



PASSIVE SOLAR DESIGN PRINCIPLES FOR ENERGY EFFICIENT HOMES

Commissioned by Catalina Regional Council, the Catalina Sustainable Home received the maximum 10-star NatHERS energy rating and goes beyond carbon neutrality, achieving a 105% carbon negative score with eTool. In addition, the home incorporates low-allergen design and meets Livable Housing Australia (LHA) guidelines, making it the perfect space for multi-generational living.

Designed for Perth's climate

This passive solar design demonstrates how easily homeowners can enjoy lower energy costs and a comfortable home environment throughout the year. By working with Perth's climate, not against it, the home maintains a constant temperature from summer to winter, with little to no mechanical heating and cooling required.

Thermal mass, crossflow ventilation, material selection and orientation are some of the key principles applied in the design and construction of Catalina Sustainable Home to achieve its 10-star energy rating.

Reducing energy use through design

Heating and cooling consume the largest amount of energy in the average Australian home, accounting for around 40% of household energy use. In the Catalina Sustainable Home, the need for mechanical heating and cooling is significantly reduced by applying the following climate-appropriate design principles. With the addition of solar panels (PVs) and battery storage, the home will generate more energy than it requires.



Orientation



As the path of the sun changes with the seasons, the home's orientation takes advantage of the warming winter sun and cooling summer breezes.

Orientation for passive heating aims to maximise northern exposure in winter, of walls and windows, while reducing east and west exposure to avoid overheating in summer. And for passive cooling, orientation aims to eliminate solar access with appropriate shading and maximise access to cooling breezes.

Catalina Sustainable Home demonstrates how good orientation can be achieved on almost any block with considered design – even small, narrow blocks where the garage minimises northern exposure.

- ✓ Long side facing north with thermal mass (concrete tiled floors and rammed limestone walls) accessing direct solar gain for heating in the winter months.
- ✓ Strategic placement of windows and doors for crossflow cooling and ventilation in summer.
- ✓ Ensuite positioned to the north to receive direct winter sun, maximising cross-ventilation and minimising condensation/humidity to reduce mould, fungal spores and bacteria.
- ✓ Covered alfresco positioned to the east, allowing maximum solar gain in the dining area

Thermal Mass

Slab-on-ground construction with medium/dark tiled floors and strategically placed vertical wall mass (brick and rammed limestone walls) absorb winter warmth in the daytime and radiate that heat when the temperature drops at night.

In summer this process is reversed, when internal mass is shaded from the sun to minimise increases in mass temperature. Any excess heat stored during the day can then be purged at night with crossflow ventilation.



Crossflow Ventilation

Strategically placed windows create a high-volume air exchange that refreshes the house with outside cooler air and releases heat gain, keeping the home cool throughout the day and night. The shape of the Catalina Sustainable Home also assists with airflow, directing the cooling breezes through the smaller windows on the south side.

Shading

The pergola shades the dining, living and kitchen area from the heat of the summer sun. Deciduous vines have been planted to grow over the pergola, restricting the summer sun and allowing access to the winter sun. While these vines mature over the next few years, the pergola will be fitted with a shade sail during the hotter months.

The covered alfresco to the east shades the main bedroom and dining area from hot morning sun in the summer months and lets the warming winter sun flood the main living space on the north side. While inside, pelmets with heavy drapes help to control the transfer of heat and cold through the double glazed doors and windows throughout.

The pergola was custom-made from recycled materials by TAFE carpentry apprentices.

Insulation

There are three main types of insulation – bulk & reflective insulation and double glazing – that help prevent the transfer of heat and cold. For the Catalina Sustainable Home, the following insulation was installed:

- R1.3 Knauf Earthwool Roof Blanket Roll with Foil Facing (under the roof sheeting)
- R5.0 Knauf Earthwool Ceiling Insulation
- R2.7 Knauf Earthwool batts with Aircell Glareshield (to external walls)
- R2.0 and R2.5 HD (High Density) Insulation (where required)
- R2.0 Knauf Earthwool batts (to internal stud walls)
- R1.85 Saviro XPS Blue Boards 50mm Insulation (to slab edge)
- Double-glazed windows and external doors
- R1.77 Insulated Garage Door with sealed top and sides

The R-value measures the product's resistance to heat flow - the higher the R-value, the better the insulation.

Glazing

Glazing works in tandem with other passive design features to maximise thermal performance. Large areas of glazing facing north allow winter sun to bring warmth into the home during the day, storing heat in the slab and walls (thermal mass). This heat is then slowly released in the evening, keeping the main living, dining and kitchen areas warmer for longer.

Wet areas with north-facing windows also keep bathrooms warm without the need for underfloor heating and ensure water dries quickly, reducing slip hazards and avoiding the build-up of allergens such as mould.

Smaller windows facing southwest draw summer breezes in, cooling down the interior spaces as they flow through the home and out the larger windows to the north. Shape of roof promotes increased airflow.

Window treatments also help to control heat transfer throughout the home.

- ✓ Pelmet built into the ceiling reduce the transfer of heat over the top of curtains.
- ✓ Heavy curtains/drapes and blinds to insulate windows – minimising heat entering the home during the day in summer and ensuring heat released from the thermal mass (floor and walls) isn't lost in winter.



Zoning

Internal doors allow areas to be air-locked to minimise heat loss and maintain warmth throughout the night in winter. And during the summer months, doors can be opened to promote cross-flow ventilation and purge heat from the home.

The Catalina Sustainable Home has also been designed to operate as one home or two. Bedrooms 2 and 3, plus the main bathroom, can be separated allowing for multi-generational living (creating a separate grandparents' suite) or an additional income stream.

By locking the joining door in the hallway and using the sliding door to access bedroom two, this room can also be used as a home office allowing visitors/clients to enter without going through the main home.

How to reduce energy use in your home

Making small changes to your home will reduce the amount of mechanical heating and cooling required, reducing your energy usage. Use the natural energy from the sun to heat your home in the winter and the breeze to cool your home in summer.

- ✓ External shading reduces summer heat but still provides winter warmth (Shade sails, deciduous trees, awning blinds).
- ✓ Install heavy curtains, which can be opened to let the winter sun in and closed, keeping the summer heat out.
- ✓ When the temperature is cooler outside than inside, open windows letting the fresh air through, cooling your home naturally.
- ✓ Insulate to keep comfortable temperatures for longer. Insulation can be added to the underside of the roof, ceiling, walls and garage door.
- ✓ Seal the gaps
 - Draught stoppers for internal doors
 - Sealant around window frames
 - Weather strip inside door frames
 - Close air vents in air-conditioning
- ✓ Close internal doors so that you heat/cool only the rooms that you are going to use
- ✓ Ceiling fans create cooling breezes in summer and can assist in moving warm air in winter.
- ✓ Adjust air conditioning settings. Minimise your air-conditioner use and set it to 24°C - 27°C.

Useful Links & Additional Reading

- Your Home Guide - www.yourhome.gov.au
- Renew Australia Inc - www.renew.org.au
- Climate Change in Australia - www.climatechangeinaustralia.gov.au
- NatHERS Nationwide Energy Rating Scheme - www.nathers.gov.au
- Sanctuary magazine - www.renew.org.au/sanctuary-magazine
- Renew magazine - www.renew.org.au/renew-magazine



Join one of our talks this September to learn about Catalina Sustainable Homes' design features. Use the QR code to find out more and book tickets.

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