Yarra Junction VIC

NEW HOME

ZONE 7: Cool temperate

Topics covered	
Passive solar heating	
Reducing water use	
Rainwater harvesting	
Greenhouse gas reductions	
Wastewater recycling	
AccuRate (thermal comfort)	6.9 (full rating)

This case study shows how a well designed suburban home can cost effectively minimise its environmental impact whilst simultaneously improving comfort and lifestyle for its occupants.

The innovative wall construction system used yields high level insulation whilst providing thermal mass and reducing noise transmission.

The house also eliminates heating, cooling, water and sewage disposal costs.

This single storey house has been designed to allow for maximum winter sun whilst totally excluding summer sun. It is split into two sections: the main section has three bedrooms and a study while the second section is a self-contained unit with a separate living area.

The brief called for the house to be very comfortable and take advantage of the magnificent views. The house was designed with a high emphasis on winter warmth with low running costs as the house is in an area that can get quite cold as it is surrounded by Yarra Valley mountains.

The site is in an urban residential area in the Yarra Valley, Victoria. It is surrounded by mountains that often have snow on them in the winter. It has a gentle slope down to the East. The northern aspect of the block is open with no overshadowing from trees or other houses.

The climate is temperate to cool temperate. The prevailing winds coming from the Southwest in winter and temperatures in the area range from –5° in winter to 40° in summer.

DESIGN SOLUTIONS

The land has northerly aspect to the long side of the block. This allowed the design of the living, lounge, dining and kitchen to have northerly aspect. This amount of solar access enabled the house to be designed so that it did not require any auxiliary heating devices.

Great northerly aspect and good passive solar design were combined to maximise winter sun penetration.

Floor plan

High levels of insulated thermal mass in the wall and floor construction absorb this free energy from the sun during the day and re-release it at night. This maintains winter indoor temperatures above 17° with no auxiliary heating.

The designer was asked to incorporate two separate living quarters under the one roofline. The only part of the house to be shared was the laundry.

The unit was not to look any different to the rest of the house and was to take advantage of the northerly aspect and views just like the main section of the house and required a separate entry. These client requirements were successfully achieved by locating the unit at the front of the block.

Specially designed shade battens on all windows exclude all summer sun to protect the house from overheating in summer. Well designed cross ventilation paths allow cool breezes to draw heat from thermal mass when night time temperatures are lower, maintaining summer daytime temperatures below 24°. The western side of the house was also designed with minimal windows.

The house remains comfortable without auxiliary heating and cooling because it was designed well with:

> zoned floor plan with north facing living areas

> passive solar orientation

> very high insulation levels

> advanced shading details

> high thermal mass

> efficient windows

> well planned cross ventilation

> thorough draught sealing

[See: 2.2 Choosing a Site; 4.0 Passive Design]

East elevation

North elevation

MATERIALS

Walls

Internal and external walls are all built with Thermacell™ (polystyrene blocks filled with concrete). This construction system provides insulated thermal mass and low sound transmission between rooms.

The polystyrene insulates the thermal mass to ensure that its benefits are felt inside and not wasted to external temperature extremes. It provides a barrier against the extreme cold in winter and high daytime temperatures in summer. [See: 4.9 Thermal Mass; 5.5 Construction Systems]

Floors

A concrete slab floor provides additional thermal mass. Winter sun passes through the windows and onto the floor, the warmth is stored in the slab during sunny days and is radiated back into the rooms throughout the night and on sunless days.

The high thermal mass solution with passively shaded north glazing is ideal for the climate and is a major contributor to the thermal stability and comfort of the house without auxiliary heating. [See: 4.9 Thermal Mass; 5.12 Concrete Slab Floors]

Roof

Plantation grown radiata pine roof trusses are a renewable resource which is structurally efficient minimising waste. Colourbond steel sheeting is durable, can be recycled and has low transport costs.

Good insulation levels make for a durable, resource efficient roof structure which minimises heat loss in winter and heat gain in summer.

Windows

Well shaded PVC frame double-glazed windows were used in the project. The style was double hung to maximise the amount of opening area to improve cross flow ventilation.

PVC frames are an insulator and minimise heat loss by conduction through the frames.

Double glazing restricts heat loss through the glass allowing larger areas of glass to be used to maximise passive solar heat gains in winter.

The air gap in the clear double glazed units is 14 –16mm. The windows are Generic Type 11 from the WERS table of Generic Window Types and are rated: Four stars for heating climates and two stars for cooling climates, making them ideal in this climate. [See: 4.10 Glazing]

Insulation

Walls: Thermacell™ 250mm thick external walls have an overall system insulation value of R2.9.

Roof: The ceiling and roof space have R2.5 wool/polyester bulk insulation with a layer of concertina foil batts placed on top. These reflect any radiant heat that escapes through the bulk insulation back to the inside in winter. They also reflect heat back out in summer but this effect will eventually be lost as a coating of dust on the upper surface reduces the reflective properties.

Reflective Tyvek™ was placed on the underside of the roof sheeting. The Tyvek™ is the first barrier against radiant heat gain through the roof cladding.

The downward facing reflective surface into the roof cavity works in two ways. Firstly, it reflects heat back into the building in winter and secondly, the low emissivity surface prevents downward radiation of heat gained through the roof cladding in summer. [See: 4.7 Insulation]

Thorough construction draught sealing combined with advanced seals on the windows and doors has eliminated heat loss by infiltration and leakage.

Ventilation

We introduced a mechanical form of ventilation to bring fresh air into the home in a controlled manner. The unit also filters the existing and incoming air and distributes it around the house. This eliminates the need to open the windows and lose warmth during the winter months.

Hot water

The hot water in the house and unit is supplied by separate solar hot water systems positioned on the northern roof space.

Greywater and black water

An aerated wastewater treatment system has been installed to treat all household wastewater. Treated wastewater is recycled onto the garden. [See: 7.4 Wastewater Re-use]

Water use and rain water

All roof water is piped to a large inground tank of adequate capacity to meet all household needs. An electric pump is used to pump the water back to the house for all house hold requirements. [See: 7.3 Rainwater]

All shower and tap fittings are WELS 3 Star rated to reduce water consumption.

Walling system

The main advantage of the wall system used is its very high system insulation values. These occur because of the combined effect of thermal mass and insulation as a system.

Because the thermal mass of the concrete fill is insulated from the interior of the house by the polystyrene blocks, some of its effectiveness as a thermal battery is lost.

The internal insulation slows absorption of heat energy into the mass. However, it also slows the re-release of that energy. The slower absorption and release rate of the insulated mass in the walls is of benefit in prolonged sunless winter periods and summer heatwaves.

With similar insulation levels internally and externally, more heat is lost to the outside (because this direction has the largest temperature difference).

The amount of accessible thermal mass present in the concrete slab floors is adequate for evening out day/night (diurnal) variations and maintaining the passive design function in the home. [See: 4.7 Insulation; 5.0 Material Use]

Shading system

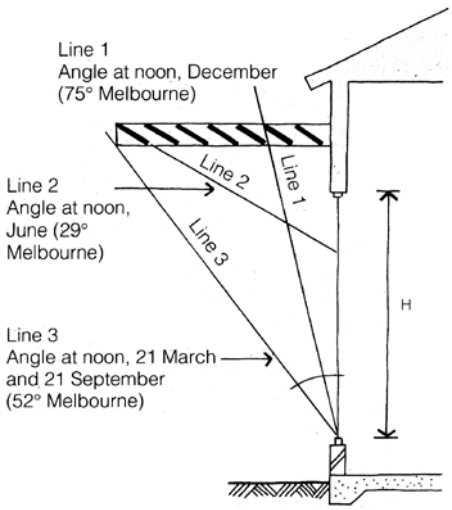
The system of angled louvres used to shade the north facing glass has distinct passive solar design advantages over other systems.

In most eave shaded applications, up to 30 per cent of the glass area remains in constant shade. This is always a significant source of heat loss in cool and cold climates as the warmest inside air rises to the ceiling causing greater heat transfer rates. Double glazing and insulating drapes with snug pelmets drawn at night can almost eliminate this.

With a louvre shading system, a shallow eave is used and the louvres are set to allow full winter sun penetration on the whole glass area whilst gradually excluding it in bands of shadow over the whole glass area in autumn and spring. Winter sun penetration at the top of the window allows deeper penetration of sun onto the concrete floors where it is absorbed for night time release.

This system is also ideal for shading an elevation where window sill heights vary. A single uniform system provides correct passive shading to all windows regardless of their height.

All overhead summer sun is excluded and a larger shade area outside the windows can be created by extending the system. This minimises heating of paved surfaces and lowers the temperature of air entering the building through open windows in summer.



Courtesy SEAV

In this example, the thick timber louvre blades, whilst attractive, cast shadows over 25 per cent of the glass in mid winter, This is a loss that can be reduced to around 5 per cent by using thin metal louvres that are longer and set further apart.

EVALUATION

The owners are extremely happy and have found the house meets all their requirements. [See: 4.4 Shading]

PROJECT DETAILS	
Designer:	Darren Evans – Solar Solutions Design and Drafting
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Images courtesy of Solar Solutions Design and Drafting