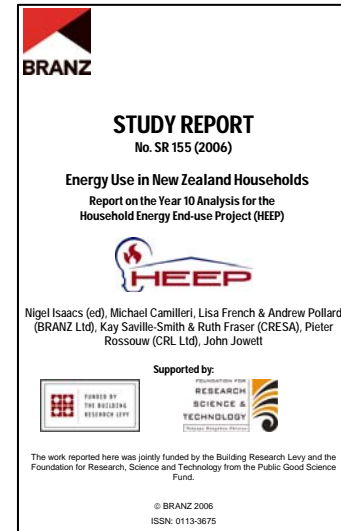
Not all fun

- 5 fridges/freezers accidentally defrosted
- 5 other appliances damaged
- 1 porcelain ornament crushed by logger
- 1 linen cupboard soaked
(no more wet-back flow monitoring!)
- 2 houses damaged removing meters
- 2 LPG cabinet heater incidents
- 1 LPG connection valve repaired.
- 4 house occupants died



Technology Transfer

- **10 ‘Annual Reports’**
 - Years 1,2 & 3 published by EECA
 - Years 4 – 10 BRANZ Study Reports
- **Since January 2004 downloads:**
 - 14,000 copies of Executive Summaries
 - 870 copies of annual reports (Year 7-10)
 - Many talks to industry & public
 - 800 international e-mails

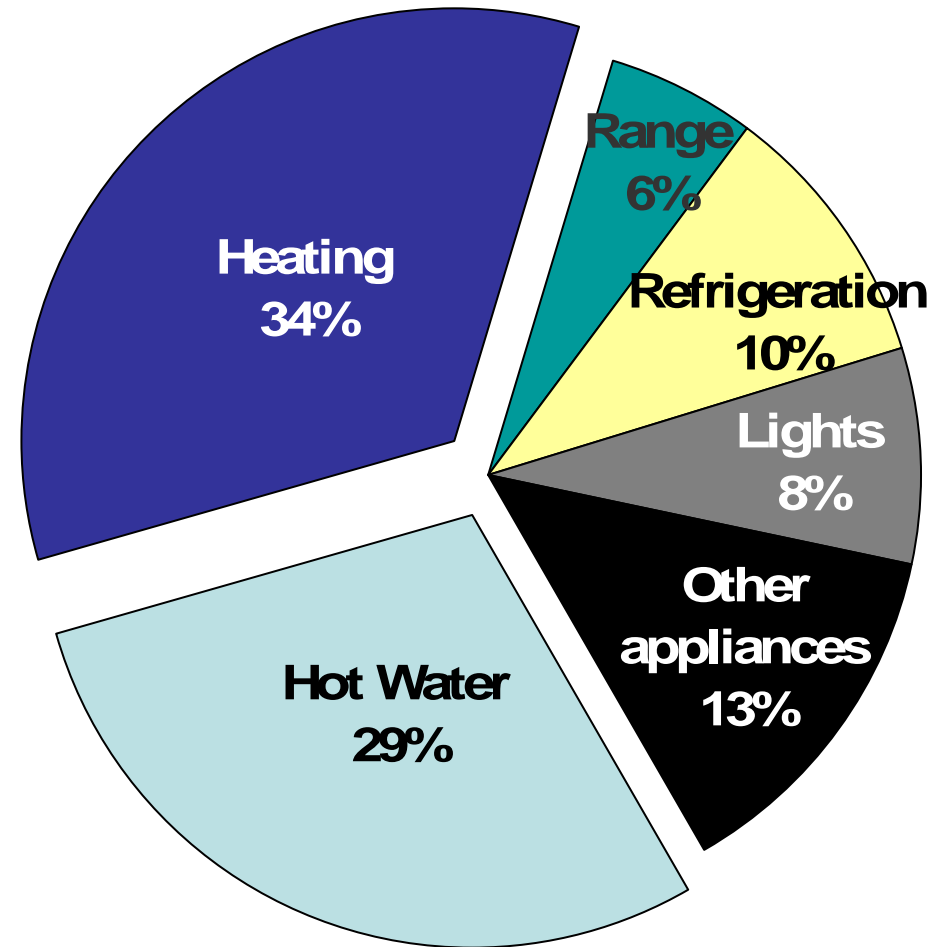
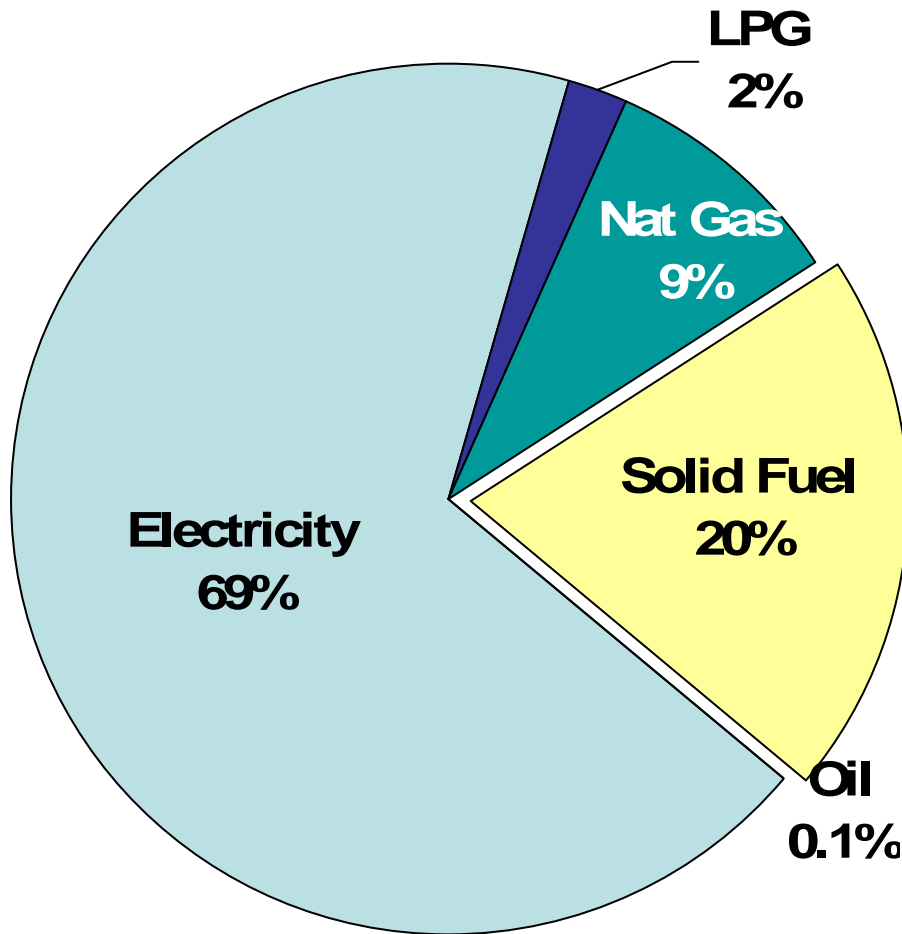


Some numbers

Per house	Minimum	Maximum
Floor area	51m ²	315m ²
Number of people (per house)	1	10
Occupancy (1 person per ...)	178m ²	10m ²
Number of lights	7	143
Appliance power measurements	7	82
Sewing machines		22
Largest freezer		~ 3,000 l
Televisions		9
Electric hot water cylinders	15 litres	315 litres

- **Electric Water cylinders:**
 - 90% of houses = 1 DHW cylinder
 - 9% of houses = 2 DHW cylinders
 - 1% of houses = 3 DHW cylinders

Stationary Fuels & End-uses



Includes electricity, natural gas, LPG, coal & wood ('solid fuel')

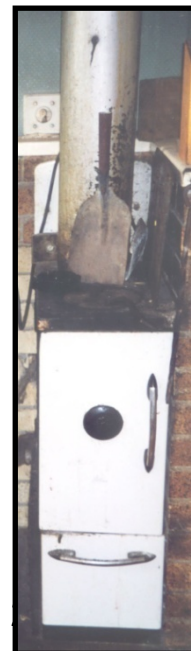
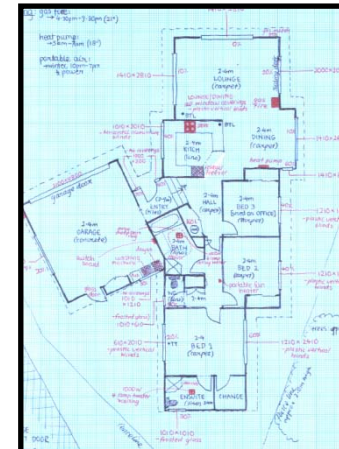
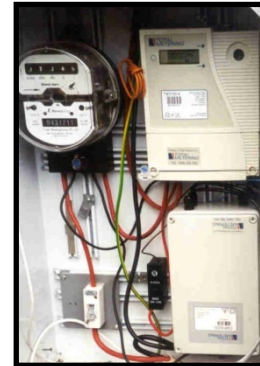
Source: HEEP Year 10

Application to policy - examples

- **NZ Building Code Clause H1 Energy Efficiency**
 - Realistic houses & operation
- **Standby electricity**
 - Quantify & help set MEPS levels
- **Baseload electricity**
 - Identified importance of heated towel rails
- **Space heating fuels**
 - Quantified wood (~530 MW power station)
 - New heat pumps = New power station(s)
- **Many other possibilities**
 - Up to imagination

Current HEEP team

- **BRANZ (Data & analysis)**
 - Michael Camilleri
 - Lisa French
 - Nigel Isaacs
- **CRESA (Social science)**
 - Ruth Fraser
 - Kay Saville-Smith
- **CRL Energy Ltd (Modelling)**
 - Pieter Rossouw
- **John Jowett (Statistical support)**



BRANZ staff involved with HEEP

- Lynda Amitrano
- Sarah Bishop
- Sean Flanagan
- Mark Hearfield
- Susan Keddy
- Helen Mallon
- Desiree Pickering
- Andrew Pollard
- Rodger Stanford
- Sue Stevens
- Albrecht Stoecklein
- Jeremy Tries
- Norm Wood



Field Staff & Summer Students

- **Patrick Arnold**
- **Mike Davis**
- **Alasdair Duncan**
- **Andrew Egan**
- **Ruwan Fernanado**
- **Ron Findlay**
- **Hamish Garland**
- **Caroline Hendricks**
- **Daniel Jang**
- **Lou Kolff**
- **Jacky Lee**
- **Ken Mitchell**
- **Jack Rutherford**
- **Sally Simpson**
- **Judith Steedman**
- **Nick Smith**
- **Krystle Stewart**
- **Garry Summers**



Victoria University of Wellington
BBSc 331 class of 2004
helped with installations

