TECHNICAL

cool living

ed. 'Hot Dry'

A framework & guidebook for improved thermal comfort through targeted passive design upgrades in Aboriginal community housing in hot periods

Bobbie Bayley | www.coolliving.info

I would like to acknowledge that where ever we are in this big country, that we are with deep time and deep stories with a long history and future of people and place co-existing.

To all the communities I have worked with and the people who have entrusted stories of their lived experiences with me and showed me their homes - thank you.

To my mentors - new and old, especially Healthabitat - for continuing to invest in me and weaponise me with knowledge, awareness and gratitude - thank you isn't enough.

Thank you to all the people who have contributed to my thesis journey..

Adrian Page / legend
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Owen Kelly / Co-conspirer
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Tim Sourbutts / Healthabitat
Tori Walker / Bera Sustainability

Cool Living, Edition: Hot Dry
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This project is based on this quote:

"Without action to stop climate change, people will be forced to leave their Country and leave behind much of what makes them Aboriginal.

Climate change is a clear and present threat to the survival of our people and their culture." [1]

1 - (Allam and Evershed 2019) from 2021 AHURI Report, 'Sustainable Indigenous housing in regional and remote housing'

About the author:

This book is part of the 'cool living' project.

This project is by Bobbie Bayley as a part of her final year of the Masters of Architecture program at the University of Newcastle (UON) in 2023.

Bobbie began her studies and architectural journey in 2012 at UON. She has spent the last 6 years working with Healthabitat and carrying out australian-centric thinking, arid architectural journeys, research, discovery and community engagement.

The year-long Independent Design Thesis was the vehicle to explore a topic which is of increasing concern to many:
Sub-par community housing and the threat of climate change. People's houses will cost them their lives, or people will have to walk away.

This project attempts to create a suite of tools which don't currently exist -

- A hierarchical list of what you do first and what you do last to improve thermal comfort in existing community housing
- An action list backed by data and relevant for the patterns of living often experienced in remote communities
- Work that can be used by community who are tired of hot houses OR by the organisations who have the 'power' over the 'asset,' not just the powercard

Who is this for & why should you care?

WHO FOR?

This book is the 'cool living' TECHNICAL EDITION. It is for professionals such as building designers, architects and builders, and Housing organisations who may be planning house upgrades or carrying out proposals for grant funding and research.

This work is to convince people of the importance of passive upgrades to improve thermal comfort. This is a suite of tools to inform prioritised upgrades to community housing to improve thermal comfort in summer. See chapter 4 for project parts.

For best possible outcomes, in any venture, it is long known that if you involve the people who the outcome is for in the process, you get far better and long term results. It is expected the Community Edition will be used by the professionals to carry out tenant education and community consultation

WHY CARE?

With climate change, this will become more important because the weather will be hotter for more days a year.

When people don't have power on hot days, they can't use the air-conditioner to stay cool and their health is at risk. Sub-par community houses are a burden to its often already disadvantaged tenants and their hip pocket. 74.6% of the NT's Aboriginal population live in remote or very remote areas, meaning climate change will disproportionately affect Aboriginal people.

When temperatures soar, people's houses will cost them their lives, or people will have to walk away from their Country, family and identity.

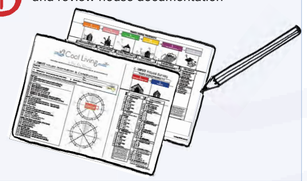
How do you use ‘cool living’?

1 $ allocated for cooling modifications to houses

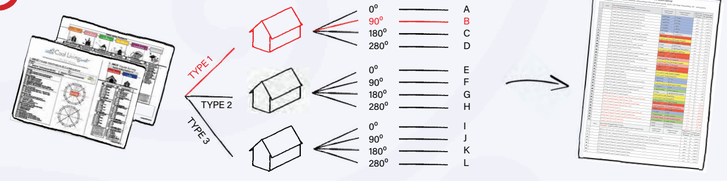
2 Learn about ‘cool living’ project

3 Community consultation about targeted modifications and budget

4 Complete cool living house survey at house and review house documentation

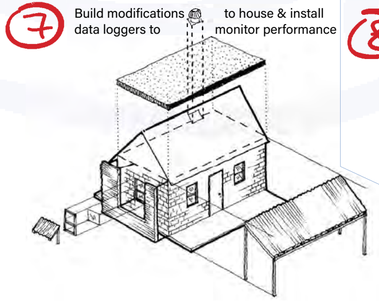


5 Select correct Bang for your Buck list which is closest to house type surveyed



6 Refer to survey answers and select modifications in your bduget for the BIGGEST impact - Refer to Built examples gallery for ideas

7 Build modifications to house & install data loggers to monitor performance

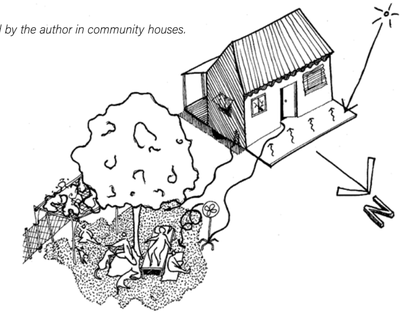


8 Monitor and document house performance, energy use and tenant feedback (post-occupancy evaluation)

What’s in this book?

www.coolliving.info

This sketch shows common things experienced by the author in community houses.



Common Questions on this topic:

Q - Why is my house so hot?

Answer - Depending how old your house is, what your house is built from, which walls face the sun, if you have insulation in the walls or roof, if you have verandahs or shading or how good windows and doors work will depend how hot your house is without a power card. A powercard to use the fans and
Air-Conditioner will help cool the house down, but if the house is not designed right for the climate, you will have to spend more money ($) on power.
Action - Use the House Survey to work out what your house does and does not have to make it cool.

Q - Will Housing make my house cooler?

Answer - Housing have a responsibility to the tenants of their houses to make sure they are safe and the houses do not make them sick. Houses should be well built and have working air-conditioners. If your house does not have verandahs, shaded walls, insulation or a working air-conditioner, you need to talk to housing and tell them it is a health problem on hot days and they need to fix it.
Action - Show them this book and the website, tell them research shows my house needs these things to keep us cool, healthy and safe.

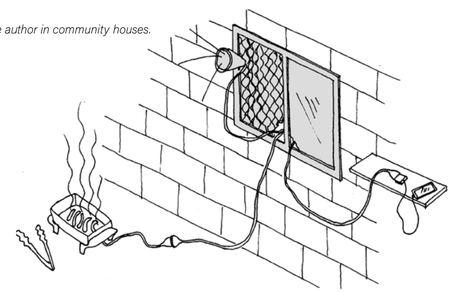
Q - Can i build the verandah and window awning myself?

Answer - Try to talk to Housing first before you build anything yourself. Make sure you record what day and time you have the meeting and what you talk about. At the meeting, tell them your house must be appropriate for the climate and be safe and liveable. If not, they are breaching the residential tenancy law (see recent news on Santa Teresa law suit).
Action - Use the House Survey to see what each house needs. Take this to your meeting with Housing and demand better housing.

Q - Who will pay for the house upgrades?

Answer - Housing get money from rent collection and money from the government. At the end of financial year (June every year), Housing might need to spend money quick. Depending how much money ($) is in their budget will depend how much they can spend.
Action - Talk to Housing at the start of the year before June about what the houses need and much money they have for your community for cooling house upgrades.

This sketch shows common things experienced by the author in community houses.



Q - What is Climate Change?

Answer - Climate change means a change in weather patterns because the temperature of the Earth is getting hotter because of the impacts people have had from burning fossil fuels (like coal), cutting down trees and farming. Climate change means rising sea levels, hotter days more often and more extreme floods and fires.
Action - Climate Change is a threat to your health if your house does not stay cool. Housing must do something. *Read more on page 14.*

Q - What is a good orientation for a house and what is passive solar design?

Answer - Orientation is the way your house faces in relation to the path of the sun and prevailing wind in your region. Because the path of the sun in Australia is to the north, the best orientation is to face your home and the living areas north. This means the living areas will get sun in winter to help heat them up. There should be big eaves or verandahs to block the sun in winter, to help keep the house. When house orientation is bad, this means the house will stay cold in winter and be hot in summer.
Action - The house should be built facing north (or within a certain range east and west of north) with good shading all around especially to the north, east and west. Read more on page 23 and 24.

Chapter 1

The Climate

- What is the ‘hot dry’ climate?
- What is climate change?
- What is the right temperature for a house?
- Heat & health
- Healthabitat & HLP8

Climate Profile - Arid / 'hot dry' ▪ Alice Springs

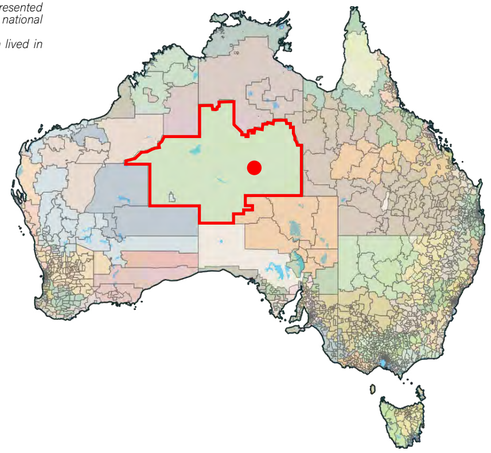
Arid/ 'hot dry' areas have little rain (arid <250mm rain & semi arid <350mm rain[1]) and high temperatures in summer. This covers about 70% of Australia. Australia is the direst inhabited continent in the world. The government has maps that define building rules.

NT government is responsible for about 5,498 houses across 73 remote communities, Alice Springs town camps, and Tenant Creek community living areas.[2]

In June 2021, Aboriginal people represented 30.8% of NT's population and 7.8% of the national Aboriginal population.
74.6% of the NT's Aboriginal population lived in remote or very remote areas.[4]

National Construction Code (NCC) Climate Divisions Map

This map has 8 climate zones. Government says new homes in each zone must be built to certain rules. This project is focusing on Zones 3 and 4.
'Climate zone 3 - hot dry summer, warm winter'
'Climate zone 4 - hot dry summer, cool winter'



Alice Springs (zone 6) NatHERS Map

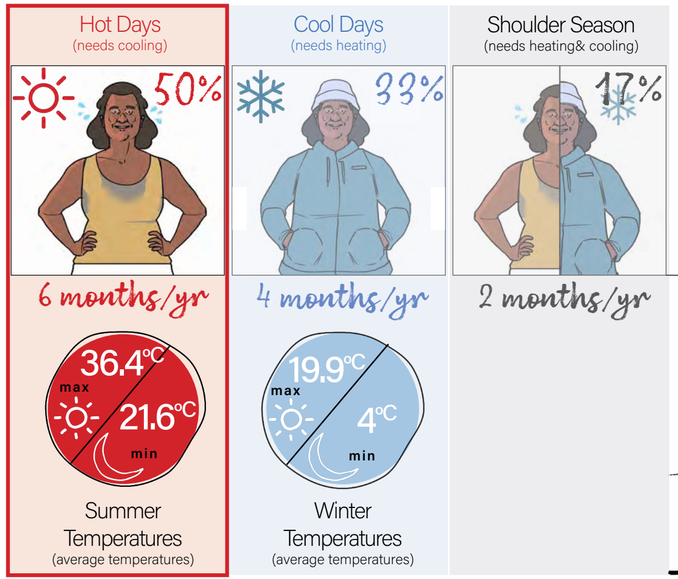
NatHERS = Nationwide House Energy Rating Scheme map has 67 climate zones.
Government says new homes built in each zone must reach a certain star between 1 to 10, with 10 being the best performing house thermally.
Government says all new houses and renovations to existing houses in Alice Springs should be built to at least 5 stars.[3]

1 - Department of Climate Change, E., the Environment and Water. (2023). Outback Australia - the rangelands. Australian Government. https://dcceew.gov.au/environment/land/rangelands
2 - Grealy, L. (2023). Healthy Homes Monitoring and Evaluation Project Final Report.
3 - Government, N. (2023). Residential building and energy efficiency. NT Government. https://nt.gov.au/property/building/build-or-renovate-your-home/building-and-energy-efficiency
4 - Finance, D. o. T. a. (2021, 30 June 2021). Northern Territory Economy https://nteconomynt.gov.au/population

Climate Profile - Arid / 'hot dry' ▪ Alice Springs

A building in Alice Springs should be built right for the Arid/ 'hot dry' climate.

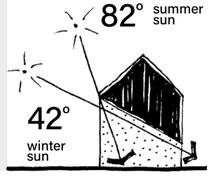
Yearly Heating & Cooling need [4]



"In Alice Springs... there were 55 days above 40°C in the year to July 2019, which included the hottest summer on record and the driest in 27 years [65.8mm of rain that year]" [1]

Key climate characteristics: [2]

- Distinct summer and winter seasons; very hot summers with hot, dry winds and cool winters with cold dry winds
- Very high day–night (diurnal) temperature range
- Very low rainfall



Seasonal Sun
Giasma

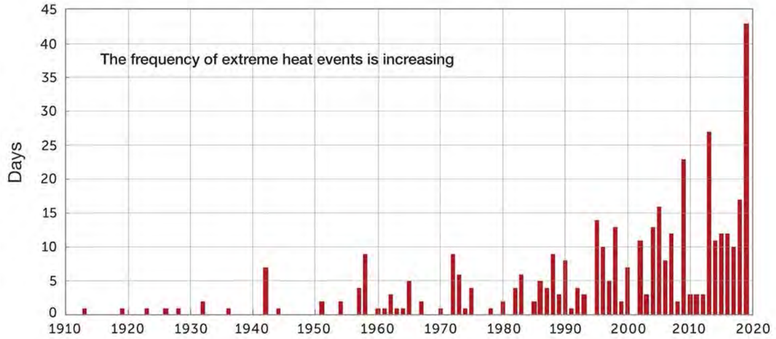
Rainfall [3]
(avg/yr BOM 1941-2023)

Wind Speed
(avg/yr BOM 1941-2014)

1 - Tess Lea, L. G. (2021). FINAL REPORT NO. 368: Sustainable Indigenious housing in regional and remote Australia. AHURI.
2 - Reardon, C. (2013, 2020). Your Home; Design for Climate. DCCEEW. https://www.yourhome.gov.au/passive-design/design-climate
3 - Majority of rainfall falls between October - March
4 - Hill, J. (2004). Improving thermal performance of social housing for better health of occupants and to reduce costs of temperature control University of Sydney]

Climate Change

Climate change means a change in weather patterns because the temperature of the Earth is getting hotter. This is from the impacts people have had from burning fossil fuels (like coal), cutting down trees and farming. Climate change means rising sea levels, hotter. days more often and more extreme floods and fires.



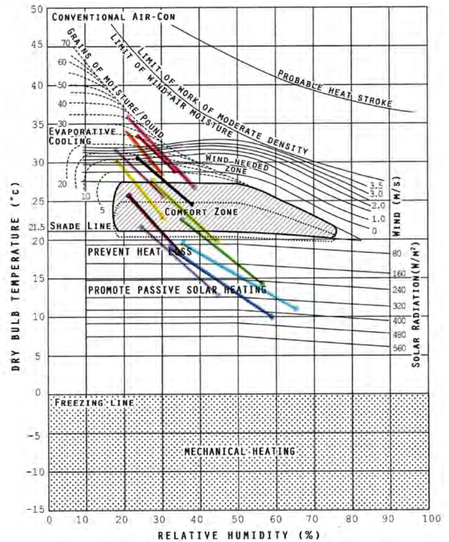
This graph shows that extreme heat events (very hot days for a long time) are becoming more and more often every year. [2]

"CSIRO modeling estimates that without climate action, Darwin would experience a rise in days above 35^{0}C, from 22.2 days/yr to 132 days/yr in 2030 and 275 days/yr in 2070. " [1]

1 - Elizabeth Hanna, M. O. (2018). Cooked with Gas, Extreme heat in Darwin. https://australiainstitute.org.au/report/cooked-with-gas-extreme-heat-in-darwin/
2 - Shiel, D. I. I. (2021). Cooling your home: Home retrofits, appliances and adaptations for a hotter future. B. Z. E. Inc. http://bze.org.au

What is the right temperature for a house?

Thermal comfort is how hot or cold a person feels because of the environment they are in. Our houses should help to keep us at a comfortable temperature.



Qualitative Bioclimatic Chart with Alice Springs data [2]

The high and low temperature and humidity of every month is marked on the chart and a line is drawn between them. Where the line is drawn shows what is needed in the environment to help get the body closer to The Comfort Zone. As the climate gets hotter, the house will have to work harder to keep people cool inside.

Our bodies need to stay at a stable temperature. If heat is lost or gained too fast or too slowly, the temperature of the body is changed and the environment needs to help cool the body by:

1. *Conduction (from touching cold floors and walls)*
2. *Convection (air flowing across the body)*
3. *Evaporation (sweat drying to keep you cool)* [1]

<u>If it's too hot and dry (i.e. low humidity)</u> we need shade and cool surrounding surfaces. Air movement can be an irritant because it is at a higher temperature than the skin (approximately 32C) [3] so will make you take on heat and feel hotter (evaporative heat gain).

<u>The comfortable temperature for people in summer is:</u>
20-27^{0}C when relative humidity is below 60%. [4]

1 & 2 - Olgyay, V. (2015). Design with Climate: Bioclimatic Approach to Architectural Regionalism (new and expanded edition). Princeton University Press.
3 & 4 - Hollo, N. (2011). Warm House Cool House - inspirational designs for low-energy housing (Second Edition ed.). NewSouth Publishing.

Heat & health

Extreme heat is a well-documented cause of immediate and long-term adverse health impacts, particularly in at-risk groups. [1]

Extreme heat exacerbates many pre-existing health conditions. Adverse health conditions associated with high climatic temperatures are generally termed 'heat stress' and include heatstroke, heat exhaustion, heat syncope (fainting/unconsciousness) and heat cramps. The mildest forms of heat-related illnesses, which respond well to outpatient treatment, are heat rashes or prickly heat, heat cramps, and heat syncope. Heat exhaustion and heatstroke are far more serious and can be fatal even with prompt medical care.

Infants and Young Children (susceptible population)

The risk of heat-related illness and fatality are high among infants and young children. Young children are more vulnerable to heat illness due to their reduced ability to sweat, larger body surface area per body mass, increased risk of dehydration and rapid rises in core body temperature if dehydrated. Also, infants and children under five years are sensitive to heat. Conditions such as mild fever can progress quickly to heatstroke if heat stress occurs.4 Extreme temperatures affect the ability to resist infection, particularly among young children.

In Aboriginal communities, malnutrition is a major health concern. Aboriginal infants have a lower average birth weight, and 14% of Aboriginal infants and 22% of children in Western Australia have been reported as being underweight. During high environmental temperatures, Aboriginal children with malnutrition are at risk of heat-related illness and death. The likelihood of heat intolerance in children increases with conditions that are associated with excessive fluid loss such as abnormal hypothalamic thermoregulatory function (regulation of body temperature, water balance, etc.). Such abnormal function occurs in advanced malnutrition and where there has been a prior episode of heat-related illness.

Elderly (susceptible population)

The elderly are susceptible to heat-related illness due to their reduced ability to adjust to physical changes in the body, which occur when exposed to excessive heat. The elderly are also at greater risk of heatstroke because of their increased likelihood of chronic medical conditions (like cardiovascular disease and peripheral neuropathiesa), use of medication, and their reduced mobility in terms of removing themselves from hot environments.

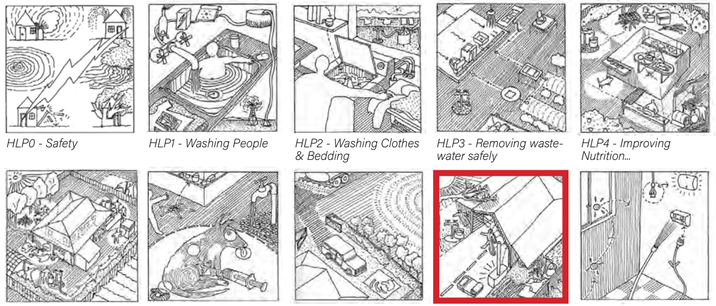
Some of the medications taken by the elderly that increase the risk for heat-related illness include tranquilizers, anticholinergicsb, diuretics (which can further rob the body of fluids), antihistaminesc and phenothiazinesd. The latter two both decrease the body's capacity to sweat.

In Australian capital cities, it has been estimated that 1,100 people aged over 65 die each year from extremely hot temperatures. Australian studies have noted increased sensitivity among the elderly to prolonged spells of hot or cold and also sudden falls or rises in temperature.

1 - Pitts, A. (2004). Social and Health impacts of temperature in Aboriginal Housing; a Review of Literature. N. Health.

Healthabitat's Healthy Living Practices (HLP's) & HLP8

Healthabitat has an increasing interest in the importance of temperature control and HLP8. [1]



HLP0 - Safety
HLP1 - Washing People
HLP2 - Washing Clothes & Bedding
HLP3 - Removing waste-water safely
HLP4 - Improving Nutrition..
HLP5 - Reducing the negative impacts of overcrowding
HLP6- Reducing negative effects of animals, insects and vermin
HLP7 - Reducing the health impacts of dust
HLP8 - Controlling the temperature of the living environment
HLP9 - Reducing hazards that cause minor injury (trauma)

Healthabitat's Healthy Living Practices (HLP's)

Healthabitat

Since 1985, Healthabitat has worked with Indigenous communities throughout Australia to improve the health performance of more than 10,000 houses through understanding house function, providing targeted repairs and maintenance and data collection on benefits to the house. Housing for Health—the methodology that underpins this work—adopts nine Healthy Living Practices (HLPs) to understand how the built environment hierarchically impacts upon people's health.

As climate change continues to destabilise who gets to live where and on what terms, architects must understand how their particular skillset—and the labour that sits behind it—can meaningfully assist communities in resisting the broader forces of uneven development. [2]

HLP8 - Controlling the temperature of the living environment

Living in houses that are too cold or too hot can contribute to a range of physical illnesses and can cause emotional distress for residents. Extended exposure to high temperatures can also result in illness, with increased risk of dehydration and heat stress for sick children and elderly people.
It can be expensive to use 'active' heating and cooling systems, such as heaters and air conditioners to make poorly performing houses more comfortable. Houses that incorporate passive design features will require less days of active heating and cooling and less energy will be required to heat or cool the house on extreme temperature days. This means reduced costs for the resident.

As a result of the increasingly hot temperatures in the communities in which Healthabitat work, they are reconsidering the significance of HLP #8 (Controlling the temperature of the living environment) and the place in which it sits in the 9 principle hierarchy and within the wider Housing for Health methodology prioritised list.

1 - Healthabitat. (2023). B 8 - Controlling the temperature of the living environment
2 - UON ARBE 6231 Hot House Course Guide

Chapter 2

Community Houses

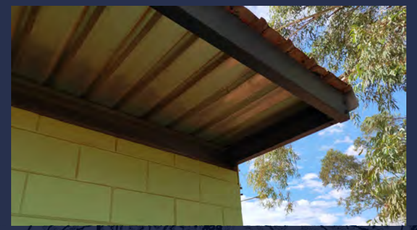
- Community Living - The yard is a house
- Common types of community houses
- 3 Key problems with these houses
- 'Out of Area'

No powercard, painting by Sally Mulda, 2020, Tangentyere Artist

The

reality

of



many

The 2014-15 National Aboriginal and Torres Strait Islander Social Survey (NATSISS) showed that more than one-third (38%) of remote Indigenous people over 15 years lived in crowded conditions, compared to 13% elsewhere.

comm-

unity

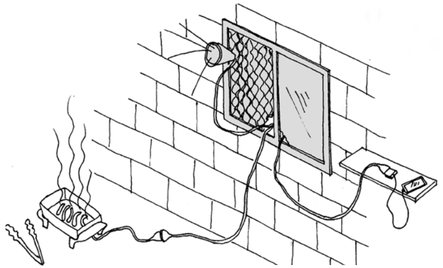
Images from UON 'Hot House' semester 1 stream and research reports

houses

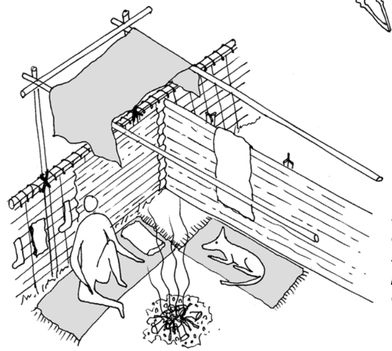
Community Living - The yard is a house

The drawings show yard taps, outside powerpoints, strong fences and shade planting is important to help cool the house and yard and reduce the negative effects of crowding.

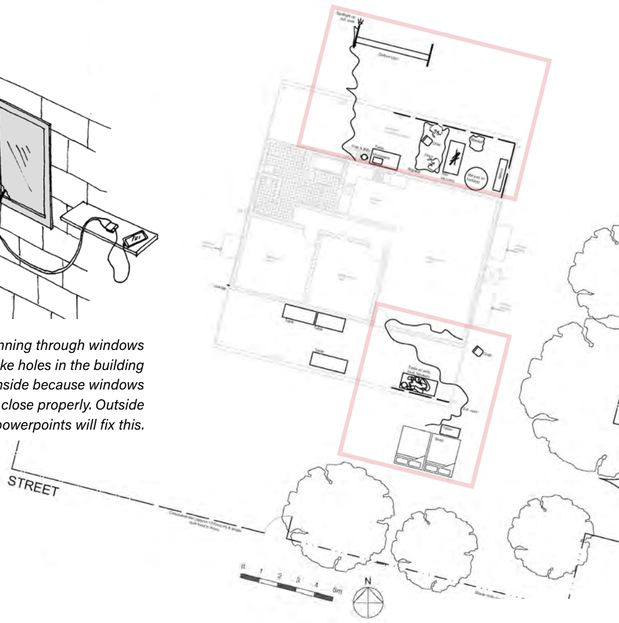
Yard taps are good for people camping in the yard, for pets and to help water trees and grass to help shade the yard and lower the temperature of the ground.



Power cords running through windows and doors make holes in the building and let hot air inside because windows and doors can't close properly. Outside powerpoints will fix this.

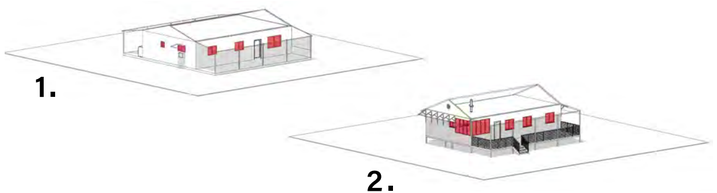


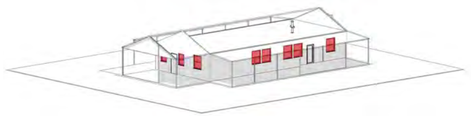
Strong fences are good so family camping in the yard can build shade structures to make more shaded places to sit and sleep outside and cool the ground.



Common types of community houses

Across the 5,498 houses the NT Goverment is responsible for[1], these are 3 common types, read more on page 76.





3. (light-weight house) Framed house with a slab on ground - often sound in South Australia on the APY Lands

(Heavy-weight house) Block wall house with a slab on ground[3]

- *Verandahs on long ends of the house (often facing the street) and no shading on short ends of the house*
- *Awnings over windows on short ends*
- *Single skin block wall (190mm) with no insulation*
- *Often no ceiling or roof insulation*

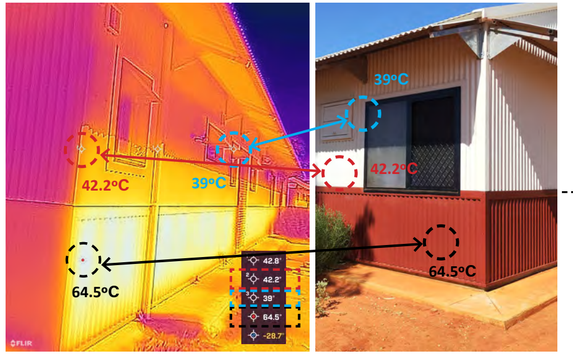
(Light-weight house) Framed house built off the ground [2]

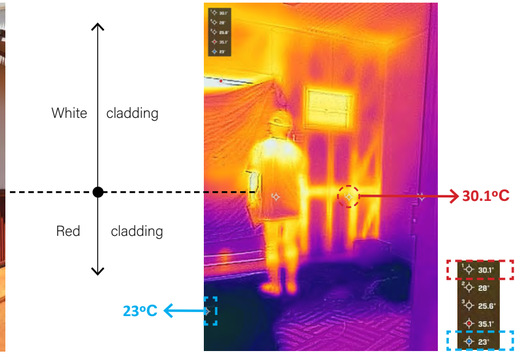
- *Verandah to one long end of house (often facing the street)*
- *Mesh to the perimeter of the underfloor to stop pets, but no edge cladding*
- *Often no insulation under the floor*
- *Steel framed walls with metal cladding ot outside, fibre-cement lining to inside with bulk insulation inside the cavity*
- *Often can't access the roof cavity to see if there is insulation*
- *Small awnings to short ends of house and other long end*

1 - Grealy, L. (2023) Healthy Homes Monitoring and Evaluation Project Final Report.
2 - DIPL, N. T.G. (2022, 08 December 2022). Designing and building homes for our remote communities https://dipl.nt.gov.au/news/2022/designing-and-building-homes-for-our-remote-communities
3 - Image from UON 'Hot House' semester 1 2023 stream with Healthabat and Dr Jasper Ludewig

3 Key problems with these houses - Thermal bridging

These Thermal Image pictures of community houses show where hot and cold parts of the house are. These pictures show alot of heat is coming from outside to inside the house through the walls, ceiling, lights and vents.



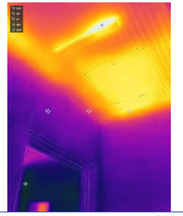


The red cladding in full sun at the bottom is very hot at 64.5°C
The white cladding in full sun above the red is 22.3°C cooler, at 42.2°C

The wall inside behind the red cladding at the bottom is 30°C
The wall inside behind the white cladding at the top is cooler

< This picture shows the metal frame inside the wall (yellow) at the end of the hallway is very hot.

> This picture shows a lot of heat comes through the light fittings and ceiling access hole to the roof.



< This picture shows the ceiling (yellow) is hotter than the walls and floor and makes inside the house hotter.

> This picture shows a lot of heat comes through the air-conditioner vents in the ceiling and makes inside the house hotter

***FLIR photos taken with Healthabitat in August 2023. Outside ambient temperature was 26C/ Inside ambient temperature was 24.3C (no active cooling in use at time of test)*

3 Key problems with these houses - Bad Orientation

Orientation means the way a house faces. Good orientation (passive solar design) can make a house hotter in winter and colder in summer, because the house is using the sun and wind to help[1] Bad house orientation can make a house hotter in summer. This means you need an air conditioner more, and more money ($) spent on power cards.

The shaded area shows best house orientation - when a house faces between 20 degrees west of north to 30 degrees east of north. [2]

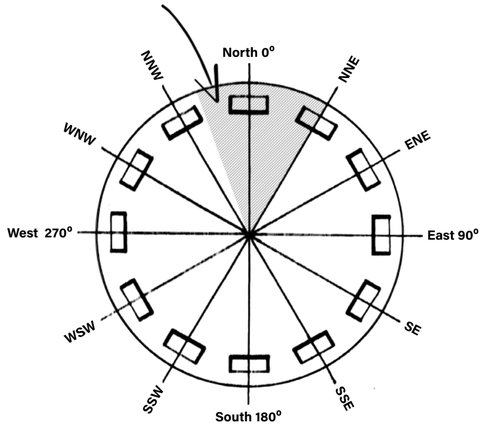
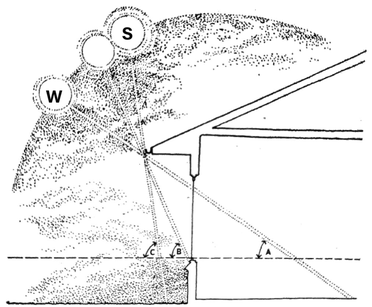


Diagram to explain house orientation [3]

This diagram shows which direction a house faces means it has that orientation. For example, if a long house has the long side facing north, it has a north orientation.

A house NEEDS to block sun coming inside in summer to keep it cool. Because we know the path of the sun all year, we can work this out when we design a house to make it work best.

The house should be orientated for the sun and wind, not where the street is. The diagram below shows how the sun moves in winter and summer [2]:



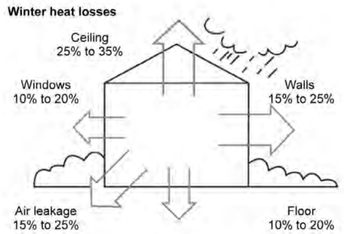
In Alice Springs, the best orientation for hot periods is to:

- *Face the long side of the house north, or up to 30 degrees east of north and 20 degrees west of north*
- *Short ends of the house should face east and west*

1 - McGee, C. (2020). Your Home; Orientation. DCEEW. https://www.yourhome.gov.au/passive-design/shading
2 - Hollo, N. (2011). Warm House Cool House - inspirational designs for low-energy housing (Second Edition ed.). NewSouth Publishing.
3 - Olgyay, V. (2015). Design with Climate: Bioclimatic Approach to Architectural Regionalism (new and expanded edition). Princeton University Press.

3 Key problems with these houses - Not right for the climate

Houses should be made with different materials and have different size verandahs in different climates. For example, Alice Springs is in a 'Hot Dry' (arid) climate but Sydney in NSW where it snows, is in a 'cool' climate.



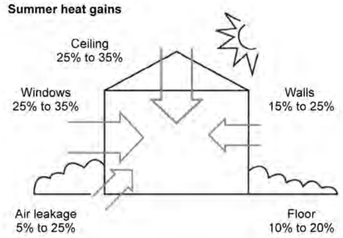


Diagram showing typical heat losses and gains without insulation [2]

Many community houses are not built right for the climate.

Because of the key climate characteristics (on page X), houses in Alice Springs should have some key things [1] to help keep them cool on hot days:

Have good shading:

- *Shade all walls to stop direct sun hitting them and heating them up, especially on the west and east. There should be a big verandah to the north, east and west. South is good too.*
- *Shade all windows to stop any sun hitting the glass and coming inside*
- *Shade the ground around house to stop radiant heat bouncing off the hot ground and heating up the house*

Insulation

- *Insulation in the floors (if built off the ground), walls, ceiling and roof will lessen how much heat from outside comes inside*

Heavy-weight materials:

- *Houses should have a concrete slab-on-ground and not be raised off the ground with a light-weight framed floor. A shaded concrete slab can help keep the house cool*
- *Block walls inside (if shaded) will help keep the house cool*
- *All block walls to outside walls must be shaded*

Less Air Leaks:

- *If not sealed and insulated - hot air comes through air-conditioner vents, kitchen and bathroom exhaust fans and gaps around windows, doors and the corner of the wall and ceiling*
- *Windows and doors should close properly and have seals at the top and bottom*

1 - Drysdale, J. W. (1952). Designing Homes for Australian Climates (Second ed.). Commonwealth Experimental Building Station.
2 - Mosher, C. M. M. (2010). Your Home; 4.7 Insulation. DCCEEW. https://www.yourhome.gov.au/passive-design/insulation

‘Out of Area’

A two-tier system removes some requirements (“means fewer permits and paperwork are needed”) for buildings in remote NT areas to meet the National Construction Code. [1]

The two-tier system, creates Tier 1 and Tier 2 areas and non building control areas for building work across the NT. Areas in the non building control areas include:

- freehold land
- most Indigenous communities
- pastoral properties
- some mining towns
- mining sites
- resorts in remote locations.

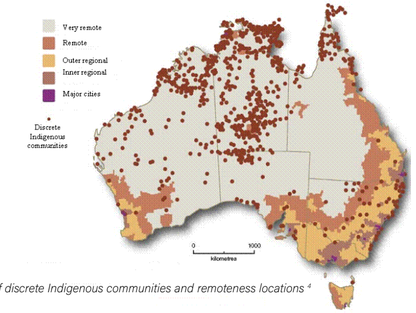
Building within the: [3]

- *Tier 1 areas: (Alice Springs/ Darwin) require full certification requirements, including inspections and an occupancy certificate at completion.*
- *Tier 2 areas: (Katherine, Tennant Creek) require NCC and technical requirements to apply to all building work, where full certification applies to most building works and part certification to some prescribed residential building work*
- *Tier 2 areas Part Certification: require a building permit before starting construction but the building certifier does not need to conduct inspections. At completion, the certifier does not need to issue an occupancy permit, but the builder needs to give a builder’s declaration and trade certificates for plumbing and electricals. This applies to the following buildings in Tier 2 areas:*
  - *class 1a buildings such as a single dwelling or detached house, but it does not apply to class 1a buildings such as duplexes*
  - *class 10 buildings such as a shed, attached to and built at the same time as the class 1a building*
- *Non Building control areas: Engaging a registered builder is optional and only due to funding, grant, loan or land lease conditions in the building contract the building be required to be built to the NCC or by a registered builder. 2*

What does this mean for remote community housing?

Many Aboriginal communities in the NT fall under the non building control areas. This fundamentally means there are less eyes on the ground, ensuring appropriate accountability and good quality design and construction of houses.

The National Construction Codes (NCC) are a consistent set of rules to raise and conform standards of building across the board. By having pockets of building areas that are not required to be built to this code, or have certified inspections of building progress and at the completion of building, who is making sure these houses are the best possible built outcomes or consistent with promises made for communities?



Map of discrete Indigenous communities and remoteness locations [4]

1 - https://nt.gov.au/property/building/build-in-a-controlled-area/building-control-areas/requirements-in-building-control-areas
2 - https://nt.gov.au/property/building/build-in-a-controlled-area/building-control-areas/building-outside-of-building-control-areas
3 - https://kilgariffestate.com.au/wp-content/uploads/building-and-renovating-in-the-nt-consumer-guide.pdf
4 - Australian Bureau of Statistics, Housing and Infrastructure in Aboriginal and Torres Strait Islander Communities, Australia, 2006 (Cat. 4710.0)

Chapter 3

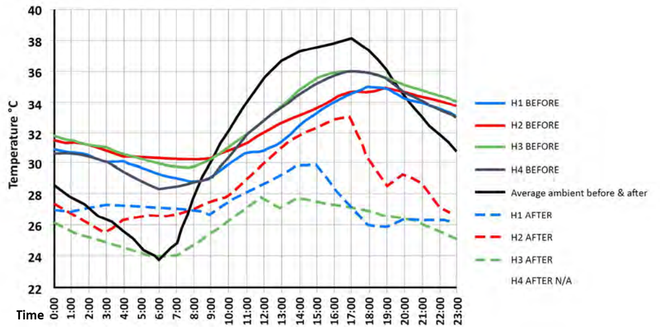
Why Passive Upgrades?

- Proof passive works
- Energy insecurity Issues
- Why upgrades and not new houses?
- Cost of remote construction and maintenance

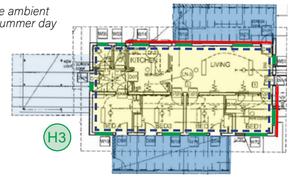
Why passive? There is proof passive works

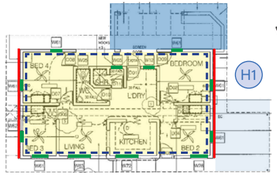
This rigorous Temperature Improvement Project case-study is one example. Results from upgrades on four houses in Alice Springs town camps shows passive upgrades can have an improvement of up to 9C cooling during summer.

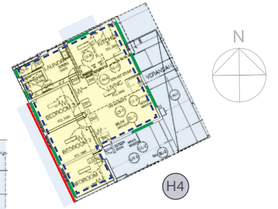
What	Monitoring of thermal environments & energy use through data logging, passive & active upgrades made & results compared (H3 upgrades listed in table with legend) [TAN TCP final report 110911]
By	Tangentyere Council & Healthabitat
Year	March 2009 monitoring equipment installed, testing and works
Location/ Climate	Alice Springs & 'Hot Dry'
Geography	Urban
Results	All houses showed significant temperature improvement, as seen in the graph below. H3 showed the most improvement of 9C cooling in the hottest part of the day (30-36C before and 24-28C after). It is essential to make passive modification before active modifications.

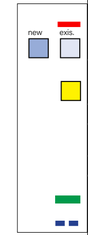


Graph comparison between living/ lounge temperatures & average ambient temperature before & after installations in a hot/dry climate over a summer day









Legend

1. Passive Cooling Retrofits
1. Shade the Building Fabric • *New shade walls to north (low) & east (low)* • *New roof lining to south external area* • *North pergola extended with new roof lining*
2. Insulation • *New roof insulation & panel rib lining to bedrooms*
3. Close the Underfloor
4. Venting/Airflow • *New crimsafe window screens & doors*
5. Thermal Mass
6. Less hot air inside • *New windows inc. lowering of some sills* • *Repair/ replace external doors* • *Repair/ replace cornice*
2. Active Cooling Retrofits
1. Active Air movement • *4 existing ceiling fans*
2. Active cooling (&heating) • *New ducted evaporative cooling system* • *7 x new ceiling mounted radiant heaters*
3. Cosmetic Changes
1. Paint • *new paint full exterior & interior*
2. Yard • *repair/new fence and gates to yard*
Additional • *New lino tiles throughout*

4 house plans with upgrades shown as per legend [4]

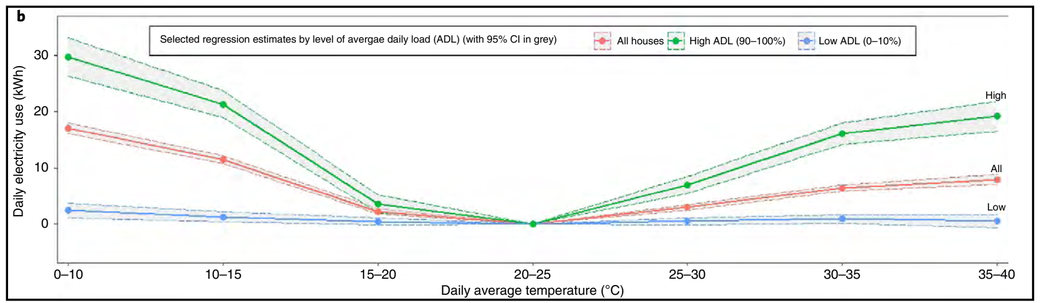
Why passive? Energy Insecurity Issues

Energy Insecurity is a real problem communities face. Disconnection rates are an indicator of energy insecurity issues.

Observations were made across 3,300 houses in 28 remote NT communities between June 2018 - July 2019 (1,674,786 daily observations in sample). The research showed that households in the 'hot dry' zone increased electricity use on days between 30-40C and corresponded to an average of an increased 16-19kWh/day ($5.13). When temperatures hit between 35-40C, chances of disconnection increased to 1:11. [1]

"83% of households experienced multi-day disconnections at least once
16% of households experienced multi-day disconnections at least 10 times
Average length of disconnection was 125.49hrs (5 days)"

**Disconnection means the power service that is cut due to non-payment. Power will not be turned back on until payment is made.*



Graph (b) showing daily electricity use by temperature and month. [1]

This graph clearly shows use of electricity is increased when temperatures fall outside of comfort zones for active heating and cooling. If the house is low-functioning for thermal performance, this means more electricity will be needed to bring it down to a healthy temperature in summer. This means a bigger burden on the household.

1 - Thomas Longden, S. Q., & co. (2021). Energy insecurity during temperature extremes in remote Australia. Nature Energy, 15.

Why Upgrades?

The reality is that alot of the existing and legacy housing stock will continue to be lived in for many decades to come.

General and priority wait times for housing is 6-8 years in Alice Springs, where for remote housing this is even longer. For 2 bedroom houses, there are 393 people on the wait list and only 8 vacant homes, the need is approximately 50 times more than available housing stock. The question arises, while people wait where do they stay and how functional is that living environment?

Public Housing wait times [1]

Estimated wait times for public housing (years)						
Region	General wait times			Priority wait times		
	1 bedroom	2 bedroom	≥3 bedroom	1 bedroom	2 bedroom	≥3 bedroom
Darwin/Casuarina	8-10	4-6	4-6	6-8	4-6	4-6
Palmerston	6-8	2-4	2-4	6-8	4-6	2-4
Katherine	6-8	6-8	6-8	4-6	4-6	4-6
Nhulunbuy	6-8	6-8	6-8	4-6	4-6	6-8
Tennant Creek	6-8	6-8	8-10	6-8	2-4	4-6
Alice Springs	6-8	6-8	6-8	6-8	6-8	6-8

Applications vs. vacant homes [1]

Region	1 bedroom		2 bedroom		≥3 bedroom		Total	
	Wait list	Vacant homes	Wait list	Vacant homes	Wait list	Vacant homes	Wait list	Vacant homes
Darwin region	1,582	14	438	43	420	19	2,440	76
Palmerston	604	18	196	17	176	23	976	58
Katherine	328	3	102	13	125	5	555	21
Nhulunbuy	49	1	42	3	74	1	165	5
Tennant Creek	71	1	36	1	86	1	193	3
Alice Springs	677	9	393	8	451	15	1,521	32
Total	**3,311**	**46**	**1,207**	**85**	**1,332**	**64**	**5,850**	**195**

NTG Public Housing Wait-lists as of 31 December 2022 (accessed 240523)

The immediate future of community housing? [2]

HOUSING AUSTRALIA FUTURE FUND

"(Labor's $10 billion housing bill), The Northern Territory's $50 million share from the fund will see 1,200 social and affordable homes build in the Territory. There are close to 6,000 families on urban public housing wait lists in the NT."

"In the first five years, the Australian government intends to use $200 million for the repair, maintenance and improvements of housing to meet the specific needs of remote Indigenous communities (nationally)."

1 - https://nt.gov.au/property/public-housing/apply-for-housing/apply-for-public-housing/waiting-list
2 - https://nit.com.au/13-09-2023/7657/aboriginal-housing-nt-welcomes-breakthrough-on-housing-australia-future-fund

Cost of remote construction & maintenance

'Sustainable Indigenous Housing in Regional and Remote Australia' AHURI report publishes building and maintenance cost data of SA Housing Authorities housing stock. This research gives a snapshot into the complexities and huge expenses of construction in remote areas.

Life-cycle cost components for remote and very remote Indigenous housing [1]

	Base case#		6-person occupancy		Remote		Very remote	
Construction	129,000	62%	129,000	58%	219,300	44%	258,000	24%
O and M*	74,000	35%	88,800	40%	266,400	54%	799,200	75%
Disposal	5,600	3%	5,600	2%	11,200	2%	11,200	1%
Total	**208,600**	**100%**	**223,400**	**100%**	**496,900**	**100%**	**1,068,400**	**100%**

Findings:

- In remote and very remote regions, operating and maintenance (O&M) costs are substantially higher than the base cost
- In very remote regions 75% or the life-cycle costs of a dwelling are related to O&M, where construction is a minor component of the cost. This means it is important to invest in good quality construction, health hardware and construction details which lessen energy use and impact on the tenants over it's life-time.

Comparison of planned vs. responsive maintenance program costs by region [1]

Year	1	2	3	4	5	Total ($)	Ratio R/P
Cost of planned maintenance (P) in $							
Routine maintenance	25	25	25	25	25	125	
Replacement		500		500		1,000	
Total	25	525	25	525	25	1,125	
Cost of responsive maintenance (R) in $:							
Metropolitan		500	500	500	500	2,000	1.8
Regional		1,000	1,000	1,000	1,000	4,000	3.6
Remote		2,000	2,000	2,000	2,000	8,000	7.1

Findings:

- Cost of responsive maintenance in remote areas is 7.1 x the cost of planned maintenance

Planned versus responsive maintenance annual costs [1]

	2019-2020		2020-2021	
	$	%	$	%
Responsive	1,300,000	25.7	1,300,000	20.8
Planned	2,600,000	51.3	3,700,000	59.2
Homelands	200,000	4.0	200,000	3.2
Vacancies	500,000	9.9	505,000	8.0
Travel	460,000	9.1	550,000	8.8
Total	**5,060,000**	**100**	**6,255,000**	**100**

Findings:

- The cost to carry out responsive maintenance is 35% of the cost of planned maintenance ie. it is more feasible to carry out planned maintenance
- The cost of trade mobilisation is over 8% of the total cost of maintenance ie. $550,000 in 2020-2021

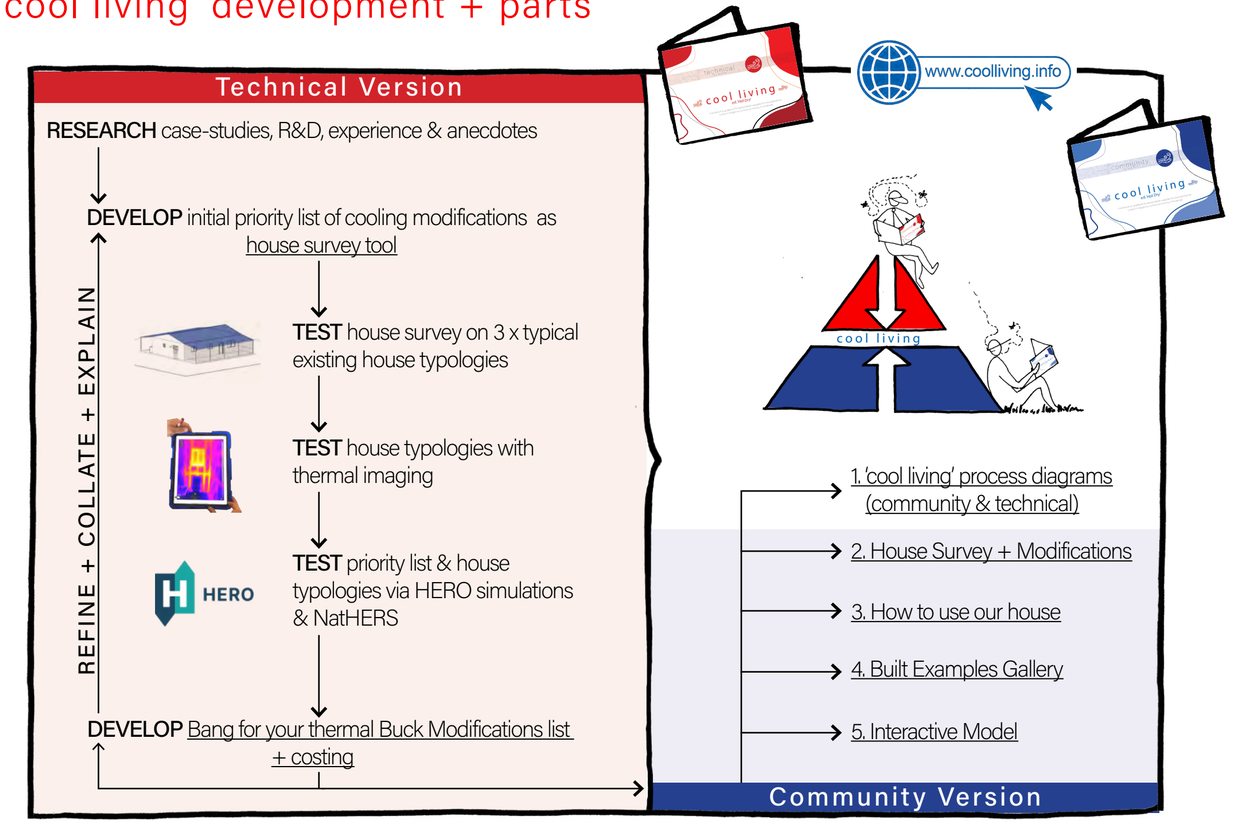
1 - Tess Lea, L. G. (2021). FINAL REPORT NO. 368: Sustainable Indigenous housing in regional and remote Australia. AHURI. https://www.ahuri.edu.au/research/final-reports/368

Chapter 4

'cool living' Project Parts

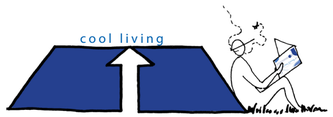
- ‘cool living’ project + parts
- 'cool living' Community Edition
- 'cool living' Technical Edition

‘cool living’ development + parts



‘cool living’ Community Edition

Explanation of the Community Edition suite of tools



The COMMUNITY EDITION is the blue book and is for community members who are sick of hot houses, or would like to talk to housing about house upgrades or apply for grant funding.

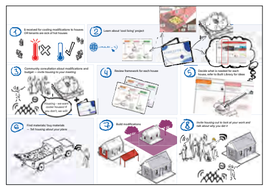
The content frames the fundamentals of the problems faced in community housing, and gives tools to understand how it is best to use houses in summer, prioritised for improved cooling in houses and a survey tool to audit all houses.

The Community Edition suite of tools include:

1. *‘cool living’ process diagram (community)*
2. *House Survey + Modifications*
3. *How to use our house*
4. *Built Examples Gallery*
5. *Interactive Model*

All of this is communicated through the cool living website and blue book.

1.



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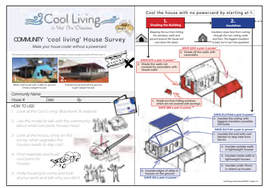

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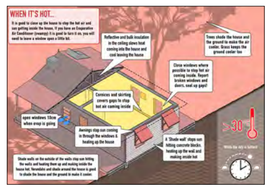


4.

5.

‘cool living’ Technical Edition

Explanation of the Technical Edition suite of tools

The TECHNICAL EDITION is the red book and is for built environment professionals and Housing organisations who may be planning house upgrades or carrying out proposals for grant funding and research.

The content frames the fundamentals of the problems faced in community housing, but operates on the assumptions that the professional has experience in the realities of community living.

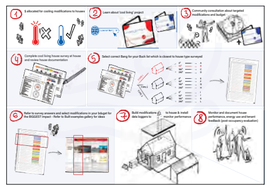
This is a suite of tools to inform prioritised upgrades to community housing to improve thermal comfort in summer. It is expected the Community Edition will be used by the professionals to carry out tenant education and community consultation.

The Technical Edition suite of tools include:

1. *‘cool living’ process diagram (technical)*
2. *House Survey*
3. *Bang for your Buck Modifications list + costing*
4. *Cooling priorities explained*
5. *Built Examples Gallery*

All of this is communicated through the cool living website and red book.

1.



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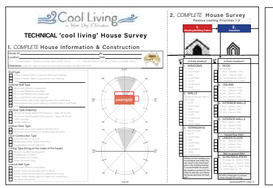

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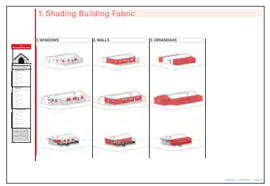

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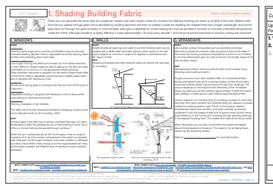


4.2

5.

Chapter 5

‘cool living’ House Survey

- ‘cool living’ House Survey - How to fill out..
- Step-by-step explanation

Cool Living House Survey - How to fill out...

The 'cool living' TECHNICAL House Survey must be filled out at every house in the community to see what is missing on the house to make it cooler.
Use a new copy of this survey for every house. Tick or cross what parts of each priority are on the house.

These are the parts you will look at the correct modifications list for what upgrades will give best bang for buck for that house. The Built Examples Gallery will give more ideas about what to build.
This chapter will give a step-by-step explanation of house to fill out the survey.

1. *Get an empty printed set of the house survey on a clipboard. Visit the house you need to survey as you will need to walk around it to answer the survey..*

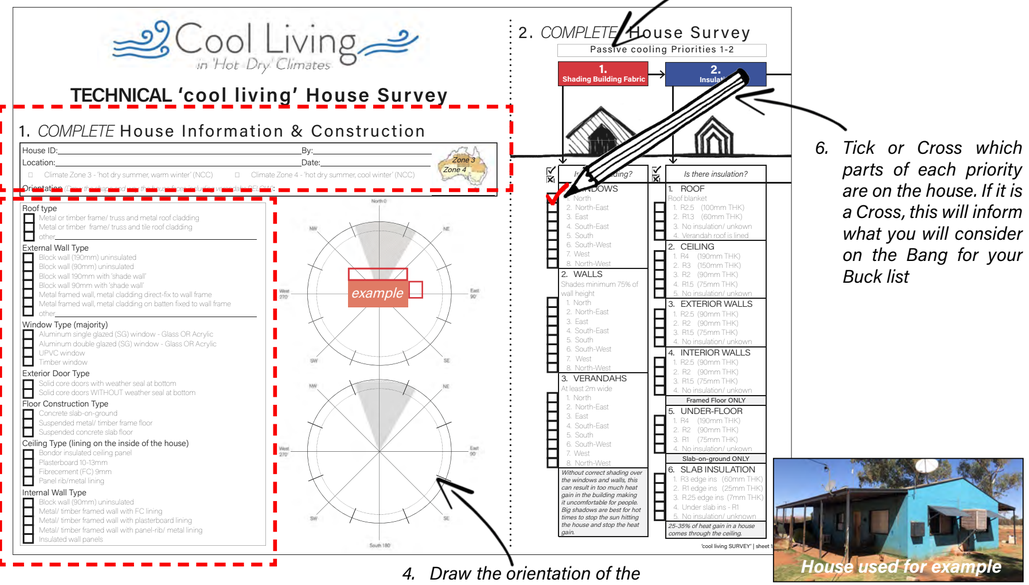
2. *Write down house number, where it is, the date and who is filling out the survey.*

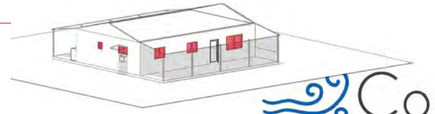
3. *Fill out building fabric information about what the house is constructed from*

4. *Draw the orientation of the house (which way it faces)*

5. *Start at #1*

6. *Tick or Cross which parts of each priority are on the house. If it is a Cross, this will inform what you will consider on the Bang for your Buck list*





Cool Living
in 'Hot Dry' Climates

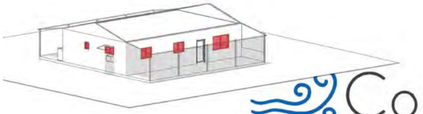
TECHNICAL 'cool living' House Survey

1. COMPLETE House Information & Construction

House ID: #54 north street
Location: Ernabella community South Australia
By: Bobbie Bayley
Date: 5/09/23
☐ Climate Zone 3 - 'hot dry summer, warm winter' (NCC) ✓ Climate Zone 4 - 'hot dry summer, cool winter' (NCC)
Orientation (Draw the shape and way the house faces including verandahs BELOW):

Zone 3
Zone 4

Write down house number, where it is, the date and who is filling out the survey. Tick which climate zone it is in.



Cool Living
in 'Hot Dry' Climates

TECHNICAL 'cool living' House Survey

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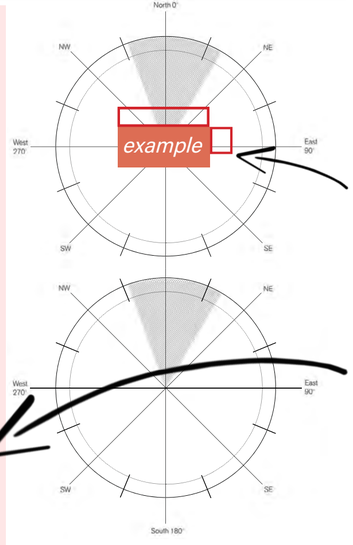

Draw the orientation of the house (which way it faces). The grey section shows best orientation for this climate. See the red book for more information.

Fill out building fabric information about what the house is constructed from. This information will be used in selecting the correct Bang for your Buck Modifications list to guide what upgrades you should apply to the building first.

Roof type
- [x] Metal or timber frame/ truss and metal roof cladding
- [ ] Metal or timber frame/ truss and tile roof cladding
- [ ] other

External Wall Type
- [x] Block wall (190mm) uninsulated
- [ ] Block wall (90mm) uninsulated
- [ ] Block wall 190mm with 'shade wall'
- [ ] Block wall 90mm with 'shade wall'
- [ ] Metal framed wall, metal cladding direct-fix to wall frame
- [ ] Metal framed wall, metal cladding on batten fixed to wall frame
- [ ] other

Window Type (majority)
- [x] Aluminum single glazed (SG) window - Glass OR Acrylic
- [ ] Aluminum double glazed (SG) window - Glass OR Acrylic
- [ ] UPVC window
- [ ] Timber window

Exterior Door Type
- [ ] Solid core doors with weather seal at bottom
- [x] Solid core doors WITHOUT weather seal at bottom

Floor Construction Type
- [x] Concrete slab-on-ground
- [ ] Suspended metal/ timber frame floor
- [ ] Suspended concrete slab floor

Ceiling Type (lining on the inside of the house)
- [ ] Bondor insulated ceiling panel
- [ ] Plasterboard 10-13mm
- [ ] Fibrecement (FC) 9mm
- [x] Panel rib/metal lining

Internal Wall Type
- [x] Block wall (90mm) uninsulated
- [ ] Metal/ timber framed wall with FC lining
- [ ] Metal/ timber framed wall with plasterboard lining
- [ ] Metal/ timber framed wall with panel-rib/ metal lining
- [ ] insulated wall panels

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- [ ] insulated wall panels

2. *COMPLETE* House Survey

Passive cooling Priorities 1-2

1. Shading Building Fabric → **2. Insulation**

Is there shading?

1. WINDOWS
- [x] 1. North
- [ ] 2. North-East
- [x] 3. East
- [ ] 4. South-East
- [x] 5. South
- [ ] 6. South-West
- [x] 7. West
- [ ] 8. North-West

2. WALLS
Shades minimum 75% of wall height
- [x] 1. North
- [ ] 2. North-East
- [ ] 3. East
- [ ] 4. South-East
- [x] 5. South
- [ ] 6. South-West
- [ ] 7. West
- [ ] 8. North-West

3. VERANDAHS
At least 2m wide
- [x] 1. North
- [ ] 2. North-East
- [ ] 3. East
- [ ] 4. South-East
- [x] 5. South
- [ ] 6. South-West
- [ ] 7. West
- [ ] 8. North-West

Without correct shading over the windows and walls, this can result in too much heat gain in the building making it uncomfortable for people. Big shadows are best for hot times to stop the sun hitting the house and stop the heat gain.

Start at 1. Shading Building Fabric.

Tick or Cross which parts of each priority are on the house. If it is a Cross, this will inform what you will consider on the Bang for your Buck list to improve the cooling of the house when it is hot.

Is there insulation?

1. ROOF
Roof Blanket
- [ ] 1. R5.0 (190mm THK)
- [ ] 2. R4.0 (140mm THK)
- [ ] 3. R3.2 (100mm THK)
- [ ] 4. No insulation/ unknown
- [ ] 5. Insulation not required

2. CEILING
- [ ] 1. R4.1 (200mm THK)
- [ ] 2. R3.1 (150mm THK)
- [ ] 3. R2.1 (100mm THK)
- [ ] 4. R1.5 (75mm THK)
- [ ] 5. No insulation/ unknown

3. EXTERIOR WALLS
- [ ] 1. R2.5 (90mm THK)
- [ ] 2. R2.0 (75mm THK)
- [ ] 3. No insulation/ unknown

4. INTERIOR WALLS
- [ ] 1. R2.5 (90mm THK)
- [ ] 2. R2.0 (75mm THK)
- [ ] 3. No insulation/ unknown

Framed Floor ONLY

5. UNDER-FLOOR
- [ ] 1. R4.1 (200mm THK)
- [ ] 2. R2.5 (90mm THK)
- [ ] 3. No insulation/ unknown

Concrete slab-on-ground ONLY

6. SLAB INSULATION
- [ ] 1. R5 edge by 1.2m (50mm THK)
- [ ] 2. R3 edge by 0.6m (50mm THK)
- [ ] 3. R2.5 edge by 0.6m (25mm THK)
- [ ] 4. Under slab (50mm THK)
- [ ] 5. No insulation/ unknown

25-35% of heat gain in a house comes through the ceiling

Try to access around or under the house and look inside any holes in the walls and inside the access hole in the ceiling.

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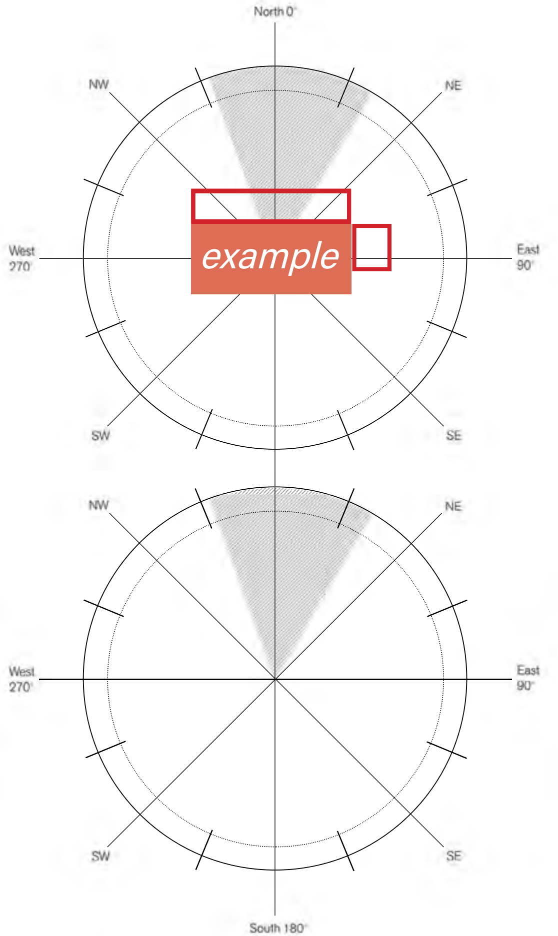
- ☐ Fibrecement (FC) 9mm
- ☑ Panel rib/metal lining

Internal Wall Type
- ☑ Block wall (90mm) uninsulated
- ☐ Metal/ timber framed wall with FC lining
- ☐ Metal/ timber framed wall with plasterboard lining
- ☐ Metal/ timber framed wall with panel-rib/ metal lining
- ☐ Insulated wall panels



2. *COMPLETE* House Survey

Passive cooling Priorities 1-2

1. Shading Building Fabric — *Is there shading?*

1. WINDOWS
- ☑ 1. North
- ☐ 2. North-East
- ☑ 3. East
- ☐ 4. South-East
- ☑ 5. South
- ☐ 6. South-West
- ☑ 7. West
- ☐ 8. North-West

2. WALLS
Shades minimum 75% of wall height
- ☑ 1. North
- ☐ 2. North-East
- ☐ 3. East
- ☐ 4. South-East
- ☑ 5. South
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3. VERANDAHS
At least 2m wide
- ☑ 1. North
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- ☐ 8. North-West

Without correct shading over the windows and walls, this can result in too much heat gain in the building making it uncomfortable for people. Big shadows are best for hot times to stop the sun hitting the house and stop the heat gain.

2. Insulation — *Is there insulation?*

1. ROOF
Roof blanket
- ☐ 1. R2.5 (100mm THK)
- ☐ 2. R1.3 (60mm THK)
- ☑ 3. No insulation/ unkown
- ☐ 4. Verandah roof is lined

2. CEILING
- ☐ 1. R4 (190mm THK)
- ☐ 2. R3 (150mm THK)
- ☐ 3. R2 (90mm THK)
- ☐ 4. R1.5 (75mm THK)
- ☑ 5. No insulation/ unkown

3. EXTERIOR WALLS
- ☐ 1. R2.5 (90mm THK)
- ☐ 2. R2 (90mm THK)
- ☐ 3. R1.5 (75mm THK)
- ☑ 4. No insulation/ unkown

4. INTERIOR WALLS
- ☐ 1. R2.5 (90mm THK)
- ☐ 2. R2 (90mm THK)
- ☐ 3. R1.5 (75mm THK)
- ☑ 4. No insulation/ unkown

Framed Floor ONLY

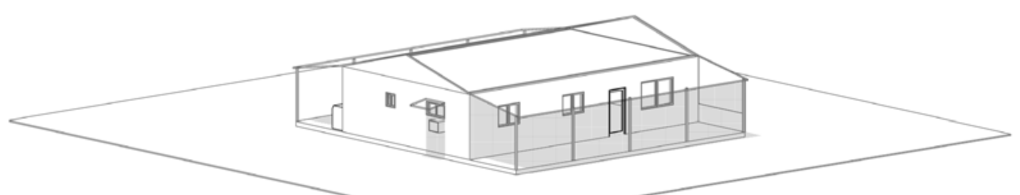
5. ~~UNDER-FLOOR~~
- ☐ 1. R4 (190mm THK)
- ☐ 2. R2 (90mm THK)
- ☐ 3. R1 (75mm THK)
- ☐ 4. No insulation/ unkown

Slab-on-ground ONLY

6. SLAB INSULATION
- ☐ 1. R3 edge ins (60mm THK)
- ☐ 2. R1 edge ins (25mm THK)
- ☐ 3. R.25 edge ins (7mm THK)
- ☐ 4. Under slab ins - R1
- ☑ 5. No insulation/ unknown

25-35% of heat gain in a house comes through the ceiling.

'cool living SURVEY' | sheet 1/2



Passive cooling Priorities 3-8

3. Close the Underfloor — *What's under the house?*

Slab-on-ground ONLY (+0mm AGL)
- ☑ NA - ensure ground is shaded (refer to 1)

Low Set House ONLY (+600-1200mm AGL)

~~1. UNDERFLOOR CLADDING~~
- ☐ 1. Fully lined
- ☐ 2. Part lined
- ☐ 3. No lining/ NA

~~2. PERIMETER CLADDING~~
- ☐ 1. Enclosed w/ some vents
- ☐ 2. Enclosed w/ many vents
- ☐ 3. Very open (no cladding)

Elevated floors, if unlined and uninsulated, can cause the house to gain heat. If the ambient outside air temperature is higher, the more it will heat up the inside of the house.

4. Venting/ Airflow — *What type of venting?*
1. ROOF SPACE
2. INTERNAL LIVING SPACES
3. VERANDAH ROOF

Venting/airflow is important to improve cooling. Airflow across the body, if the ambient temperature is below 32ºC, will help you feel cooler. Venting the roof-space will make the house cooler.

5. Thermal Mass — *Is there Thermal mass?*

6. *Where are gaps?*

7. *What colour is it?*

8. Yard Improvements — *In the yard, is there?*

Fill out each subsequent cooling priority. Strike out sections which are not relevant for the house you are surveying.

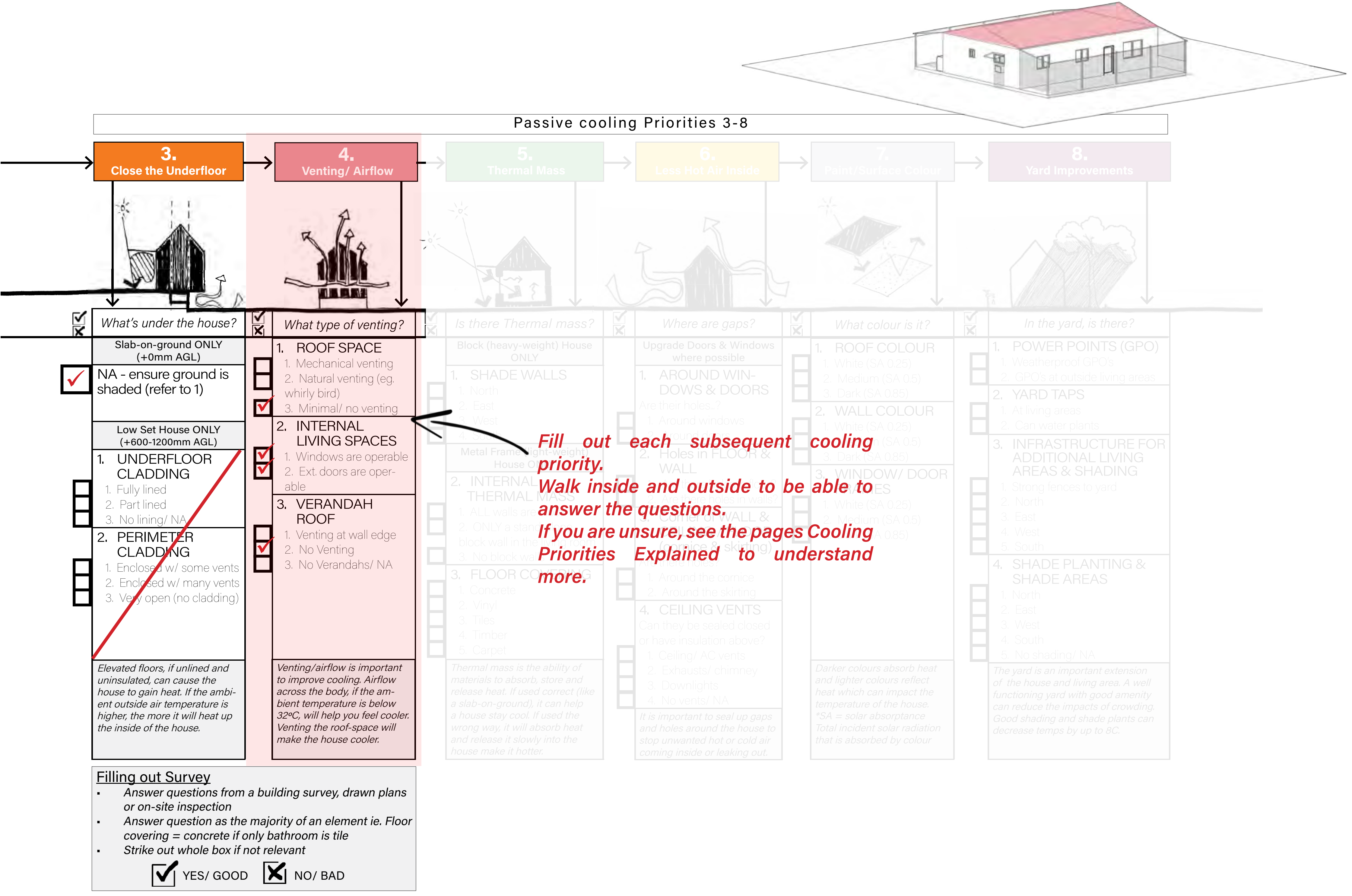
This box explains what the ticks and crosses mean

Filling out Survey
- *Answer questions from a building survey, drawn plans or on-site inspection*
- *Answer question as the majority of an element ie. Floor covering = concrete if only bathroom is tile*
- *Strike out whole box if not relevant*

☑ YES/ GOOD ☒ NO/ BAD

Notes

3. *REFER TO & IMPLEMENT* Bang for your Buck modifications list


Passive cooling Priorities 3-8
3. Close the Underfloor
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Elevated floors, if unlined and uninsulated, can cause the house to gain heat. If the ambient outside air temperature is higher, the more it will heat up the inside of the house.
What type of venting?
1. ROOF SPACE
1. Mechanical venting
2. Natural venting (eg. whirly bird)
3. Minimal/ no venting
2. INTERNAL LIVING SPACES
1. Windows are operable
2. Ext. doors are operable
3. VERANDAH ROOF
1. Venting at wall edge
2. No Venting
3. No Verandahs/ NA
Venting/airflow is important to improve cooling. Airflow across the body, if the ambient temperature is below 32ºC, will help you feel cooler. Venting the roof-space will make the house cooler.
Fill out each subsequent cooling priority.
Walk inside and outside to be able to answer the questions.
If you are unsure, see the pages Cooling Priorities Explained to understand more.
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Answer questions from a building survey, drawn plans or on-site inspection
Answer question as the majority of an element ie. Floor covering = concrete if only bathroom is tile
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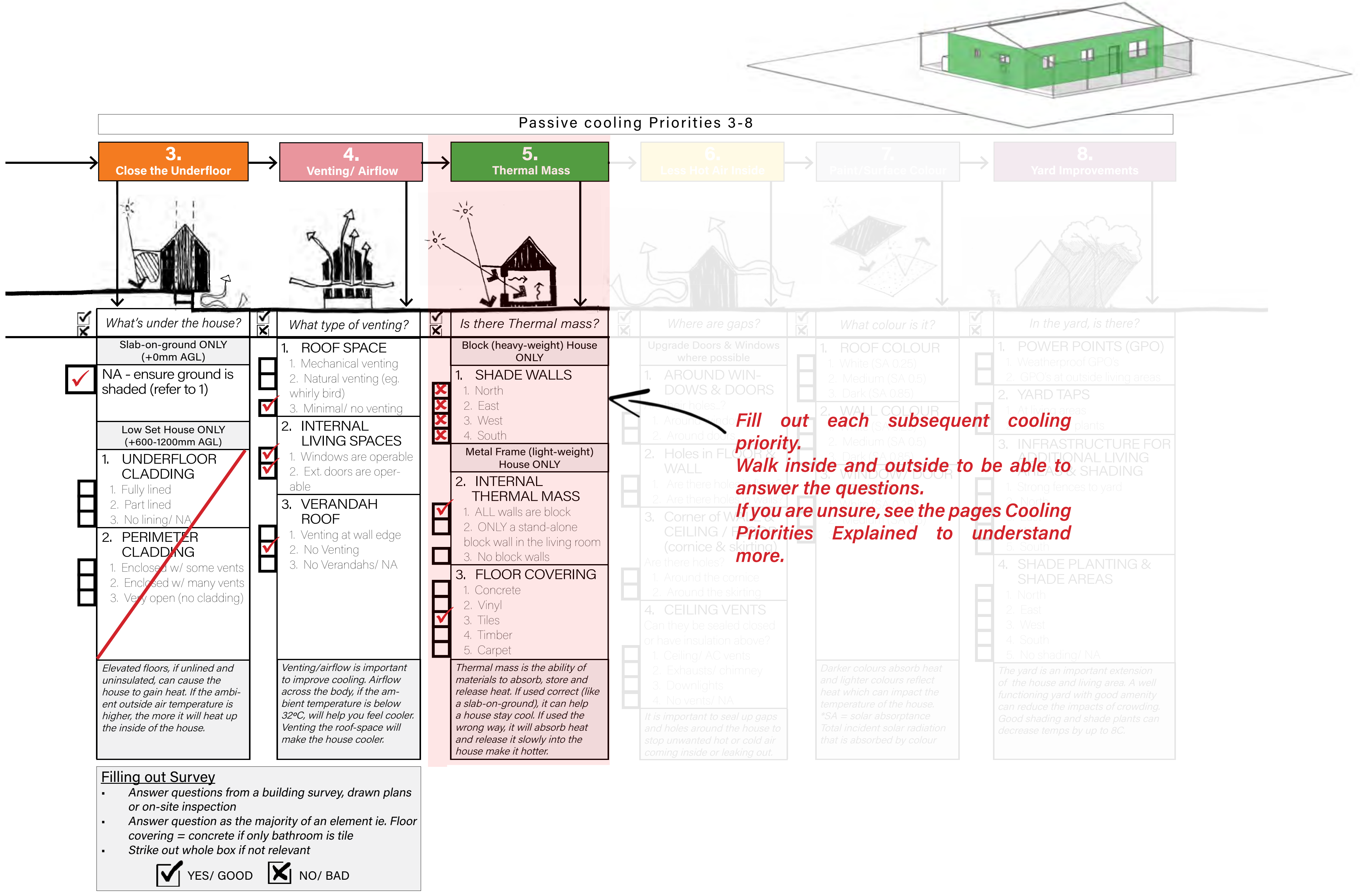
YES/ GOOD
NO/ BAD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Is there Thermal mass?
Block (heavy-weight) House ONLY
1. SHADE WALLS
1. North
2. East
3. West
4. South
Metal Frame (light-weight) House ONLY
2. INTERNAL THERMAL MASS
1. ALL walls are block
2. ONLY a stand-alone block wall in the living room
3. No block walls
3. FLOOR COVERING
1. Concrete
2. Vinyl
3. Tiles
4. Timber
5. Carpet
Thermal mass is the ability of materials to absorb, store and release heat. If used correct (like a slab-on-ground), it can help a house stay cool. If used the wrong way, it will absorb heat and release it slowly into the house make it hotter.
Fill out each subsequent cooling priority.
Walk inside and outside to be able to answer the questions.
If you are unsure, see the pages Cooling Priorities Explained to understand more.
Filling out Survey
Answer questions from a building survey, drawn plans or on-site inspection
Answer question as the majority of an element ie. Floor covering = concrete if only bathroom is tile
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YES/ GOOD
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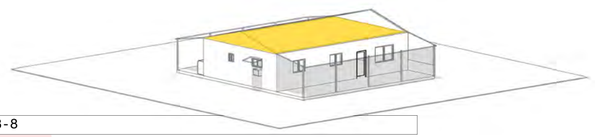

Passive cooling Priorities 3-8

3. Close the Underfloor → **4. Venting/ Airflow** → **5. Thermal Mass** → **6. Less Hot Air Inside** → **7. Paint/Surface Colour** → **8. Yard Improvements**

What's under the house?

Slab-on-ground ONLY (+0mm AGL)

- [ ] NA - ensure ground is shaded (refer to 1)

Low Set House ONLY (+600-1200mm AGL)

1. UNDERFLOOR CLADDING
   - [ ] 1. Fully lined
   - [ ] 2. Part lined
   - [ ] 3. No lining/ NA
2. PERIMETER CLADDING
   - [ ] 1. Enclosed w/ some vents
   - [ ] 2. Enclosed w/ many vents
   - [ ] 3. Very open (no cladding)

Elevated floors, if unlined and uninsulated, can cause the house to gain heat. If the ambient outside air temperature is higher, the more it will heat up the inside of the house.

What type of venting?

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   - [x] 3. Minimal/ no venting
2. INTERNAL LIVING SPACES
   - [x] 1. Windows are operable
   - [x] 2. Ext. doors are operable
3. VERANDAH ROOF
   - [ ] 1. Venting at wall edge
   - [x] 2. No Venting
   - [ ] 3. No Verandahs/ NA

Venting/airflow is important to improve cooling. Airflow across the body, if the ambient temperature is below 32ºC, will help you feel cooler. Venting the roof-space will make the house cooler.

Is there Thermal mass?

Block (heavy-weight) House ONLY

1. SHADE WALLS
   - [x] 1. North
   - [x] 2. East
   - [x] 3. West
   - [x] 4. South

Metal Frame (light-weight) House ONLY

2. INTERNAL THERMAL MASS
   - [x] 1. ALL walls are block
   - [ ] 2. ONLY a stand-alone block wall in the living room
   - [ ] 3. No block walls
3. FLOOR COVERING
   - [ ] 1. Concrete
   - [x] 2. Vinyl
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   - [ ] 4. Timber
   - [ ] 5. Carpet

Thermal mass is the ability of materials to absorb, store and release heat. If used correct (like a slab-on-ground), it can help a house stay cool. If used the wrong way, it will absorb heat and release it slowly into the house make it hotter.

Where are gaps?

Upgrade Doors & Windows where possible

1. AROUND WINDOWS & DOORS
   Are their holes..?
   - [x] 1. Around windows
   - [x] 2. Around doors
2. Holes in FLOOR & WALL
   - [x] 1. Are there holes in floor?
   - [x] 2. Are there holes in walls?
3. Corner of WALL & CEILING / FLOOR (cornice & skirting)
   Are there holes?
   - [x] 1. Around the cornice
   - [ ] 2. Around the skirting
4. CEILING VENTS
   Can they be sealed closed or have insulation above?
   - [x] 1. Ceiling/ AC vents
   - [ ] 2. Exhausts/ chimney
   - [ ] 3. Downlights
   - [ ] 4. No vents/ NA

It is important to seal up gaps and holes around the house to stop unwanted hot or cold air coming inside or leaking out.

What colour is it?

1. ROOF COLOUR
   - [ ] 1. White (SA 0.25)
   - [ ] 2. Medium (SA 0.5)
   - [ ] 3. Dark (SA 0.85)
2. WALL COLOUR
   - [ ] 1. White (SA 0.25)
   - [ ] 2. Medium (SA 0.5)
   - [ ] 3. Dark (SA 0.85)
3. WINDOW/ DOOR FRAMES
   - [ ] 1. White (SA 0.25)
   - [ ] 2. Medium (SA 0.5)
   - [ ] 3. Dark (SA 0.85)

Darker colours absorb heat and lighter colours reflect heat which can impact the temperature of the house.
**SA = solar absorptance*
Total incident solar radiation that is absorbed by colour

In the yard, is there?

1. POWER POINTS (GPO)
   - [ ] 1. Weatherproof GPOs
   - [ ] 2. Weatherproof lighting
2. YARD TAPS
   - [ ] 1. At living areas
   - [ ] 2. Non-water efficient
3. INFRASTRUCTURE FOR ADDITIONAL LIVING AREAS & SHADING
   - [ ] 1. Roof
   - [ ] 2. Walls
   - [ ] 3. Shade cloth/ NA

The yard is an important extension of the house and living area. A well functioning yard with good amenity can reduce the impacts of crowding. Good shading and shade plants can decrease temps by up to 8ºC.

Fill out each subsequent cooling priority.
Walk inside and outside to be able to answer the questions.
If you are unsure, see the pages Cooling Priorities Explained to understand more.

Filling out Survey

- *Answer questions from a building survey, drawn plans or on-site inspection*
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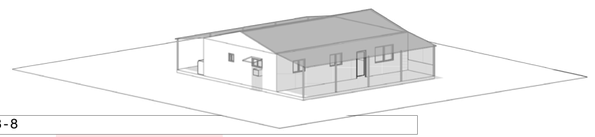
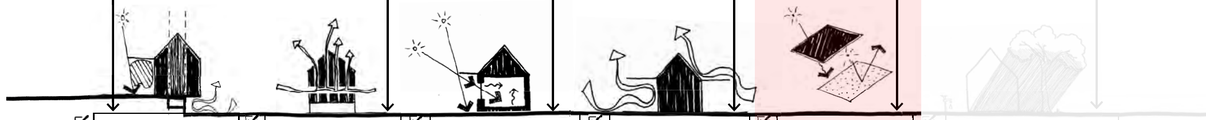


Passive cooling Priorities 3-8

3. Close the Underfloor → **4. Venting/ Airflow** → **5. Thermal Mass** → **6. Less Hot Air Inside** → **7. Paint/Surface Colour** → **8. Yard Improvements**



What's under the house?

Slab-on-ground ONLY (+0mm AGL)

- [ ] NA - ensure ground is shaded (refer to 1)

Low Set House ONLY (+600-1200mm AGL)

1. UNDERFLOOR CLADDING
   - [ ] 1. Fully lined
   - [ ] 2. Part lined
   - [ ] 3. No lining/ NA
2. PERIMETER CLADDING
   - [ ] 1. Enclosed w/ some vents
   - [ ] 2. Enclosed w/ many vents
   - [ ] 3. Very open (no cladding)

Elevated floors, if unlined and uninsulated, can cause the house to gain heat. If the ambient outside air temperature is higher, the more it will heat up the inside of the house.

What type of venting?

1. ROOF SPACE
   - [ ] 1. Mechanical venting
   - [ ] 2. Natural venting (eg. whirly bird)
   - [x] 3. Minimal/ no venting
2. INTERNAL LIVING SPACES
   - [x] 1. Windows are operable
   - [x] 2. Ext. doors are operable
3. VERANDAH ROOF
   - [ ] 1. Venting at wall edge
   - [x] 2. No Venting
   - [ ] 3. No Verandahs/ NA

Venting/airflow is important to improve cooling. Airflow across the body, if the ambient temperature is below 32ºC, will help you feel cooler. Venting the roof-space will make the house cooler.

Is there Thermal mass?

Block (heavy-weight) House ONLY

1. SHADE WALLS
   - [x] 1. North
   - [x] 2. East
   - [x] 3. West
   - [x] 4. South

Metal Frame (light-weight) House ONLY

2. INTERNAL THERMAL MASS
   - [x] 1. ALL walls are block
   - [ ] 2. ONLY a stand-alone block wall in the living room
   - [ ] 3. No block walls
3. FLOOR COVERING
   - [ ] 1. Concrete
   - [x] 2. Vinyl
   - [ ] 3. Tiles
   - [ ] 4. Timber
   - [ ] 5. Carpet

Thermal mass is the ability of materials to absorb, store and release heat. If used correct (like a slab-on-ground), it can help a house stay cool. If used the wrong way, it will absorb heat and release it slowly into the house make it hotter.

Where are gaps?

Upgrade Doors & Windows where possible

1. AROUND WINDOWS & DOORS
   Are their holes..?
   - [x] 1. Around windows
   - [x] 2. Around doors
2. Holes in FLOOR & WALL
   - [x] 1. Are there holes in floor?
   - [x] 2. Are there holes in walls?
3. Corner of WALL & CEILING / FLOOR (cornice & skirting)
   Are there holes?
   - [x] 1. Around the cornice
   - [ ] 2. Around the skirting
4. CEILING VENTS
   Can they be sealed closed or have insulation above?
   - [x] 1. Ceiling/ AC vents
   - [ ] 2. Exhausts/ chimney
   - [ ] 3. Downlights
   - [ ] 4. No vents/ NA

It is important to seal up gaps and holes around the house to stop unwanted hot or cold air coming inside or leaking out.

What colour is it?

1. ROOF COLOUR
   - [ ] 1. White (SA 0.25)
   - [x] 2. Medium (SA 0.5)
   - [ ] 3. Dark (SA 0.85)
2. WALL COLOUR
   - [ ] 1. White (SA 0.25)
   - [x] 2. Medium (SA 0.5)
   - [ ] 3. Dark (SA 0.85)
3. WINDOW/ DOOR FRAMES
   - [ ] 1. White (SA 0.25)
   - [ ] 2. Medium (SA 0.5)
   - [x] 3. Dark (SA 0.85)

Darker colours absorb heat and lighter colours reflect heat which can impact the temperature of the house.
**SA = solar absorptance*
Total incident solar radiation that is absorbed by colour

In the yard, is there?

1. POWER POINTS (GPO)
   - [ ] 1. Weatherproof GPOs
   - [ ] 2. Weatherproof lighting
2. YARD TAPS
   - [ ] 1. At living areas
   - [ ] 2. Non-water efficient
3. INFRASTRUCTURE FOR ADDITIONAL LIVING AREAS & SHADING
   - [ ] 1. Roof
   - [ ] 2. Walls
   - [ ] 3. Shade cloth/ NA

The yard is an important extension of the house and living area. A well functioning yard with good amenity can reduce the impacts of crowding. Good shading and shade plants can decrease temps by up to 8ºC.

Fill out each subsequent cooling priority.
Walk inside and outside to be able to answer the questions.
If you are unsure, see the pages Cooling Priorities Explained to understand more.

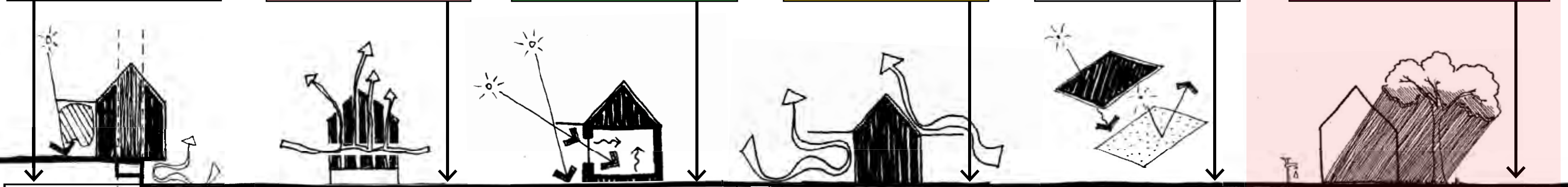
Filling out Survey

- *Answer questions from a building survey, drawn plans or on-site inspection*
- *Answer question as the majority of an element ie. Floor covering = concrete if only bathroom is tile*
- *Strike out whole box if not relevant*

☑ YES/ GOOD ☒ NO/ BAD

Passive cooling Priorities 3-8

3. Close the Underfloor → **4. Venting/ Airflow** → **5. Thermal Mass** → **6. Less Hot Air Inside** → **7. Paint/Surface Colour** → **8. Yard Improvements**



3. Close the Underfloor — What's under the house?

Slab-on-ground ONLY (+0mm AGL)

- [✓] NA - ensure ground is shaded (refer to 1)

Low Set House ONLY (+600-1200mm AGL) (struck out)

1. UNDERFLOOR CLADDING
   - [ ] 1. Fully lined
   - [ ] 2. Part lined
   - [ ] 3. No lining/ NA
2. PERIMETER CLADDING
   - [ ] 1. Enclosed w/ some vents
   - [ ] 2. Enclosed w/ many vents
   - [ ] 3. Very open (no cladding)

Elevated floors, if unlined and uninsulated, can cause the house to gain heat. If the ambient outside air temperature is higher, the more it will heat up the inside of the house.

4. Venting/ Airflow — What type of venting?

1. ROOF SPACE
   - [ ] 1. Mechanical venting
   - [ ] 2. Natural venting (eg. whirly bird)
   - [✓] 3. Minimal/ no venting
2. INTERNAL LIVING SPACES
   - [✓] 1. Windows are operable
   - [✓] 2. Ext. doors are operable
3. VERANDAH ROOF
   - [ ] 1. Venting at wall edge
   - [✓] 2. No Venting
   - [ ] 3. No Verandahs/ NA

Venting/airflow is important to improve cooling. Airflow across the body, if the ambient temperature is below 32°C, will help you feel cooler. Venting the roof-space will make the house cooler.

5. Thermal Mass — Is there Thermal mass?

Block (heavy-weight) House ONLY

1. SHADE WALLS
   - [✗] 1. North
   - [✗] 2. East
   - [✗] 3. West
   - [✗] 4. South

Metal Frame (light-weight) House ONLY

2. INTERNAL THERMAL MASS
   - [✓] 1. ALL walls are block
   - [ ] 2. ONLY a stand-alone block wall in the living room
   - [ ] 3. No block walls
3. FLOOR COVERING
   - [ ] 1. Concrete
   - [ ] 2. Vinyl
   - [✓] 3. Tiles
   - [ ] 4. Timber
   - [ ] 5. Carpet

Thermal mass is the ability of materials to absorb, store and release heat. If used correct (like a slab-on-ground), it can help a house stay cool. If used the wrong way, it will absorb heat and release it slowly into the house make it hotter.

6. Less Hot Air Inside — Where are gaps?

Upgrade Doors & Windows where possible

1. AROUND WINDOWS & DOORS
   Are their holes...?
   - [ ] 1. Around windows
   - [✓] 2. Around doors
2. Holes in FLOOR & WALL
   - [✓] 1. Are there holes in floor?
   - [✗] 2. Are there holes in walls?
3. Corner of WALL & CEILING / FLOOR (cornice & skirting)
   Are there holes?
   - [✗] 1. Around the cornice
   - [ ] 2. Around the skirting
4. CEILING VENTS
   Can they be sealed closed or have insulation above?
   - [✗] 1. Ceiling/ AC vents
   - [ ] 2. Exhausts/ chimney
   - [ ] 3. Downlights
   - [ ] 4. No vents/ NA

It is important to seal up gaps and holes around the house to stop unwanted hot or cold air coming inside or leaking out.

7. Paint/Surface Colour — What colour is it?

1. ROOF COLOUR
   - [ ] 1. White (SA 0.25)
   - [✓] 2. Medium (SA 0.5)
   - [ ] 3. Dark (SA 0.85)
2. WALL COLOUR
   - [ ] 1. White (SA 0.25)
   - [✓] 2. Medium (SA 0.5)
   - [ ] 3. Dark (SA 0.85)
3. WINDOW/ DOOR FRAMES
   - [ ] 1. White (SA 0.25)
   - [ ] 2. Medium (SA 0.5)
   - [✓] 3. Dark (SA 0.85)

*Darker colours absorb heat and lighter colours reflect heat which can impact the temperature of the house. *SA = solar absorptance Total incident solar radiation that is absorbed by colour*

8. Yard Improvements — In the yard, is there?

1. POWER POINTS (GPO)
   - [ ] 1. Weatherproof GPO's
   - [✗] 2. GPO's at outside living areas
2. YARD TAPS
   - [✗] 1. At living areas
   - [✓] 2. Can water plants
3. INFRASTRUCTURE FOR ADDITIONAL LIVING AREAS & SHADING
   - [✓] 1. Strong fences to yard
   - [ ] 2. North
   - [ ] 3. East
   - [ ] 4. West
   - [ ] 5. South
4. SHADE PLANTING & SHADE AREAS
   - [ ] 1. North
   - [ ] 2. East
   - [ ] 3. West
   - [ ] 4. South
   - [✓] 5. No shading/ NA

The yard is an important extension of the house and living area. A well functioning yard with good amenity can reduce the impacts of crowding. Good shading and shade plants can decrease temps by up to 8C.

Filling out Survey

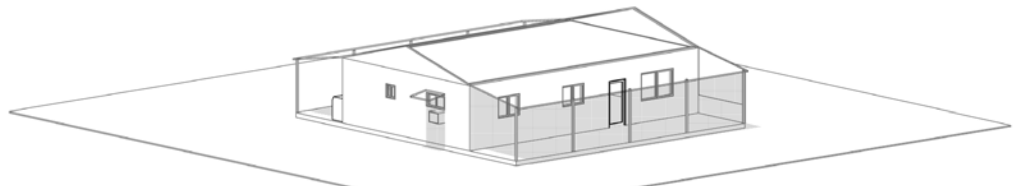
- *Answer questions from a building survey, drawn plans or on-site inspection*
- *Answer question as the majority of an element ie. Floor covering = concrete if only bathroom is tile*
- *Strike out whole box if not relevant*

☑ YES/ GOOD ☒ NO/ BAD

Notes

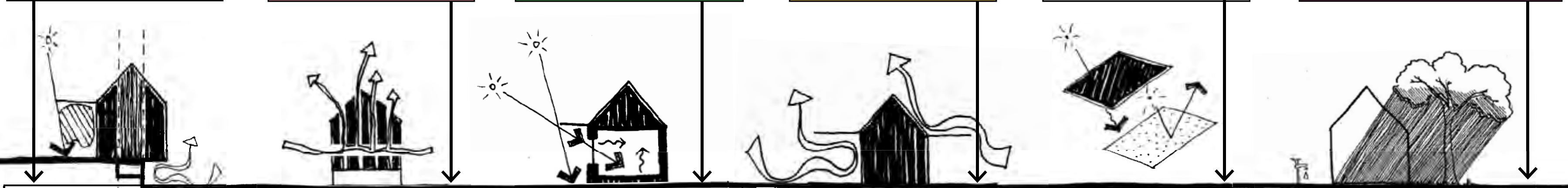
Fill out each subsequent cooling priority. Walk inside and outside to be able to answer the questions. If you are unsure, see the pages Cooling Priorities Explained to understand more.

3. *REFER TO & IMPLEMENT* Bang for your Buck modifications list



Passive cooling Priorities 3-8

3. Close the Underfloor → **4. Venting/ Airflow** → **5. Thermal Mass** → **6. Less Hot Air Inside** → **7. Paint/Surface Colour** → **8. Yard Improvements**



3. Close the Underfloor — What's under the house?

Slab-on-ground ONLY (+0mm AGL)

- [✓] NA - ensure ground is shaded (refer to 1)

Low Set House ONLY (+600-1200mm AGL) (struck out)

1. UNDERFLOOR CLADDING
   - [ ] 1. Fully lined
   - [ ] 2. Part lined
   - [ ] 3. No lining/ NA
2. PERIMETER CLADDING
   - [ ] 1. Enclosed w/ some vents
   - [ ] 2. Enclosed w/ many vents
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Elevated floors, if unlined and uninsulated, can cause the house to gain heat. If the ambient outside air temperature is higher, the more it will heat up the inside of the house.

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1. ROOF SPACE
   - [ ] 1. Mechanical venting
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   - [✓] 3. Minimal/ no venting
2. INTERNAL LIVING SPACES
   - [✓] 1. Windows are operable
   - [✓] 2. Ext. doors are operable
3. VERANDAH ROOF
   - [ ] 1. Venting at wall edge
   - [✓] 2. No Venting
   - [ ] 3. No Verandahs/ NA

Venting/airflow is important to improve cooling. Airflow across the body, if the ambient temperature is below 32°C, will help you feel cooler. Venting the roof-space will make the house cooler.

5. Thermal Mass — Is there Thermal mass?

Block (heavy-weight) House ONLY

1. SHADE WALLS
   - [✗] 1. North
   - [✗] 2. East
   - [✗] 3. West
   - [✗] 4. South

Metal Frame (light-weight) House ONLY

2. INTERNAL THERMAL MASS
   - [✓] 1. ALL walls are block
   - [ ] 2. ONLY a stand-alone block wall in the living room
   - [ ] 3. No block walls
3. FLOOR COVERING
   - [ ] 1. Concrete
   - [ ] 2. Vinyl
   - [✓] 3. Tiles
   - [ ] 4. Timber
   - [ ] 5. Carpet

Thermal mass is the ability of materials to absorb, store and release heat. If used correct (like a slab-on-ground), it can help a house stay cool. If used the wrong way, it will absorb heat and release it slowly into the house make it hotter.

6. Less Hot Air Inside — Where are gaps?

Upgrade Doors & Windows where possible

1. AROUND WINDOWS & DOORS
   Are their holes...?
   - [ ] 1. Around windows
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2. Holes in FLOOR & WALL
   - [✓] 1. Are there holes in floor?
   - [✗] 2. Are there holes in walls?
3. Corner of WALL & CEILING / FLOOR (cornice & skirting)
   Are there holes?
   - [✗] 1. Around the cornice
   - [ ] 2. Around the skirting
4. CEILING VENTS
   Can they be sealed closed or have insulation above?
   - [✗] 1. Ceiling/ AC vents
   - [ ] 2. Exhausts/ chimney
   - [ ] 3. Downlights
   - [ ] 4. No vents/ NA

It is important to seal up gaps and holes around the house to stop unwanted hot or cold air coming inside or leaking out.

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3. WINDOW/ DOOR FRAMES
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2. YARD TAPS
   - [✗] 1. At living areas
   - [✓] 2. Can water plants
3. INFRASTRUCTURE FOR ADDITIONAL LIVING AREAS & SHADING
   - [✓] 1. Strong fences to yard
   - [ ] 2. North
   - [ ] 3. East
   - [ ] 4. West
   - [ ] 5. South
4. SHADE PLANTING & SHADE AREAS
   - [ ] 1. North
   - [ ] 2. East
   - [ ] 3. West
   - [ ] 4. South
   - [✓] 5. No shading/ NA

The yard is an important extension of the house and living area. A well functioning yard with good amenity can reduce the impacts of crowding. Good shading and shade plants can decrease temps by up to 8C.

Filling out Survey

- *Answer questions from a building survey, drawn plans or on-site inspection*
- *Answer question as the majority of an element ie. Floor covering = concrete if only bathroom is tile*
- *Strike out whole box if not relevant*

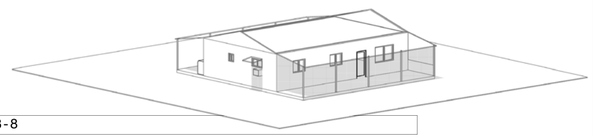
☑ YES/ GOOD ☒ NO/ BAD

Write any comments made by the tenant about house performance or things you notice during the survey. It is important to capture as much information as possible.

Notes

- couldn't access ceiling to see if there was insulation but from hole looked like there is none
- Tenant says west bedroom is very hot and aunty has to sleep outside instead of inside
- windows in bedroom don't close properly as power lead is running through window to verandah

3. *REFER TO & IMPLEMENT* Bang for your Buck modifications list



Passive cooling Priorities 3-8

3. Close the Underfloor | **4. Venting/ Airflow** | **5. Thermal Mass** | **6. Less Hot Air Inside** | **7. Paint/Surface Colour** | **8. Yard Improvements**

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Venting/airflow is important to improve cooling. Airflow across the body, if the ambient temperature is below 32ºC, will help you feel cooler. Venting the roof-space will make the house cooler.

Is there Thermal mass?

Block (heavy-weight) House ONLY

1. SHADE WALLS
   - [x] 1. North
   - [x] 2. East
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   - [x] 4. South

Metal Frame (light-weight) House ONLY

2. INTERNAL THERMAL MASS
   - [x] 1. ALL walls are block
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3. FLOOR COVERING
   - [ ] 1. Concrete
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   - [x] 3. Tiles
   - [ ] 4. Timber
   - [ ] 5. Carpet

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   Are their holes..?
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2. Holes in FLOOR & WALL
   - [x] 1. Are there holes in floor?
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3. Corner of WALL & CEILING / FLOOR (cornice & skirting)
   Are there holes?
   - [x] 1. Around the cornice
   - [ ] 2. Around the skirting
4. CEILING VENTS
   Can they be sealed closed or have insulation above?
   - [x] 1. Ceiling/ AC vents
   - [ ] 2. Exhausts/ chimney
   - [ ] 3. Downlights
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It is important to seal up gaps and holes around the house to stop unwanted hot or cold air coming inside or leaking out.

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3. WINDOW/ DOOR FRAMES
   - [ ] 1. White (SA 0.25)
   - [ ] 2. Medium (SA 0.5)
   - [x] 3. Dark (SA 0.85)

Darker colours absorb heat and lighter colours reflect heat which can impact the temperature of the house.
**SA = solar absorptance*
Total incident solar radiation that is absorbed by colour

In the yard, is there?

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   - [ ] 1. Weatherproof GPO's
   - [x] 2. GPO's at outside living areas
2. YARD TAPS
   - [x] 1. At living areas
   - [x] 2. Can water plants
3. INFRASTRUCTURE FOR ADDITIONAL LIVING AREAS & SHADING
   - [x] 1. Strong fences to yard
   - [ ] 2. North
   - [ ] 3. East
   - [ ] 4. West
   - [ ] 5. South
4. SHADE PLANTING & SHADE AREAS
   - [ ] 1. North
   - [ ] 2. East
   - [ ] 3. West
   - [ ] 4. South
   - [x] 5. No shading/ NA

The yard is an important extension of the house and living area. A well functioning yard with good amenity can reduce the impacts of crowding. Good shading and shade plants can decrease temps by up to 8C.

Once you have completed the survey, refer to correct Bang for your Buck modifications list, according to the type of house you have surveyed and its orientation.

Filling out Survey

- *Answer questions from a building survey, drawn plans or on-site inspection*
- *Answer question as the majority of an element ie. Floor covering = concrete if only bathroom is tile*
- *Strike out whole box if not relevant*

☑ YES/ GOOD ☒ NO/ BAD

Notes

- couldn't access ceiling to see if there was insulation but from hole looked like there is none
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- windows in bedroom don't close properly as power lead is running through window to verandah

3. *REFER TO & IMPLEMENT* Bang for your Buck modifications list

Chapter 6

Cooling Priorities explained

1. Shading Building Fabric
2. Insulation
3. Close the Underfloor
4. Venting/ Airflow
5. Thermal Mass
6. Less Hot Air Inside
7. Paint/ Surface Colour
8. Yard Improvements

1. Shading Building Fabric

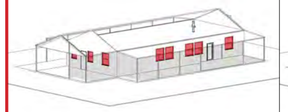
1.
Shading Building Fabric

Is there shading?

1. WINDOWS
   1. North
   2. North-East
   3. East
   4. South-East
   5. South
   6. South-West
   7. West
   8. North-West
2. WALLS
   Shades minimum 75% of wall height
   1. North
   2. North-East
   3. East
   4. South-East
   5. South
   6. South-West
   7. West
   8. North-West
3. VERANDAHS
   At least 2m wide
   1. North
   2. North-East
   3. East
   4. South-East
   5. South
   6. South-West
   7. West
   8. North-West

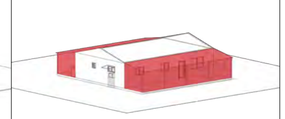
Without correct shading over the windows and walls, this can result in too much heat gain in the building making it uncomfortable for people. Big shadows are best for hot times to stop the sun hitting the house and stop the heat gain.

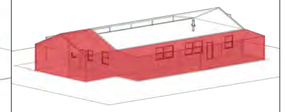
1. WINDOWS



2. WALLS

3. VERANDAHS





HLP's Targeted

1. Shading Building Fabric

Refer to Built Examples Gallery


5


8

Direct sun can generate the same heat as a single bar radiator over each square metre of a surface, but effective shading can block up to 90% of this heat. Radiant heat from the sun passes through glass and is absorbed by building elements and then re-radiate it inside the dwelling. Re-radiated heat has a longer wavelength and cannot pass back out through the glass as easily. In most climates, solar gain is desirable for winter heating but must be avoided in summer to minimise undesirable temperatures inside the home.[1] Although Insulation is highly effective, it loses approximately 1 R-value every decade [6], and hence structural responses to improve cooling are important.

1. WINDOWS

WHAT:

North (N) -

Receive higher angle sun in summer and therefore require narrower overhead shading devices. Fixed or adjustable horizontal shading above window and extending past it each side.

East (E) & West (W) -

Low-angle morning and afternoon summer sun from these directions is more difficult to shade. Keep the area of glazing on the east and west orientations to a minimum, or use appropriate shading devices.

Deep verandas, balconies or pergolas can be used to shade these sides of the home. Fixed or adjustable vertical louvres or blades; deep verandas or pergolas with deciduous vines

South (S) -

Shade south-facing glass in buildings only that are north of the tropic of Capricorn.

NE & NW -

Adjustable shading or pergolas with deciduous vines to allow winter solar heating or verandas to exclude it

SE & SW -

Planting: Evergreen in hot climates

The '45% rule of thumb' should be followed for designing window shading for latitudes south of, and including, 27.5°S.

WHY:

Shading glass is the best way to reduce unwanted heat gain, as unprotected glass is often the greatest source of heat entering a home. Up to 87% or a homes heat can be gained through windows. [5]

When the sun is perpendicular (at 90°) to the glass, it has an angle of incidence of 0° and the window will experience the maximum possible solar heat gain. As the angle increases, more solar radiation is reflected, and less is transmitted. It falls sharply once the angle exceeds 55°. Also, as the angle increases, the effective area of exposure to solar radiation decreases.

MUST COMPLY WITH *NCC 13.3.4 SHADING & SCHEDULE 6 NT PART 13.3 EXTERNAL GLAZING*
REFS - *CAIRNS STYLE DESIGN GUIDE* / *NATHERS ASSESSORS HANDBOOK*

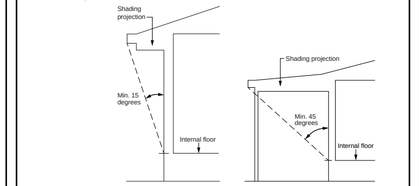
2. WALLS

WHAT:

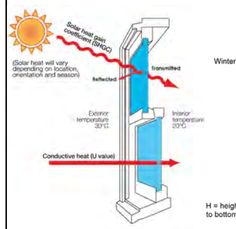
Shade all external openings and walls in summer. External walls can be shaded with a Shade Wall, verandah, balcony, eave, carport or the like which projects at a minimum angle of 15 degrees in accordance with NT Figure 13.2.5b.

WHY:

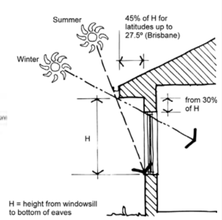
Shading uninsulated and dark-coloured walls can reduce the heat load on a building.[1]



NT Figure 13.2.5b: Measurement of a projection for wall shading



Key properties of glass & heat [2]



45% rule of thumb for latitudes south of, and including, 27.5°S [7]

MUST COMPLY WITH *NCC 13.3.4 SHADING* / *NT PART 13.2.5 EXTERNAL WALLS*
REFS - *CAIRNS STYLE DESIGN GUIDE* / *NATHERS ASSESSORS HANDBOOK CH.9* / *DIPL BUILDING SUSTAINABLE DESIGN GUIDELINES SECTION 4 & 5* / ***(5)*** *RAIA ENVIRONMENT DESIGN GUIDE FOR HOT ARID CLIMATES* / ***(6)*** *DESIGNING HOUSES FOR AUSTRALIAN CLIMATES*

3. VERANDAHS

WHAT:

Use covered outdoor living areas such as verandahs and deep balconies to shade all windows, walls and ground around the edge of the house.[1] SA Housing construct verandahs at a minimum of 3 metres to not only reduce solar gain, but also to ensure a full length swag can fit with circulation space.

WHY:

Well designed outdoor rooms provide for year-round outdoor living , reducing overcrowding impacts. [3]

Roughly twice as much solar radiation falls on a horizontal surface during overheated times as on a vertical surface; so that surrounding horizontal surfaces reflect a good amount of heat onto buildings. The amount depends on the exposure and reflectivity of the immediate terrain, e.g. Bare ground (dry) reflects approximately 10-25% of incident solar radiation vs. Bare ground (wet) reflects approximately 8-9%. [4]

Ground adjacent to a northerly face of a building is subject to solar heat load both from direct sunlight and reflected heat from adjacent surfaces, notably the building exterior itself. The air in this location reaches temperatures higher than ambient, and vents vertically by thermal convection. From this pressure reduction at ground level, suction draws ground level air in from all around, including through abutting openings in the adjacent building itself. This makes the inside of the house hotter. [5]

When Verandahs are not lined, air beneath them becomes heated above the temperature of shade air. This leads to hot air being blown indoors by the prevailing breeze. [6]

Refer to *4. Venting/ Airflow 3. Verandah* for more information.

1 - McGee, C. (2013). Your Home; Shading. DCEEW. https://www.yourhome.gov.au/passive-design/shading
2 - Dr Peter Lyons, B. H. (2013, 2020). Your Home; Glazing. DCCEEW. https://www.yourhome.gov.au/passive-design/glazing
3 - Healthabitat. (2023). B5.2 Developing the edges of the house and yard. Healthabitat. https://www.housingforhealth.com/housing-guide/developing-the-edges-of-the-house-and-the-yard/
4 - Olgyay, V. (2015). Design with Climate: Bioclimatic Approach to Architectural Regionalism (new and expanded edition). Princeton University Press. (pg 33)

2. Insulation

2.
Insulation

Is there insulation?

1. ROOF
Roof blanket
1. R2.5 (100mm THK)
2. R1.3 (60mm THK)
3. No insulation/ unkown
4. Verandah roof is lined

2. CEILING
1. R4 (190mm THK)
2. R3 (150mm THK)
3. R2 (90mm THK)
4. R1.5 (75mm THK)
5. No insulation/ unkown

3. EXTERIOR WALLS
1. R2.5 (90mm THK)
2. R2 (90mm THK)
3. R1.5 (75mm THK)
4. No insulation/ unkown

4. INTERIOR WALLS
1. R2.5 (90mm THK)
2. R2 (90mm THK)
3. R1.5 (75mm THK)
4. No insulation/ unkown

Framed Floor ONLY

5. UNDER-FLOOR
1. R4 (190mm THK)
2. R2 (90mm THK)
3. R1 (75mm THK)
4. No insulation/ unkown

Slab-on-ground ONLY

6. SLAB INSULATION
1. R3 edge ins (60mm THK)
2. R1 edge ins (25mm THK)
3. R.25 edge ins (7mm THK)
4. Under slab ins - R1
5. No insulation/ unknown

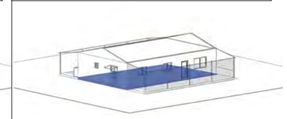
25-35% of heat gain in a house comes through the ceiling.

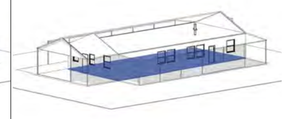
1. ROOF

2. CEILING

3. EXTERIOR WALLS
4. INTERIOR WALLS

5. UNDER-FLOOR INSULATION
6. SLAB INSULATION





HLP's Targeted

1. Insulation

Refer to Built Examples Gallery

8

For insulation to be effective, it should work in conjunction with good passive design. For example, if insulation is installed but the house is not properly shaded in summer, built-up heat can be kept inside by the insulation, creating an 'oven' effect. Walls and skillion roofs are the hardest to insulate post-construction, as the internal or external lining must be removed. Reflective foil insulation must be on the warm side of any building system. This means it should be inward facing and on the inside of insulation for all but Climate zone 1. Maintain an air space of at least 25mm (45mm is ideal), next to the shiny surface of reflective insulation. Because it only works by radiation and non-emittance, contact with any other building element will reduce its insulative properties to zero.[1] Batts can reduce summer heat in homes by up to 8 - 12 °C.[2] Save up to 5% on energy costs with appropriate floor insulation.[1]

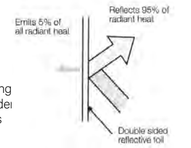
1. ROOF
2. CEILING

WHAT:
Use reflective insulation and roof blanket under the roof and minimum bulk insulation at the ceiling level. Reflective insulation mainly resist radiant heat flow due to its high reflectivity and low emissivity and relies on an adjacent air gap to work. Bulk insulation mainly resists the transfer of conducted and convected heat, relying on trapped pockets of air. Dust settling on the reflective surface of insulation greatly reduces its performance, so should be faced reflective surfaces downwards. (except in Climate zone 1). [1]

The NCC requires a minimum total R-Value depending on roof ventilation, under-roof reflective insulation and roof colour (eg. Table 13.2.3d). NT requirements are generic and less prescriptive and require:

- *Total R-Value of 2.7 for downwards and upwards heat flow*
- *This is reduced to 2.2 if:*
  - *Roof upper surface has solar absorptance of not more than 0.55*
  - *Roof space is ventilated by gable vents, ridge vents, eave vents*
- *Must have a thermal break, with an R-Value of not less than 0.2, installed between the metal sheet roofing and supporting member*

Verandah roofs should also be insulated in hot climates where outdoor living spaces are used extensively, to reduce radiant heat gain. Heat build up under verandahs not only affects the space below but can increase temperatures inside the house.



NT Table **13.2.3b**: Typical insulation options for typical roof and ceiling construction: Pitched roof with flat ceiling – ventilated roof space

		Climate zone 1	Climate zone 3
Tiled roof (clay or concrete)	Total R-Value of roof and ceiling materials	0.73	0.22
	Minimum value of added R-Value of insulation	1.97	2.48
Metal roof	Total R-Value of roof and ceiling materials	0.71	0.20
	Minimum value of added R-Value of insulation	1.99	2.50
Minimum required Total R-Value		2.70	2.70

NT Table **13.2.3c**: Typical insulation options for typical roof and ceiling construction: Pitched roof with flat ceiling – unventilated roof space

		Climate zone 1	Climate zone 3
Tiled roof (clay or concrete)	Total R-Value of roof and ceiling materials	0.55	0.40
	Minimum value of added R-Value of insulation	2.15	2.30
Metal roof	Total R-Value of roof and ceiling materials	0.53	0.38
	Minimum value of added R-Value of insulation	2.17	2.32
Minimum required Total R-Value		2.70	2.70

NT Part 13.2.3 roof tables (total R-Value of 2.7 for downwards and upwards heat flow).

MUST ACHIEVE R-VALUES IN NCC 13.2.3 ROOFS AND CEILINGS TABLES 13.2.3D & NT PART 13.2.3 ROOFS
REFS - DIPL BUILDING SUSTAINABLE DESIGN GUIDELINES SECTION 2 / NATHERS ASSESSORS HANDBOOK CH. 8.5
INSULATION INSTALLATION TO NCC NT PART 13.2.2

3. EXTERIOR WALLS
4. INTERIOR WALLS

WHAT:
Use bulk or reflective insulation in walls and include external insulation to all thermal mass. [3]
An example of retrofitting insulation to existing walls can be seen in Temperature control work by Healthabitat, see built example gallery for more information. Further explanation of wall insulation retrofit options can be found in Your Home: Insulation Guide.

The NCC 2022 requires a minimum total R-Value depending on wall shading and wall height, NT requirements for climate zone 3 are generic and lower:

Climate Zone	NT 13.2.5. (3) External Walls
3	a) Achieve a minimum Total R-Value of 1.9
	b) Achieve a minimum Total R-Value of 2.4 and be constructed on a flooring system that is in direct contact with the ground such as a concrete slab-on-ground or the like
Thermal bridging of block and metal-framed walls must address NCC requirements and have a thermal break as noted.	

WHY:
As noted above.
Insulating your walls can typically save around 15% on heating and cooling costs.

Wall insulation reduces radiant, conducted and convected heat transfer from the outside of the building to the inside. [1]

MUST ACHIEVE R-VALUES IN NCC 13.2.5 TABLES 13.2.5 E/F & NT PART 13.2.5 EXTERNAL WALLS / NATHERS ASSESSORS HANDBOOK CH. 6.3
INSULATION INSTALLATION TO NCC NT PART 13.2.2

5. UNDER-FLOOR INSULATION
6. SLAB INSULATION

WHAT:
Insulate elevated floors (lightweight or concrete)[1], especially where air conditioning is used to improve the performance of the interior space. Edges of slab-on-ground should be insulated to stop heat traveling in through the slab,

Consider using earth-coupled slabs in all areas where deep ground temperature (depth of 3 metres) are less than 19C in summer. [1]

Ceilings and suspended floors with easy access are relatively simple to insulate post construction. Insulation board can be laid beneath floor finishes if there is no under-floor access.

The NCC requires:
Floor over unenclosed space (min R-Value of floor insulation):
Zone 3 = 1.5
Floor over an enclosed subfloor space (min R-Value of subfloor wall insulation):
Zone 3 = 0.5

In Zone 4, the NCC requires minimum R-Value of floor and subfloor wall insulation where the floor is over an enclosed subfloor space between R0.5 - R2.0 (table 13.2.6d).

WHY:
Earth-coupled slab achieves the stable temperature of the earth meaning it is cool in summer to help cool a house. [4]
Approximately 80% of heat loss occurs through the edge of the slab, insulating the edges is important. [1]

MUST ACHIEVE R-VALUES IN NCC 13.2.6 FLOORS AND SUBFLOOR WALLS TABLE 13.2.6C/D

1 - Mosher, C. M. M. (2010). Your Home; 4.7 Insulation. DCCEEW. https://wwwyourhome.gov.au/passive-design/insulation
2 - Insulation, F. (2012). Thermal Insulation for Homes. In.
3 - Reardon, C. (2013, 2020). Your Home; Design for Climate. DCCEEW. https://wwwyourhome.gov.au/passive-design/design-climate
4 - Clarke, D. (2020). Your Home; Concrete slab floors. DCCEEW. https://wwwyourhome.gov.au/materials/concrete-slab-floors

3. Close the Underfloor

What's under the house?

Slab-on-ground ONLY (+0mm AGL)

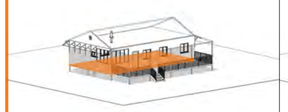
NA - ensure ground is shaded (refer to 1)

Low Set House ONLY (+400-1200mm AGL)

1. UNDERFLOOR CLADDING
   1. Fully lined
   2. Part lined
   3. No lining/ NA
2. PERIMETER CLADDING
   1. Enclosed w/ some vents
   2. Enclosed w/ many vents
   3. Very open (no cladding)

Elevated floors, if unlined and uninsulated, can cause the house to gain heat. If the ambient outside air temperature is higher, the more it will heat up the inside of the house.

1. UNDERFLOOR CLADDING



2. PERIMETER CLADDING

FOR RAISED HOUSES ONLY

HLP's Targeted

3. Close the Underfloor

Refer to Built Examples Gallery


5


8

Raised floors vary in temperature according to the temperature outside. The temperature of the air reaching the underside of a suspended house without perimeter walls or equivalent protection for the under-floor space, will be the same as the outdoor air temperature and hence the floor materials will increase to this temperature. It is therefore advisable for raised floors to have insulation, be lined and have enclosed underfloor spaces to enable the air cavity to act as insulatation and stabilise the temperature of the floor. [1] 10-20% of heat gains and loses come through the floor. [2]

FOR RAISED HOUSES ONLY

1. UNDERFLOOR CLADDING

WHAT:
Clad underneath the floor with rigid insulation or rigid lining over insulation. The lining must be durable such as fibre cement and well sealed around all edges and perforations such as around water pipes or electrical conduits.

NCC requires a certain quantity and size of vents for sealed subfloors.

WHY:
Elevated floors, by contrast, are subject to changes in climatic conditions. Elevated floors may be useful where ventilation under the floor, coupled with the cooler shaded air, is beneficial to thermal comfort. [3]

MUST COMPLY WITH NCC PART 6.2.1 SUBFLOOR VENTILATION

2. PERIMETER CLADDING

WHAT:
If access to the underside of the house is difficult, cladding can be installed to the perimeter of the floor edge.

The lining must be durable and hard wearing such as fibrecement, composite material sheeting or metal cladding. It must be well sealed around all edges and vents.

NCC requires a certain quantity and size of vents for sealed subfloors.

WHY:
Sealing the underfloor will minimise air flowing underneath the house of a highr temperature and heating up the floor. The air underneath will stay coupled with the ground and remain at shade air temperature.

NCC requires sub floors to have cross ventilation of the subfloor space between the underside of the subfloor and the ground surface under a building. Alice Springs sits in 'Zone A' (NCC Table 6.2.1a) and for every meter of subfloor requires a minimum vent of 2000mm^2 (40mm x 50mm).

MUST COMPLY WITH NCC PART 6.2.1 SUBFLOOR VENTILATION

1 - Drysdale, J. W. (1952). Designing Houses for Australian Climates (Second ed.). Commonwealth Experimental Building Station.
2 - Mosher, C. M. M. (2010). Your Home; 4.7 Insulation. DCCEEW https://wwwyourhome.gov.au/passive-design/insulation
3 - NatHERS. (2019). NatHERS assessor handbook. Retrieved from https://www.nathers.gov.au/publications/nathers-assessor-handbook

4. Venting/ Airflow

4.
Venting/ Airflow

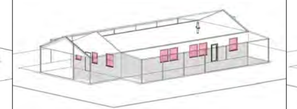
What type of venting?

1. ROOF SPACE
   1. Mechanical venting
   2. Natural venting (eg. whirly bird)
   3. Minimal (no venting)
2. INTERNAL LIVING SPACES
   1. Windows are operable
   2. Ext. doors are operable
3. VERANDAH ROOF
   1. Venting at wall edge
   2. No Venting
   3. No Verandahs/ NA

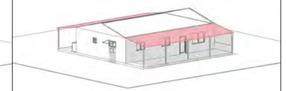
Venting/airflow is important to improve cooling. Airflow across the body, if the ambient temperature is below 32ºC, will help you feel cooler. Venting the roof-space will make the house cooler.

1. ROOFSPACE

2. INTERNAL LIVING SPACES



3. VERANDAH ROOF



HLP's Targeted

4. Venting/ Airflow

Refer to Built Examples Gallery

8

Ventilation is the deliberately controlled movement of air between the inside and outside of the house. Air movement throughout the house is needed to provide fresh air, to cool occupants and cool the house interior. [4]

Our body temperature is about 37C and needs to stay stable. The most effective cooling method is the evaporation of perspiration (sweat). Evaporation rates are influenced by air movement, greater air speed is needed for greater benefit. [1] The NCC requires minimum ventilation amounts to be provided to all habitable rooms, bathroom and any other room occupied by a person for any purpose.

1. ROOF SPACE

WHAT:
Use ventilated roof spaces to create a thermal buffer zone to summer heat gain. Use gable vents, mechanical fans or whirlybirds.

Roof ventilators remove the hot air built up in the roof space and replace it with fresh air from outside of a lower ambient temperature.

WHY:
The level of ventilation or openness to the roof space or attic significantly affects the thermal performance of house. [3] On average ventilating a ceiling space in a hot climate through the use of whirly birds can increase the star rating by up to 0.5 stars. [5]

Hot air rises and without ventilation it is unable to escape the roof cavity. This means the ceiling insulation has to work harder to stop hot air coming inside into the living areas. Roof ventilation also helps remove excess water vapour from the roof space to avoid mould and condensation buildup.

NCC 10.8.3 Ventilation of roof spaces as a part of condensation management only applies to Climate zones 6, 7 and 8.

MUST COMPLY WITH NCC ***PART 10.6 VENTILATION***
REFS - NATHERS ASSESSORS HANDBOOK CH. 8.3 , /

2. INTERNAL LIVING SPACES

WHAT:
Ventilation to habitable rooms must be from natural ventilation through a window, opening, door or other device from an adjoining room. It must not have an openable area of less than 5% of the floor area of the room to be ventilated e.g. for a 20sqm bedroom, the openable window sash has to be a minimum of 1 sqm big.

Doors and windows should be operable, if they do not work, they need to be replaced.

WHY:
Air movement affects body cooling. It does not increase the temperature but causes a cooling sensation due to heat loss by convection and due to increased evaporation from the body. As velocity of air movement increases, the upper comfort limit is raised. However, this rise slows as higher temperatures are reached. [6]

It is important to open up the house of a night time during cooler temperatures to 'flush the house' This will remove all the hot air and cool walls which may have heated up overnight, ready for the following day when the house needs to be shut up during the hot part of the day to stay cool inside.

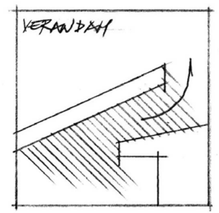
MUST COMPLY WITH NCC NT ***PART 10.6.2 VENTILATION REQUIREMENTS / 13.5.2 AIR MOVEMENT / 13.5.3 VENTILATION OPENINGS***

3. VERANDAH

WHAT:
Seperate the shading device from the structure and expose it to wind convection to vent out built up hot air. Lap the verandah roof over the house roof or pull the roof lining away from the wall to create a gap.

WHY:
Where the sunward facing veranda roof has an air gap to and over the building face, accumulated solar heat load under the veranda roof can vent away. The veranda roof angle results in a larger shade footprint than the traditional veranda fixed to the building eave. Both aspects reduce solar heat load intensity on the building. [2]

Refer to *1.Shading 3.Verandahs* for more information.

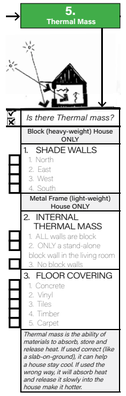


Vented Verandah diagram [2]

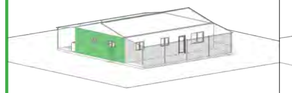
STRUCTURE MUST COMPLY WITH NCC
REF - RAIA ENVIRONMENT DESIGN GUIDE FOR HOT ARID CLIMATES[2].

1 - Reardon, C. (2013, 2020). Your Home; Design for Climate. DCCEEW. https://www.yourhome.gov.au/passive-design/design-climate
2 - Architects, A. I. o. (2010). Environment Design Guide, Climate Responsive Design: Cooling systems for Hot And Climates. A. I. o. Architects.
3 - NatHERS. (2019). NatHERS assessor handbook. Retrieved from https://www.nathers.gov.au/publications/nathers-assessor-handbook
4 - Hollo, N. (2011). Warm House Cool House - inspirational designs for low-energy housing (Second Edition ed.). NewSouth Publishing.
5 - Energy, C. (2019). 6 Design Tips for a 6 Star NatHERS Energy Rating. Certified Energy.
6 - Olgyay, V. (2015). Design with Climate: Bioclimatic Approach to Architectural Regionalism (new and expanded edition). Princeton University Press. (pg 19-23)

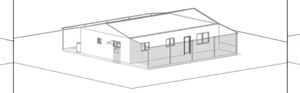
5. Thermal Mass



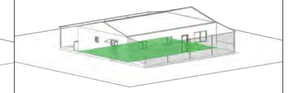
1. SHADE WALLS

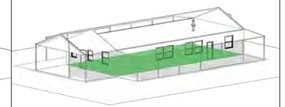


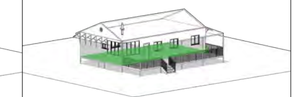
2. INTERNAL THERMAL MASS



3. FLOOR COVERING







HLP's Targeted

5. Thermal Mass

Refer to Built Examples Gallery

In many remote communities, concrete slab floors and concrete masonry are preferred due to their high durability. The disadvantage of using concrete is that it has a high thermal mass: daytime heat gains are stored in the walls and floors and are released into the house at night, negating any benefit from cool breezes or lower temperatures. These heat loads can be minimised through design by shading the walls from direct sun with verandas, roof overhangs, plants and external screens or louvres. Generating a flow of slightly cooler air across the walls due to shading can also help to remove excess heat. Include external insulation to all thermal mass. [1]

1. SHADE WALLS

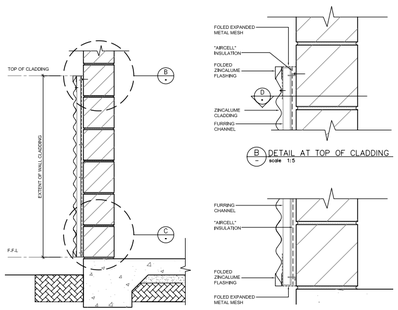
WHAT:
If it is not possible to extend the roof eave or install a verandah, it is possible to install 'Shade Walls' directly fixed to the external face of a block wall to shade it.

Healthabitat has extensively trialled a type of shade wall on community houses (as per detailed drawings below):

- *Colorbond cladding on battens with aircell behind to underside windows or across entire wall faces* [2]

WHY:
Unshaded uninsulated block walls will gain heat in the day and release it inside the house in the evening.

The Healthabitat trial showed Shade Walls can help cool houses by 9C.



Shade Wall detailed documentation for construction [2]

2. INTERNAL THERMAL MASS

WHAT:
For slab-on-ground houses, build internal thermal mass walls by building new walls, cladding existing walls, or building half-height or dividing walls out of 90mm or 140mm concrete block, bricks or stone.

Locate them where no sun will hit them, air can pass them during 'night flushing' or adjacent to cooling systems so they soak up the cool air.

WHY:
Thermal mass can help passive cooling by stablising the inside temperatures and help cool the house as it radiates often cooler air than ambient temperature.

For passive cooling, thermal mass should: [1]

- *be protected from summer sun with shading and insulation*
- *ensure cool night breezes and air currents can pass over the thermal mass to draw out stored energy*
- *be located inside, connected to the ground*
- *located in the center of the building, particularly if an air-conditioner is positioned there.*

Thermal mass should not: [1]

- *be in rooms or building with poor orientation and poor insulation from external temperature extremes and rooms with minimal exposure to cooling summer breezes*
- *be on upper levels as it is slow to cool*
- *be exposed to thermal bridging*

High-mass construction (slab-on-ground and high mass walls) is most appropriate in climates with a larger diurnal range, over 10C.
Low-mass construction generally performs best where diurnal ranges are consistently 6C or less. [1]

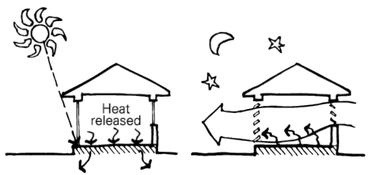
3. FLOOR COVERING

WHAT:
Slab-on-ground is the most advisable floor construction in this climate and should have should have exposed concrete or tile floors to benefit from the high thermal mass and hence passive cooling.

Raised floors should be insulated underneath or have the sub-floor enclosed and have tile floors to benefit from passive cooling.

Raised floors that are uninsulated and do not have an enclosed sub-floor will transfer the ambient outside temperature through the floor material. Tile floor covering and other higher thermal mass coverings will store this high temperature for longer and make the house hotter.

WHY:
High thermal mass floors can 'wick away substantial heat loads and provides a cooler surface for human bodies to radiate heat to, or conduct to with bare feet, lowering their body temperature and making them feel cooler. [3]



Thermal mass in summer for passive cooling [3]

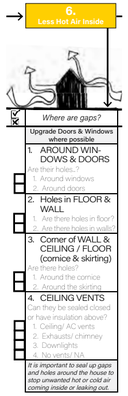
SHADING OVER WINDOWS MUST COMPLY WITH NCC NT PART 13.2.5 (3) (4) EXTERNAL WALLS

REF - BDP ENVIRONMENT DESIGN GUIDE THERMAL MASS IN BUILDING DESIGN

FLOOR COVERING FINISHES TO AS4586-2013

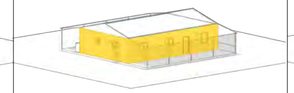
1 - Reardon, C. (2013). Your Home; Passive cooling. DCCEEW. Retrieved 2020 from https://wwwyourhome.gov.au/passive-design/passive-cooling
2 - Tangentyere Documentation and Healthabitat RD4c Temperature Control Final Report
3 - Reardon, C. (2013, 2020). Your Home; Thermal Mass. DCEEW. https://wwwyourhome.gov.au/passive-design/thermal-mass

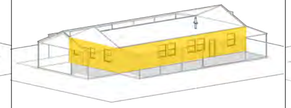
6. Less Hot Air Inside



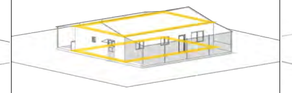
1. AROUND WINDOWS & DOORS

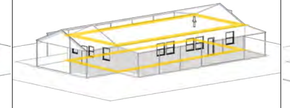
2. HOLES IN FLOOR & WALL



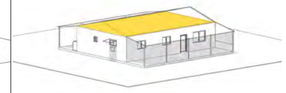


3. CORNER OF WALL & CEILING/FLOOR (CORNICE & SKIRTING)





4. CEILING VENTS



HLP's Targeted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6. Less Hot Air Inside

Refer to Built Examples Gallery

Houses should be constructed to minimise undesirable air infiltration or loss, this is called airtightness. During construction it is important to avoid gaps in the building fabric, ensure windows and doors fit snugly in their frames and weather seals are installed where necessary. [1] Overseas standards and research recognise that the weather proofing or draught sealing of houses is the most cost effective retrofit method of achieving direct energy savings, where draughts can account for 15- 25 % of heat loss from a home. [2]
A Blower door test measures the airtightness of a building in a measurement of air changes per hour or ACH at 50 pascals. Some old houses are very leaky at 30 ACH. The current average new Australian home has an airtightness of 15.4 air changes per house. NCC does not currently quantify an air leakage rate for new buildings or major renovations. [4]

1. AROUND WINDOWS & DOORS

WHAT:
Upgrade doors and windows where possible to be more thermal efficient e.g. low-e film, double glazed or thermally broken frames.

Doors and windows should be installed tight in the construction opening or have gaps filled around them such as with spray expanding foam.
Install draught-proofing strips and seals at the bottom and top of doors as per NCC requirements. For example, using neoprene pillow or foam strip seals, or rubber compressible strips,
Avoid cavity sliding doors in critical air-leak paths because they are hard to seal and acoustically poor.

They should be tight-closing as protection against high diurnal (day and night) heat change.

AS2047 specifies maximum air infiltration rates for windows.

WHY:
After the type of glazing, frames have the biggest impact on thermal performance of windows.[6] It is important to have high performing window units.

Windows and doors that are poorly sealed in the unit themself and the surrounds, allow hot air inside and cool air from inside to leak out.

2. HOLES IN FLOOR & WALL

WHAT:
All holes in the floor and wall lining should be repaired ASAP, either patched over or the lining repaired.

All larger gaps should have fixed or operable products to ensure they can be sealed whilst in use. This includes holes around RAC wall air conditioner units. Install adjustable covers over RAC wall holes and covers to the surrounds of units to seal the hole.

WHY:
Holes in the building fabric contribute to a leaky house which lets hot air inside and cool air from inside to leak out. These holes also act as entry points for vermin and pests.

3. CORNER OF WALL & CEILING / FLOOR (CORNICE & SKIRTING)

WHAT:
Ceilings, walls and floors to any conditioned space or habitable room must be constructed to minimise air leakage in accordance with:

- *enclosed by internal lining systems that are close fitting at ceiling, wall and floor junctions*
- *sealed at junctions and penetrations with close fitting skirting, architrave, cornices OR expanding foam, caulking or seals*

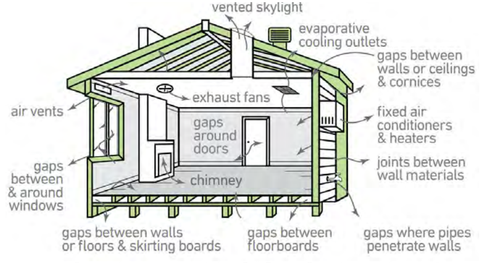
Walls and ceilings should be built with flat materials or have sealant to seal any gaps such as those with ribbed metal cladding.

WHY:
Houses with metal ceilings or ribbed ceiling linings are 33% more leakier due to gaps at junctions. [5]

4. CEILING VENTS

WHAT:
Chimneys and flues to solid burning appliances, around roof lights, exhaust fans and evaporative coolers must be fitted with self-closing dampers, filters or damper with a flap to stop air infiltration.
They should be sealed around their edges against other materials with mastic or caulking to ensure no gaps.

WHY:
Exhausts and AC vents are responsible for approximately 23-59% of air leakage. [5]



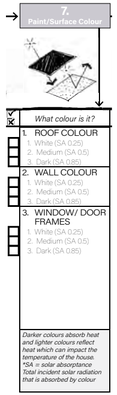
Sources of draughts diagram (refer to Built Example Gallery for more information) [3]

MUST COMPLY WITH NCC NT PART *13.4.4 EXTERNAL WINDOWS AND DOORS*
REFS - *AS2047 WINDOWS IN BUILDINGS - SELECTION*

MUST COMPLY WITH NCC NT PART *13.4.2 CHIMNEYS AND FLUES / 13.4.5 EXHAUST FANS / NCC 13.4.6 CONSTRUCTION OF CEILINGS, WALLS AND FLOORS / 13.4.7 EVAPORATIVE COOLERS*
REFS - *AS2047 WINDOWS IN BUILDINGS - SELECTION AND INSTALLATION / DRAUGHT SEALING RETROFIT TRIAL*

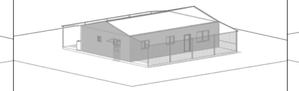
1 - Hollo, N. (2011). Warm House Cool House - inspirational designs for low-energy housing (Second Edition ed.). NewSouth Publishing.
2 - Mosher, C. M. M. (2010). Your Home; 4.7 Insulation. DCCEEW. https://wwwyourhome.gov.au/passive-design/insulation
3 - Victoria, S. (2016). Draught Sealing Retrofit Trial. https://assets.sustainabilityvic.gov.au/susvic/Report-Energy-Draught-Sealing-Retrofit-Trial-Sep-2016-1.pdf
4 - Reardon, C. (2013). Your Home; Ventillation and airtightness. DCCEEW. https://wwwyourhome.gov.au/passive-design/ventilation-airtightness
5 - Maxwell, S. (2023). Draft Report; APY Retrofit Pilot Study. A. A. Limited.
6 - Dr Peter Lyons, B. H. (2013, 2020). Your Home; Glazing. DCCEEW. https://wwwyourhome.gov.au/passive-design/glazing

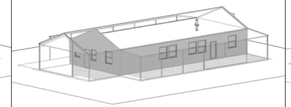
7. paint/ Surface Colour



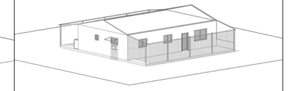
1. ROOF COLOUR

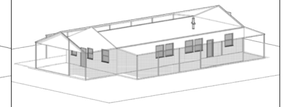
2. WALL COLOUR

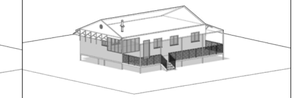




3. WINDOW/ DOOR FRAMES







HLP's Targeted

7. paint/ Surface Colour

Refer to Built Examples Gallery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Dark colours tent to absorb heat, whereas light colours more effectively reflect the sun's heat. In summer, dark colours on the exterior can add considerably to the heat load on the house. Therefore lighter colours are recommended, especially for areas exposed to direct sun. [1] The higher the Solar Absorptance (SA) number of a colour, the more heat it absorbs and the hotter it will be. The lower the SA number, the more light it reflects and the cooler it will be.

1. ROOF COLOUR

WHAT:
Use light colours on roofs.

In climate zones 1 to 5, the solar absorptance of the upper surface of a roof must be not more than 0.64 Solar Absorptance. Black roofs are no longer allowed.
In the NCC NT the total required roof R-Value of 2.9 is reduced to 2.2 if the roof upper surface has a solar absorptance value of not more than 0.55.

WHY:
25-35% of a house's heat gain is through the roof and ceiling. [2] If a house does not have roof or ceiling insulation, the colour of the roof will have a bigger impact on the house.
The lighter the colour, the more heat that will be reflected and not gained inside the roof cavity. Once heat is inside, the house has to work harder to get rid of the heat so it doesn't negatively affect the thermal comfort for people.

2. WALL COLOUR

WHAT:
Use light colours on walls.

In climate zones 1 to 5, the solar absorptance of the outer surface of a wall must be not more than 0.7 Solar Absorptance.
In the NCC NT, the requirements do not apply if the external surface of the external wall achieves a solar absorptance of not more than 0.45 and the external walls are shaded in accordance with NT Figure 13.2.5b.

WHY:
15-25% of a house's heat gain is through the walls. If a house does not have wall insulation, the colour of the walls will have a bigger impact on the house.

The lighter the colour, the more heat that will be reflected and not gained by the walls and transfered inside.

3. WINDOW/ DOOR FRAMES

WHAT:
Use light colours on window and door frames in partial and full sun.

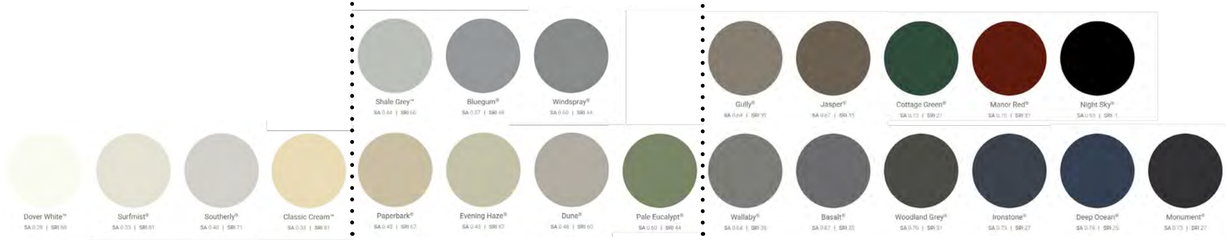
WHY:
After the type of glazing, frames, including the colour have the biggest impact on thermal performance of windows.

Aluminium frames, especially dark coloured ones in full sun, absorb a lot of solar heat and conduct it inside. [4]

Light Solar Absorptance (SA) = 0.00 - 0.475 3

Medium Solar Absorptance (SA) = 0.475 - 0.70 3

Dark Solar Absorptance (SA) = 0.70 - 1.00 3



ROOF COLOUR MUST COMPLY WITH NCC NT PART 13.2.3 ROOFS
REFS - NATHERS ASSESSORS HANDBOOK CH.8.6

WALL COLOUR MUST COMPLY WITH NCC 13.2.5 (3) BUILDING FABRIC/ EXTERNAL WALLS & NT PART 13.2.5 (4) EXTERNAL WALLS
REFS - NATHERS TECHNICAL NOTE CH.6.4

1 - Hollo, N. (2011). Warm House Cool House - inspirational designs for low-energy housing (Second Edition ed.). NewSouth Publishing.
2 - Mosher, C. M. M. (2010). Your Home; 4.7 Insulation. DCCEEW. https://wwwyourhome.gov.au/passive-design/insulation
3 - Steel Select: Colours and Finishes, classic finishes
4 - Dr Peter Lyons, B. H. (2013, 2020). Your Home; Glazing. DCCEEW. https://wwwyourhome.gov.au/passive-design/glazing

8. Yard Improvements

1. POWERPOINTS (GPO)
2. YARD TAPS
3. INFRASTRUCTURE FOR ADDITIONAL LIVING AREAS & SHADING
4. SHADE PLANTING & SHADE AREAS

HLP's Targeted

8. Yard Improvements

Refer to Built Examples Gallery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The effects of crowding can be reduced by designing useful yards and 'edge' spaces around the house, such as verandahs, decks, sleep-outs, shady areas for summer, and sunny, wind protected areas in winter. Allowing space between houses will increase the size of the yard and the capacity to use it for different activities. It will also reduce the overall level of crowding in the community. [1] It has been observed "that the design of the building perimeter and the adjoining yard areas is vital to the successful functioning of a house."

1. POWERPOINTS (GPO)

WHAT:
Install powerpoints to all aspects of the outside of the house. It is important to install multiple GPO's along the length of covered verandahs as this is often the first location in the yard crowding spills to.

Weatherproof GPO's should be used on the exterior of the house, to ensure they are safe to use during all weather and locations.

Housing for Health recommends: [3]
- *There are outside power points for external living areas and verandahs*

WHY:
When there are no exterior GPO's, powercords often run through windows, doors and vents for family camping in the yard to use power.

Not only are these powercords a trip hazard, this also perforates the building envelope meaning more holes in the building fabric and windows and doors can't close properly. This means more hot air is let inside the house and cool air from the air-conditioner escapes easily.
When there are no powercords or outside GPO's, people have to go inside the house which means doors and windows are opened and closed more often, also letting hot air in and cool air out.

LOCATION AND INSTALLATION OF GPO'S TO AS/NZS 3000/2007

2. YARD TAPS

WHAT:
Install yard taps to different areas of the yard including next to verandahs, growing trees and shady areas of the yard where people are more likely to stay.

The tap should be protected by bollards, rocks or a heavy gauge steel universal column.

A generous concrete splash pad minimises erosion and pooling for mosquito breeding areas. It is advisable to have a drain connected to stormwater or to a soakage pit underneath the stream of water.

Housing for Health recommends: [1]
- *B5.2.7 At least two yard taps on robust tap standards with drainage directly underneath are installed*

WHY:
Yard taps are important to encourage shade planting and ground cover to decrease temperatures of the ground. They are also important drinking, washing and cooling points for people staying in the yard.

This is important to reduce the amount of times people have to walk in and out of the house to access water either from the kitchen, laundry or bathroom. The less the doors and windows open reduces the amount of hot air coming inside or letting cool air out.

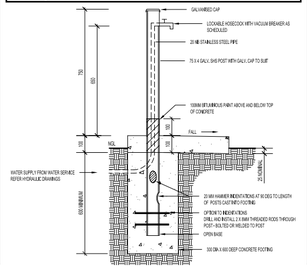
LOCATION AND INSTALLATION OF YARD TAPS TO ABCB PLUMBING CODE OF AUSTRALIA

3. INFRASTRUCTURE FOR ADDITIONAL LIVING AREAS & SHADING

WHAT:
"Consider providing at least one outdoor living area that is positioned to suit prevailing weather conditions, and that the outdoor area is shaded, rain-protected, well lit, and easily accessed from the house."

Housing for Health recommends: [1]
- *B5.2.1 the yard area is safe, particularly for children, by enclosing it with robust fencing materials and providing car and pedestrian gates at key access points*
- *B5.2.3 the fence structure and infill material is robust and that the fence design will allow windbreak planting vines and / or the drying of washing*

WHY:
Fencing is significant in defining the extent of individual house yards and differentiating areas within them. Fences are also used as structure for windbreaks, bough shade structures, tents, washing and additional living areas.



DIPL NT Yard Tap Specification

REFS - DEVELOPING THE EDGES OF THE HOUSE AND THE YARD

4. SHADE PLANTING & SHADE AREAS

WHAT:
Match plant characteristics (such as foliage density, canopy height and spread) to shading requirements. Choose local native species with low water requirements wherever possible. [2]
Deciduous plants - allow winter sun through their bare branches and exclude summer sun with their leaves.
Trees - with high canopies are useful for shading roofs and large portions of the building structure.
Shrubs - are appropriate for more localised shading of windows.
Wall vines and ground cover - insulate against summer heat and reduce reflected radiation. [2]

WHY:
Plantings should be used instead of paving to reduce ground temperature and the amount of reflected heat. [2]

Plants can also help assist cooling by transpiration.

The species selection and planting arrangement of urban trees can reduce local heat. More than twice as many days of >40°C were recorded along a street in North Parramatta, where canopy cover was only 10%, compared to a nearby street where canopy cover was 30%. Air temperatures under trees with very dense canopies were more than 7°C lower during a heatwave compared to trees with open canopies. [4]

1 - Healthabitat. (2023). Housing for Health; The Guide - Reducing the negative impacts of crowding.
2 - McGee, C. (2013). Your Home; Shading. DCEEW. https://www.yourhome.gov.au/passive-design/shading
3 - Healthabitat. (2023). Housing for Health; The Guide - A14 Power points, lights and other fittings.
4 - Sebastian Pfautsch, S. R. (2019). Benchmarking heat across Cumberland council, NSW. https://research.direct.westernsydney.edu.au/islandora/object/uws:52866 (pg 49)

Chapter 7

Best Bang for your Buck Modifications + Costing

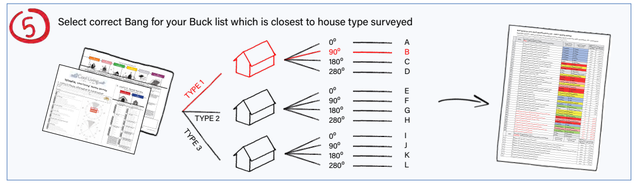
- Best Bang for your Buck as proof of concept
- Best Bang for your Buck metric
- Typical house base models
- Best Bang for your Buck explanation

‘Best Bang for your Buck’ as proof of concept

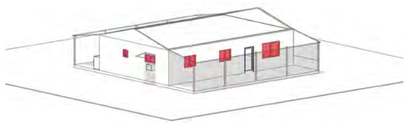
Only one Modifications list (Type H1B) is available in this project as a proof of concept.

The Best Bang for your Buck modifications list in this project is based off House type 3 at 90º orientation in the NatHERS software HERO. The existing base house was modeled and then the cooling priorities were added iteratively to the base model and the impacts on the heating and cooling load documented. This list was then ordered from biggest impact on cooling load to least impact on cooling load. From the change in KWh, a standard figure for the supply of electricity was equated to give cost savings benefits.

This project sets up the structure, where moving forward this would not be a manual process, but a developed database would produce the correct modifications list from the survey information.

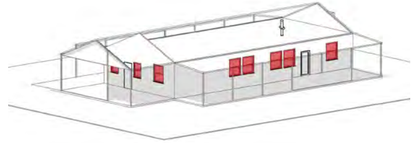


Excerpt from ‘cool living’ process diagram to explain Best Bang for your Buck versions



House type 1 | H01

This is a typical older-style house type found across many different communities and town camps.



House type 3 | H03

This is a typical house found across SA and the APY lands

House type 2 | H02

This is a new style prefabricated house type currently being rolled out in remote communities.

‘Best Bang for your Buck’ metric

Only one Modifications list (Type H1B) is available in this project as a proof of concept.

This metric explains the 3 typical house types and their orientations set up by this project. Ultimately, this means initially 12 Modifications lists would be available to inform house upgrades.

Moving forward the project needs to increase its scope to include more typical house types and more orientations.

Typical house base models

Typical construction specifications for the three typical houses used in this project are outlined to inform the base models in NatHERS modeling software.

BUILT ELEMENT / *HOUSE TYPE*	FLOOR/UNDER-FLOOR	WALLS (STRUC-TURE, EXT, INT)	CEILING	ROOF	VERANDAHS	WINDOWS & DOORS	CONFIGURATION/ LAYOUT	ORIENTATION	SHADING	YARDS
H01	• slab on ground • concrete or tile floor to interior	• Besser block (390x190x 190mm) corefilled at varying intervals • no internal lining • painted various bright colours on ext.	• flat ceiling to inside living spaces	• low pitch gable roof with	• one or two verandahs to long sides • approximately 3m wide with unlined verandah roofs	• at least one aluminium sliding window to each room • two external doors off each verandah • often no draught proofing to doors	• two - three bedrooms • one bathroom (1 wc, 1 shwr, 1 basin) • one laundry, one kitchen	• orientation varies, often parallel to the street (community plan & layout is important for this)	• shading to windows on end walls vary, sometimes shaded by retrofitted 900mm awning fixed to the wall	• yards often fenced with metal mesh fence a pedestrian gate and a car gate • outbuildings can vary • mature trees and gardens can vary
INSULATION	*no insulation*	*no insulation*	*varies*	*varies*						
H02	• slab on ground • tile floor to interior	• metal framed walls • ext. horizontal corrugated iron cladding • int. lining • painted various colours on ext.	• flat ceiling to inside living spaces	• 22.5 o pitch gable roof with a metal truss	• two verandahs to long side with a carport to 3rd gable end • verandah is 3.4m wide with unlined verandah roofs	• at least one aluminium sash window to each room • external doors off each verandah inc. one off carport to the laundry	• three - four bedrooms • often two bathrooms (1 wc, 1 shwr/ 1 bath, 1basins) and (1 wc, 1 shwr, 1 basin) • one laundry, one kitchen	• orientation varies, often parallel to the street (community plan & layout is important for this)	• no shading or windows to 4th gable end wall (often location for EAC)	• yards often fenced with metal mesh fence a pedestrian gate and a car gate • outbuildings can vary • mature trees and gardens can vary
INSULATION	*no insulation*	*R2.5*	*R4.0*	*Sarking*						
H03	• framed floor, with tile floor to interior • underfloor lined with rigid foilboard insulation only (taped in place) • Floor raised approx. 600mm AGL on piers • perimeter caged with wire mesh 50x50mm and single access gate	• metal framed walls • ext. corrugated iron cladding • int. lining • painted various colours on ext.		• approx. 20 o pitch gable roof with a metal truss • flat ceiling to inside living spaces •	• One verandah to long side often facing the street • approx 4m wide with unlined verandah roof	• at least one aluminium sliding window to each room • one external door off front verandah, one side door off laundry • draught proofing to doors vary	• Three bedrooms with a screened internal room acting as fourth bedroom • Often one bathroom (1 wc, 1 shwr, 1 basin) one toilet room (1 wc, 1 basin) • one open laundry, one kitchen, each with sliding windows	• orientation varies, often parallel to the street (community plan & layout is important for this)	• windows on walls shaded by retrofitted fixed awnings	• yards often fenced with metal mesh fence a pedestrian gate and a car gate • outbuildings can vary • mature trees and gardens can vary
INSULATION	*GREEN 10 HFO: R3.9/ HFI: R1.9)*	*R2.0*	*R2.0*	*Sarking*						

'Best Bang for your Buck' explanation

Modifications list in order from biggest impact to least impact.

Answers from the house survey inform what modifications are selected as upgrades. If the house already has the element, keep moving down the list until there is a cooling priority the house does not have. This should then be selected as a priority modification.

The list also details the difference in cooling load achieved, cost savings from the modification and average payback years. See Costing Reference Sheet **on page x** for more information.

Best Bang for your Buck Modifications List - TYPE H1B (BLOCK HOUSE - 90°)

EXISTING HOUSE FABRIC DETAILS = Refer to House types list for correct house selection

** all modifications should consult completed cool living survey and supporting documentation and explanations*

** Consult costing reference document for further details*

** All energy savings are based off existing climate files, with climate change, more energy will be used for cooling and payback periods will be decreased*

technical

	Notes	Type of Retrofit Modification to house SINGLE MODIFICATIONS USING EXISTING HOUSE AS BASE MODEL	Cooling Priority (from survey)	Location in Priority (from survey)	Difference in Cooling Load (MJ/m2yr)	$ saved/ year (@ .40c/kWh)	$ per modification (avg cost based on ref)	Unit of rate	Number required	Total	Avg payback (years)	Reference for cost (see attached sheet)
1		Change bulk ceiling insulation to R4 (no roof blanket R.15)	2. Insulation	2. Ceiling	159.9	$ 1,275.65	$ 16.10	$ / sqm	105	$ 1,690.50	1.33	2.2.1
2		Change bulk ceiling insulation to R3 (no roof blanket R.15)	2. Insulation	2. Ceiling	156.9	$ 1,251.71	$ 14.33	$ / sqm	105	$ 1,504.65	1.20	2.2.2
3		Change bulk ceiling insulation to R2 (no roof blanket R.15)	2. Insulation	2. Ceiling	150.7	$ 1,202.25	$ 11.90	$ / sqm	105	$ 1,249.50	1.04	2.2.3
4		Change roof insulation to R2.5 (no bulk ceiling insulation)	2. Insulation	1. Roof	146.9	$ 1,171.94	$ 17.40	$ / sqm	110	$ 1,914.00	1.63	2.1.1
5		Change bulk ceiling insulation to R1.5 (no roof blanket R.15)	2. Insulation	2. Ceiling	145.3	$ 1,159.17	$ 11.30	$ / sqm	105	$ 1,186.50	1.02	2.2.4
6		Change roof insulation to R1.3 (no bulk ceiling insulation)	2. Insulation	1. Roof	143.4	$ 1,144.01	$ 12.30	$ / sqm	110	$ 1,353.00	1.18	2.1.2
7		Change roof colour to white (SA 0.25)	7. Paint	1. Roof Colour	75.3	$ 600.73	$ 16.90	$ per sqm	110	$ 1,859.00	3.09	7.1.1
8		Add Shade Walls to all ext walls with R0.13 insulation	1. Shading	2. Wall	54.1	$ 431.60	$ 361.80	$ per sqm	221.6	$ 80,174.88	185.76	1.2/5.1
9		Upgrade window to add Low-E film (U5.6) (aluminium SG Black frame)	6. Less hot air inside	WINDOW UPGRADE	29.2	$ 232.95	$ 111.15	$ per sqm	5.39	$ 599.10	2.57	6.1
10		Add 100% verandahs all around (Add to E + W - 3m wide, 2.4m high eave)	1. Shading	3. Verandahs	27.9	$ 222.58	$ 690.00	$ per sqm	49.2	$ 33,948.00	152.52	1.3
11		Change wall colour to white (SA 0.25)	7. Paint	2. Wall Colour	26.4	$ 210.61	$ 17.67	$ per sqm	221.6	$ 3,915.67	18.59	7.2.1
12		Change windows/door frame colour to white (SA 0.25)	7. Paint	3. Windows/ Door Frames	26.3	$ 209.82	$ 13.50	$ per sqm	4	$ 54.00	0.26	7.3.1
13		Upgrade window to UPVC DG (U3.0) sliding window COLOUR?	6. Less hot air inside	WINDOW UPGRADE	24.0	$ 191.47	$ 1,388.50	$ per unit	7	$ 9,719.50	50.76	1.3
14		Add verandah to width of wall - EAST (3m wide, 2.4m eave)	1. Shading	2. Walls	21.7	$ 173.12	$ 690.00	$ per sqm	24.6	$ 16,974.00	98.05	1.3.2
15		Add Shade Wall to ext block wall - EAST	1. Shading	2. Walls	17.7	$ 141.21	$ 361.80	$ per sqm	19	$ 6,874.20	48.68	1.2/5.1
16		Add roofspace venting - Mechanical Venting	4. Venting/ Airflow	1. Roofspace	12.8	$ 102.12	$ 2,515.50	$ per item	2	$ 5,031.00	49.27	4.1.1
17		Upgrade window to aluminum DG Clear-Clear Sliding (U4.8) Black frame	6. Less hot air inside	WINDOW UPGRADE	12.0	$ 95.73	$ 669.24	$ per sqm	11.62	$ 7,776.57	81.23	6.1
18		Add roofspace venting - Natural Venting e.g fixed or Whirley Bird	4. Venting/ Airflow	1. Roofspace	7.9	$ 63.02	$ 1,017.90	$ per item	2	$ 2,035.80	32.30	4.1.2
19		Add verandah to width of wall - WEST (3m wide, 2.4m eave)	1. Shading	3. Verandahs	5.4	$ 43.08	$ 690.00	$ per sqm	24.6	$ 16,974.00	394.01	1.3.3
20		Add Shade Wall to ext block wall - WEST	1. Shading	2. Walls	5.4	$ 43.08	$ 361.80	$ per sqm	14	$ 5,065.20	117.58	1.2/5.1

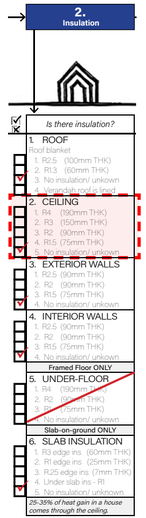
Cost detail example - '$ saved/year @ 40c/kWh'

= Energy savings (159.9 MJ/m2yr) x Power cost ($0.40 kWh) x Conditioned house area (71.8sqm)

x Conversion MJ to kWh (1MJ/m2/yr = 0.277778 kWh/m2/yr)

= $1,275.65 saved per year from installing R4 ceiling insulation

Costing information & calculations detailed in reference sheet



Chapter 8

Built Examples Gallery

- Principles for building in community
- Built Examples Gallery - How to use it...

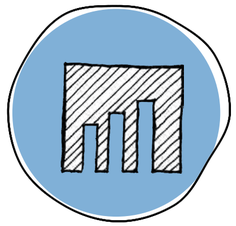
1. Shading Building Fabric
2. Insulation
3. Close the Underfloor
4. Venting/ Airflow
5. Thermal Mass
6. Less Hot Air Inside
7. Paint/ Surface Colour
8. Yard Improvements

Principles for building in community

8 important things to remember when designing and selecting things to build in community housing.

Appropriate

Appropriate climatically, culturally, socially and for remote community living.
Community is always consulted.



Data Driven

Data to drive decisions, not ideas, wants or box ticking.
Data is collected over its lifetime.

Modular + Minimal Labour + Replaceable Parts

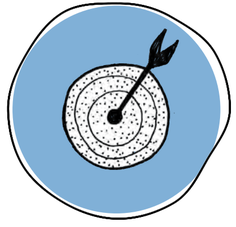
Made of easy to source and replaceable parts which don't need highly skilled trades.
All work is inspected and checked for accountability.

Low Maintenance + life cost

Doesn't need much attention or money over its life.

Secure + Robust + Durable

Made strong to not break when traveling to site and once built.

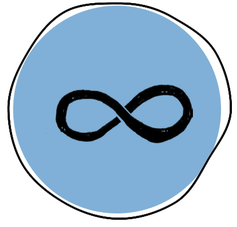


Targeted

Data is used to identify problem areas and these are targeted for measurable gains.

Resourceful

Good design, well built, adaptable, recycled materials could be used.

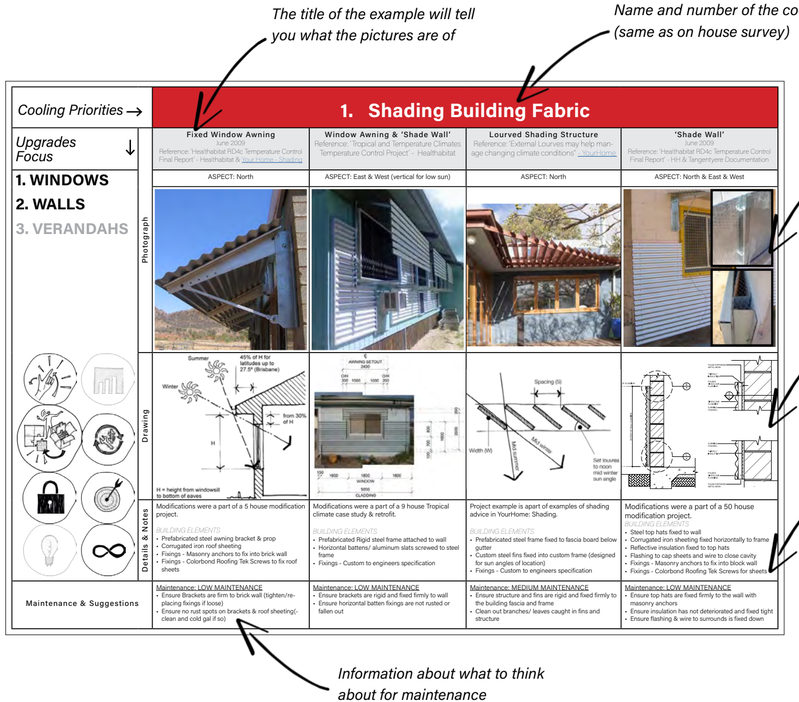


Long-Life

Long-term solutions. Something that is strong, designed well + built well will last a long time.

Built Examples Gallery - How to use it...

This is a gallery of pictures showing ideas for house upgrades to help the house stay cool. This will give you different ideas of what you could do and gives more information about why it is important.



1. Shading Building Fabric

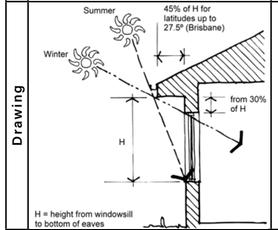
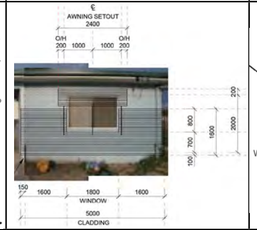
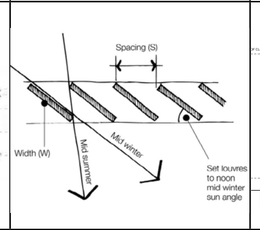
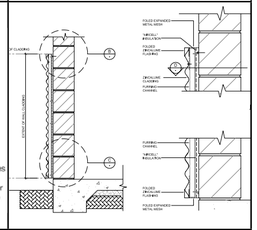
Cooling Priorities →

Upgrades Focus ↓

1. WINDOWS

2. WALLS

3. VERANDAHS

	Fixed Window Awning June 2009 Reference: 'Healthabitat RD4c Temperature Control Final Report' - Healthabitat & Your Home - Shading	Window Awning & 'Shade Wall' Reference: "Tropical and Temperature Climates Temperature Control Project' - Healthabitat	Lourved Shading Structure Reference: "External Lourves may help man-age changing climate conditions" - YourHome	'Shade Wall' June 2009 Reference: 'Healthabitat RD4c Temperature Control Final Report' - HH & Tangentyere Documentation
	ASPECT: North	ASPECT: East & West (vertical for low sun)	ASPECT: North	ASPECT: North & East & West
Photograph				
Drawing				
Details	Modifications were a part of a 5 house modification project. *BUILDING ELEMENTS* • Prefabricated steel awning bracket & prop • Corrugated iron roof sheeting • Fixings - Masonry anchors to fix into brick wall • Fixings - Colorbond Roofing Tek Screws to fix roof sheets	Modifications were a part of a 9 house Tropical climate case study & retrofit. *BUILDING ELEMENTS* • Prefabricated Rigid steel frame attached to wall • Horizontal battens/ aluminum slats screwed to steel frame • Fixings - Custom to engineers specification	Project example is apart of examples of shading advice in YourHome: Shading. *BUILDING ELEMENTS* • Prefabricated steel frame fixed to fascia board below gutter • Custom steel fins fixed into custom frame (designed for sun angles of location) • Fixings - Custom to engineers specification	Modifications were a part of a 50 house modification project. *BUILDING ELEMENTS* • Steel top hats fixed to wall • Corrugated iron sheeting fixed horizontally to frame • Reflective insulation fixed to top hats • Flashing to cap sheets and wire to close cavity • Fixings - Masonry anchors to fix into block wall • Fixings - Colorbond Roofing Tek Screws for sheets
Maintenance	Maintenance: LOW MAINTENANCE • Ensure Brackets are firm to brick wall (tighten/re-placing fixings if loose) • Ensure no rust spots on brackets & roof sheeting(-clean and cold gal if so)	Maintenance: LOW MAINTENANCE • Ensure brackets are rigid and fixed firmly to wall • Ensure horizontal batten fixings are not rusted or fallen out	Maintenance: MEDIUM MAINTENANCE • Ensure structure and fins are rigid and fixed firmly to the building fascia and frame • Clean out branches/ leaves caught in fins and structure	Maintenance: LOW MAINTENANCE • Ensure top hats are fixed firmly to the wall with masonry anchors • Ensure insulation has not deteriorated and fixed tight • Ensure flashing & wire to surrounds is fixed down

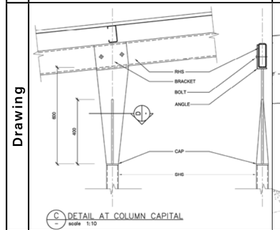
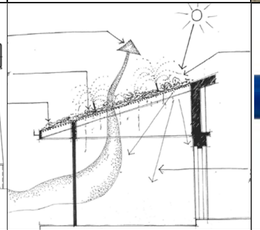
Cooling Priorities →

Upgrades Focus ↓

1. WINDOWS

2. WALLS

3. VERANDAHS

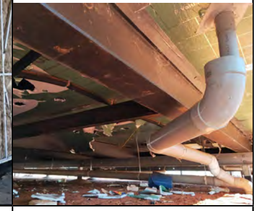
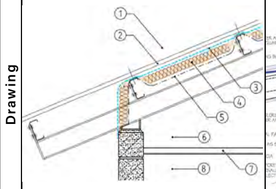
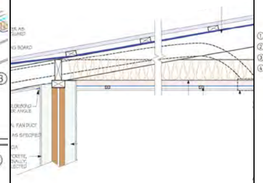
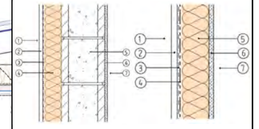
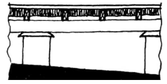
	Freestanding Pergola June 2009 Reference: 'Healthabitat RD4c Temperature Control Final Report' - HH & Tangentyere Documentation	Contemporary Bough Shade Verandah May 2017 Reference: Birdsville - The Grand Section study	Shade Awning June 2009 Reference: 'Healthabitat RD4c Temperature Control Final Report' - Healthabitat	Shade Awning June 2011 Reference: ' Tangentyere Thermal Efficiency Project, Community Research Report'
	ASPECT: North & East & West	ASPECT: North & East & West	ASPECT: North & East & West	ASPECT: North & East & West
Photograph				
Drawing			Example of 'Interclamp' fittings to hold the pipe together 	
Details	Modifications were a part of a 50 house project. Image & Drawings from Tangentyere Design. *BUILDING ELEMENTS* • SHS steel posts (painted) concreted into ground • Custom steel column capital/ bracket • RHS pergola rafter & C-Purlins above • Fixings - structural bolts, steel triple grips and tek screws	A part of an Architectural study of Birdsville, this contemporary Bough shade is a great example of an old technology on a new building. You could also use living vines or plants. See on page 18 of zine document (link) *BUILDING ELEMENTS* • Light gauge reinforcing mesh fixed to rafters • Branches, spinifex, leaves placed on top • Sprinkler put on top in summer months	Existing shade structures attached to external walls were fitted with new metal roof sheeting *BUILDING ELEMENTS* • Bent 50mm galvanised pipe structure with end plate at wall and footing, 50mm gal pipe cross members • Proprietary Interclamp (or similar) fittings • 1 x sheet of corrugated iron roof sheeting • Fixings - Colorbond Roofing Tek Screws to fix roof sheets	A part of an upgrade project to add sun shading to west and east ends of the house. *BUILDING ELEMENTS* • Square steel posts (painted) concreted into ground • Timber roof frame - bearer, rafter and battons • Corrugated iron roof sheeting • Flashing to both ends to cover sharp edges of the roof sheeting • Fixings - Colorbond roof tek screws, steel triple grips
Maintenance	Maintenance: LOW MAINTENANCE • Ensure Brackets are firm to posts (tighten/replacing fixings if loose) • Ensure posts are fixed into concrete & no rust spots (clean and cold gal or replace & build off the ground)	Maintenance: MEDIUM MAINTENANCE • Ensure fixings holding mesh are secure • Ensure roof structure is in good condition • Regularly collect new branches with leaves and add on top of mesh	Maintenance: LOW MAINTENANCE • Ensure brackets are rigid and fixed firmly to wall • Ensure pipe connections to ground are rigid and not damaged or rusted • Ensure roof sheeting is fixed securely down	Maintenance: LOW MAINTENANCE • Ensure posts are strong into concrete & no rust spots especially where it meets the ground (clean and cold gal or replacs) • Ensure no termites eating roof structure

2. Insulation

Cooling Priorities →

Upgrades Focus ↓

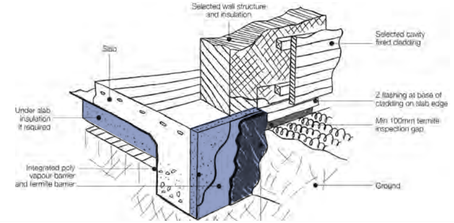
1. ROOF
2. CEILING
3. EXTERIOR WALLS
4. INTERIOR WALLS
5. UNDER-FLOOR
6. SLAB INSULATION

	Reflective roof Insulation (silver) December 2021 Building Sustainable Design Guidelines - DIPL & author project photos	Ceiling (bulk) Insulation Your Home - Insulation	Wall (bulk) Insulation December 2021 Building Sustainable Design Guidelines - DIPL & photo from Bluesky Modular Buildings	Underfloor Insulation (for raised houses) Warm House Cool House - Nick Hollo & author project photos
Photograph	Installed to the whole roof underneath the tin	Installed to above the whole ceiling	Installed to all outside walls (if light-weight walls)	Installed to the underneath of all the floor if raised
				Image of foil board insulation on underside of community house (see holes and and tape holding it in place - when it is broken that is bad) 
Drawing			 Drawing of a Block Wall with steel frame and insulation on the outside Drawing of a steel framed wall with insulation in the cavity	Raised floor with bulk insulation between joists  Raised floor with reflective foil draped over joists 
Details	Reflective roof insulation (roof blanket) should be installed properly at the time the house is built and the roof is put on. This is very important to stop heat coming into the house. If a house does not have roof insulation, it is best to take off the roof sheets and install it.	Many old houses do not have ceiling insulation. Ceiling (bulk) insulation is very important to stop heat coming into the house. BUT IT SHOULD BE INSTALLED PROPERLY - IF NOT, IT WON'T WORK PROPERLY. It is easy to install insulation after a house is built, but should be done by a professional. The builder will have to crawl into the roof space and install the insulation.	Wall insulation is inside the wall so has to be installed when the house is built. This is very important to stop heat coming into the house. If it is damaged or gets holes in it because of mice living in the wall, the wall lining will have to be taken off and the insulation replaced.	Underfloor insulation should be installed properly at the time the house is built. It should not have holes or gaps. This is very important to stop heat coming into the house.
Maintenance	It is very hard to carry out any maintenance on roof insulation. If it is damaged or gets holes in it, it should be taped with reflective tape.	No maintenance is needed on ceiling insulation. When dust goes into the roof space over time, it will squash the insulation and make it less effective. (approx loses 1R value every decade).	It is very hard to carry out any maintenance on wall insulation.	It is very hard to carry out any maintenance on floor insulation. If it is damaged or gets holes in it, it should be taped with reflective tape. This can be installed after the house is built but if the space under the house is small, it will be hard.

Cooling Priorities →

Upgrades Focus ↓

1. ROOF
2. CEILING
3. EXTERIOR WALLS
4. INTERIOR WALLS
5. UNDER-FLOOR
6. SLAB INSULATION

	Slab Insulation (for slab-on-ground houses) Your Home - Insulation
Photograph	Installed to the underneath or edge of the slab
Drawing	
Details	Underslab insulation should not be used in the 'hot dry' climate. It is important for the slab to be connected directly to the ground. Slab edge insulation helps stop hot outside air heating up the edge of the slab and travelling into the house to make it hot. This is helpful to make a house cooler, but not the most important insulation to have in a house.
Maintenance	Maintenance : (depending how much insulation is exposed to outside) • Ensure there are no holes in the insulation to let hot air touch the slab • Tape or seal up holes in insulation

Cooling Priorities →

3. Close The Underfloor

Upgrades Focus ↓

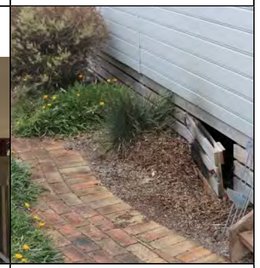
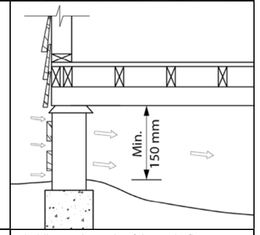
Slab on Ground (+0mm AGL)

NA

Low-set & High-set House (+600 to 2400mm AGL)

1. UNDERFLOOR CLADDING

2. PERIMETER CLADDING

	Underfloor Cladding Author photo	Perimeter Cladding to underfloor Reference: Photo from CSIRO & Diagram from NCC Subfloor ventilation
	ASPECT: all sides of house	ASPECT: all sides of house
Photograph		
Drawing		
Details	Cladding to the unside of the floor stops the hot air going underneath the house and heating up the floor and air coming inside. If you clad the underside, you do not need to clad the perimeter. This can be done with sheets of materials or with board insulation. (see a broken insulation picture in insulation section)	Cladding to the egde of the underfloor stops the hot air going underneath the house and heating up the floor and air coming inside. This can be done with different materials like fibrecement, timber boards or bricks. But there must be some vents in the wall to let under the house breath.
Maintenance	Maintenance: REGULAR MAINTENANCE • Check no holes have been made in the cladding • If there are holes, try to cover them up or report it to housing	Maintenance: REGULAR MAINTENANCE • Check no holes have been made cladding • Check the vents are not blocked • If there are holes, try to cover them up or report it to housing

Cooling Priorities →

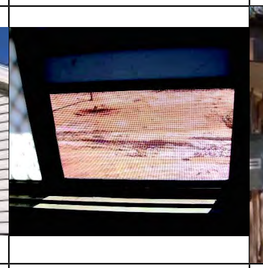
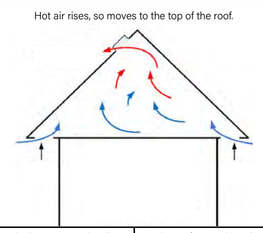
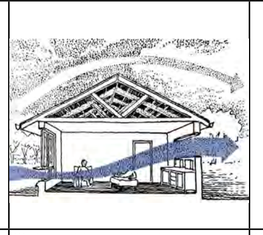
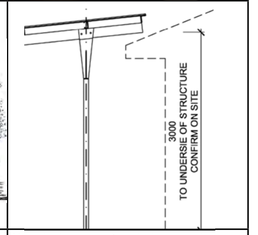
4. Venting/ Airflow

Upgrades Focus ↓

1. ROOF SPACE

2. INTERNAL LIVING SPACES

3. VERANDAH ROOF

	Whirley Birds Reference: Photo from online source - Evo Building Products, drawing from online source - Roof ventilation blog	Roof vents Reference: Photo from online source - The spruce - attic venting	Freestanding Pergola Reference: 'Tangentyere Thermal Efficiency Project, Community Research Report' & Drawing from 'Warm House Cool House pg 45)	Freestanding Pergola June 2009 Reference: 'Healthabitat RD4c Temperature Control Final Report' - HH & Tangentyere Documentation
	Install a few whirley birds along the roof ridge	Install vents at gable ends of the roof and along eave	ASPECT: North & East & West	ASPECT: North & East & West
Photograph				
Drawing	Hot air rises, so moves to the top of the roof. 			
Details	Whirley birds use the wind to turn and pull hot air out of the roof space to help keep the house cool. *BUILDING ELEMENTS* • Whirley Bird • Pan Flashing installed underneath ridge cap and fixed to steel roof sheets • Fixings - Colorbond Roofing Tek Screws for sheets	Static roof vents lets the hot air move out slowly - it is not as good as a whirley bird. A hole needs to be made in the wall and a vent put into the hole and sealed around the edges so rain and animals can't get inside.	Windows and doors should work so you can open them and vent the house out. Windows should be design across from each other so the house gets cross ventilated.	Verandah is seperate from the house so air can circulate through. *BUILDING ELEMENTS* • SHS steel posts (painted) concreted into ground • Custom steel column capital/ bracket • RHS pergola rafter & C-Purlins above • Fixings - structural bolts, steel triple grips and tek screws
Maintenance	Ensure whirley birds are installed properly to the roof sheet. Check from the ground by looking at the roof that the whirley bird cap is still there and spinning in the wind.	Ensure vents are installed properly. Check from the ground by looking at the roof that the vent is in place and is not damaged.	Ensure windows and doors are installed properly and can open and close fully. If window framed or glass is broken, they need to be fixed - report to housing.	Maintenance: LOW MAINTENANCE • Ensure Brackets are firm to posts • Ensure posts are fixed into concrete & no rust spots (clean and cold gal or replace & build off the ground)

Cooling Priorities →

5. Thermal Mass

Upgrades Focus ↓

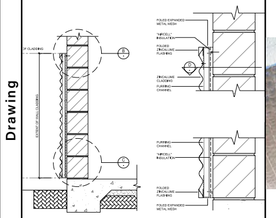
1. SHADE WALLS

Block (heavy-weight) House ONLY

2. INTERNAL THERMAL MASS

Metal Frame (light-weight) House ONLY

3. FLOOR COVERING

	'Shade Walls' June 2009 Reference: 'Healthabitat RD4c Temperature Control Final Report' - HH & Tangentyere Documentation	'Shade Walls' June 2009 Reference: 'Healthabitat RD4c Temperature Control Final Report' - HH & Tangentyere Documentation	Floor Covering (tiles are best) & Internal thermal mass walls 2022 Reference: Indigenizing practice: Inclusive Indigenous community housing
Photograph	ASPECT: North & East & West	ASPECT: North & East & West	Throughout all floors inside house
			
Drawing			
Details	Modifications were a part of a 50 house modification project. *BUILDING ELEMENTS* • Steel top hats fixed to wall • Corrugated iron sheeting fixed horizontally to frame • Reflective insulation fixed to top hats • Flashing to cap sheets and wire to close cavity • Fixings - Masonry anchors to fix into block wall • Fixings - Colorbond Roofing Tek Screws for sheets	Modifications were a part of a 50 house modification project. *BUILDING ELEMENTS* • Steel top hats fixed to wall • Corrugated iron sheeting fixed horizontally to frame • Reflective insulation fixed to top hats • Flashing to cap sheets and wire to close cavity • Fixings - Masonry anchors to fix into block wall • Fixings - Colorbond Roofing Tek Screws for sheets	Tile floors and concrete floors are best for houses in the 'hot dry' climate because they keep the house cool. Internal thermal mass (block) walls (if the house has light-weight outside walls) is important to help the house stay cool. Both the floor and the walls need to make sure there is no sun on them when it's hot.
Maintenance	Maintenance: LOW MAINTENANCE • Ensure top hats are fixed firmly to the wall with masonry anchors • Ensure insulation has not deteriorated and fixed tight • Ensure flashing & wire to surrounds is fixed down	Maintenance: LOW MAINTENANCE • Ensure top hats are fixed firmly to the wall with masonry anchors • Ensure insulation has not deteriorated and fixed tight • Ensure flashing & wire to surrounds is fixed down	Maintenance: LOW MAINTENANCE • Ensure tiles are not cracked or have missing grout in-between them, if there are cracked tiles - tell housing • Ensure there are no big cracks in the walls between the blocks, if there are holes - tell housing

Cooling Priorities →

6. Less Hot Air Inside

Upgrades Focus ↓

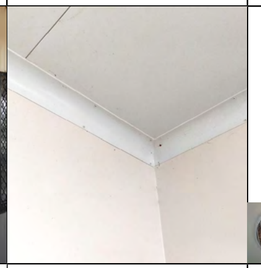
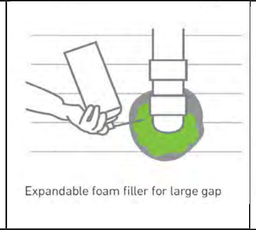
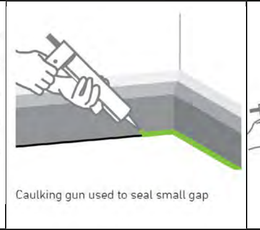
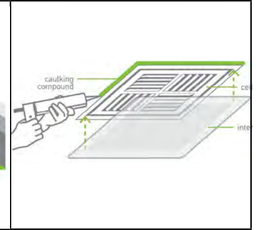
Upgrade Doors & Windows where possible

1. AROUND WINDOWS & DOORS

2. HOLES IN FLOOR & WALL

3. CORNER OF WALL & CEILING / FLOOR (CORNICE & SKIRTING)

4. CEILING VENTS

	Weather strips to doors & windows 2016 Reference: 'Draught Sealing Retrofit Trial' Sustainability Victoria 2016	Sealing gaps in floor and walls 2016 Reference: 'Draught Sealing Retrofit Trial' Sustainability Victoria 2016 & author photo	Sealing gaps at wall & floor corners 2016 Reference: 'Draught Sealing Retrofit Trial' Sustainability Victoria 2016 & author photo	Sealing Ceiling Vents 2016 Reference: 'Draught Sealing Retrofit Trial' Sustainability Victoria 2016 & 'Evapseal' vent covers
Photograph	To all outside doors and windows	To all walls and floors where there are holes	To all walls and floor corners where there are holes	To all vents inside house
				
Drawing				
Details	Modifications were a part of a 16 house sealing trial. Doors need draught proofing at the top, bottom and between the door and door frame. Windows need to be draught proofed about the sash and frame. Sliding windows and doors are very hard to seal.	Modifications were a part of a 16 house sealing trial. Larger holes or gaps expandable foam filler can be used or it can be covered by a builder with a board. This includes holes for window airconditioners (RAC). It is good to seal up big holes to stop hot air coming in or cold air from the air-conditioner escaping outside.	Modifications were a part of a 16 house sealing trial. Smaller holes or gaps can be filled with a gap filler or silicone. This is easy to do and can be done by the tenant of the house. It is good to seal up small holes to stop hot air coming in or cold air from the air-conditioner escaping outside.	Modifications were a part of a 16 house sealing trial. The edges of vents can be sealed with gap filler, silicon or even tape. This is easy to do and can be done by the tenant of the house. Vents to the ceiling and walls in a house can let hot are inside the house and cool air out if they are not installed properly or sealed around the edges.
Maintenance	Maintenance: REGULAR MAINTENANCE • Check there are no gaps around door frames • Check door and window seals are installed properly and working - if not, fix them or report to housing	Maintenance: REGULAR MAINTENANCE • Check no holes have been made in the walls or floor • If there are holes - cover them up or report to housing	Maintenance: REGULAR MAINTENANCE • Check there are no holes at the corner of the walls and floor AND walls and ceiling • If there are holes - cover them or fill them or report to housing	Maintenance: REGULAR MAINTENANCE • Check there are no holes around the vents • Check vents can be closed tight when not being used • If there are holes - cover them or fill them or report to housing

Cooling Priorities →

7. Paint/ Surface Colour

Upgrades Focus ↓

1. ROOF COLOUR
2. WALL COLOUR
3. WINDOW / DOOR FRAMES

Photograph

Roof Colour and Wall Colour

Author project photo & Colour photos and information from Colorbond and BASIX

ASPECT: To all of roof and walls to all sides of house

Window / Door Frames

Photo by ATTMA

ASPECT: all outside winows and doors

Drawing

Light Solar Absorptance (SA) = 0.00 - 0.475

Medium Solar Absorptance (SA) = 0.475 - 0.70

Dark Solar Absorptance (SA) = 0.70 - 1.00

Details

The Australian Building Rules has classified what number light, medium and dark colours are.

The lower the number, the lighter the colour and which means it reflects more sun.

Dark colours have a high number and don't reflect but absorb more sun and make a roof or wall heat up more.

In a 'Hot Dry' climate it is better to have light colours on the roof, walls, floor, window and door frames, especially on anything that the sun hits in summer.

Maintenance

Maintenance: LOW MAINTENANCE

- Clean down the walls and roof when they get dirty or are covered in dust or leaves to show the light colour to the sun

Cooling Priorities →

8. Yard Improvements

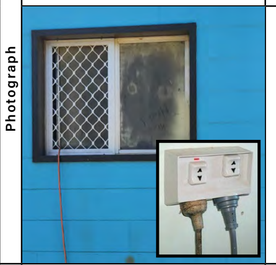
Upgrades Focus ↓

1. POWER POINTS (GPO)
2. YARD TAPS
3. INFRASTRUCTURE FOR ADDITIONAL LIVING AREAS & SHADING
4. SHADE PLANTING & SHADE AREAS

Photograph

Power Points (GPO)
2023
Author project photos

ASPECT: all sides of house



Yard Taps
2022
Author project photos

ASPECT: all sides of houseand in the yard

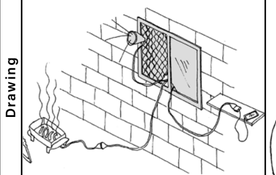
Infrastructure for additional shade areas (frame off verandah)
2023
Author project photos

ASPECT: North, East, South, West - in the yard

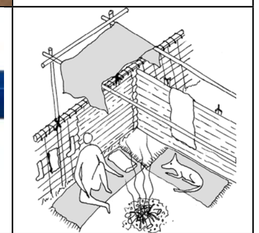
Infrastructure for additional shade areas (Bough Shade)
?

ASPECT: North, East, South, West - in the yard

Drawing



Example of 'Interclamp' fittings to hold the pipe together



Details

Weatherproof GPO's should be installed around the outside of the house. They should be weatherproof to make sure they are safe to use in all weather.

BUILDING ELEMENTS

- IP-rated weatherproof GPO installed by electricians

The yard tap is protected by a steel universal column. The splash pad is important to stop erosion, pooling for mosquito breeding, and to help people wash their faces and drink from the tap.

BUILDING ELEMENTS

- Gal steel water pipe and brass yard tap
- Concrete splash pad
- Steel Universal Column

Steel pipe structure in front yard off verandah structure

BUILDING ELEMENTS

- Bent 50mm galvanised pipe structure with end plate at verandah, 50mm gal pipe cross members
- Posts should be dug or concreted into the ground
- Proprietary Interclamp (or similar) fittings

A DIY constructed bough shade gives welcome shade and provides support for a growing sapling.

BUILDING ELEMENTS

- Found timber sticks for structure, dug into ground and backfilled
- Wire mesh roof between posts and tie wires
- Found branches with leaves, grass etc. laid on top of wire netting
- Fixings - wire

Maintenance

Maintenance: REGULAR MAINTENANCE

- Ensure powerpoint check done regularly to ensure GPO is electrically safe and secure to wall

Maintenance: REGULAR MAINTENANCE

- Do tap check regularly (turn on and off 3 times) to ensure tap is not leaking and has good flow and handle is easy to use

Maintenance: LOW MAINTENANCE

- Ensure brackets are rigid and fixed firmly to wall
- Ensure pipe connections to ground are rigid and not damaged or rusted

Maintenance: MEDIUM MAINTENANCE

- Regularly tighten wire fixings around posts and mesh
- Regularly collect new branches with leaves and add on top of mesh

Cooling Priorities →

8. Yard Improvements

Upgrades Focus ↓

1. POWER POINTS (GPO)
2. YARD TAPS
3. INFRASTRUCTURE FOR ADDITIONAL LIVING AREAS & SHADING
4. **SHADE PLANTING & SHADE AREAS**

Maintenance

Photograph

Landscape Mounding

April 2002 | Reference: The use of Mounds to improve community environments on the APY Lands - MW Last

ASPECT: North, East, South, West - in the yard

Landscape Mounding

April 2002 | Reference: The use of Mounds to improve community environments on the APY Lands - MW Last

ASPECT: North, East, South, West - in the yard

Drawing

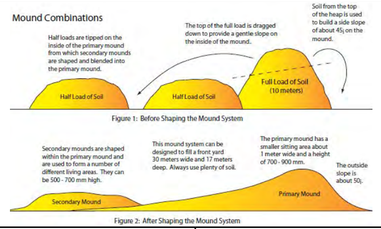


Figure 1: Before Shaping the Mound System

Figure 2: After Shaping the Mound System

Details

A trial program at Pipalyatjara by Nganampa Health Council, to build 5 mounds 12-18m wide by 40-60m long to improve traffic control, manage storm water, wind protection and dust control.

BUILDING ELEMENTS

- Tonnes of earth shaped by trucks, hand shovels and excavators
- Plants, fence structures and watering systems

A trial program at Pipalyatjara by Nganampa Health Council, to build 5 mounds 12-18m wide by 40-60m long to improve traffic control, manage storm water, wind protection and dust control.

BUILDING ELEMENTS

- Tonnes of earth shaped by trucks, hand shovels and excavators
- Plants, fence structures and watering systems

Maintenance

Maintenance: LOW MAINTENANCE

- Ensure mounds are not being eroded by stormwater or damage by vehicles
- Water plants and continue to plant out the mounds where low points are for water to pool

Maintenance: LOW MAINTENANCE

- Ensure mounds are not being eroded by stormwater or damage by vehicles
- Water plants and continue to plant out the mounds where low points are for water to pool

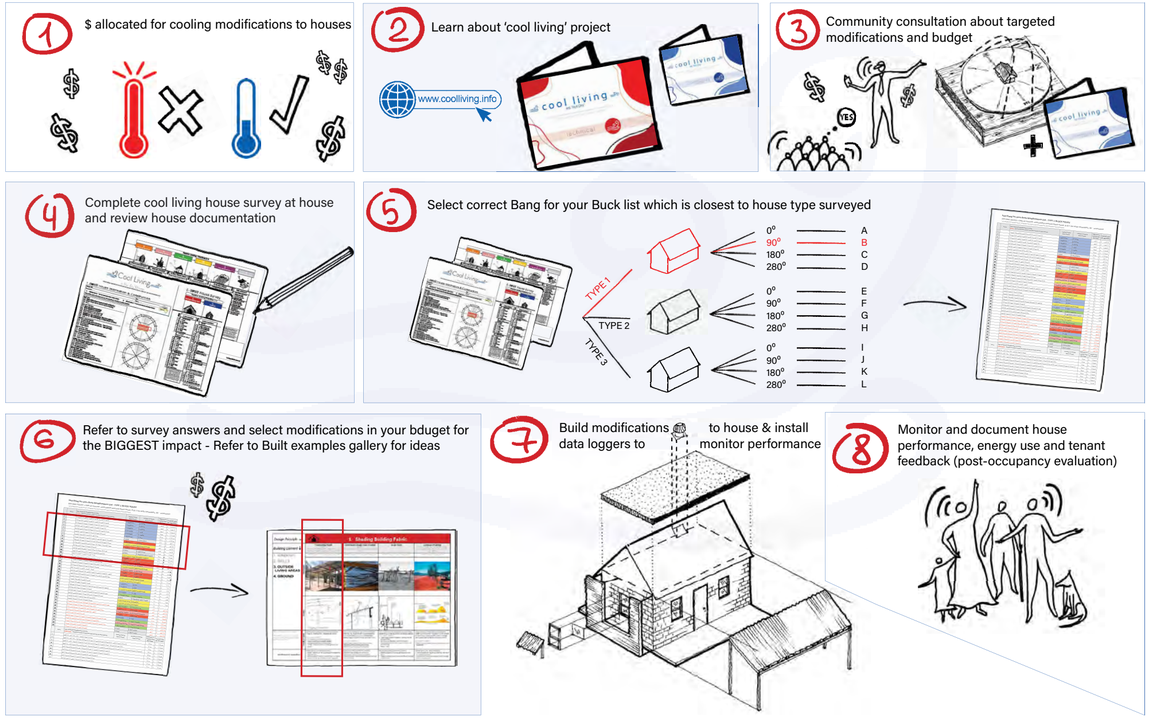
Chapter 9

Worksheets & Guides

- ‘cool living’ process diagram - TECHNICAL (1 page)
- ‘cool living’ process diagram - COMMUNITY (1 page)
- ‘cool living’ TECHNICAL house survey (2 pages)
- ‘cool living’ COMMUNITY house survey (3 pages)
- Best Bang for your Buck Modifications List - Type H1B (2 pages)
- How to use our house (3 pages)
- Interactive Model explanation (refer to community book)

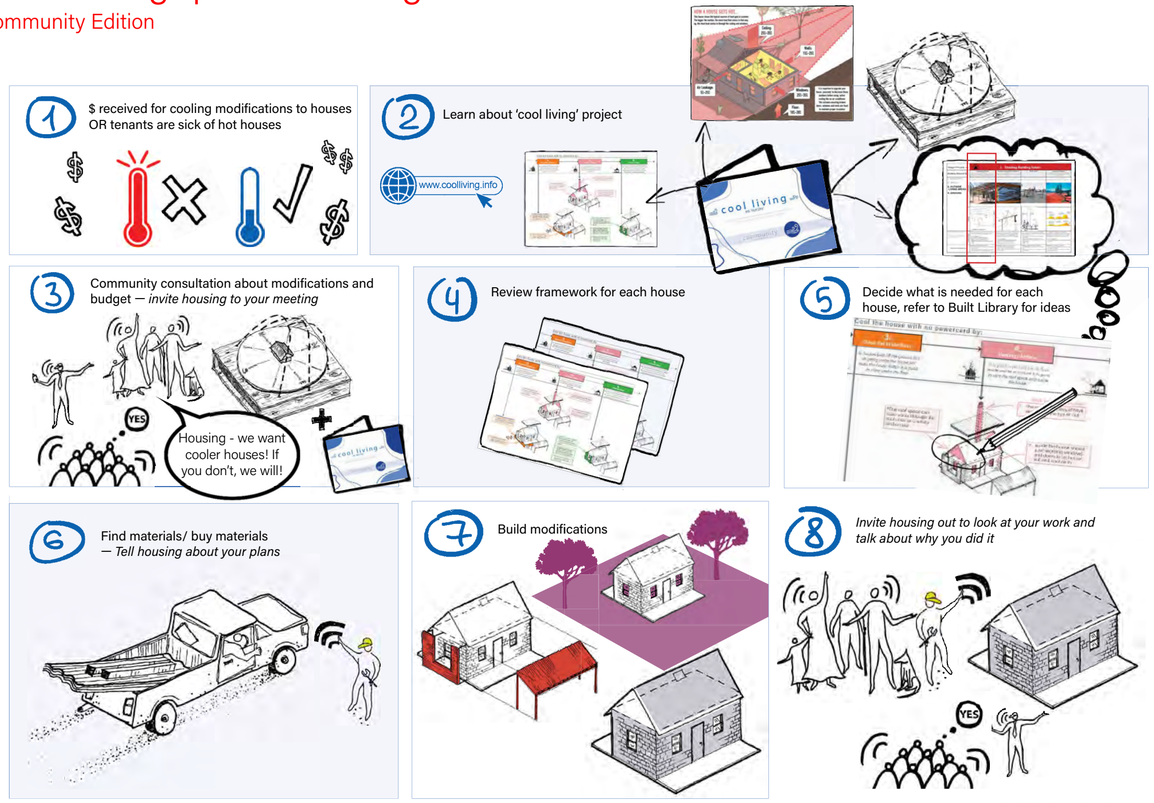
‘cool living’ process diagram - TECHNICAL

Technical Edition



‘cool living’ process diagram - COMMUNITY

Community Edition



Cool Living in ‘Hot Dry’ Climates

TECHNICAL ‘cool living’ House Survey

1. *COMPLETE* House Information & Construction

House ID:_____ By:_____

Location:_____ Date:_____

☐ Climate Zone 3 - ‘hot dry summer, warm winter’ (NCC) ☐ Climate Zone 4 - ‘hot dry summer, cool winter’ (NCC)

Zone 3 Zone 4

Orientation *(Draw the shape and way the house faces including verandahs BELOW)*:

Roof type
- ☐ Metal or timber frame/ truss and metal roof cladding
- ☐ Metal or timber frame/ truss and tile roof cladding
- ☐ other_____

External Wall Type
- ☐ Block wall (190mm) uninsulated
- ☐ Block wall (90mm) uninsulated
- ☐ Block wall 190mm with ‘shade wall’
- ☐ Block wall 90mm with ‘shade wall’
- ☐ Metal framed wall, metal cladding direct-fix to wall frame
- ☐ Metal framed wall, metal cladding on batten fixed to wall frame
- ☐ other_____

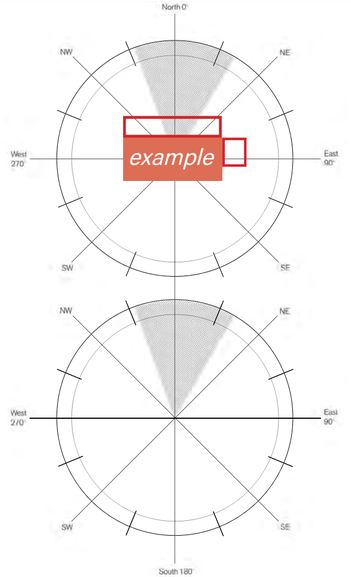
Window Type (majority)
- ☐ Aluminum single glazed (SG) window - Glass OR Acrylic
- ☐ Aluminum double glazed (SG) window - Glass OR Acrylic
- ☐ UPVC window
- ☐ Timber window

Exterior Door Type
- ☐ Solid core doors with weather seal at bottom
- ☐ Solid core doors WITHOUT weather seal at bottom

Floor Construction Type
- ☐ Concrete slab-on-ground
- ☐ Suspended metal/ timber frame floor
- ☐ Suspended concrete slab floor

Ceiling Type (lining on the inside of the house)
- ☐ Bondor insulated ceiling panel
- ☐ Plasterboard 10-13mm
- ☐ Fibrecement (FC) 9mm
- ☐ Panel rib/metal lining

Internal Wall Type
- ☐ Block wall (90mm) uninsulated
- ☐ Metal/ timber framed wall with FC lining
- ☐ Metal/ timber framed wall with plasterboard lining
- ☐ Metal/ timber framed wall with panel-rib/ metal lining
- ☐ Insulated wall panels



2. *COMPLETE* House Survey

Passive cooling Priorities 1-2

1. Shading Building Fabric → **2. Insulation**

☑ ☒ *Is there shading?*

1. WINDOWS
   1. North
   2. North-East
   3. East
   4. South-East
   5. South
   6. South-West
   7. West
   8. North-West
2. WALLS
   Shades minimum 75% of wall height
   1. North
   2. North-East
   3. East
   4. South-East
   5. South
   6. South-West
   7. West
   8. North-West
3. VERANDAHS
   At least 2m wide
   1. North
   2. North-East
   3. East
   4. South-East
   5. South
   6. South-West
   7. West
   8. North-West

Without correct shading over the windows and walls, this can result in too much heat gain in the building making it uncomfortable for people. Big shadows are best for hot times to stop the sun hitting the house and stop the heat gain.

☑ ☒ *Is there insulation?*

1. ROOF
   Roof blanket
   1. R2.5 (100mm THK)
   2. R1.3 (60mm THK)
   3. No insulation/ unkown
   4. Verandah roof is lined
2. CEILING
   1. R4 (190mm THK)
   2. R3 (150mm THK)
   3. R2 (90mm THK)
   4. R1.5 (75mm THK)
   5. No insulation/ unkown
3. EXTERIOR WALLS
   1. R2.5 (90mm THK)
   2. R2 (90mm THK)
   3. R1.5 (75mm THK)
   4. No insulation/ unkown
4. INTERIOR WALLS
   1. R2.5 (90mm THK)
   2. R2 (90mm THK)
   3. R1.5 (75mm THK)
   4. No insulation/ unkown

Framed Floor ONLY

5. UNDER-FLOOR
   1. R4 (190mm THK)
   2. R2 (90mm THK)
   3. R1 (75mm THK)
   4. No insulation/ unkown

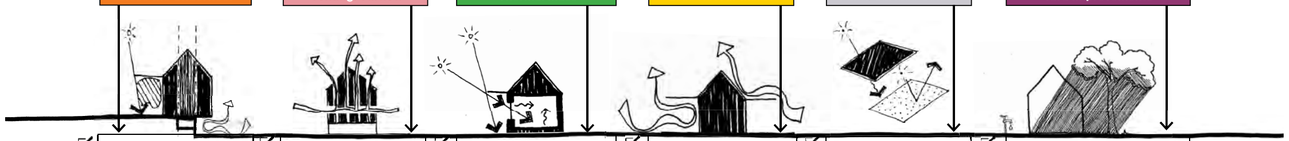
Slab-on-ground ONLY

6. SLAB INSULATION
   1. R3 edge ins (60mm THK)
   2. R1 edge ins (25mm THK)
   3. R.25 edge ins (7mm THK)
   4. Under slab ins - R1
   5. No insulation/ unknown

25-35% of heat gain in a house comes through the ceiling.

Passive cooling Priorities 3-8

3. Close the Underfloor → **4. Venting/ Airflow** → **5. Thermal Mass** → **6. Less Hot Air Inside** → **7. Paint/Surface Colour** → **8. Yard Improvements**



What's under the house?

Slab-on-ground ONLY (+0mm AGL)

☐ NA - ensure ground is shaded (refer to 1)

Low Set House ONLY (+600-1200mm AGL)

☐ 1. UNDERFLOOR CLADDING
- 1. Fully lined
- 2. Part lined
- 3. No lining/ NA

☐ 2. PERIMETER CLADDING
- 1. Enclosed w/ some vents
- 2. Enclosed w/ many vents
- 3. Very open (no cladding)

Elevated floors, if unlined and uninsulated, can cause the house to gain heat. If the ambient outside air temperature is higher, the more it will heat up the inside of the house.

What type of venting?

☐ 1. ROOF SPACE
- 1. Mechanical venting
- 2. Natural venting (eg. whirly bird)
- 3. Minimal/ no venting

☐ 2. INTERNAL LIVING SPACES
- 1. Windows are operable
- 2. Ext. doors are operable

☐ 3. VERANDAH ROOF
- 1. Venting at wall edge
- 2. No Venting
- 3. No Verandahs/ NA

Venting/airflow is important to improve cooling. Airflow across the body, if the ambient temperature is below 32ºC, will help you feel cooler. Venting the roof-space will make the house cooler.

Is there Thermal mass?

Block (heavy-weight) House ONLY

☐ 1. SHADE WALLS
- 1. North
- 2. East
- 3. West
- 4. South

Metal Frame (light-weight) House ONLY

☐ 2. INTERNAL THERMAL MASS
- 1. ALL walls are block
- 2. ONLY a stand-alone block wall in the living room
- 3. No block walls

☐ 3. FLOOR COVERING
- 1. Concrete
- 2. Vinyl
- 3. Tiles
- 4. Timber
- 5. Carpet

Thermal mass is the ability of materials to absorb, store and release heat. If used correct (like a slab-on-ground), it can help a house stay cool. If used the wrong way, it will absorb heat and release it slowly into the house make it hotter.

Where are gaps?

Upgrade Doors & Windows where possible

☐ 1. AROUND WINDOWS & DOORS
Are their holes..?
- 1. Around windows
- 2. Around doors

☐ 2. Holes in FLOOR & WALL
- 1. Are there holes in floor?
- 2. Are there holes in walls?

☐ 3. Corner of WALL & CEILING / FLOOR (cornice & skirting)
Are there holes?
- 1. Around the cornice
- 2. Around the skirting

☐ 4. CEILING VENTS
Can they be sealed closed or have insulation above?
- 1. Ceiling/ AC vents
- 2. Exhausts/ chimney
- 3. Downlights
- 4. No vents/ NA

It is important to seal up gaps and holes around the house to stop unwanted hot or cold air coming inside or leaking out.

What colour is it?

☐ 1. ROOF COLOUR
- 1. White (SA 0.25)
- 2. Medium (SA 0.5)
- 3. Dark (SA 0.85)

☐ 2. WALL COLOUR
- 1. White (SA 0.25)
- 2. Medium (SA 0.5)
- 3. Dark (SA 0.85)

☐ 3. WINDOW/ DOOR FRAMES
- 1. White (SA 0.25)
- 2. Medium (SA 0.5)
- 3. Dark (SA 0.85)

*Darker colours absorb heat and lighter colours reflect heat which can impact the temperature of the house. *SA = solar absorptance Total incident solar radiation that is absorbed by colour*

In the yard, is there?

☐ 1. POWER POINTS (GPO)
- 1. Weatherproof GPO's
- 2. GPO's at outside living areas

☐ 2. YARD TAPS
- 1. At living areas
- 2. Can water plants

☐ 3. INFRASTRUCTURE FOR ADDITIONAL LIVING AREAS & SHADING
- 1. Strong fences to yard
- 2. North
- 3. East
- 4. West
- 5. South

☐ 4. SHADE PLANTING & SHADE AREAS
- 1. North
- 2. East
- 3. West
- 4. South
- 5. No shading/ NA

The yard is an important extension of the house and living area. A well functioning yard with good amenity can reduce the impacts of crowding. Good shading and shade plants can decrease temps by up to 8C.

Filling out Survey

- *Answer questions from a building survey, drawn plans or on-site inspection*
- *Answer question as the majority of an element ie. Floor covering = concrete if only bathroom is tile*
- *Strike out whole box if not relevant*

☑ YES/ GOOD ☒ NO/ BAD

Notes

3. *REFER TO & IMPLEMENT* Bang for your Buck modifications list

Cool Living
in 'Hot Dry' Climates

COMMUNITY 'cool living' House Survey

Make your house cooler without a powercard

This document works for both house types below, but energy & money savings are based off house type 1.

Block wall house with a slab on ground (Heavy-weight house)

Framed house built off the ground (Light-weight house)

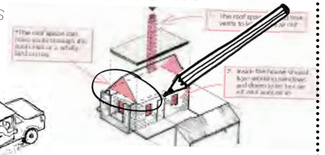
Community Name:

House #: *Date:* *By:*

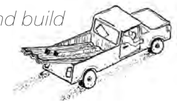
HOW TO USE:

1. *Look at the Cool Living 'Blue book' & website*
2. *Use the model to talk with the community about what cool parts houses need*

3. *Look at the house, circle on this survey what upgrades the houses needs to stay cool*



4. *Find materials and build cool parts for houses*



5. *Invite housing to come and look at your work and talk why you did it*

Cool the house with no powercard by starting at 1:

1. Shading the Building → **2. Insulation**

Stopping the sun from hitting the windows, walls and ground around the house will cool down the down.

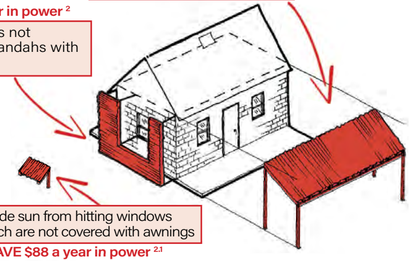
Insulation stops heat from coming through the roof, ceiling, walls and floor. The biggest insulation is best, but it can't be squashed.

SAVE $222 a year in power [1]

3. Shade all the walls with verandahs

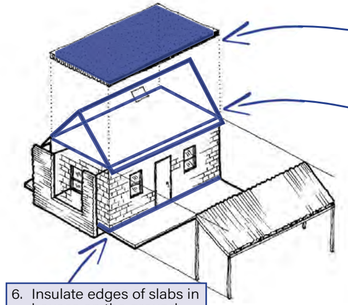
SAVE $141 a year in power [2]

2. Shade the walls not covered by verandahs with 'shade walls'



1. Shade sun from hitting windows which are not covered with awnings

SAVE $88 a year in power [2,1]



SAVE $1,275.65 a year in power [3]

2. Insulate the ceiling with biggest insulation possible (R4 bulk)

SAVE $1,171.94 a year in power [4]

1. Insulate the roof with roof blanket to stop heat from the tin

3. Insulate outside walls in lightweight houses

4. Insulate inside walls in lightweight houses

5. Insulate under floors in raised up houses

6. Insulate edges of slabs in houses on the ground

SAVE $10 a year in power [5]

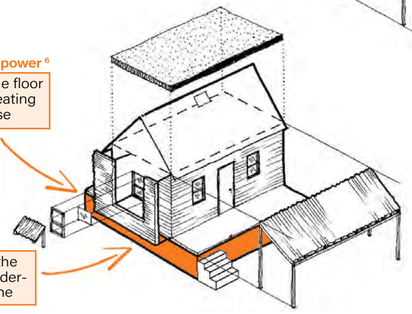
Cool the house with no powercard by starting at 1:

3. Close the Underfloor

In houses built off the ground, hot air going under the house will make the house hotter. It is good to close under the floor.

SAVE $153 a year in power [6]

1. Cladding under the floor will stop hot air heating up inside the house



2. Cladding around the edge is good if under-neath can't be done

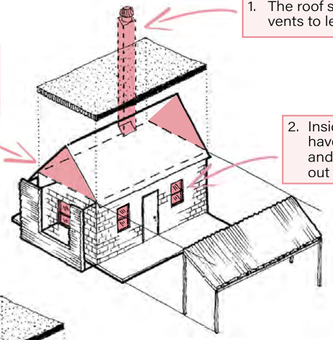
4. Venting/ Airflow

It is good to vent out hot air from inside and let in cool air. It is good to vent the roof space and inside the house.

SAVE $102 a year in power [7]

1. The roof space should have vents to let the hot air out

*The roof space can have vents through the roof ends or a whirly bird on top



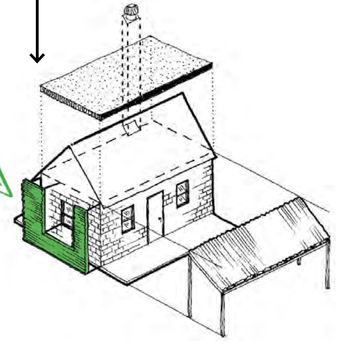
2. Inside the house should have working windows and doors to let hot air out and cool air in

5. Thermal Mass

When the sun hits walls of block houses, they heat up and stay hot inside for a long time, so it is good to shade the walls. Block walls inside and tile and concrete floors help to keep the house cool.

SAVE $141 a year in power [8]

1. In block houses, all outside walls should be shaded, 'shade walls' are good
2. In lightweight houses block walls inside are good to cool the house (speak to housing first)
3. Floors covered with concrete or tiles stay most cool



COSTING REFERENCE Refer to Bang for your Buck spreadsheet: [1] Row 10 | [2] Row 15 | [21] Row 31 + 34 | [3] Row 1 | [4] Row 4 | [5] Row 23
[6] From Modifications List House Type 3I | [7] Row 16 | [8] Row 15 | [9] Row 9 | [10] Row 22 | [11] Row 7 | [12] Row 11 | [13] Row 12

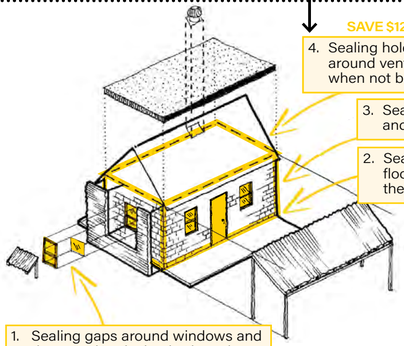
Cool the house with no powercard by:

6. Less Hot Air Inside

It is good to seal holes around windows and doors, in walls, floor and vents in the ceiling. Sealing them will stop hot air coming in and keep cool air inside.

SAVE $12 a year in power [10]

4. Sealing holes in the ceiling and around vents and blocking them when not being used is good
3. Sealing holes in the wall and at corners is good
2. Sealing holes in the floor and at the edge of the wall is good



1. Sealing gaps around windows and doors and replacing broken glass & frames will stop hot air coming in and keep cool air inside.

SAVE $233 a year in power [9]

7. Paint/Surface Colour

White and light colours reflect heat and don't absorb heat from the sun like a blue wall does. It is good to have white and light colours on the house to keep it cool.

SAVE $600 a year in power [11]

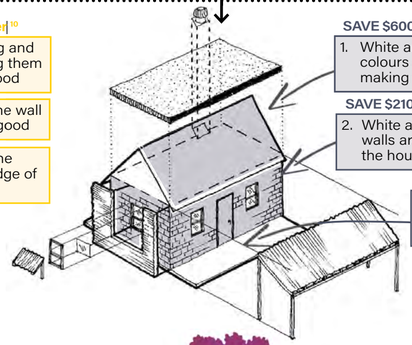
1. White and light roof colours are best for making the house cooler

SAVE $210 a year in power [12]

2. White and light colour walls are best for making the house cooler

SAVE $210 a year in power [13]

3. Window and door frames should be white and light colours too



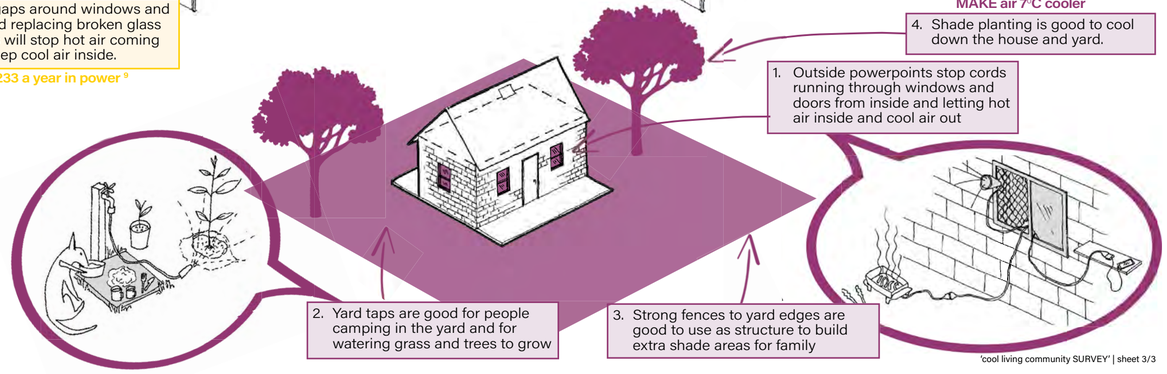
8. Yard Improvements

Yards are important living areas for family visiting and when it is too hot inside. A good yard can help cool your house and make cool places to camp outside.

MAKE air 7°C cooler

4. Shade planting is good to cool down the house and yard.

1. Outside powerpoints stop cords running through windows and doors from inside and letting hot air inside and cool air out



2. Yard taps are good for people camping in the yard and for watering grass and trees to grow

3. Strong fences to yard edges are good to use as structure to build extra shade areas for family

Best Bang for your Buck Modifications List - TYPE H1B (BLOCK HOUSE - 90°)

EXISTING HOUSE FABRIC DETAILS = Refer to House types list for correct house selection

** all modifications should consult completed cool living survey and supporting documentation and explanations*

** Consult costing reference document for further details*

** All energy savings are based off existing climate files, with climate change, more energy will be used for cooling and payback periods will be decreased*

technical the red book

	Notes	Type of Retrofit Modification to house SINGLE MODIFICATIONS USING EXISTING HOUSE AS BASE MODEL	Cooling Priority (from survey)	Location in Priority (from survey)	Difference in Cooling Load (MJ/m2yr)	$ saved/ year (@ .40c/kWh)	$ per modification (avg cost based on ref)	Unit of rate	Number required	Total	Avg payback (years)	Reference for cost (see attached sheet)
1		Change bulk ceiling insulation to R4 (no roof blanket R.15)	2. Insulation	2. Ceiling	159.9	$ 1,275.65	$ 16.10	$ / sqm	105	$ 1,690.50	1.33	2.2.1
2		Change bulk ceiling insulation to R3 (no roof blanket R.15)	2. Insulation	2. Ceiling	156.9	$ 1,251.71	$ 14.33	$ / sqm	105	$ 1,504.65	1.20	2.2.2
3		Change bulk ceiling insulation to R2 (no roof blanket R.15)	2. Insulation	2. Ceiling	150.7	$ 1,202.25	$ 11.90	$ / sqm	105	$ 1,249.50	1.04	2.2.3
4		Change roof insulation to R2.5 (no bulk ceiling insulation)	2. Insulation	1. Roof	146.9	$ 1,171.94	$ 17.40	$ / sqm	110	$ 1,914.00	1.63	2.1.1
5		Change bulk ceiling insulation to R1.5 (no roof blanket R.15)	2. Insulation	2. Ceiling	145.3	$ 1,159.17	$ 11.30	$ / sqm	105	$ 1,186.50	1.02	2.2.4
6		Change roof insulation to R1.3 (no bulk celing insulation)	2. Insulation	1. Roof	143.4	$ 1,144.01	$ 12.30	$ / sqm	110	$ 1,353.00	1.18	2.1.2
7		Change roof colour to white (SA 0.25)	7. Paint	1. Roof Colour	75.3	$ 600.73	$ 16.90	$ per sqm	110	$ 1,859.00	3.09	7.1.1
8		Add Shade Walls to all ext walls with R0.13 insulation	1. Shading	2. Wall	54.1	$ 431.60	$ 361.80	$ per sqm	221.6	$ 80,174.88	185.76	1.2/ 5.1
9		Upgrade window to add Low-E film (U5.6) (aluminium SG Black frame)	6. Less hot air inside	WINDOW UPGRADE	29.2	$ 232.95	$ 111.15	$ per sqm	5.39	$ 599.10	2.57	6.1
10		Add 100% verandahs all around (Add to E + W - 3m wide, 2.4m high eave)	1. Shading	3. Verandahs	27.9	$ 222.58	$ 690.00	$ per sqm	49.2	$ 33,948.00	152.52	1.3
11		Change wall colour to white (SA 0.25)	7. Paint	2. Wall Colour	26.4	$ 210.61	$ 17.67	$ per sqm	221.6	$ 3,915.67	18.59	7.2.1
12		Change windows/door frame colour to white (SA 0.25)	7. Paint	3. Windows/ Door Frames	26.3	$ 209.82	$ 13.50	$ per sqm	4	$ 54.00	0.26	7.3.1
13		Upgrade window to UPVC DG (U3.0) sliding window COLOUR?	6. Less hot air inside	WINDOW UPGRADE	24.0	$ 191.47	$ 1,388.50	$ per unit	7	$ 9,719.50	50.76	1.3
14		Add verandah to width of wall - EAST (3m wide, 2.4m eave)	1. Shading	2. Walls	21.7	$ 173.12	$ 690.00	$ per sqm	24.6	$ 16,974.00	98.05	1.3.2
15		Add Shade Wall to ext block wall - EAST	1. Shading	2. Walls	17.7	$ 141.21	$ 361.80	$ per sqm	19	$ 6,874.20	48.68	1.2/ 5.1
16		Add roofspace venting - Mechanical Venting	4. Venting/ Airflow	1. Roofspace	12.8	$ 102.12	$ 2,515.50	$ per item	2	$ 5,031.00	49.27	4.1.1
17		Upgrade window to aluminum DG Clear-Clear Sliding (U4.8) Black frame	6. Less hot air inside	WINDOW UPGRADE	12.0	$ 95.73	$ 669.24	$ per sqm	11.62	$ 7,776.57	81.23	6.1
18		Add roofspace venting - Natural Venting e.g fixed or Whirley Bird	4. Venting/ Airflow	1. Roofspace	7.9	$ 63.02	$ 1,017.90	$ per item	2	$ 2,035.80	32.30	4.1.2
19		Add verandah to width of wall - WEST (3m wide, 2.4m eave)	1. Shading	3. Verandahs	5.4	$ 43.08	$ 690.00	$ per sqm	24.6	$ 16,974.00	394.01	1.3.3
20		Add Shade Wall to ext block wall - WEST	1. Shading	2. Walls	5.4	$ 43.08	$ 361.80	$ per sqm	14	$ 5,065.20	117.58	1.2/ 5.1
21		Upgrade 2 x external doors to replicate sealed (R0.96)	6. Less hot air inside	DOOR UPGRADE	2.7	$ 21.54	$ 123.00	$ per door	2	$ 246.00	11.42	6.1
22		Seal all exhaust fans in house	6. Less hot air inside	4. Ceiling vents	1.5	$ 11.97	$ 61.00	$ per vent	1	$ 61.00	5.10	6.4.2
23		Add slab edge insulation - R1	2. Insulation	6. Slab	1.2	$ 9.57	$ 53.70	$ per sqm	6.3	$ 338.31	35.34	2.6.2
24		Add slab edge insulation - R3	2. Insulation	6. Slab	1.0	$ 7.98	$ 86.30	$ per sqm	6.3	$ 543.69	68.15	2.6.1
25		Upgrade windows to alumnium SG awning opening (not sliding)	6. Less hot air inside	WINDOW UPGRADE	0.9	$ 7.18	$ 521.90	$ per sqm	11.62	$ 6,064.48	844.63	6.1
26		Add slab edge insulation - R0.25	2. Insulation	6. Slab	0.7	$ 5.58	$ 19.00	$ per sqm	6.3	$ 119.70	21.43	2.6.3
27		Change floor covering to vinyl (unconditioned areas remain tile)	5. Thermal Mass	3. Floor Covering	0.1	$ 0.80	$ 58.50	$ per sqm	110	$ 6,435.00	8,066.15	5.3.2
28		Change windows/door frame colour to medium (SA 0.5)	7. Paint	3. Windows/ Door Frames	0.1	$ 0.80	$ 13.50	$ per sqm	4	$ 54.00	67.69	7.3.2
29		Seal AC hole in living room wall	6. Less hot air inside	4. Ceiling vents	0.1	$ 0.80	$ 61.00	$ per vent	1	$ 61.00	76.46	6.4.1
30		Add Insulation above exhaust fans	6. Less hot air inside	4. Ceiling vents	0.0	$ -	$ 61.00	$ per vent	1	$ 61.00	0.00	6.4.2
31		Change floor covering to 'exposed' (unconditioned areas remain tile)	5. Thermal Mass	3. Floor Covering	-2.3	$ (18.35)						
32		Remove existing window shade awnings - EAST	1. Shading	1. Windows	-3.4	$ (27.12)						
33		Doors changed to not openable (to simulate not operable)	4. Venting/ Airflow	2. Internal Living Spaces	-6.9	$ (55.05)						
34		Remove existing window shade awnings - WEST	1. Shading	1. Windows	-7.6	$ (60.63)						
35		Install underslab insulation R1	2. Insulation	6. Slab	-11.7	$ (93.34)						
36		Change floor covering to timber (unconditioned areas remain tile)	5. Thermal Mass	3. Floor Covering	-13.2	$ (105.31)						
37		Windows changed to fixed (to simulate not operable)	4. Venting/ Airflow	2. Internal Living Spaces	-27.5	$ (219.39)						
38		Change floor coverer to carpet (unconditioned areas remain tile)	5. Thermal Mass	3. Floor Covering	-32.4	$ (258.48)						
39		Change wall colour to dark (SA 0.85)	7. Paint	2. Wall Colour	-36.7	$ (292.78)						
40		Change roof colour to dark (SA 0.85)	7. Paint	1. Roof Colour	-114.3	$ (911.86)						

	Notes	Type of Retrofit Modification to house COMPOSITE MODIFICATIONS USING EXISTING HOUSE AS BASE MODEL	Cooling Priority (from survey)	Location in Priority (from survey)	Difference in Cooling Load (MJ/m2yr)	$ saved/ year (@ .40c/kWh)
1		**BASE V1 + V2 + V3 + V4 =** Change walls to white			205.0	$ 1,635.45
2		**BASE V1 + V2 + V3 =** Upgrade windows to SG low-e to windows & insulated doors - white frames (SA 0.25)			197.8	$ 1,578.01
3		**BASE V1 + V2 =** Upgrade windows to SG low-e to windows & insulated doors - dark frames (SA 0.85)			193.6	$ 1,544.50
4		**BASE V1 =** Add bulk ceiling insulation R4, roof insulation R1.3, roofpsace venting to natural, white roof, Install verandah to E & W wall			184.7	$ 1,473.50
5		ADD bulk ceiling insulation R4, roof insulation R1.3, roospace venting to natural			166.8	$ 1,330.69
6		ADD bulk ceiling insulation R4, roospace venting to natural and paint roof white			165.5	$ 1,320.32
7		ADD bulk ceiling insulation R4 and roofspace venting natural			161.5	$ 1,288.41
8		ADD roof insulation R1.3 and roofspace venting natural			137.8	$ 1,099.34
9		Change walls to white, add verandah to east and west			43.6	$ 347.83

Cool Living - H1B (Block 90) Modifciations List

Best Bang for your Buck Modifications List - TYPE H1B (BLOCK HOUSE - 90°)

EXISTING HOUSE FABRIC DETAILS = Refer to House types list for correct house selection

* all modifications should consult completed cool living survey and supporting documentation and explanations

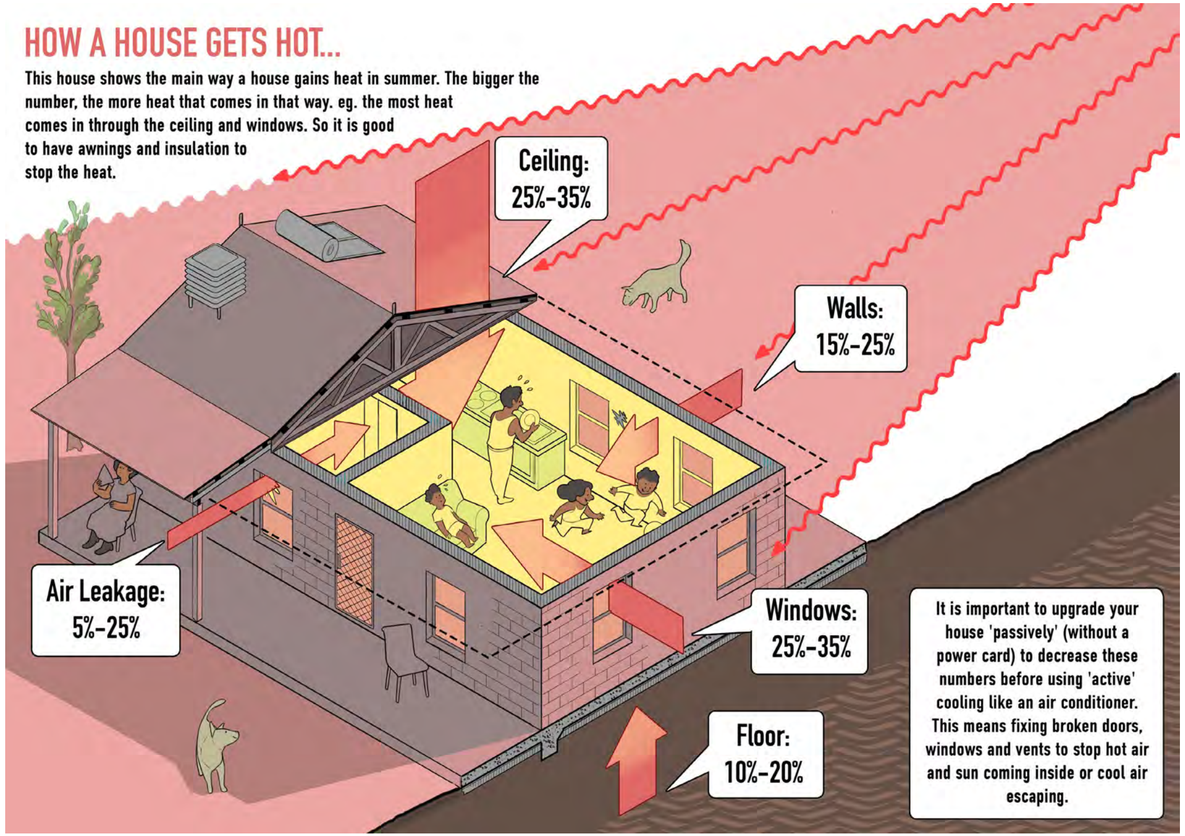
* Consult costing reference document for further details

* All energy savings are based off existing climate files, with climate change, more energy will be used for cooling and payback periods will be decreased

technical the red book

HOW A HOUSE GETS HOT...

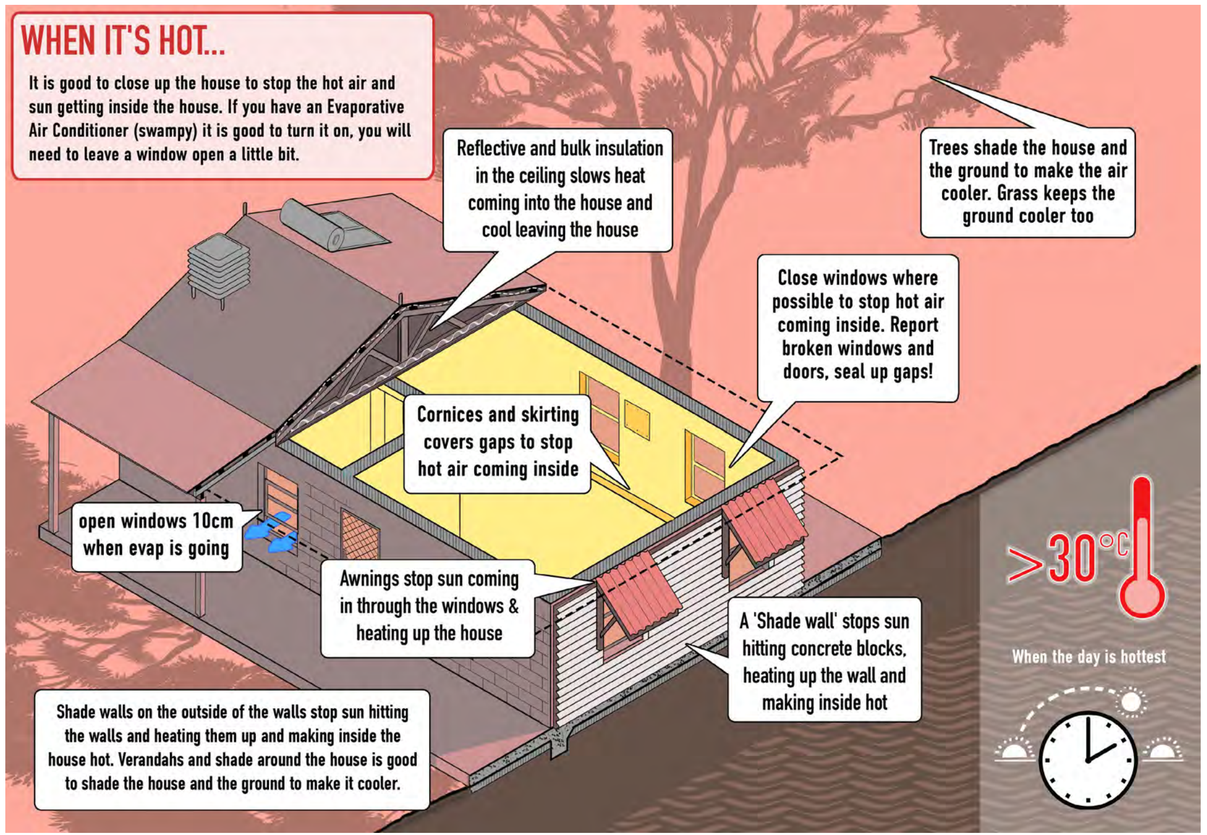
This house shows the main way a house gains heat in summer. The bigger the number, the more heat that comes in that way. eg. the most heat comes in through the ceiling and windows. So it is good to have awnings and insulation to stop the heat.

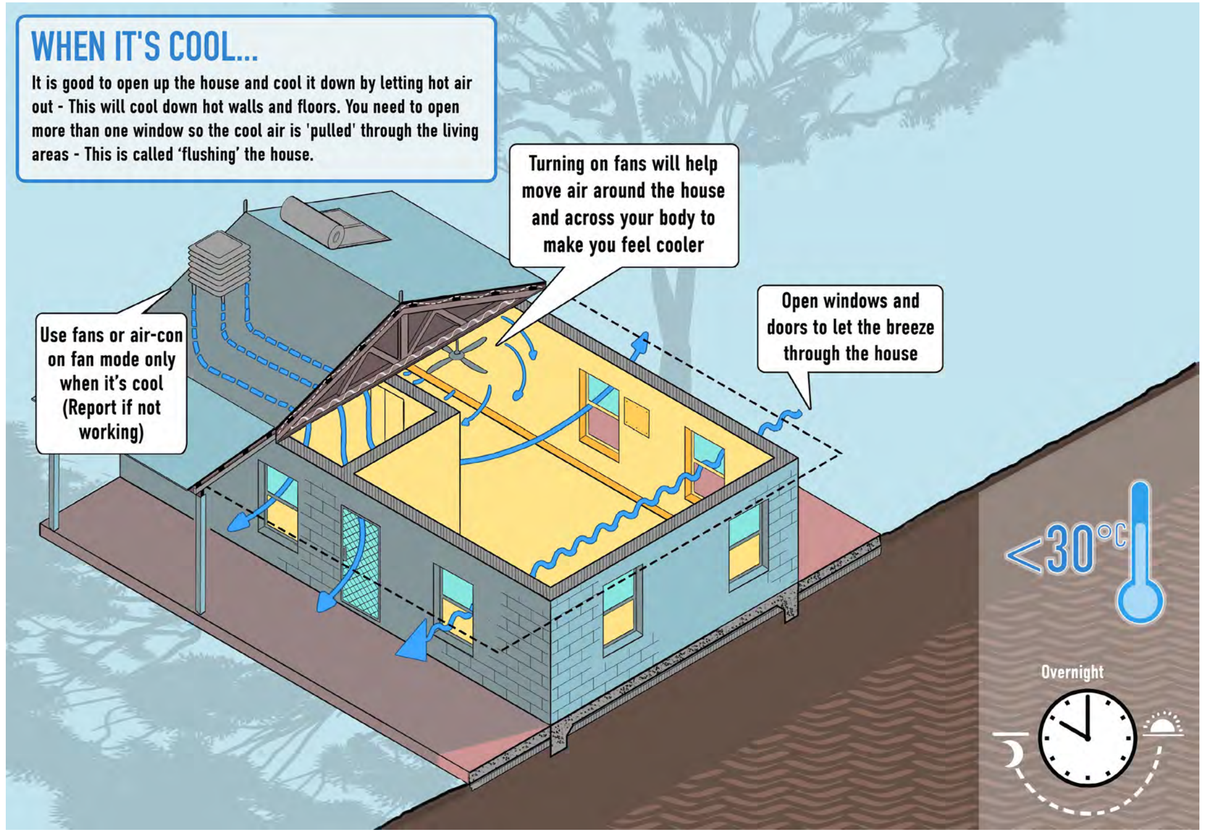


It is important to upgrade your house 'passively' (without a power card) to decrease these numbers before using 'active' cooling like an air conditioner. This means fixing broken doors, windows and vents to stop hot air and sun coming inside or cool air escaping.

WHEN IT'S HOT...

It is good to close up the house to stop the hot air and sun getting inside the house. If you have an Evaporative Air Conditioner (swampy) it is good to turn it on, you will need to leave a window open a little bit.




WHEN IT'S COOL...
It is good to open up the house and cool it down by letting hot air out - This will cool down hot walls and floors. You need to open more than one window so the cool air is 'pulled' through the living areas - This is called 'flushing' the house.
Turning on fans will help move air around the house and across your body to make you feel cooler
Use fans or air-con on fan mode only when it's cool (Report if not working)
Open windows and doors to let the breeze through the house
<30°c
Overnight

Chapter 10

Appendix

- NatHERS Energy Rating Software
- NatHERS software assumptions
- HERO - NatHERS Software
- Costing Reference Sheet
- Cost Savings Visualised (Insulation)
- Australian Vernacular Architecture Studies
- What makes the 'hot dry' climate in Australia?

NatHERS Energy Rating Software

NatHERS (Nationwide Energy Rating Scheme).

The NatHERS software provides energy ratings for residential buildings and is the most popular pathway to meet the National Construction Code (NCC) energy efficiency requirements in Australia. [1]

There are over 400 tools able to evaluate energy efficiency, renewable energy and sustainability in buildings, and only 120 of these tools are for whole building energy simulations. [2] To demonstrate compliance, the NCC requires that the choice of simulation engines used meet the requirements of ANSI/ASHRAE Standard 140 and allow using a time-step of not more than one hour throughout an entire year from which to assess building performance, using representative local weather data. [3]

From October 1, 2023, the process all assessors must use, includes:

- *use accredited software based on Chenath Engine V3.22 or V3.23*
- *use thermal only NatHERS certificates*
- *use the NatHERS technical note Version June 2019 (as reference)*
- *use heating and cooling load limits of ABCB Standard 2019.1*
- *use additional requirements for apartments detailed in clause J0.2 of the NCC 2019 Volume One*
- *additional requirements for houses details in subclause 3.12.0(a)(i) of the NCC 2019 Volume Two*

Climate and Selected Weather Files

NatHERS divides Australia into regions of similar climatic conditions, referred to as climate zones. The number of climate zones is defined by the availability of quality climate data, and whether locations are sufficiently unique to warrant separation from nearby zones. [2] There are currently 67 zones and they are aligned with postcode boundaries for convenience, except where there is likely to be a topographical or other feature within the postcode area that impacts the local climate. [4]

Typical Meteorological Year (TMY) and the Actual Meteorological Year (AMY) are the two common types of weather files used in building energy simulation studies;

- *TMY's - contain statistically derived weather data from the past 10-30 years of historic data, presented in 8760-hour format (year-long hourly time series) and do not capture extreme periods.*
- *AMY's - represent actual hourly observations for a given year and capture any extremes observed within the given year or time frame (often in the standard weather data format .epw)*
- *RMY's - Reference Meteorological Year climate files compiled from the Bureau of Meteorology raw climate data*

Reliability of results

The reliability of simulation, and hence the resultant data, is dependent on factors such as,
The quality and detail of inputs into the energy model
Data obtained from existing documentation
Underlying uncertainties in available weather databases
The working knowledge of the user [2]

Climate Change & NatHERS

CSIRO has developed predictive weather data that can be used by building energy simulation software to explore the impact of climate change on building energy consumption.

Hourly weather data is available for 83 Australian locations for 4 future years (2030, 2050, 2070, or 2090) under 3 future climate scenarios (RCP2.6, RCP4.5, or RCP8.5). The Representative Concentration Pathway (RCP) climate projections reflect a range of possible climate futures.

These files are available:

- *In .epw format that can be used by building energy simulation software such as EnergyPlus, ESP-r, and IESVE*
- *In a weather file format suitable for building energy simulations using Nationwide House Energy Rating Scheme (NatHERS) software such as AccuRate, BERSPro, FirstRate5, and HERO in non-regulatory mode. 6*

Thermal comfort in Nathers

NatHERS software adjusts modeled temperatures to achieve thermal comfort through three ways:

1. by natural means (e.g. open windows)
2. cooling via mechanical air movement (e.g. ceiling fans)
3. by adding or extracting an amount of energy to that space via heating and cooling appliances and equipment

1, 2 & 3 -Samuel Udom, Saeed Banihashemi, Charles Lemckert. "Impact of Energy Conservation Measures in Residential Buildings in Very Remote Communities in Australia" Architectural Science Review 66, NO. 4 (13/06/23 203): 330-54.
4 & 5 - NatHERS. "Nathers Climate Zones and Weather Files." Online: Commonwealth of Australia, 2022. https://www.nathers.gov.au/nathers-accredited-software/nathers-climate-zones-and-weather-files.
6 - "Predictive Weather Files for Building Energy Modeling." CSIRO, 2023, https://ahd.csiro.au/what-impact-is-climate-change-having-on-energy-consumption-in-australian-buildings/.

The software makes assumptions on both when and how people interact with their living environment and that, for example the house has working and operable windows and active heating and cooling to improve thermal comfort.
There are concerns about the software assumptions against the reality of new and existing community housing stock. Modeling can be carried out in non-regulatory mode, however one cannot obtain the official energy certificate. In this 'free running' mode, assumptions are removed and simulations hence are closer to the reality of the housing stock.

Below begins a list of some assumptions found during simulations by the author which challenge the reality of community housing stock and living.

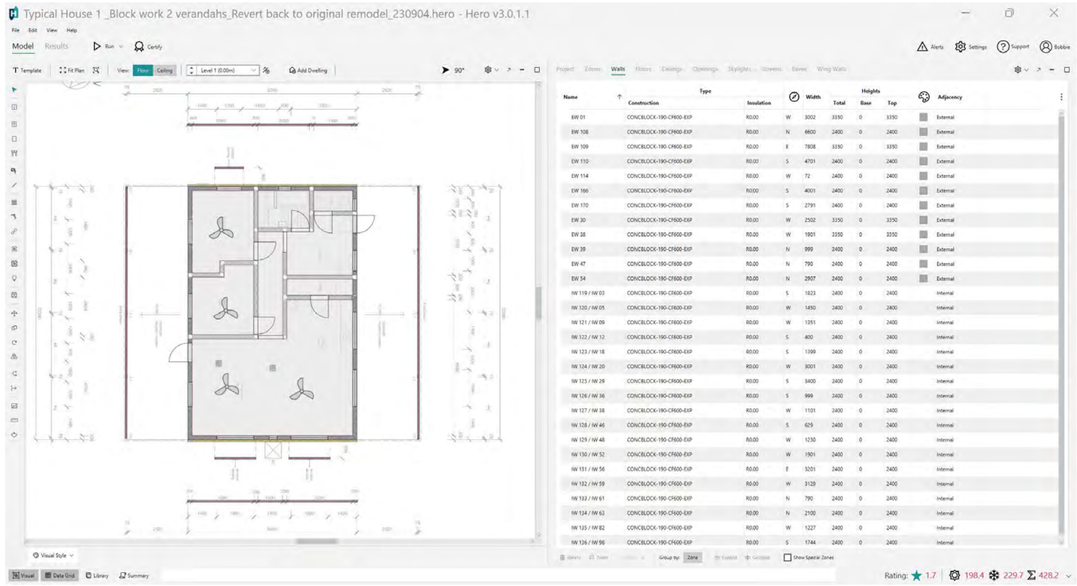
SOFTWARE ASSUMPTIONS & EXPLANATION	***CONCERN OF ASSUMPTION AGAINST THE REALITY OF COMMUNITY HOUSING STOCK***
GENERAL THERMOSTAT SETTINGS • Those that are made in the software that artificial heating and cooling will be turned on and that occupants will close the windows and doors at various times of the day.	See below.
HEATING THERMOSTAT SETTINGS: • For living spaces (kitchens and other Spaces typically used during the waking hours), a heating thermostat setting of 20 C is used [1] • For sleeping spaces (including bedrooms, bathrooms and dressing rooms, or other spaces closely associated with bedrooms), a heating thermostat setting of 18C from 7:00 - 9:00 & 16:00 - 24:00, and 15C from 24:00 - 7:00. This lower minimum heating thermostat settings is used during sleeping hours to reflect the likelihood of bedding being used	This assumes the dwelling has working 'active' heating and that people sleep during the designated hours. If there are more people sleeping in a space due to crowding, this would alter the need for heating and cooling.
COOLING THERMOSTAT SETTINGS: • The cooling methodology is based on the effective temperature method of calculating thermal comfort, where the thermostat setting varies according to the climate region to account for acclimatisation. • It also varies from room-to-room to take into account the effect of air movement, air temperature and humidity level. which is 27C for Alice Springs (for all conditioned spaces).	This assumes the dwelling has working 'active' cooling such as air-conditioner, fans and operable windows etc. for people to be able to maintain a comfortable temperature.
INFILTRATION CALCULATIONS • NatHERS calculates hourly air changes for each dwelling zone. These are influenced by the terrain, dwelling height above ground, number and nature of ceiling penetrations, windows and doors, and the characteristics of the roof and sub-floor spaces. [2]	This assumes a certain standard of construction is achieved and that infiltration only occurs at the assumed penetrations. For modeling existing dwellings, this does not take into account holes throughout the building fabric such as in wall linings, windows, doors.
WINDOWS All external openings (e.g. windows) are considered to be operable at all hours, although a factor has been incorporated to limit the number of operations to one per each three hour period. The default windows library consists of 136 generic windows. If a default window is used, an allowable tolerance for the U-value and SHGC value will be shown on the NatHERS Certificate. [3]	This assumes a certain standard of construction including effective infiltration sealing around the window units. For modeling existing dwellings, this does not take into account the largely inoperable windows with broken glass panes. One would then make assumptions and model a different window type to reflect this, yet this lacks consistency and accuracy according to the technical requirements of the software.
OCCUPANCY HOURS The software allocates functions to each space in a home, along with a period of time during which the space is likely to be used and required to be kept at a comfortable thermal range. For example: • For living spaces: thermal comfort is maintained from 7.00am to midnight • For sleeping spaces: thermal comfort is maintained from 4.00pm to 9.00am [4]	This does not reflect how a home is used in a large amount of communities where un-employment is very high, and so the home is inhabited all day long. Bedrooms operate as households with families living separately in each bedroom. The fact of allocating function to rooms in a house makes a general assumption when and how they are used.

1 - NatHERS. "Internal Heat Loads." Online: Commonwealth Government, 2022.
2 & 3 - NatHERS. Software Accreditation Protocol - Thermal 2022: Commonwealth Government, 2022.
4 - NatHERS. "Internal Heat Loads." Online: Commonwealth Government, 2022.

HERO - NatHERS Software

Using the MOA as an opportunity to learn energy rating software. See a video capturing the process and progress on the website.

HERO
Link to video (here)



Costing reference sheet

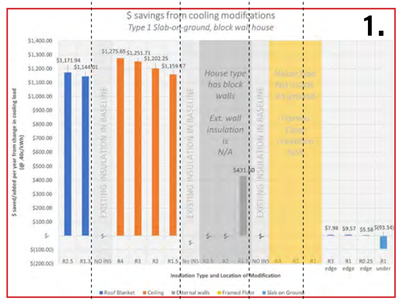
Explanations behind the calculation of modifications and payback period costs in the Best Bang for your Buck modifications list.

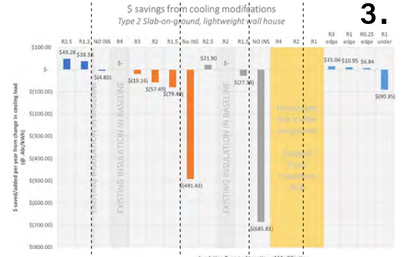
Priority ref	Notes	Reference
1.2.3	Shade Walls – Add Verandah (calculated) Steel-framed roof = $213/sqm 90x90 SHS Verandah posts $424 / 8m x 0.3 Concrete slab $297 / cum (0.15 cum/ sqm calculation) = $44.55 Total = $384.75 + 117% = $450.16	Rawlinsons 2023: Steel framed roof Construction (Zinaclume Steel) pg 119 SHS Posts (req 1 x 2.4m length per 9sqm with typical 3m verandah) https://www.scottmetals.com.au/rhsgalv.php Concrete Slab (assume local plant set up), Reinforced concrete 25 MPa (slabs and thickening on fill 150mm thick) pg 238
1.2.3	Shading Walls – Add verandah Residential – Verandah - ground floor level comprising, ground floor timber framing, decking, timber balustrade, timber posts, roof tile of exposed timber rafters $590/qm + 117% = $690.3 / sqm	Rawlinsons 2023 pg 42 13.1.2.9
2.1.1	Change roof insulation to R2.5 $14.9 + 117% = $17.4	Rawlinsons 2023 pg 336 – Glasswool blanket with lightweight foil facing one side (Anticon) laid over purlins – R2.5
2.2.1	R4 Bulk ceiling insulation $13.75/sqm + 117% = $16.1	Rawlinsons 2023 pg 336 – Glasswool Insulation batts laid between ceiling joists
2.2.2	R3 Bulk ceiling insulation $12.25 + 117% = $14.33	Rawlinsons 2023 pg 336 – Glasswool Insulation batts laid between ceiling joists
2.2.2	Change roof insulation to R1.3 $10.5 + 117% = $12.3	Rawlinsons 2023 pg 336 – Glasswool blanket with lightweight foil facing one side (Anticon) laid over purlins – R1.5
2.2.3	R2 Bulk ceiling insulation $10.2 + 117% = $11.9	Rawlinsons 2023 pg 336 – Glasswool Insulation batts laid between ceiling joists
2.2.4	R1.5 Bulk ceiling insulation $9.65 + 117% = $11.3	Rawlinsons 2023 pg 336 – Glasswool Insulation batts laid between ceiling joists
2.6.2	Slab Edge Insulation R1 (R1.15 25mm) $45.9 / sqm + 117% = $53.7 x 6.3sqm (on building)	Rawlinsons 2023 pg 337 – Phenolic Board, Fixed to underfloor (concrete soffit)
2.6.1	Slab Edge Insulation R3 (R3 60mm) $73.8 / sqm + 117% = $86.3 x 6.3sqm (on building)	Rawlinsons 2023 pg 337 – Phenolic Board, Fixed to underfloor (concrete soffit)
2.6.3	Slab Edge Insulation R0.25 $38.35 / sheet (2.88sqm) +20% for fixing + 117% = $19/ sqm	Polastic Insulation Board 7mm 1200x2400 (2.88sqm) - https://insulationeasy.com.au/product/polastic-insulation-system-1200-x-2400-2-88m2-7mm-silver-black-white/
4.1.1	Venting Roofspace – Add mechanical venting Roof mounted exhaust ventilators (Single speed single phase low profile fan with free inlet capacity of – 1.40 cum/s) $2,150.00 x 117% = $2,515.50	Rawlinsons 2023 pg 645 – Mechanical Ventilation
4.1.2	Venting Roofspace – Add natural venting Inlet Louvres – Non-adjustable wall louvre (colorbond steel) $870 x 117% = $1017.9	Rawlinsons 2023 pg 644 – Inlet Louvres

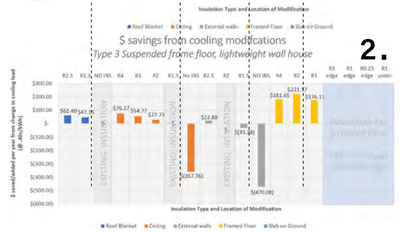
5.1	Shade Walls – Build – Change wall type to venting cavity on ext with R0.13 insulation to east and west Wall Cladding 0.42mm corrugated = $45.1 / sqm x 1 Insulation (aircell) = $18.3 / sqm x 1 Z Purlin = $17.25 / lm x 2 Zincalume flashing top = $46.1/ lm x 1 Zincalume flashing bottom = $46.1/ lm x 1 Wire mesh top = $ 24.99/sqm x 0.1 (100mm depth wall section) Wire mesh bottom = $ 24.99/sqm x 0.1 Screw box = $36.25/2 Labour $96.25/hr x 1 Total = $309.25 + 117% = $361.82 / sqm	Rawlinsons 2023: Pg 414 Reflective air cell, fixed to walls (steel framed, lightweight) Pg 335 Standard Purlin (Z or C10010) pg 288 Zincalume Straight flashing 0.55mm x 250mm girth pg 408 Ibid Rapid Mesh 25x25 square (https://www.bunnings.com.au/rapidmesh-900-x-1200mm-25-x-25mm-silver-wire-mesh-panel_p0087124) Ibid Buildex roof screws box 100 https://www.bunnings.com.au/buildex-m6-11-x-50mm-manor-red-hex-head-hi-grip-with-seal-roof-zip-screws-100-box_p2409892 Labour rates Adelaide Carpenter pg 732
5.1	Shade Walls – Change wall type to vented cavity on ext with R0.13 insulation - Add figure for shade walls to all walls to house 221.6sqm total wall area	
5.3.2	Thermal Mass – Floor Covering Change floor covering to vinyl $50/ sqm + 117% = $58.5 / sqm	Rawlinsons 2023 pg 151 – Floor Finishes, Tile and Sheet resilien, Medium Duty vinyl sheet
6.1	Add low-e coating glazing treatment (to existing Aluminium SG window unit) – Reflective high performance film $95 / sqm + 117% = $111.15 / sqm (.77 sqm of glazing per window x approx 7 windows of this size = 5.39sqm)	Rawlinsons 2023 pg 447 – Glazing, Solar Control Film
6.1	Window Upgrade to UPVC DG Sliding Windows $767 + Double glazing $320sqm (1.66sqm in unit) + 117% = $1388.5	https://prestigeplus.sydney/calc/ - Use reference of uPVC Awning Window 900x600mm ($767) Rawlinsons 2023 pg 445 – Double Glazing (6mm x 6mm clear float)
6.1	Window Upgrade to Aluminium DG Clear-Clear $572/sqm + 117% = $669.24 / sqm (1.66sqm in unit, need approx. 7 units)	Rawlinsons 2023 pg 363 – Aluminum Windows, Sealed double glazed unit comprising two panes of 6mm clear float glass Sliding 50% opening (assume replace whole unit)
6.1	Window Upgrade to aluminium SG awning opening (not sliding) $413/sqm (1.08 sqm in 1.2m W x .8 H window unit) + 117% = $521.9 / sqm (1.66sqm in unit, need approx.. 7 units)	Rawlinsons 2023 pg 363 – Aluminium Windows, SG unit Awning 50% opening
6.1.1	Seal around doors $172 (1.91 doors) + 16.7% inflation (2016-2023) + 117% regional indices = $123 / door	'Seal door' Report - Draught Sealing Retrofit Trial (Sustainability Victoria) pg 58 - Cost is based on a project which sealed doors for air infiltration to 11 houses and tested results for changes in air infiltration See the extensive list in the report. Regional Indices from Rawlinsons
6.4.1	Seal air-conditioner vents $299.4 (6.7 vents) + 16.7 inflation (2016-2023) + 117% regional indices = $61 / vent	'Evaporative cooler covers' Report – Draught Sealing Retrofit Trial (Sustainability Victoria) pg 56 Regional Indices from Rawlinsons
7.1	Paint roof colour - Use wall finishes reference Seal and two coats acrylic paint on" (PLaser or similar smooth surface) Adelaide - $14.45/sqm x 117% = $16.9	Rawlinsons 2023 pg 148 – Wall finishes
7.2	Paint wall colour Seal and two coats acrylic paint on: (Fair face masonry or similar rough surface) Adelaide - $15.10/sqm x 117% = $17.67 / sqm	Rawlinsons 2023 pg 148 – Wall finishes
7.3	Paint – Windows/ Door Frames to Medium/ White $11.55 / sqm + 117% = $13.5 (1.2x.9 window = (.5x1.1x4) + (.5x.9.4))	Rawlinsons 2023 pg 449 – Internal Paintwork – Metalwork, Acrylic, Touch up primer and two coats semi-gloss or gloss acrylic on general surfaces

Cost savings visualised - Insulation

Cost savings from the Modifications list compared for the 3 house types in graph form to compare







1.

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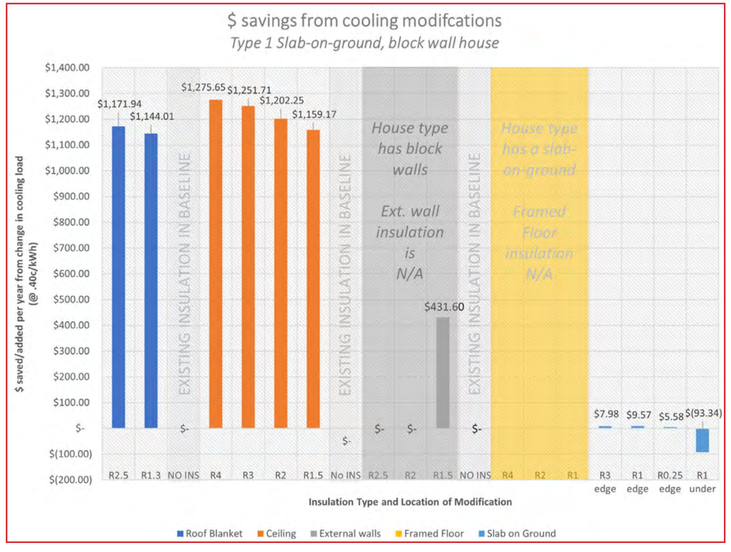
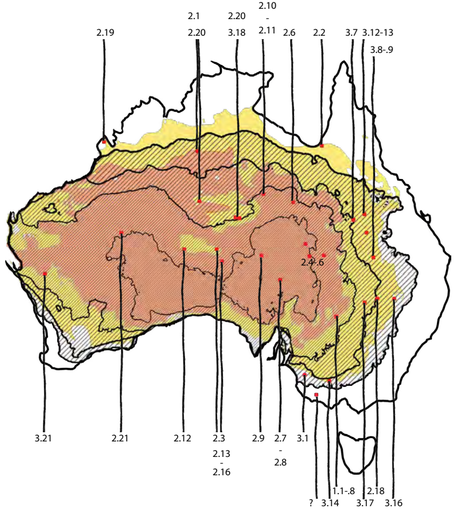


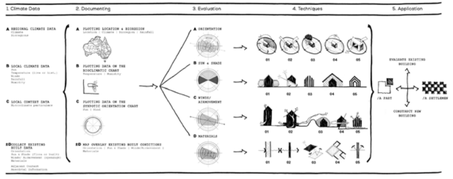
Graph of House Type 1 Insulation cost savings **(equation based off explanation on page x)**

Australian Vernacular Architecture Studies

Studying vernacular passive cooling techniques as precedents for contemporary cooling techniques

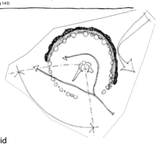


EXCERPT from the 2 part work (MOA 4th year 2018/2019) - Australia's forgotten inland; How can we re-inhabit the 70% again? by Bobbie Bayley



2.4 | Arid
Whitsuda Coopers Creek, 1947 [Winter evening structure]
(Memmott pg 139)

2.7 | Arid
Lake Eyre, 1920's [Summer day structure]
(Memmott pg 143)

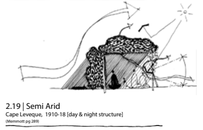


2.8 | Arid
Lake Eyre, 1920's [Summer day structure]
(Memmott pg 146)

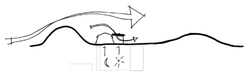
2.10/.11 | Arid
Sandover River, 1971 [Summer day structure]
(Memmott pg 188)

2.10/.11 | Arid
Sandover River, 1971 [Summer day structure]
(Memmott pg 188)

2.15/.16 | Arid
Mimili Camp, 1972 [Summer day/night structure]
(Memmott pg 226)

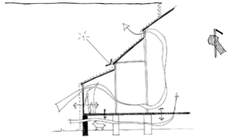


2.19 | Semi Arid
Cape Leveque, 1910-18 [day & night structure]
(Memmott pg 289)

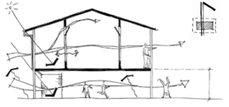


3.1 | Semi Arid
Bordertown SA, 1901 [Woolshed]

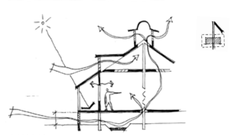
3.10 | Semi Arid
Uralla NSW, 1872 [Deagree Woolshed]



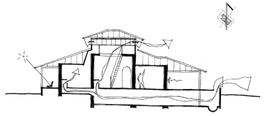
3.16 | Semi Arid
Collarenebri NSW [School building]



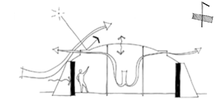
3.17 | Semi Arid
Bourke NSW, 1890 [Administrative Building]



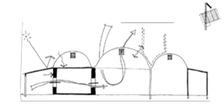
3.18 | Arid
Alice Springs NT, 1927 [Adelaide House]



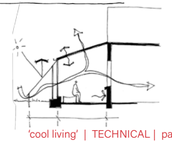
3.20 | Arid
Cordillo Downs SA, 1880's [Woolshed]



3.21 | Arid
Woolern Station WA, 1918 [Workshop]



3.22 | Arid
Old Bettoota Pub Verandah, 1880's [Pub]



What makes the ‘hot dry’ climate in Australia?

Australia’s climate is largely determined by its latitude, with the mainland lying between 10 degrees south (°S) and 39°S and Tasmania extending south to 44°S. This places much of Australia under the influence of the sub-tropical high pressure belt (or ridge), which is a major influence on climate near, and poleward of, the tropics in both hemispheres. The aridity of much of Australia is largely a consequence of the subsiding air associated with this ridge of high pressure.

Extensive depressions (lows) over the Southern Ocean have associated frontal systems embedded in the westerlies, which bring periods of rain and showers to southern parts of the country. Tasmania is under the influence of westerly flow for much of the year.

North of the sub-tropical ridge, the flow is generally easterly. In winter this easterly to south-easterly flow is especially persistent over the northern half of the continent, bringing dry conditions to most locations, except along the east coast. Elsewhere, moist easterlies flow from the Pacific Ocean and Tasman Sea brings summer rain to most of the east coast.

Australia’s generally low relief means that topography has less impact on atmospheric systems that control the climate than is the case in more mountainous continents. This lack of topographic obstruction, and the absence of cool ocean currents off the west coast (as are found at similar latitudes off Africa and the Americas) as a stabilising influence, allows the occasional penetration of tropical moisture deep into the continent. As a result, the Australian desert, while relatively dry, does not match the extreme aridity of deserts such as the Sahara where vast areas have average annual rainfalls below 25 mm. There are also no barriers to occasional bands of moisture and cloud extending from the warm waters of the Indian Ocean off north-western Australia right across the continent to the southern states. These ‘north-west cloud bands,’ which are most common in late autumn and early winter, can produce good rainfall in their own right, sometimes in significant amounts, but their major influence is to provide an additional in-feed of moisture into frontal systems traversing southern Australia, thus enhancing the rainfall produced by those systems.

One area where topography does have a major influence on rainfall is in Tasmania. Westerly winds are intercepted by the island’s mountains, causing heavy rainfall on the western (windward) side, and leaving eastern and central Tasmania in a much drier so-called ‘rain-shadow.’ The Great Dividing Range and associated ranges in eastern Australia enhance rainfall over the east coast hinterland during periods of easterly flow, and partially block moisture from penetrating further inland.[1]

In summer (Figure 2.0.1 Nov-April), dry winds and stable weather conditions prevail in the south, while in the hot north, the southward shift of the equatorial trough produces the monsoonal north-westerlies, with prolonged cloud cover and rainfall as well as tropical cyclones. In summer, the rainfall pattern is reversed: the north experiences maximum rainfall and the southern part is mostly dry.[2]

During winter (Figure 2.0.2 May-Oct), this pattern reverses: cool westerly winds driven by cold frontal systems flow across the southern continent, bringing rain; while northern Australia is under the influence of dry south-easterly winds. In Winter, it is wet in the south and dry in the north.[2]

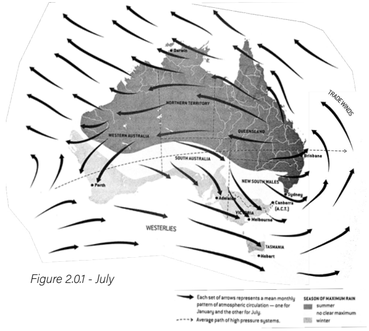


Figure 2.0.1 - July

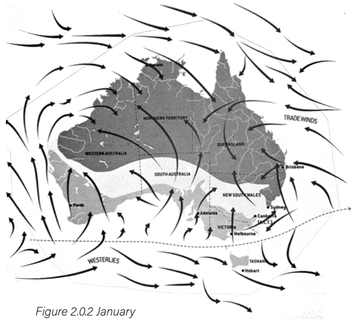


Figure 2.0.2 January

1 - Statistics, A. B. o. (2012). Geography and climate. ABS. https://www.abs.gov.au/ausstats/abs@nsf/lookup/1301.0main+features1432012
2 - Memmott, P. (2007). Gunyah, Goondie + Wurley: The Aboriginal Architecture of Australia. University of Queensland Press.

cool living

ed. 'Hot Dry'

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