Australian Institute of Building Surveyors
Queensland & NT Chapter

2013 Conference
Southern Region

ENERGY EFFICIENCY CASE STUDIES CLASS 2-9

Dr Clyde Anderson, RPEQ 5482

Disclaimer:

The contents of this presentation are a simplified interpretation of the Energy Efficiency Part of the National Construction Code and are specifically intended for this Conference.
For further information consult the NCC.

SUMMARY

- NCC Volume 1 Section J
- Class 2 Buildings
- Verification Method JV3, Classes 3, 5-9
- Examples of Trading Between Elements
- Roof Insulation Compression

NCC Volume 1 Section J

- Part J0 – Heating & Cooling Loads for Class 2 and Class 4 = NatHERS Star Ratings
- Part J1 – Roof+Ceiling, Walls, Floors: total R-value ~ conductive heat transfer
  - Roof Lights : U-value and SHGC
- Part J2 – Glazing: Conductance and Solar Heat Gain ~ air conditioning energy
- Part J3 – Building Sealing: air leakage

NCC Volume 1 Section J

- Part J5 – Air Conditioning+Ventilation Systems
- Part J6 – Artificial Lighting
- Part J7 – Hot Water, Pool & Spa
- Part J8 – Maintenance and Metering

Class 2 Buildings

- QDC MP4.1 Acceptable Solution A2
- Parts J1, J2 and J3 achieved by Star Rating
- Individual Units at least 4 Stars and
- Building Average between 4 and 5 Stars
- Average depends on number of Outdoor Living Areas and with ceiling fans
- J5, J6, J7 and J8 must still be by DTS

Class 2 Buildings

NatHERS Star Ratings

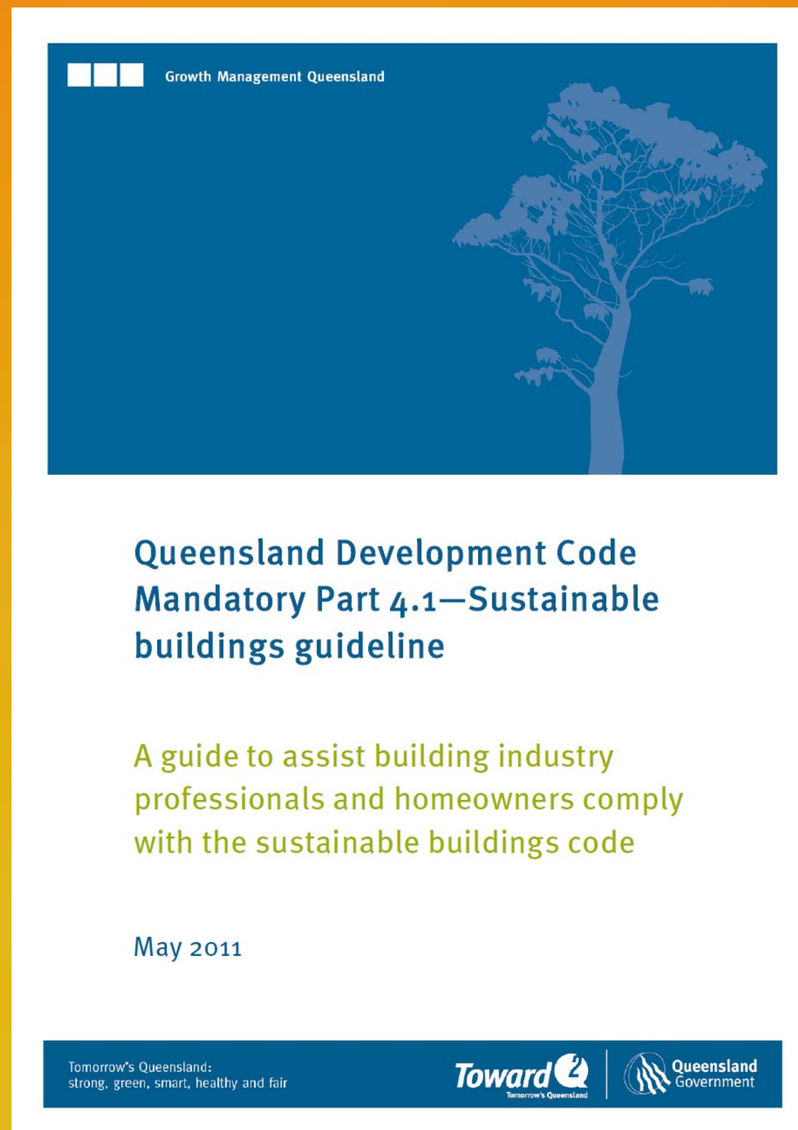
Must be with NatHERS-approved software

Must be according to NatHERS Procedures

Must be by trained, competent persons

Must have a system of quality assurance

Competent Persons?



Growth Management Queensland

Queensland Development Code Mandatory Part 4.1—Sustainable buildings guideline

A guide to assist building industry professionals and homeowners comply with the sustainable buildings code

May 2011

Tomorrow's Queensland: strong, green, smart, healthy and fair

Toward Q2 Tomorrow's Queensland

Queensland Government

Competent Persons?

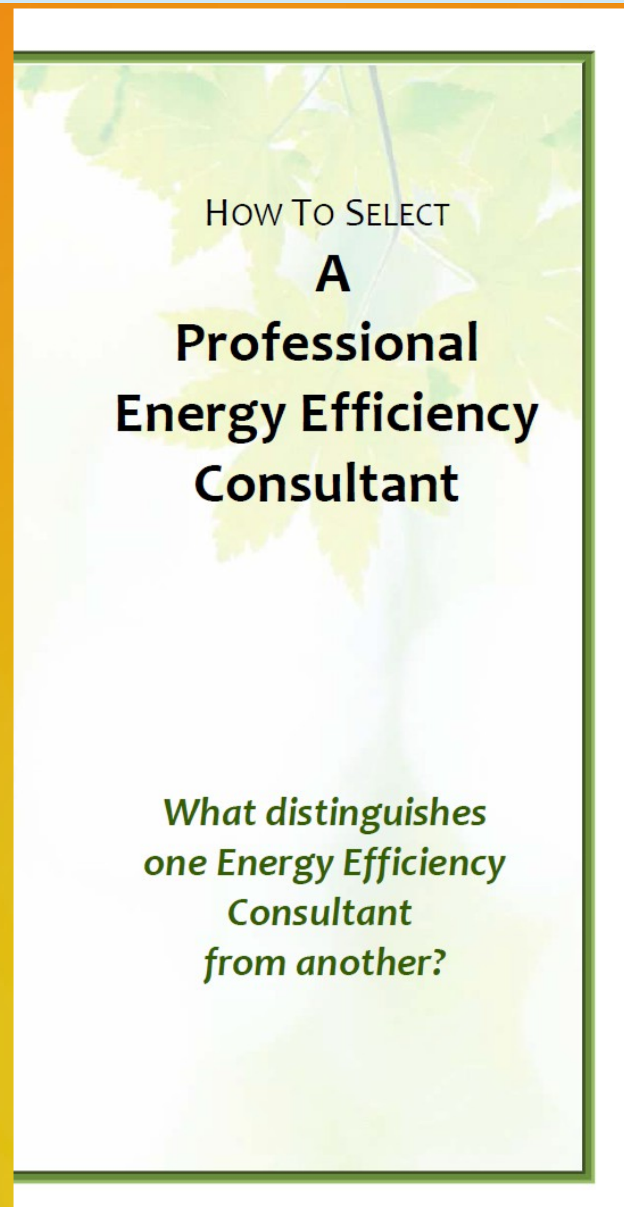
QDC Mandatory Part 4.1

Sustainable Buildings Guideline

Part 5.3.2 Accredited House Energy Assessors

"It is recommended that **only** a person who is accredited (with an Assessor Accrediting Organisation), or who can demonstrate their use of the *software* is <u>current and tested</u>, be considered as a **competent person** to use *software* to meet energy equivalence requirements"

Confidence in EE Assessors


HOW TO SELECT
A
Professional
Energy Efficiency
Consultant

What distinguishes one Energy Efficiency Consultant from another?

Confidence in EE Assessors

Does the Assessor have a good Reputation?

Are they known to be tough occasionally?

Do they abide by a Code of Conduct?

Does the Assessor have the Experience?

Does the Assessor have the Education?

Do they participate in a CPD program?

Do they have a Quality Management System?

Do they have Professional Indemnity Insurance?

Star Rating Credits

Climate Zones 1 and 2

½ **Star** for a complying Outdoor Living Area

- Connected to Living area
- Minimum $12.0m^2$ floor area
- Minimum 2.5m deep
- Open on at least one side (minimum 50%)
- Balcony above or impervious roof, R_T1.5

PLUS...

Star Rating Credits

Climate Zones 1 and 2

½ **Star** for a ceiling fan in Outdoor Living Area

<u>But</u> to achieve this credit...

If there is an air-conditioner in the adjacent Living area - the a/c must automatically shut down if the adjoining door is open more than 1 minute.

Class 2 Building Average

Two parts: what does the building achieve? and, what is the Requirement?

Which one is correct?

a. Average Stars = sum individual Stars / number of Units

Example: 4 Units with 4 Stars and 2 Units with 5 Stars

Average = (4*4+2*5)/6 = 26/6 = 4.25 Stars

Class 2 Building Average

Which one is correct?

b. Average Star Rating from average Cooling MJ/m^2 + average Heating MJ/m^2

Example: Av Cooling = $20MJ/m^2$ and

Av Heating = $35MJ/m^2$, Total = $55MJ/m^2$

say 4½ Stars = $50MJ/m^2$ & 5 Stars = $60MJ/m^2$

Average Stars = 4½ + (55-50)/(60-50)*½
= 4½ + 5/10*½ = 4.75 Stars

Class 2 Building Average

Two parts: what does the building achieve? and, what is the Requirement?

Which one is correct?

a. Average Stars = sum individual Stars / number of Units

Example: 4 Units with 4 Stars and 2 Units with 5 Stars

Average = (4*4+2*5)/6 = 26/6 = 4.25 Stars

THIS FORMULA FOR THE REQUIREMENT

Class 2 Building Average

Which one is correct?

b. Average Star Rating from average Cooling MJ/m^2 + average Heating MJ/m^2

Example: Av Cooling = $20MJ/m^2$ and

Av Heating = $35MJ/m^2$, Total = $55MJ/m^2$

say 4½ Stars = $50MJ/m^2$ & 5 Stars = $60MJ/m^2$

Average Stars = 4½ + (55-50)/(60-50)*½
= 4½ + 5/10*½ = 4.75 Stars

USE THIS FORMULA FOR THE PROPOSED

Verification Method JV3

- Must be with software complying with the ABCB Protocol
- Must be according to JV3 conditions
- Must be by trained, competent persons
- Must have a system of quality assurance

Verification Method JV3

The Reference Building is a building that (just) complies with all the Deemed-To-Satisfy elemental Requirements with DTS-compliant services (a/c & lighting). This represents the maximum Annual Energy Consumption the NCC will allow, or the "allowance"

The proposed building Annual Energy Consumption (with the same services) must be below this allowance.

Verification Method JV3

- JV3 thermal simulation conditions, e.g.
  - Thermostats 18°C to 26°C
  - Conditioned coverage 98%
  - Minimum operating 2500 hours/year
- Reference Building properties
  - Solar Absorptance - Walls 0.6, Roof 0.7
  - DTS-compliant insulation and glazing
    - including walls >220kg/m²

Everything else is the same

JV3 Inputs

- Three-dimensional building model
- Location and weather specific
- Occupancy, Internal Heat Loads, Building Envelope heat transfer, Lighting and HVAC systems
- Simulation for 8760 hours
- Calculating aggregate heat transfer and cumulative energy consumption

Annual Energy Consumption

- Conductive heat transfer of surfaces
  - Roof, ceiling, walls, external floor, glazing
- Solar Heat Gain through glazing
- Electricity for lights
- Electricity for electrical equipment
- HVAC for fresh air treatment
- HVAC for indoor climate control

JV3

- The Annual Energy Consumption of the proposed building needs to be less than the Reference Building to achieve a **Building Solution**.
- If the proposed services are more efficient than DTS then there is no need to model the proposed building with the proposed services.

JV3

The proposed building need not comply with DTS in some elements.

- It is possible for a proposed building to not comply with DTS in many elements, so long as it is better than DTS in other elements to compensate.
- Trading between different building elements is possible. How does this work?

JV3 Elemental Trading

For example, it is possible to trade for “less than” DTS-compliant insulation for:

- Better than DTS-compliant glazing
- Better than DTS surface solar absorptance
- Better than DTS in available thermal mass

Let's look at an example to illustrate this...

JV3 Elemental Trading

We conducted original research using JV3 conditions for a standard building in three locations (Darwin, Brisbane and Melbourne).

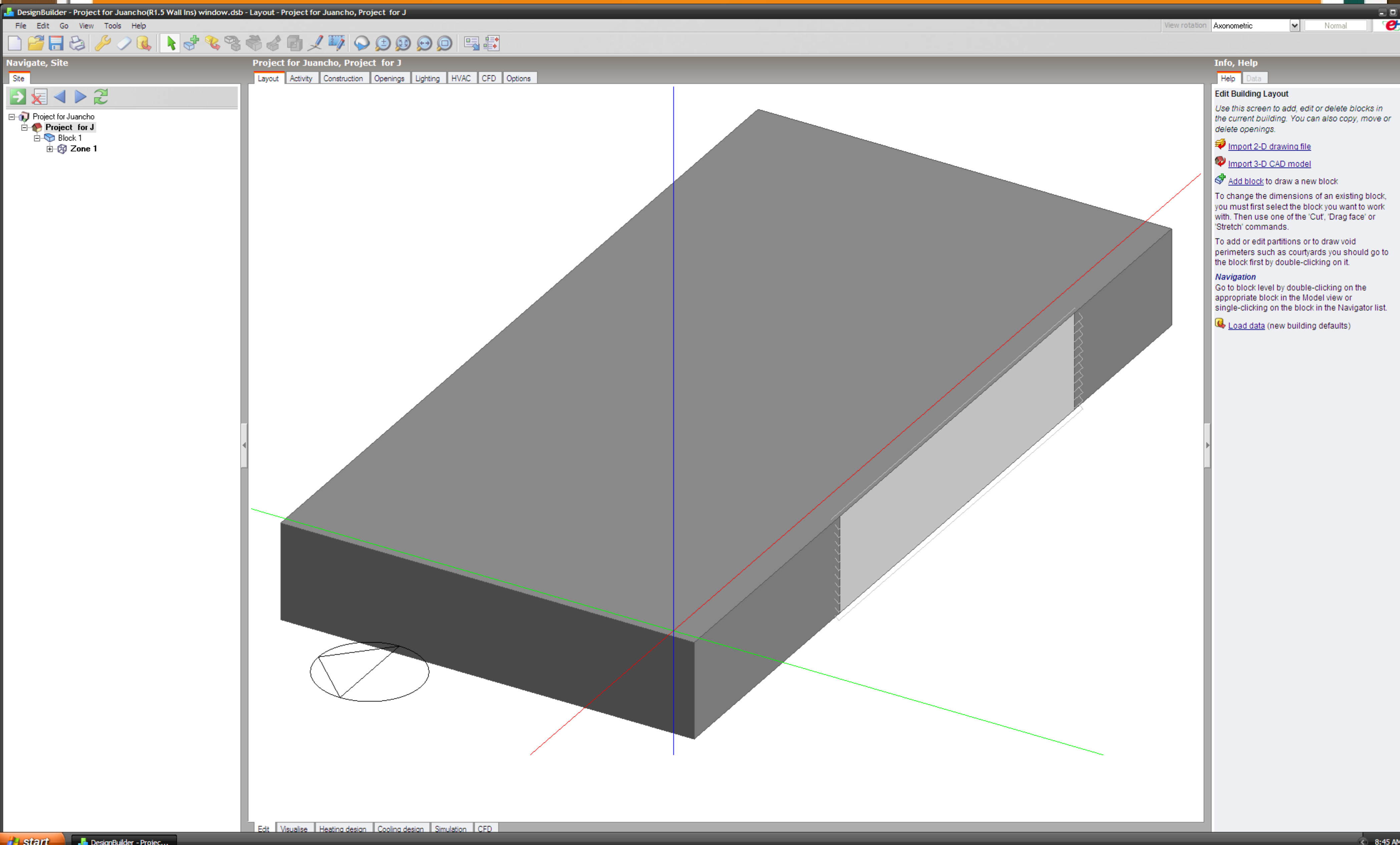
The office building was 30m x 15m x 3.5m
Long-side facing North

For roof, walls & suspended floor:

Solar absorptance 0.2 to 0.9

Added insulation from nothing to R3.0/R2.0

Thermal mass, lightweight to 150mm concrete


DesignBuilder - Project for Juancho(R1.5 Wall Ins) window.dsb - Layout - Project for Juancho, Project for J
File Edit Go View Tools Help
View rotation
Axonometric
Normal
Navigate, Site
Site
Project for Juancho
Project for J
Block 1
Zone 1
Project for Juancho, Project for J
Layout
Activity
Construction
Openings
Lighting
HVAC
CFD
Options
Info, Help
Help
Data
Edit Building Layout
Use this screen to add, edit or delete blocks in the current building. You can also copy, move or delete openings.
Import 2-D drawing file
Import 3-D CAD model
Add block to draw a new block
To change the dimensions of an existing block, you must first select the block you want to work with. Then use one of the 'Cut', 'Drag face' or 'Stretch' commands.
To add or edit partitions or to draw void perimeters such as courtyards you should go to the block first by double-clicking on it.
Navigation
Go to block level by double-clicking on the appropriate block in the Model view or single-clicking on the block in the Navigator list.
Load data (new building defaults)
Edit
Visualise
Heating design
Cooling design
Simulation
CFD
start
DesignBuilder - Projec...
8:45 AM

Interpretation of Results

The results should not be taken out of context.

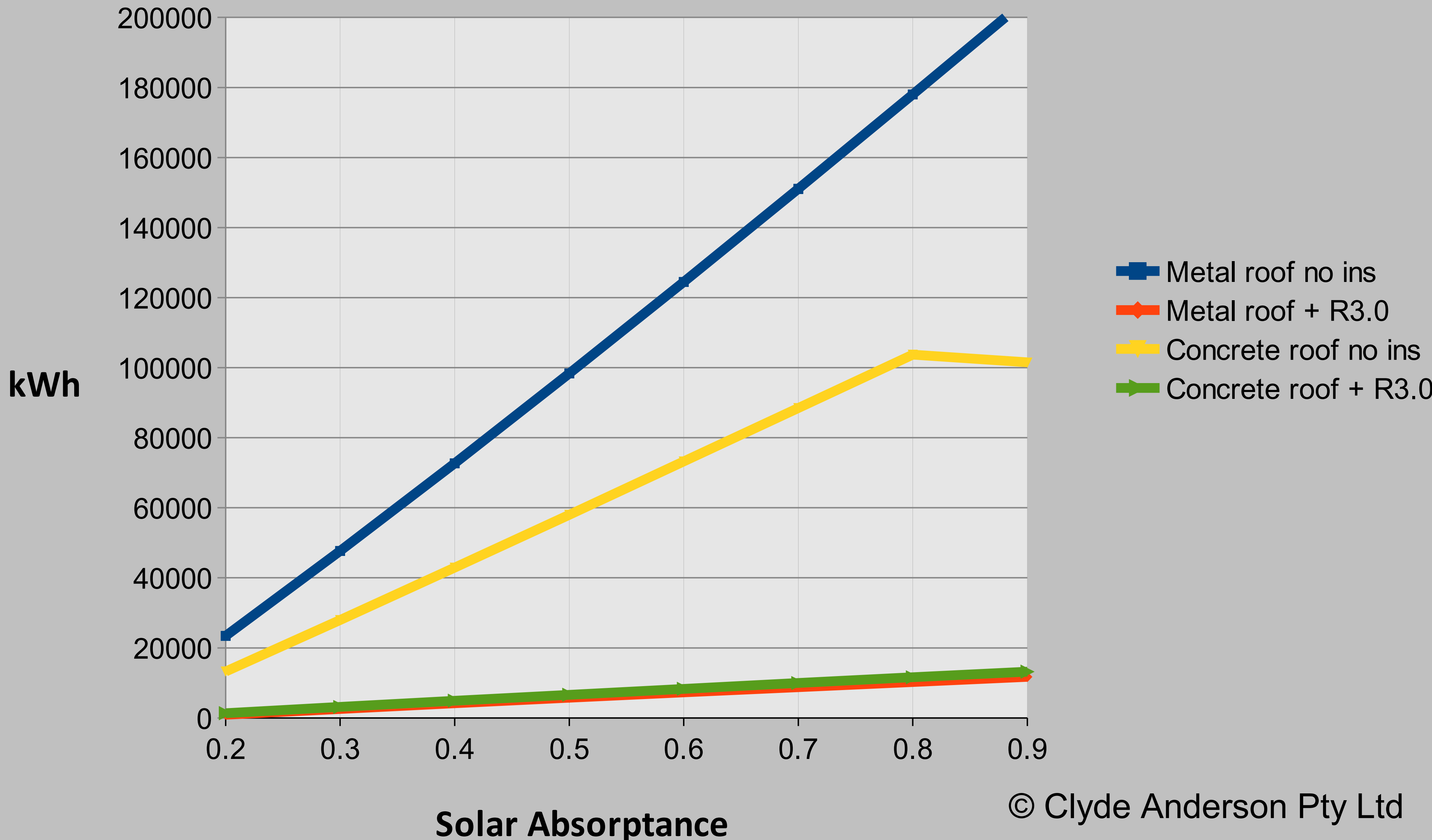
We report the heat transfer through each varying element only.

The heat transfer through other elements change because the building is holistic.

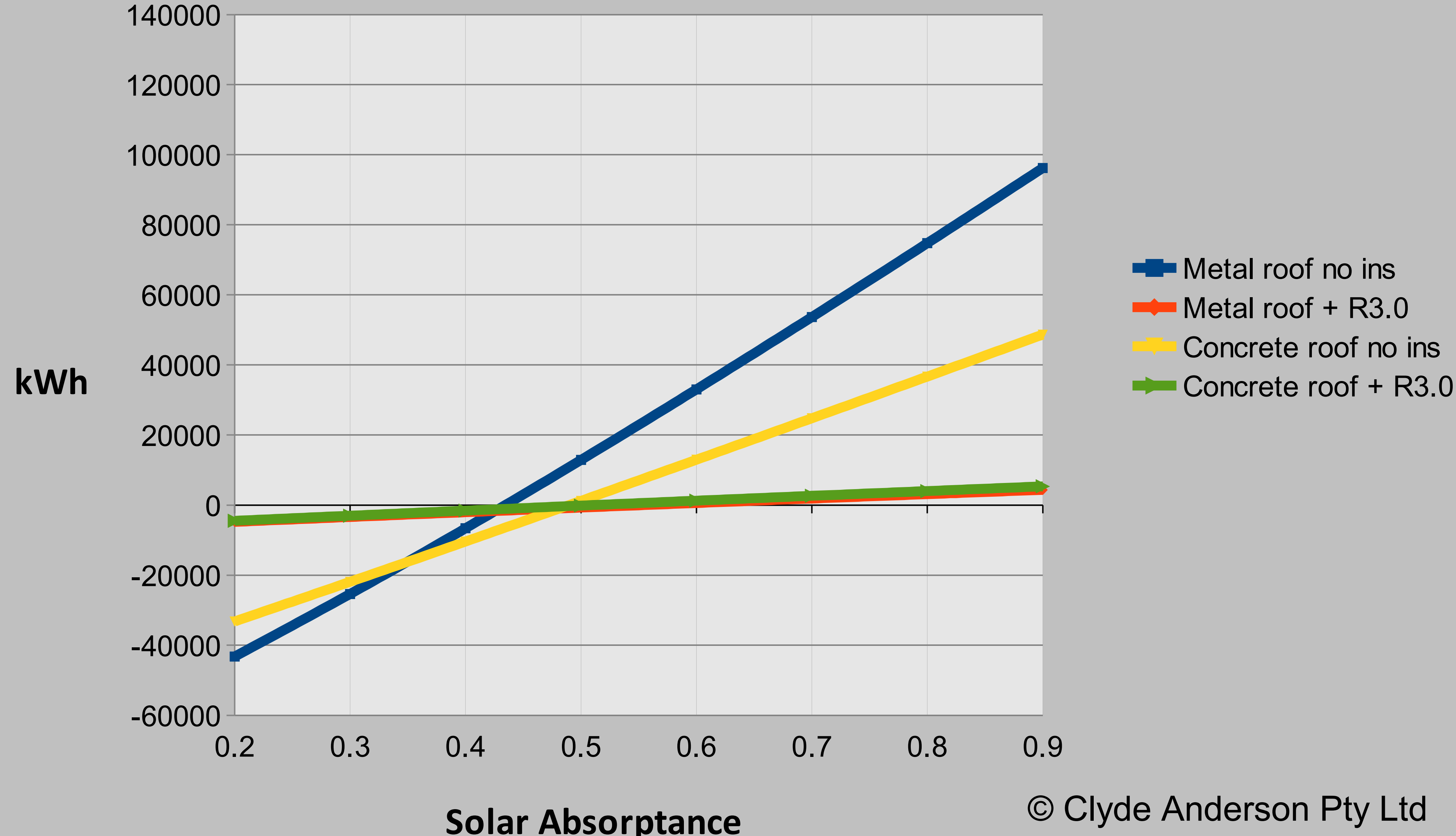
Inferences on the contribution of different surfaces depend on the relative contribution of each element to the total.

Do <u>not</u> add individual elements.

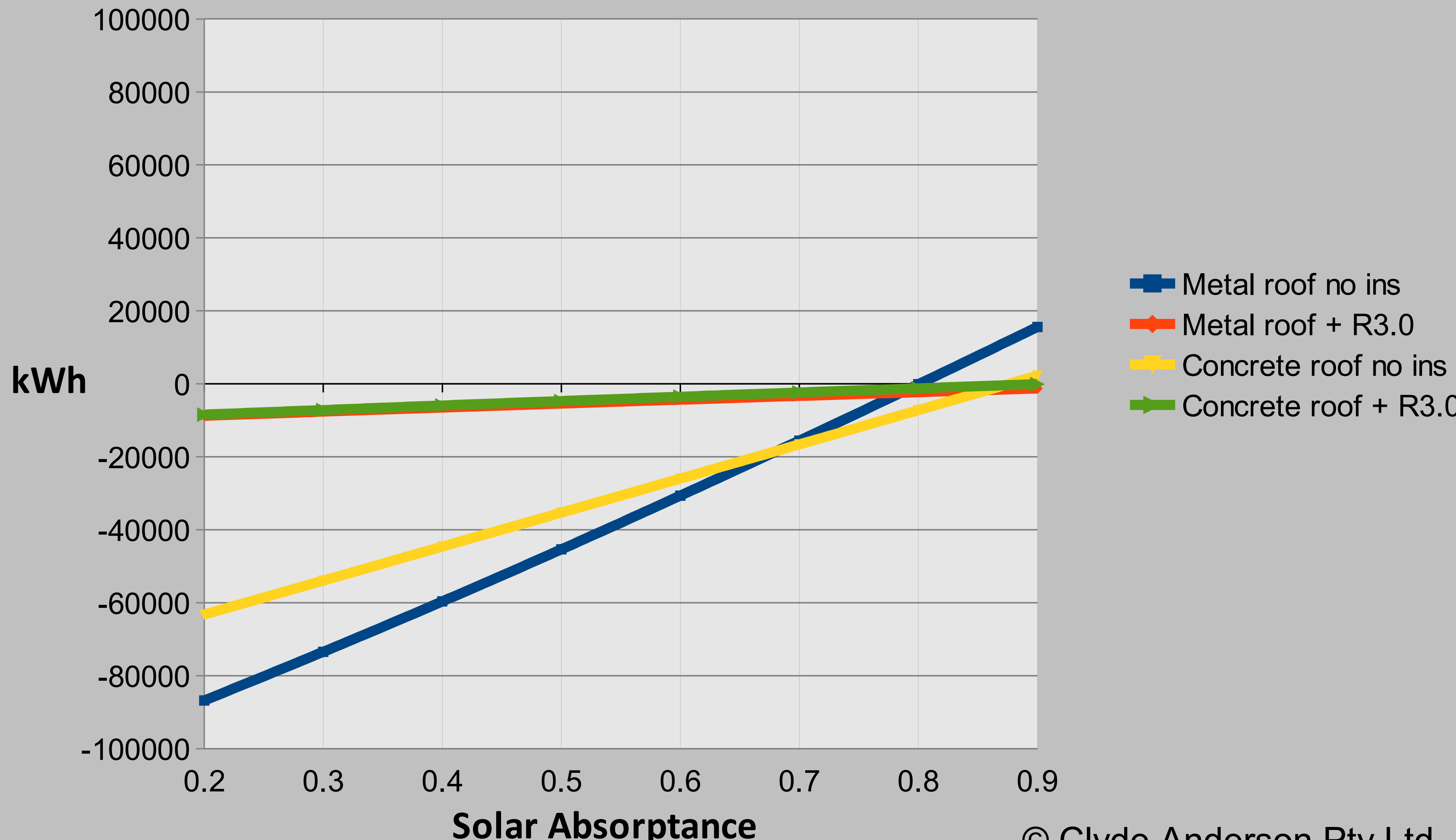
Darwin Roof Energy vs Solar Absorptance



Brisbane Roof Energy vs Solar Absorptance



Melbourne Roof Energy vs Solar Absorptance



Roof Conclusion

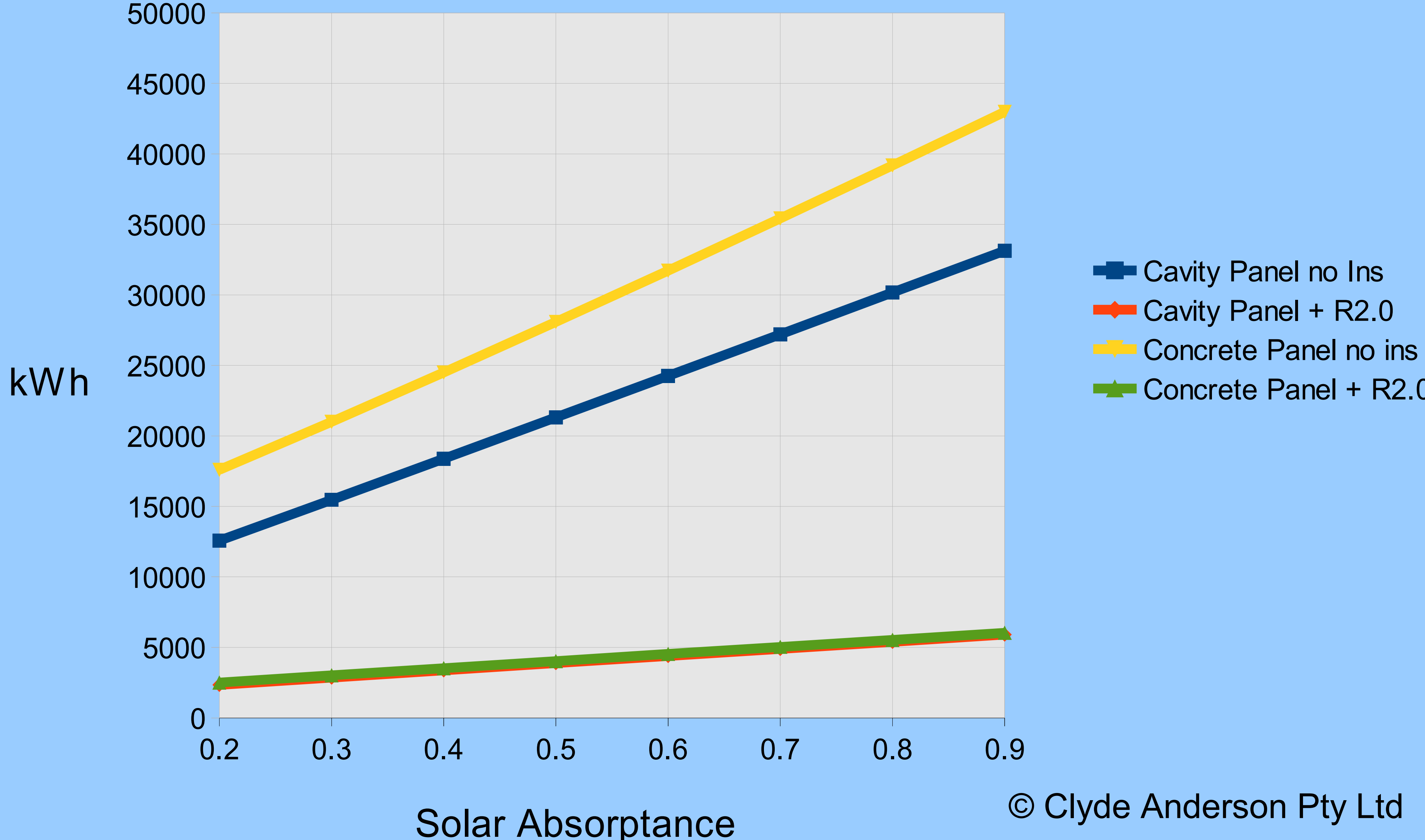
Darker colours (higher SA) are hotter, lighter colours (lower SA) are cooler

Uninsulated concrete roof is less responsive than uninsulated metal roof

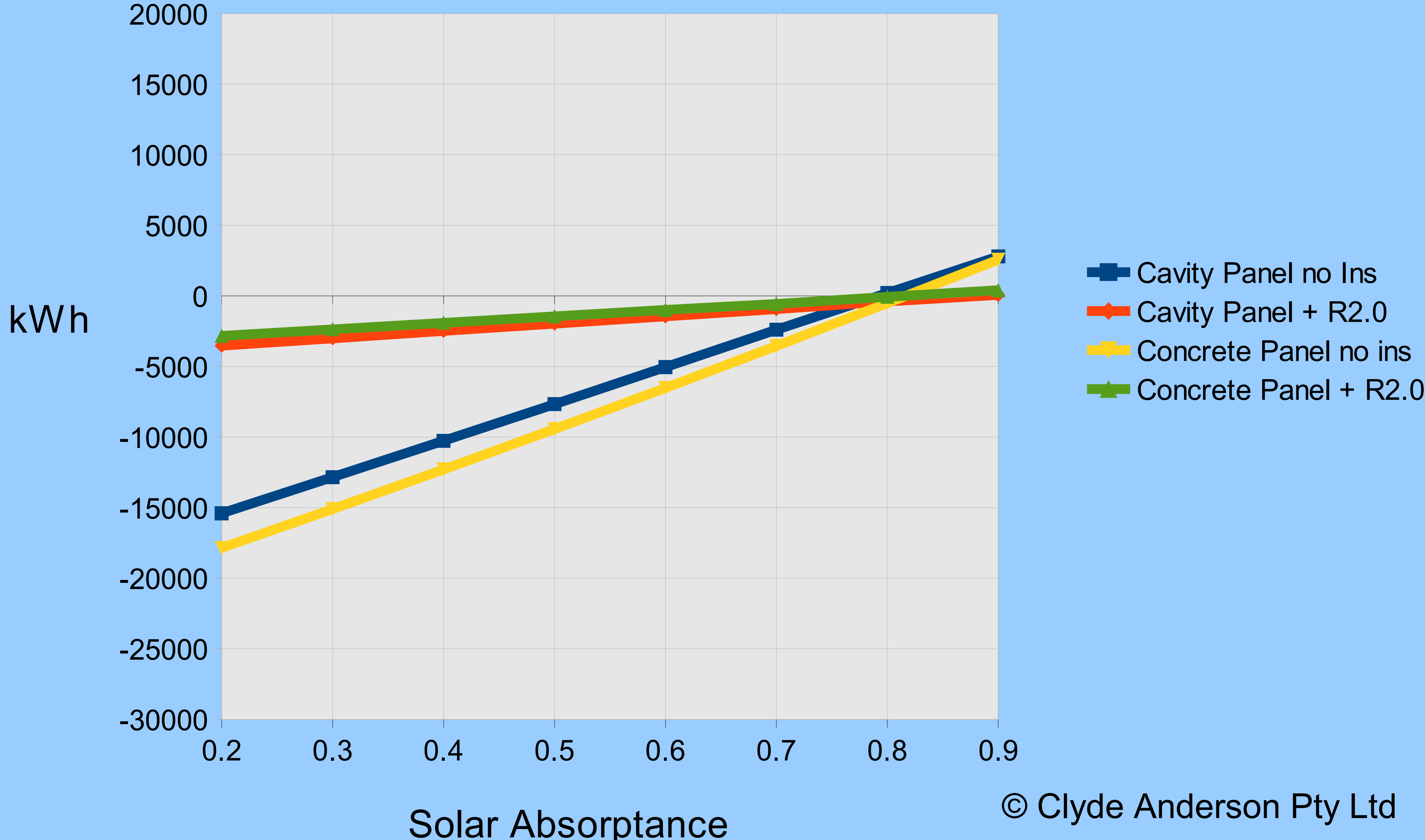
For an insulated roof there is little difference between metal or concrete

The optimum colour for highest benefit depends on insulation, thermal mass and climate (hot, warm/cool, cold)

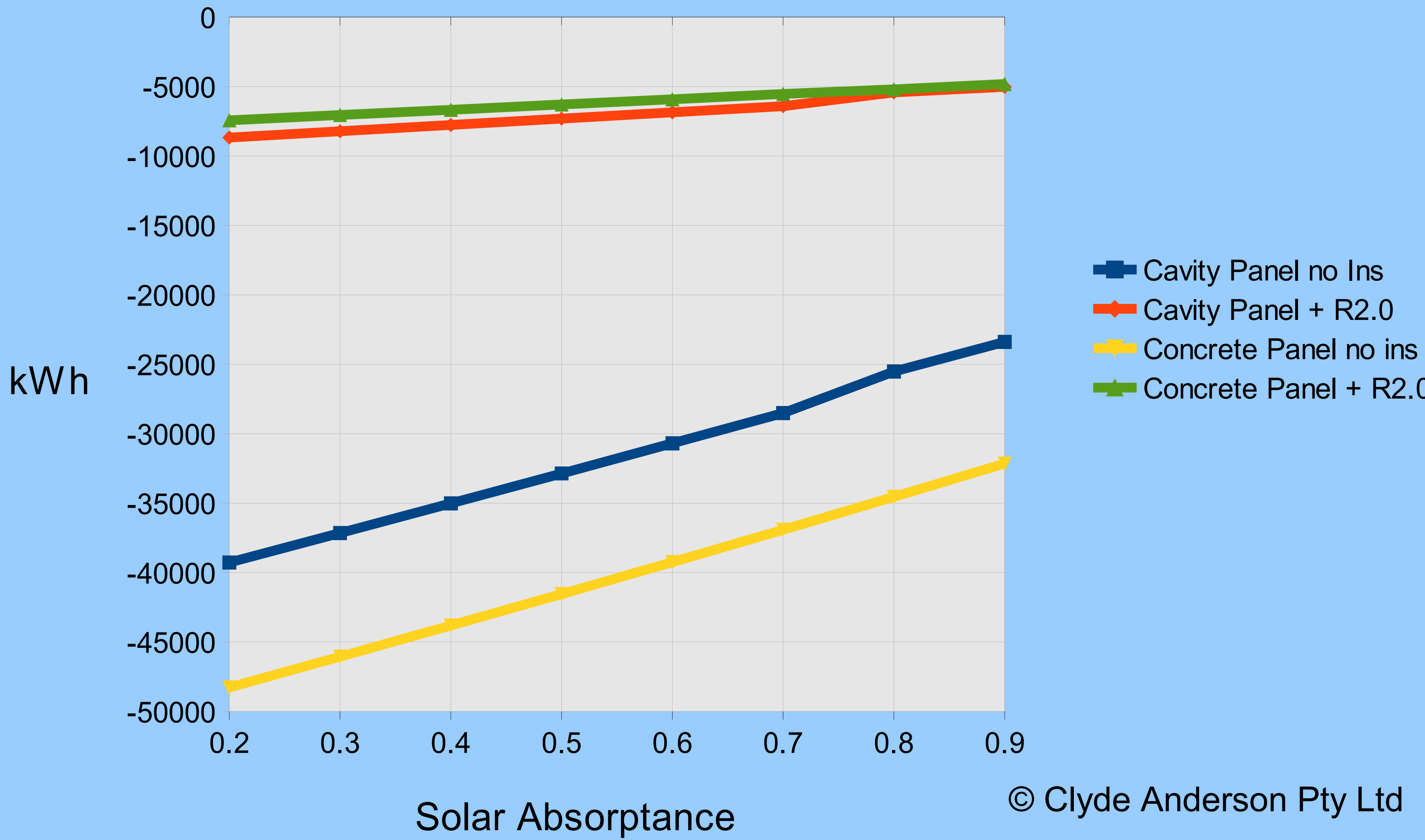
Darwin Wall Energy vs Solar Absorptance



Brisbane Wall Energy vs Solar Absorptance



Melbourne Wall Energy vs Solar Absorptance



© Clyde Anderson Pty Ltd

Wall Conclusion

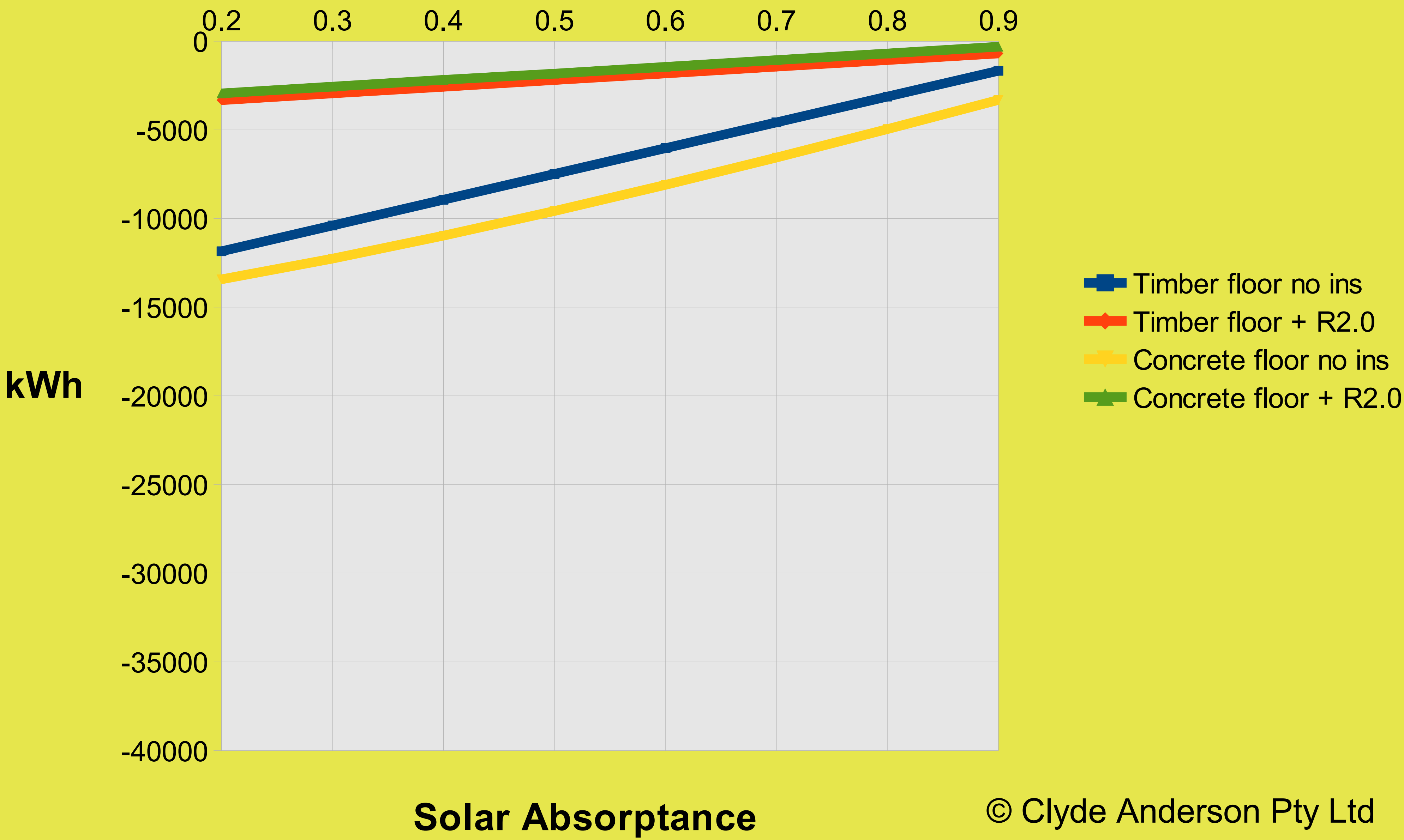
Darker colours (higher SA) are hotter, lighter colours (lower SA) are cooler

For insulated walls there is little difference between FC Panel or Concrete Panel

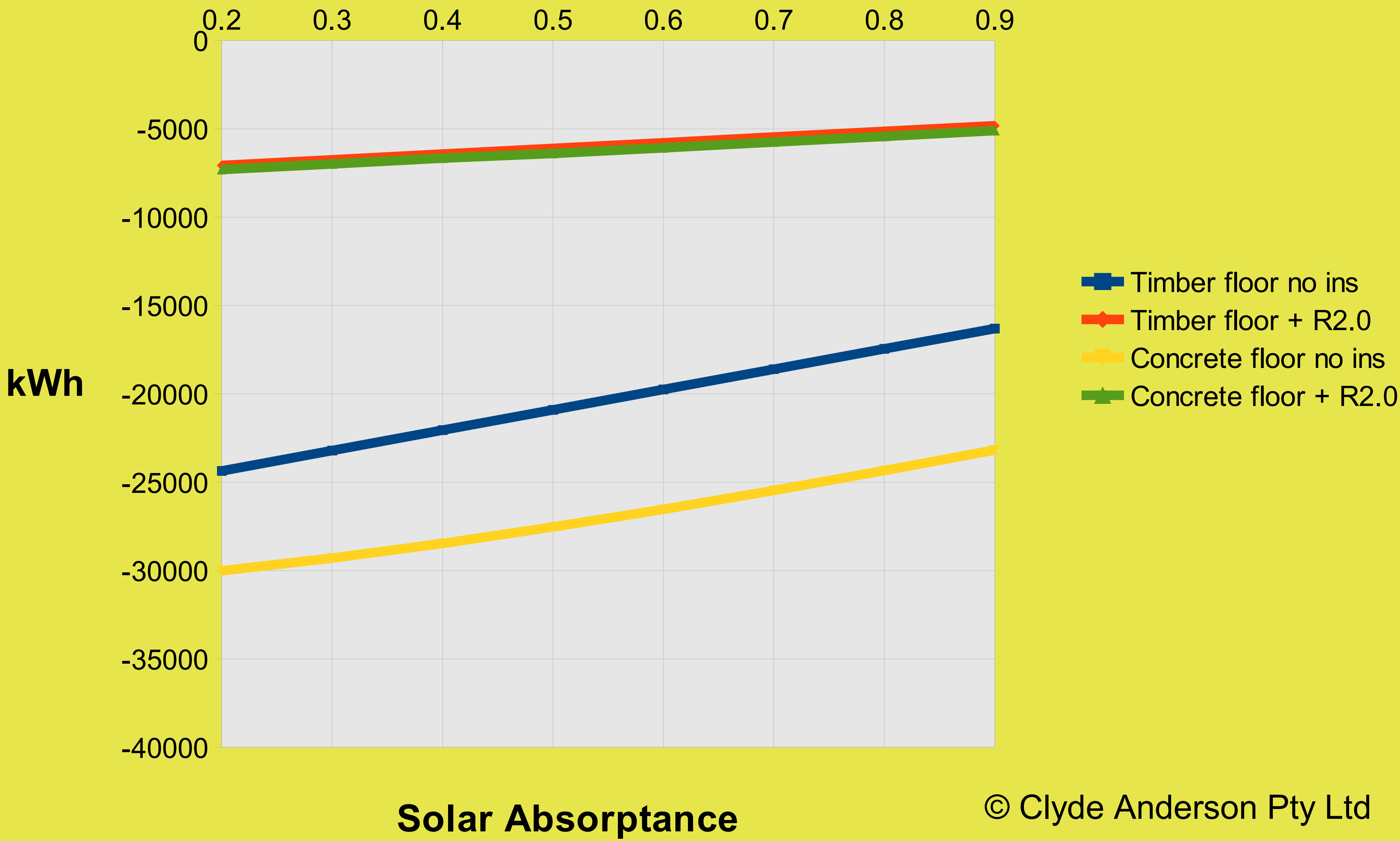
The optimum colour for highest benefit depends on insulation, thermal mass and climate (hot, warm, cold)

For maximum benefit, some wall insulation is needed for Hot and Cold climates, but less insulation for Warm/Cool climates

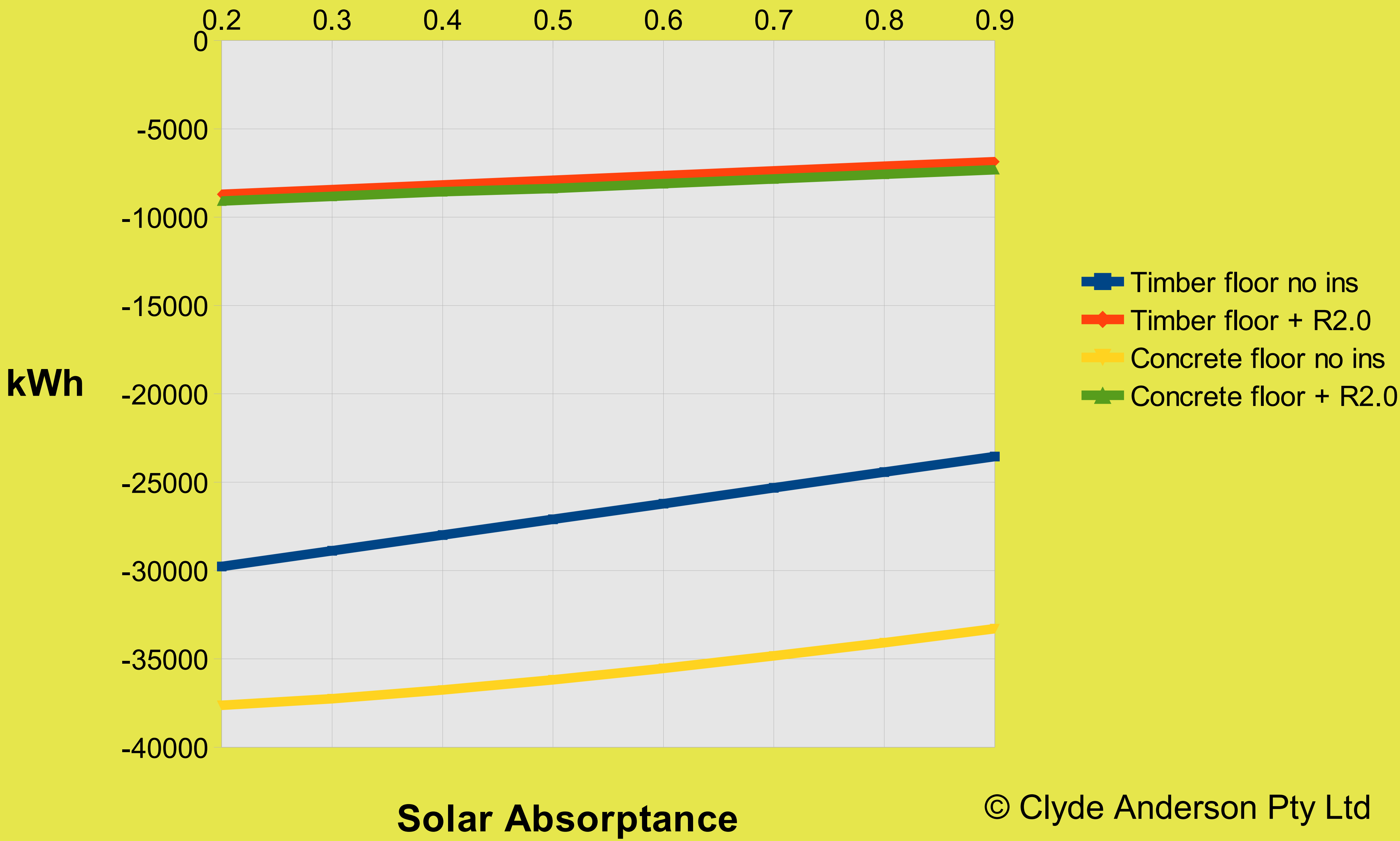
Darwin Floor Energy vs Solar Absorptance



Brisbane Floor Energy vs Solar Absorptance



Melbourne Floor Energy vs Solar Absorptance



Floor Conclusion

Darker colours (higher SA) are hotter, lighter colours (lower SA) are cooler

For insulated floors there is little difference between Timber or Suspended Concrete

The optimum colour for highest benefit depends on insulation, thermal mass and climate (hot, warm, cold)

For maximum cooling benefit, no floor insulation is needed for Hot and Warm climates, but some insulation is needed for Cold climates

Roof Insulation Compression

Given the previous results for roof solar absorptance, insulation and thermal mass vs location, the achieving of a Building Solution according to Verification Method JV3 may include roof insulation compression.

Roof Insulation Compression

Compressing bulk fibre insulation reduces it's R-value

Without roof spacers, bulk insulation is compressed between metal roof and purlins

Insulation is also compressed by the safety mesh (taut or dished?)

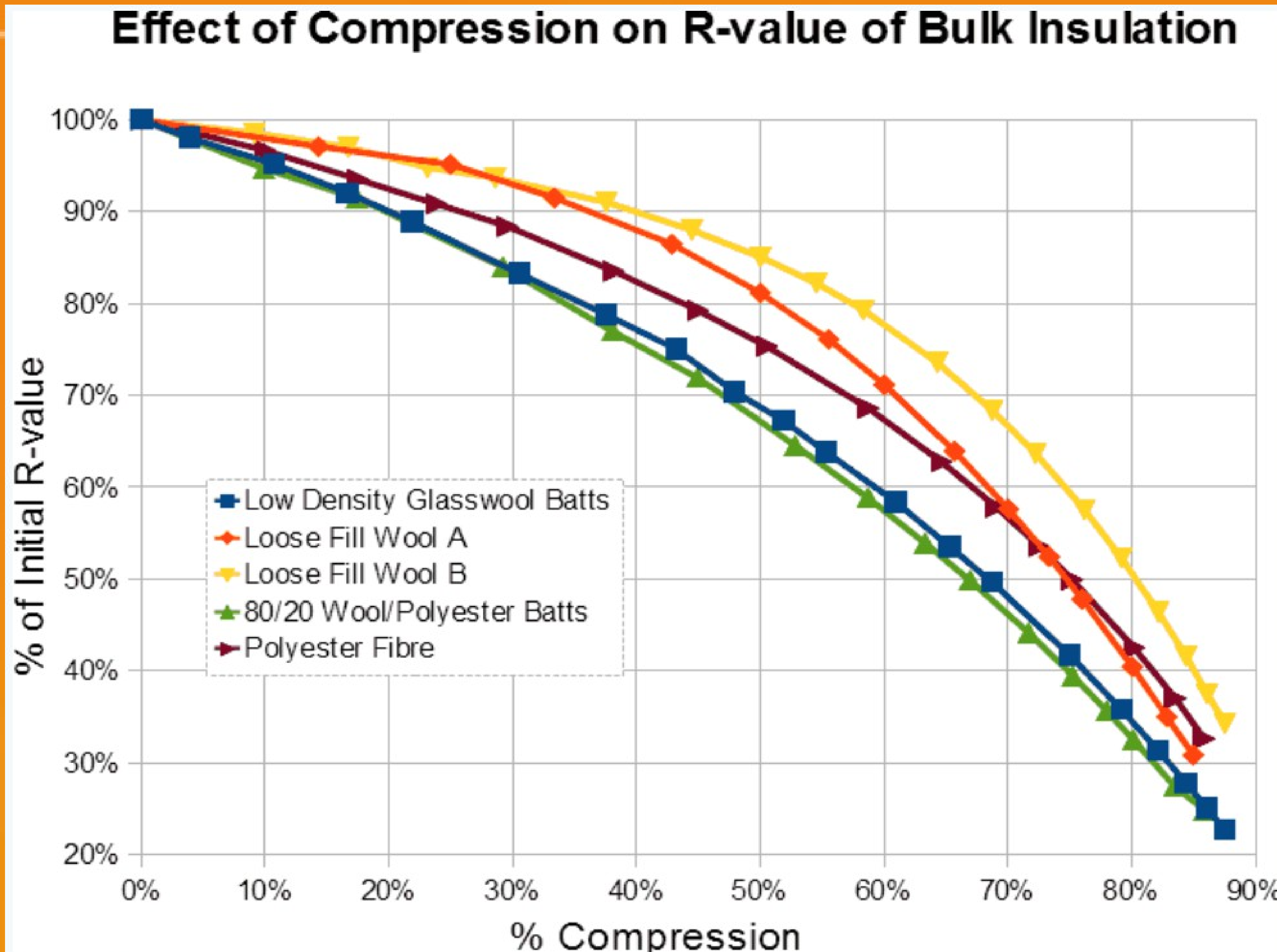
We have calculated the effect of roof insulation compression and put a calculator on our website, www.clydeanderson.com.au

Roof Insulation Compression

Insulation compression formulas interpolated from data from CSIRO and AIRAH Technical Handbook

Correlation coefficient, R^2 at least 0.999

The stiffness of fibre insulation products can vary between fibre type, fibre thickness, binder, manufacturer and batches



Effect of Compression on R-value of Bulk Insulation
% of Initial R-value
100%
90%
80%
70%
60%
50%
40%
30%
20%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
% Compression
Low Density Glasswool Batts
Loose Fill Wool A
Loose Fill Wool B
80/20 Wool/Polyester Batts
Polyester Fibre

CLYDE ANDERSON PTY LTD

Back to Resources

Roof Insulation Compression Calculator

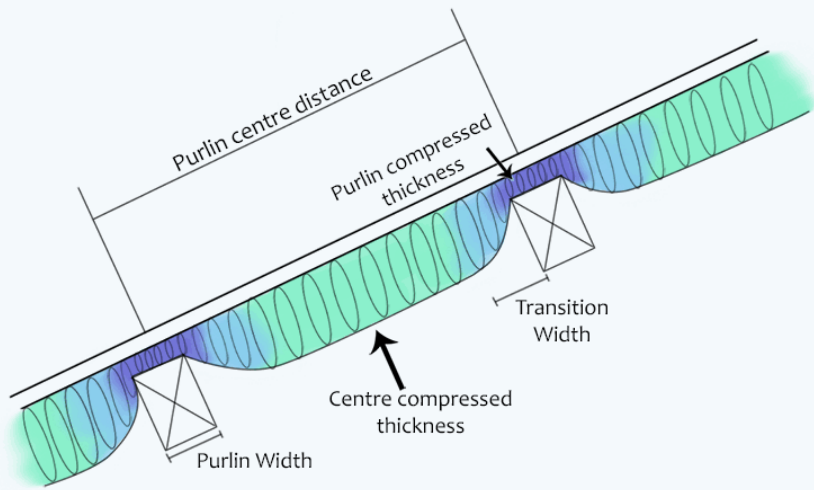
When fibre insulation is compressed (to fit into a tight space, squished underneath purlins or even by a retaining mesh), its R-value decreases. This change isn't a simple linear reduction, but a complex curve that is different for each material.

To assist in calculating the R-value of compressed roof insulation, we are releasing for free this handy tool to crunch the insulation compression value for you. This can be used to accurately work out the thickness of installed insulation required under a building's roof to meet the requirements of the National Construction Code or your Energy Efficiency Assessment.

Reset

	Low Density Glasswool Batts
Uncompressed Fibre R-value	2
Uncompressed thickness, mm	100
Centre compressed thickness, mm	90
Purlin width, mm	50
Purlin centre distance, mm	1500
Purlin compressed thickness, mm	20
Insulation Transition width	20%

Effective Insulation R-value	1.62
Centre Compression	10%
Centre Compressed R-value	1.91
Purlin Compression	80%
Purlin Compressed R-value	0.69
Transition Average Compression	45%
Transition Average R-value	1.46



Calculations come from data obtained from the AIRAH Technical Handbook (2007), AS/NZS 4859.1:2002, "The Thermal Performance of Several Australian Fibrous Insulating Materials", Journal of Building Physics, July 1995, Volume 19, Number 1, Pages 72-88 by J.G. Symons, R.E. Clarke and J.V. Peirce, with original raw data through personal communication with Dr Robin Clarke (CSIRO) in 2012.

Whilst the calculations are accurate from the original data provided (Regression Coefficient >0.9992), the values given are for generic products that may not match any individual product currently on the market. Insulation performance can be affected by other factors outside the scope of this calculator such as variations in the make-up of the raw material, the individual fibre strand thickness, the production process (including binder), packaging, handling of the product from factory to site, temperature, moisture content and installation. Products made on the same equipment to the same nominal specifications can vary slightly from batch to batch so results should be independantly confirmed. Some finely-spun fibreglass products may have results closer to "Rockwool" data. The calculator does not work for lateral compression, eg squishing insulation to fit between trusses on a ceiling. Calculation data is accurate up to ~85% compression (~60% for Loose Cellulose) and is extrapolated above this.

Back to Resources

Conclusion

Energy Efficiency is part of Building Sustainability and the ABCB may introduce additional measures where there may be a market failure and an acceptable benefit/cost

Increased stringency in Energy Efficiency Requirements may occur in 2015, subject to Regulation Impact Analysis, e.g. Glazing is likely to be tightened.

QUESTIONS?

www.clydeanderson.com.au