Keeping homes warm in Dunedin

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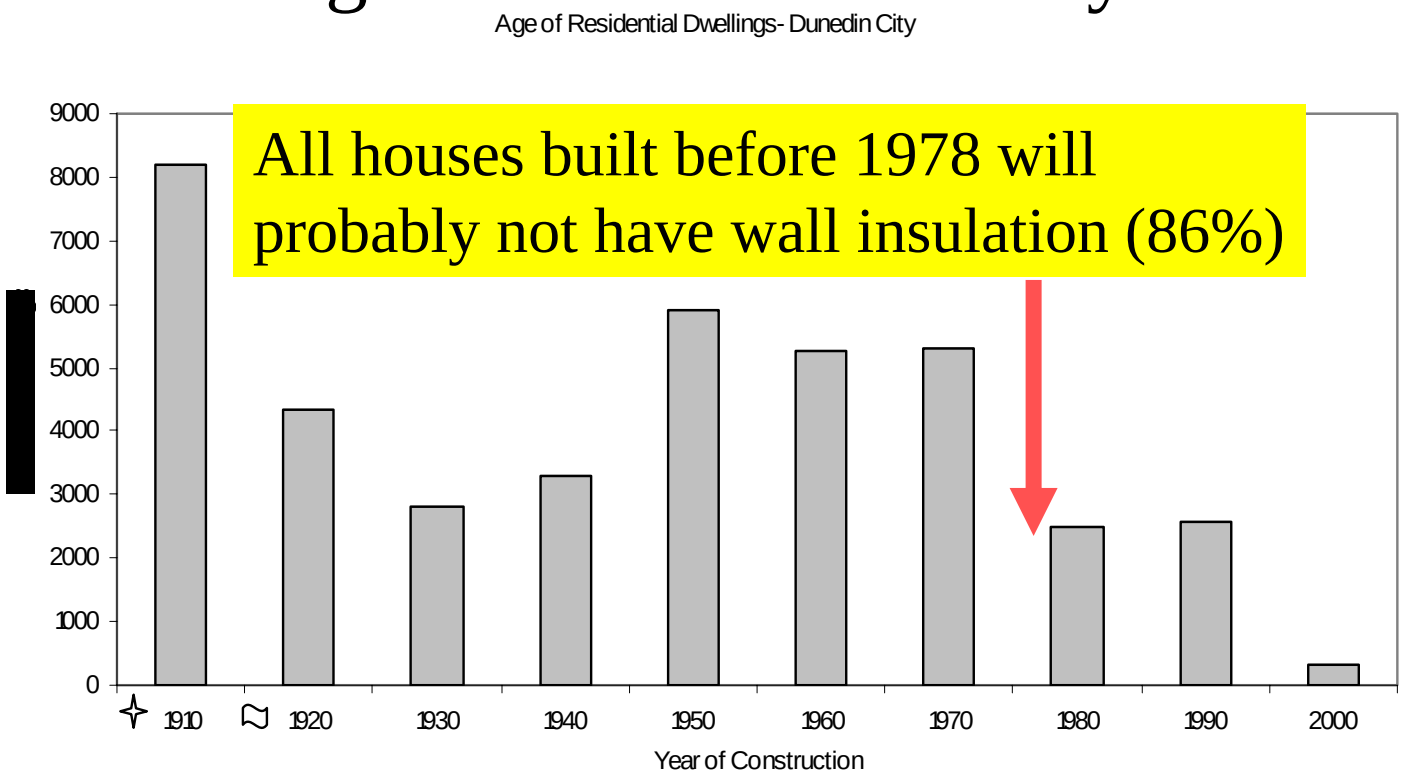
This afternoon's menu

- Housing introduction
- Housing in Dunedin
- Energy use in Housing
- Health and indoor temperatures
- How to keep warm and healthy

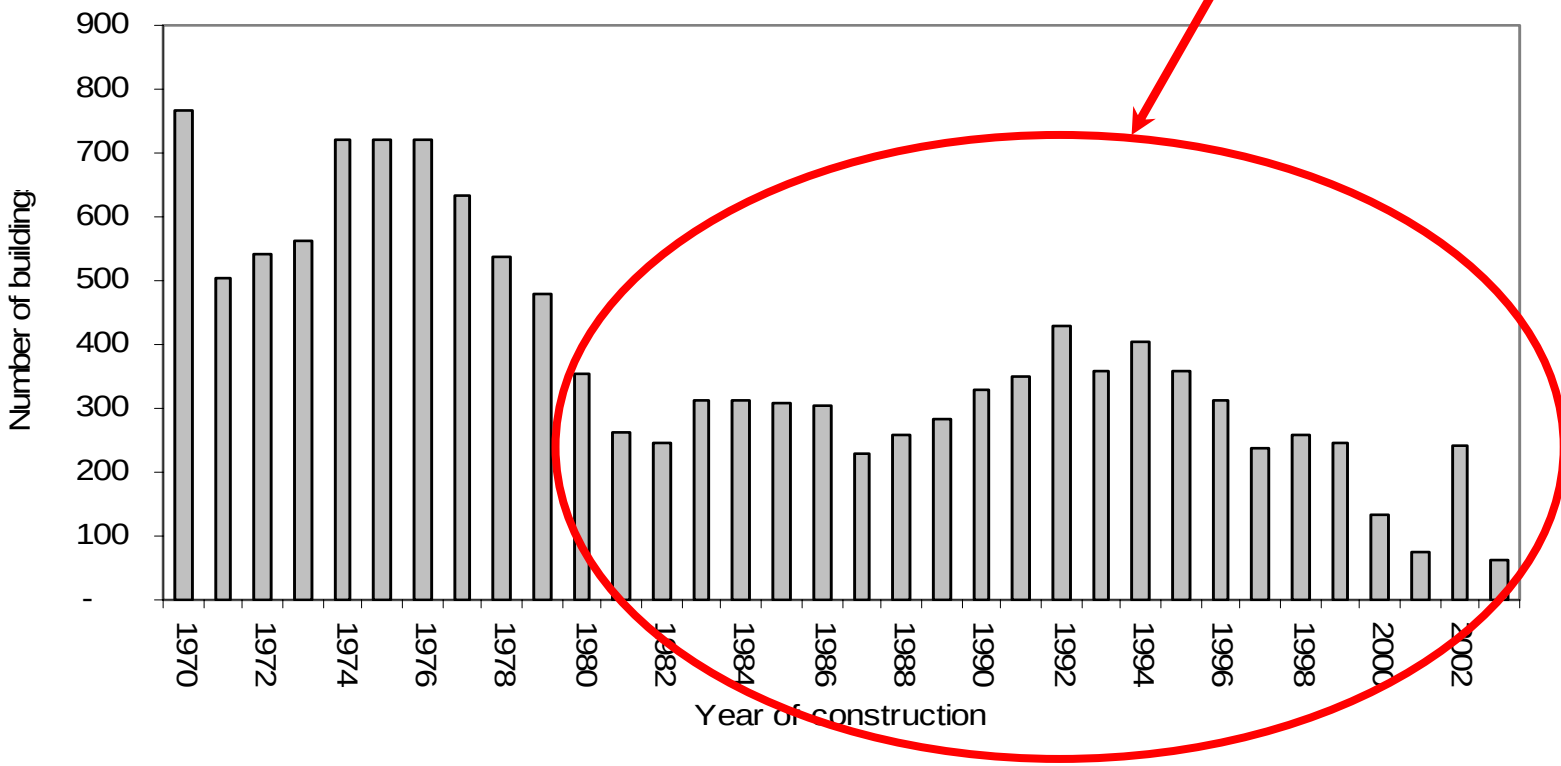
Dunedin Housing stock

- In all there are around 40,000 residential dwellings in Dunedin City.
- The 2003 mean age for residential dwellings in Dunedin was 53 years

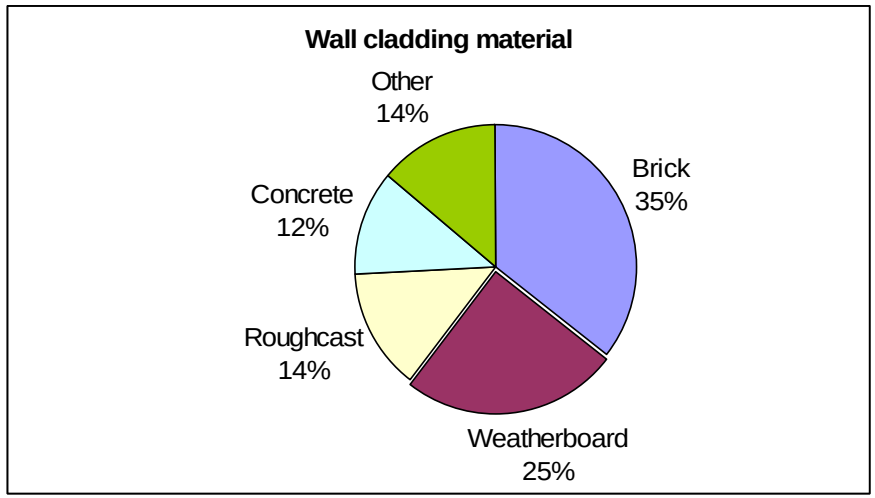


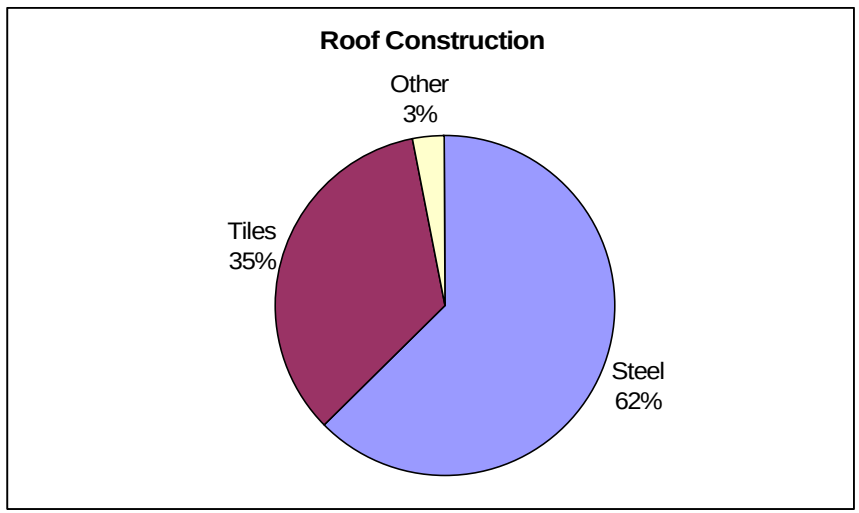
Buildings in recent decades

14% with walls insulated



Housing types





Energy Use in NZ houses

- “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”.

Cold Houses!

- The low values for NZ residential energy use reflect low levels of space heating.
- Not until 1977/78 that building regulations specified insulation in walls and ceiling space.
- Low heating and low levels of insulation means low interior temperatures.
- Plus Dunedin has many areas with poor solar aspect ie not much sun get to the window area.

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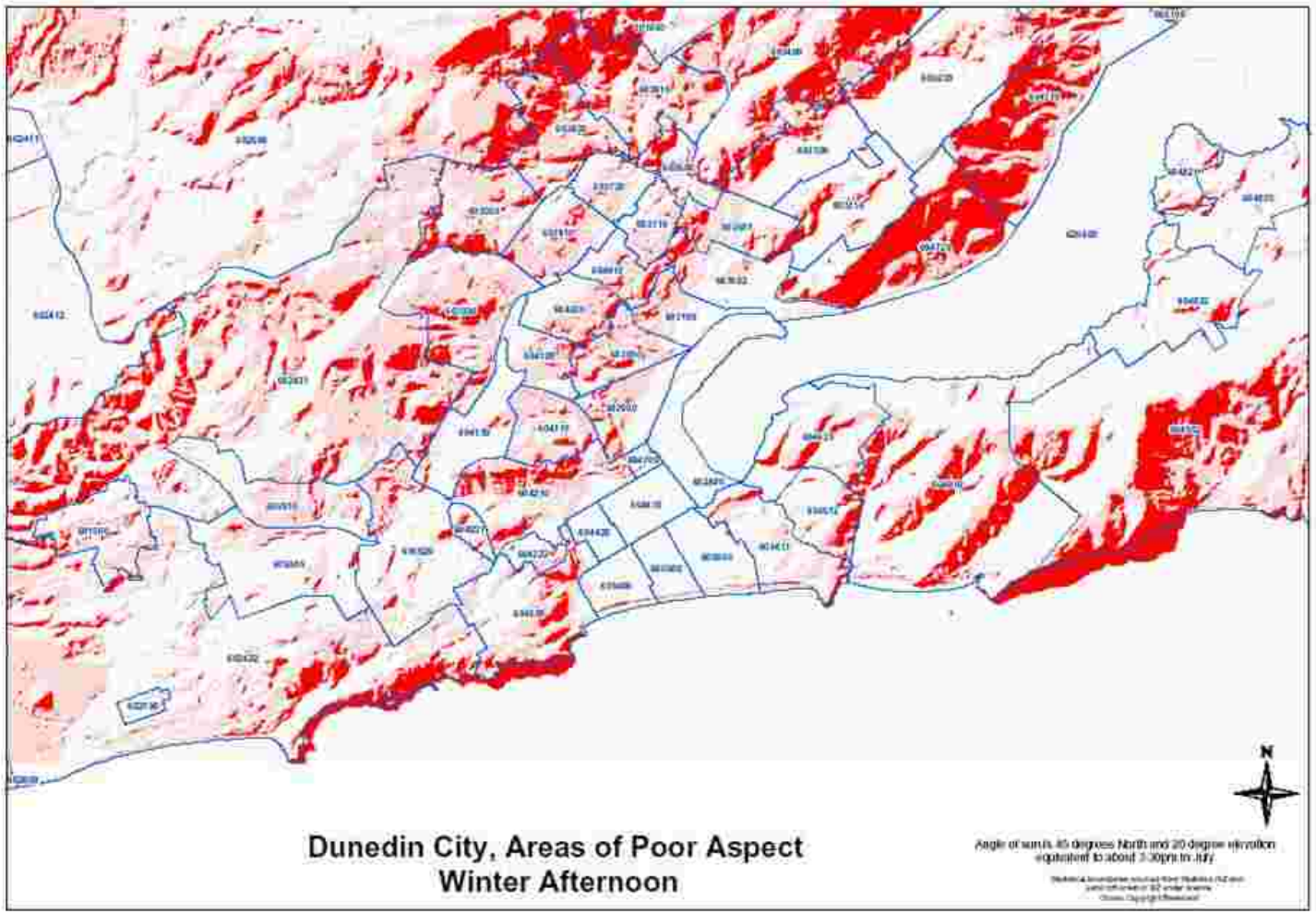
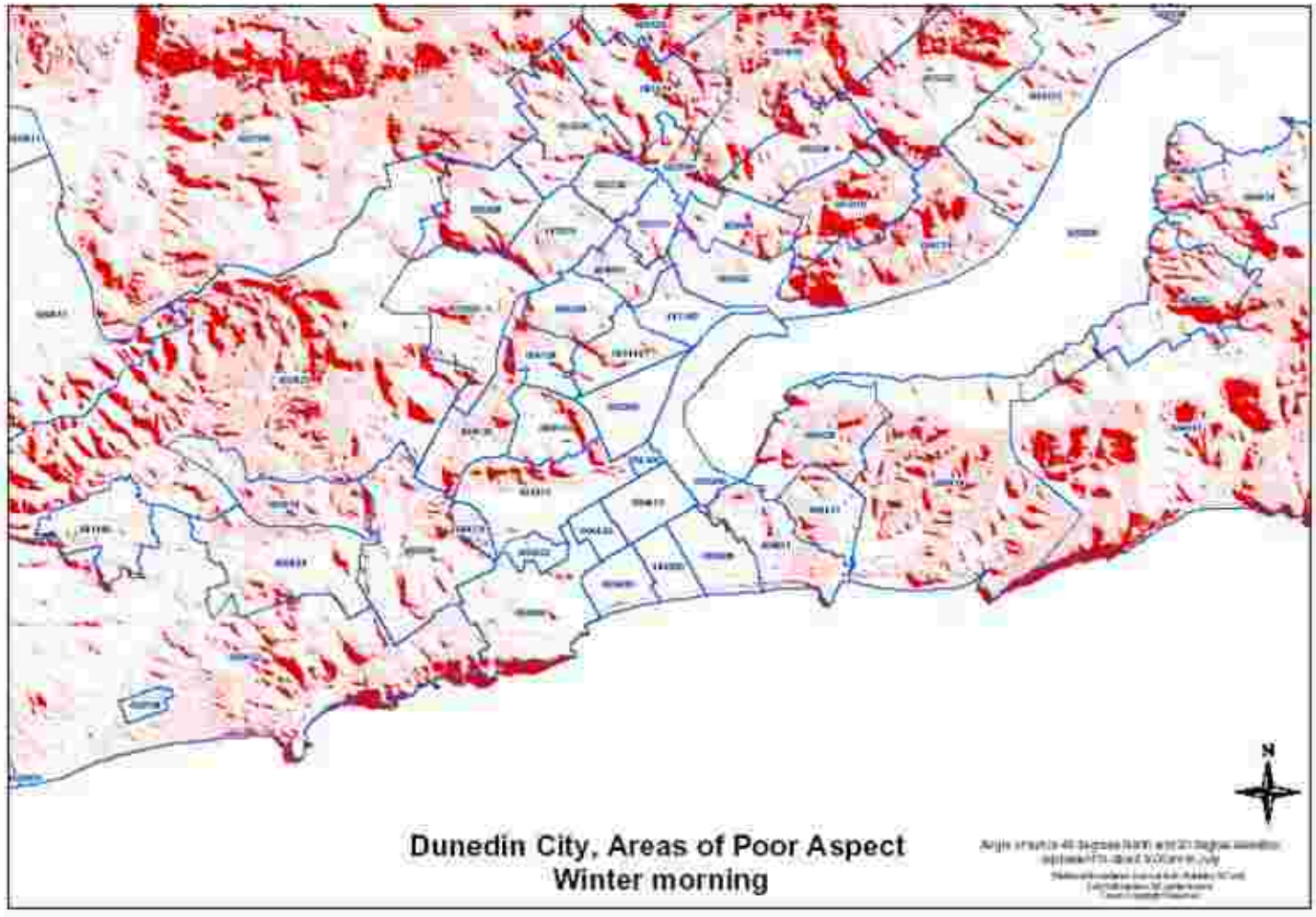
Te Whare Wānanga o Otāgo

Sciences

Poor Solar Aspect afternoon



Poor Solar aspect morning



Least sunshine
Ravensbourne
Pine Hill
Kaikorai Hill
Glenleith
Halfway Bush
Helensburgh
Abbotsford
Mornington
Wakari
Belleknowes
Corstorphine West
Stuart street

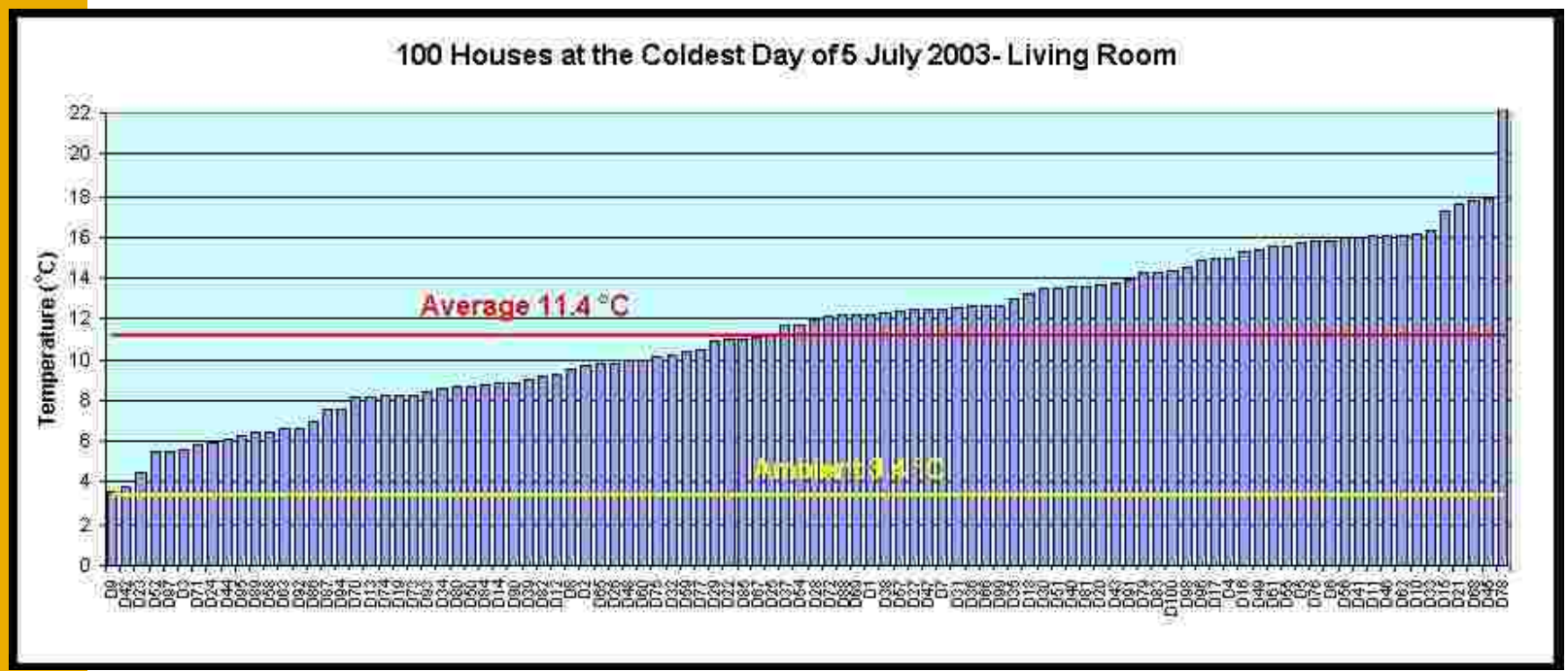
Most people affected
Caversham
Mornington
North-East Valley
Brockville
Wakari
Pine Hill
Vauxhall
St Clair
Halfway Bush
High St-Stuart St
Otago University
North Dunedin

Warm houses!

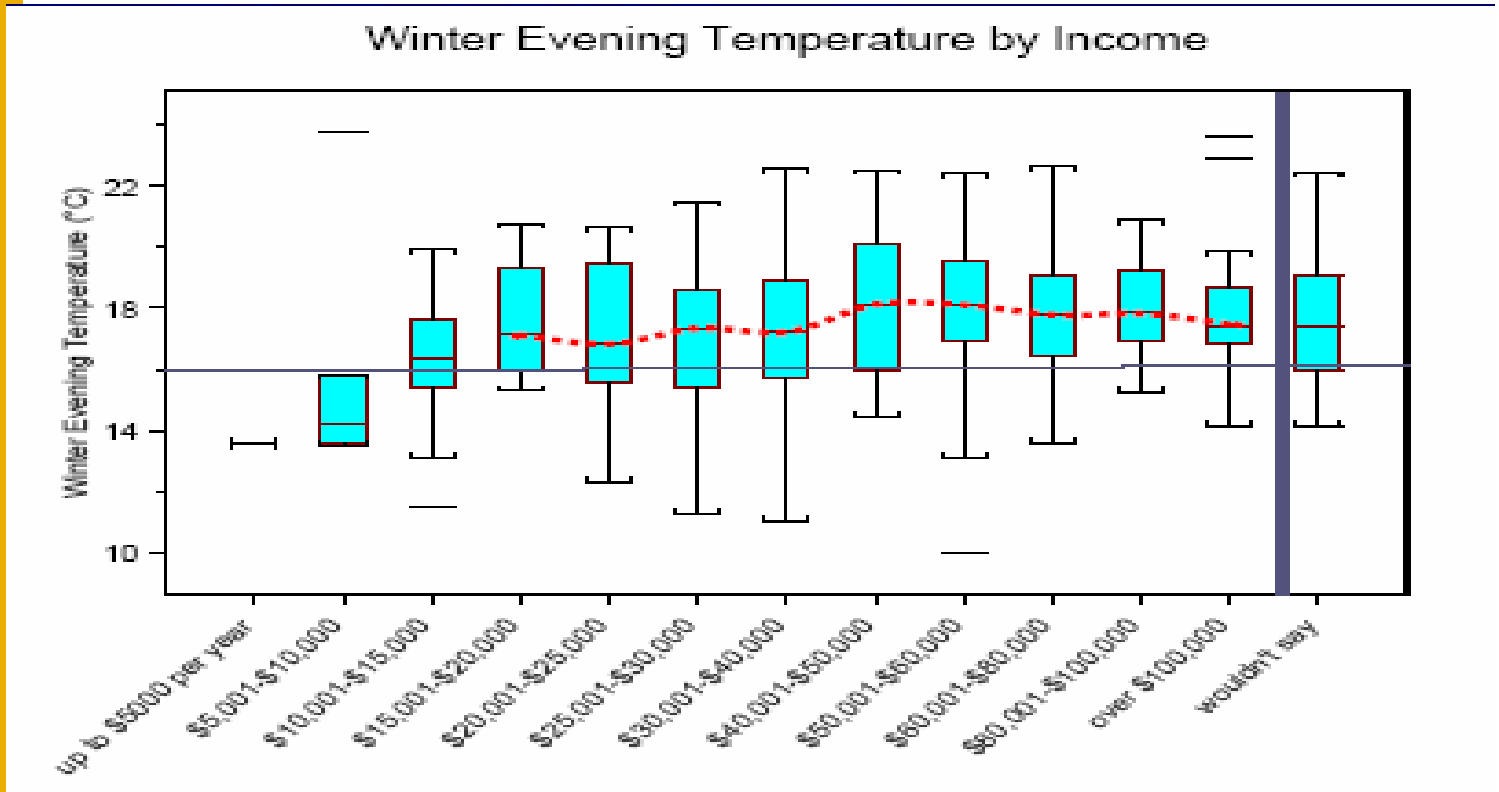
- Well not yet
- Surveys show quite low indoor temperatures across a wide spectrum of housing in NZ and Dunedin in particular.
- A study by Stats NZ in 1971/72 showed temperatures in the living rooms in Dunedin were around 13.6 ^{o}C during the winter
- Our study of 100 HNZ homes in 2003/2004 showed temperatures of 13.6 ^{o}C in the living rooms in Dunedin during the winter!
- A separate study of student flats showed temperatures as low as 2 ^{o}C indoors and yes that was while the flat was occupied

How cold?

- Public housing survey 100 houses mostly in Dunedin. Looked at the situation before and after an insulation upgrade



The rich are as cold as the poor



From BRANZ HEEP study for NZ wide homes

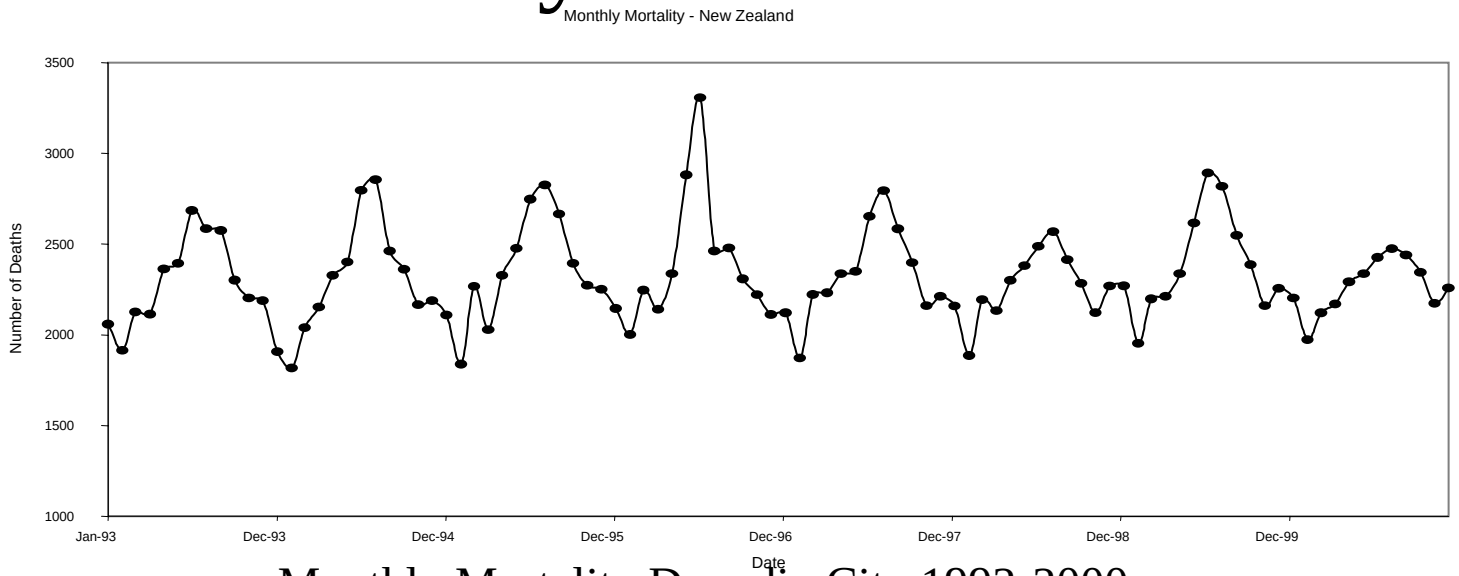
Why should we be worried about low temperatures ?

- They are uncomfortable

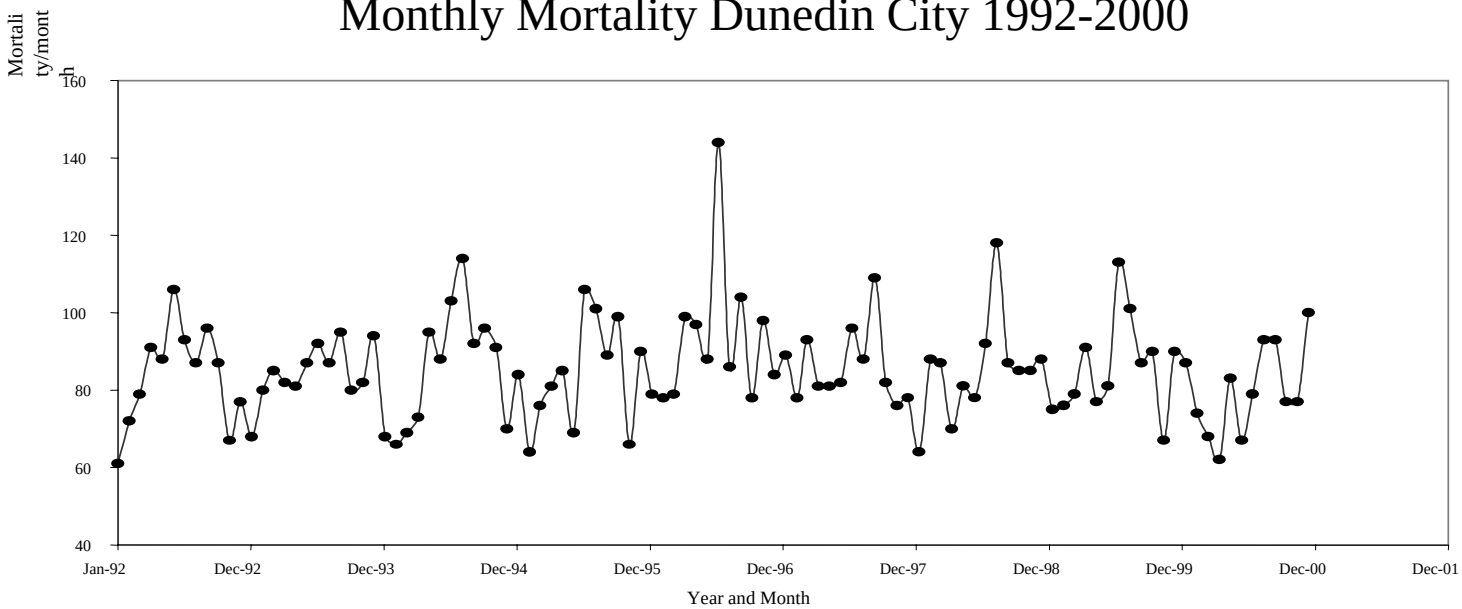
-----Even with acclimatization

- They are unhealthy
- Around 18 ^{o}C is believed to be the minimum comfortable temperature while 16 ^{o}C or below increases the risk of respiratory diseases. Below 12 ^{o}C the risk of cardiovascular strain is increased (World Health Organization, 1987).
- In the UK 21^{o}C is considered adequate for living areas and 18 ^{o}C for other areas of the house
- Mould and dust mites !

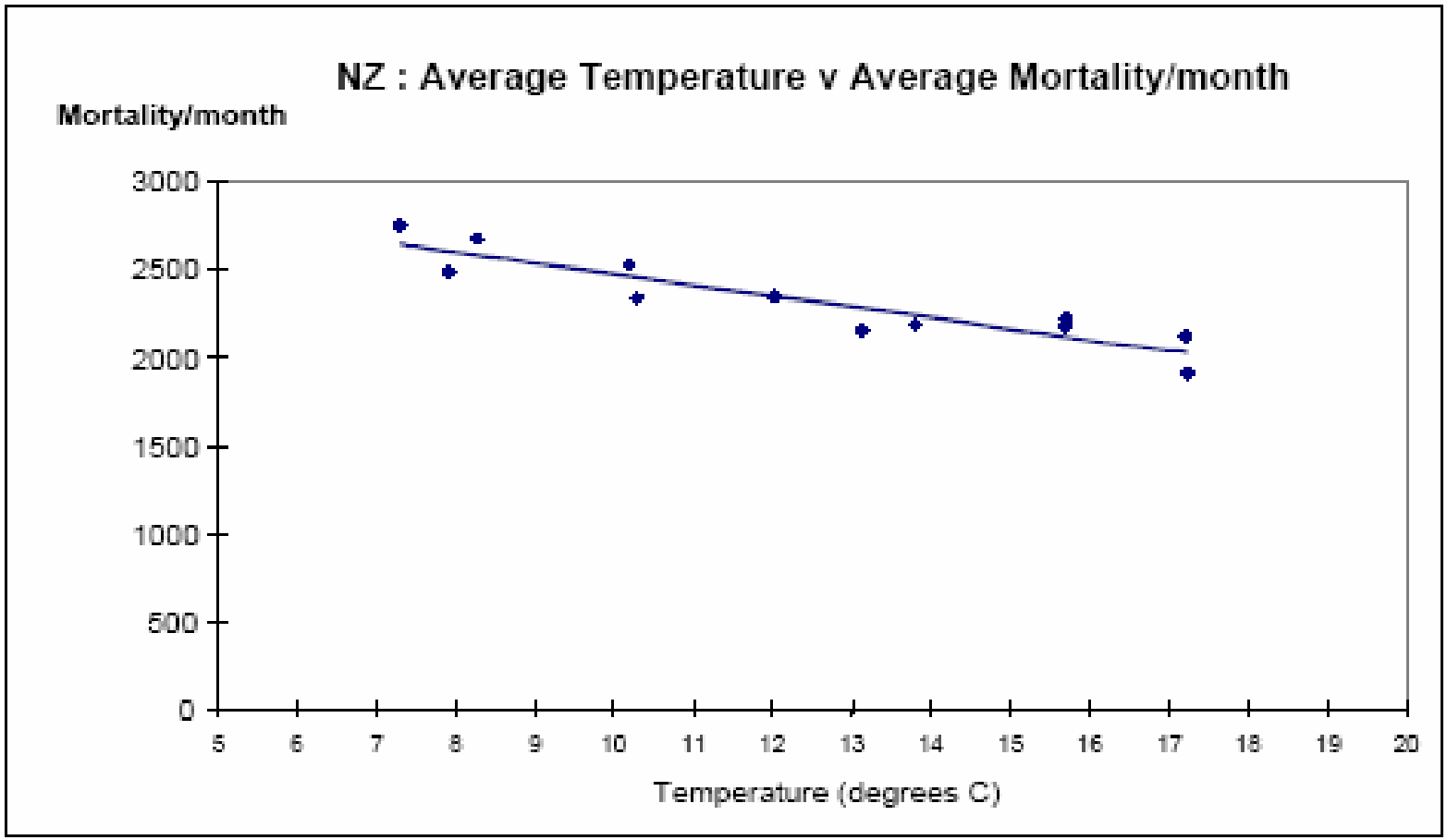
Health effects : Mortality versus season



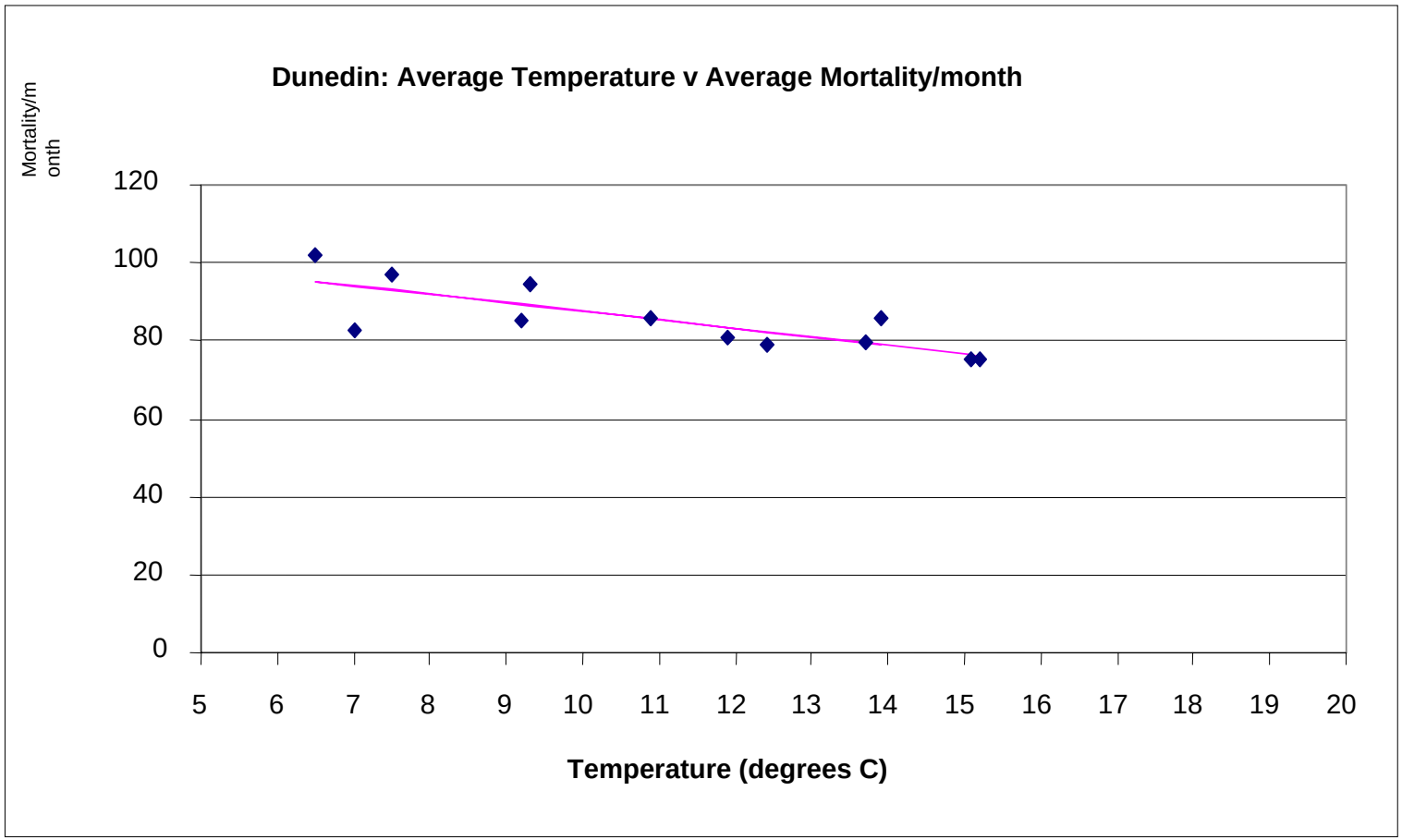
Monthly Mortality Dunedin City 1992-2000



Mortality v temperature



Mortality v temperature



Bottom line

- Dunedin: A one degree fall in temperature causes a 2.6% increase in monthly mortality cf UK 2% increase in mortality per degree fall in temperature

- Data on other illnesses related to cold and damp houses are a bit more difficult to access but it is generally acknowledged that cold damp houses are unhealthy places to live

- With a cool climate, poor solar access, relatively poor population (by NZ standards) and an old mostly un-insulated housing stock, Dunedin could be surmised to be a health risk in terms of having indoor house temperatures below normally acceptable levels.

OK that's the bad news what can we do to keep warm and healthy?

- If you have plenty of money and don't mind using lots of energy its easy:

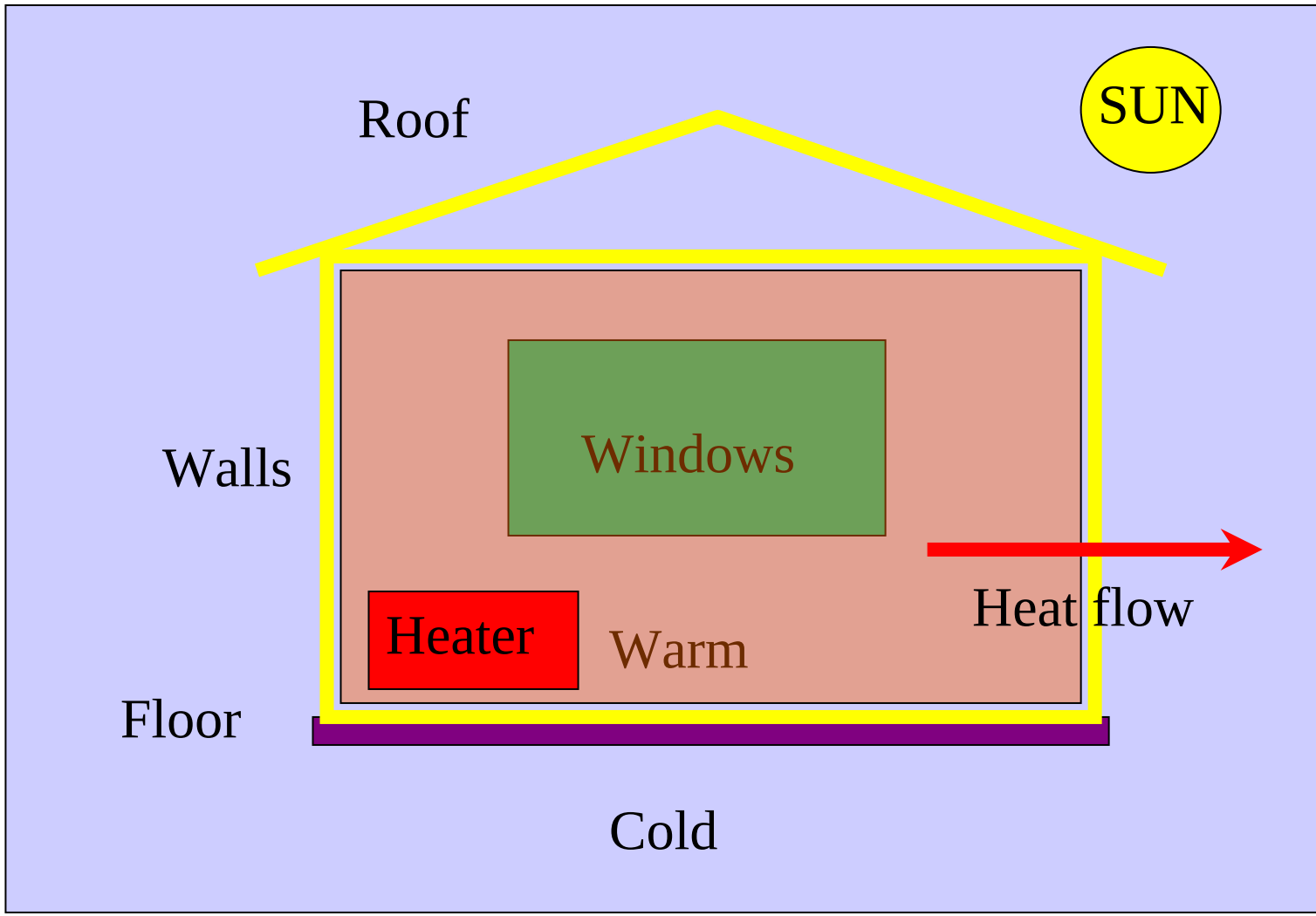
- Heat the house

  (ALL THE HOUSE)

- If you don't have lots of money - or are worried about the environmental effects of energy use then it can be difficult, especially if you have an old house, and even worse if you are renting

- But there are options

Lets start off simple



R values

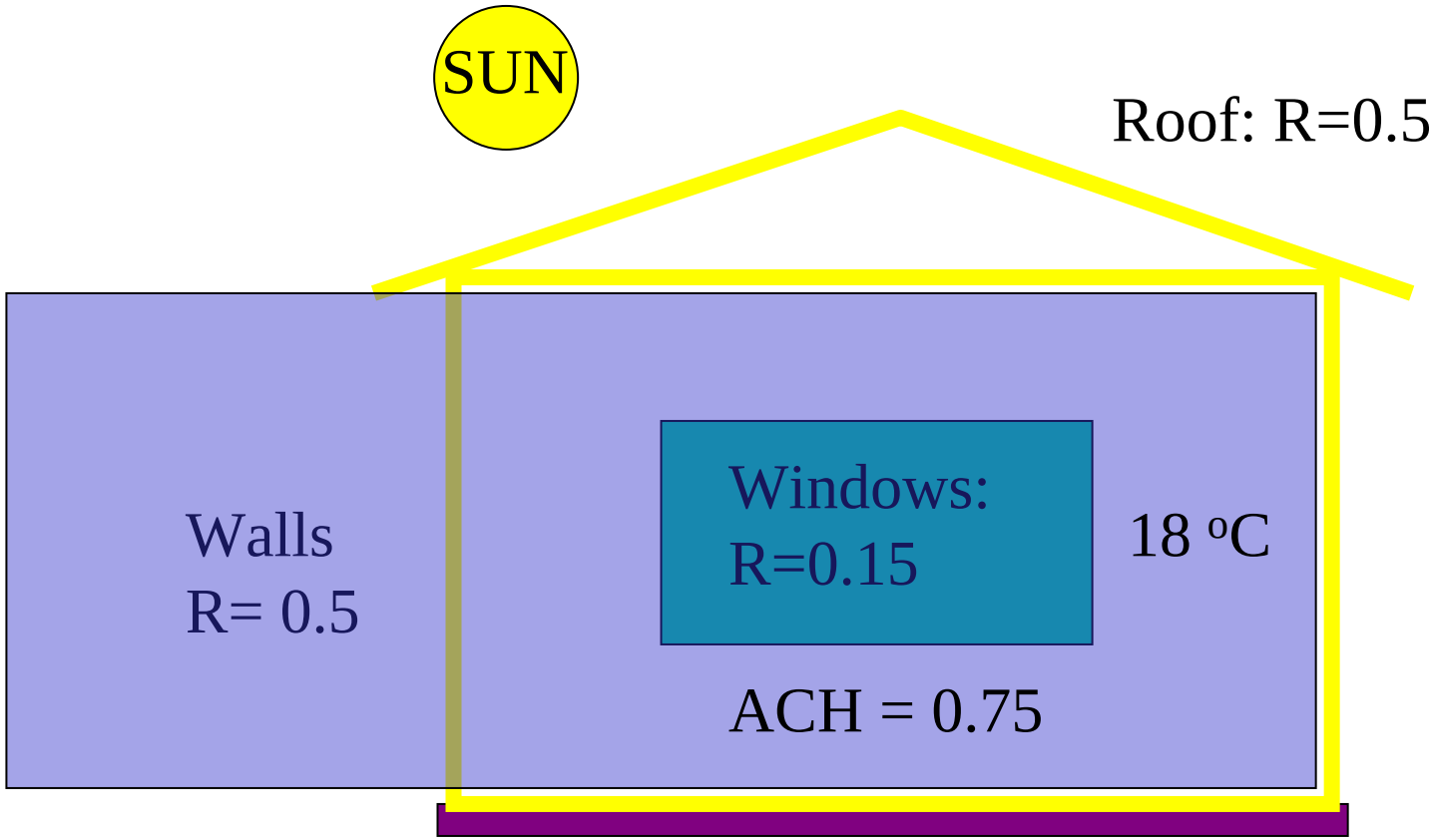
- The thermal resistance of a material tells us how well the material can prevent heat from escaping (or entering) a building
- The overall resistance value for a building component is called the R value and is a number which can vary from close to zero (ie a perfect conductor) to a large number
- The R value also depends on the thickness of the material.
- Air, which is a pretty good insulator, if kept still, has an R value of around 3.0 [m^2C/W] for a layer 100mm thick

- Lets see now what energy and money is needed to heat various houses to a comfortable indoor environment

- For comfortable we will use the UK definition of 21 ^{o}C in the living areas (16 hours heating) and 18 ^{o}C in other parts of the house (16 hours heating)

- We will use the BRANZ program ALF3 and use the heating regime of 18 ^{o}C for 24 hours, which gives about the same results as heating to the UK schedule.

Un- insulated house - Pre 1978
100 m^2 inside 18 ^oC 24 hours



Energy needed = 25,700 kWh

Cost $3,964/year

Suspended
Floor R=0.5

Electricity cost

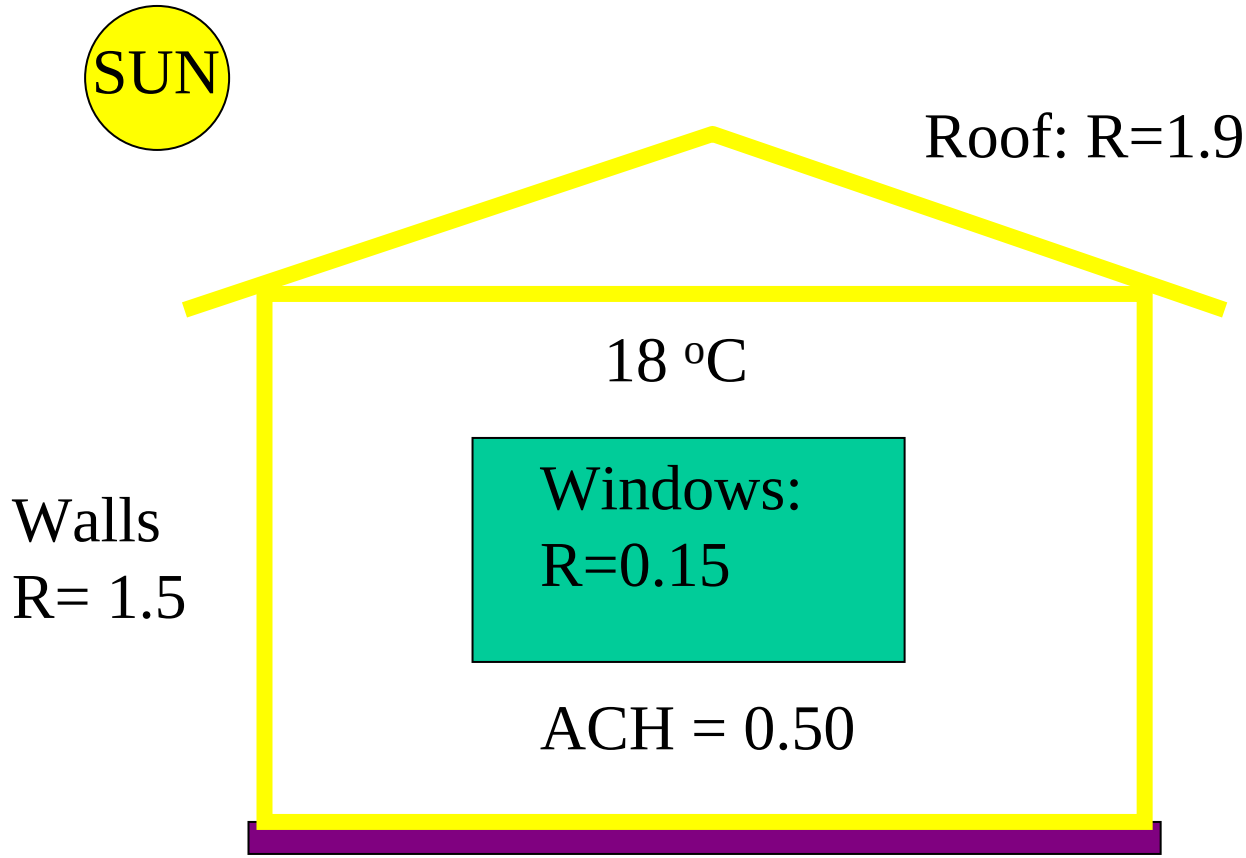
- Contact

All Day Economy

Daily Charge	76.51c
All Day Economy	14.34c/kWh

Obtained: from consumer magazine web site

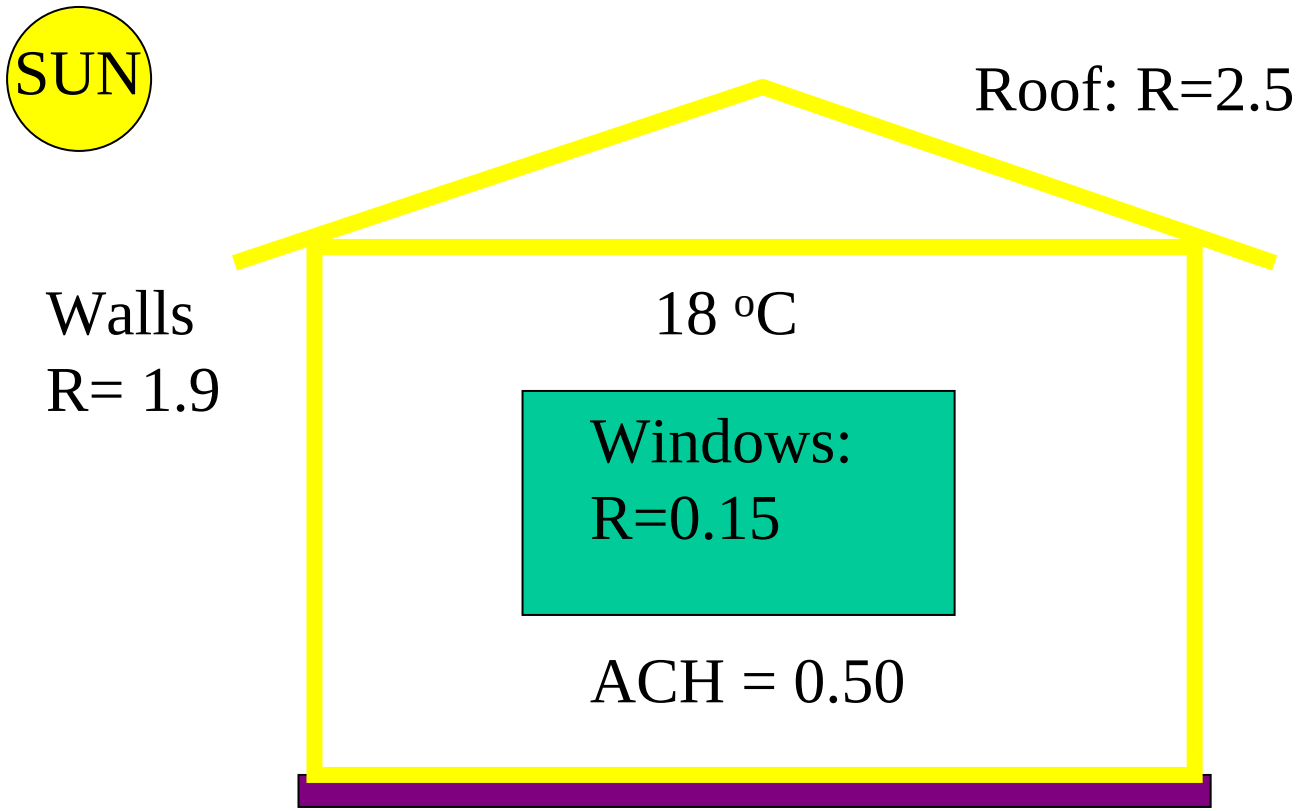
Insulated house – Post 1978 NS standard 4218 1977



Energy needed 9,680 kWh

Cost $1,667/year

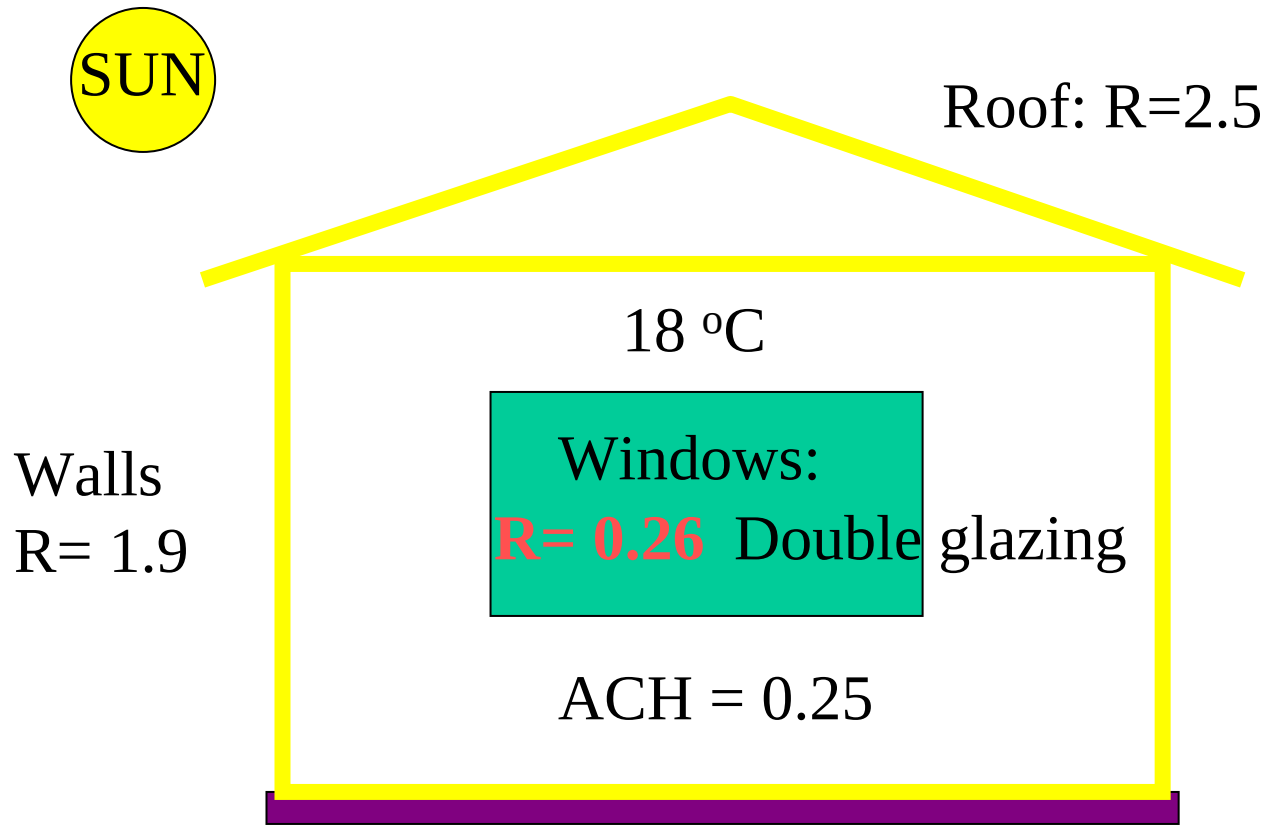
Insulated house – Post 1996
NZS 4218: 1996 - Zone 3



Energy needed 8,740 kWh

Cost $1,532/year

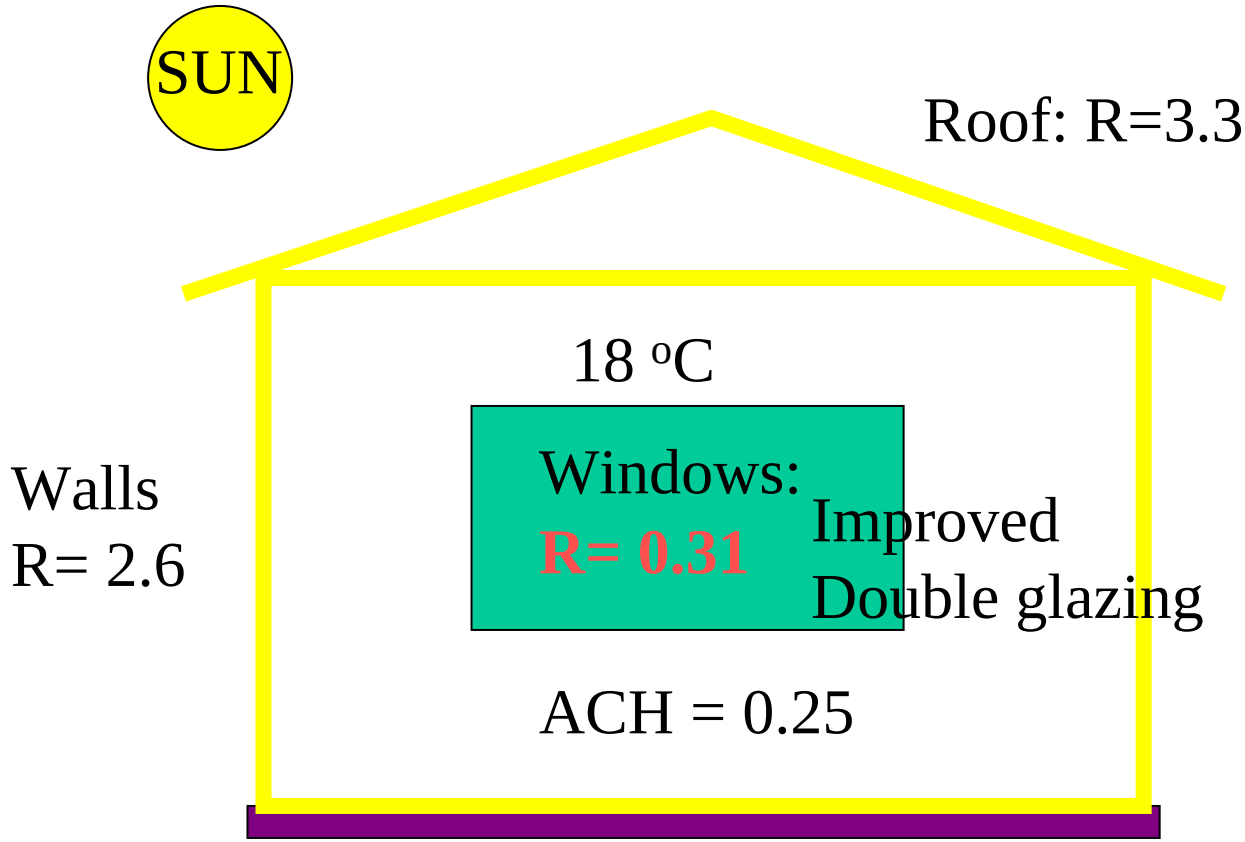
Insulated house – Post 2005?
NZS 4218 :2004



Energy needed 6,790 kWh

Cost $1,252/year

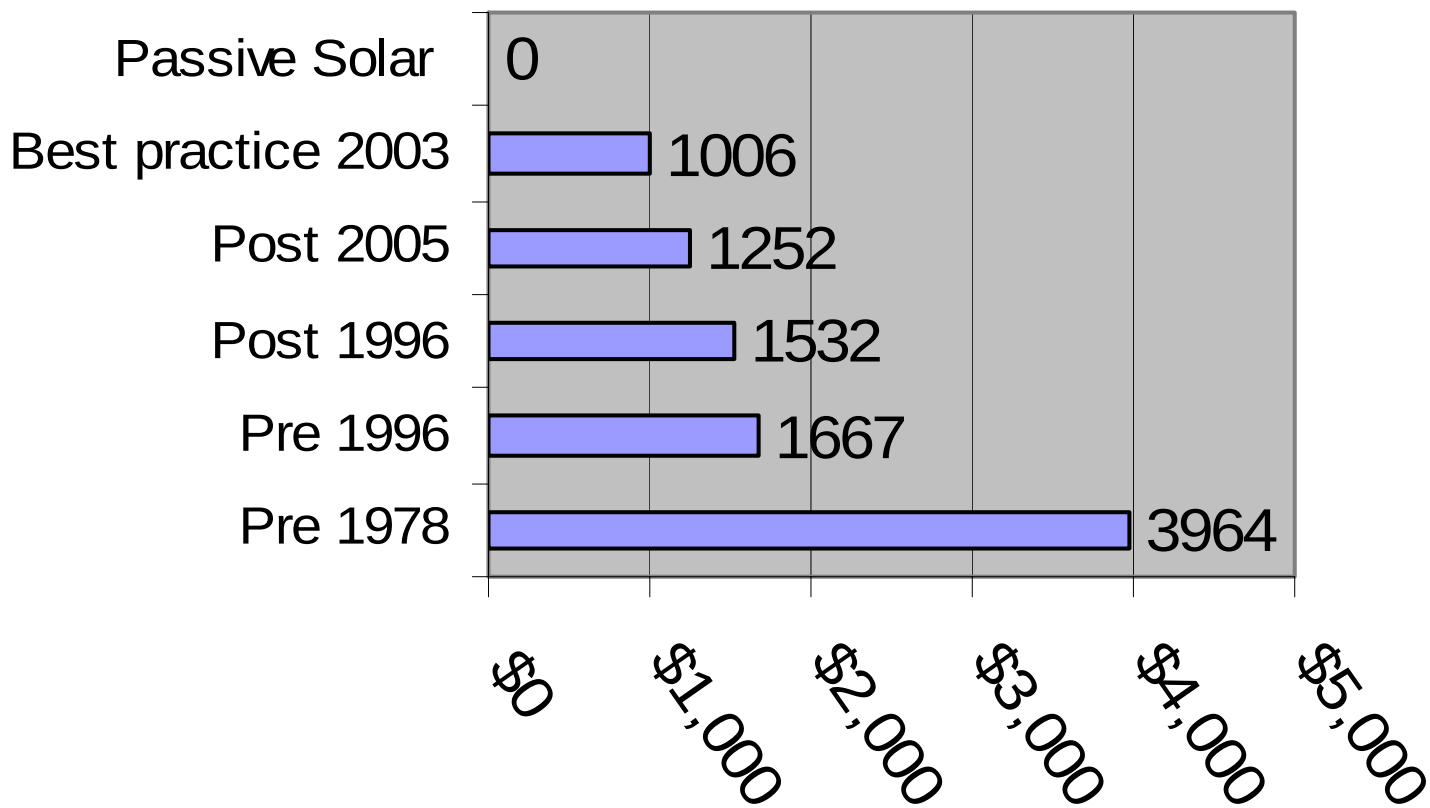
Best Practice NZS PAS 4244: 2003



Energy needed 5,070 kWh

Cost $1006/year

Summary



But remember the savings only occur if the house is heated 24 hours

Heating sources ?

- Avoid using resistive electric heating
- If you can afford it, use a heatpump or approved solid fuel heater
- Heatpumps have Coefficients of Performance (COPs) of around 3 so you get up to 3kWh of heat for 1 kWh of electricity . This will reduce your $1,252 bill to perhaps around $500
- Wood can cost between 4 and 8 c/kWh

What about gas?

- LPG prices in Dunedin are pretty close to electricity prices so you don't get any more heat for your money -
- except free extra indoor humidity and a variety of hydrocarbon and other pollutants from non flued heaters
- Cyclic heating with gas (or other sources) usually encourages condensation
  - Surveys show NZ households don't have central heating

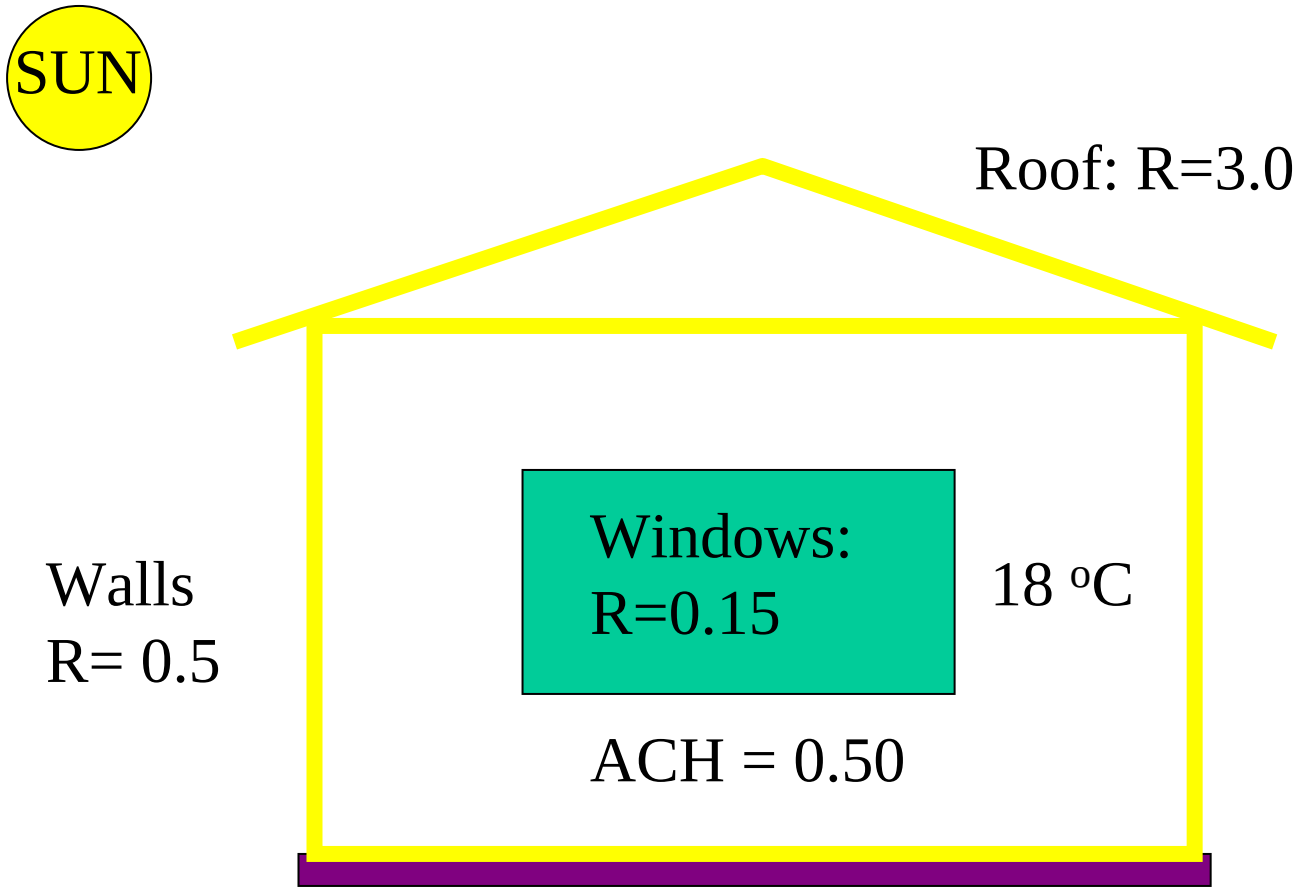
Any more hints ?

- Well there are the really easy ways of saving energy such as:
- Fitting a hot water wrap on the hot water cylinder and checking the thermostat is set at the right temperature.
- Lagging hot water pipes
- Replacing all the lights with energy saving fluorescents
- Sealing as many air leaks as possible to reduce the air changes per hour
- Installing a ground vapor barrier

Then come the more difficult retrofits

- Adding insulation where ever possible
- **Ceiling:** usually fairly easy - you can get R 5.0 ceiling batts or 3.4 polyester blankets
- **Floor:** either foil lined batts or polystyrene if a suspended floor or edge insulation if a slab floor.
- **Walls:** are difficult as they generally require stripping and re Gibbing - R 3.0 wall batts are available for 100 mm studs
- **Windows:** Retrofit double glazing or use plastic add ons

Roof and basic floor retrofit to pre 1978 house



Energy needed = 13,800 kWh

Cost $2,258/year

Use free heat energy wherever possible

- The sun
- Really only practical in terms of design although it can influence choice of purchase
- add on conservatories or retrofitted active solar systems are possible
- Cut down any trees shading window areas
- (if they are yours)

For new houses use:
Solar Passive Design Principles

- Orientation
- Zoning
- Thermal mass
- Windows
- Insulation
- Sun control (usually not a problem in Dunedin)
- Ventilation
- Landscaping

Orientation

- Orientation optimum depends critically on the climate
- In cold climates arrange to orient the house to admit as much sunlight as possible
- This usually means to run the house in an east west direction with windows facing north

Zoning

- Arrange living areas to suit the climate – pretty much a matter of common sense but often not followed
- In cool climates this means to put the living areas on the north side of the building and the sleeping/utility areas on the south
- Bedrooms on the east will get morning sun on the west afternoon sun

Thermal mass

- Thermal mass acts as heat storage
- Minimum thermal mass is needed on a diurnal basis to store heat captured during the day to release during the night.
- Must be coordinated with insulation and climate ie;
  - In tropics low thermal mass is desired
  - Cooler climates high thermal mass
  - Desert regions high thermal mass
  - Can be arranged differently in different parts of the house ie in desert climates: high for living areas low for sleeping areas
- Considerable literature on pros and cons of high thermal mass houses

Windows

- Windows collect solar radiation when sun shines and emit thermal radiation otherwise
- Generally glass is high transparency, high conductance and high emittance (thermal) Windows are the weak point of houses in terms of thermal insulation
- Placed on north facades for overall collection, east for morning collection, west for afternoon collection.
- Should be minimal in very hot or very cold climates. If you want to preserve a view go for a framed view- not a floor to ceiling exposure

Special windows

- Double glazing
- Triple glazing
- Gas fills – argon or krypton
- Low emissivity glass
- Thermally broken frames

Reduces heat loss and also prevents condensation on windows

Landscaping

- Can be used for solar control
  - Eg trees for direct shading
  - Groundcover -Reduce or enhance reflected/emitted radiation
  - Deciduous vines – shade in summer only
- Reduce unwanted ventilation ie protect from winds

Special passive design

- This is where special structures are put in place to capture, store or remove heat energy from insolation Eg.
  - Conservatories
  - Trombe walls
  - Lawrence walls
  - Water walls/roofs

Active solar systems

- Active systems generally use some external energy (or fluid) to control the heat flow inside buildings
- Solar hot water systems are generally classified as active solar systems even though many such systems rely on a thermosyphon to circulate the water
- Air or water based systems
- Includes solar air conditioning systems

Active solar heating

- Involves a collector which is a good absorber of solar radiation
- This can heat air directly which can be circulated to the building via a fan
- Or water can be heated and the water pumped to radiators/convectors in the building
- Can involve storage elements such as water tanks/ latent heat/ rock stores