SESSION 2: VENTILATION FOR INDOOR AIR QUALITY AND HEALTH
Heat stress resistance in the Nationwide House Energy Rating Scheme

Project team
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Heatwaves in Australia

- Heatwaves are the most deadly natural hazard
- The frequency and intensity of heatwaves are rising due to climate change
- Heatwaves are exacerbated by Urban Heat Islands with 89% of Australians living in cities and towns
- Ageing population
Solution: air conditioning

“According to the Australian animal welfare standards and guidelines for exhibited animals, all animal enclosures must provide temperature and humidity control,” she said. “So why does the Australian government care enough about the well-being, comfort and care of zoo animals to create legislation in the interests of animal protection, yet does not show the same level of compassion and devotion to our elderly citizens?

Shockingly, half of all public classrooms in Western Sydney have no air-conditioning at all, but we’ve had three 40 degree days in the last three weeks alone. Can you imagine trying to learn in that environment?

There is a renewed push for air-conditioning to be installed in social housing sites in regional New South Wales, where temperatures exceed 40 degrees Celsius several days per year.
All of these are from public petitions


Solution: air conditioning

- drives peak electricity demand, prices and energy poverty
- warms up the outdoors
- increased dependence
What can we do?
Are our buildings heat stress resistant?
Online survey

- Representative sample from Adelaide (N=393)
- Panel provider

- Questions about
  - Demography
  - Built environment
  - Retrofitting activity
  - Adaptation
  - Heat-related health problems
NatHERS

- Two compliance pathways: elemental approach and simulation compliance
- Rates dwellings from 1 to 10 stars
- Minimum requirement is 6 stars
- NatHERS software
- Based on the annual thermal energy requirement, including both heating and cooling
AccuRate simulation

**AccuRate** building energy simulation of design variations with a typical floor plan

Traditional double-brick and brick veneer from the 70s  
New homes from 6 to 8 stars
Floor plan and section of the simulated home
**House design elements**

<table>
<thead>
<tr>
<th>Star rating in Adelaide</th>
<th>2.6 stars (double brick)</th>
<th>2.6 stars (brick veneer)</th>
<th>6.2 stars cooling-dominant</th>
<th>6.2 stars heating-dominant</th>
<th>7.1 stars heating-dominant</th>
<th>7.2 stars cooling-dominant</th>
<th>8.0 stars cooling-dominant</th>
<th>8.0 stars heating-dominant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Star rating in Sydney</td>
<td>2.3 stars (double brick)</td>
<td>2.4 stars (brick veneer)</td>
<td>5.6 stars cooling-dominant</td>
<td>5.7 stars heating-dominant</td>
<td>6.7 stars cooling-dominant</td>
<td>6.9 stars cooling-dominant</td>
<td>7.9 stars cooling-dominant</td>
<td>8.1 stars heating-dominant</td>
</tr>
<tr>
<td>Roof colour, material and total solar absorptance</td>
<td>light metal (0.30)</td>
<td>light metal (0.30)</td>
<td>dark tiles (0.75)</td>
<td>white, concrete tiles (0.25)</td>
<td>white, concrete tiles (0.25)</td>
<td>dark metal (0.75)</td>
<td>dark metal (0.75)</td>
<td>white, concrete tiles (0.25)</td>
</tr>
<tr>
<td>Foil in roof</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
<td>yes</td>
<td>yes</td>
<td>NIL</td>
<td>NIL</td>
<td>yes</td>
</tr>
<tr>
<td>Roof insulation</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
<td>R2</td>
<td>R2</td>
</tr>
<tr>
<td>Ceiling insulation</td>
<td>NIL</td>
<td>NIL</td>
<td>R4.0</td>
<td>R4.0</td>
<td>R4.0</td>
<td>R4.0</td>
<td>R4.0</td>
<td>R4.0</td>
</tr>
<tr>
<td>External wall</td>
<td>double brick with cavity</td>
<td>brick veneer</td>
<td>brick veneer, R2.5</td>
<td>brick veneer, R2.5</td>
<td>brick veneer, R2.5</td>
<td>brick veneer, R3.5</td>
<td>reverse brick veneer, R3.5</td>
<td></td>
</tr>
<tr>
<td>Foil in wall</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Internal walls</td>
<td>brick</td>
<td>plasterboard</td>
<td>plasterboard, R1.5</td>
<td>brick</td>
<td>plasterboard, R1.5</td>
<td>plasterboard, R2.0</td>
<td>plasterboard, R2.0</td>
<td></td>
</tr>
<tr>
<td>Windows</td>
<td>single, clear glazing</td>
<td>single, clear glazing</td>
<td>single, high solar gain (U=5.4 W/m²K)</td>
<td>single, low solar gain (U=6.6 W/m²K)</td>
<td>double, low solar gain (U=3.0 W/m²K),</td>
<td>double, argon, high solar gain (U=2.90 W/m²K),</td>
<td>double, high solar gain (U=2.0 W/m²K),</td>
<td>double, low solar gain (U=2.0 W/m²K),</td>
</tr>
<tr>
<td>Roller shutters</td>
<td>in western bedrooms</td>
<td>NIL</td>
<td>NIL</td>
<td>in western bedrooms</td>
<td>in western bedrooms</td>
<td>NIL</td>
<td>NIL</td>
<td>all rooms</td>
</tr>
<tr>
<td>Floor slab</td>
<td>suspended timber floor</td>
<td>slab-on-ground</td>
<td>slab-on-ground</td>
<td>slab-on-ground</td>
<td>slab-on-ground</td>
<td>225 mm waffle pod</td>
<td>225 mm waffle pod</td>
<td>slab-on-ground</td>
</tr>
<tr>
<td>Floor covering</td>
<td>timber</td>
<td>ceramic &amp; carpet</td>
<td>ceramic &amp; carpet</td>
<td>ceramic &amp; carpet</td>
<td>ceramic &amp; carpet</td>
<td>ceramic &amp; carpet</td>
<td>ceramic &amp; carpet</td>
<td>ceramic only</td>
</tr>
<tr>
<td>Fan</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
<td>NIL</td>
<td>in main rooms</td>
</tr>
</tbody>
</table>
Results of the online survey

- The health of one fifth of the population was affected by heatwaves
- Three quarters of dwellings were reported as having insufficient heat stress resistance
- Roof and wall insulation, and double glazing predicted less health issues
- Availability and level of air-conditioning correlate with less natural adaptation
G1  Availability - yes or no
Gertrud, 19/03/2018

G2  Level: one-room, two-rooms or more, whole house
Gertrud, 19/03/2018
Cooling energy and star rating in Adelaide and Sydney

![Graph showing energy consumption and cooling star ratings in Adelaide and Sydney.]

Energy consumption (MJ/m²) vs. star rating.

- 2.3 stars: Traditional brick, 24.5 MJ/m²
- 2.4 stars: Cooling-dominant, 24.3 MJ/m²
- 5.6 stars: Heating-dominant, 59.1 MJ/m²
- 5.7 stars: Heating-dominant, 57.0 MJ/m²
- 6.2 stars: Cooling-dominant, 41.0 MJ/m²
- 7.9 stars: Cooling-dominant, 28.8 MJ/m²
- 8.1 stars: Heating-dominant, 26.0 MJ/m²

Cooling energy unadjusted (MJ/m²/year):

- 2.6 stars traditional double brick, 271.0 MJ/m²/year
- 2.6 stars traditional brick veneer, 275.2 MJ/m²/year
- 6.2 stars cooling-dominant, 94.8 MJ/m²/year

Total energy unadjusted (MJ/m²/year):

- 50.0 MJ/m²/year
- 88.7 MJ/m²/year
- 49.1 MJ/m²/year

LOW CARBON LIVING CRC
Peak cooling demand and star rating in Adelaide and Sydney

- Total annual energy consumption (MJ/m²):
  - 2.6 stars traditional double brick
  - 2.6 stars traditional brick veneer
  - 6.2 stars cooling-dominant
  - 6.2 stars heating-dominant

- Peak cooling demand (KW):
  - 2.3 stars traditional double brick
  - 5.6 stars cooling-dominant
  - 5.7 stars heating-dominant
  - 6.9 stars cooling-dominant
  - 7.9 stars cooling-dominant
  - 8.1 stars heating-dominant

- Total energy unadjusted (MJ/m²/year)
- Peak cooling demand (KW)
Relative peak cooling demand and star rating in Adelaide and Sydney

no график с данными

28/03/2018
Overheating thresholds

- Static threshold adopted from AccuRate thermostat set point for cooling
- Upper limit of the adaptive comfort model (Morgan and de Dear, 2003)
- Excess heat factor (Nairn and Fawcett, 2015)
Overheating analysis in Adelaide

28/03/2018

Excess heat factor (indicator of health problems due to heatwave)

Indoor temperature (°C)

February

- Excess heat factor
- 2.6 stars brick veneer
- 2.6 stars double brick
- 6.2 stars heating-dominant
- 7.2 stars cooling-dominant
- 7.1 stars heating-dominant
- 8.0 stars cooling-dominant
- 8.0 stars heating-dominant
- Adaptive comfort model (80% satisfaction)
- 25°C AccuRate thermostat set point
- Outdoor
North-facing bedroom
Gertrud, 21/03/2018
Overheating analysis in Adelaide and Sydney

Indoor temperatures in two degree blocks (°C)

Number of hours

8.0 stars cooling-dominant
8.0 stars heating-dominant
7.1 stars heating-dominant

20-24.9
25-29.9
30-34.9
35-39.9
40-44.9
45-49.9

28/03/2018
in the bedroom
Gertrud, 19/03/2018
Policy recommendations

Guidelines to heat stress resistant building design

Financially incentivise heat stress resistant design

Showcase heat stress resistant public buildings

Integrate heat stress resistance into the Australian National Construction Code (NCC)

Implement Building Energy Performance Certification (EPC)

Address non-compliance issues
Financial incentive: lower tax for white coloured roof materials

Gertrud, 19/03/2018
Review NatHERS and BASIX

- Report separately both heating and cooling (version 2019)
- Set separate thresholds for heating and cooling
- Run simulation in free-running mode with overheating thresholds
- Implement future TMY
Thank you

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