

Solar Passive Designed Units

377 Conadilly St, Gunnedah



With the increasing demand for rental accommodation in Gunnedah we decided to expand our Serviced Apartment Business with the addition of three new units.

Influenced by my brother who specialises in Solar Passive Design as a designer, draftsman and builder we designed these units to maximise natural heating and cooling. These units are sustainable, not only from an environmental viewpoint, but also an economic one as outlined below:

How does sustainability apply to building materials?

Building construction consumes 32 per cent of the world's resources.

At the same time, approximately 40 per cent of waste to landfill in OECD countries is generated from construction and deconstruction of buildings.

These statistics underline why the ecological sustainability of building materials is so important.

Ecological sustainability, in the context of our built environment, is about ensuring the minimum environmental impact from human activities.

Ecological sustainability includes the following components:

- energy efficiency, greenhouse gas generation and depletion of fossil fuels
- water conservation and water quality
- waste generation

- resource depletion
- land degradation
- conservation of biological diversity
- human and ecological health

We are committed to the economic sustainability of both Gunnedah and Australia by using local tradesmen to keep money cycling through our community as well as where possible supporting Australian owned and manufactured products with high green credentials such as using recycled materials in the manufacturing process, being recyclable and locally manufactured to reduce our carbon footprint through reduced transport.

Efficient use of available land:

Australia is now unfortunately labelled as the country with the biggest houses. We have used the land available efficiently by building three 2 bedroom units on a 1000m² block.

Undercover Parking:

A carport has been provided instead of an expensive double lock up garage.

Orientation:

The orientation of the units are north facing which allows for the low winter sun to warm while 600mm eaves prevent the high summer sun from entering and making the unit excessively hot.

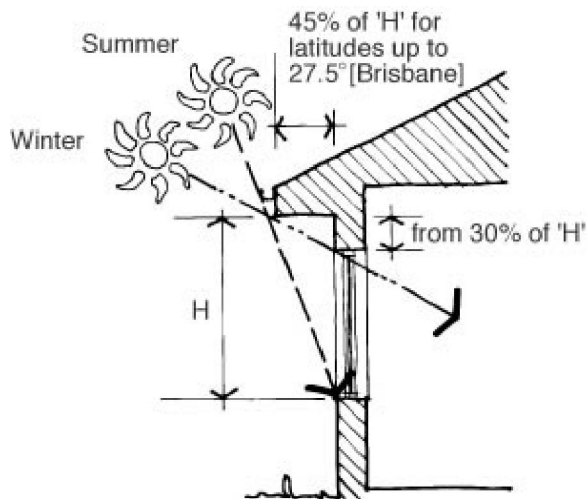
Living areas are on the northern side of the unit allowing cheerful sunlight in the most frequently used rooms.

A retractable blind with a wind sensor is located over the northern window to protect the unit in the summer when extended, but in winter the awning is retracted to maximise warmth from the winter sun. By providing external shade the amount of heat entering the unit can be reduced by up to 80%.

The northern window area is larger than half the floor area allowing for maximum solar gain in winter while also keeping with Australians love of seamless indoor/outdoor entertaining. Inside the northern window heavy curtains and a pelmet block out summer sun and allow in winter sun.

There are no windows on the southern side of the unit with small windows on the east and west walls to reduce solar gain in summer.

Diagram 1: Placement of window and width of eaves for maximum solar efficiency.



Gunnedah's latitude is 30.98 decimal degrees and is considered a temperate climate.

Roofing:

Light coloured roofing material keeps cooler than darker coloured roofing material. The cooler temperature has many benefits including the ability to reduce the energy costs for cooling a building. In order to recognise the cooling benefit of lighter coloured roofing some building regulation has incorporated colour as an energy efficiency design parameter.

The Building Code of Australia (BCA) has classified roof colour on the basis of their solar absorptance, referred herein as very light, light and dark. BASIX also has a similar rating.

Table 1 - Colour Classification in Accordance with the BCA (Source: www.colorbondcolours.com)

Colour	Solar Absorptance	Classification
Classic Cream™	0.31*	Very Light
Surfmist®	0.318*	Very Light
Paperbark®	0.421	Light
Evening Haze®	0.427	Light
Shale Grey™	0.433	Light
Sandbank®	0.455	Light
Dune®	0.466	Light
Windspray®	0.584	Dark
Pale Eucalypt®	0.597	Dark
Bushland®	0.619	Dark
Headland®	0.632	Dark
Wilderness®	0.651	Dark
Jasper®	0.682	Dark
Manor Red®	0.688	Dark
Woodland Grey®	0.706	Dark
Loft®	0.711	Dark

Chosen for these units.

Monument®	0.732	Dark
Ironstone®	0.743	Dark
Cottage Green®	0.746	Dark
Deep Ocean®	0.749	Dark

Please note, these readings are for standard COLORBOND® colours incorporating Thermatech® technology.

How can steel and COLORBOND® steel products contribute to the sustainable performance of building materials?

Durability. Steel products have a long life. By using durable building products, such as steel, we can conserve resources and reduce energy consumption that would otherwise be spent on manufacturing products with shorter life spans.

Reusability. Steel doesn't rot, split, warp, twist or burn. This means many existing steel products can be reused without reprocessing, again saving on energy and resource use.

Recyclability. At the end of its useful life, steel can be recycled. In fact, steel is 100 per cent recyclable and is the most recycled material in the world.

Strength-to-weight. The high strength-to-weight ratio of steel means you can have long, column free spans and lighter structures that use minimal framing material.

It can also reduce the cost and impact of transportation – the more material a truck can carry to a building site, the fewer the total number of deliveries. This, in turn, saves on fuel and greenhouse gas emissions. High strength-to-weight ratios also mean that less material is required to construct the building, minimizing resource use.

Designed for adaptability and disassembly. Many steel products are designed and made in such a way that they can be disassembled and reused in their current form for any number of applications. This saves the cost and energy of making new products or the costs associated with recycling products.

Prefabrication. Many steel structures and building materials can be prefabricated – that is, manufactured and/or preassembled (usually in a factory) ready for fast and easy assembly on site. This helps minimise wastage and create safer building sites.

Frame:

The frame is sourced from plantation pine – a renewable and recyclable resource.

Cladding:

Lightweight EPS Building Systems (www.thinkyellow.com.au).

Building sustainably is not just about energy efficient buildings with good low energy use during the life of the structure, it is also about choosing products that have low impact on the environment during the manufacturing process but also can be recycled or reused at the end of the buildings life so that it does not end up as landfill.

Think yellow EPS cladding is made from polystyrene which is lightweight (a requirement because of the site soil type), flame retardant, insect repellent, will not rot, grow mildew or absorb moisture.

EPS is 100% recyclable and requires less energy to produce than traditional materials. It contains no CFC's nor HCFC's and does not emit any poisonous gases.

Thermal Insulation:

Walls:

We have used 75 mm thickness of EPS cladding on the walls which on its own has an R-value of 2.34 m².kw.

Total wall Thermal Performance is calculated below:

Table 2: R-Values for Lightweight cladding (Direct fixed to stud)

Source: ICANZ Reference W0200

R-Values for System W0200	
Outdoor Air Film	0.04
EPS Lightweight cladding	2.34
Reflective Insulation Material R-Value	0.00
Bulk Insulation Wall Batt	1.5
10 mm Plasterboard	0.059
Indoor Air Film (Non-reflective Surface)	0.120
Total R-Value	4.0

Ceiling:

Ceiling batts with an R-Value of 3.0 have been used in these units.

Table 3: R-Values for Pitched Metal Roof with flat ceiling - Ventilated:

Source: ICANZ Reference R0200.

R-Values for System R0200	Winter	Summer
Outdoor Air Film	0.04	0.04
Metal roof	0.00	0.00
Reflective Insulation Material	1.3	1.3
Bulk Insulation ceiling Batt	3.0	3.0
10 mm Plasterboard	0.059	0.059
Indoor Air Film (Non-reflective	0.110	0.160

Surface)		
Total R-Value	4.51	4.56

The supplier of the reflective foil (Brand name Rhino Wrap) is an Australian Owned Company and the manufacturing is done in Australia.

(www.thorbuilding.com.au)

Ceiling and Wall Batts are from the Bradford Insulation Group which has been manufacturing energy saving insulation in Australia since 1934.

(www.bradfordinsulation.com.au)

Insulation contributes to a more sustainable environment, by reducing energy consumption in buildings and industrial processes.

Bradford supports sustainability in 3 key ways:

1. Improving the living and working environment through greater thermal and acoustic comfort
2. Saving energy and reducing the associated greenhouse gas emissions
3. Reducing waste through environmentally sound manufacturing

Bradford Insulation's glasswool is manufactured from up to 80% recycled glass, waste flat glass and bottle glass, depending on availability. In addition, the remaining glass is made primarily from sand - an abundant resource.

Our glasswool and rockwool plants:

- Recycle all water used in the manufacturing process
- Use high efficiency world class process control technology
- Maximise compression packaging to reduce transportation energy use
- Comply with all relevant product and manufacturing standards including ISO9000 and AS/NZ 4859.1

Bradford glasswool and rockwool insulation products last the lifetime of the building and can be fully recycled, if left in their original condition.

Bradford glasswool and rockwool insulation uses no ozone depleting products (ODP) in manufacture, have low volatile organic compounds (VOC) and low allergen, and have low embodied energy.

Bradford glasswool and rockwool are amongst the world's most sustainable building products.

Windows:

The windows have been supplied by Trend windows and doors, an Australian owned manufacturing company. (www.trendwindows.com.au) All windows were made in Tamworth which reduced transport costs.

Double glazing has been used on the large north facing Sliding door and the two bedroom windows for improved thermal efficiency and for noise minimisation. The kitchen window is not double glazed because it is under

cover and the bathroom and toilet windows also were not double glazed because of the infrequency of use of these rooms.

All windows are well sealed against draughts

Table 4: Summary of Thermashield Windows

Star Rating	Product	Glazing	U Value	SHGC	Cooling Improvement %	Heating Improvement %
4*	Aluminium sliding door	Double glazed 4-10-4	3.0	0.41	56	44
3.5*	Aluminium sliding window	Double glazed 4-10-4	3.5	0.42	53	38

U-value measures how well a product prevents heat from escaping. The lower the U-value, the greater a window's resistance to heat flow and the better its insulating value. Trend windows range from 1.9 to 6.4 U-value.

SHGC measures how well a product blocks heat caused by sunlight. SHGC is expressed as a number between 0 and 1. The lower a window's SHGC, the less solar heat it transmits.

Flooring:

The units have a concrete slab floor with tiles throughout the living areas to absorb and store solar heat. Carpet is used in the bedrooms for comfort.

Ventilation:

Ventilation to the roof cavity to remove hot air in summer is provided in the kitchen through the rangehood and bathroom with two exhaust fans. Whirly birds on the roof and vents in the eaves allow for natural cooling by the removal of hot air from roof space and the movement of fresh air.

Rainwater Collection:

Each unit has been fitted with a 5000L rainwater tank with water recycled to the washing machine and toilet.

Excess storm water is diverted to the mains system for processing.

Heating and Cooling:

The majority of heating and cooling is provided in this unit by cross-ventilation and solar gain through the design of the unit.

Fans are located in each bedroom and the living area to distribute cool air, making the air conditioning more efficient. Moving air also creates a wind chill effect that cools your body.

A highly efficient reverse cycle air conditioner using inverter technology is also provided for weather extremes of heat and cold and for the comfort of our guests during these periods. Energy rating 3.5 star for cooling and 4.5 star for heating.

Lighting:

Maximum use of natural light is provided by large north facing windows. Artificial lighting is provided by using ecosmart compact fluorescent lights throughout the unit.

Hot Water:

A Bosche 21e gas hot water system was chosen over solar hot water because it offers a 5.5 star energy rating only heating water as required. A gas hot water system suited our needs because solar hot water often requires a manual boost after prolonged cloudy days which did not suit a rental environment.

3 Star water efficient shower heads are provided in all units with 5 star mixer taps in the bathroom and kitchen sinks.

Front loading washing machines with a water efficiency and energy efficiency rating of 4 star are provided for guest use.

A dryer is provided which is vented directly to the roof cavity to prevent build up of hot, humid air in the bathroom. Line drying facilities are provided and encouraged.

Furniture:

Most of the furniture is made from recycled teak with the beds supplied by an Australian owned manufacturer in Dubbo. The bases are made in Orange by a special needs group.

Recycling:

Recycling receptacles are available and encouraged. Biodegradable bin liners are used.

Landscaping:

Low water use plants of both native and non-native origin will be used in the garden to save water while providing a pleasant place to reside.

A gravel driveway has been chosen to allow rainfall to enter the ground where it falls in keeping with water sensitive urban design principles.

Affordability:

Quotes were sourced for a traditional brick veneer unit with a tiled roof as well as for the EPS cladded system with a colourbond roof.

Even with the addition of energy savings devices the cost of the two building methods was comparable. The reduced running cost of the new unit will far outweigh any extra costs incurred in making these units sustainable.

In Summary:

Orientation:

North facing with large double glazed windows with external shade structures including deciduous trees, pergola or retractable awning.

Internally heavy curtains with a pelmet to reduce heat gain in summer when closed and allow warming sun in winter when open.

Living areas located to the north.

Roofing:

Light coloured metal roofing instead of heavy, expensive and damage prone tiled roofing.

Insulation:

Use the most appropriate R-Value for the climate you live in. Ceilings should be insulated to a minimum of R3.5 rating.

Use reflective foil sarking to minimise summer heat gain.

All walls should be insulated to a minimum R2.0 rating.

Windows:

Large windows on the northern side. Small windows on south, east and west side. Double glazed and protected by external blinds, especially on west and southern walls.

Well sealed against draughts.

Flooring:

Cement slab with dark coloured tiles in cooler climates for maximum heat storage and radiation in winter and lighter coloured tiles in warmer climates to reflect some of the heat while still providing some thermal storage.

Cladding:

I chose a lightweight cladding with excellent thermal insulation and green credentials. I can safely nickname the units Esky units as the polystyrene looks like that of the inside of an esky.

If brick veneer is the finish of choice a reverse brick veneer should be considered as it has much higher thermal properties than that of a traditional brick veneer home.

Solar power and hot water:

With the forecast increase in costs of traditional electricity solar should be considered. Both solar hot water and solar electricity were considered for these units but it was not considered viable due to the long payback period. Instead we have concentrated on minimising our reliance on electricity. Green electricity can be purchased through energy suppliers.

Ventilation:

Whirly birds are installed in the roof to remove hot air from the roof cavity as well as provide ventilation.

Internal ceiling vents are provided to remove hot air from rooms to the roof cavity where it is extracted by the whirly birds.

Heating and Cooling:

Ceiling fans and passive solar heating are the main sources of heating and cooling in these units, although a highly efficient reverse cycle air conditioner is also provided to cater for weather extremes.

Lighting and appliances:

Lighting and appliances were chosen based on their energy efficiency.

Water:

AAA rated taps and shower heads installed.

Rainwater is collected, stored and reused through the unit.

Toilets are 4 star rated and one has a basin above the cistern so that hand washing water is recycled back into the cistern for re-use.

Gravel driveway is used to keep rainwater on site.

Furniture:

Furniture is made from recycled teak.

Beds are made close by in Dubbo by Australian company (www.latexbedding.com.au).

Reference Material:

Your home Technical Manual: Aust Greenhouse Office (www.yourhome.gov.au)

Warm House Cool House by Nick Hollo pub: Aust. Consumers Association Sydney.

Energy Smart Information Centre: 1300 138638 (www.energysmart.com.au)

Low Energy Affordable Housing: Derek F. Wrigley OAM.

Energy Conservation and Solar Energy: Stephen Lesiuk and Paul Pholeros.

The green directory: (www.thegreendirectory.com.au)

Buy energy efficient: (www.buyenergyefficient.org)

Comfort in an unheated Solar-Passive House at Manilla: J Garry Speight –
Manilla (www.cyberspeights.com)