DEPARTMENT OF
INFRASTRUCTURE, PLANNING AND LOGISTICS

A GUIDE TO DESIGNING HOMES

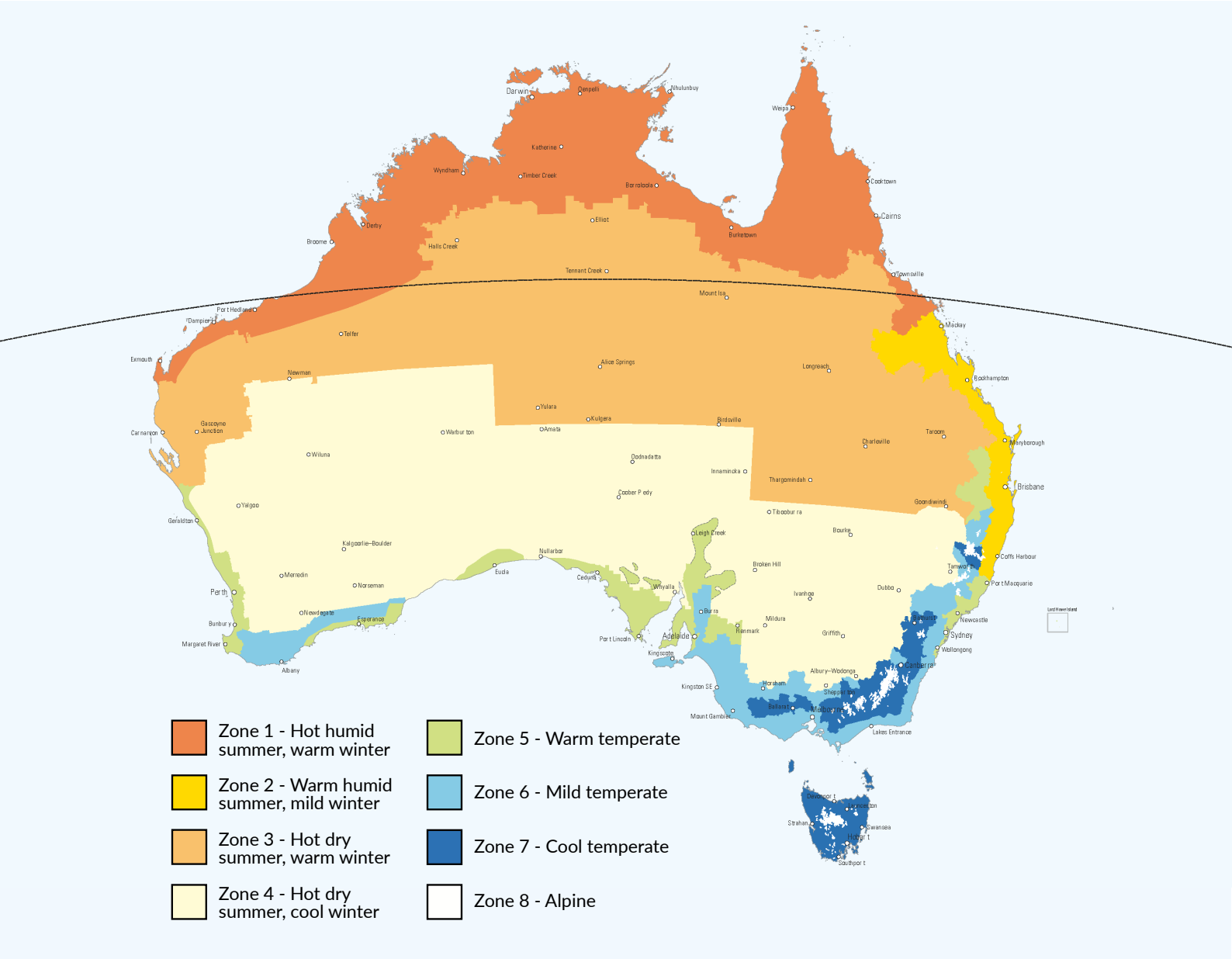
for the Top End climate

NORTHERN TERRITORY GOVERNMENT

Note

In this guide, the region referred to as the Top End is indicated in the map below and known as Zone 1 in the National Construction Code climate zones.

Zone 1 has a hot humid summer and a warm winter.



Australian climate zones, National Construction Code

Source: Australian Building Codes Board - abcb.gov.au

Contents

Designing homes for the Top End climate

Building, buying or renovating a home

Building, buying or renovating a home can be some of the biggest decisions you make. Making sure that you plan and design for the Top End climate will help make your home more sustainable, enjoyable and comfortable.

Designing with features that work in the Top End climate will save money on your energy bills and may increase the value of your home. Adding these features may not cost any more than to build a standard home.

This guide outlines design features that can be used in your new home or renovation. Using the right combination of features will help create a more comfortable home. Work with your architect/designer and builder from the start and even choose your block of land with this in mind.

Design for climate

Designing for the climate is building or modifying a home to best suit the local climate. In the Top End this means a design to keep the heat out and keep your home as cool as possible.

To achieve this, passive building design and energy efficient cooling systems are important. Achieving higher energy efficiency means using less energy for the same results.

Installing more efficient appliances and using them in a way to minimise energy use can also decrease energy consumption. This guide includes a few tips about this but is primarily focussed on home design.

Optimising home design

There are many issues that affect heat flows in Top End homes. Many design responses interact (and sometimes seemingly conflict) with each other.

To find out if you're getting the best possible design, consider asking an accredited home energy rating assessor to model your proposed home design before it is finalised. If you plan to live without air conditioning, seek modelling of its passive solar design performance without air-conditioning in addition to its energy efficiency. Improvement options can be modelled so that you can make informed decisions.

The Top End climate

Understanding the local climate is the first step to designing your home. The Top End has higher average temperatures than other regions in Northern Australia and less variation between the hot humid wet season (November-April) and warm dry season (May-October).

In the dry season this variation increases in locations south of Darwin. The variation in temperature between day and night is also relatively small in the Top End.

In the wet season, the high humidity and temperature can be extreme compared to most other Australian climates. When the dew point is high i.e. there is a high quantity of moisture in the air, it can feel oppressive and muggy making people feel uncomfortable.

This region also experiences higher rainfall totals during the wet season than dry tropical areas.

These hot and humid conditions generally mean a high demand for cooling buildings and it can be hard to keep homes comfortable under these conditions.

Due to a warming climate*, hotter conditions and extreme heat waves will become common during your home's lifetime, so designing for the hot climate is important. You can build a more resilient home by considering what the climate may be in 10, 20 or 50 years' time.

Cyclones are a well-recognised climate risk in the Top End and a changing climate may increase the intensity of cyclones. Structures and building materials must be designed to cope with driving rain, heavy winds and cyclones.

Heatwaves can be a risk to people's health. It is important to minimise heat in a home through good design to keep those living there safe from the extreme heat.

Dew point is the temperature to which air must be cooled in order to produce condensation (dew). It represents how much moisture is in the air: the higher the dew point temperature, the greater the atmospheric moisture content.

Source: Bureau of Meteorology - bom.gov.au

Evaporative heat transfer is heat moving out of your body. It is transferred by air moving across your skin and absorbing moisture/perspiration. By increasing air movement through natural ventilation and permanently fixed fans, you can increase heat transfer to the air, having a cooling effect on your body.

Where the dew point is high, evaporative heat transfer does not occur so well and this is when you feel that the air is muggy and it is harder to get cool.

Thermal comfort - feeling comfortable in your home

People are sensitive to heat and cold, and are comfortable within a narrow range of thermal conditions. The average body temperature is about 37°C and our bodies constantly produce heat, which is lost to the environment. To stay comfortable in a hot climate, we must lose heat at the same rate it is produced.

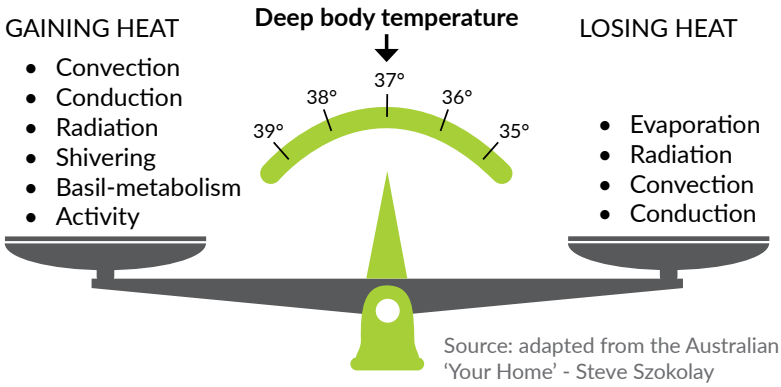
The main factors influencing a person's thermal comfort are:

- temperature
- humidity
- air movement
- exposure to heat sources
- exposure to cool surfaces.

* Climate Change in Australia - climatechangeinaustralia.gov.au

Heat in your home

The different ways that our bodies maintain a comfortable body temperature

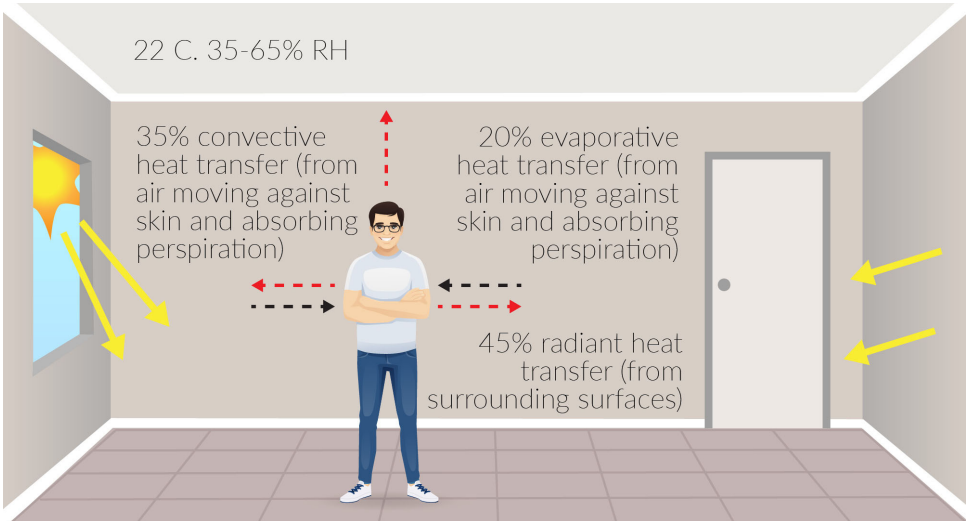


Source: adapted from the Australian Government's 'Your Home' - Steve Szokolay

How heat affects you

The three main ways that heat flows affect how comfortable people feel are radiant, convective and evaporative heat transfer.

Evaporation helps heat flow out of our bodies. Both conductive and convective heat flows into your home contribute to the internal air temperature, which affects convective heat transfer to your body.

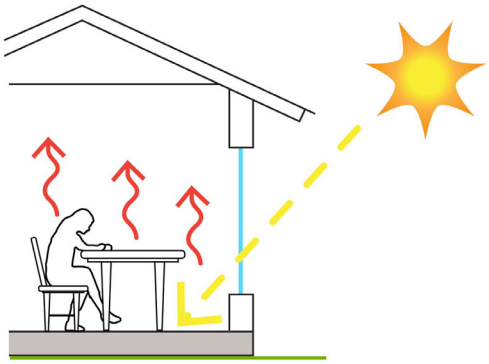


This diagram shows the typical contributions of heat to experiences of comfort in a tropical climate at 22 degrees Celsius and 35-65% Relative Humidity, based on available international research and comfort standards.

How heat flows through your home

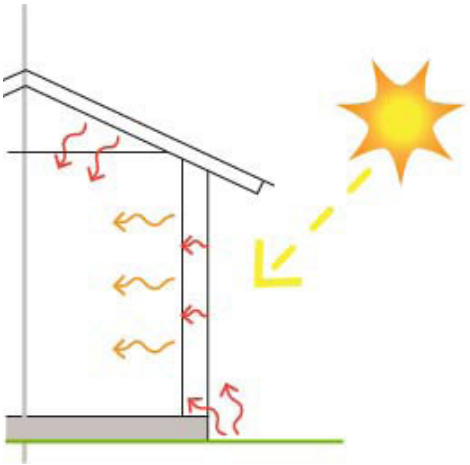
Radiant heat transfer

Radiant heat transfer is heat travelling from a heat source to warm up a surface and then transferring from surrounding surfaces to your body. Sun shining through a window and directly heating up the floor or furniture is an example. Keeping glazing, walls, ceilings and floors cool will minimise radiant heat transfer.



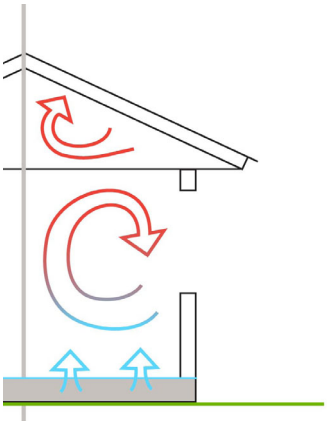
Conductive heat transfer

Conductive heat transfer is heat travelling through solid objects. Heat travelling from the outside of a blockwork wall to the inside of a blockwork wall is an example of this. Using insulation will reduce the heat moving through walls and roofs.



Convective heat transfer

Convective heat transfer is heat being carried by liquids and gases. In homes it is how the air moves around and the temperature of that air. Keeping heat out by using materials with good insulation properties and keeping indoor air as cool as possible minimises this type of heat transfer.



Design concepts

You can design your home for comfort and energy efficiency by:

- minimising the heat that transfers in through your building envelope (this can also minimise the cool air that is lost out of your home)
- keeping internal surfaces cool
- maximising air movement
- being able to be seal your home where air conditioning is used.

This will improve your comfort levels and lower your energy bills and greenhouse gas emissions.

Building envelope relates to the design and construction of the exterior of the home.

Homes designed for the climate can also be designed for energy efficiency. The Nationwide House Energy Rating Scheme (NatHERS) measures a home's energy efficiency to give it a star rating. The higher the star rating, the less energy that is needed to keep it comfortable.

A NatHERS Accredited Assessor* can conduct a house energy rating. Ask your architect or designer to engage with an assessor.

Passive design for a more comfortable home

Passive design can keep your home naturally cooler, improving your comfort and reducing the need for air conditioning. The aim is to maximise the amount of time that a home is comfortable without needing air conditioning.

Building a new home is the best time to incorporate passive design features. It is possible to add features through renovations and home improvements if your home has already been built.

Making sure that your designer or architect knows and designs your home with the local sun position, wind direction and temperature in mind will have a positive impact on the comfort of your home. Passive design includes choosing the best orientation for the building, shading, building shape, room placement, ventilation and materials. These are explored further in this guide.

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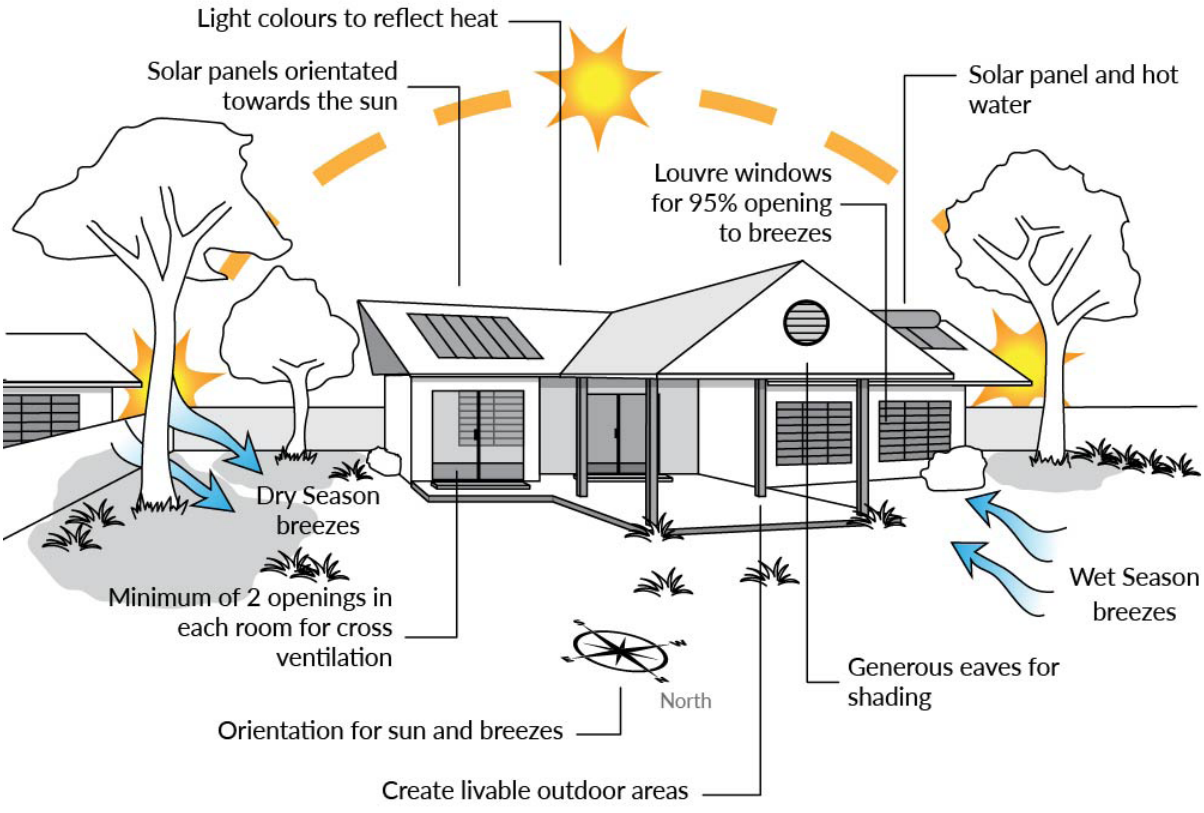
* Nationwide House Energy Rating Scheme (NatHERS) - nathers.gov.au

Design for cooling

Choosing your block size and building shape, as well as not over-sizing your home, will allow you to maximise on building orientation and breezes coming through our home and minimising impacts of the sun.

Ensure the placement of your home on your block maximises opportunities for breezes to flow. Building close to surrounding buildings can prohibit airflow.



Choosing an elevated or ground level home

When building, an early decision to make is the type of home you want. Since the early days of development in Darwin, before air conditioning, many homes were built as elevated structures, which have many advantages to keeping occupants as comfortable as possible. Over time and particularly after Cyclone Tracy, ground level houses have become popular.

Elevated or ground level homes can be built as naturally ventilated, air conditioned or a combination of both and have advantages and disadvantages. Consider which style of home will suit your lifestyle and cooling needs.

Elevated homes

Advantages

- Usually built of lightweight materials that cool down quickly at night making it more comfortable to sleep without air conditioning.
- Catch the breeze more easily than a ground level home.
- The under home area can provide an entertainment space, shaded living, car parking, children's play area or shelter from the wet season rains to dry washing. Maximising liveable space is increasingly important, especially on small blocks.
- Can also be designed for air conditioning if this is needed during the daytime by adequately sealing openings and adding insulation to prevent heat gain through the ceiling, floor and walls.

Disadvantages

- Can be hotter during the day as the lightweight materials heat up quickly (see later in this guide). This may not be an issue for people who aren't home during the day.
- Can heat up through the floor during the day especially if heat is reflected from a concrete or paved area under the home to the underside of the floor. Shading to keep the sun off this area will help and insulation can be installed to prevent heat gain through the ceiling, walls and floors.

Ground level homes

Advantages

- Can be built with lightweight materials that cool down quickly at night, similar to elevated homes.
- Can also be built with heavyweight, high thermal mass materials. If these are managed with good shading or insulation (see later in this guide), the amount that walls heat up during the day can be managed so that rooms are cooler than the outside conditions during the day and don't emit too much stored heat at night.
- Homes built on a concrete slab can stay cooler due to the thermal mass of the slab. The floor is the coolest part of the house during the day and potentially also at night. The temperature of the floor will only change slowly and remain equivalent to ground temperature.
- Shading with a specifically positioned garage and vegetation can be easier than elevated homes.

Disadvantages

- Lack the height to help capture breezes effectively.
- Reduce the undercover outdoor area that can be taken advantage of.
- Prone to slower breezes due to other buildings around them.

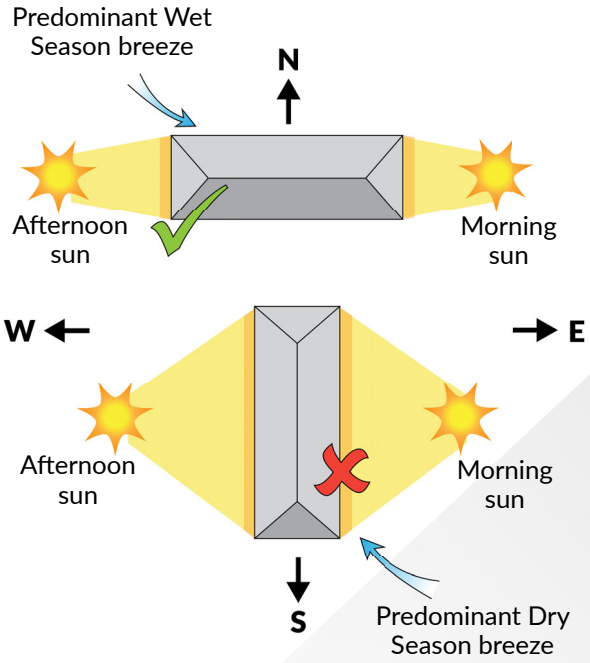
Orientation

Orientating, or positioning a home to minimise the impact of heat from the sun, should be the one of the first priorities in the design process.

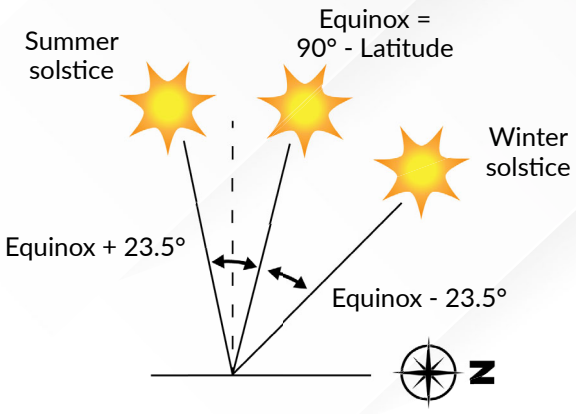
Choosing a block that can accommodate the ideal orientation and layout will improve your comfort and energy usage.

In the Top End it is best to orient a house with the long axis from east to west. Having long walls facing north and south means eaves can shade these walls and windows as much as possible.

Minimising wall areas facing east and west and avoiding windows on these sides will reduce the impact of the low morning and afternoon sun. A well designed floor plan can still capture a range of breezes with the ideal solar orientation.



The sun angles for areas north of the Tropic of Capricorn at midday are illustrated below.



Source: Energy Smart Housing Manual (2018)

If you are unable to build your home with the ideal orientation it is still possible to take advantage of other design features detailed in this guide for a climate sensitive home.

External wall areas

With hot outside conditions in the Top End causing heat conduction through external walls, rooms in the largest external wall area are the hottest in the house. Particularly when those walls are unshaded or uninsulated.

Designing for your preferred method of cooling

In hot humid climates people tend to be sensitive to air movement as this takes away perspiration allowing evaporation to cool your body.

Natural breezes, fans and air conditioning can all make a difference to how cool you feel in your home and these can be used separately or in combination.

Good building envelope design and the use of permanently fixed fans, even in air conditioned spaces will keep you cooler in your home.

Permanently fixed fans

As fans cool people, not rooms they are best used when people are present. Whilst fans use much less energy than air conditioners, energy use can add up if used unnecessarily.

Ceiling fans have the best air flow effect. Consider placing them over areas where you will spend significant time. Large internal areas will require several fans to have the best cooling effect.

Fans with a large blade length are better. Where possible use at least a 1400mm diameter fan and select the brand carefully to get maximum airflow and quieter operation.

Wall fans can be used in areas where there is no space for ceiling fans.

Natural ventilation, maximising breezes and air movement

Capturing breezes for air movement will make you feel more comfortable in your home.

Ensure the placement of your home on your block maximises opportunities for breezes to flow, as building close to surrounding buildings can block breezes.

An open plan layout without internal walls and halls is good for air movement where air conditioning is not used. Design your home to maximise natural ventilation using short and direct cross ventilation with openings like doors and windows in opposite walls and internal partitions.

If your home has closable rooms, aligning

internal doors with external openings will make the most of cross ventilation by leaving internal doors open. A narrow or pavilion style home can be the best way to capture breezes by maximising spaces for doors and windows to open internal areas to the outside.

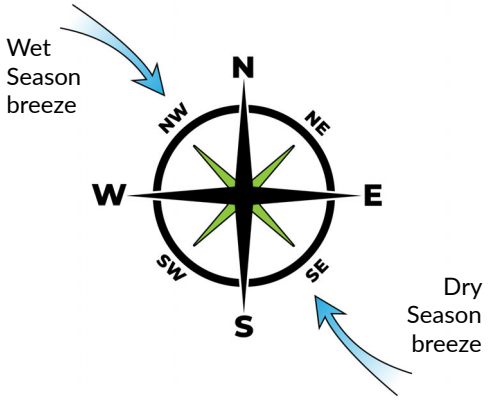
If openings on different walls are not possible, then more than one opening in the same wall will set up pressure differences that will encourage air circulation. If two openings are not possible then reasonably sized 95% openable single windows in rooms also help.

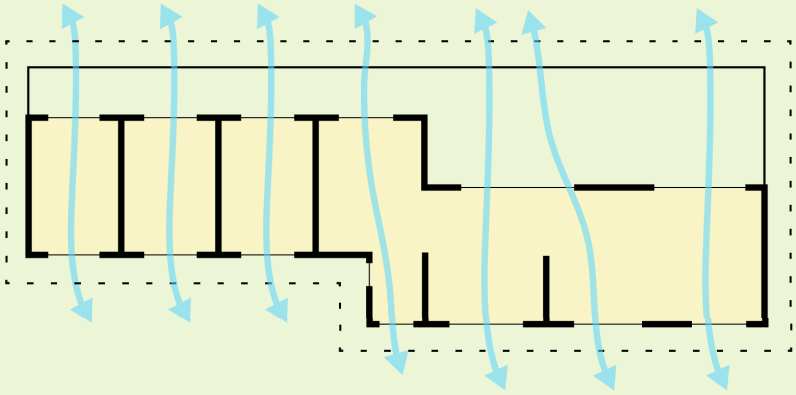
Top End breezes come from the north-west in the wet season and the south-east during the dry season.

A long narrow floor plan orientated to catch these breezes is best for natural ventilation and allows enough room for breezes to enter windows and doors. Courtyard spaces and breezeways can also be used to direct airflow.

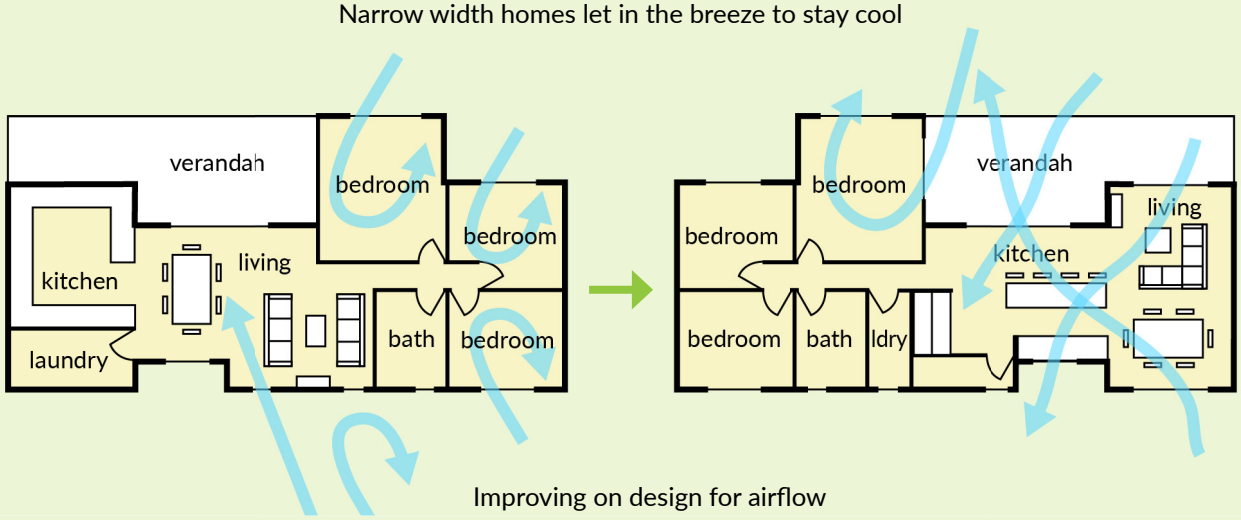
Incorporating wing walls into your design can also help to capture airflow.

A wing wall is a solid panel alongside windows that redirects air into a home.





Narrow width homes let in the breeze to stay cool



Improving on design for airflow

Dirty flyscreens block breezes so it's best to clean them regularly. Design verandas, boundary fences and pool fences to allow breezes to get to your home.

Floor plans should be oriented with the long axis aligned east west as much as possible (as described in the orientation section) and design features, such as wing walls, used to help capture breezes.

Coastal areas can experience a sea breeze in the afternoons as the land surface temperature stays higher causing localised high pressure areas which suck the air from off the sea which is cooler.

Air conditioning

Air conditioning lowers both air temperature and humidity.

If you intend to air condition your home or certain rooms then there are design features that will improve the efficiency of the air conditioning and minimise your energy bills.

The better your home seals the less cool air will be lost and your home or rooms should be well insulated to keep the cool in.

When designing for air conditioning, a square floor plan minimises external wall area and reduces cooling energy loss through walls. The smaller the area each air conditioner has to cool, the lower your energy usage will be.

Consider installing doors to internal hallways to effectively zone areas within the building.

Using exposed heavy construction materials (e.g. concrete and bricks) inside the insulation barrier of the external walls can store cooling energy when using air conditioning.

The more glass windows and doors, the harder air conditioners will need to work. Up to 87% of a home's heat can be gained through windows. Using heavy snug-fitting window furnishings and pelmets can reduce cooling energy loss from radiation and air flow against glass.

Carefully design where you locate the external unit of your air conditioner to ensure it is well ventilated and the hot air it produces can be dispersed away from the home and any outside living areas. A shaded area to protect it from the sun will help keep the unit cool.

Identify the months and times of day when you use air conditioning and use control systems, sensors and timers to reduce total operating hours to reduce energy usage.

Source: YourHome - yourhome.gov.au

Bathrooms can fill with warm, moist air especially in air conditioned homes where the windows are kept shut. Exhaust fans ducted to the outside of the building will remove the damp, warm air reducing the potential for mould growth in these rooms.

A split system air conditioner, for each room that is to be conditioned, is more efficient than a whole-of-house ducted system – as then only the rooms in use at any one time are cooled.

Ensure your air conditioners are sized appropriately and choose models with the highest energy star cooling ratings for a hot climate, noting that energy star ratings provided for other climates are not applicable in the Top End region.

You can improve thermal comfort and save on energy bills by installing and running fans at the same time as air conditioning.

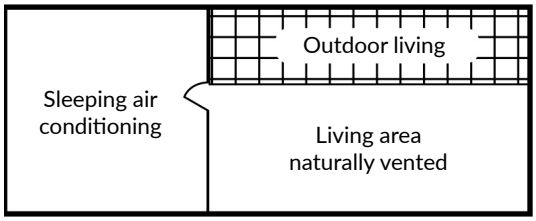
Many people find that setting air conditioning to 27-28°C is comfortable with fans on at the same time. Increasing the air conditioning temperature as high as you can will decrease your energy bills and reduce risks of condensation and mould forming.

Combining natural ventilation and air conditioning in your home

Many homes in the Top End have spaces that can be air conditioned or naturally ventilated. Whilst people make choices to best suit their lifestyle, bedrooms are more frequently air conditioned in the build-up and wet season, and living areas are more likely to be naturally ventilated all year.

The design of each area should find a balance between the principles and design features for air conditioning and natural ventilation.

Ideally this type of home would have zones with walls separating naturally ventilated and frequently air conditioned spaces that are insulated and have doors to limit the loss of cooled air.



Running air conditioning in a closed room for an hour at bedtime often lowers humidity levels to the point where air movement from a fan can provide sufficient evaporative cooling for sleeping comfort.

Source: YourHome - yourhome.gov.au

Choosing building materials

Different types of building materials perform differently throughout the day. This is important to think about when you are designing your home. For most people living in the Top End, feeling comfortable at night and when they sleep is important.

Lightweight structures

Light structures used in the Top End are generally steel frames with cement sheeting or metal wall cladding.

Lightweight wall materials do not store heat like concrete blocks and so lightweight houses tend to cool down quickly as the outdoor temperature drops at the end of each day. Insulating and shading lightweight structures

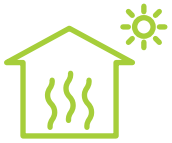
will help keep inside conditions cooler during the day and increase energy efficiency, if air conditioning is being used.

Thermal breaks (an insulation layer) need to be installed between cladding and steel frames to reduce thermal bridging (heat bypassing insulation batts and travelling inside along steel framing).

Heavyweight structures

Heavyweight materials with a high thermal mass such as besser blocks, concrete and brick store heat if exposed to the sun.

Heavyweight roofing materials, such as concrete tiles, will store the energy from the sun and release it after the sun goes down.

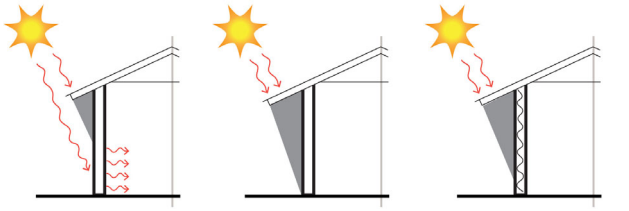


Thermal mass is the ability of a material to absorb, store and release heat. Concrete, bricks and tiles are considered to have a high thermal mass. Thermal mass should be combined with other passive design principles such as shading, orientation, and insulation to be effective.

Source: YourHome - yourhome.gov.au

Unshaded or uninsulated heavyweight walls heat up during the day and radiate the stored heat into the house at night. This affects comfort in bedrooms if walls are exposed to the afternoon sun. However, well shaded and/or insulated heavyweight building material can keep indoor spaces cooler than outdoors during the middle of the day, work well for daytime living areas and do not release stored heat at night.

It is important to insulate and/or shade walls with eaves, verandas or vegetation to minimise the heat build-up in the wall materials during the day and so reducing the heat that transfers into your home overnight.



Blockwork - inadequate shading

Well-shaded blockwork

Steel frame light material, with insulation

Insulation

Insulation in the walls and roof of your home can improve comfort significantly by keeping the cool in and the heat out. The amount of heat that transfers into your home can be greatly reduced by insulation.

The most cost effective time to insulate your home is at the building stage. Make sure you consider insulation when designing your home.

Insulation is a material that reduces the flow of heat and is measured in R-value. All material, not just insulation has an R-value. It is a measure of its effectiveness to resist heat flow or transfer. The higher the R-value the more effective it is. The two main types of insulation are reflective and bulk insulation.

Reflective insulation prevents radiant heat from entering the space by reflecting the heat away from a surface. Reflective foil insulation on its own has a zero R-value, but increases the R-value of a structure by creating a reflective air gap. A minimum 25mm air gap between the reflective insulation and another surface is important - a 45mm gap is ideal.

Using products with higher R-values will make a big difference to the comfort of your home and the cost may not be that different from products with lower R-values.

Roof insulation

With the roof of a home being the largest surface exposed to the sun, choosing the right materials and insulation will make a big difference to keeping your home comfortable.

In the Top End where there is high humidity in summer and a warm winter, reflective insulation, sarking or foil batts beneath the roof increases the resistance to radiant heat. Reflective insulation is often laid immediately under roof sheeting to protect from water entering the roof space.

Bulk insulation has been added to many designs - either as a blanket under roof sheeting or on top of ceilings. In hot climates, reflective insulation should be used on the outside, or the warm side of the bulk insulation. If a roof blanket is used, the foil is laid between the roof sheets and the roof blanket.

Bulk ceiling insulation can be very effective for a well-designed home. Where air conditioning might be used often, ceiling insulation reduces the radiant heat entering the living spaces and working against the air conditioning. It is also very effective at keeping rooms cool and reducing aircoditioning energy use by decreasing the amount of heat transfer from the roof space into rooms.

A combination of under-roof and ceiling insulation is ideal and will reduce the heat build-up in a sealed roof space.

Historically under-roof foil has been combined with eave and ridge openings or roof ventilators to draw heat out of the roof space. Roof ventilation draws ambient air into the roof to replace the hotter air.

This type of ventilation introduces moisture in the wet season, especially early morning and overnight humid air and even wind driven rain. This moisture stimulates mould and fungus growth in the roof enclosure. When used in conjunction with air conditioning, the cool surface of the ceiling can also become prone to condensation, causing damage to the ceiling plasterboard.

Most homes nowadays use some air conditioning and as the climate heats up, air conditioning is likely to be used more often in Top End homes. Sealed (unventilated) roof spaces reduce the risk of condensation build up, mould growth and potential damage to ceiling plasterboard. So where air conditioning is used, roof vents are not recommended.

Wall insulation

As part of good design, walls that are exposed to the sun, particularly the east and west walls, should be insulated to reduce heat gain.

If you use blockwork, insulation can be external or internal using a frame attached to the wall providing a space for the insulation or insulation board. Cladding can be used to protect the insulation. Insulation on the outside works well, preventing the blockwork from heating up.

If you use steel framed walls you could ideally use:

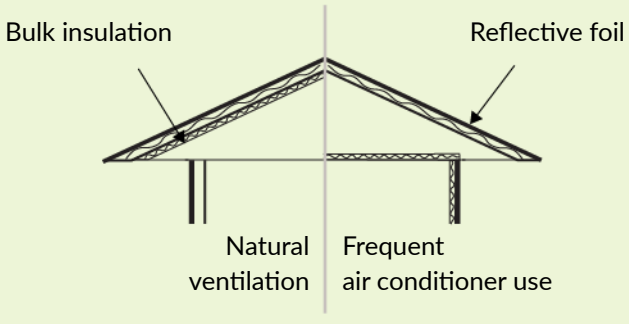
- a reflective insulation vapour and water barrier installed on the outside of the frame (or incorporated within)
- thermal breaks to reduce heat flowing through the steel framing into the house
- insulation batts fitted between the steel framing members.

Steel framing comes in 70mm, 90mm or 150mm widths. The wider the framing, the greater the R-value of the insulation batts that the frame can hold.

However, trying to fit wider bats into thinner frames can reduce their effectiveness. Work with your builder to ensure the right insulation size is used.

Installing roof and ceiling insulation can save up to 45% on heating and cooling costs, while insulating walls can typically save around 15%.

Source: Australian Government 2020



Consider the location of reflective and bulk insulation for natural or artificially cooled homes.

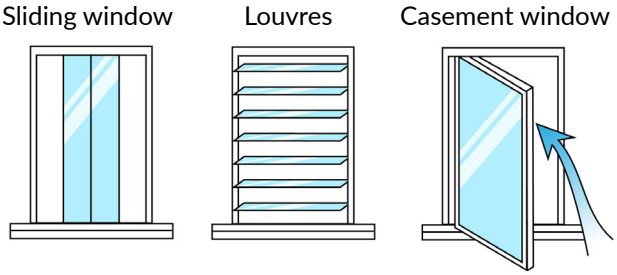
Maximise breezes

Windows and doors

The size, type, external shading and positions of any openings are important for passive home cooling.

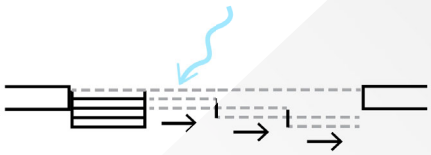
Achieving good air flow through a home allows hot air to be flushed out (such as in the evenings) and improves the evaporative cooling of occupants.

In the Top End, windows that fully open work best for natural ventilation as they offer the most air flow benefit.

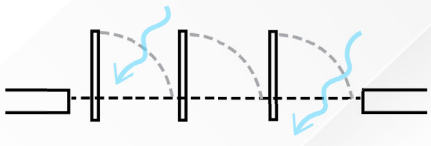


Bi-fold or stacker sliding doors can also maximise breezes and link internal living areas with the outdoor spaces.

If you are intending to use airconditioning, choose windows that close and seal well to help keep cool air inside. Modern louvres seal far better than old louvres.



Example of stacking doors



Example of pivoting doors. These can also be used to direct breezes inside.

Example of folding doors

If you plan to use air conditioning some of the time, then it is best to use medium sized windows and position them for cross ventilation. They will still help naturally ventilate your home when the air conditioner is not used.

As the best orientation for wall and window shading is for the building's long axis to run east-west, wing walls can be added to help direct the breeze through windows. These can also have the benefit of providing some shading.

Glass conducts more heat per square metre than walls and allows radiant heat into your home. Adding shading structures, such as eaves or fixed overhangs to all windows is the best option for reducing radiant heat. It can also shelter them from tropical downpours so you can enjoy the cooling effect of the rain as well as shading when it is sunny.

Even when shaded, glass and openings allow indirect solar radiation to pass through, which can warm your home. Designing window placement, using high performance glass, tinting the glass or switching to opaque window materials (e.g. metal or wooden louvres) where openings cannot be shaded will reduce the heat that radiates into your home.

Where possible ask your builder to use glazing with a low U-value (the measure of how much heat is conducted through a window), a low solar heat gain coefficient and thermally broken window frames to avoid heat gain and cooling loss.

Choosing windows* with good thermal performance such as double glazing, reduces heat gain.

Double glazed windows containing an air gap filled with argon gas reduces internal condensation forming within the glazing and provides additional insulation compared to double glazed windows filled with air.

Tinted glass can also help reduce glare and heat transfer as less heat passes though tinted glass. There are a number of products on the market including reflectivity films that can be applied to the glass surface.

* Australian Glass and Window Association - awa.associationonline.com.au

Outdoor spaces

Outdoor spaces

Outdoor rooms or living areas are popular in the Top End and these can be designed carefully to reduce the impact of the hot climate.

Shading of outdoor spaces can make the space more usable, providing protection from the sun and rain. This can be achieved by verandas, screens, sails, awnings and vegetation.

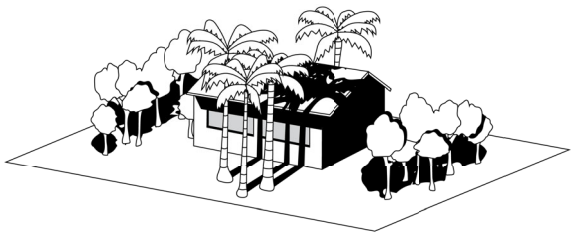
Air flowing past natural plants can harness the natural cooling effect of plant transpiration maintaining a cooler temperature close to the surface of the ground and feeding the plants surrounding it.

You can keep the outdoor space cooler by insulating the roof and keeping the space open on 2-3 sides to provide breeze paths. Installing fans directed to sitting areas will also make a big difference to your comfort.

Large windows and doors opening onto the outdoor room can increase the connection between indoor and outdoor spaces. For example, bi-fold doors can provide large functional indoor/outdoor spaces.

Shading, landscaping and window rain protection

In the Top End it is ideal to minimise direct sun on all sides of your home while capturing and funnelling breezes when not using air conditioning. Well designed window sun hoods also allow windows to be open when it rains.



Shading keeps your home cool by reducing:

- radiant heat transferring through your windows
- the air temperature immediately outside your home and therefore the amount of heat conducted through your home's building envelope
- the temperature of the air that flows through your home.

Generous eaves (minimum 900mm), verandas and shading devices such as shade sails and screens can be used to shade windows and any uninsulated walls to reduce the impact of heat on your home. North facing verandas are good for shading northern walls and windows from the low angle of the dry season sun. Shading or placing garages and carports for ground level homes on the eastern and western walls reduces the impact of low morning and afternoon sun striking those walls.

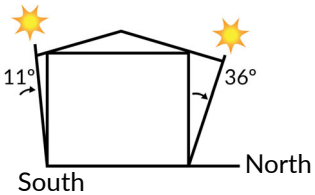
Trees and other vegetation are also very effective as they provide shade and set up a micro-climate that precools air before it enters your home.

Using water features and ponds may also help to set up a cooling microclimate that pre-cools air before it enters the house.

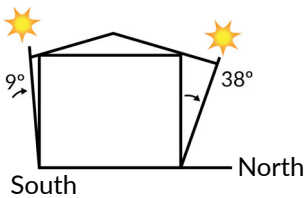
Carefully consider the species and placement of trees as some species are more prone to developing problematic root systems that could negatively impact the structure and services of a home.

Choose plants that don't block breeze paths through windows (i.e. light folage at window height). Also consider that shading from plants blocks natural light. However, keep in mind that more energy is used airconditioning hot rooms than it takes to operate lights.

Examples of appropriate minimum eave angles:



Darwin eave angles



Katherine eave angles

It is best to avoid using concrete or paved ground surfaces near your home or outdoor living spaces because these surfaces can radiate significant amounts of heat and the localised air temperature can increase significantly.

If you cannot avoid these surfaces then it is important to use light colours and shading to reduce the heat build-up in the thermal mass. It is best to avoid unshaded driveways in front of prevailing breezes so air passing over the surface doesn't heat up before it reaches your home.

Colour choice

Light coloured roofs and walls reflect the radiant heat and reduce heat build-up. Using light colours in combination with insulation can make a significant difference to the comfort of your home. Reflective paint can also help reduce the heat radiating into your home.

The colour of concrete makes a difference to heat absorption. Using a light coloured concrete for driveways and other areas will help reduce radiant heat around your home.

Lighting

You may choose to design your home to take advantage of natural light as much as possible. Installing energy efficient lighting, such as compact fluorescent lamp (CFL) and light emitting diode (LED) can help reduce your energy bills when you need to use artificial light.

Note that 'low voltage' does not mean 'low energy'. Halogen lights use more energy (and emit more heat into rooms) that LEDs and fluorescents.

Star ratings and comfort ratings

In the Northern Territory all new homes need to achieve minimum energy efficiency requirements as part of the building approvals process. There are three ways that the design can be assessed:

- using deemed to satisfy requirements
- verification using a reference building
- using an approved energy rating tool and achieving the required minimum star rating for the NT.

A higher star rating means a more energy efficient home and gives an indication of future performance and comfort levels.

The more energy efficient your home is the less energy that you will use and may even increase the future value of your home.

Accredited house energy rating assessors are available through the NatHERS website nathers.gov.au

A Darwin Living Lab project has developed comfort ratings for living rooms and bedrooms. Comfort ratings relate to how well living areas and bedrooms are designed for comfort without airconditioning. You can ask if comfort ratings can be provided for deisng options by the energy rating assessor.

Resources to help you to choose features that improve the sustainability and energy efficiency of your home are listed at the end of this guide.

Planning for future energy use

It is important to consider how your home's energy use may change in future and plan accordingly when designing a new home.

Electrical panel considerations

If you are considering installing additional fixed appliances, solar photovoltaics (PV) or a battery in future, ensure that your new home has an electrical panel (switchboard) with space for additional circuits and sufficient capacity to handle an increasing electrical load.

Solar power and home batteries

Choosing to install solar power generating rooftop PV can reduce or eliminate greenhouse gas emissions from your home electricity use and help you save money on ongoing energy costs into the future. If more solar energy is generated than you use, your home could export excess solar power to the grid and further help reduce the Northern Territory's greenhouse gas emissions.

Solar PV works by capturing energy from the sun and converting it into electricity. It is important that PV panels are installed on your roof in a position that maximises their exposure to sunlight (either north, west or east facing). In addition to solar PV panels, an inverter will also need to be installed that converts the solar electricity into a form that can be used throughout your home or exported to the electricity grid.

A household battery storage system allows you to store electricity generated by solar panels during the day for later use, reducing your reliance on power from the electricity grid. To minimise your use of power from the grid, consider running fixed appliances such as pool pumps during daylight hours so that their energy use is sourced from your rooftop solar system.

The quality of solar PV panels and batteries can vary widely so it is important to research products and installers and consider reviews from past customers. Low cost solar PV may not last as long or generate as much power as higher quality solar PV systems which may be more expensive.

Electric vehicle (EV) charging

EVs are becoming increasingly widespread. Even if you are not currently driving an EV, you may wish to consider including a charging outlet for an EV in your new home design, ready for using an EV in future.

Most EVs can be charged with conventional electric power outlets. Specialised charging units can also be installed that enable faster charging. It is important to seek advice from an electrician about preparing your home to be EV ready. An electrician can advise on the potential to include a charging outlet for an EV within your garage, carport or an outdoor location that could be accessed by a vehicle for charging purposes.

Pool pumps

If you are installing a pool or spa, a pool pump will comprise a major source of energy use within your home. The larger the pump, the greater the energy use, upfront costs and ongoing running costs.

Choose the smallest pump, with the highest possible energy star rating, that can be used by your pool or spa to meet the needs of your filtration system and circulate water effectively.

It's a good idea to seek professional advice on the upfront and running costs of water treatment options (e.g. salt verses chlorine) and which pool pump will be the most energy efficient. For example, if a multi or variable speed pump would save energy compared to a single speed pump.

Other considerations include:

- keeping filters clean and clear of debris that can otherwise stop pumps from working effectively
- use the time switch to run the pump for the shortest possible period each the day. Experiment to find the lowest acceptable running time to keep your pool water sufficiently filtered for safe use. One complete turnover of water every 24 hours will provide adequate filtering for the average residential pool.
- whether you can access an off-peak tariff, and want to run the pump after 6pm, or run it in the middle of the day to use power from your rooftop solar PV panels.

Energy efficient appliances

Fixed appliances within your home will have a major impact on a home's ongoing energy use. Choosing to install energy efficient appliances can save you energy, money and carbon emissions over the life of each appliance. All appliances must contain an energy star label detailing their relative energy efficiency. Compare the star rating for different makes and models of the same appliance to help make a decision which product is best for your needs.

Preventing mould on internal surfaces

The high humidity in the Top End build-up and wet season can result in mould growth in homes. Mould needs moisture, food (dirt) and shade to grow in our hot conditions.

There are some specific choices you can make to avoid mould growth, even without running fans continuously such as:

- avoiding porous surfaces
- using quality paints
- ensuring good ventilation (leave windows open a little when you go away if security mesh or bars are in place)
- use insulation/high R-value materials between regularly air conditioned and unconditioned areas. This prevents surface temperatures on the non-air conditioned side from dropping below the dew point of the air conditioned air and mould-attracting condensation forming
- avoid setting low temperatures for air conditioning during humid periods
- keeping surfaces such as walls clear from dust.

Running air conditioners at very low temperatures can result in moisture from the humid air condensing on cold walls in adjacent unconditioned rooms and in the roof space above a room creating condensation and mould issues.

Resources

Energy efficiency and sustainable homes

Nationwide House Energy Rating Scheme (NatHERS), Accredited house energy rating assessors, NatHERS, website: nathers.gov.au
(accessed 28/4/2022)

Australian Government, Your Home, Insulation, website: yourhome.gov.au
(accessed 28/4/2022)

Beagley, 2011, Greenhouse Friendly Design for the Tropics – Cool Mob, coolmob.org
(accessed 28/04/22)

Climate Council, 2022, Tents To Castles: Building Energy Efficient, Cost-Saving Aussie Homes, website: climatecouncil.org.au
(accessed 28/04/22)

Climateworks ASBEC, 2018, Built to perform in Northern Australia, website: asbec.asn.au

Northern Territory Government, Building and energy efficiency, website: nt.gov.au
(accessed 28/04/22)

Establishing a Resilient Urban forest for Darwin – Preferred trees for Darwin, City of Darwin Council, website: darwin.nt.gov.au
(accessed 28/04/22)

Window Energy Rating Scheme - Australian Glass and Window Association, website: awa.associationonline.com.au
(accessed 28/04/22)

Appliance energy ratings
www.energyrating.gov.au

Climate change

Australian Government, Climate Change in Australia, website: climatechangeinaustralia.gov.au
(accessed 28/04/22)

NT planning requirements

Northern Territory Government, NT Planning Scheme 2020 (refer to Part 4 and Part 5 for specific requirements for homes - residential dwellings), website: nt.gov.au
(accessed 28/04/22)

Northern Territory Government, Community Safety Design Guide

Northern Territory Government, Northern Territory Land Suitability Guidelines

Checklist for cool homes

Use this checklist to help guide you in designing, building or renovating your home.

Orientation, shape and shading

- Understand how the sun and breezes move across your block.
- Long axis of house running east to west will minimise wall area exposed to the sun.
- Generous eaves (minimum 900mm) to shade walls and windows.
- Use sun path modelling to check that windows and uninsulated walls are shaded.
- Verandas to the north side preferably or otherwise south side.
- Use verandas, shading devices and vegetation to shade walls and windows, particularly on eastern and western walls.
- Use toned or thermally high performance glazing in window openings exposed to sun.
- Design your garden to shade your home but allow breezes in.

Building materials

- Lightweight materials cool down quickly at night.
- If using concrete blockwork walls, shaded and/or insulation can help keep them cool.
- Use light colours for the walls and roof to reflect heat.

Insulation

- Reflective foil and bulk insulation, such as a blanket under the roof and/or batts on ceilings will keep your roof cool.
- For lightweight walls have foil for vapour and water proofing, thermal breaks and insulation batts to keep your home cool.

Outdoor spaces

- Design connected, well ventilated and weatherproof outdoor spaces.
- Insulate the roof over outdoor spaces and install fans.
- Courtyard spaces and breezeways help to direct breezes into homes.

Ventilation and air movement

- Good ventilation promoted through cross ventilation – minimal hallways, open plan design and two openings per room where possible.
- Maximise openable area of doors and windows to assist natural airflow, place windows to capture breezes.
- Install fans to improve air movement.

Air conditioned areas

- Separate the natural ventilated areas and air conditioned areas with walls and doors.
- Walls between the areas should be insulated to keep the cool air in.
- Use medium sized windows and place for cross ventilation to reduce the amount of time air conditioning is felt to be needed.
- Ensure building seals well – select well sealing windows and weather seal gaps around windows, air conditioners and doors.
- Shade walls and choose the highest R-value possible.
- Insulate roof well including ceiling insulation of at least R2.5.
- Don’t design bigger air conditioned areas than needed.
- Minimise external wall area (reducing heat gain).

A guide to designing homes for the Top End climate

Department of
INFRASTRUCTURE, PLANNING AND LOGISTICS

NORTHERN TERRITORY GOVERNMENT