

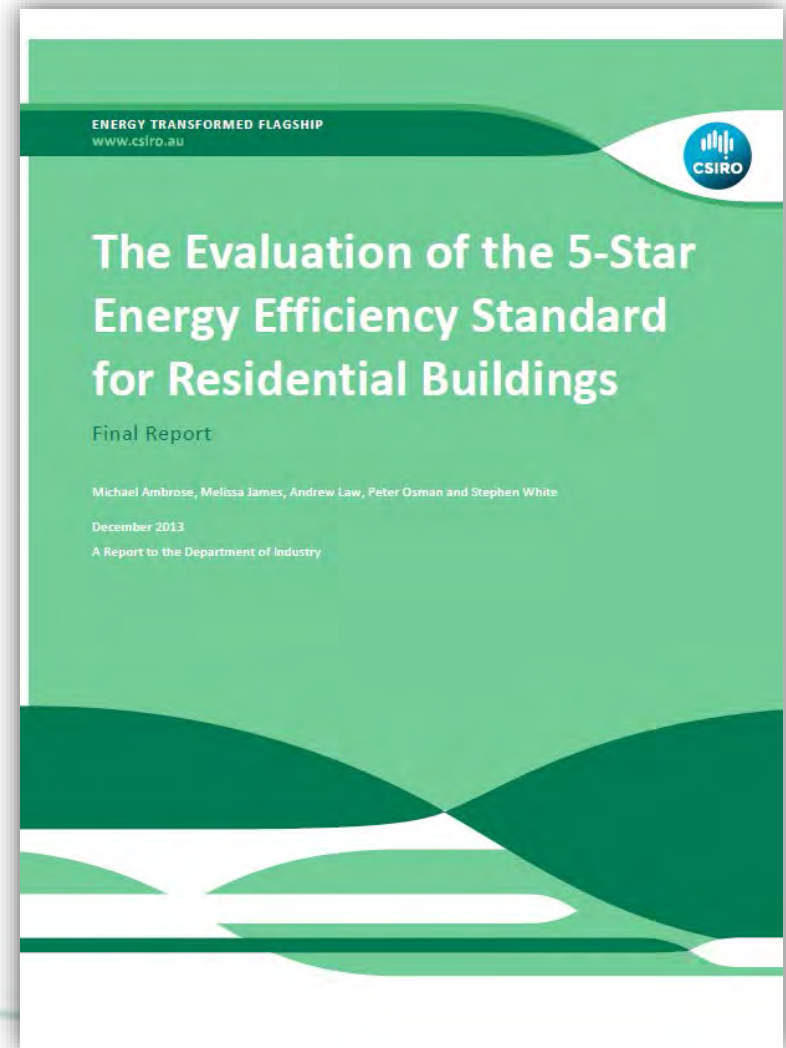
Managing Summer Cooling Loads in Code Compliant Australian Housing

A Cost Benefit Analysis for Mass
Market Implementation of Purge
Ventilation Technologies

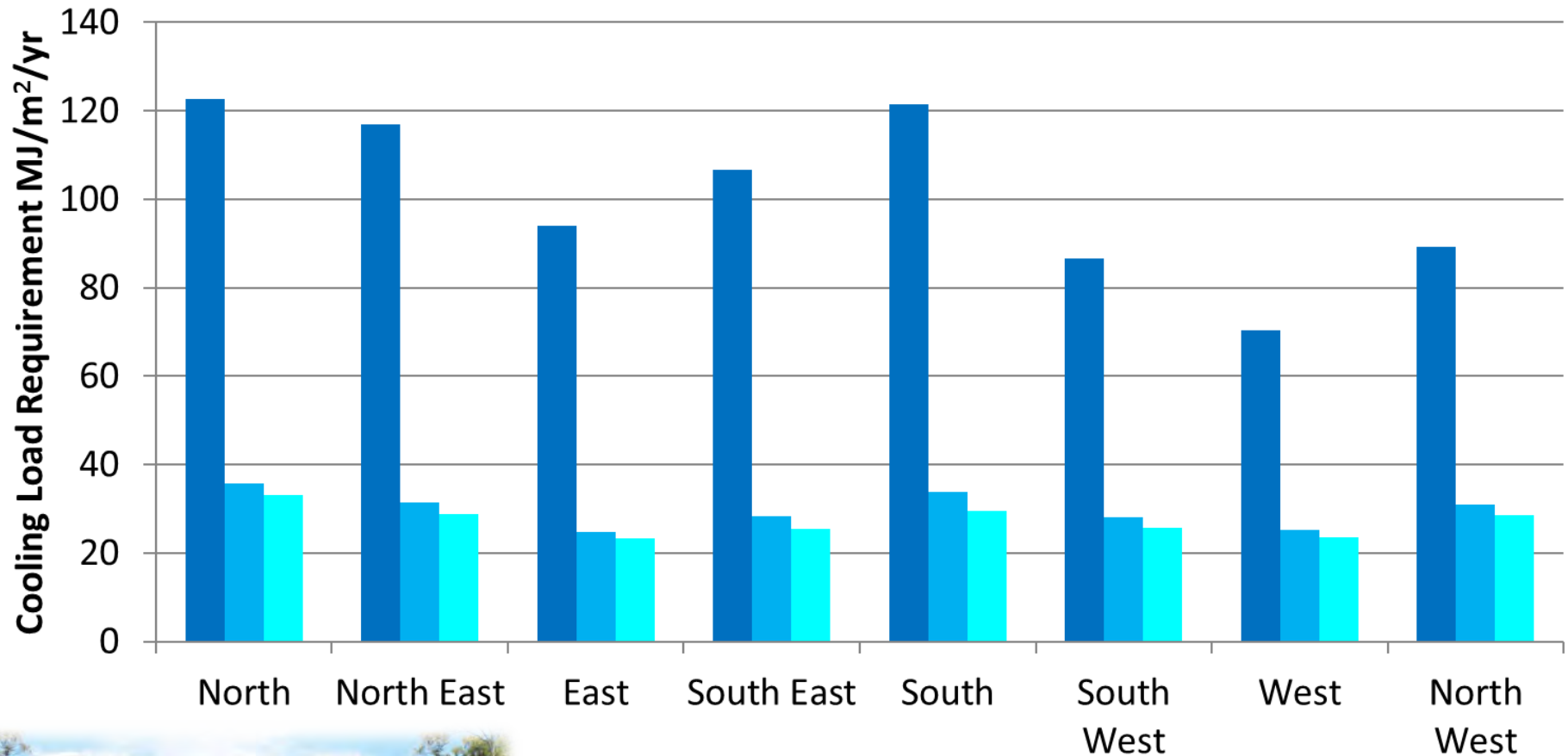
The Issue



“The average cooling energy use in summer was greater in (...) higher-rated houses in Brisbane and Melbourne. (...) However, it is not clear whether this was due to (...) behavioural factors (...) [including] **the extent of window opening and closing during summer.**”



When Windows Remain Shut



Front Door Orientation

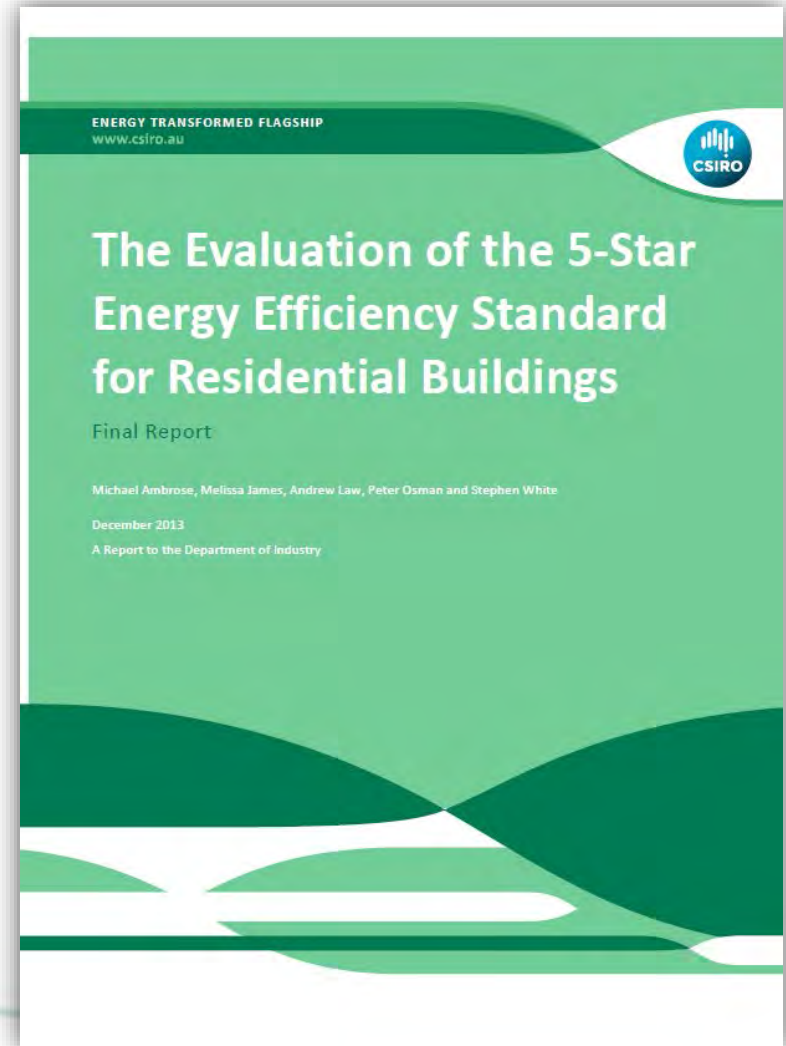
- Do not operate windows
- Operate windows as assumed by regulatory software
- Guaranteed with purge ventilation technology



Expectations Vs Reality



“The unexpected trend appears to be that energy consumption increases with star rating.”



Exacerbated Cooling Loads

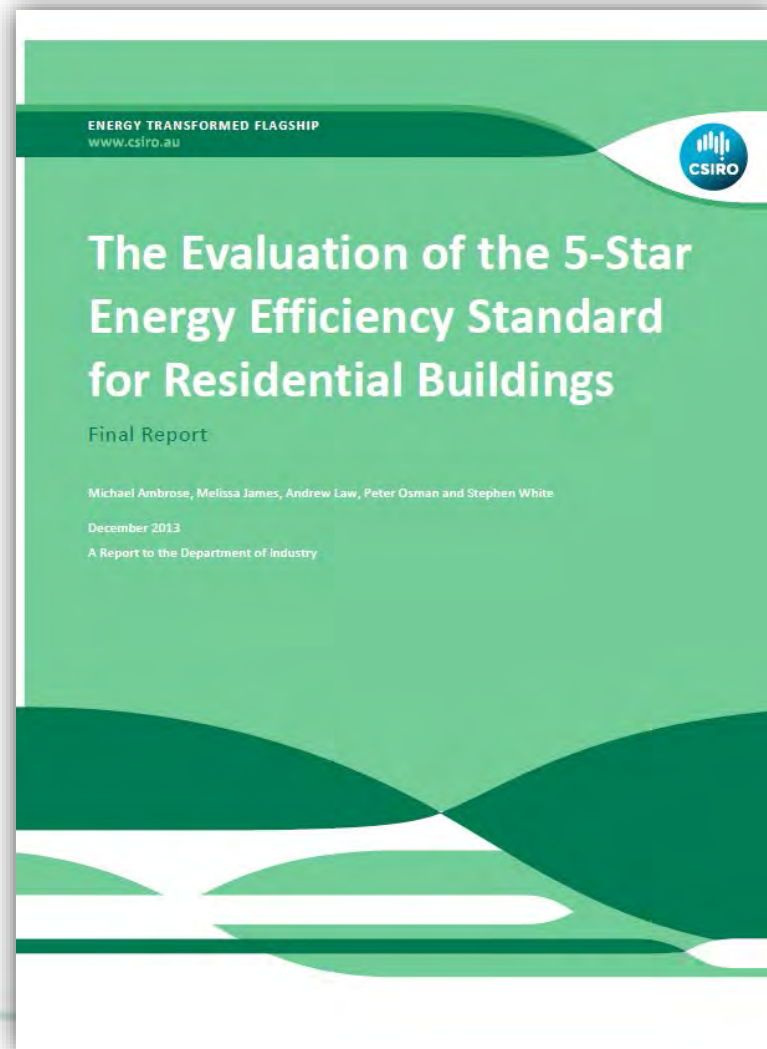


In **Brisbane** cooling loads increased on average by

31%

Compared to lower-rated houses

Ambrose, James, Law, Osman, & White,
2013, CSIRO (2013)



Exacerbated Cooling Loads

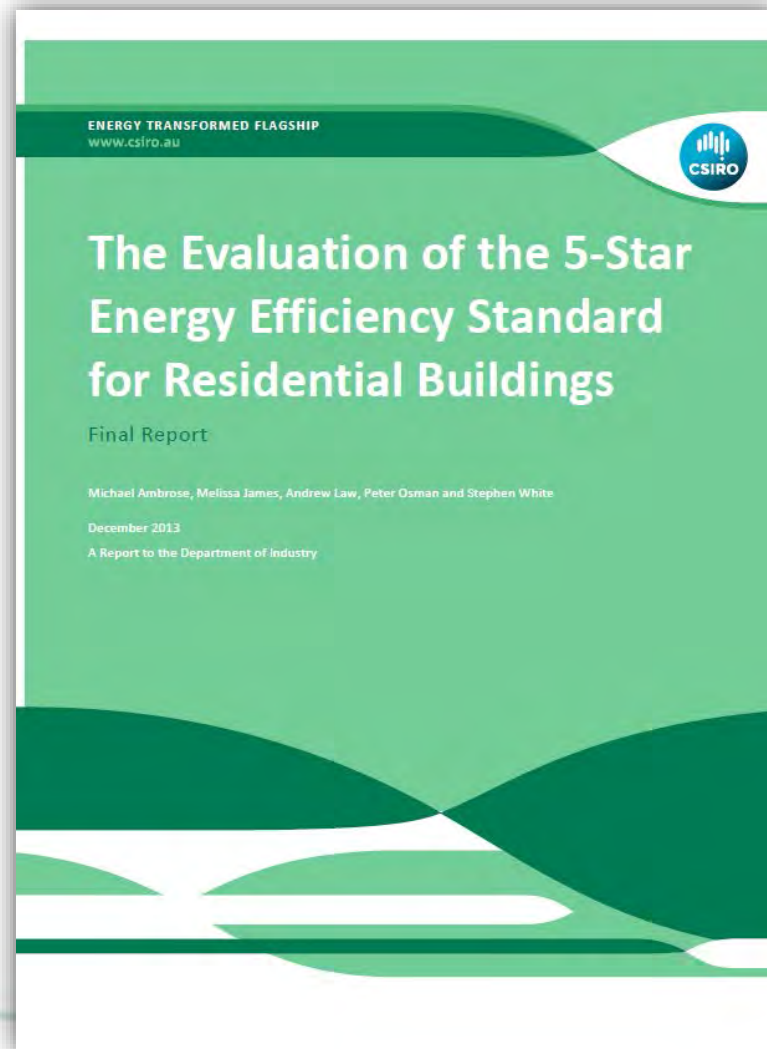


In **Melbourne** cooling loads increased on average by

38%

Compared to lower-rated houses

Ambrose, James, Law, Osman, & White,
2013, CSIRO (2013)



Reducing Stars Is Not An Option



- Increase R-Values



- Reduce U-Values



- Shading



- Seal it Tight



- Ventilate Right

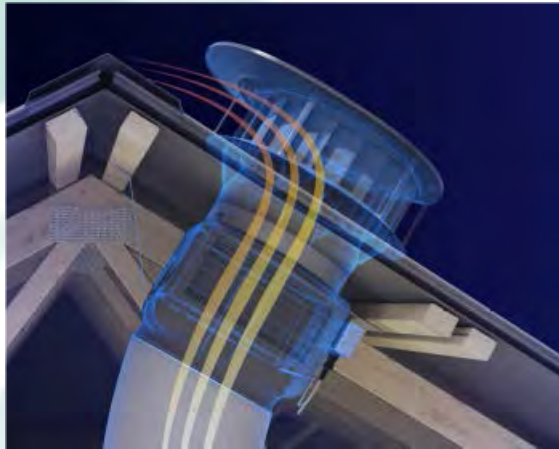


NatHERS Inputs

“Data input assumptions to the NatHERS methodology may not adequately represent typical end user behaviour [...]. If an air conditioner is turned off in summer and the house is shut up (e.g. if people are away from home), then stored heat is likely to build up in the fabric of the house. This may not be being adequately accounted for in the current data input assumptions.”

Smart Purge Ventilators

Centrifugal Roof Mounted
Hybrid: Wind & Powered



Axial Roof Space
Powered



Engineering Terminology; Economy Cycle, Economiser

To be Successful

- The technology needs to be “smart”
 - An automated response to indoor and outdoor temperature conditions in relation to occupant comfort, and
 - Must communicate with the air conditioning system to prevent the two technologies opposing each other and delivering perverse energy outcomes.

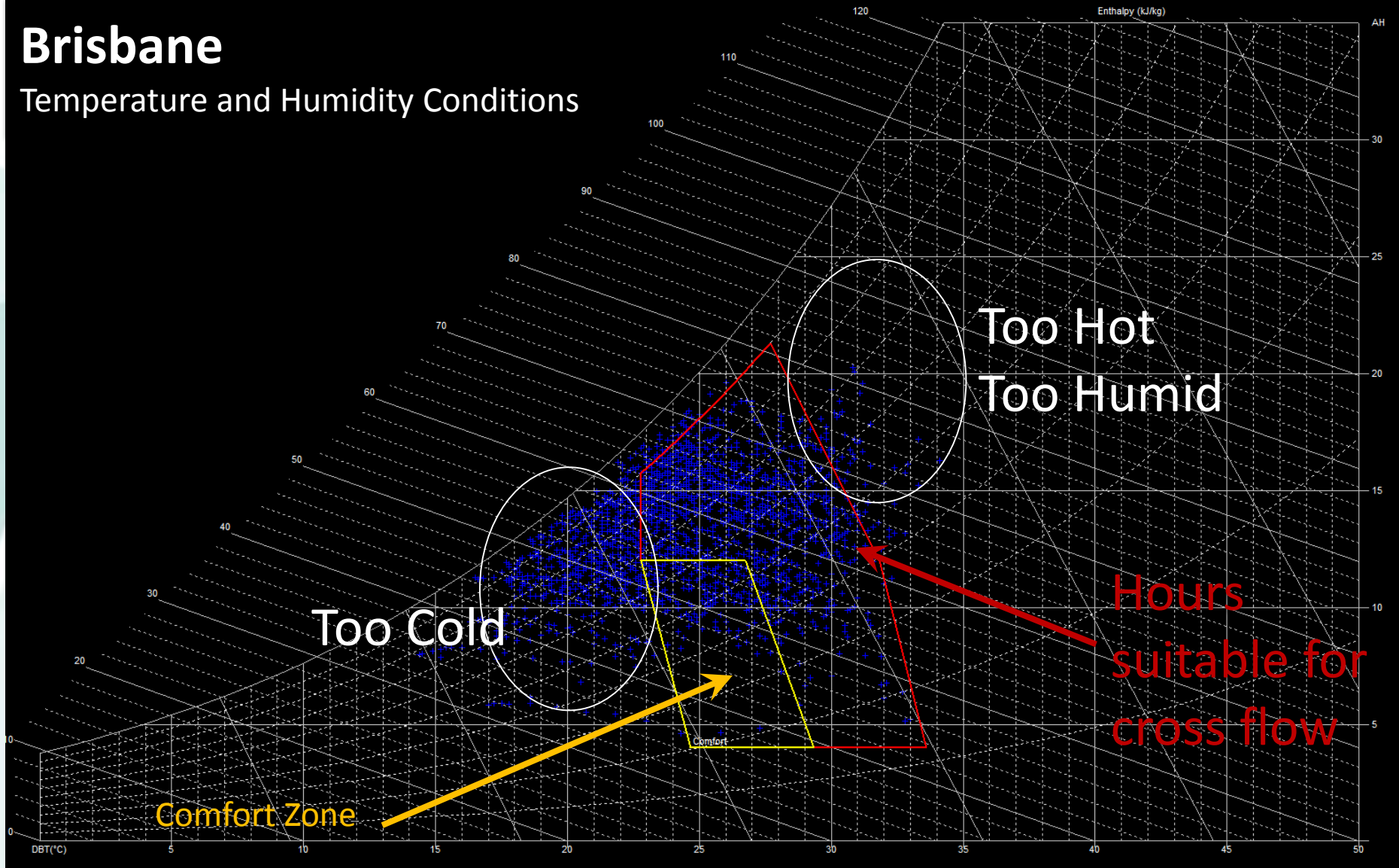
Note:

1. Must have sufficient air inlets relative to the air tightness of the house.
2. Noise levels need to be considered.

The Lost Opportunity

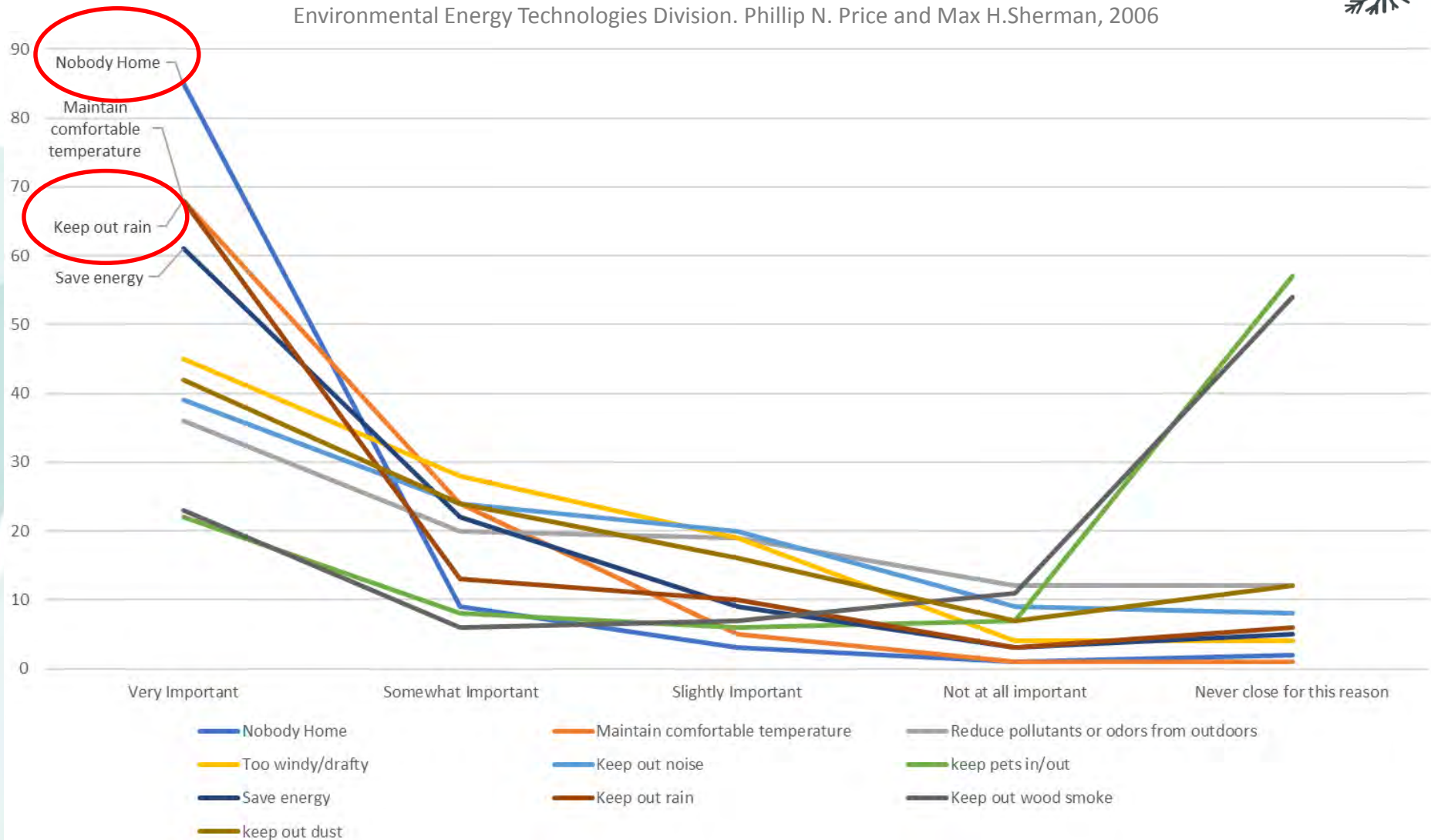
Brisbane

Temperature and Humidity Conditions



International Research

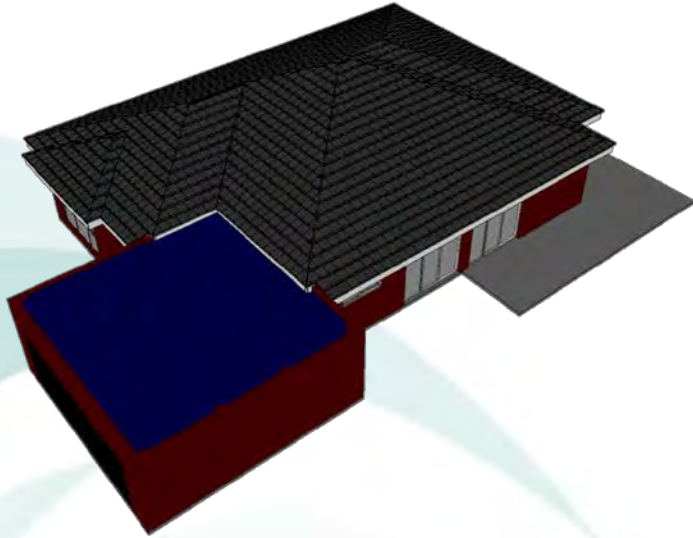
Ventilation Behaviour and Household Characteristics in New California Houses. LBNL Environmental Energy Technologies Division. Phillip N. Price and Max H. Sherman, 2006



This Analysis

- Compares Purge Ventilation with:
 1. Full use of windows for ventilative cooling as per NatHERS assumptions
 2. Windows operated effectively to achieve only 50% of the cooling savings as predicted in the NatHERS scheme
 3. Windows never opened and a full reliance on mechanical air conditioning for cooling

BCR Quantification



Single Storey



Double Storey

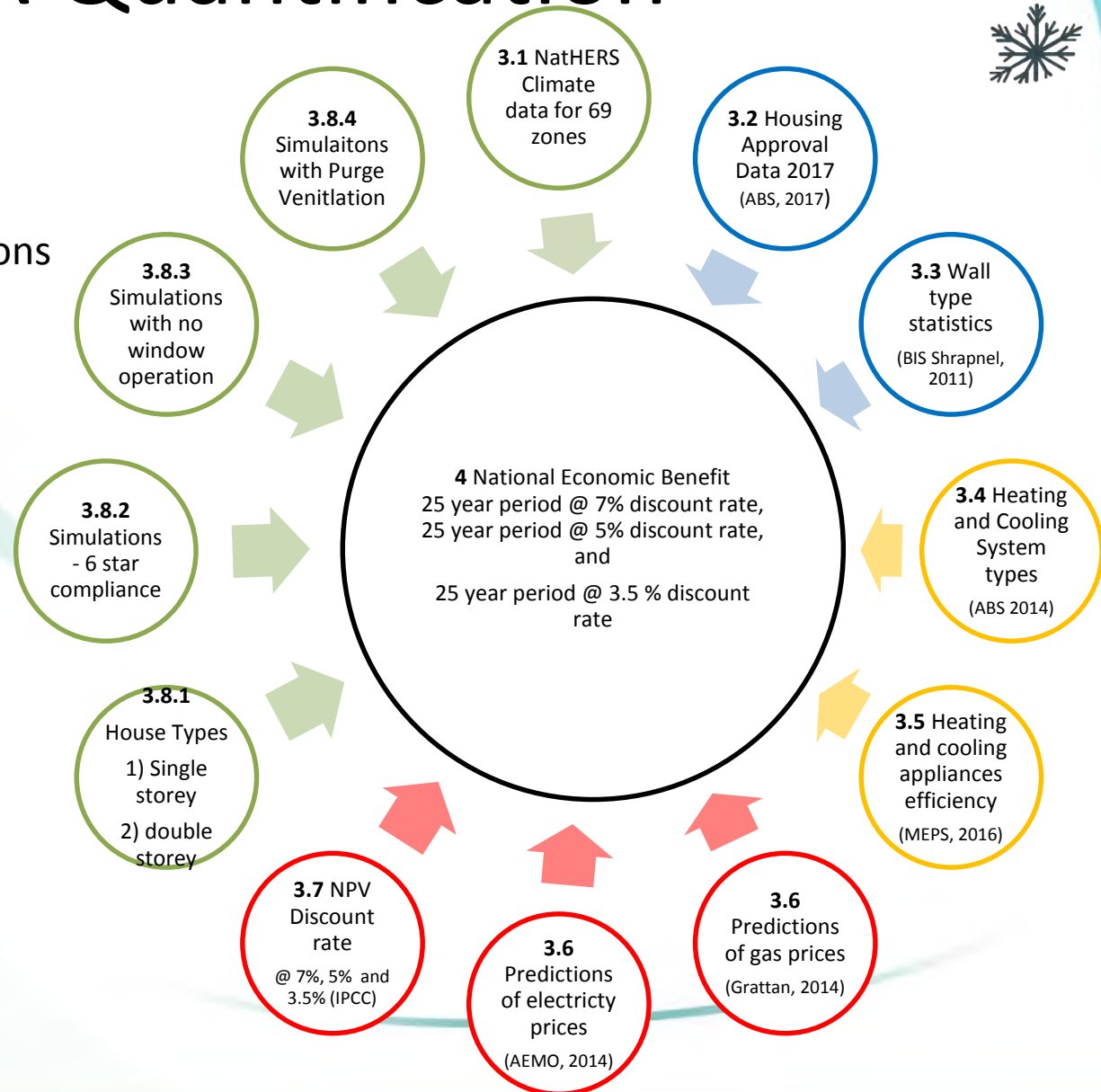
BCR Quantification

 **NatHERS Load Calculations**

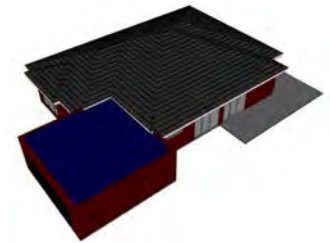
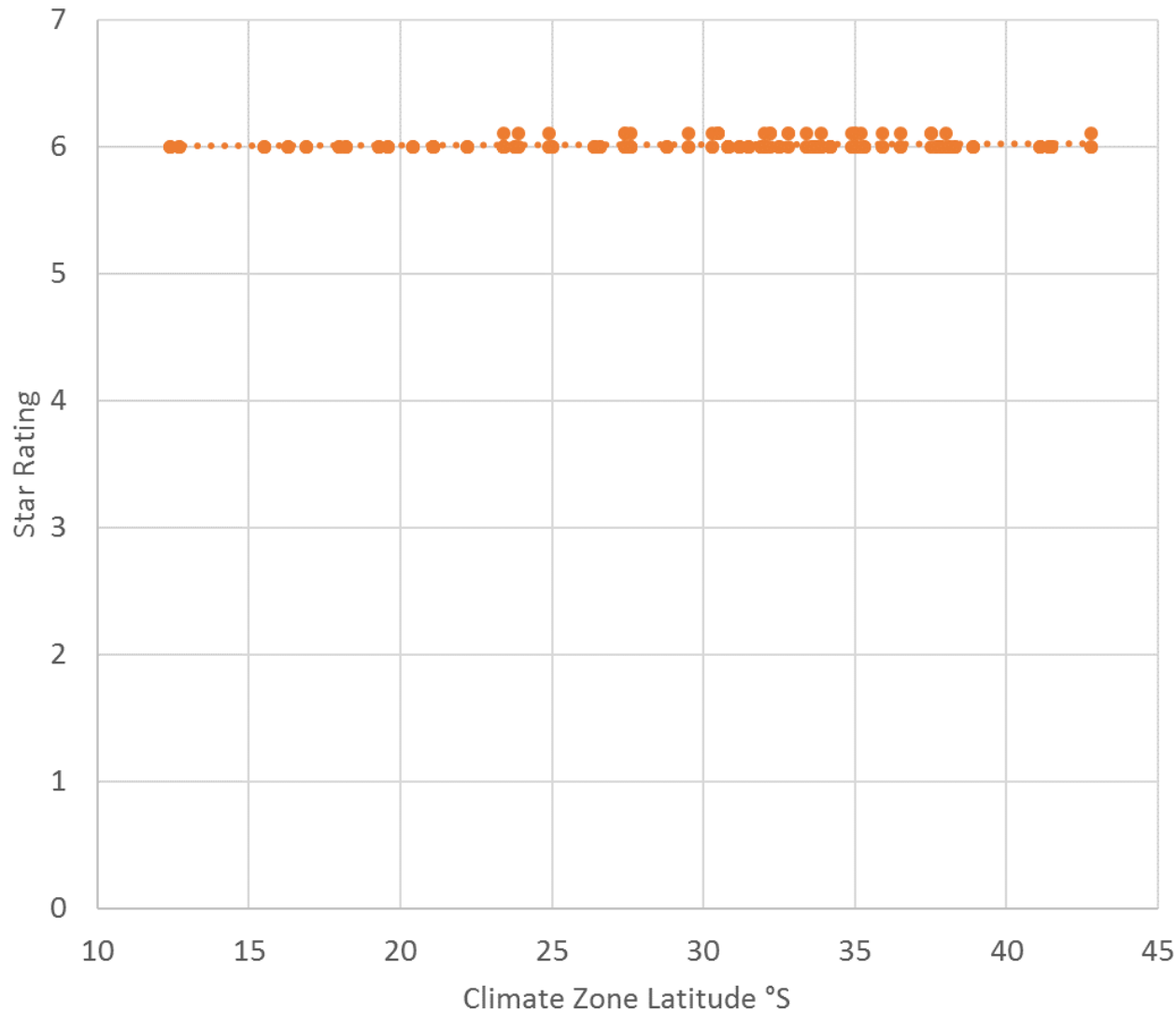
 **National Energy Load**
(Housing Data)

 **Fuel Consumption**
(HVAC Appliances)

 **NPV Calculation**
Fuel Prices & Discount



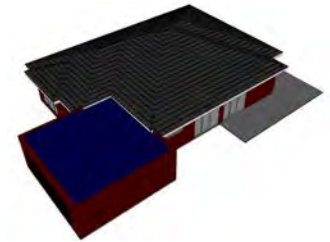
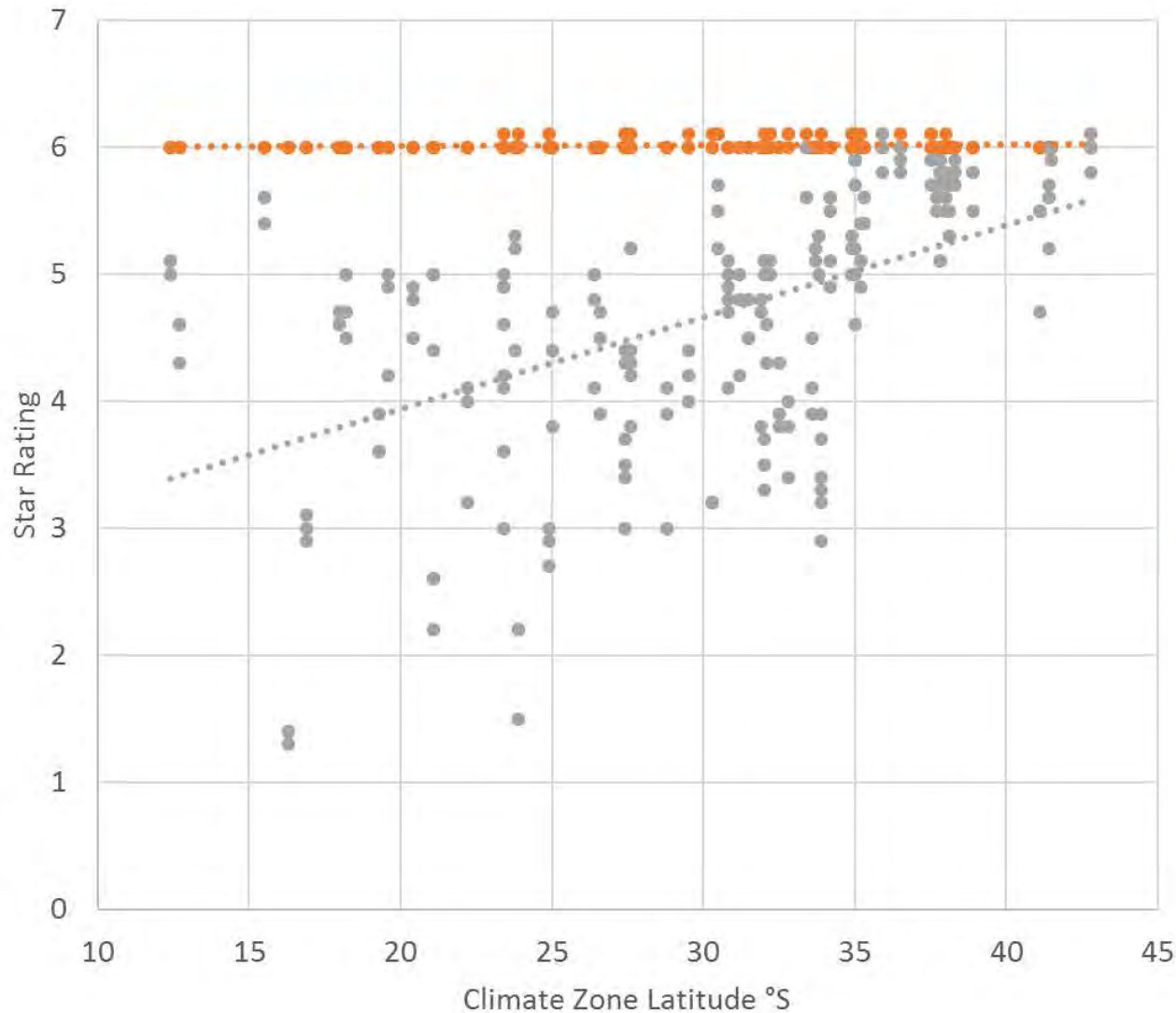
NatHERS Load Calculations



● Nat Vent Occupants

..... Linear (Nat Vent Occupants)

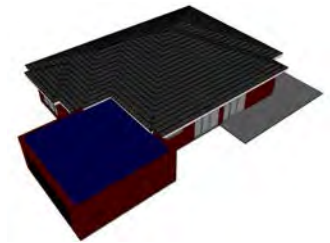
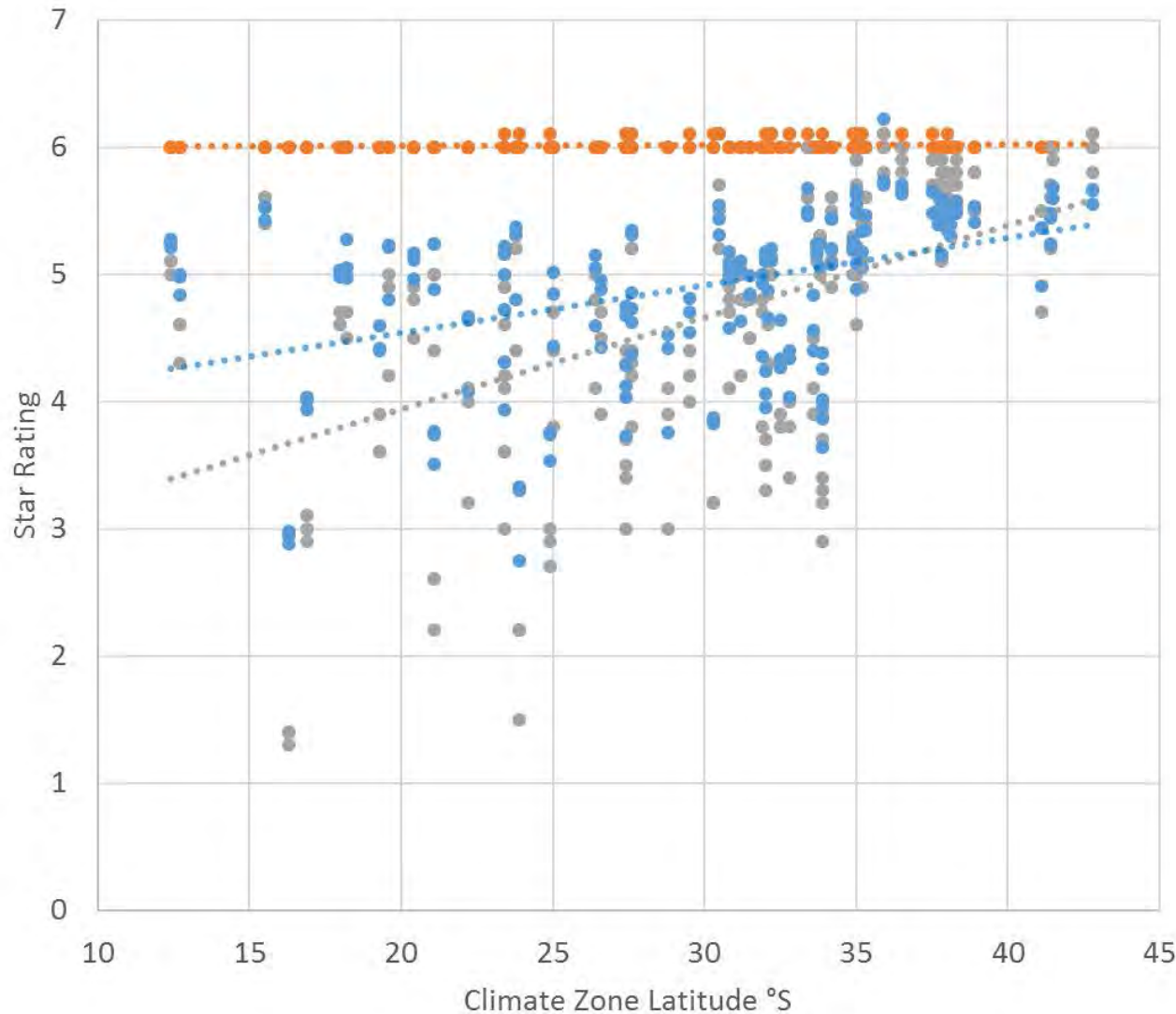
NatHERS Load Calculations



- Nat Vent Occupants
- No Nat Vent

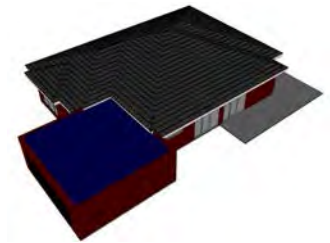
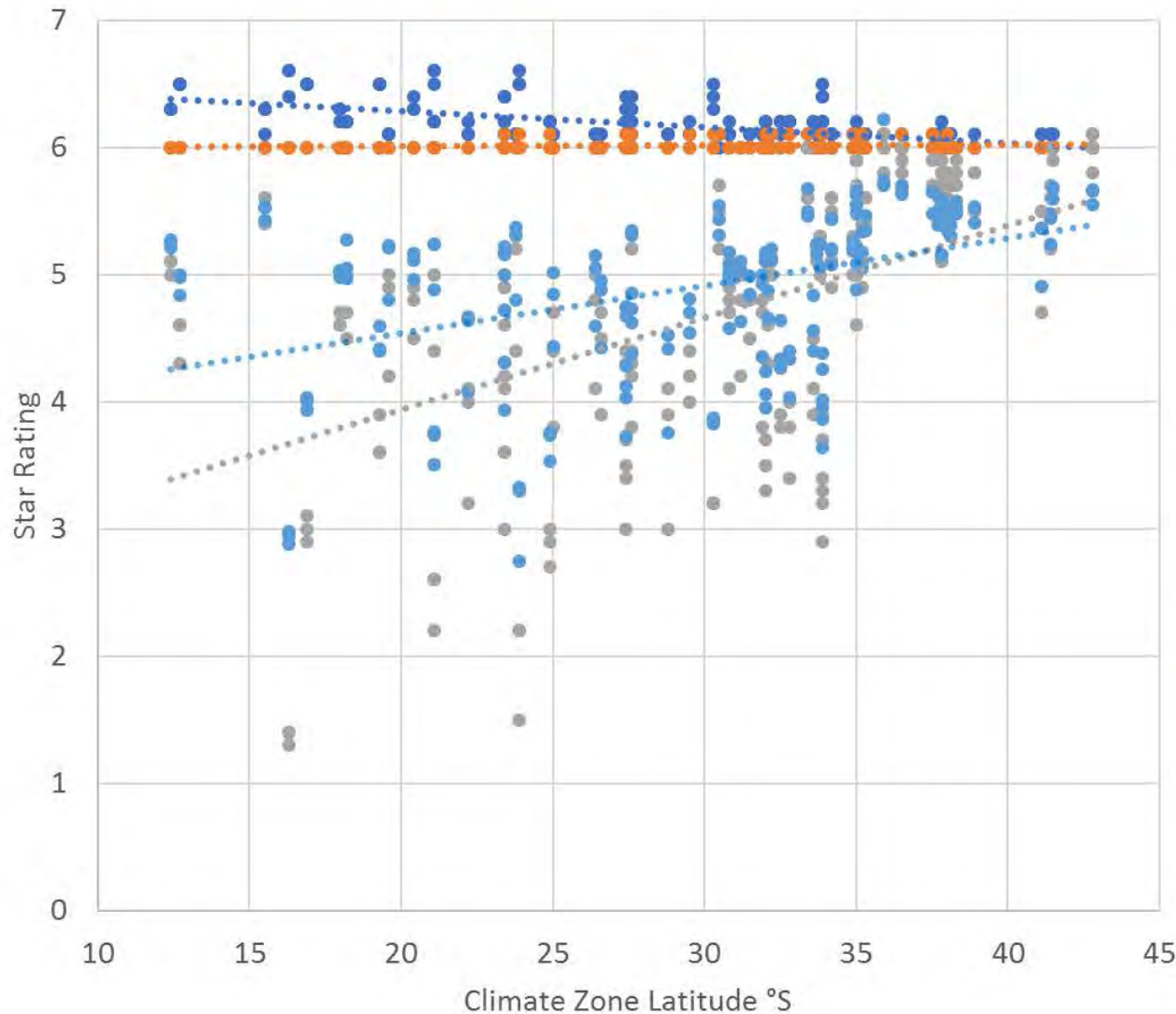
- Linear (Nat Vent Occupants)
- Linear (No Nat Vent)

NatHERS Load Calculations



- Nat Vent Occupants
- No Nat Vent
- Cross Flow Utilisation Factor 50%
- Linear (Nat Vent Occupants)
- Linear (No Nat Vent)
- Linear (Cross Flow Utilisation Factor 50%)

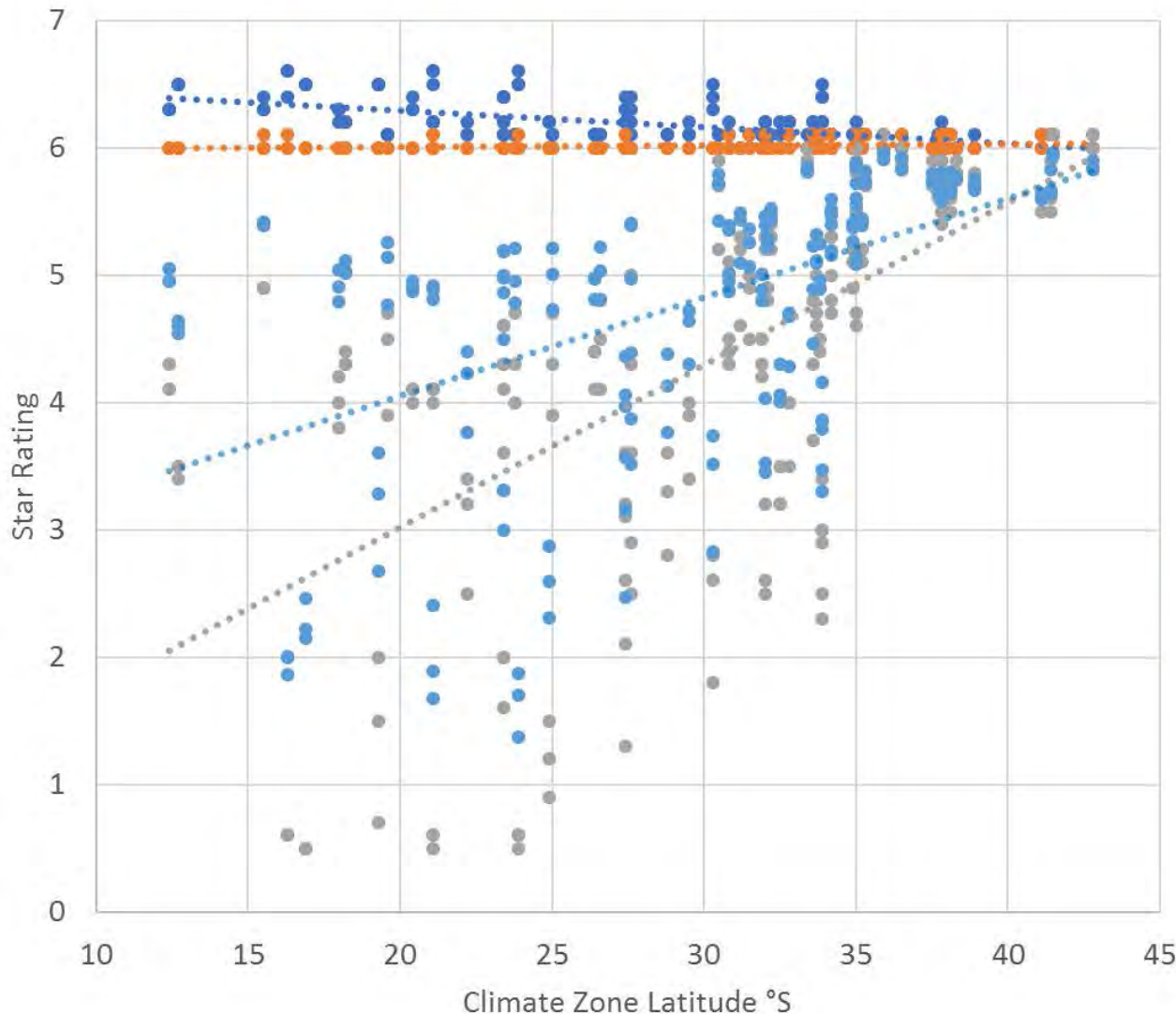
NatHERS Load Calculations



- Smart Ventilator
- Nat Vent Occupants
- No Nat Vent
- Cross Flow Utilisation Factor 50%
- Linear (Smart Ventilator)
- Linear (Nat Vent Occupants)
- Linear (No Nat Vent)
- Linear (Cross Flow Utilisation Factor 50%)

Calculated using a modified Chenath engine as derived for "Potential Benefit of Odyssey System for House Cooling System. CSIRO, Dong Chen, 2017"

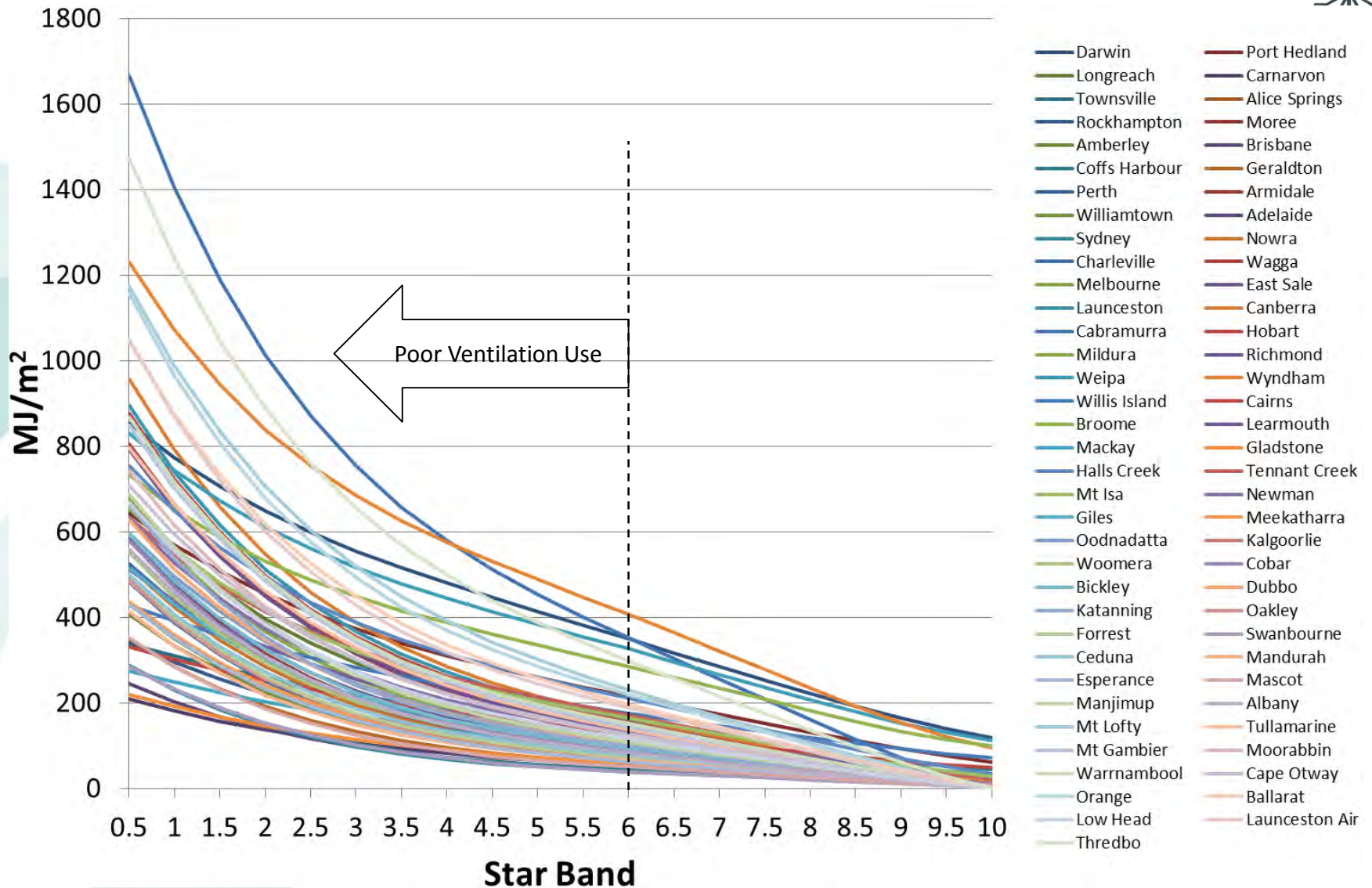
NatHERS Load Calculations



- Smart Ventilator
- Nat Vent Occupants
- No Nat Vent
- Cross Flow Utilisation Factor 50%
- Linear (Smart Ventilator)
- Linear (Nat Vent Occupants)
- Linear (No Nat Vent)
- Linear (Cross Flow Utilisation Factor 50%)

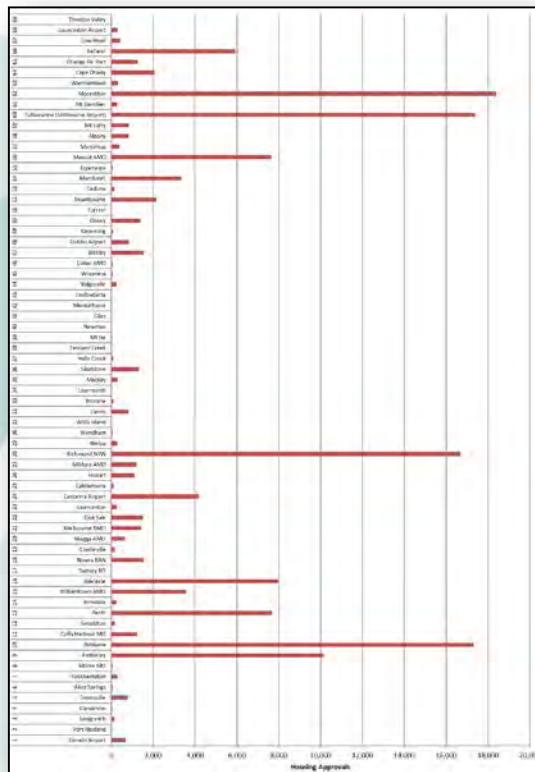
Calculated using a modified Chenath engine as derived for "Potential Benefit of Odyssey System for House Cooling System. CSIRO, Dong Chen, 2017"

Star Vs Energy

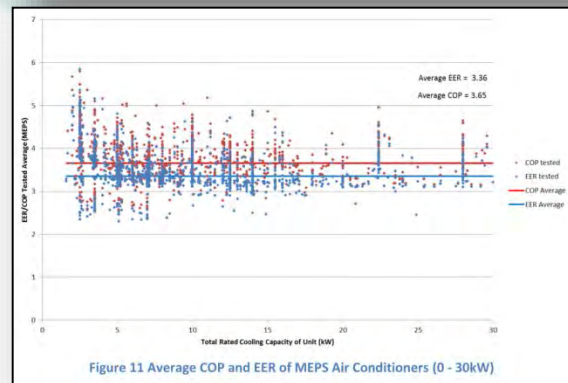
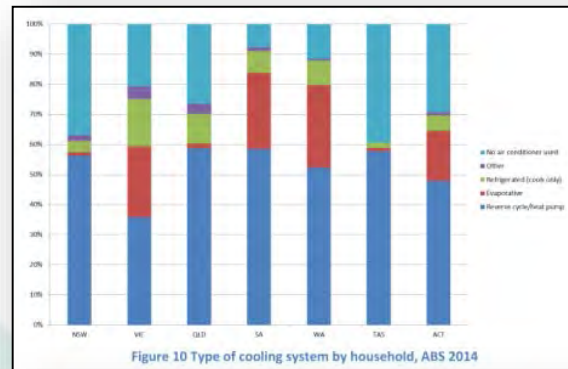


Benefit

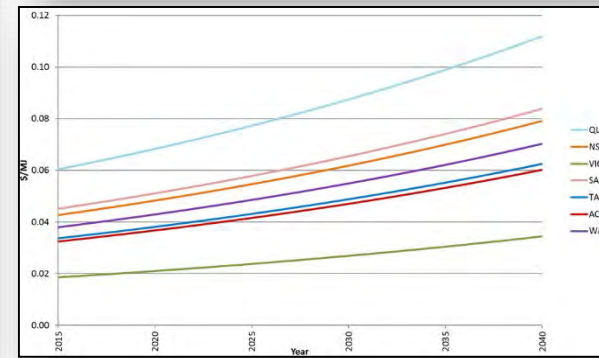
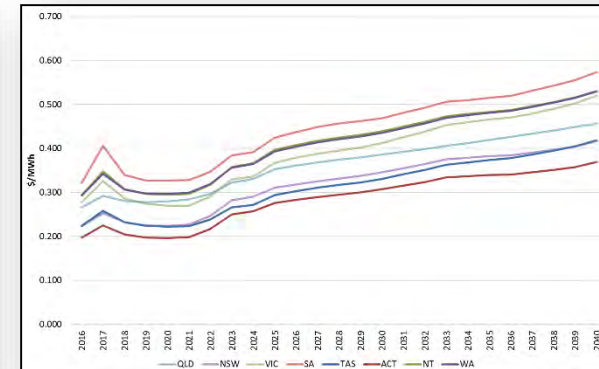
• Housing Approvals



■ Heating and Cooling

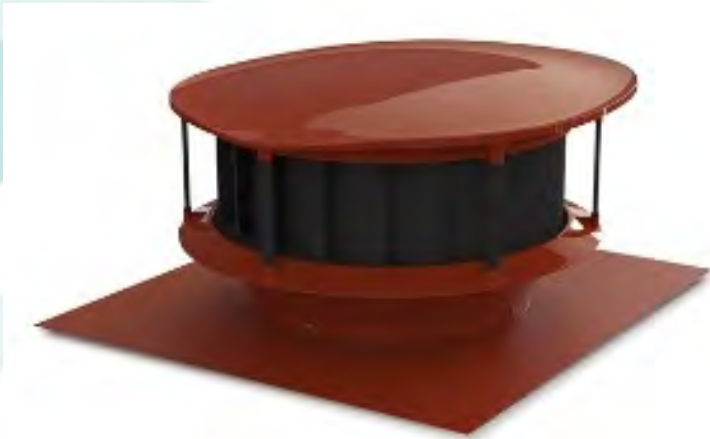


■ Energy and Gas



Costs

Centrifugal Roof Mounted



\$2400 Fully Installed

Axial Roof Space



\$3600 Fully Installed

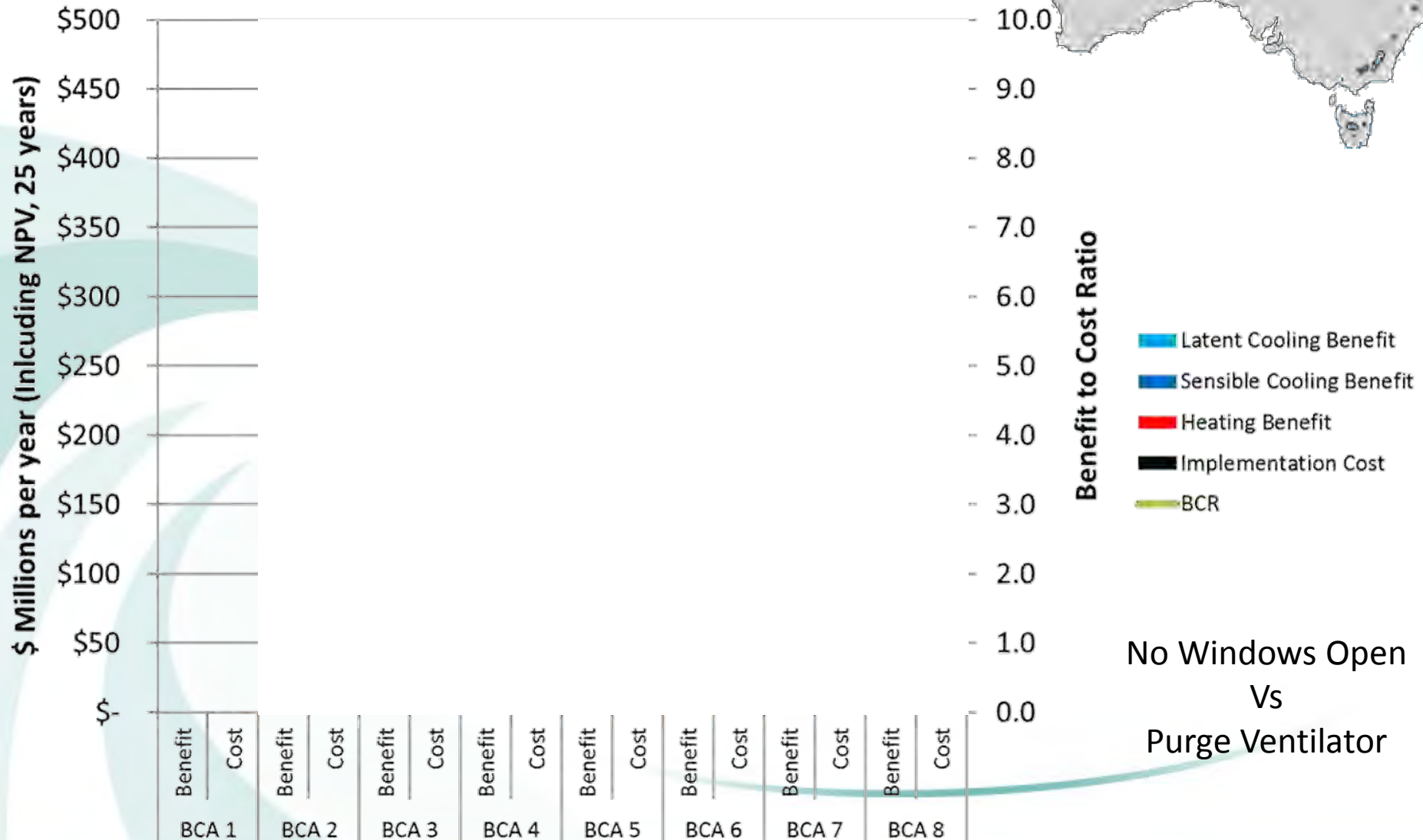
Average \$3000 per unit

Climatic Humidity

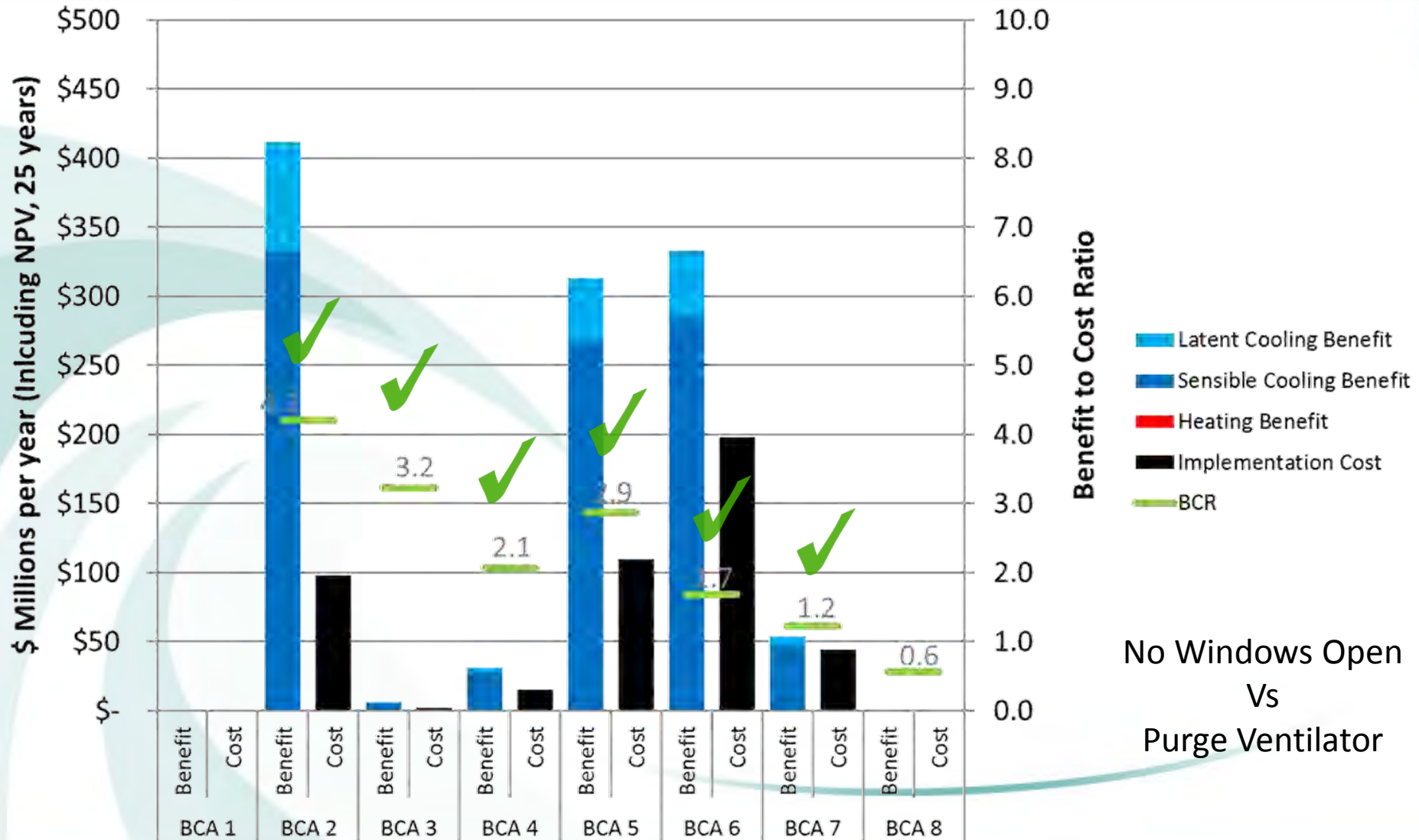


Photo: Heath Bussell, QBCC Cairns Regional Service Centre

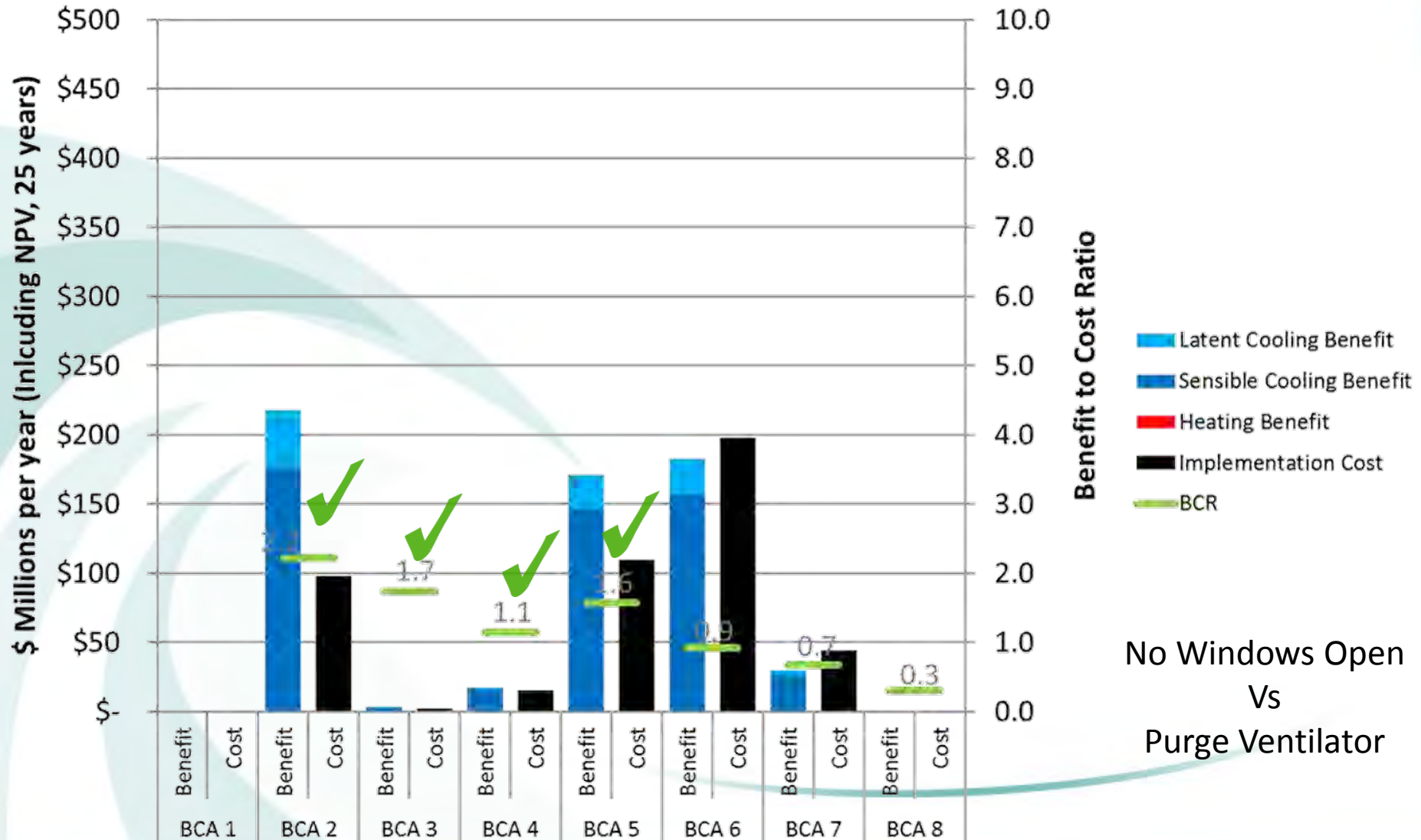
BCR – 5% Discount



BCR – 3.5% Discount - IPCC



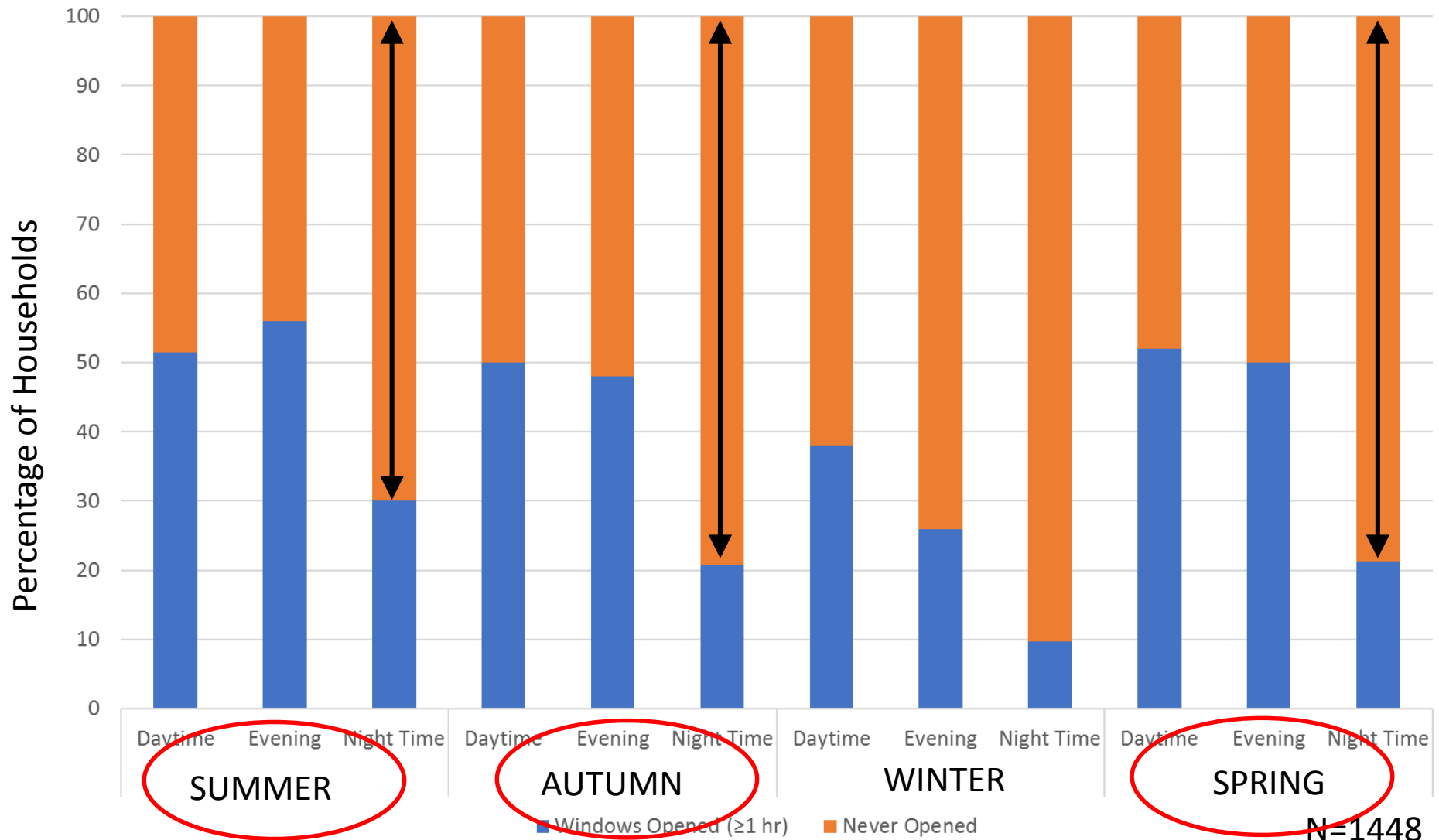
BCR – 7% Discount OBPR



Window Operation Week Days



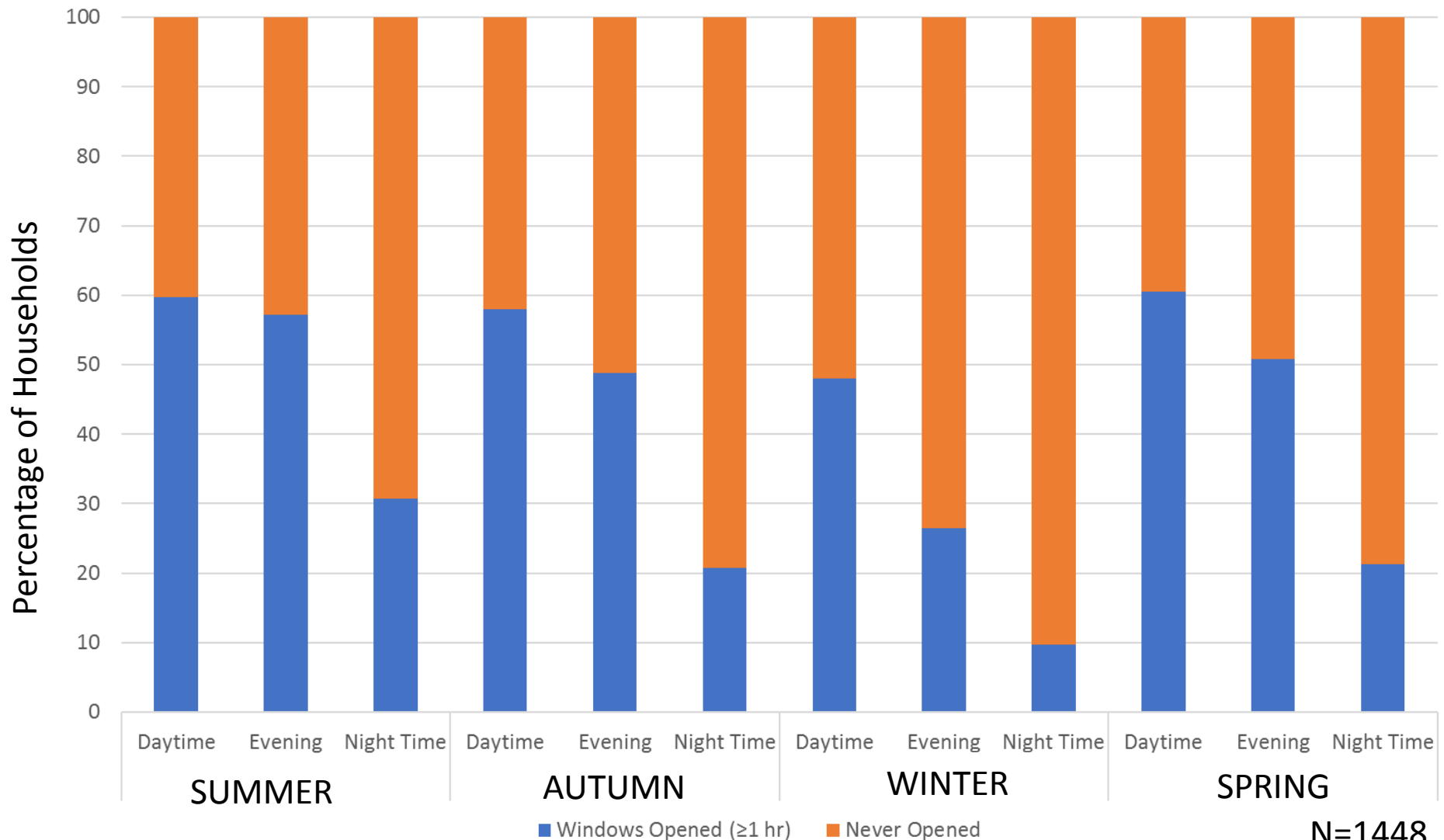
Calculated from: *Ventilation Behaviour and Household Characteristics in New California Houses*. LBNL Environmental Energy Technologies Division. Phillip N. Price and Max H. Sherman, 2006



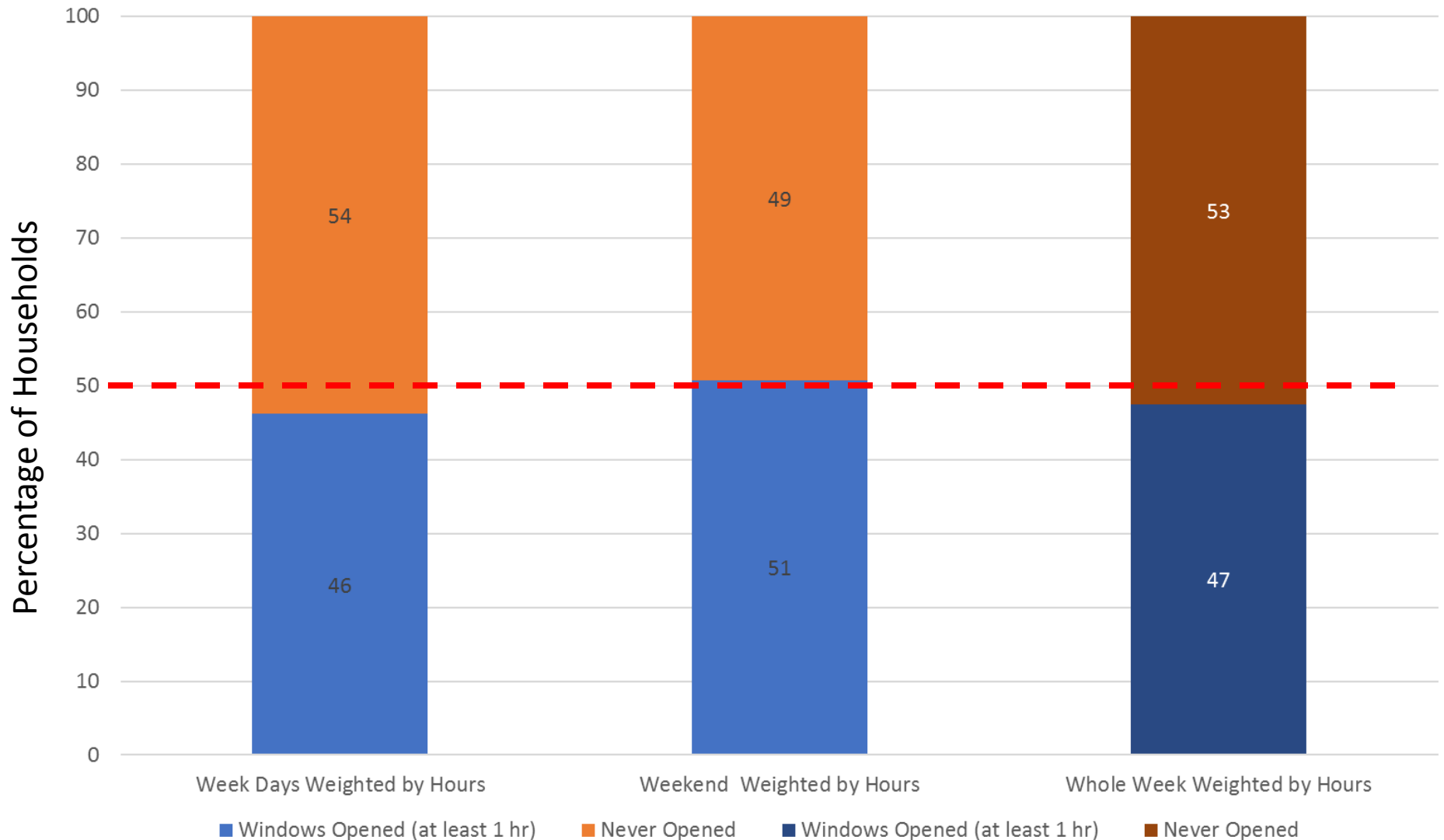
Window Operation Weekends



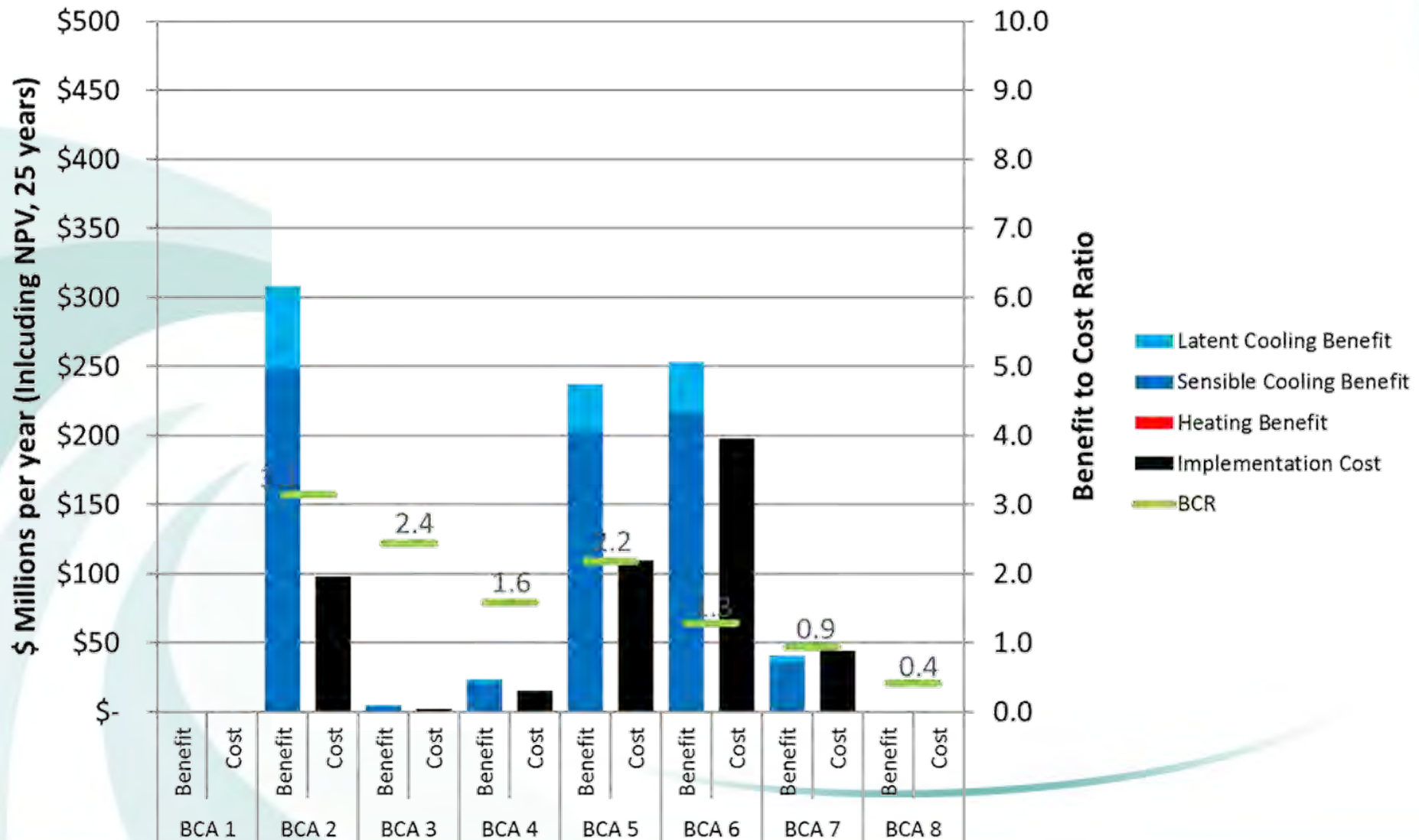
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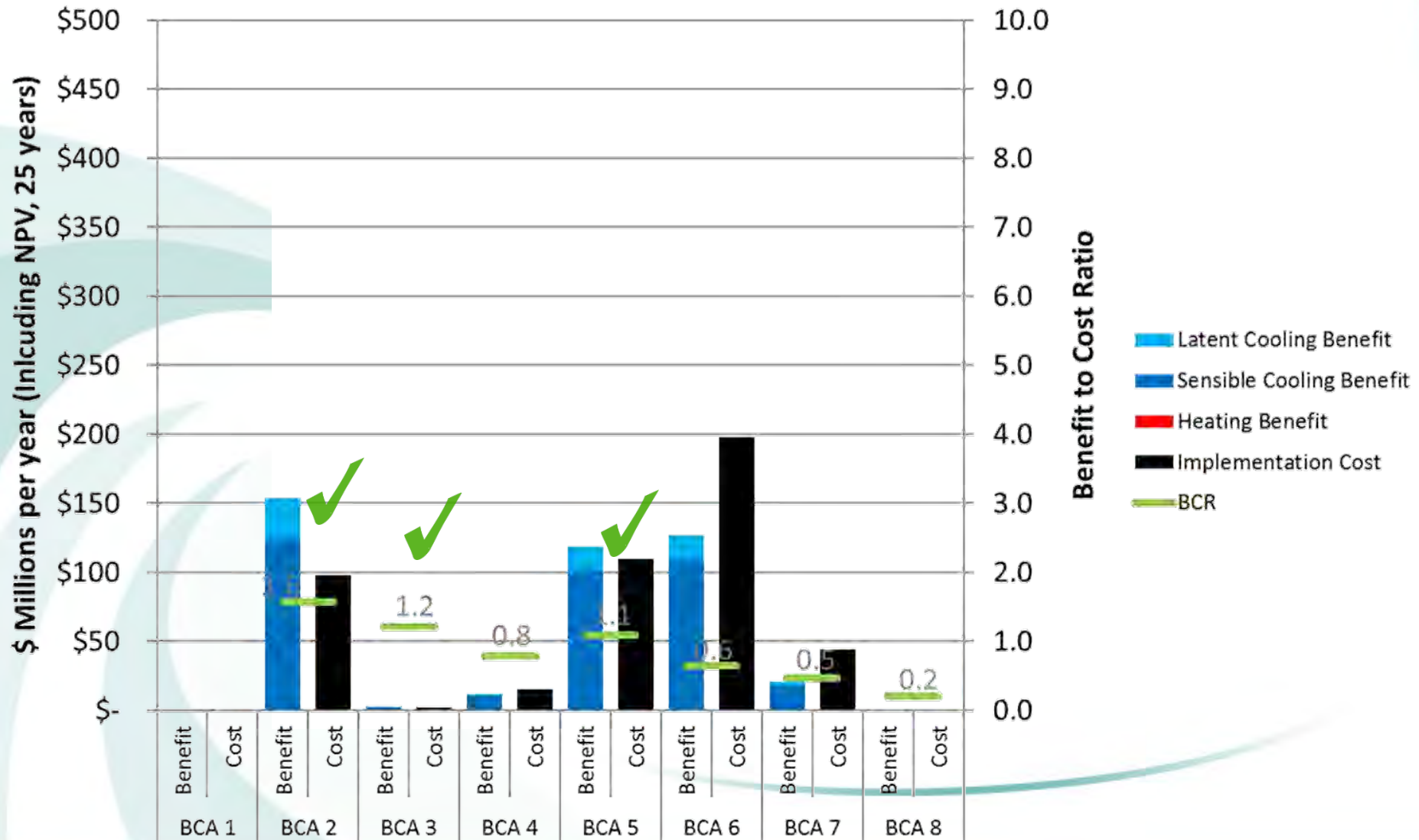
Averages



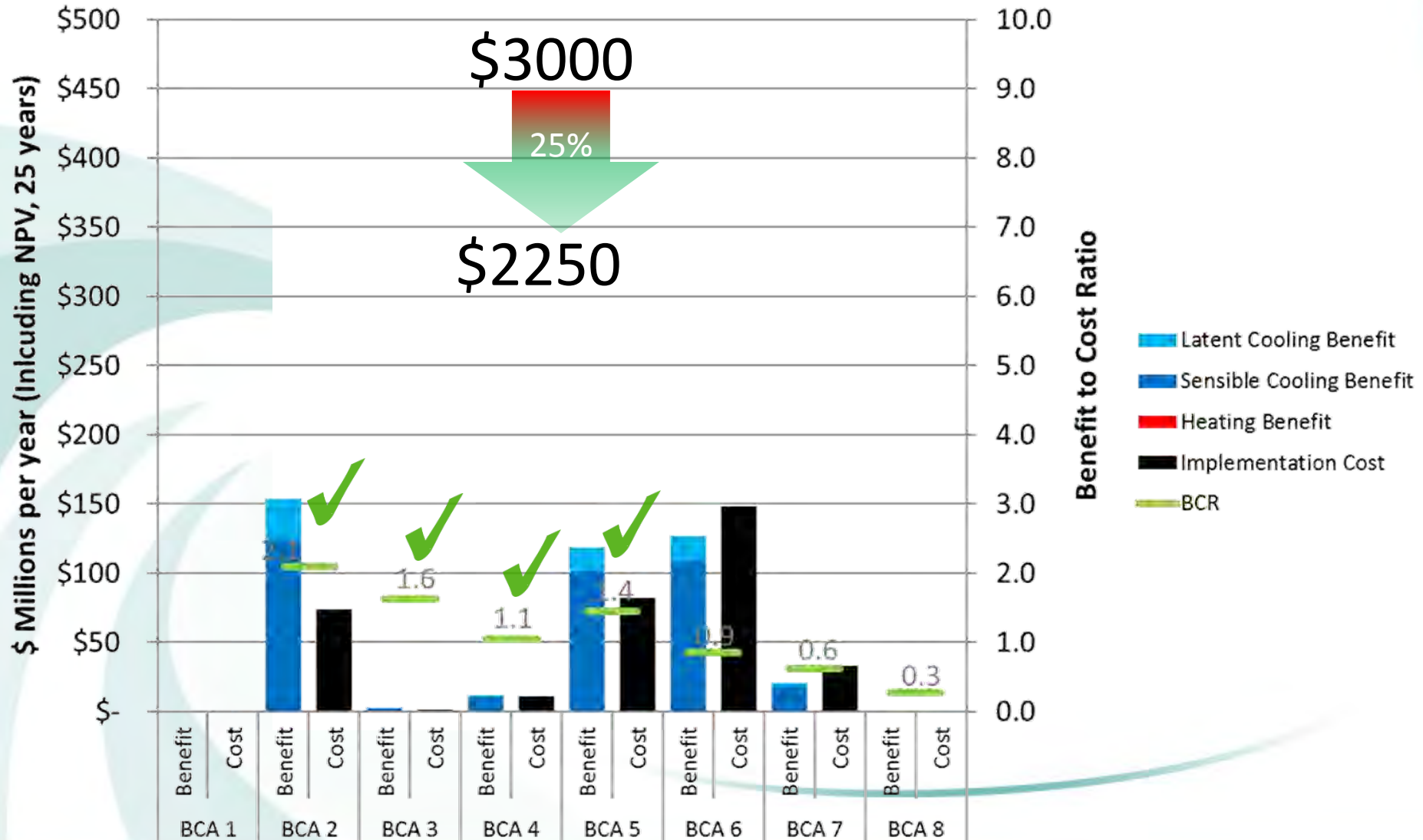
BCR – 5% Discount



50% Benefit Achieved



25% Reduction in Cost



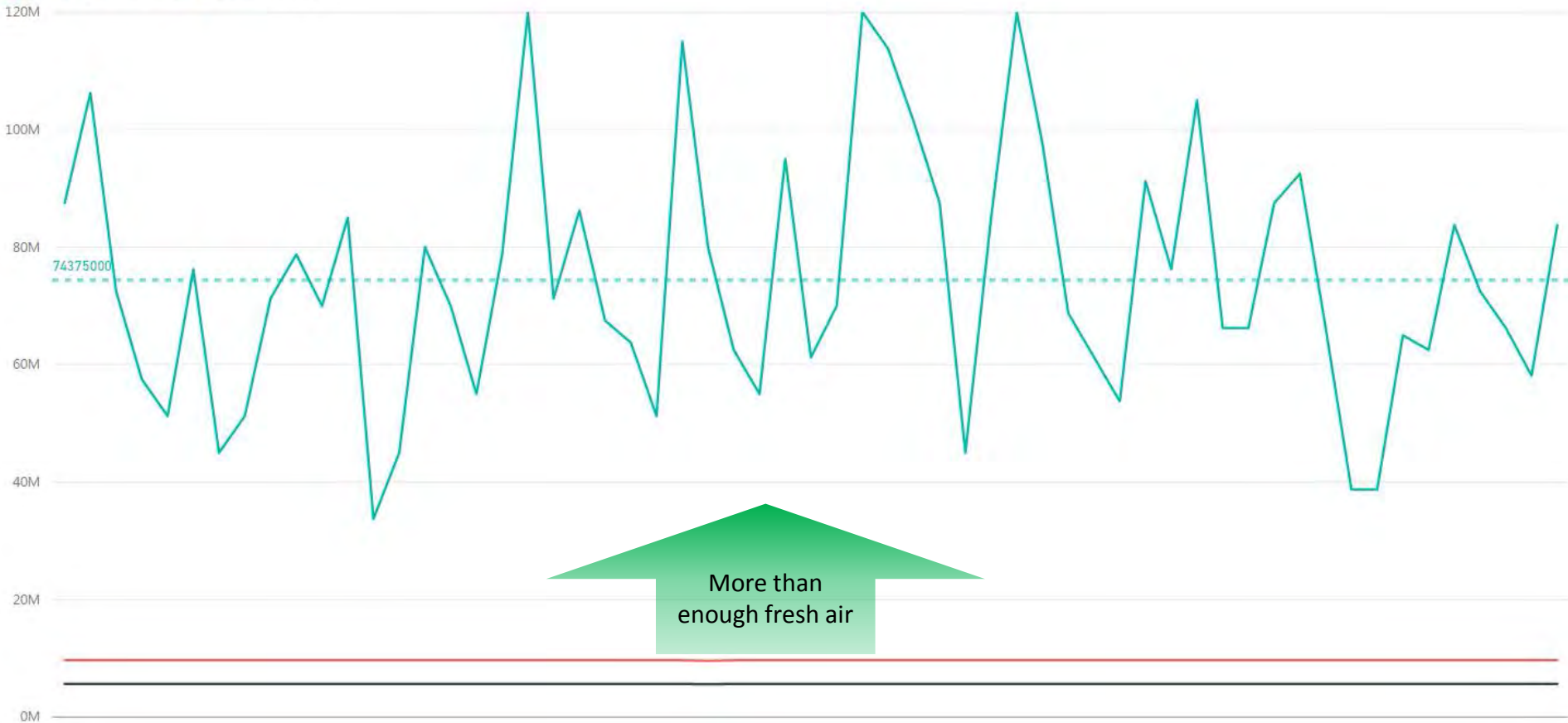
Fresh Air - Summer

(Summer flow rates – Sydney Retrofit House)



Est Odyssey Flowrate over 24hours VS ASHRAE Min over 24hours

● Flowrate ● ASHRAE Flowrate ● 1668_2 Reference



1st Jan

28 Feb

Fresh Air - Winter

(Winter flow rates – Sydney Retrofit House)

1/06/2017 31/07/2017



Est Odyssey Flowrate over 24hours VS ASHRAE Min over 24hours

● Flowrate ● ASHRAE Flowrate ● 1668_2 Reference

30M

25M

20M

15M

10M

8319672

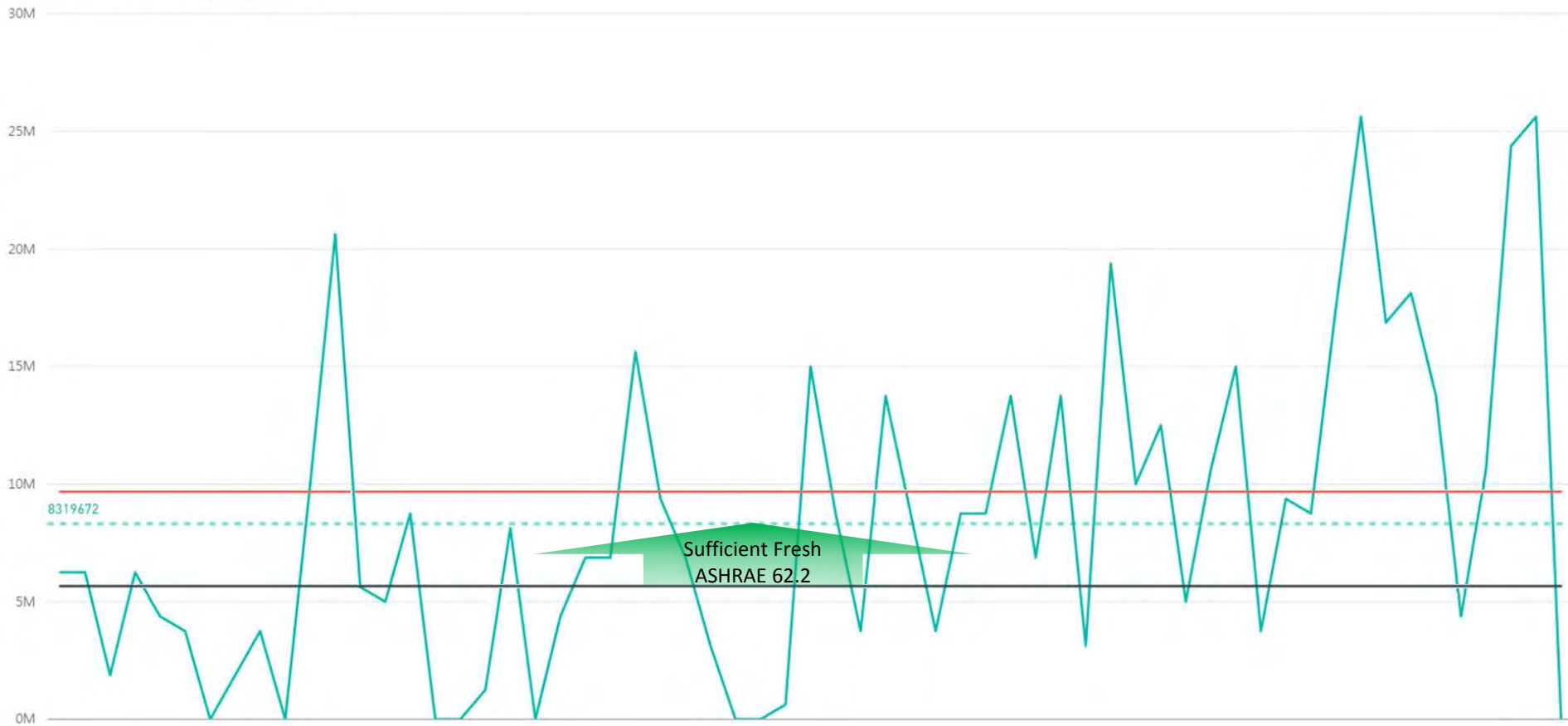
5M

0M

1st Jun

31st Jul

Sufficient Fresh
ASHRAE 62.2



“I think the value of beauty and inspiration is very much underrated, no question. But I want to be clear. I'm not trying to be anyone's saviour. [...] I'm just trying to think about the future and not be sad.”

Elon Musk | TED2017