house – temperate

Home Design for lifestyle & the future

Perth

This passive solar home was designed to operate with minimal energy consumption. It demonstrates how high mass construction, good orientation and the very reliable "Freemantle Doctor" are a simple recipe for increasing comfort and reducing operating costs in a Perth home. Low embodied energy materials were used throughout the house and its compact design reduces demand for resources.

A solar hot water service and photovoltaic array significantly reduce greenhouse gas emissions.

Building Type:	New home, High mass construction
Climate:	Warm temperate East Perth

Topics Covered	Success Level
Passive design	Excellent
Reducing embodied energy	Excellent
Greenhouse gas reductions	Excellent
Sustainable materials use.	Very Good
Renewable energy generation	Excellent
NatHERS rating 4 stars (see conclusion)	★★★★

The home is a part two storey with a lower single storey pavilion, built on a slope in the inner city suburb of East Perth, Western Australia. The house is located on a 600 square metre block. The subject land was once a wetland that drained into the Swan River at Banks Reserve. The main reason for selecting this site was its inner city location and its uninterrupted solar access.

WHY BUILD THE HOUSE?

The owners wanted to create a living demonstration of passive solar design. One owner, Bill Parker, is the editor of the Australian and New Zealand Solar Energy Society's journal, entitled "Solar Progress".

Previously, he found himself in the somewhat ironic situation of talking and writing about passive solar design yet living in a house that was elegant but consumed a great deal of energy and was thermally uncomfortable. Building a new house was an opportunity to put his words into action to create a thermally and ethically comfortable home.

SITE SELECTION

Finding a north-facing block in the general inner city area proved to be a challenge. The decision to buy this particular block in East Perth was made in consultation with the architect who thought there was potential for solar gain from the natural slope of the block.

THE BRIEF

The owners briefed the architect and specified a simple concept that would include two bedrooms, an office and a large open living area with an integrated kitchen.

The living area and the kitchen were faced north in accordance with principles of passive solar design. The kitchen's northerly aspect also meant that cooking odours could be exhausted naturally using the prevalent south-westerly breeze.

Winter heating is achieved without the use of purchased energy. Energy requirements for summer cooling have also been minimised. Air-conditioning was not considered necessary.

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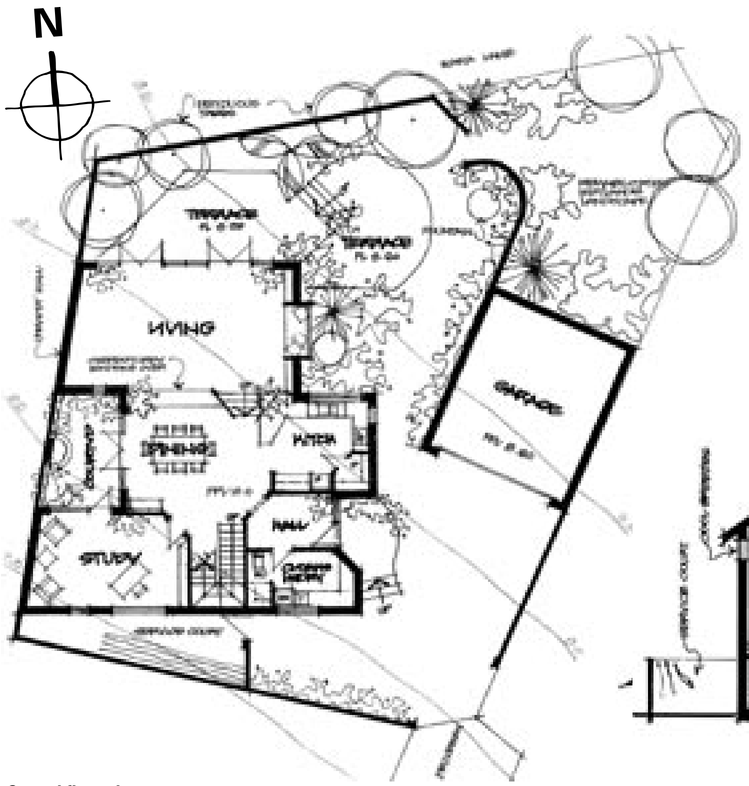
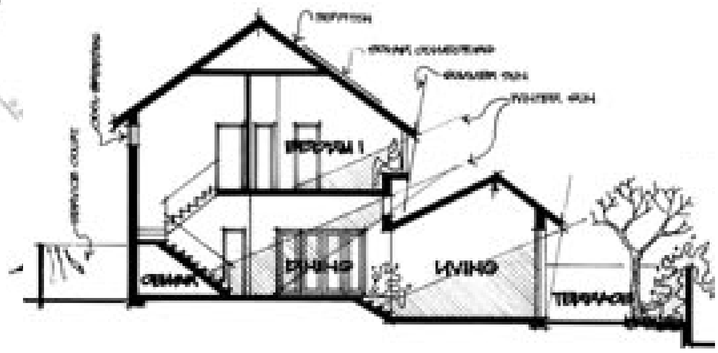


Ground floor plan



Section

DESIGN SOLUTIONS

The slope of about 1.5 metres from south to north has been exploited, allowing further solar gain through windows situated above the lower pavilion. This provides natural lighting during the day and only task-oriented lighting is required in the office.

In winter, the sun can penetrate to the rear of the lower floor to provide adequate warmth. The mass of the upper floor provides a good sink for bedroom and bathroom warmth. This means that the entire house is always warm in winter.

In summer, the house is comfortable, but the design does depend on the strong afternoon sea breeze. The house uses four bladed ceiling fans for comfort in summer in combination with the strategic placement of windows and openings for breeze entrapment.

The “Fremantle Doctor” can be captured and warmth flushed out of the building from the south-west to north-east. If the breeze is mild or fails (which is rare), the upper floor can become hot but by using the low noise fans, sleeping is still comfortable with flyscreened full length opening doors and open windows.

With predictions of higher climatic temperatures in future due to global warming, it is possible that additional adjustable external blinds might be required, especially in March when daytime temperatures are still high and the sun is lower in the sky.

ENERGY CONSUMPTION

Electricity is supplied by a 1kW array of solar panels. The house is connected through an inverter and excess electricity is sold to the grid. A refrigerator rated at 2kWh/day uses the most electricity. All other uses are minimised by either using efficient appliances or by using gas (cooking and boosting solar hot water). Some of the lighting is low wattage compact fluorescent (CFL).

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EMBODIED ENERGY

Although the owners were well aware of what could be achieved in terms of low energy construction, they had not paid much attention to embodied energy data and its environmental impact.

As the designs were finalised and the task of specifying was closed off, considerable information about material selection was revealed by investigation or by chance. For example, the roof is supported by engineered trusses made from local plantation timber, which is claimed to consume 25 percent less timber and is cheaper to install.

All buildings consume energy in construction. The major wall construction is locally derived rammed limestone. The embodied energy is much lower than for fired clay bricks.

Some clay bricks have been used in retaining walls and for some internal walls, for space and load bearing reasons.

External paving uses bricks fired by landfill gas.

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CONCLUSIONS

There are two major benefits of living in the home. Firstly, the house maintains an even, natural temperature throughout in winter. Secondly, the home consumes very little energy and consequently has comparatively low running costs.

The owners firmly believe that the benefits of winter warmth from the sun can be enjoyed for the life of the house at no cost.

High thermal mass construction is ideal in Perth's climate. The "Freemantle Doctor" is the most reliable cooling breeze in Australia. However, on the rare days the breeze does not arrive, un-insulated, high thermal mass construction (particularly first floor) can cause overheating.

The rammed earth walls have only R 0.5 insulation value which is quite low. Thermal lag can slow the transfer of heat through the walls but solar exposed walls will still overheat in no breeze periods and they are a source of heat loss during a Perth winter.

At design stage, the house was modelled on NatHERS. It was also modelled on the "Tecto" program (Garry Baverstock, WA).

On the first pass NatHERS rating, the building "easily" reached 161MJ/m^2, a 4 star rating in the inner Perth climate. The Tecto rating gave a very similar result to NatHERS. This was:

Heating required 66MJ/m^2/annum

Cooling required 95MJ/m^2/annum

The design data entered had to be adapted to accommodate NatHERS limitations (two storey convective ventilation). Modelling of the cooling energy was complicated by the large retractable blind that shades a west facing courtyard. This was not "recognised" in the assessment and the window was counted as unshaded glazing. (The blind is removed in mid May and re-erected in early November).

Alterations were made to the glazing as a result of recommendations from the rating. It is now assumed that, as a result of the alterations, the building would achieve a 5 star rating. But this has not been confirmed.

In this example, HERS software was used to good effect as a design tool.

CREDITS

Architect: Zdenka Underwood

Principal author: Bill Parker (owner)
Contributing author: Chris Reardon