BUILDING ENERGY EFFICIENCY
Focus of this talk

Challenge your thoughts on energy efficiency…

- People are more important than energy
- Consumers need to demand comfortable & healthy homes

Structure of the talk

- Overview of the performance of our building stock
- Key design/science topics behind comfortable & energy efficient homes
About Me

• Building Environmental Scientist

• Masters of Building Science from the Victoria University of Wellington

• Key Research Areas:
  • Building Simulation
  • Building Information Modelling (BIM)
  • Whole Building Life Cycle Assessment (LCA)

• Current Research Projects Include:
  • The Quantifiable Evidence of Building Beyond Code
  • Development of a Best Practice Thermal/Energy Simulation Guide for Building Designers
Better Buildings Through Research-Driven Leadership

Our objective is to support industry through provision of robust analysis, modelling, forecasting, evidence and advice so we are building better for New Zealand.
Current BRANZ Research

People Focus
• The choice to exceed building code
• Who benefits from exceeding the minimum?

Science Focus
• The quantifiable evidence of building beyond code
The Need For Building Energy Efficiency

- Building sector is responsible for ~20% of NZ’s energy-related Green House Gas emissions
- Majority of buildings that will be in existence in 2050 have already been built.

Source: Transition to a low-carbon economy for New Zealand April 2016 The Royal Society of New Zealand
# How Energy Is Used In Buildings

## Electricity End Uses

### Commercial Office Buildings
- Hot Water Heating: 3%
- Processes: 3%
- Miscellaneous: 10%
- Space Conditioning (HVAC): 25%
- Equipment plug Loads: 30%
- Lighting: 30%

### Residential Buildings
- Hot Water: 34%
- Range: 7%
- Lights: 12%
- Heating: 12%
- Refrigeration: 15%
- Other Appliances: 20%

---

Figure 63 Page 51
Building Energy End-use Study (BEES) Part 1: Final Report (Building Energy End-use Study (BEES) No. BRANZ Study Report 297/1)

Figure 6 Page 9
An Energy Efficient Home Is…

Passive House Standards:
• Annual heating and cooling <15 kWh/m² per year
• Total energy consumption for heating, hot water and electricity <120 kWh/m² per year

HEEP House = NZ :
• Heating ~20kWh/m²

…but it is not necessarily a comfortable or healthy one

Table 34
Performance of New NZ Homes

Auckland House’s Annual Space Heating Energy Use kWh/m²

Amount of Time per Year Living Room Spaces are within Comfortable temperatures (from 7am-11pm 18-25°C) with no mechanical heating/cooling

### Table 10 Page 25 BRANZ Study 2015

- **Location**
  - Auckland
  - Hamilton
  - Christchurch

- **NOW Home®**
  - Auckland: 5652 hrs/yr, 97% of daytime
  - Hamilton: 5299 hrs/yr, 91% of daytime
  - Christchurch: 4419 hrs/yr, 76% of daytime

- **Random mean**
  - Auckland: 4877 hrs/yr, 84% of daytime
  - Hamilton: 4099 hrs/yr, 70% of daytime
  - Christchurch: 3248 hrs/yr, 56% of daytime

Figure 5 Page 17 BRANZ Study 2015 - Measuring our sustainability progress: Benchmarking New Zealand’s new detached residential housing stock
Future Performance of New NZ Homes

<table>
<thead>
<tr>
<th>YEAR</th>
<th>OVERHEATING # hours/day for Summer Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>1 hour 20 mins</td>
</tr>
<tr>
<td>2030</td>
<td>2 hours 9 mins</td>
</tr>
<tr>
<td>2080</td>
<td>4 hours 43 mins</td>
</tr>
</tbody>
</table>

Why Spaces Overheat?

- Lack of cross ventilation
- Lack of insulation
- No or poor location of summer north and west shading
- Too much unshaded glazing
An Energy Efficient Home: Performance

Criteria

Reticulated Energy Use

Climate Zone 1: Auckland
- New homes 5800 kWh/yr
- Existing homes: 6200 kWh/yr

Climate Zone 2: Wellington
- New homes 6300 kWh/yr
- Existing homes: 7300 kWh/yr

Climate Zone 3: South Island
- New homes 7300 kWh/yr
- Existing homes: 8400 kWh/yr

Indoor Environmental Quality

Average Temperature
- Living room 5-11pm >18°C
- Bedroom 11pm – 7am >16°C

Average Relative Humidity
- Living room 5-11pm in winter 40-70%
- Bedroom 11pm – 7am in winter 40-70%
- Surface relative humidity <80% year round

Source:
http://www.beaconpathway.co.nz/further-research/article/hss_benchmarks
An Energy Efficient Home

The building code is a minimum standard...

...we can build better

New Zealand Building Code:

- **H1 Energy Efficiency**
  - Sets Minimum Insulation levels e.g. Thermal Resistance (R-value m² °C/W) for Auckland Climate:
    - Roof R2.9
    - Walls R1.9
    - Floor R1.3
    - Windows R0.26

- **E3 Internal Moisture**

- **G4 Ventilation**
  - Net Openable Window Area >= 5% of the Floor Area
An Energy Efficient Home: Thermal Envelope

**Thermal Resistance (R-values):** A measure of resistance to the flow of heat. \( \text{m}^2 \cdot \circ \text{C}/\text{W} \). The higher the R-value the better.

**Construction R-value:** The R-value of a typical area of a building element.

<table>
<thead>
<tr>
<th>Framing timber</th>
<th>Insulation material R-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.8</td>
</tr>
<tr>
<td>studs 600, dwangs 800 (14%)</td>
<td>1.9</td>
</tr>
<tr>
<td>studs 600, dwangs 600 (16%)</td>
<td>1.8</td>
</tr>
<tr>
<td>studs 400, dwangs 800 (18%)</td>
<td>1.8</td>
</tr>
<tr>
<td>studs 400, dwangs 600 (20%)</td>
<td>1.8</td>
</tr>
<tr>
<td>(22%) framing ratio</td>
<td>1.7</td>
</tr>
<tr>
<td>(24%) framing ratio</td>
<td>1.7</td>
</tr>
</tbody>
</table>

**Notes**
1. All insulants should be placed against wall underlay without pushing the underlay into the cavity.
2. R3.0 is the highest practicable R-value of common insulation materials that can be used with 90 mm studs.
An Energy Efficient Home: Thermal Envelope

BRANZ modelling shows:
Thermally broken aluminium window frames with Low E IGU’s adds $4000 to a standard ‘spec’ house (at 20°C indoors) and reduces heat loss by
- 15-20% in Christchurch
- 22-30% in Wellington
- 27-36% in Auckland

Brian Berg
Building Environmental Scientist
Brian.Berg@branz.co.nz
Infiltration rates (air changes per hour) for various airtightness categories

- **Draughty** (pre-1960s house) = 0.9 ac/h
- **Leaky** (post-1960 house with some strip lining) = 0.7 ac/h
- **New Houses** 0.1-0.5 ac/h

Source: http://proclima.co.nz/air-movement-infiltration
An Energy Efficient Home: Internal Moisture

Moisture Sources:
• 3 bedroom House 4 Occupants = 14L/day (ASHRAE Standard 160-2009)

Moisture Sources by Activity (BRANZ, 2005):
• Dishes 1.0L/day
• Cooking Gas 3.0L/day
• Clothes Washing 0.5L/day
• Clothes Drying Unvented Drier 5.0L/load
• Showers/Baths 1.5L/day
• People Breathing:
  • Sleeping 7hrs 0.14L/person
  • Active 0.2L per hour per person
How and when to ventilate to manage moisture levels?

• Heat the house
• Flush ventilation and achieve a near full air exchange of the house in about 10–15 minutes
• Morning is the best time
Tools for Building Energy Efficient Buildings

**Design Tools**

- Whole Building Simulation
  - EnergyPlus - **FREE**
- **IES**
- **sefaira**
- **Alf**
  - **FREE**
- LBNL THERM 7.4 & WINDOW 7.4
  - **FREE**

**Actual Performance Tools**

- Post Occupancy Evaluation (POE) – Building Occupant Survey
- Energy Auditing
  - Temperature & RH% Sensors
- Blower Door Test – Air Tightness
- Thermal Imagery

Brian Berg
Building Environmental Scientist
Brian.Berg@branz.co.nz
How can **You** Design OR Demand An Energy Efficient Home?

[Image: homestar logo]

**Homestar**

Know your home

1* 2* 3* 4* 5* 6* 7* 8* 9* 10*

http://www.homestar.org.nz/

---

**UP-SPEC**


---

**Level**

http://www.level.org.nz/

---

Brian Berg
Building Environmental Scientist
Brian.Berg@branz.co.nz

---

FREE

[Image: brochure cover]

Designing Comfortable Homes
GUIDELINES ON THE USE OF GLASS, MASS AND INSULATION FOR ENERGY EFFICIENCY

The Take Home Message

Comfortable homes don’t have to be just for grand designs

Beacon Pathway’s NOW Home®
New Lynn 146m² ~$214,000 Build Cost (2008)