Domestic Hot Water

Household Energy End-use Project (HEEP)

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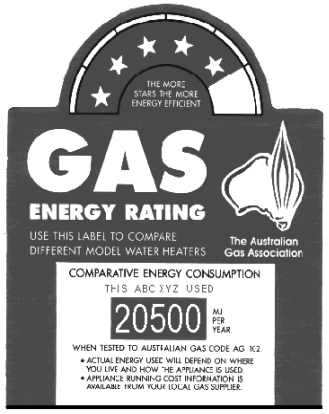
Overview

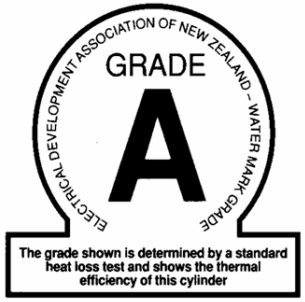
- Water heating fuels
- International comparison
- What drives hot water energy use?
- Standing losses
- Gas vs. electric hot water energy use
- Dangerously hot (electric) water
- Energy efficiency & fuel swap opportunities

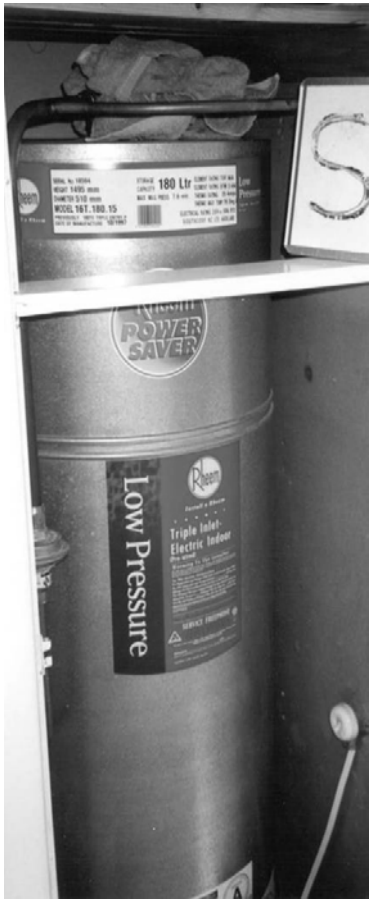
Hot water cylinders

Instant Gas



Gas storage



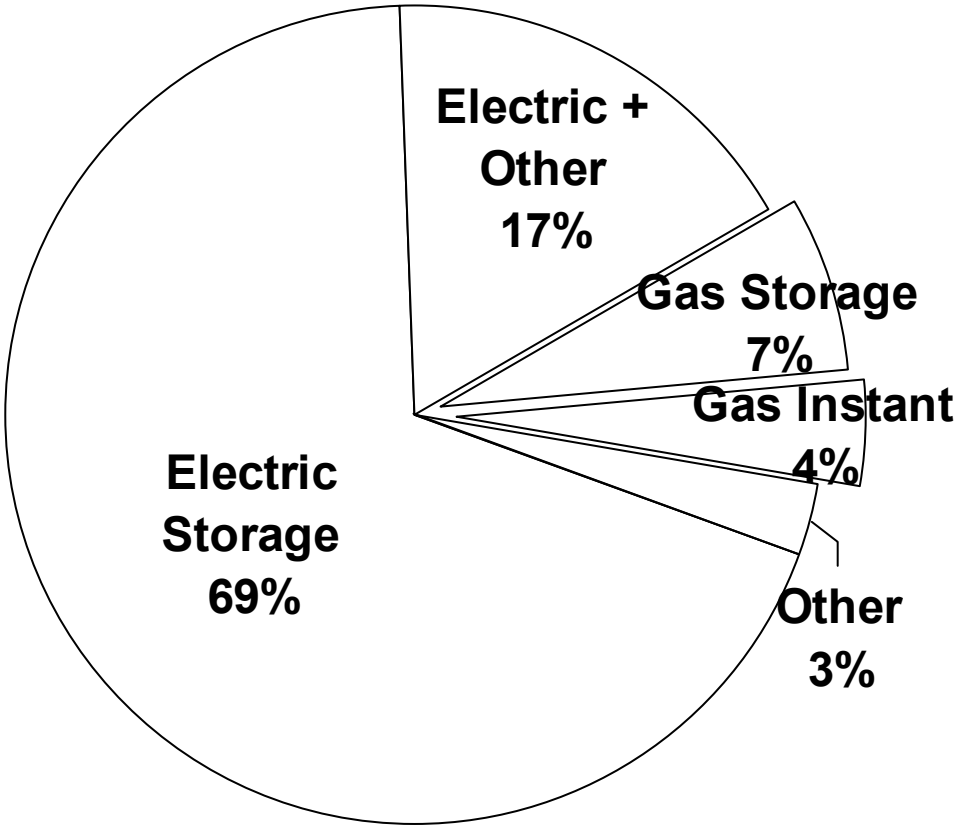


Electric Storage
A Grade

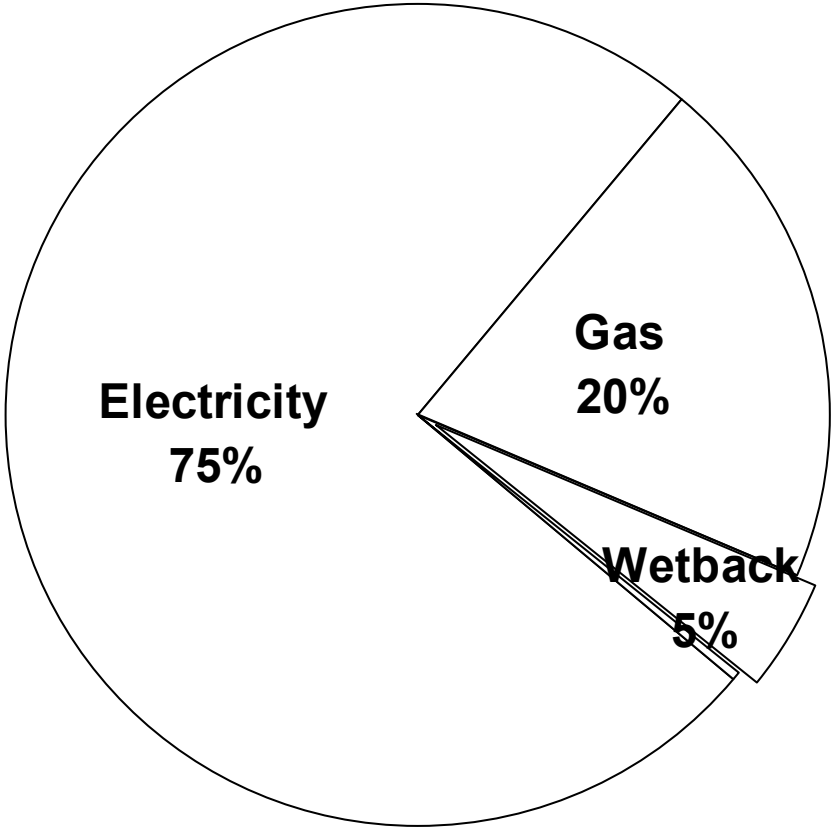
Electric Storage
C Grade

Electric Storage
D Grade

Water Heating Fuels



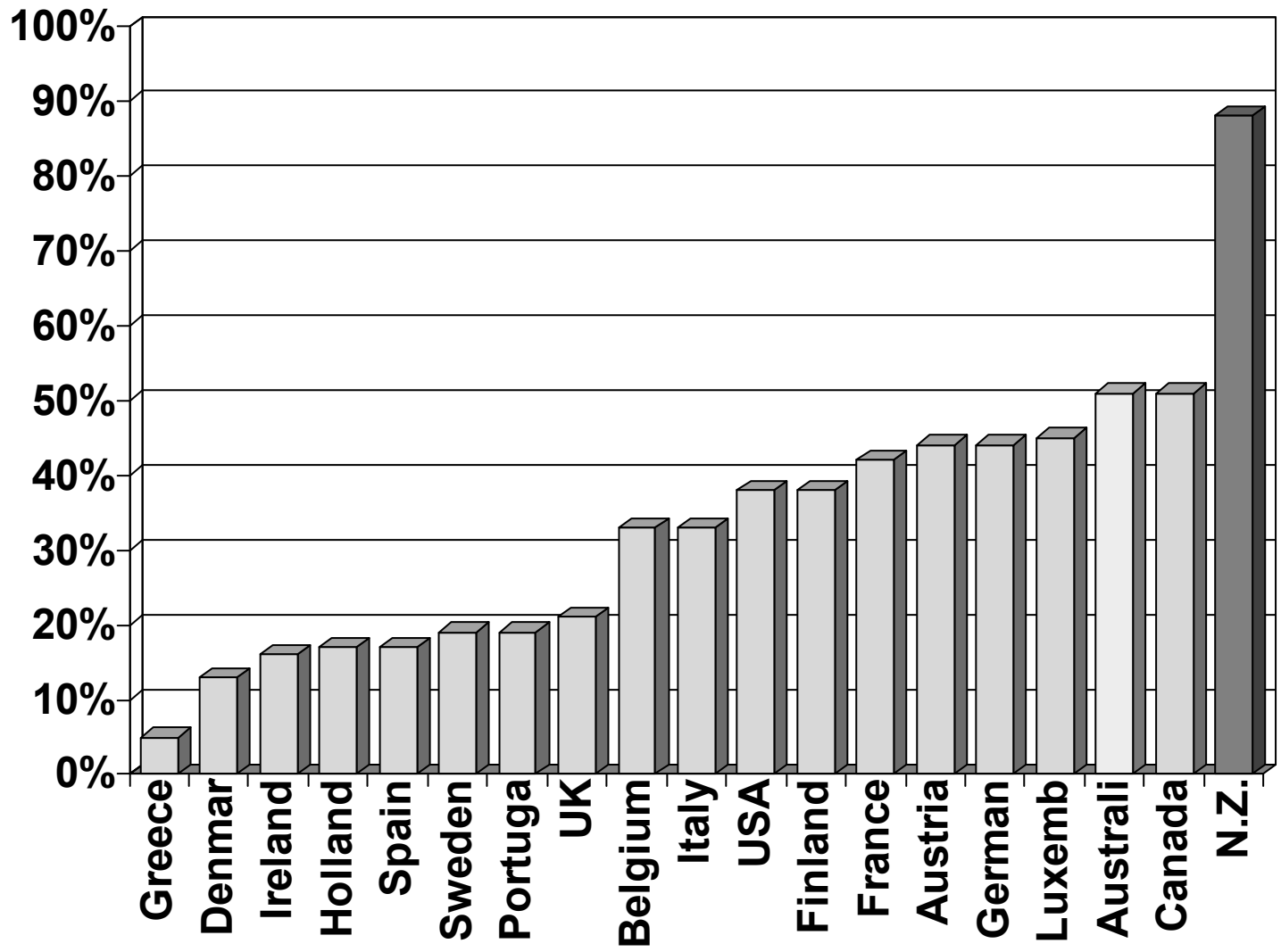
Household Count



Energy Use

Year 10

19 Country Comparison
Use of Electric DHW



Energy use distribution

Fuel	Bottom 20%		Top 20%	
	< kWh/yr	% energy	> kWh/yr	% energy
Electricity	1,600	9%	3,750	37%
Gas	3,300	13%	7,300	27%
Wetback	180	3%	1,200	55%
All fuels	1,820	9%	4,300	37%

- **Bigger users use a lot more than small users**
  - Wetbacks show greatest skew
  - Top 20% house each use ~ 2 x as Bottom 20%
  - Water efficiency to reduce water & energy use

Impact of Occupancy

Occupancy (Person)	Average (kWh/yr)	% Households
1-3	2,590	56%
Over 3	4,370	43%
All	3,130	100%

- **3+ person households use 70% more hot water**
  - Larger households use more hot water:
  - ~90% 3+ households > 2,000 kWh/yr
  - ~60% of 1-3 households > 2,000 kWh/yr

Search for NZ oldest cylinder

(Thanks to Radio NZ National, 'Sounds Historical')

Date	Type	Location	In use
1920s	Wetback	Stewart Island	☑
1930s	Electric dairy	Rahotu	☑
1934	Wetback	Taranaki	☑
1938	Electric storage	Christchurch	☑
1930s	Gas califont	Otaki	

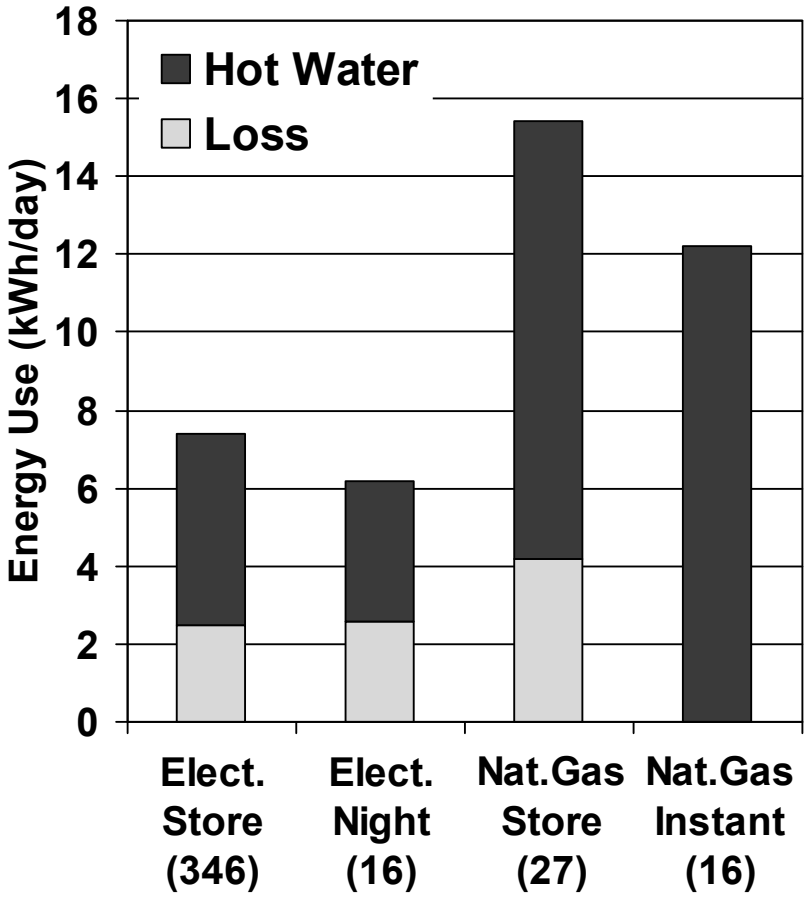
- **Copper, low pressure cylinders**
  - LONG life (depend on water quality)
- **Modern mains pressure, steel cylinders**
  - Likely to have shorter life

Changes over 35+ years

- **Bathing habits changing away from bath**
  - 1971/2: 74% Bath only, or bath ≥ shower
  - HEEP: 6%
  - Change from ‘batch’ to ‘flow’
- **Cylinder volume increasing**
  - 1971/2: 56% 135 litre, 35% 180 litre
  - HEEP: 40% 45%
  - In 1990s 180 litre became more popular

Analysis base – ONLY houses with electric water heating

Standing Losses



- **Total = Water + Standing Losses**
  - Water: Social
  - Standing Losses: Technical
- **Household Analysis**
  - Elect. Storage (346): 33% loss
  - Elect. night store (16): 42% loss
  - Nat. Gas Storage (27): 27% loss
  - Nat. Gas Instant (16): 0% loss
- **Does gas = more hot water?**
  - Graph is HEEP average
  - e.g. few & many occupants
  - Critical to **understand** data

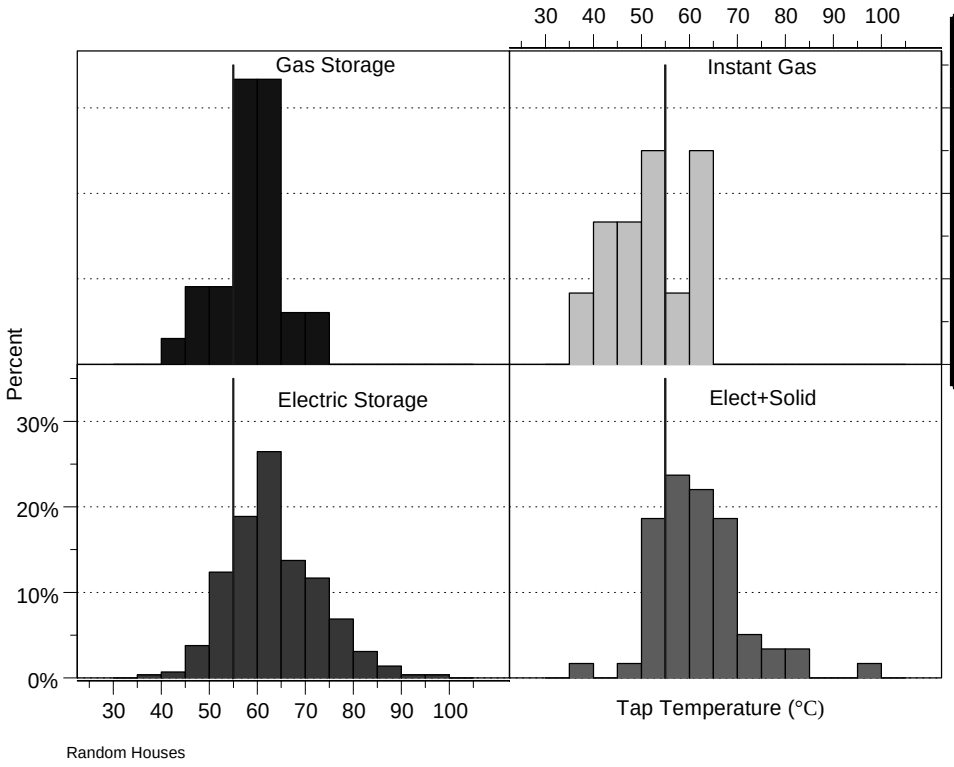
Gas vs. non-Gas energy use?

- **Must compare on same basis**
  - Standing losses 4.2 gas vs. 2.5 elect kWh/day
  - Appliance efficiency 80% vs. 100%
- **Household differences (linear model, r^2 =42%)**
  - Number occupants + 24%
  - Floor area + 13%
  - Life stage -3% to + 9%
  - Shower water use +14%
  - **Use of gas** **+44%**
- **Linear model on same average house**
  - Non-gas use = 2,100 kWh/yr
  - Increase = 981 kWh/yr * **44%** = 414 kWh/yr
- **Gas = +20% hot water energy**

Other Differences Gas vs. Electric

- **Fuel type & service**
  - **78% low pressure water (mainly electric)**
  - 22% mains pressure water (mainly gas)
- **Measured shower flow rates:**
  - Low pressure 7 l/min (avg) 20 l/min (max)
  - Mains pressure 12.5 l/min (avg) 30 l/min (max)
- **Higher pressure = higher flow = more energy**
- **Reduce 18 l/min to 9 l/min for 5 min shower**
  - Save: 18 c/shower energy + 16.2 c/shower (water)
  - 34 c/ shower = $124 per year per daily shower
  - Low-flow shower head ~ $40

Water Temperature & Fuels

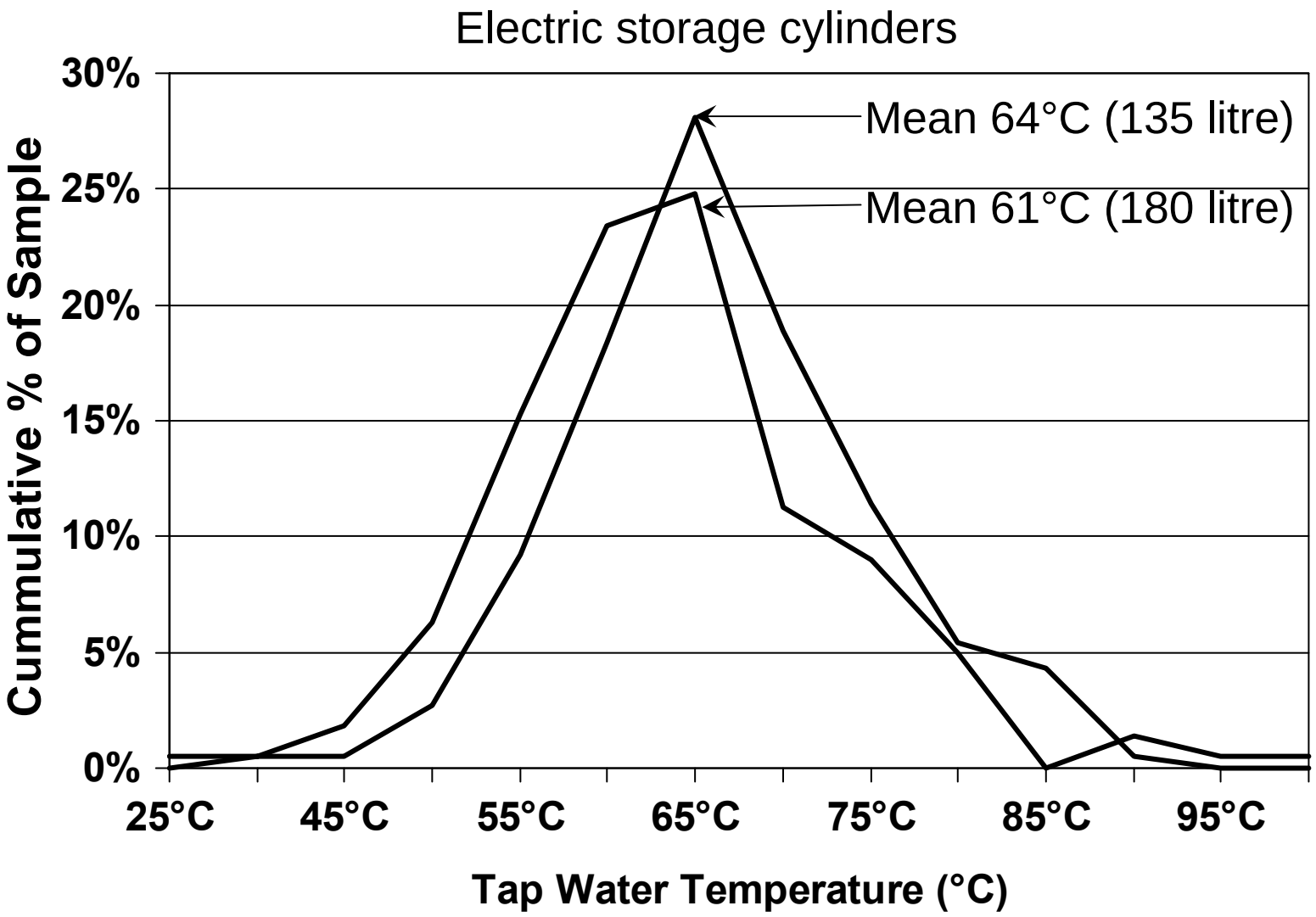


Delivered temp:	> 55°C	>60°C
Gas Storage	79%	45%
Gas Instant	33%	25%
Electric Storage	83%	64%
Elect. + solid	78%	54%

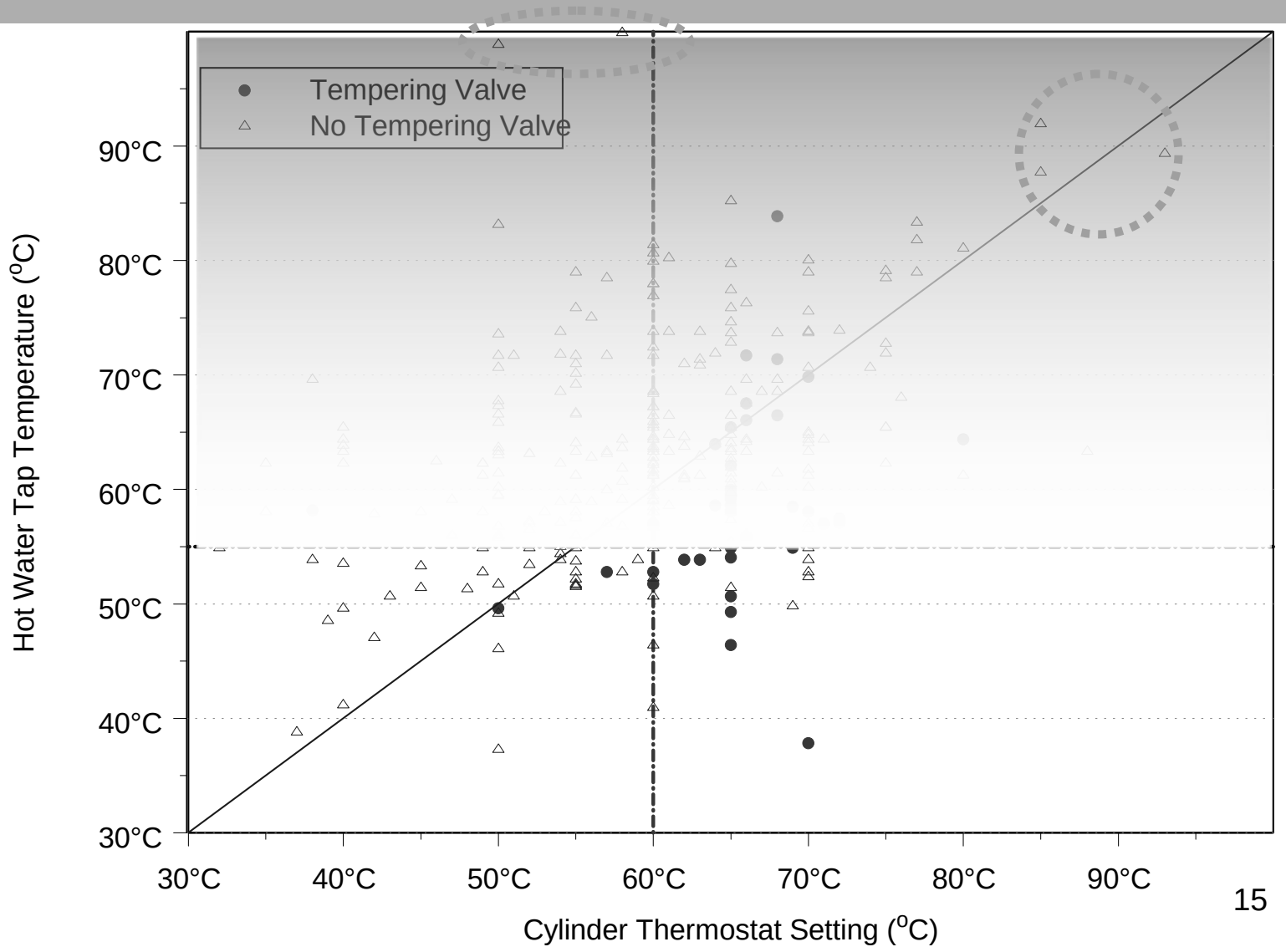
- **Most storage DHW >55°C**
- **More elect. storage >60°C**
- **Current NZ Houses**
  - 16% A Grade: temp. limited
  - Glass-on-steel: temp. limited

Reference line = 55°C

Water Temp. by Cylinder Volume



Dangerous Electric Hot Water



Hot, Hot (Electric) Water

- **NZBC G12 Water Supply – 2 goals**
  - Legionella Store > 60 °C
  - Burns Deliver < 45°C
    Early Childhood, Old Age Homes & School
    Deliver < 55°C
    All other buildings
- **81% houses deliver water > 55°C = TOO HOT**
  - Median tap temperature = 62°C (**1% OVER 80°C**) 
- **'Tempering valve' solution**
  - Mix cold & hot water to fixed (safe) temperature
  - Only required in 'new' installations
- **But why do households need such 'hot' water ?**
  - Electric storage cylinders: Demand **EXCEEDS** Supply
  - Trade-offs: **Temperature vs. Volume vs. Element kW**

Electric Cylinders & Losses

Volume (litres)	Insulation Grade	Actual Loss (kWh/day)	HEEP Sample #
135	A or B	2.1	51
	C or D	2.8	56
	Wrapped	1.8	9
180	A or B	2.2	76
	C or D	2.7	28
	Wrapped	2.1	10

How can these losses be reduced ?

Note: losses not normalised to match NZS4602 values

Reducing Electric Cylinder Losses

- **Improve efficiency**
  - Install a new cylinder; heat pump; solar
  - Retrofit ‘insulating blanket’ (wool, fibreglass)
  - Insulate pipework (NZS4305 minimum 2 metre)
  - Fuel switch: direct burn gas

Energy Efficiency Opportunities

Measure –replace old D grade 180 litre electric cylinder	Installed Cost ($)	Electric Savings ($/yr)	Simple Payback (yr)
Electric			
Self installed wrap & pipe insulation	$90	$40	2
Cylinder wrap & pipe insulation	$150	$40	3
New A grade (180 l mains)	$1,400	$40	38
Heat pump DHW (310 l)	$6,250	$420	15
Solar (inc. new electric cylinder)	$7,000	$320	22
Gas (use 20% more hot water)			
New gas cylinder (152 litre)	$2,200	$240	9
New Gas instant (24 litre)	$2,400	$400	6
Gas condensing continuous (24 litre)	$3,000	$460	7

Assumptions: Electricity 20 c/kWh; Gas 11 c/kWh; Solar = 50% of hot water
Installation: Gas $1,000; Electric $500-$1000; Solar $3,000
Efficiency: Heat pump 300%; Gas 80%; Condensing gas 95%

Summary - DHW

- **Average 29% of household energy (range 4% - 74%)**
- **Fuel mix highly skewed**
  - Electric (75% energy), Gas (20%), Wetbacks (5%)
  - NZ has **highest % electric DHW of any country**
  - DANGEROUS rod-type electric thermostats
- **Social changes**
  - Major shift in bathing to showers
- **Energy Efficiency**
  - Mains pressure = high flow **NEED** low flow showers
  - Cylinder wrap: cost effective 2 to 3 yr
- **Potential benefits from direct use of gas**
  - Gas +20% energy use over electric DHW system
  - Possibly unsatisfied demand for hot water
  - Fastest consumer payback