Residential Building Thermal Performance Assessment

Accredited Assessor Training

Presented by

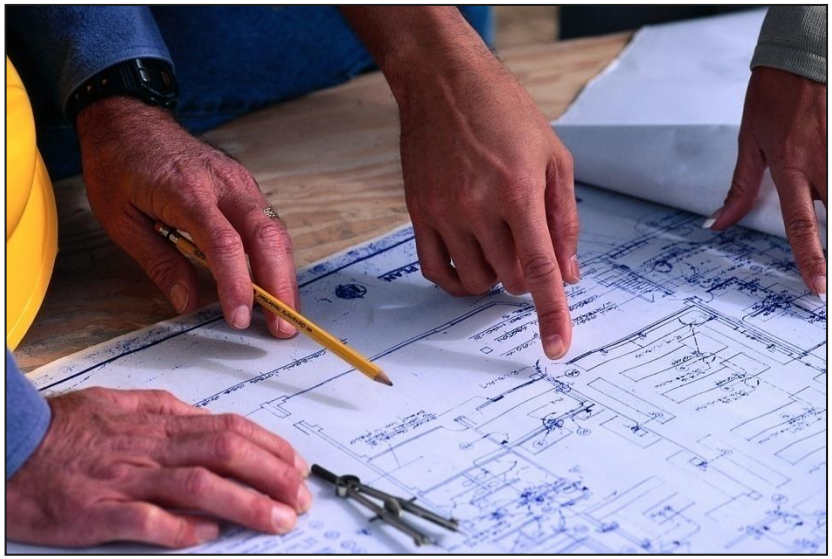
Steve Collins

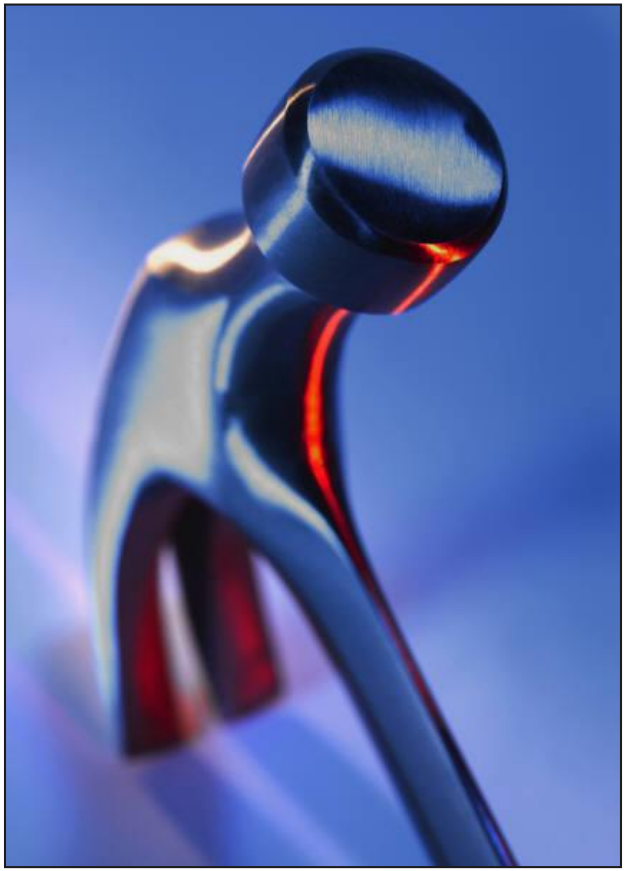
developed by
the Association of Building Sustainability Assessors

ABSA

T3. Design theory

Design and construction (Part 2)

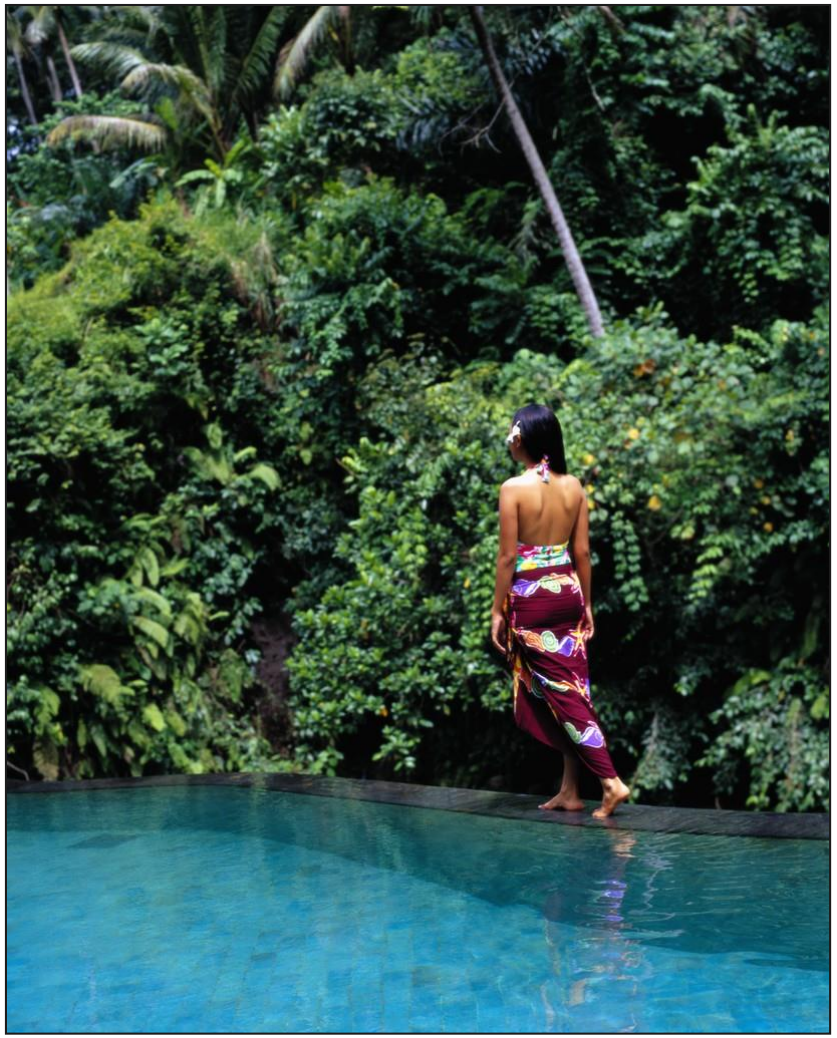




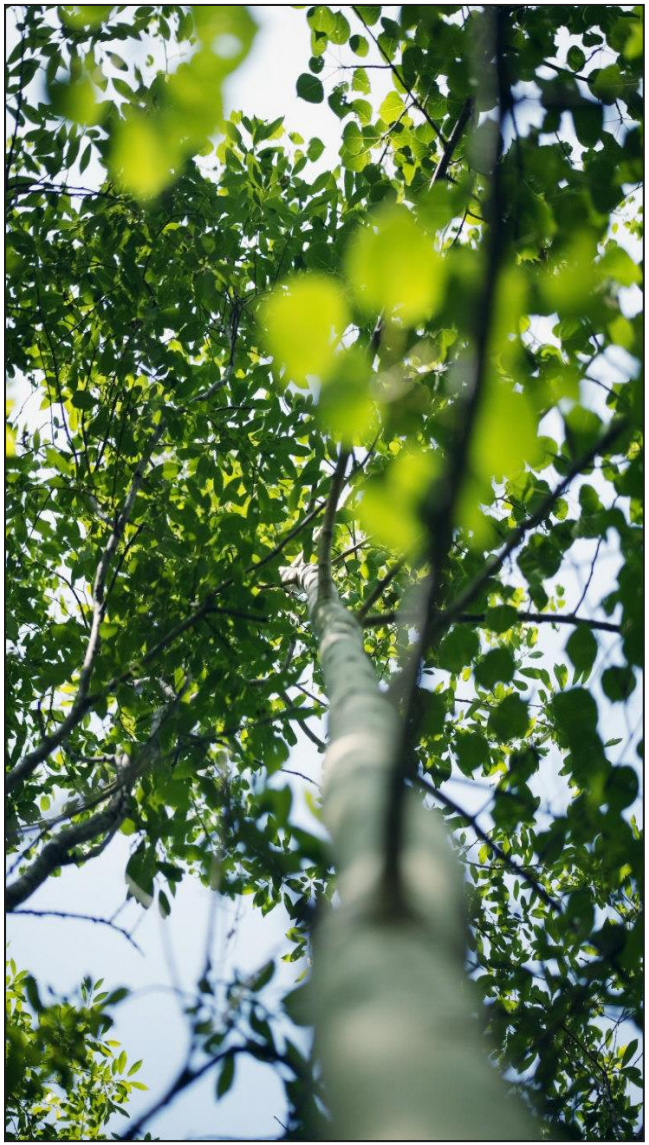
Landscaping

Landscaping can simultaneously influence:

- **aesthetics**
- **air quality**
- **climate modification**

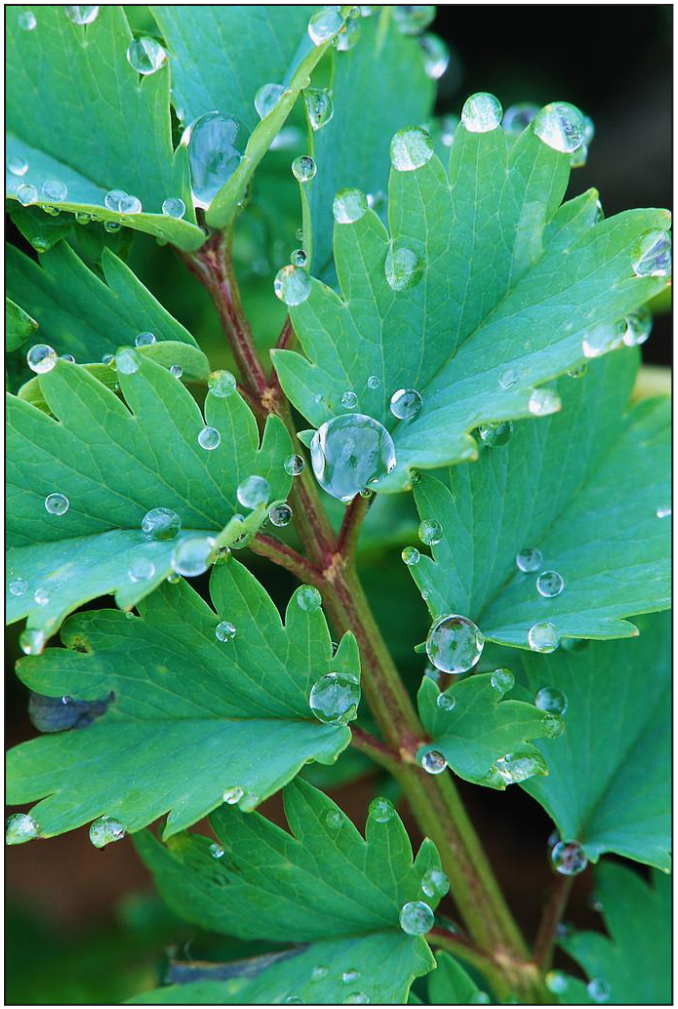


evapotranspiration



A feature of plants, evapotranspiration is effectively mass transfer that is driven by both the evaporation of water droplets from the surface of leaves and water transpired from the pores of leaves

evapotranspiration

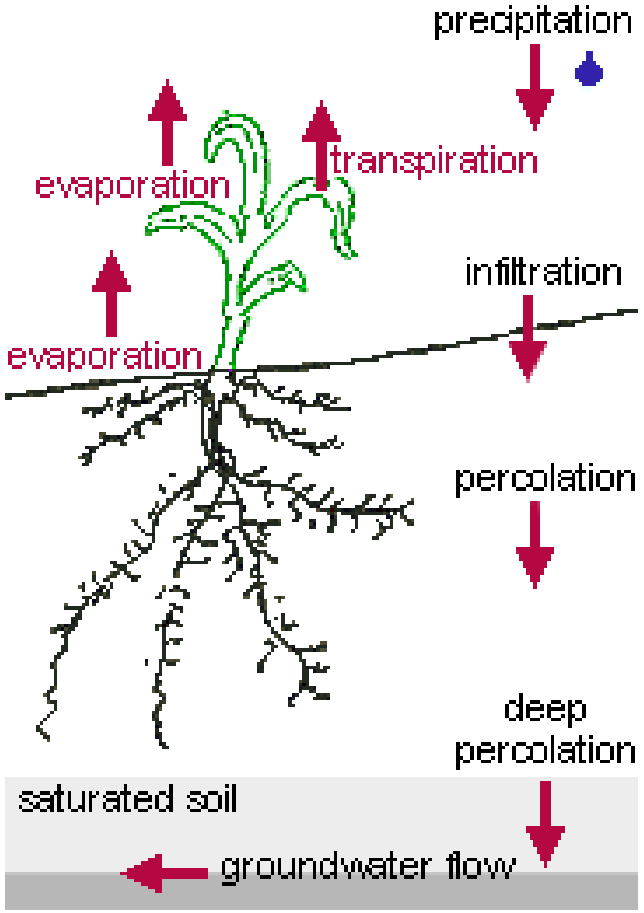


Heat is drawn from the direct environment to enable this

With evaporation of moisture from soil (as when grown in soil or soil-like media on the roof or walls of a structure) has the potential to reduce building heat load if engaged with the building thermodynamics appropriately.

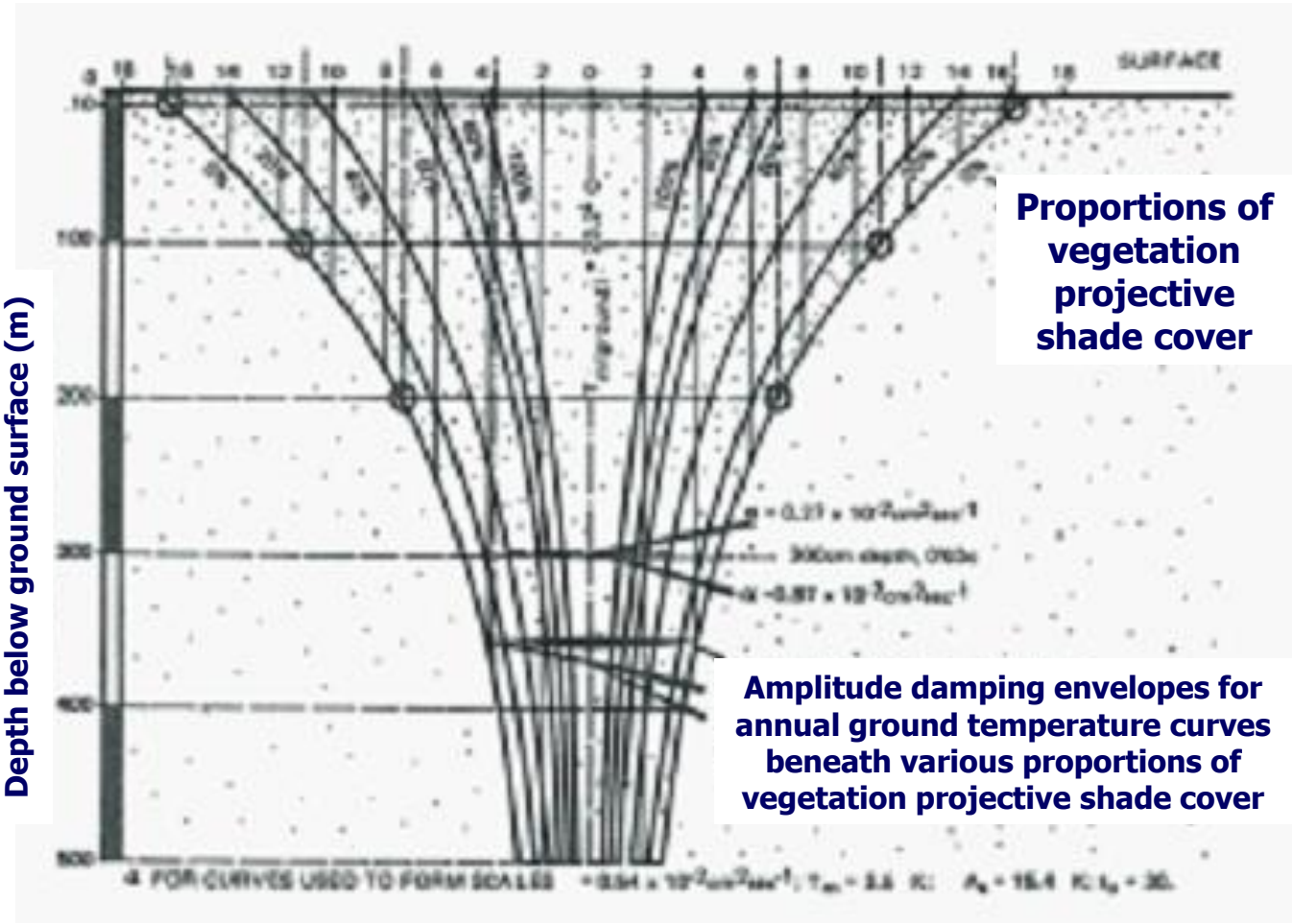
plants

In addition to evapotranspiration effects, plants can also directly shade both buildings and the ground and provide evapotranspiration cooling effects to air passing through plants which is useful in temperate, hot dry as well as hot humid climates (although in temperate climates it is important they do not block winter solar gains)



Temperature impacts of projective shade of vegetation plotted against ground depth (Ayers Rock)

source: Australian Earth Covered Buildings, Baggs, SA, DW & JC



design strategies

strategies common to all climates:

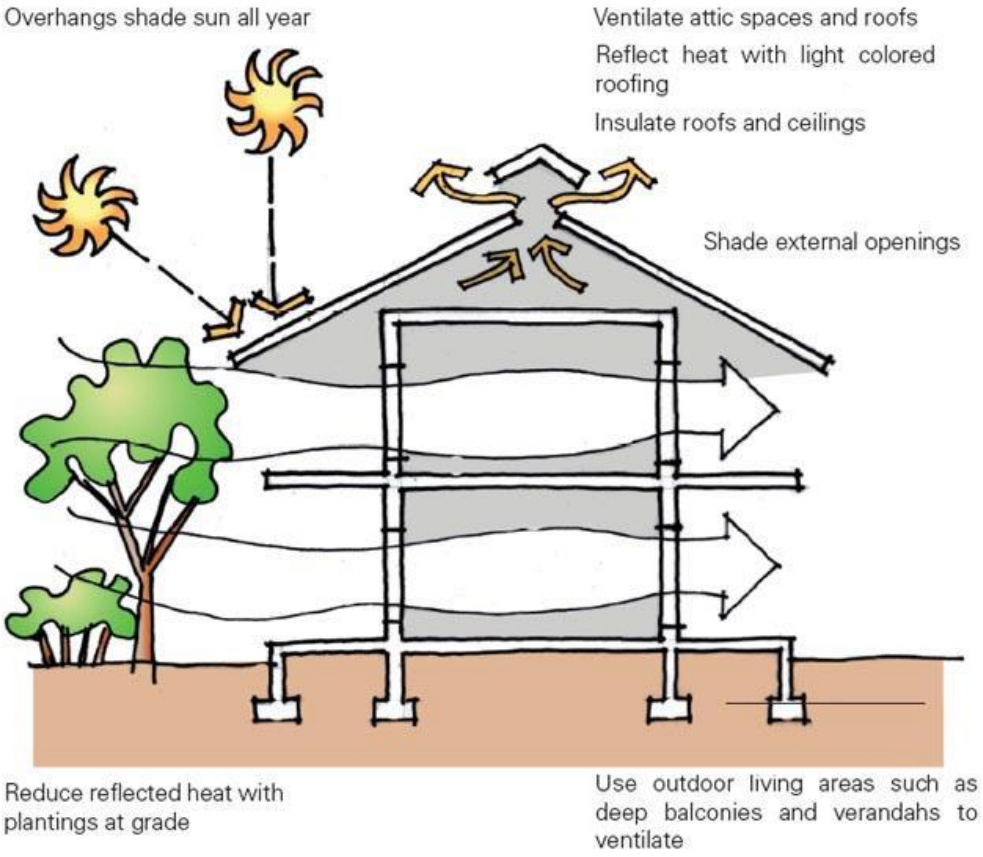
- insulate ceiling and walls
- use appropriate shading for glazing
- minimise west and, to a lesser extent, east facing glazing where variable shading is not available
- weather seal external doors and windows
- use appropriate door and window openings for cross ventilation in summer
- provide protection from unwanted winds

design strategies

1. Tropical e.g. Darwin: (Hot Humid Summer, Warm Winter)

- **low mass, elevated**
- **high levels of natural and ceiling fan ventilation**
- **moderate levels of reflective insulation**
- **light coloured, well ventilated or parasol roofs**
- **access to breezes, insect screened louvres and solid adjustable louvres for privacy**
- **landscape planting to channel breezes and provide shade**
- **wide eaves and ample shading to all elevations**
- **rain protection to ventilation openings**
- **minimise surface albedo**
- **covered insulated roof, meshed outdoor living areas**

design strategies



design strategies

1. Tropical e.g. Darwin: (Hot Humid Summer, Warm Winter)

Additional issues if air conditioning is to be installed:

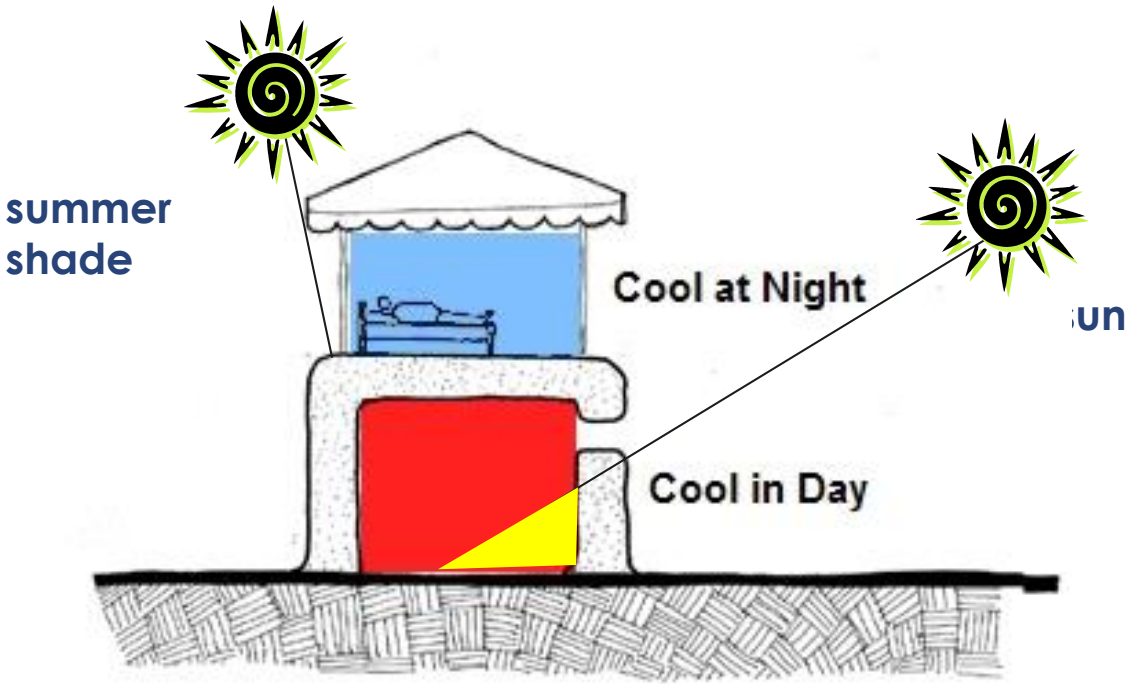
- **careful condensation control**
- **higher roof, wall and elevated floor insulation levels**
- **control infiltration pathways**
- **eliminate thermal bridging**
- **advanced hybrid design**

design strategies

2. Sub-Tropical e.g. Brisbane: (Warm Humid Summer, Mild Winter)

- **moderate mass useful particularly in winter otherwise**
- **low mass, elevated**
- **shaded north facing solar gain windows**
- **high levels of natural and ceiling fan ventilation**
- **moderate insulation**
- **light coloured roofs**
- **access to breezes**
- **landscape planting to channel breezes and provide shade**
- **moderate eaves and ample shading to N, E, W elevations**
- **rain protection to ventilation openings**
- **minimise surface albedo**
- **covered insulated roof, outdoor living areas**

design strategies



Source: Wooley, J., SNACK: PLACE, 1997, QUT , AIID

design strategies

2. Sub-tropical e.g. Brisbane: (Warm Humid Summer, Mild Winter)

Additional issues if air conditioning is to be installed:

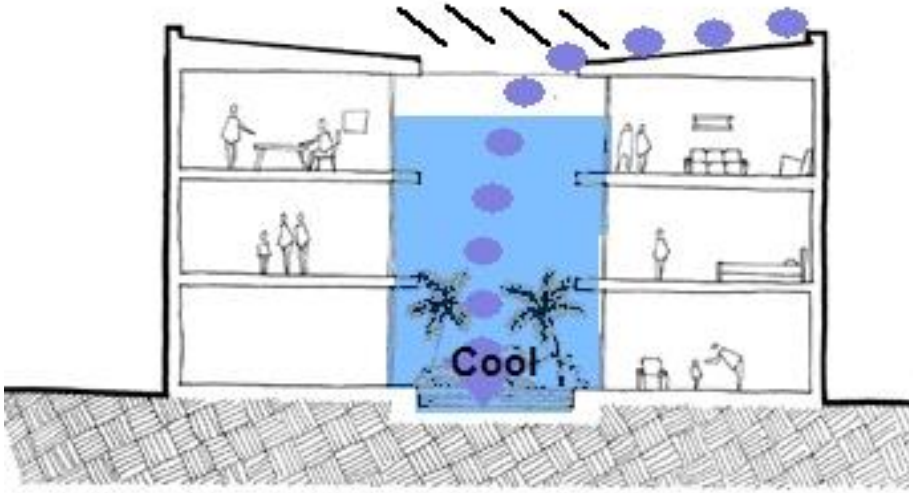
- **Careful condensation control**
- **higher roof, wall and elevated floor insulation levels**
- **control infiltration pathways**
- **eliminate thermal bridging**
- **advanced hybrid design**

design strategies

3. Hot arid e.g. Alice Springs (Hot Dry Summer Warm Winter)

- **high mass particularly useful summer and winter (earth integrated is highly suitable)**
- **moderate area well shaded north facing windows**
- **high levels of natural and ceiling fan ventilation**
- **moderate insulation**
- **light coloured roofs**
- **evaporative cooling,**
- **landscape planting to provide shade and shelter from winds**
- **wide eaves and ample shading**
- **minimise surface albedo**
- **covered insulated roof, meshed outdoor living areas**
- **control infiltration pathways**

design strategies



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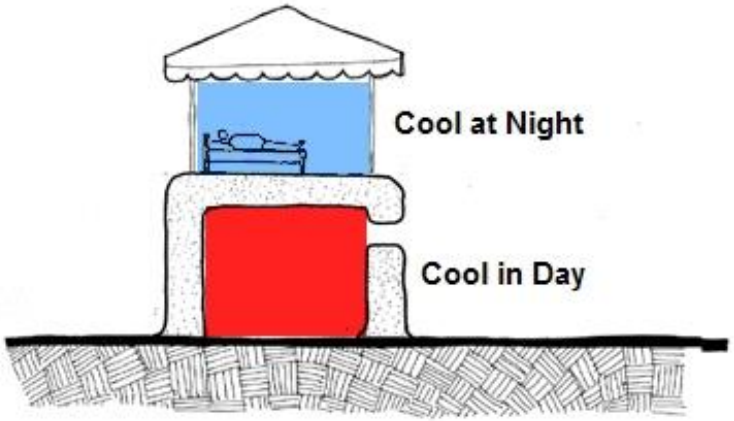


design strategies

3. Hot arid e.g. Alice Springs (Hot Dry Summer Warm Winter)

Additional issues if air conditioning is to be installed:

- **higher roof, wall and elevated floor insulation levels**
- **further control infiltration pathways**
- **eliminate thermal bridging**

design strategies

4. Hot dry e.g. Albury/Wodonga (Hot Dry Summer Cool Winter)

- **high mass particularly useful summer and winter (earth integrated is highly suitable)**
- **shaded north facing solar gain to windows mid autumn to mid spring**
- **high levels of natural and ceiling fan ventilation**
- **moderate insulation**
- **light coloured roofs**
- **evaporative cooling,**
- **night sky radiation cooling**
- **deciduous plantings to provide summer shade and winter solar gain**
- **wide eaves and ample shading**
- **minimise surface albedo**
- **covered insulated roof, meshed outdoor living areas**
- **control infiltration pathways**

design strategies

4. Hot dry e.g. Albury/Wodonga (Hot Dry Summer Cool Winter)

Additional issues if air conditioning/heating is to be installed:

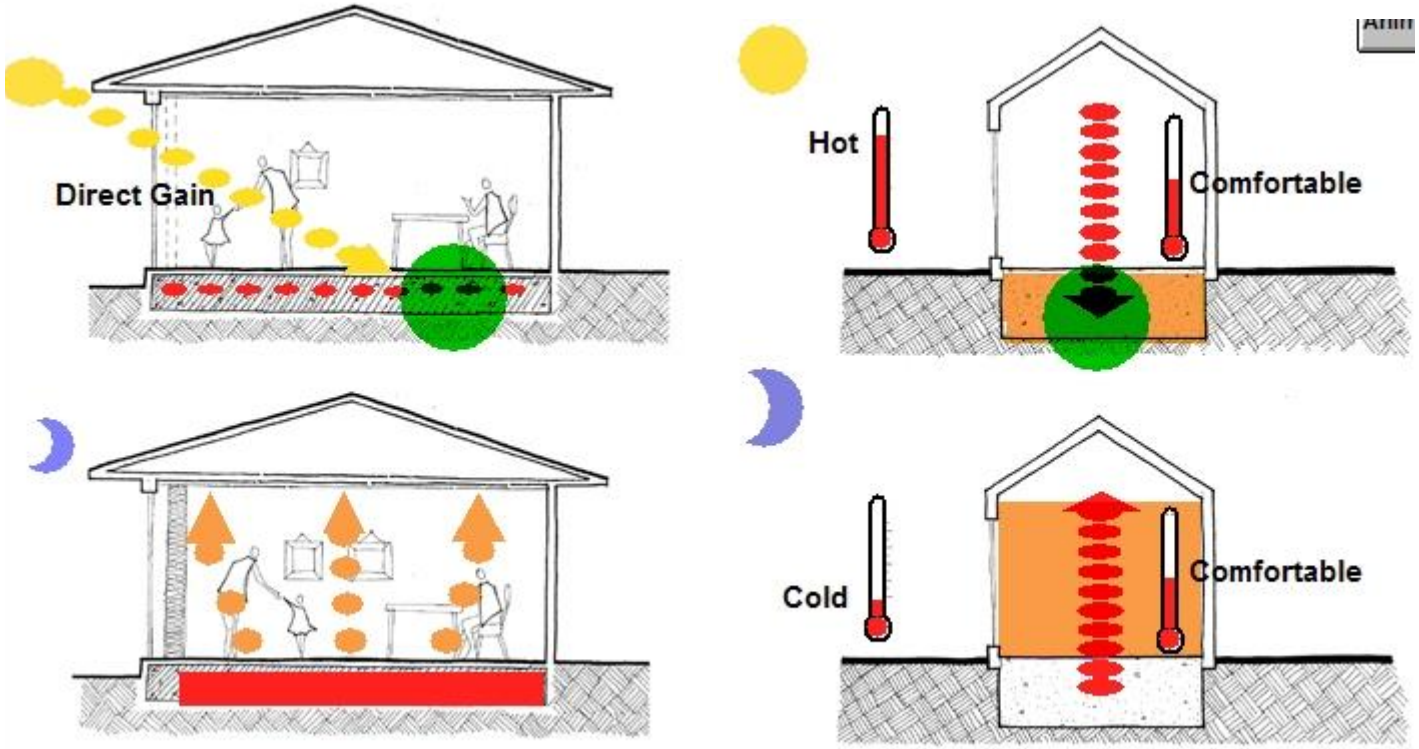
- **higher roof, wall and elevated floor insulation levels**
- **further control infiltration pathways**
- **eliminate thermal bridging**

design strategies

5. Warm temperate e.g. Perth, Sydney East (Warm Summer, Cool Winter)

- **moderate to high thermal mass for summer and winter (earth integrated is suitable)**
- **ample shaded north facing solar gain to windows mid autumn to mid spring**
- **ample access to sea breezes, ceiling fan ventilation**
- **protection from strong summer and winter winds**
- **moderate insulation**
- **light coloured roofs**
- **deciduous plantings to provide summer shade and winter solar gain**
- **moderate eaves and shading**
- **minimise surface albedo**
- **covered insulated roof, meshed outdoor living areas**
- **control infiltration pathways**

design strategies



winter

summer

Source: Wooley, J., SNACK: PLACE, 1997, QUT , AIID

design strategies

5. Warm temperate e.g. Perth, Sydney East
(Warm Summer, Cool Winter)

Additional issues if air conditioning/heating is to be installed:

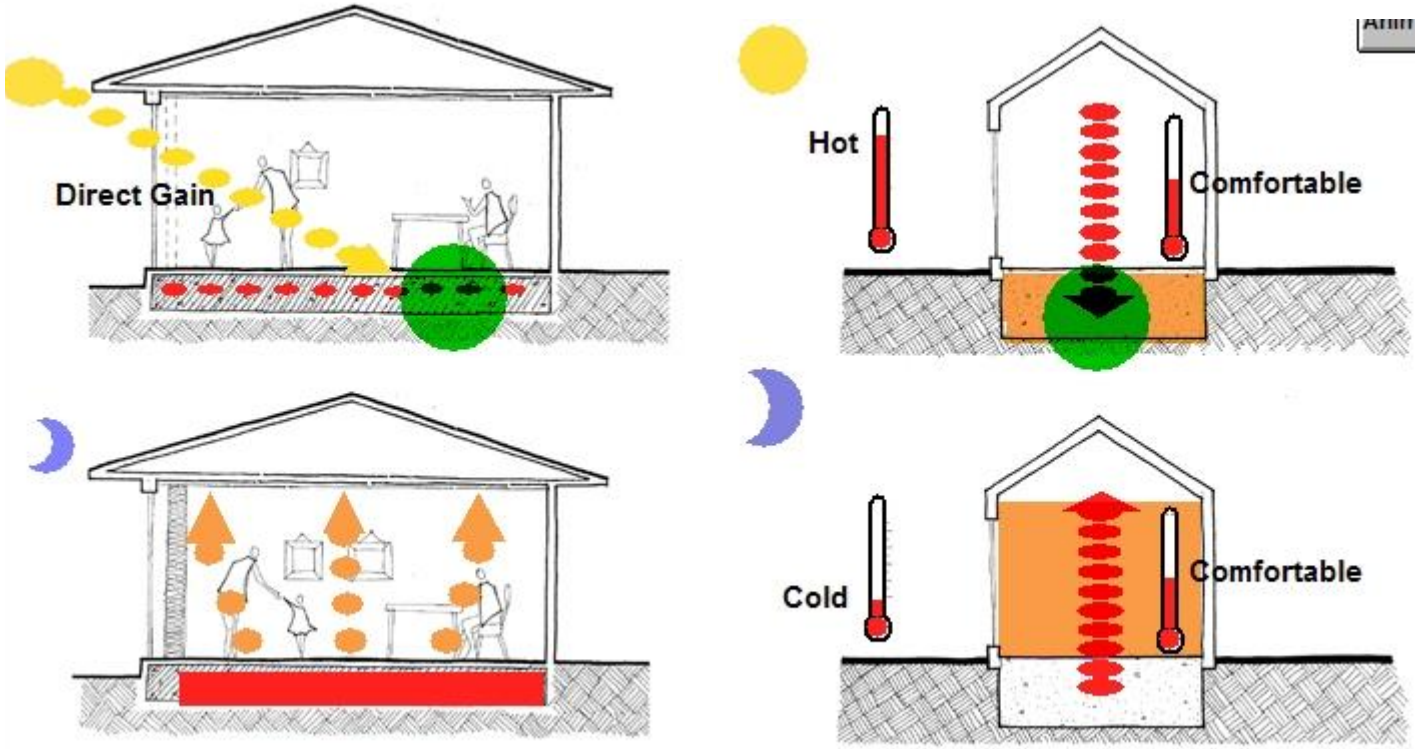
- **higher roof, wall and elevated floor insulation levels**
- **further control infiltration pathways**
- **eliminate thermal bridging**

design strategies

6. Mild temperate e.g. Melbourne, Sydney West (Mild to Warm Summer, Cool Winter)

- **moderate to high thermal mass for summer and winter (earth integrated is suitable) – reduce thermal mass if solar access is limited**
- **ample shaded north facing solar gain all autumn to all spring**
- **access to cool breezes, ceiling fan ventilation**
- **protection from strong summer and winter winds**
- **moderate to high insulation levels**
- **light – mid coloured roofs**
- **deciduous plantings for summer shade and winter solar gain**
- **moderate eaves and shading**
- **covered insulated roof, meshed outdoor living areas**
- **control infiltration pathways**

design strategies



winter

summer

Source: Wooley, J., SNACK: PLACE, 1997, QUT , AIID

design strategies

6. Mild temperate e.g. Melbourne, Sydney West
(Mild to Warm Summer, Cool Winter)

Additional issues if air conditioning/heating is to be installed:

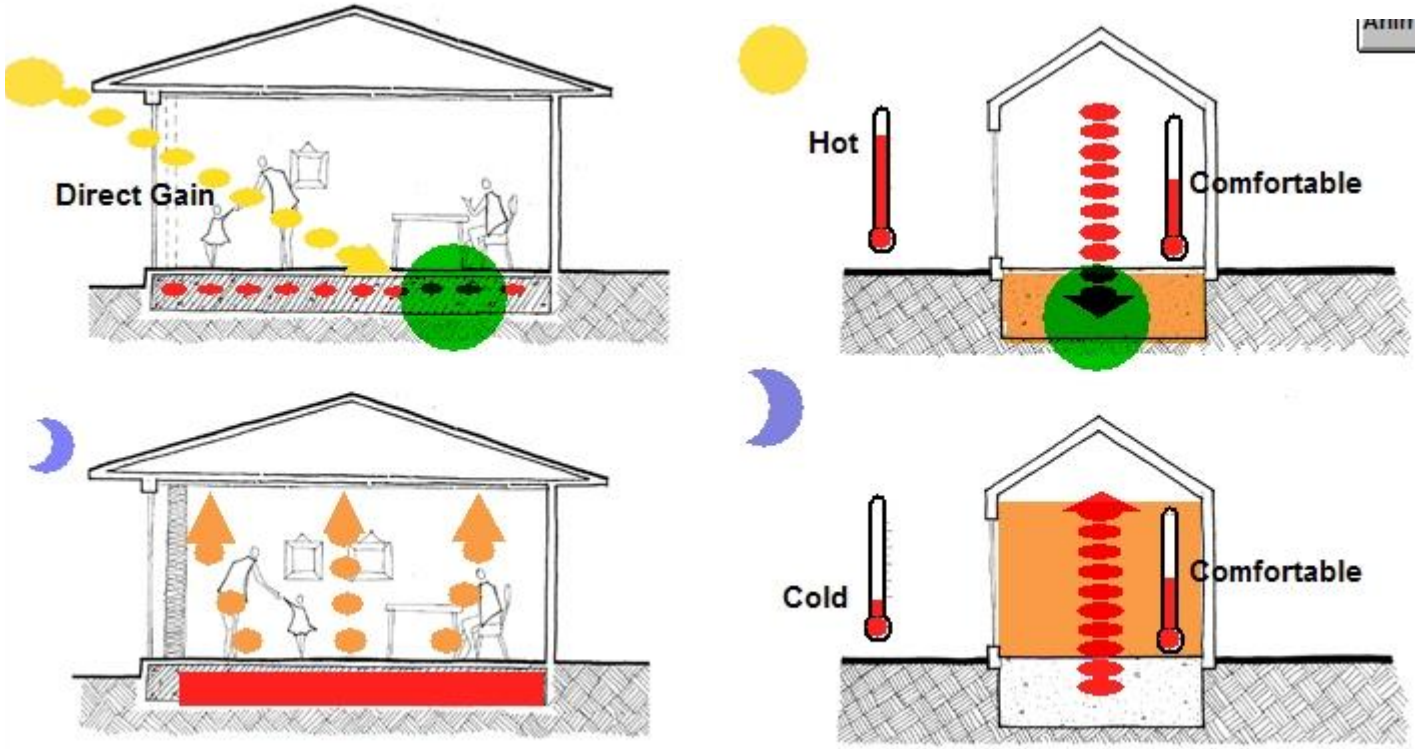
- **higher roof, wall and elevated floor insulation levels**
- **further control infiltration pathways**
- **eliminate thermal bridging**

design strategies

7. Cool temperate e.g. Canberra, Hobart, Blue Mts (Mild to Warm Summer, Cold Winter)

- **moderate to high thermal mass for summer and winter (earth integrated is suitable) – reduce thermal mass if solar access is limited**
- **ample shaded north facing solar gain autumn to spring**
- **access to cool breezes, ceiling fan ventilation**
- **protection from strong summer and winter winds**
- **moderately high insulation levels**
- **light – mid coloured roofs**
- **deciduous plantings for summer shade and winter solar gain**
- **moderate eaves and shading**
- **double glazing**
- **auxiliary solar hydronic or radionic space heating**
- **covered insulated roof, meshed outdoor living areas**
- **control infiltration pathways**

design strategies



winter

summer

Source: Wooley, J., SNACK: PLACE, 1997, QUT , AIID

design strategies

7. Cool temperate e.g. Canberra, Hobart, Blue Mts (Mild to Warm Summer, Cold Winter)

Additional issues if air conditioning/heating is to be installed:

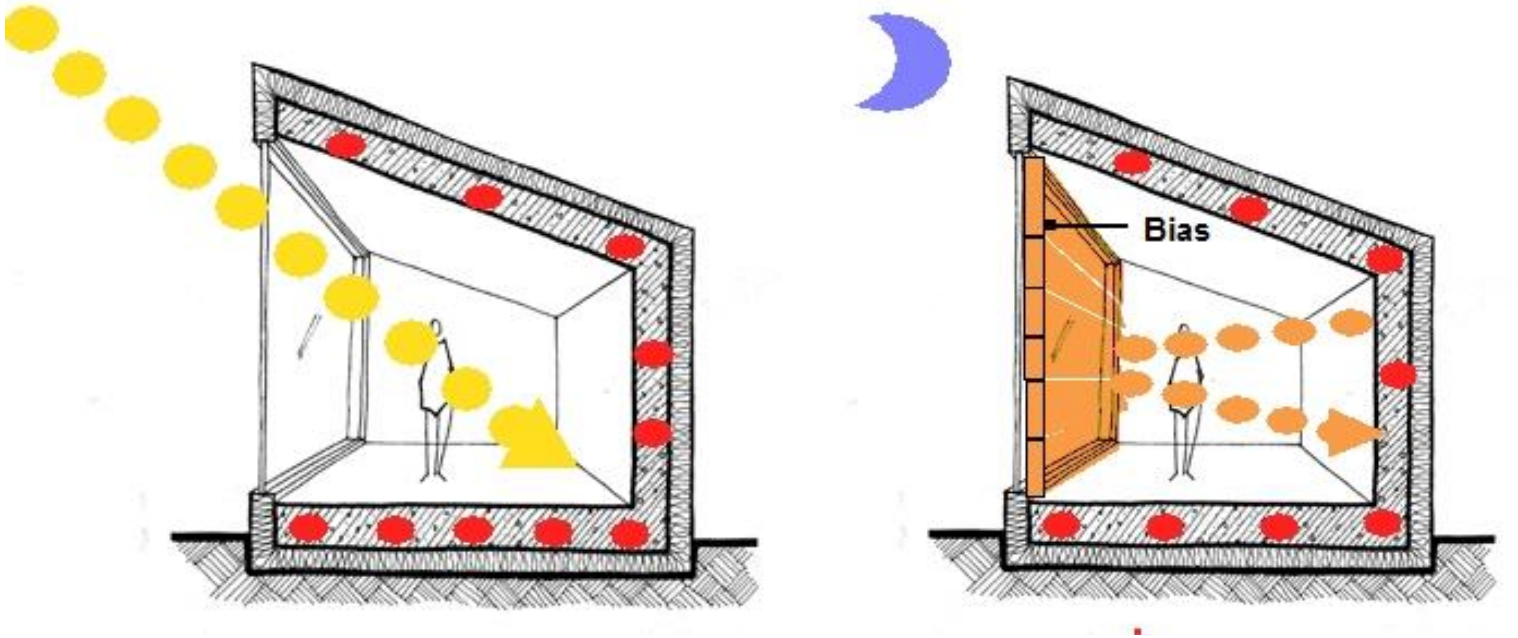
- **higher roof, wall and elevated floor insulation levels**
- **further control infiltration pathways**
- **eliminate thermal bridging**

design strategies

8. Alpine e.g. Thredbo (Warm Summer Cold to Very Cold Winters)

- **moderate to high thermal mass for summer and winter (earth integrated is suitable if external insulation is considered) – reduce thermal mass if solar access is limited**
- **ample shaded north facing solar gain all autumn to all spring**
- **access to summer breezes**
- **protection from strong winter winds and snow loads**
- **high insulation levels**
- **mid-dark coloured roofs**
- **deciduous plantings for summer shade and winter solar gain**
- **moderate eaves and shading**
- **double or triple glazing**
- **auxiliary solar hydronic or radionic space heating**
- **control infiltration pathways & eliminate thermal bridging**
- **room heaters internally located off external walls**

design strategies



day night

Source: Wooley, J., SNACK: PLACE, 1997, QUT , AIID

hot humid hybrid design

Hot Humid Hybrid (HHH) Dual Mode Design Concept

When a building is air conditioned in Hot Humid climates the temperature differential across the external envelope can typically be around 15^0C - similar to the heat loss differential in a Melbourne winter except reversed i.e. potentially the same:

- **roof,**
- **wall,**
- **underfloor,**
- **window insulation and**
- **infiltration control**

requirements as climate 7 except the vapour barrier will be on the other side of the insulation

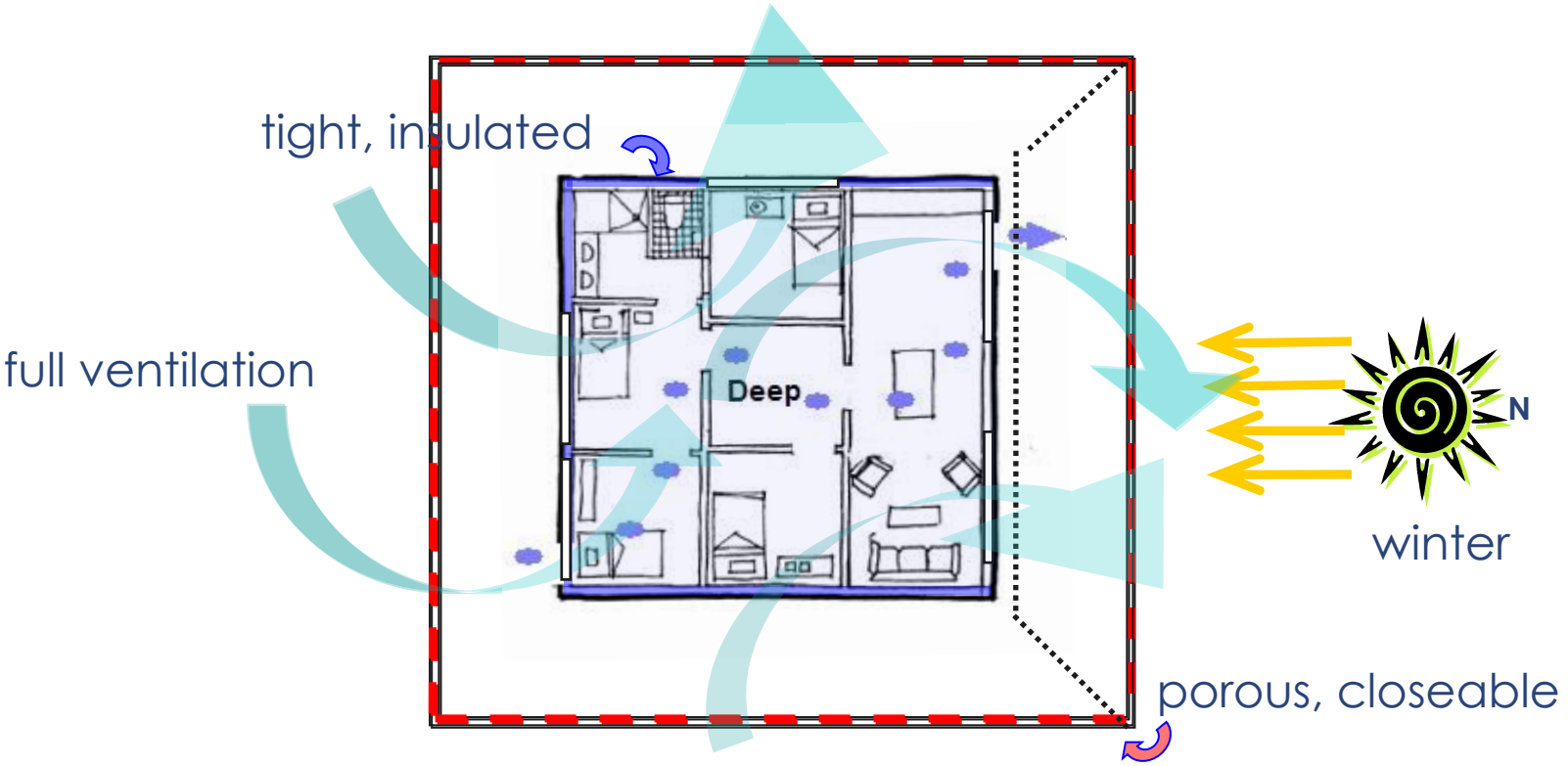
hot humid hybrid design

Hot Humid Hybrid (HHH) Dual Mode Design Concept

Buildings are designed to have zones that:

- **have an outer, lightweight, highly porous zone that is single or louvre glazed and provides total shade and radiant protection to an**
- **inner zone that while highly insulated and tightly weatherstripped to all door openings when closed can nonetheless be opened up and ventilated when desired.**

hot humid hybrid design



Source: D. Baggs

compensating strategies

issue	potential solution
large east/west view windows wanted	• **moveable shading – blinds, roller or tracked shutters** • **best to use moveable louvred options so does not interfere with ventilation in hot conditions**
double loaded corridor multi-units	• **best to use east/west orientation and shading** • **consider widening the plan form to allow increased distance between ventilation openings**

compensating strategies

issue	potential solution
insufficient solar access in heating conditions (dwelling underheating)	• **reduce mass levels and** • **increase insulation to all elements, eg:** • **use low E glass, insulated (thermally broken/timber/UPVC) frames, double glazing etc** • **reduce window area – particularly high windows under eaves or shading** • **underfloor insulation** • **roofs/ceilings and walls** • **in full brick or block walls use internal plasterboard finish with insulation between the battens**

compensating strategies

issue	potential solution
dwelling underheating generally	**as before plus:** • **add properly shaded north window area** **if above is inadequate:** • **check overall window area compared to floor area** • **check overall wall area compared to plan area** • **reduce horizontal overhangs** • **increase window area**

compensating strategies

issue	potential solution
North facing plan showing as underheated	• **reduce horizontal overhangs** • **Increase window area**

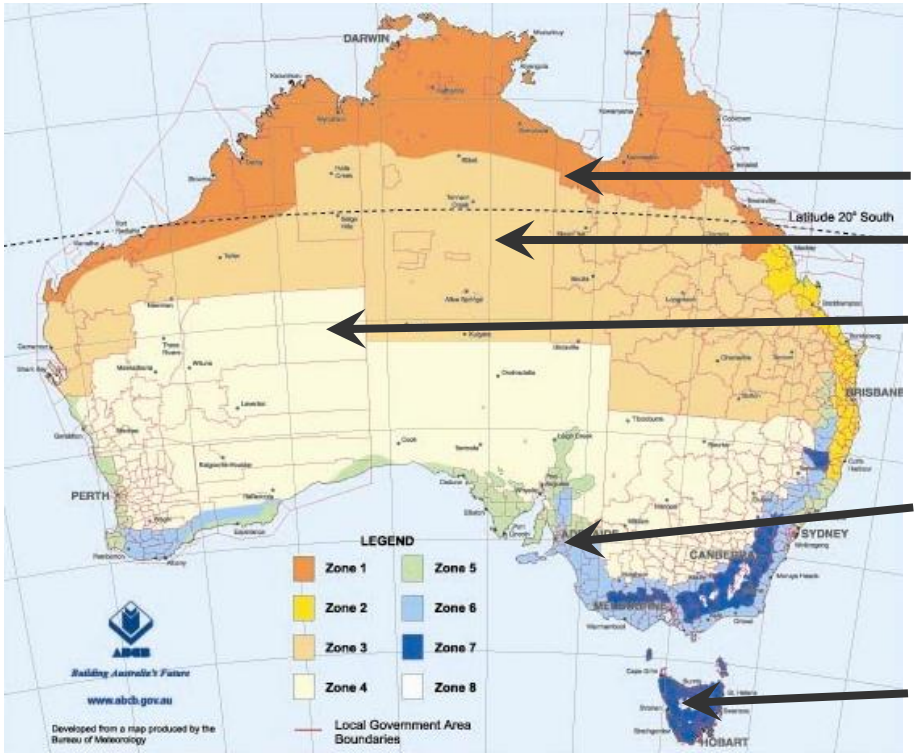
compensating strategies

issue	potential solution
dwelling overheating generally	• **check north window shading is adequate** • **consider reducing east/west window area and/or** • **adding additional vertical moveable or correctly angled louvre shading** • **check insulation levels to all elements are adequate particularly roof** • **review ventilation performance consider increased openings or streamlining pathways**

design strategies

issue	potential solution
dwelling overheating generally (cont'd)	**if previous is inadequate:** • **check overall window area compared to floor area – consider reducing east/west/south glass** • **check overall wall area compared to plan area**

Case studies - mixed climates



Hot humid climates

Hot arid climates with warm winters

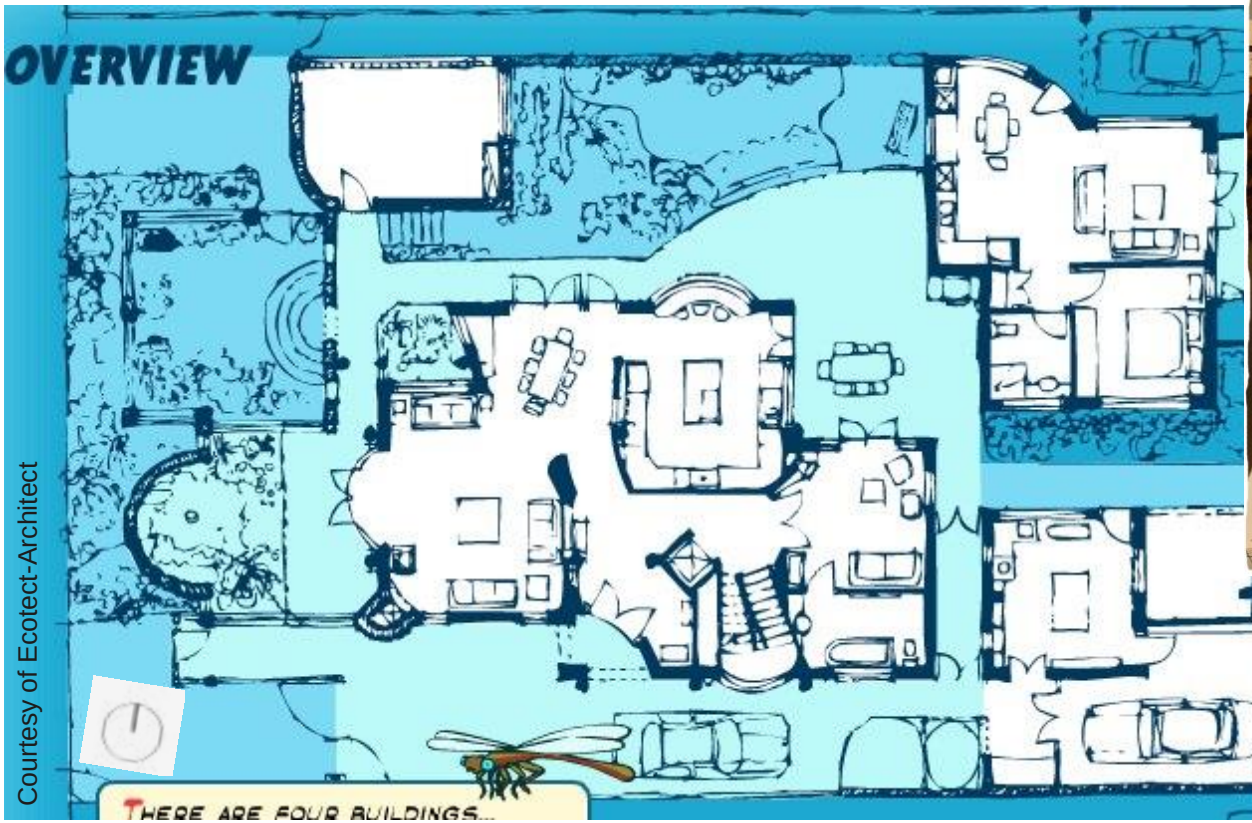
Hot arid climates with cold winters

Mixed climates

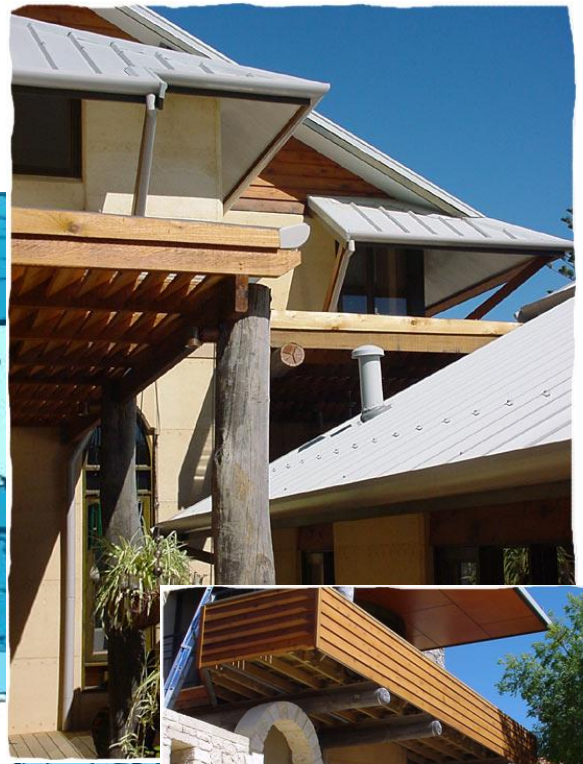
Heating climates

Case studies - mixed climates

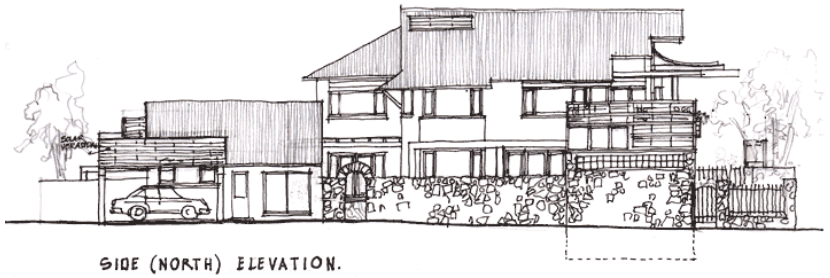
The Eco-Compound, WA

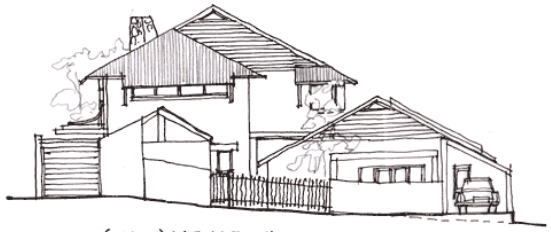


Courtesy of Ecotect-Architect



Case studies - mixed climates





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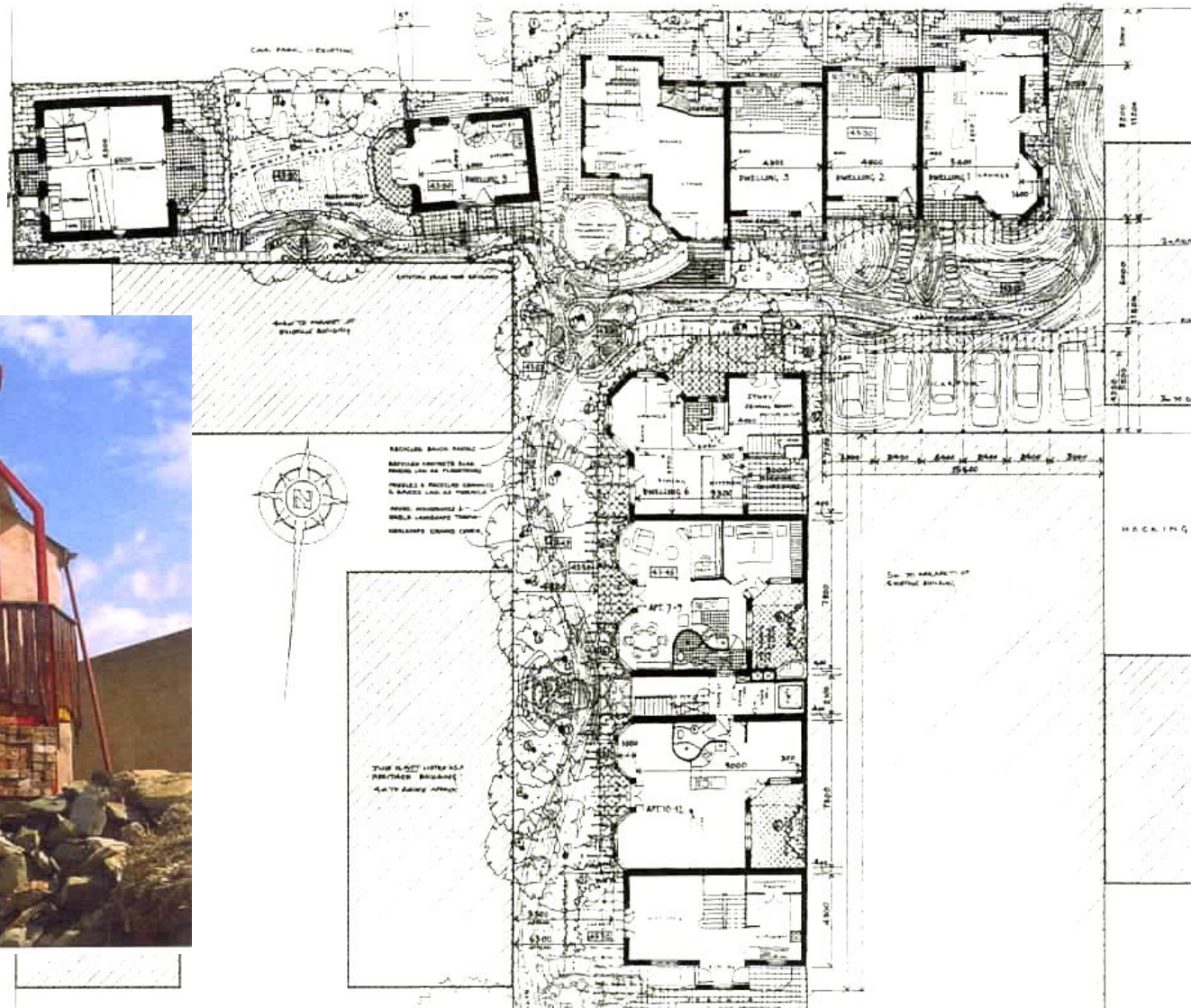
Courtesy of Ecotect-Architect

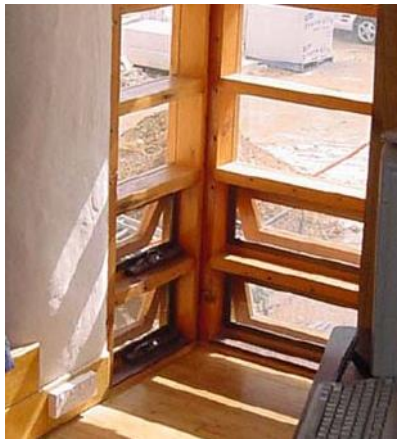
Case studies - mixed climates

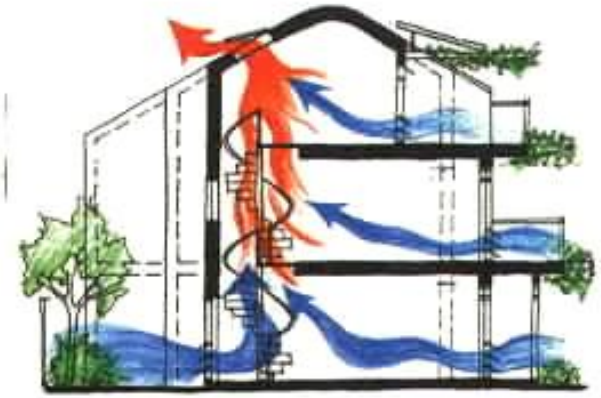
Christie Walk, Adelaide

Courtesy of Ecopolis



Case studies - mixed climates



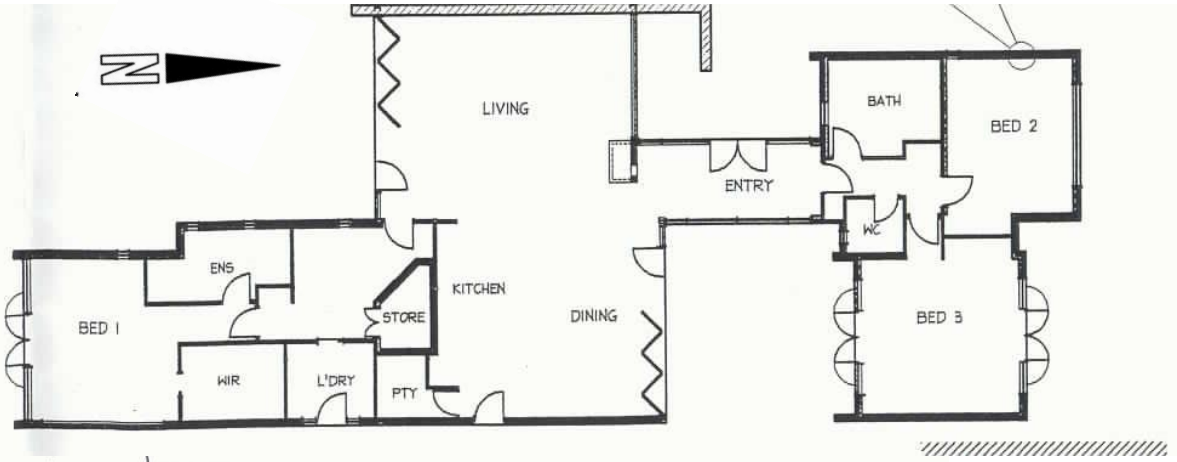


Thermal flues

Case studies - mixed climates

Case studies - mixed climates

Marleston, Adelaide



Courtesy of next - you're home

Case studies - mixed climates

Courtesy of next - you're home

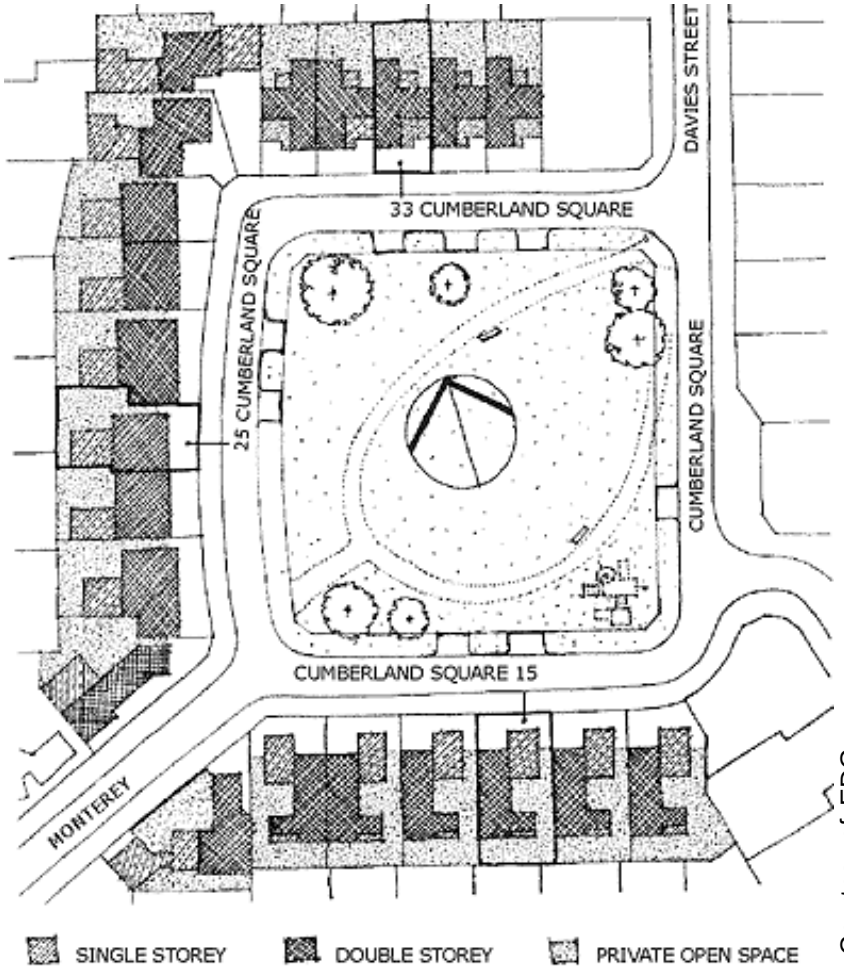
Case studies - mixed climates

Courtesy of next - you're home

Case studies - mixed climates

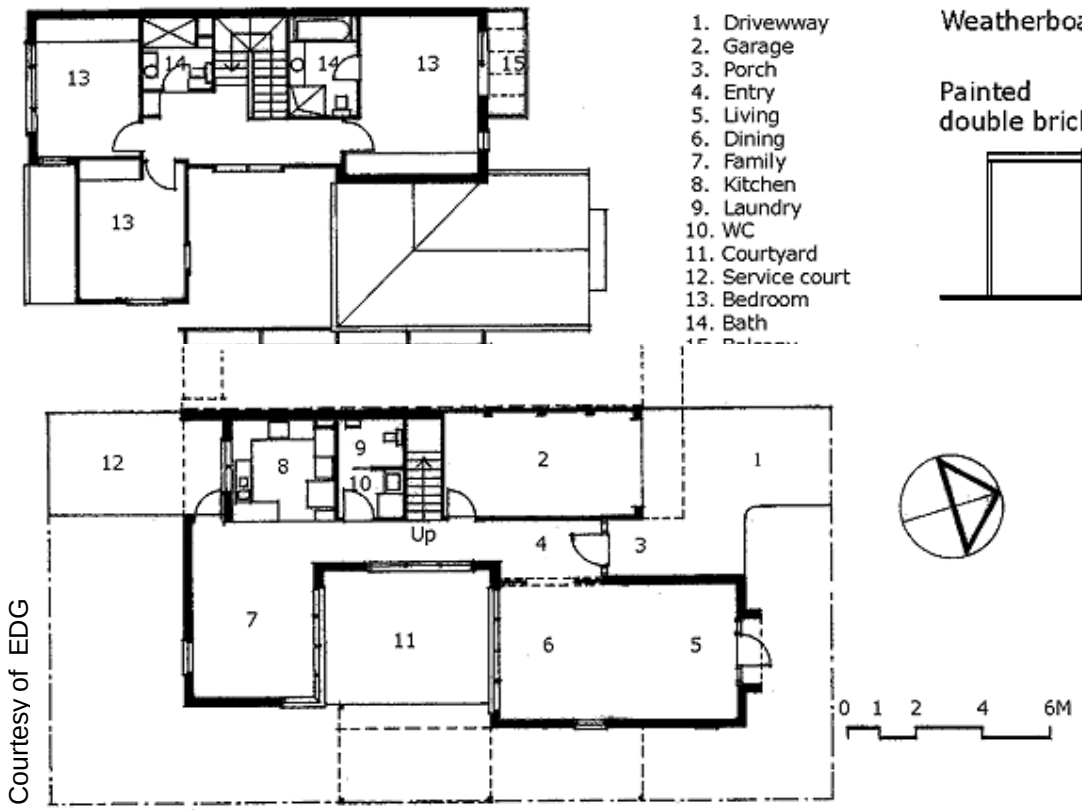
Newington Village, Sydney

Courtesy of Lend Leas & Mirvac



Courtesy of EDG

Case studies - mixed climates



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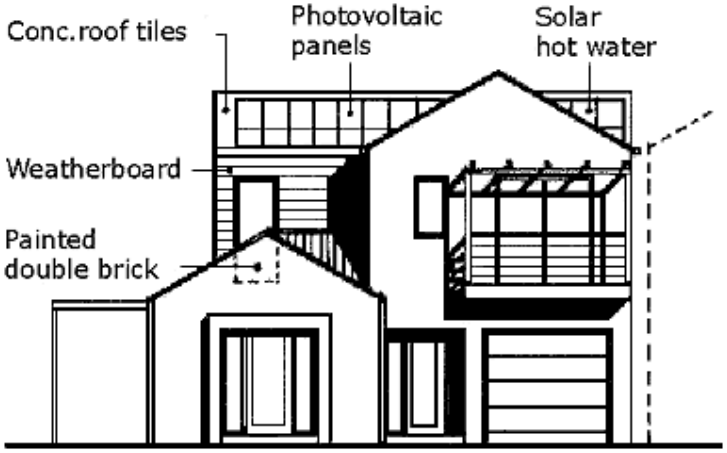
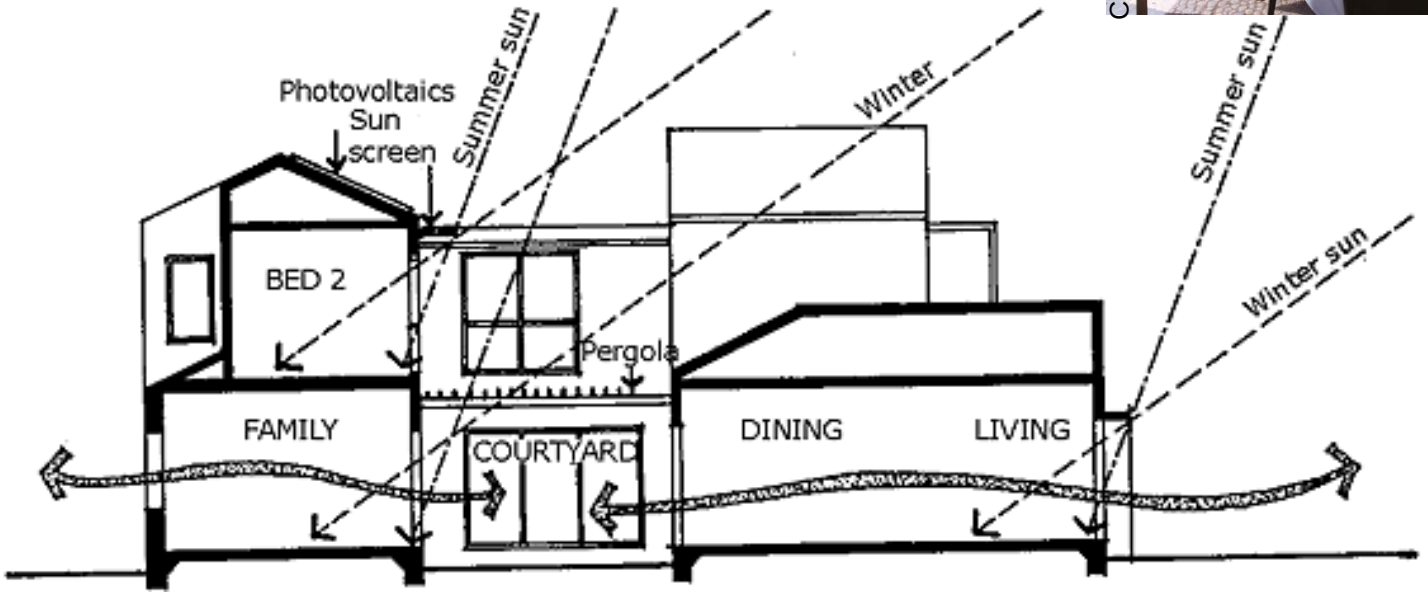


Courtesy of Lend Leas & Mirvac

Case studies - mixed climates

Courtesy of



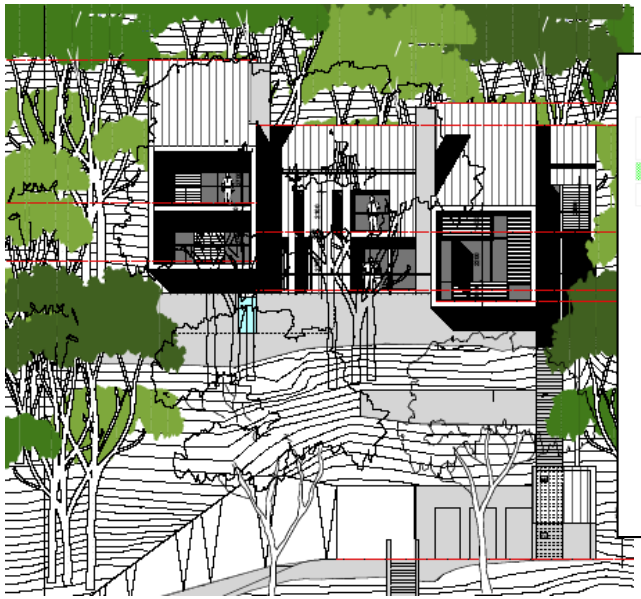
Courtesy of EDG

Case studies - mixed climates

McArthur, Sydney

Thermal loads

Suspended floor concession	No concession claimed
Heating load (MJ/m2.year)	74.90
Cooling load (MJ/m2.year)	26.00



Courtesy of Kennedy Associates Architects

NatHERS V2.32

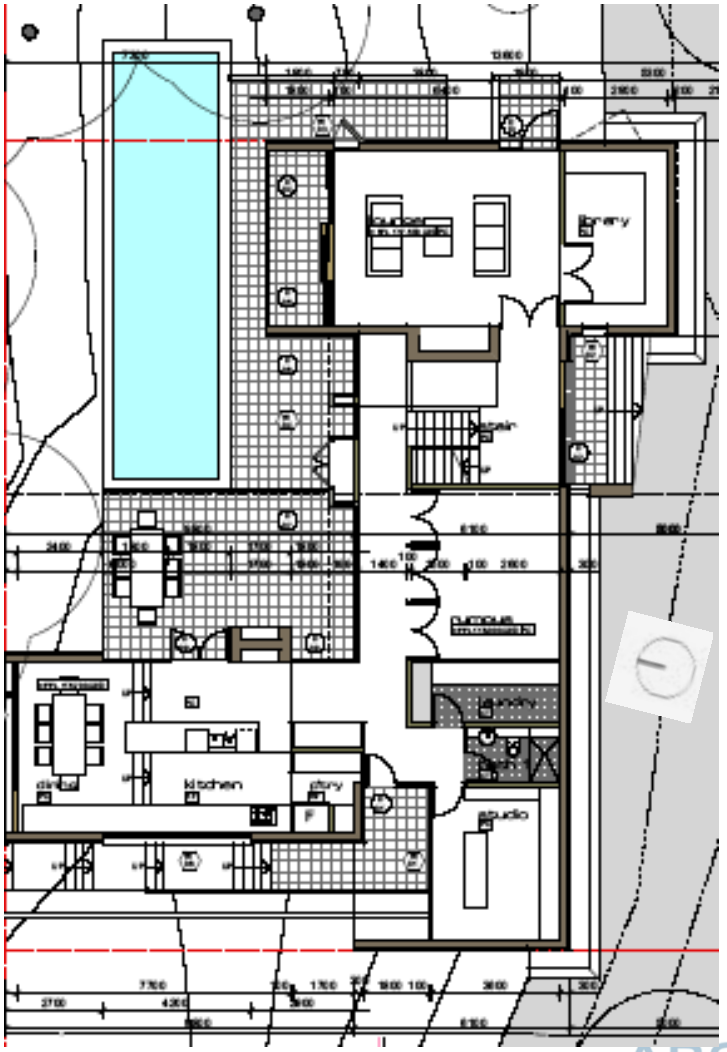
Nationwide House Energy Rating Scheme

Energy Rating Report

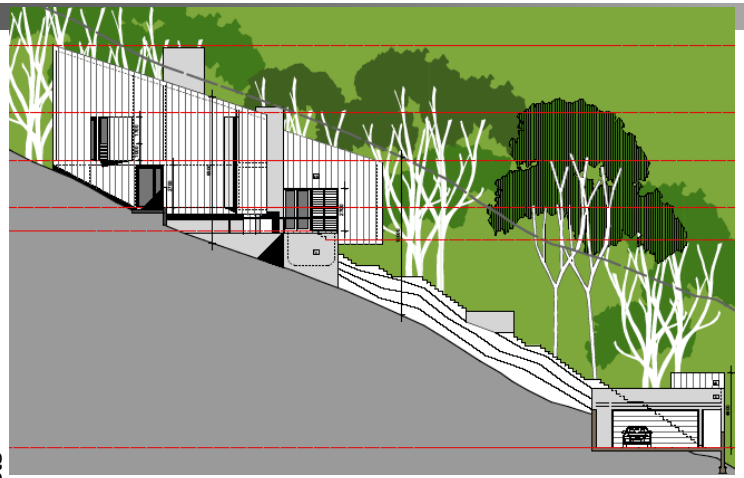
RATED ENERGY REQUIREMENTS*

★★★★★ 5 STARS

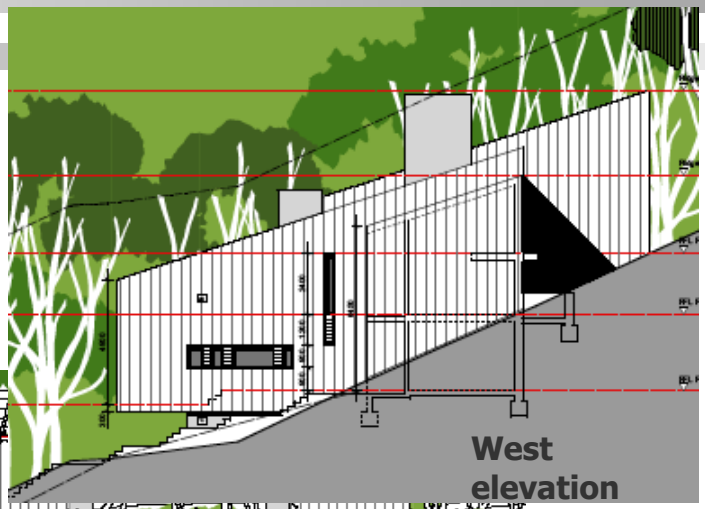
SUMMARY



Case studies - mixed climates

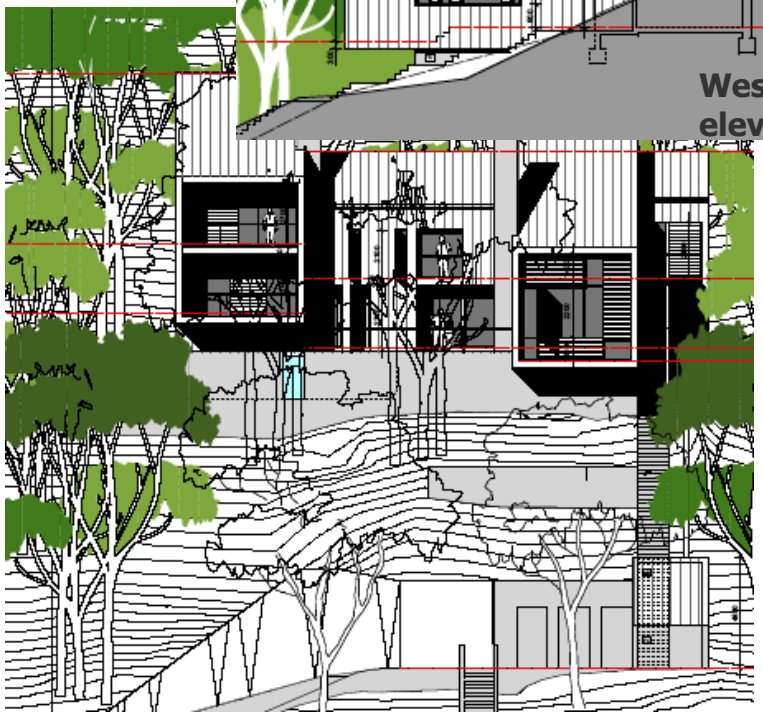


East elevation



West elevation

South elevation



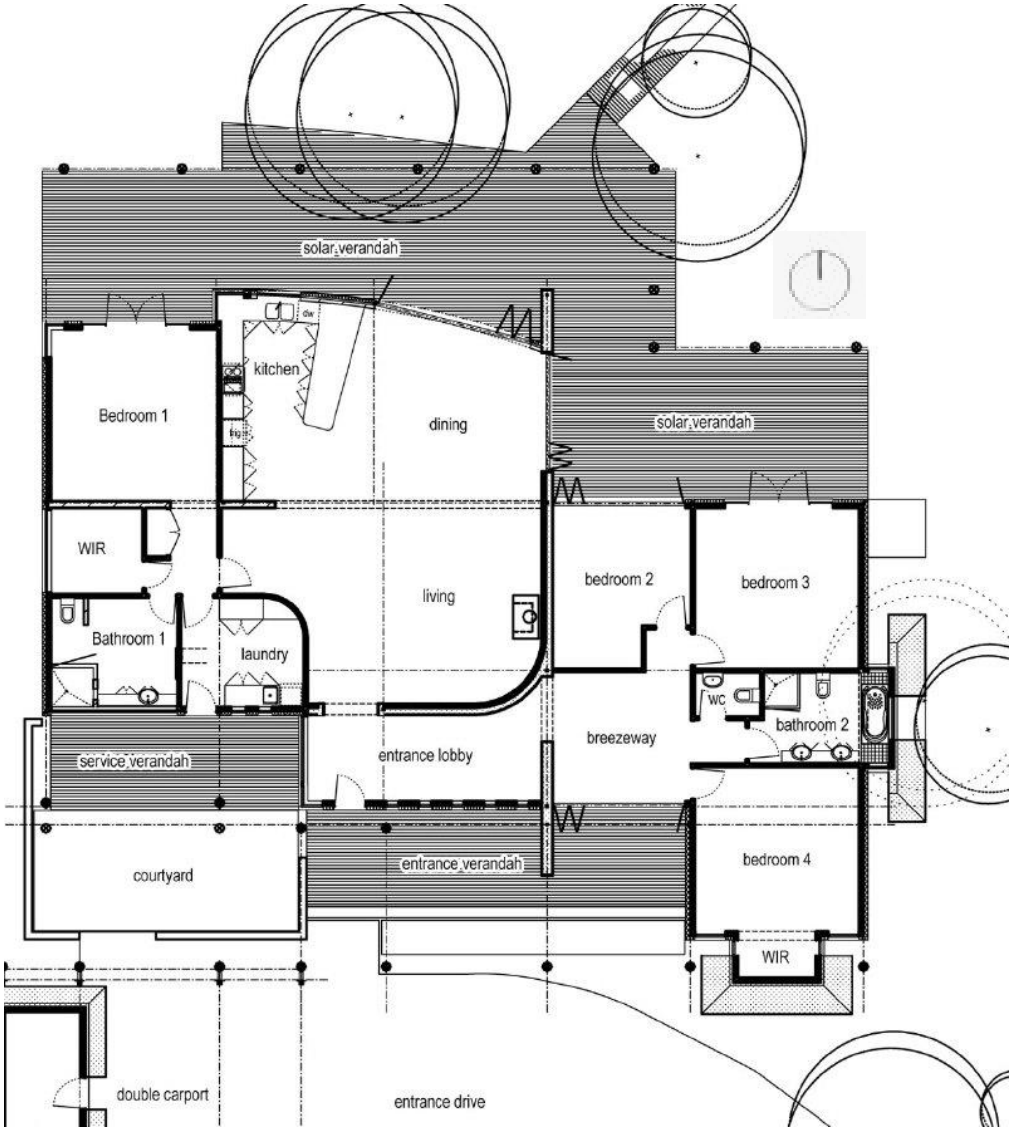
North elevation

Courtesy of Kennedy Associates Architects

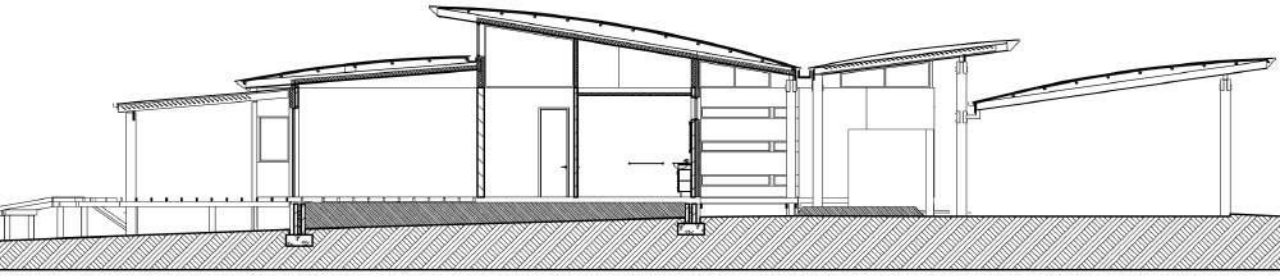
Case studies - mixed climates

The South West Beach House, WA

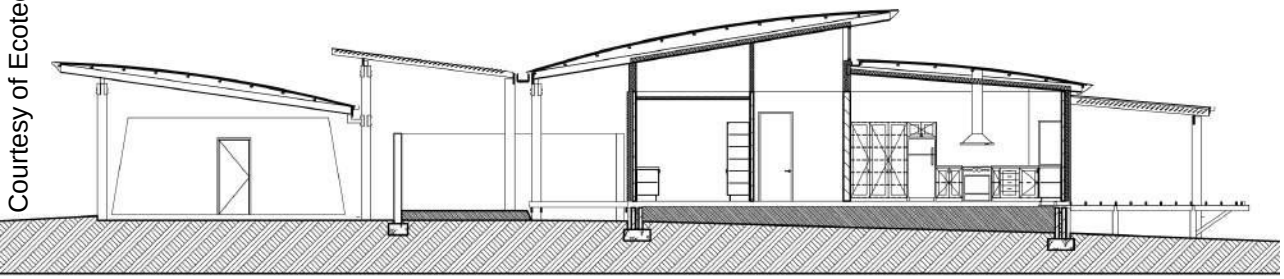
Courtesy of Ecotec Architect



Case studies - mixed climates

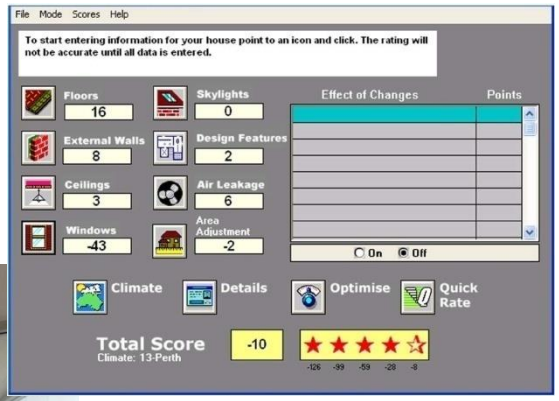


SECTION 1



Courtesy of Ecotect-Architect

Case studies - mixed climates

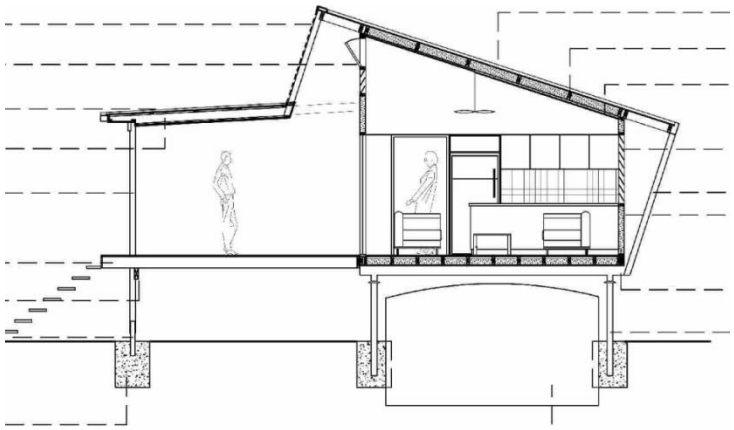


Courtesy of Ecotect Architect

Responses in other climates

Woodstock House, Melbourne,
-Heating climate

Courtesy of Sustainable Built Environments



Broome, WA.

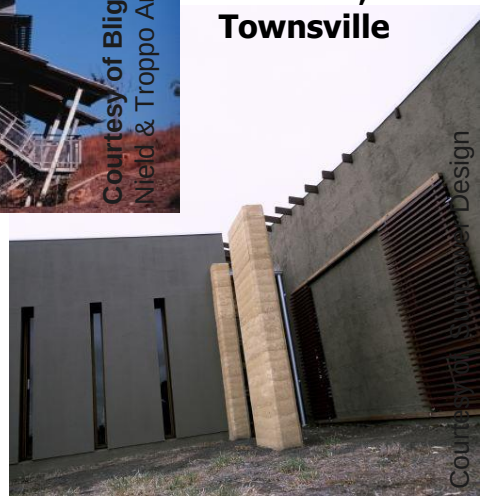
Arrihjere, Central Australia

Courtesy of Brendan J Meney Architect

Courtesy of Bligh Voller Nield & Troppo Architects

Lavarack Barracks, Townsville

Woodstock House, Vic



Questions

T3 Learning Outcomes

- **Make recommendations for improving thermal performance that are appropriate to the climate**
- **Interpret the properties of materials which can influence the thermal performance of a building (include: orientation, zoning/layout, insulation, mass, glazing, materials, ventilation, convection, shading, landscaping)**
- **Assess the cost implications of any recommendations for improving performance**
- **Consider the practical application of any recommendations (i.e., how will it / can it be built?)**

Assessment

Written assessment in class

Time allocated 30 minutes

Residential Building Thermal Performance Assessment

Accredited Assessor Training

THANK YOU FOR ATTENDING

Please complete the

Participant Evaluation Form

developed by
the Association of Building Sustainability Assessors

ABSA