

# smart&sustainable HOMES

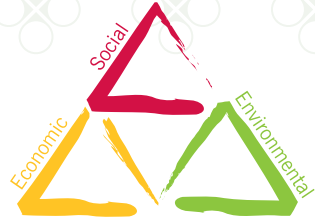


## Designing for Queensland's climate



**Queensland Government**  
Department of Public Works





# smart&sustainable HOMES

The objective of the Smart and Sustainable Homes program is to demonstrate and promote the importance of investing in sustainable design and to increase the demand from owners, builders and developers for more sustainable development practices.

All homes built under the program address the Smart and Sustainable Homes Design Objectives, which seek a balance between social, environmental and economic sustainability (triple bottom line). The Smart and Sustainable Homes Design Objectives can be viewed on line at [www.smarthousing.qld.gov.au](http://www.smarthousing.qld.gov.au).

Making a home smart and sustainable means the occupant can move around more easily, feel safer, save money and conserve the environment. A home that is designed to the Smart and Sustainable Homes principles will meet a family's needs through all stages of their lives.

A Smart and Sustainable Home is:



### **Environmentally Sustainable**

reducing waste, water and energy use



### **Socially Sustainable**

safer, more secure and comfortable



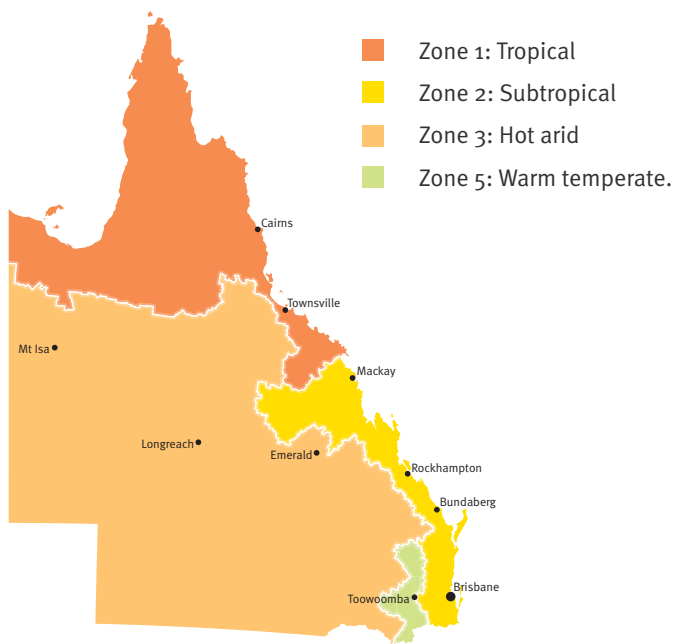
### **Economically Sustainable**

cost saving over the life of the home



# Designing for Queensland's climate

The Designing for Climate series aims to introduce concepts of smart and sustainable housing design that relate to the climate zone in which the house is located. This publication is to provide new home designers and builders with information on how to best respond to their local climate zones. There are four different climate zones in Queensland, namely:

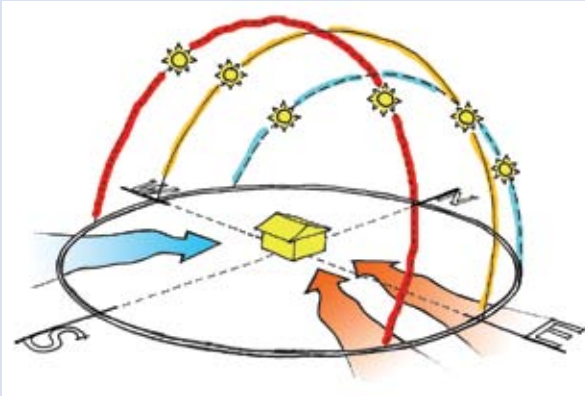


Note: There are in total eight climate zones in Australia; four of which are present in Queensland.



In this booklet, climate zones are distinguished by the area's climatic characteristics, including temperature, humidity, breezes, sunshine and rainfall.

Sun path diagrams and breeze charts are essential tools to provide guidance on how to create a climatically responsive home design.



The information presented in this publication illustrates the simple application of climate responsive design in a specific zone.

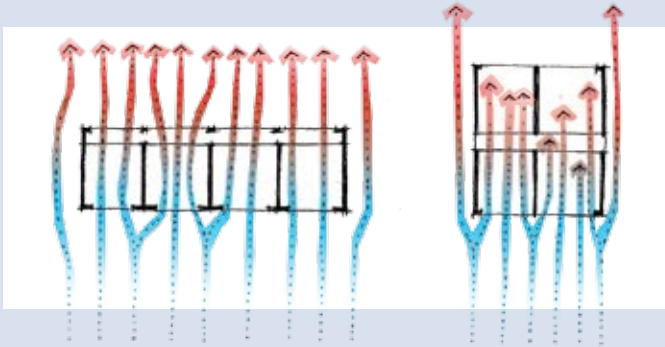
## **Design strategies for all of Queensland**

Climate responsive design improves the comfort of the home by moderating the external climate through good room planning, orientation and material choices. The following areas should be considered when planning a new home in any area of Queensland. More specific information on each of the following areas is covered in the individual climate zone design strategies.

## Building plan

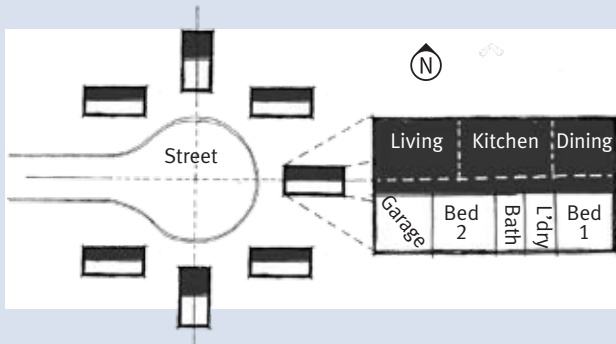
### Building shape

Varying the width of the building changes the way the building will perform. With the correct orientation, a long thin plan allows easy cross ventilation. For example, a square building will slow air movement and offer better insulation qualities.



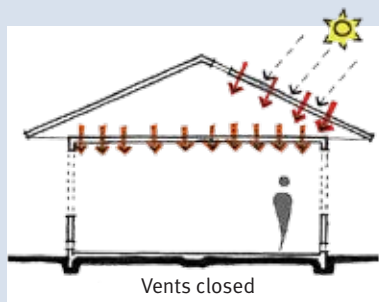
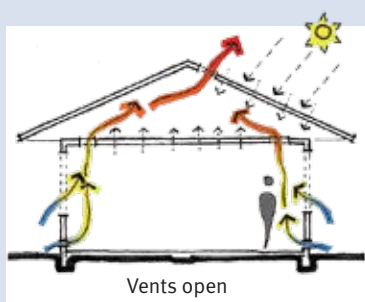
### Orientation

A good orientation will allow better use of the sun's path and natural breezes which heat or cool the home. Active spaces like living, kitchen and dining should face north to take full advantage of this.



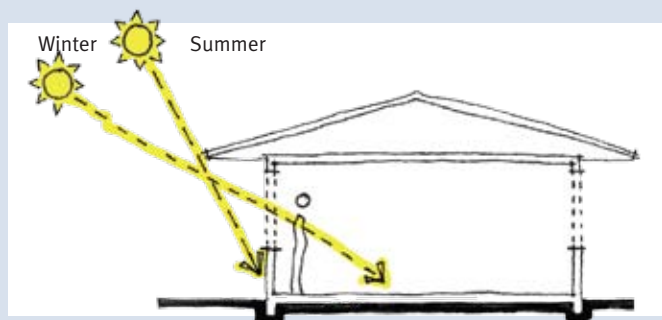
## Ventilation

Operable vents give the occupant greater control over the internal environment. Opening the vents allows hot air to escape, cooling the house. Closing the vents prevents hot air from escaping creating a build up of heat.

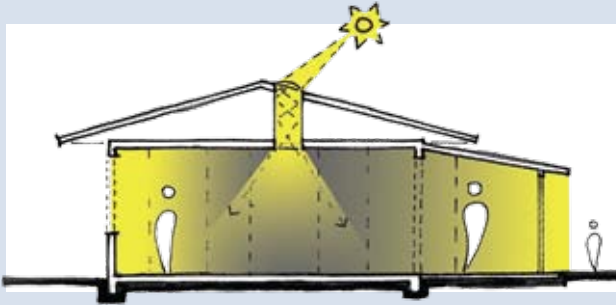


## Solar access

Careful design of eaves and shading can be used to exclude or permit sunlight using the varying angles of the sun through the yearly cycle.



Skylights allow natural light to reach deep areas of the home. Day lighting from windows in side walls will generally be adequate to a depth of two and a half times the height of the window.



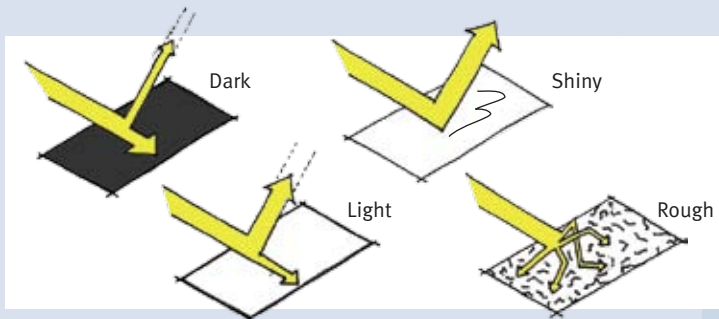
## Building material

### Construction

Materials fall into two categories: lightweight (steel and timber) and heavyweight or thermal mass (brick, blockwork or concrete). Consider the climate when selecting building materials.

### Colour and texture

In warmer climates it is best to utilise light colours and smooth surfaces to reflect heat away from the home. In cooler climates, utilise darker colours and rough materials to absorb heat.



## Insulation

Careful selection of insulation material suited to the climate zone will help to moderate the internal temperature of the home.



## Social sustainability

Social sustainability should be a consideration when designing a home in any climate. Both the economic and environmental elements of the triple bottom line approach to sustainability, are addressed in this document through the climate responsive design strategies offered. Social sustainability should be considered when building a new home in all regions.

Socially sustainable homes are designed with all people in mind. Features such as flexibility, comfort, access, safety and security are addressed so that homes accommodate the changing needs of occupants and guests. The following are elements of social sustainability.

## Human comfort

The home provides an internal environment that is thermally, visually and acoustically comfortable. This is achieved through effective design and the selection of appropriate materials and products.

## Human health

A healthy home reduces hazards to human health by lowering the presence of toxins and promoting natural light and ventilation.

## Safety

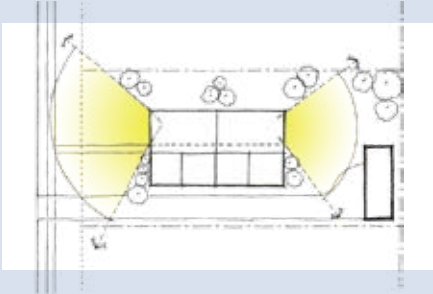
A home designed with safety in mind reduces the possibility of:

- falls
- poisonings
- driveway run-overs
- burns.



## Security

Use designs, fixtures and fittings to protect the home from intruders. Enable informal surveillance of the yard, street, and neighbouring properties.

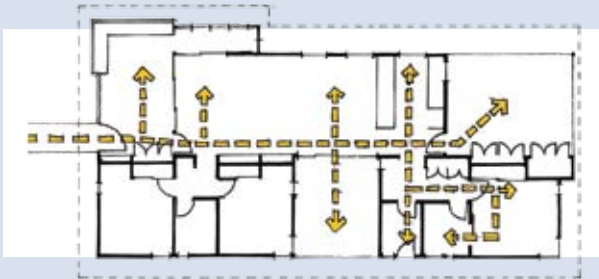


## Universal design

Design the home to be versatile and comfortable for a diverse range of people at different stages of their lives. Ensure it is easy to move around the home, and the operation of fittings and fixtures caters for people of all ages and abilities. A home should be easily accessed by occupants, visitors and emergency services.

### Design for access

Consider paths of movement when designing your home to ensure hallways and doorways are wide enough for people to move around or furniture to fit through to prevent accidents and avoid collisions.

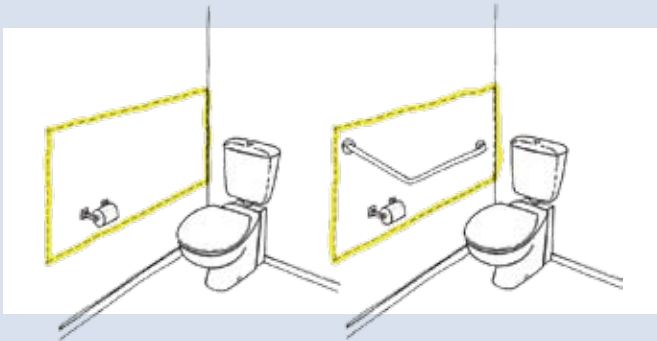


## Design for flexibility and the future

A family's needs change over time. A home needs flexibility in the design that can accommodate these changes without incurring significant costs for renovations.

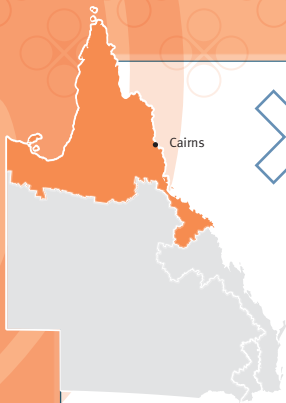


Ensure rooms are big enough, doors are wide enough and that taps and handles are easy to use. Install reinforcing during construction to reduce the cost of installing mobility aids.



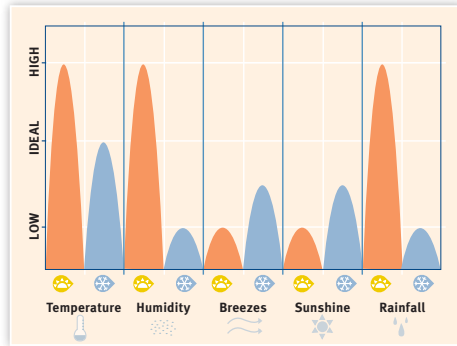
## Sense of community

The home contributes to an improved community identity by enhancing the urban fabric of the neighbourhood and promoting opportunities for neighbourhood interaction through appropriate design.






# Zone 1 Tropical Climate characteristics

Climate characteristics can be rated on a scale based on achieving an ideal level of human comfort.



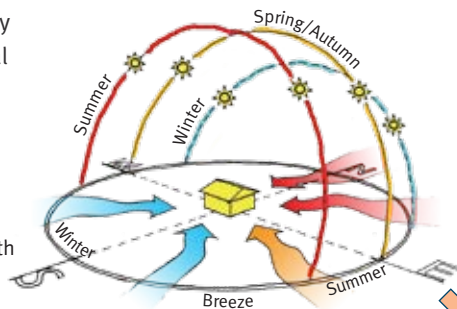
Legend: ☀ Summer ❄ Winter

From this chart three elements have been identified as key factors:

-  **Temperature:** → Very hot summers
-  **Humidity:** → Very high humidity in summer
-  **Rainfall:** → Very high rainfall in summer

To minimise the effects of these climatic conditions it is necessary to understand the sun's seasonal paths and the varying breeze patterns for the year.

## Sun map and breeze chart



Sun path: latitude 18° south



## Zone 1 Tropical

# Design features

Each zone requires a different combination of building features to achieve best results.

- For best results in zone 1
- Effective for all of QLD
- Unsuitable for zone 1

Building plan	Building shape	Suited for climate
	Orientation	For solar gain
		For breezes
	Ventilation	Heat release
		Cross ventilation
		Evaporative
Solar access	Vertical shading	
	Horizontal shading/eaves	
	Adjustable openings	
Building materials	Construction	Heavyweight
		Combination
		Lightweight
	Colour and texture	Light or shiny
		Dark or rough
	Insulation	Bulk
Reflective		
Mass		

# Design strategies

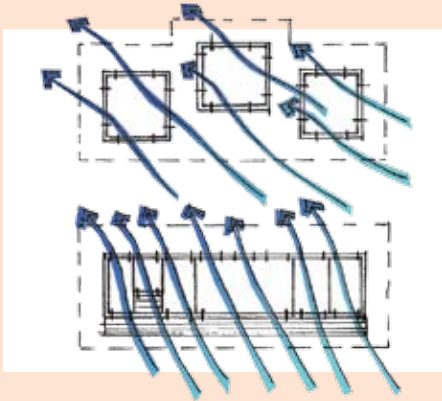
The design strategies suggested in this section will help to create a more enjoyable internal environment in the home during the hot and humid summer months. Protecting the entire home from direct sunlight and promoting good ventilation will help maintain a more comfortable internal temperature in the home.

## Building plan

### Building shape

Long thin buildings or smaller individual pods are the most suitable building shape for tropical climates. Both shapes promote high levels of air circulation and have large exposed surface areas which increase heat loss into the cooler night air.

If air conditioning is used consider zoning areas, so energy is only used to cool spaces frequently used during the hottest part of the day.

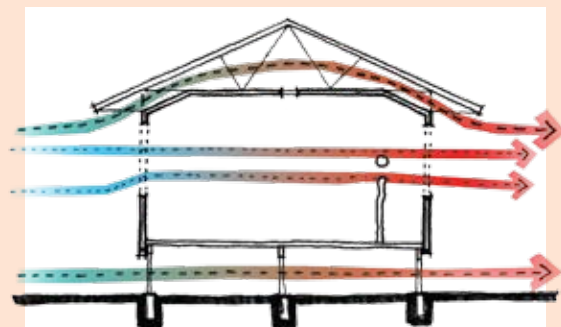
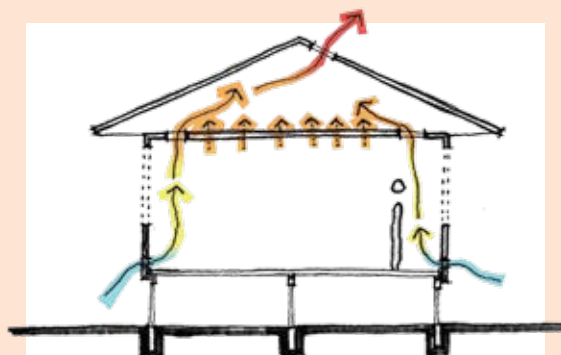


## Ventilation

When no breezes are present roof vents provide air movement and heat release by using stack ventilation. This is an effect caused by heat rising and simultaneously drawing in cooler air from below. High level or raked ceilings will aid this process.

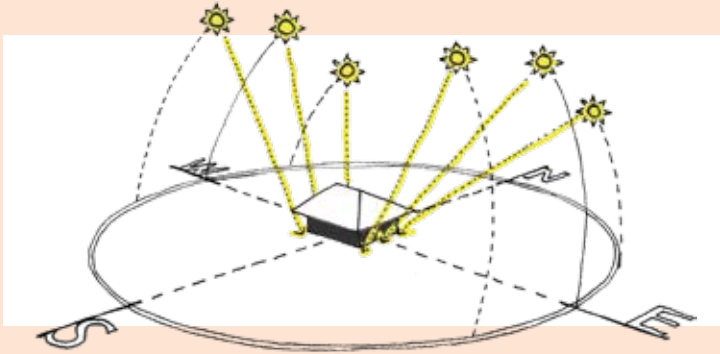
Cross ventilation should only be used during the day when the external air is cooler than the internal.

In most cases it is best to close the home during the day to protect cooler indoor temperatures and open the house at night to flush out stored heat.



## Solar access

Maximising shade over the external walls, openings and glazing will prevent direct sunlight heating the home and will reduce the build up of heat during the day.



## Building material

### Construction

If mass building materials are considered, ensure that the exterior area is protected from direct sunlight. Avoiding direct sunlight on these areas will allow the mass material to draw out heat from within the home. Providing night time ventilation will help to flush out heat build up.

Lightweight building materials such as timber and metal, transfer heat faster than mass materials such as brick, block work and concrete, this means that any internal heat gain during the day is released faster than when mass materials are used.

## Colour and texture

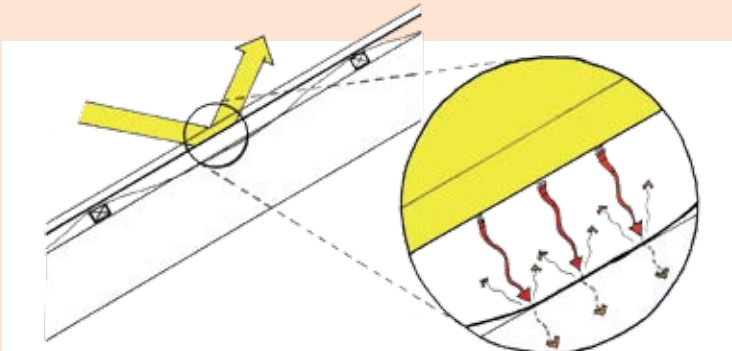
Light colours reflect more than darker shades. Choosing a lighter colour for the building's exterior reduces heat transfer.



## Insulation

To reduce the amount of heat transferred into the home choose a reflective insulation. Reflective insulation is a low remittance material and it is effective in creating a reduction in the amount of heat transferred to the home.

For an air-conditioned home use bulk insulation, mass materials and double glazing to help improve energy efficiency. Consider air-conditioning and insulating some zones of the home as a compromise.





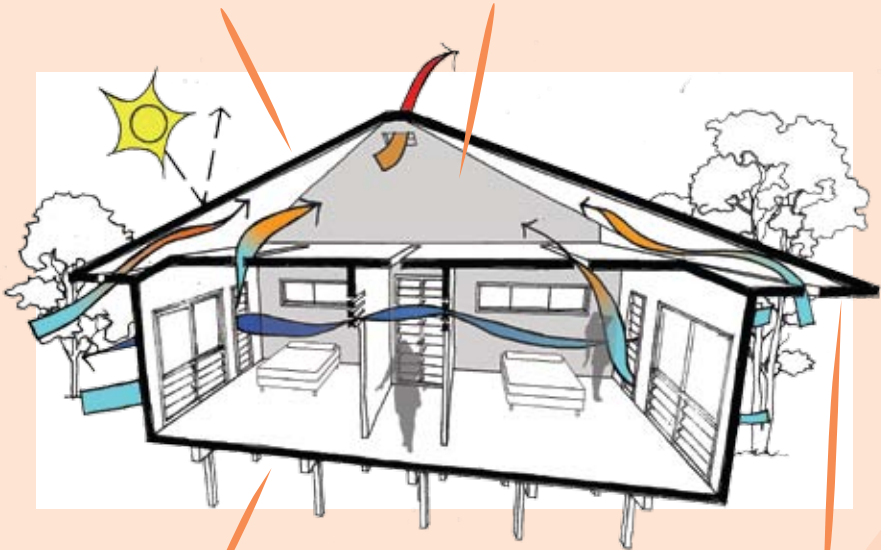
## Example design

1

Choose light colours and smooth materials for roofing. These materials will reflect more heat and reduce the amount of heat absorbed into the home. Also include reflective insulation in both the roof and walls.

2

Maintain cooler indoor air temperatures by creating good high level ventilation to release built up heat. Low level windows or vents in the floor can be placed specifically to draw in cooler air from below the house or from cooler landscaped areas using stack ventilation.



3

Raising your home off the ground increases the surface area of your home that is exposed to the cooler night time air. This helps to cool the home quickly at night using maximum cross ventilation to flush out heat stored in mass materials like the concrete, block work or brick work.

4

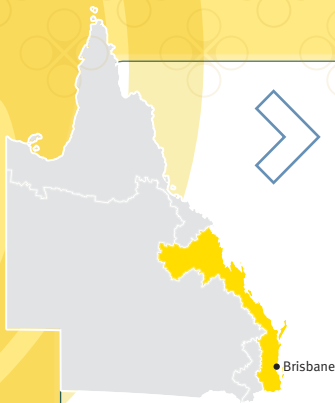
Lightweight construction and multiple openings can quickly transfer heat into the home if it is not properly shaded. Provide large overhangs to protect the entire building from direct sunlight. Consider appropriate landscaping to add to this.

## Summary

Homes in tropical climates have extremely hot and humid summers that require maximum shading, ventilation and heat release to moderate the internal environment. Shade the entire building in the summer and use light colours for exterior building materials and decoration to reflect the heat. Provide large openings for cross ventilation and consider light weight construction with controlled use of mass materials for air-conditioned areas.

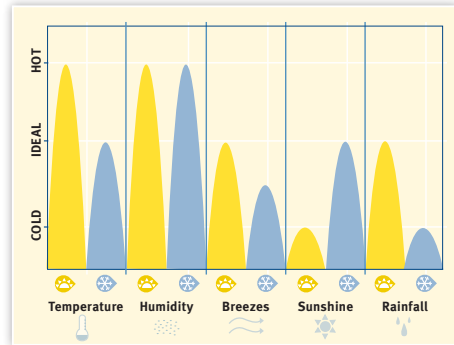


Sustainable Home Redlynch Valley showing use of light colours and large openings for cross ventilation.






# Zone 2 Subtropical Climate characteristics

Climate characteristics can be rated on a scale based on achieving an ideal level of human comfort.



Legend: ☀ Summer ❄ Winter

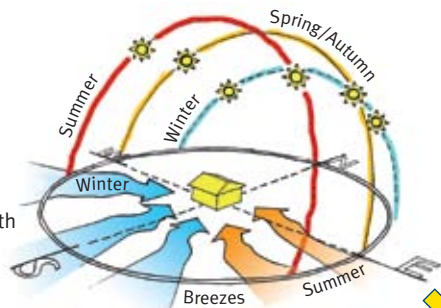
From this chart three elements have been identified as key factors:

-  **Temperature:** ➔ Hot summers
-  **Humidity:** ➔ High humidity in summer
-  **Breezes:** ➔ Ideal breezes

To minimise the effects of these climatic conditions it is necessary to understand the sun's seasonal paths and the varying breeze patterns for the year.

Sun map and breeze chart




Sun path: latitude 26° south




















## Zone 2 Subtropical

### Design features

Each zone requires a different combination of building features to achieve best results.

-  For best results in zone 2
-  Effective for all of QLD
-  Unsuitable for zone 2

Building plan	Building shape	 Suited for climate
	Orientation	 For solar gain
		 For breezes
	Ventilation	 Heat release
		 Cross ventilation
		 Evaporative
Solar access	 Vertical shading	
	 Horizontal shading/eaves	
	 Adjustable openings	
Building materials	Construction	 Heavyweight
		 Combination
		 Lightweight
	Colour and texture	 Light or shiny
		 Dark or rough
	Insulation	 Bulk
 Reflective		
 Mass		

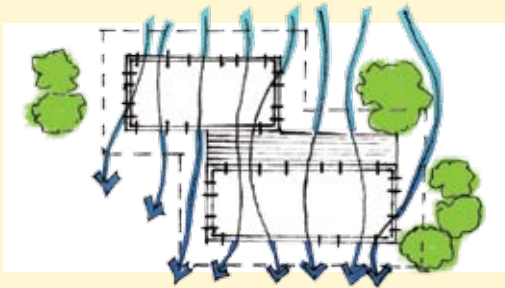
# Design strategies

The strategies suggested in this section aim to cool the home in summer and heat the home in winter. A series of passive design methods have been developed to work with the local weather patterns to moderate the internal environment. These design methods include the use of operable elements that allow the occupants to individually create their own ideal internal climate.

## Building plan

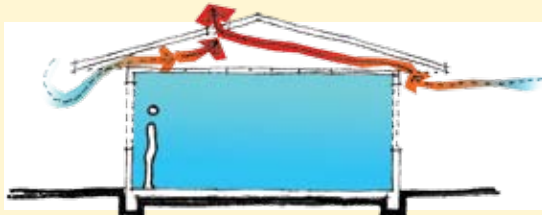
### Building shape and orientation

In this climate zone narrow spaces that promote better air circulation and maximise northern exposure offer the best possibilities for moderating the homes internal climate.

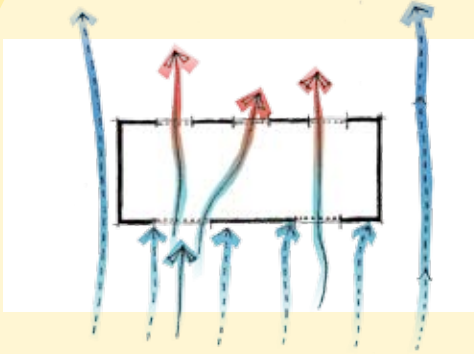


## Ventilation

Ventilation in the ceiling cavity will create stack ventilation which allows hot air to continually escape and be replaced by cooler air. This is important, especially in older homes where the ceiling is not insulated, to stop heat transferring to spaces below.

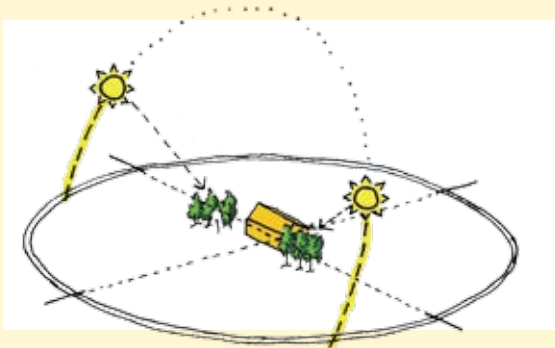


To improve cross ventilation carefully consider window size and placement. Aligning windows and doors can increase ventilation. Offsetting them can control how breezes flow through the home. Good closure of windows can help prevent heat loss in winter.

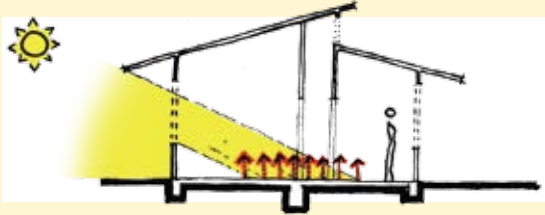


## Solar access and orientation

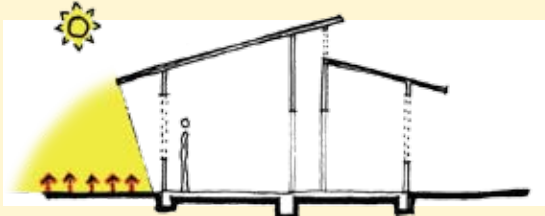
Northern orientation is the best for this zone. From sunrise to 9am and 3pm to sunset the sun is lower in sky. In summer, protect your home from heat gain from low angle sunlight on the eastern and western walls by using vertical shading like trees, screens or blinds.



During winter, solar access should be maximised to improve heat gain from the lower northerly sun path. Floors and walls made of mass materials will store heat during the day which will be released at night to warm the home.



In summer, protect the mass materials from direct sunlight to avoid heat gain.



## Building material

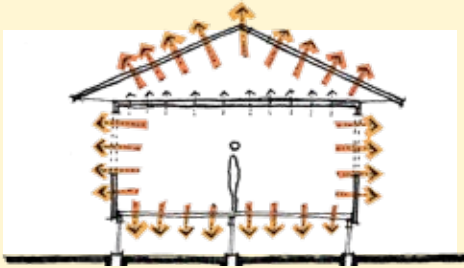
### Construction

Some areas of Zone 2 are subject to a greater range of temperatures, from hot to cold. Include mass materials such as bricks, concrete or block work to moderate the internal temperature of the home using thermal mass.



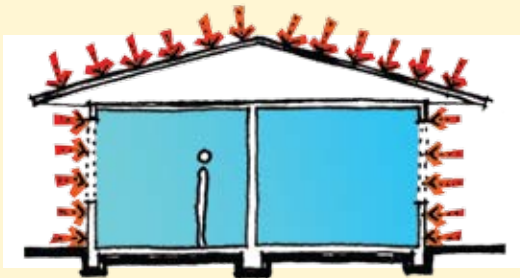
© David Sandison

In areas of Zone 2 that are subject to consistent high temperatures, lightweight building materials, such as timber and steel are recommended. This will enable heat to be released quickly to the cooler night air. To avoid heat gain during the day shading the exterior of the building is advised especially the eastern and western walls.



## Insulation

Reduce heat transfer from the roof by using reflective foil insulation. Roof insulation will also help protect the home from cold during the winter. Bulk insulation in external walls will help prevent heat transfer (conductance) in the home during the summer and will maintain warmth during the winter.





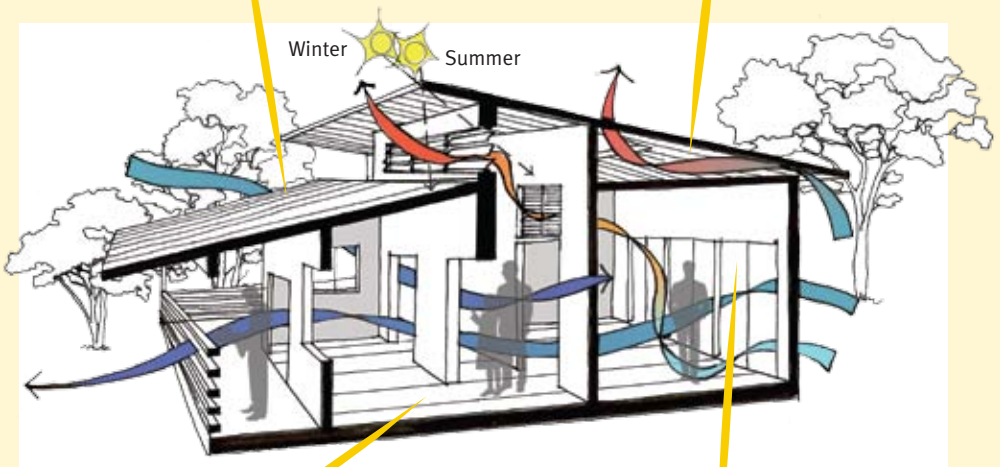
## Example design

1

Light coloured roofing materials with reflective foil insulation protects the home from heat transfer during the hot summer months and maintains warmth during winter.

2

A roof vent will allow hot air released at night to be replaced with cooler night time air, reducing heat build up in summer.



3

A shallow building depth achieves adequate cross ventilation and maximises the number of rooms that face north. If the site is too short to allow for one long thin building consider breaking it down into two thin buildings by separating and offsetting them along a breezeway.

4

Lightweight construction allows quick heat transfer. The sun path from this site shows no sun will hit the southern side. The positioning of nearby landscaping creates shading so the outdoor environment near this wall will be cooler than the indoor environment. The use of lightweight building materials makes internal heat quickly dissipate to the outside. Lightweight materials are useful for spaces that need to be cool at night as they will lose heat quickly to the night time air.

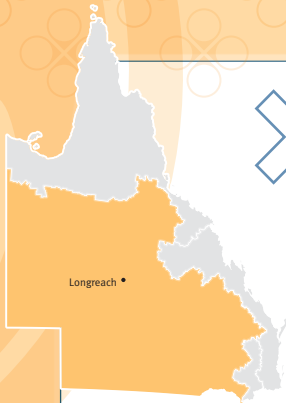
## Summary

Homes in sub-tropical climates have hot and humid summers and cool winters that require controlled shading and ventilation to moderate the internal environment. Provide shading that allows solar access in winter and solar protection in summer and operable openings to control breezes. Consider installing insulation and adequate roof, eave or ceiling vents.



© David Sandison

Sustainable Home Brisbane showing operable openings to control breezes.



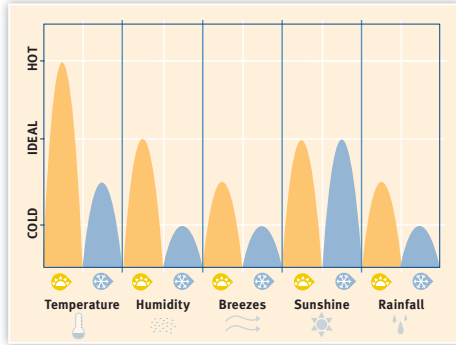
Longreach •



# Zone 3 Hot arid




## Climate characteristics

Climate characteristics can be rated on a scale based on achieving an ideal level of human comfort.



Legend: ☀ Summer ❄ Winter

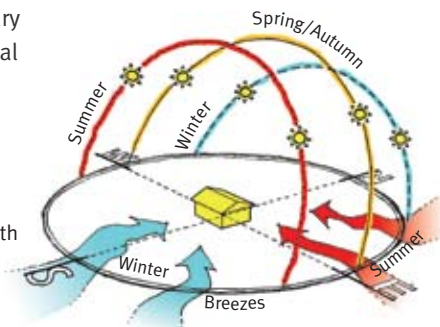
From this chart three elements have been identified as key factors:

-  **Temperature:** ➔ Very hot summers and cold winters
-  **Rainfall:** ➔ Low rainfall all year
-  **Breezes:** ➔ Dry winds all year round

To minimise the effects of these climatic conditions it is necessary to understand the sun's seasonal paths and the varying breeze patterns for the year.

Sun map and breeze chart




Sun path: latitude 24° south




















**Zone 3**  
Hot arid

## Design features

Each zone requires a different combination of building features to achieve best results.

-  For best results in zone 3
-  Effective for all of QLD
-  Unsuitable for zone 3

Building plan	Building shape	 Suited for climate
	Orientation	 For solar gain
		 For breezes
	Ventilation	 Heat release
		 Cross ventilation
		 Evaporative
Solar access	 Vertical shading	
	 Horizontal shading/eaves	
	 Adjustable openings	
Building materials	Construction	 Heavyweight
		 Combination
		 Lightweight
	Colour and texture	 Light or shiny
		 Dark or rough
	Insulation	 Bulk
 Reflective		
 Mass		

# Design strategies

The strategies suggested in this section aim to ensure that the home is kept cool in summer and retains heat in the winter. To create this effect a series of passive design methods are used to work with the local weather patterns. In this climate the design needs to control breezes by selecting, guiding and conditioning them and needs to protect indoor temperatures from the harsher external environment.

## Building plan

### Building shape

Buildings that offer better enclosure or protection are suited to climates with varying seasonal conditions that require the exclusion or considerable moderation of local weather conditions.



© David Sandison

## Ventilation

It is important to flush hot air out of the home at night in summer therefore the home design should include windows and vents that can be opened at night. During the day high level ceilings or vented ceiling cavities allow hot air to rise above the habitable space.



© David Sandison

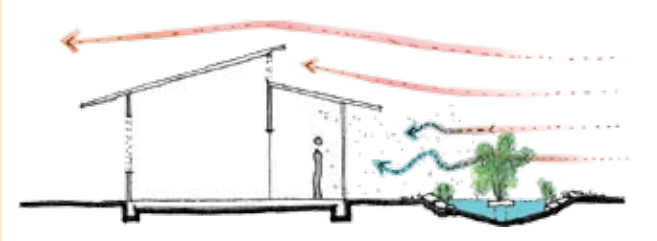
Hot air in the ceiling escapes through vents. Cooler air is drawn in via vents in the eaves. Cold air absorbs the heat build up in the roof space preventing it from transferring to the spaces below.



During the summer months the temperature in zone 3 can become extremely hot. Cross ventilation can be used if the winds are cool. If the winds are warm, close the house to protect the cooler indoor environment.

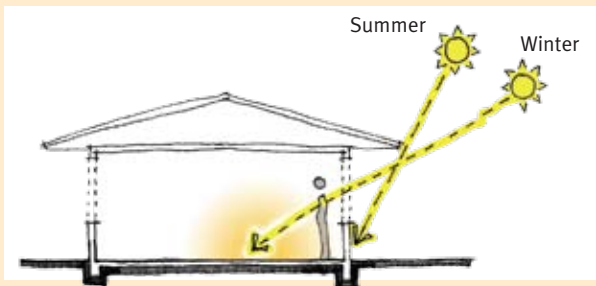


In summer the winds are hot and dry but needed for cross ventilation. Create evaporative cooling by providing shade from vegetation and combining it with a water feature in the path of the prevailing summer breeze. This will cool and humidify the air before it enters the home.



## Solar access

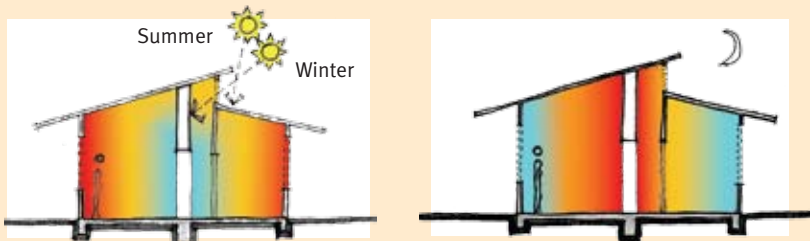
In Zone 3 conditions can vary from extremes of hot and cold. Adjustable shading such as awnings and deciduous trees allow winter sun to heat the home and helps prevent heat gain in summer.



## Building material

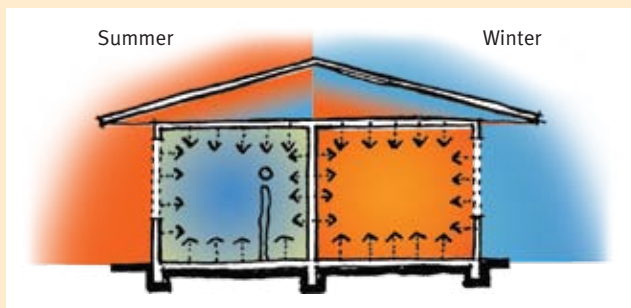
### Construction

Homes in zone 3 are subject to extremes of temperature. To help maintain a more consistent internal temperature, mass building materials such as bricks, concrete and block work are recommended. Heat inside the home will be absorbed by mass materials and at night when the temperature drops the heat will be released into the spaces around it.



### Insulation

Using bulk insulation within the light weight construction, and also in areas of heavy weight construction will protect the home from heat gain in the summer and heat loss in the winter to provide good thermal comfort all year round.





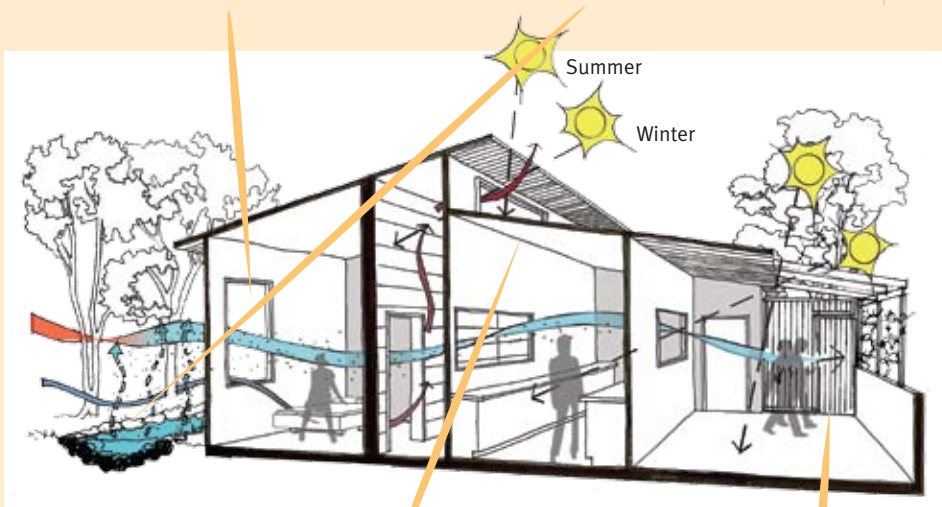
## Example design

1

Carefully aligned windows, doors and internal openings promote cross-ventilation in the direction desired. Operable windows give the occupant the ability to use cross ventilation when conditions are suitable. Even when trying to block breezes have some windows open slightly to maintain healthy amounts of fresh air.

2

Existing vegetation can be maintained and used for sun and wind protection by carefully positioning the new building. Placing a water feature in front of the hot and dry breezes means shade from the trees cools the breezes and the water feature will increase moisture levels in the air.



3

An operable, high level window allows direct sunlight to hit the wall constructed from mass building materials in winter. The wall stores the heat and releases it at night when the home is cool. In summer if the home is still warm at night the occupant can open the window and flush the hot air out before it heats the rest of the home.

4

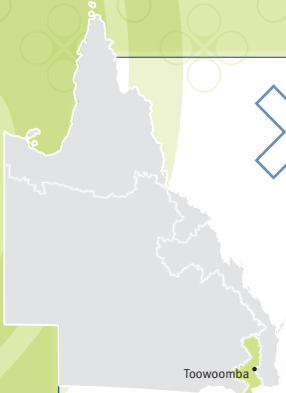
The outdoor area uses additional walls, screening and landscaping to create wind barriers to block unwanted hot and dry winds. This creates an outdoor entertaining space in an environment that often precludes this type of activity.

## Summary

Hot arid climates are dry and have hot days in summer and cold nights in winter that requires thermal mass and evaporative cooling to achieve acceptable levels of comfort. Evaporative cooling replaces humidity in the air and thermal mass works to even out the internal temperatures. Consider appropriate shading including landscaping to improve these results.



Thermal mass wall as demonstrated in Sustainable Home Currumbin (Living Laboratory).

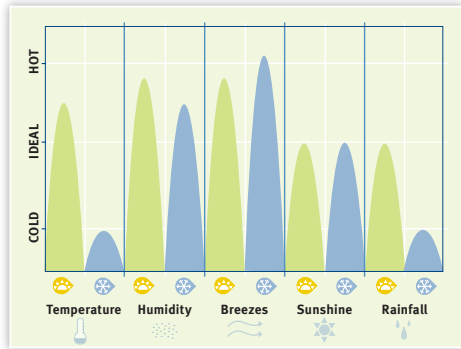


# Zone 5

## Warm temperate




### Climate characteristics

Climate characteristics can be rated on a scale based on achieving an ideal level of human comfort.



Legend: ☀ Summer ❄ Winter

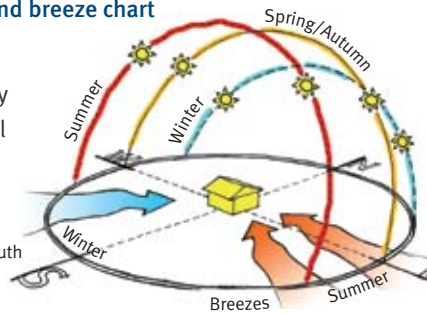
From this chart three elements have been identified as key factors:

-  **Temperature:** ➔ Very cold winters
-  **Humidity:** ➔ High humidity
-  **Breezes:** ➔ Needs protection all year round

### Sun map and breeze chart




To minimise the effects of these climatic conditions it is necessary to understand the sun's seasonal paths and the varying breeze patterns for the year.


















Sun path: latitude 28° south



## Design features

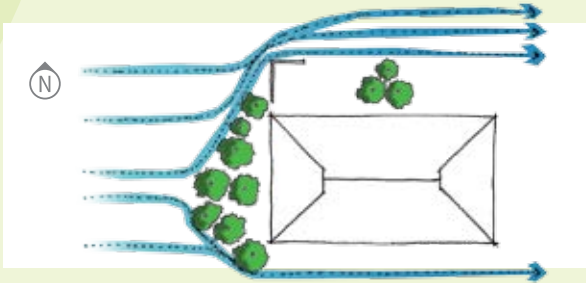
Each zone requires a different combination of building features to achieve best results.

-  For best results in zone 5
-  Effective for all of QLD
-  Unsuitable for zone 5

Building plan	Building shape	 Suited for climate
	Orientation	 For solar gain
		 For breezes
	Ventilation	 Heat release
		 Cross ventilation
		 Evaporative
Solar access	 Vertical shading	
	 Horizontal shading/eaves	
	 Adjustable openings	
Building materials	Construction	 Heavyweight
		 Combination
		 Lightweight
	Colour and texture	 Light or shiny
		 Dark or rough
	Insulation	 Bulk
 Reflective		
 Mass		



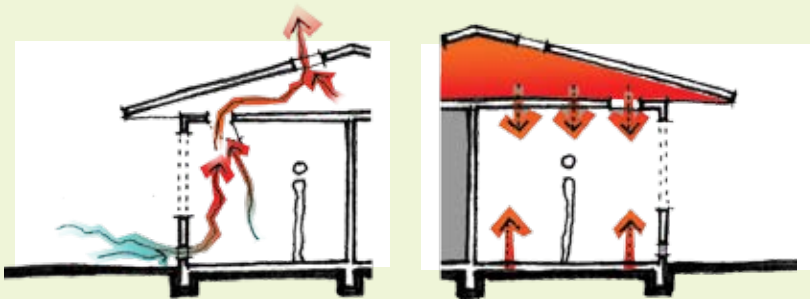
Take advantage of solar access while blocking the colder winter breezes by orientating the longest face to the north and the shortest to the east/west.



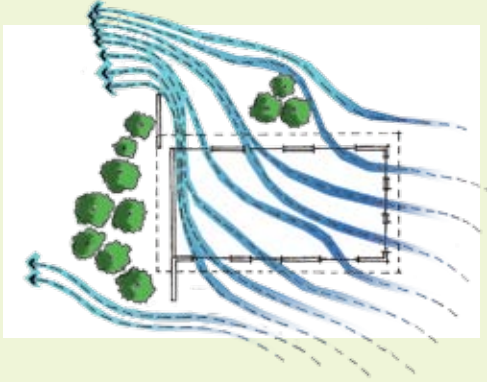
## Ventilation

In this climate zone the best way to achieve suitable indoor temperatures in summer is to avoid heat gain. Roof vents and ceiling openings will help achieve this by releasing heat from the home.

Closing roof vents in winter will increase the transfer of heat into your home by slowing the loss of heat. The heat store will continue to warm the home during the night.



In zone 5 on cool winter days the colder breezes are unwanted and need to be blocked. In summer, cross ventilation will help cool the home. Use the building shape and positioning of openings to capture the summer prevailing breezes.



## Solar access

To prevent heat gain in summer, shade the west facing windows with vertical shading like screens or vegetation. Existing built form or vegetation may already do this.

Making the screen operable or planting deciduous vegetation will permit heat gain in winter.

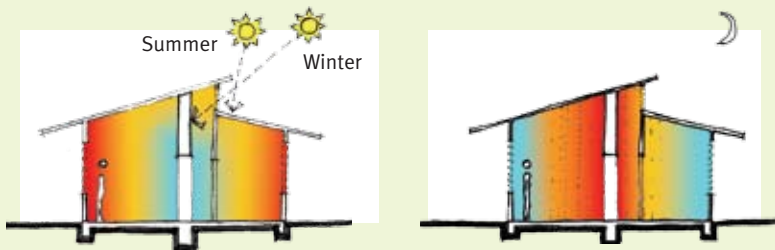


## Building material

### Construction

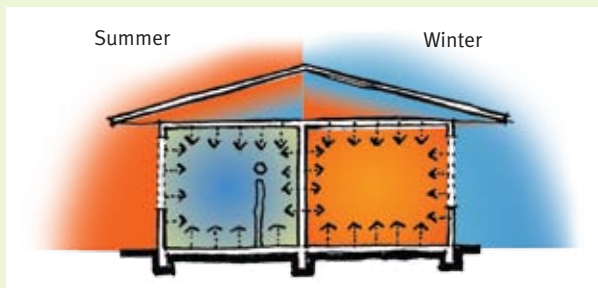
Shield areas built from mass materials from the sun during summer months so the materials absorb the heat from inside the home making it cooler. Expose areas constructed from mass materials to sunlight in winter so they can absorb the heat and then radiate the warmth into the home.

At night, as the house cools, mass elements will release heat absorbed during the day moderating the internal climate. In summer open the windows so that heat can escape. In winter, keep them closed to preserve the heat.



### Insulation

In zone 5 the focus is on protecting internal temperatures from being negatively effected by external conditions. Using bulk reflective insulation will help preserve the internal temperatures in winter and summer.





# Example design

1

The vertical shading to the north is designed with consideration for the seasonal changes in the sun's path. The overhang protects the high level windows and the shade device protects the doors and windows from summer sun. In both cases winter sun is permitted.

2

In zone 5, cross ventilation will only be needed for the hot days. A combination of bi-fold doors and windows were used to allow the occupant to open or close them to suit the daily variations in the environment.



3

A concrete floor is a thermal mass element. It can be used to store heat during the day to warm the home at night.

4

A combination of building form and vegetation was used to block the cold winter breezes. In addition, this room forces the air to go further around and away from the building.

5

These windows face west and are not protected by the overhang because of the low angle of the morning sun. Vertical screening has been used to provide shading to low angle sunlight.

## Summary

Homes in warm temperate climates have warm and humid summers and cold winters with windy conditions most of the year. Good shading that can control heat gain will reduce the reliance on breezes to cool the home. This will mean that the design will prevent unwanted cold breezes entering the home in winter. Thermal mass should be used to help moderate the temperature and insulation is essential to maintain thermal comfort.



Sustainable Home Toowoomba.



## More information

For further information and advice on creating a sustainable home the publication **Smart and Sustainable Homes Design Objectives** covers topics such as:

[Kitchen design](#)

[Outdoor living area design](#)

[Dwelling access](#)

[Bathroom/toilet design](#)

[Plumbing and drainage](#)

Smart and Sustainable Homes Design Objectives is available online.  
For more information visit [www.smarthousing.qld.gov.au](http://www.smarthousing.qld.gov.au)

You can see the principles in action in display homes built under the Smart and Sustainable Homes program, a partnership between state and local governments and building industry partners.

For information visit [www.sustainable-homes.org.au](http://www.sustainable-homes.org.au)

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