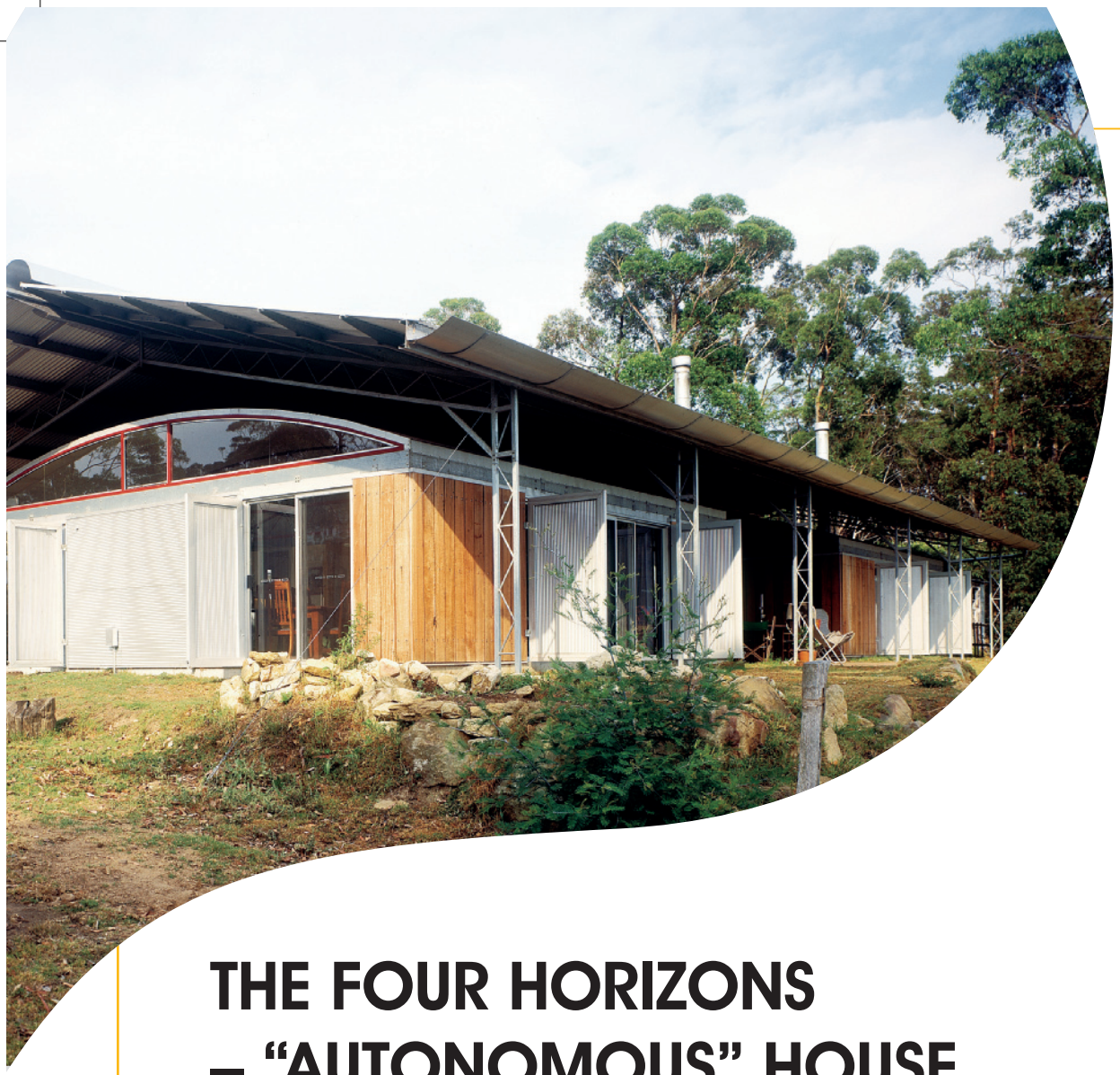


THE FOUR HORIZONS – "AUTONOMOUS" HOUSE

The site is located on the eastern seaboard of Australia, at latitude 33 ˚S at elevation 430 m above sea level facing NE on the crest of a ridge and at the top of a steep 60 m escarpment, and is part of a 45 hectare holding in a forest located 65 km west inland of Newcastle at the north end of the Watagans National Park overlooking the lower Hunter Valley. The temperature range in winter is 4 ˚C to 24 ˚C, and in summer is 14 ˚C to 38 ˚C. Prevailing winds and storms are from S to SE, and in summer there are cool NE breezes. Rainfall has averaged 1,100 mm per annum.

The site was without mains utilities – water, mains electricity, sewer, telephone – and there was absolutely no prospect of bringing any piped or wired services in. The objective was to design and construct a house that would cope with these conditions, that would consume as little energy as possible in its making, that would require as little energy as possible to sustain its use and that would do as little damage as possible to the environment. There were a number of basic premises on which the house would be developed – it must be cheap, it would be

Architectural Design: Lindsay Johnston Architect
Location: New South Wales, Australia
Completion Time: 2004
Area: House: Enclosed Areas: 182 m^2, Open Breezeway: 72 m^2, Outbuildings: 150 m^2
Copyright Photographs: Lindsay Johnston
Cost: Self Build, Low Cost
Awards: Australian Institute of Architects, New South Wales, Environment Award

self-built (thus minimalist in form, appointment and finishes), with a big roof for shade and to collect water, non-combustible materials, capability of closing up in a bushfire, slab on ground for fire reasons and for thermal mass, masonry construction for thermal mass, a low structure to minimize visual impact in its very visible location, sun penetration from the north-east and north in winter, shading from the sun at all other times. Planned as a "settlement", a group of buildings consists of the house, a 4 car garage, a 4 horse stable and a walled vegetable garden, the latter to keep out the local brush tail rock wallabies, wombats, echidnas, and other abundant wild life.

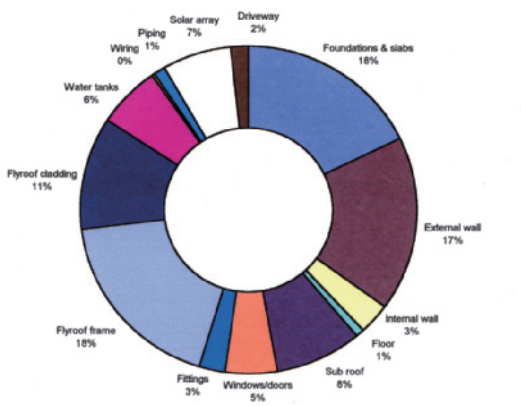
The significant feature of the house is the use of a double or "fly" roof completely independent of two separate dwelling modules beneath, a feature of early buildings in Australia since largely forgotten. This roof, and the garage and stable, are constructed using standard agricultural steel shed frames made by "Colorpanel" in rural NSW, consisting of simple lattice columns and roof portals of 50 x 50 steel tube and 20 mm dia bar, all galvanised. The main roof and the sheds are clad with standard silver 'Zincalume' corrugated steel, the outcome of a reasoned debate with the local planning authority, which understood the bloodlines of the design, from traditional rural Australian farm buildings, and the thermal advantages of a silver roof compared with often favoured dark colours. Large curved "Zincalume" steel gutters and ridge vents enhance the basic shed aesthetic. An existing chimney breast and generous open fire of recycled bricks, has been retained and now forms the centrepiece of a central breezeway between the two dwelling modules – a covered space for open air living appropriate to a relatively benign climate. The main façade of the house is orientated to 33ºC east of solar north (the sun is in the north) and the winter sunrise spills into the living areas and the summer sun is excluded by the roof overhangs. Thermal mass in walls and floors is used effectively to store warmth in winter and 'coolth' in summer.

Ecological idea:

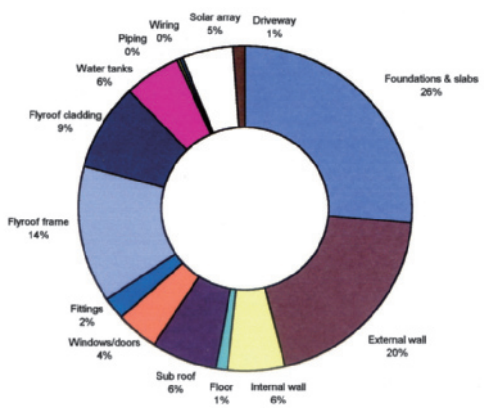
It may appear that a self-sufficient autonomous house located in a rural location is the answer to sustainable living, but although one can demonstrate low energy and sustainable design and construction practices, these are neutralised by energy consumption in transport to work, culture, education and shopping using private cars. Sustainable living really demands the ability to walk, cycle or use public transport to school, office, shops and theatres.

The Services

Good decisions in the design and construction of the buildings have minimised the in-use energy requirements. The sources of energy for the project are the sun converted into electricity, the sun converted into hot water, bottled LPG (liquid propane gas), diesel to run the back-up generator and an unending supply of firewood harvested from the forest floor (thus reducing bushfire risk). The house was not absolutely autonomous and required more investment in additional solar panels and, perhaps, a wind turbine, to reduce use of LPG and diesel fuel.



EMBODIED ENERGY DISTRIBUTION BY ELEMENT



EMBODIED GREENHOUSE GAS EMISSIONS BY ELEMENT

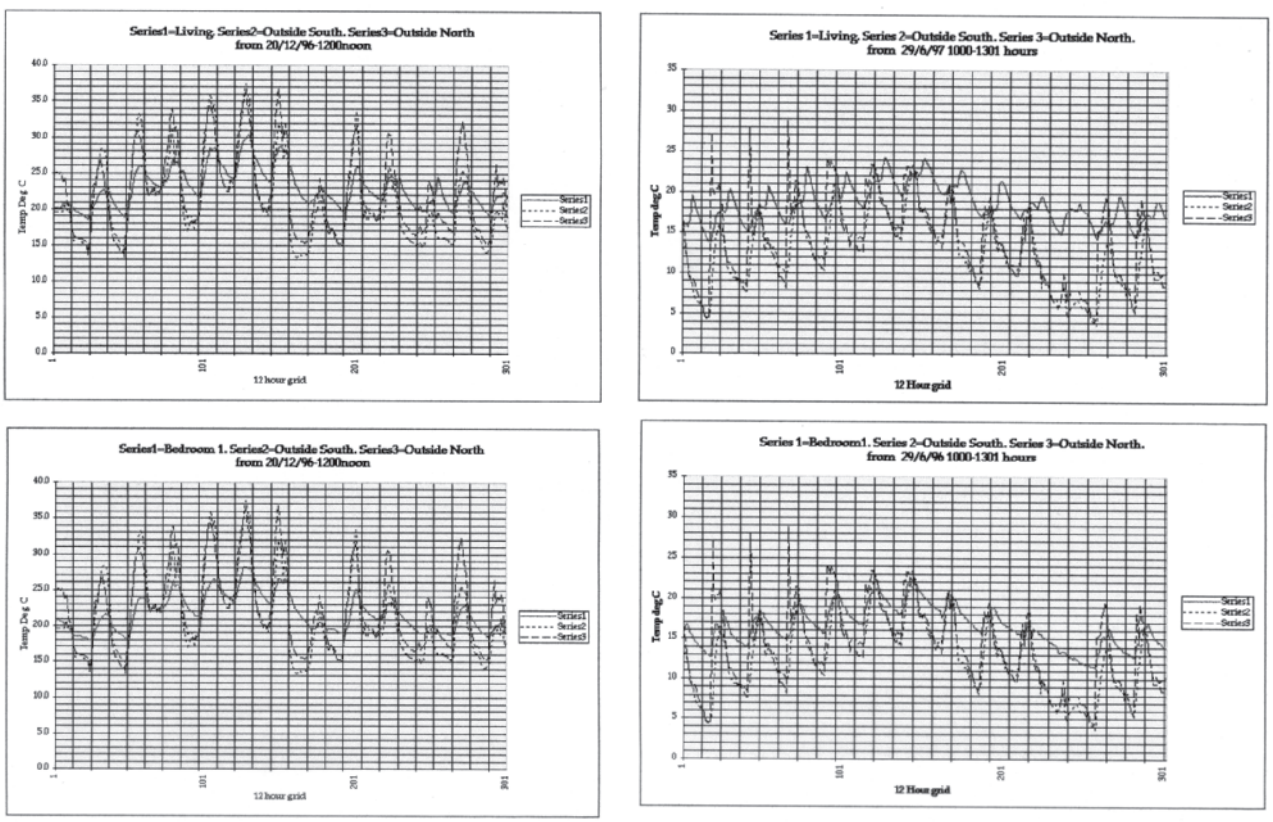
Environmental Performance

In summer, the vented “fly” roof and eave overhangs neutralize the worst of the heat of the sun, and the thermal mass and insulation keep the interior ambient temperatures at acceptable levels. The breezeway allows summer north-east sea breezes to pass through the center of the house. In winter, the sun penetrates into the house from sunrise, heating the concrete floors and "thermal wall", and the thermal mass and insulation (and warm curtains) retain the heat at night. The house has large windows towards the north (the sun is in the north) and small windows towards the south. Water tanks have been located to the west of the dwelling where retained trees also cast summer shadow. The breezeway can be closed up on the south side – the house can thus turn its back to the prevailing southerly winds. Systematic thermal monitoring of the interior and exterior temperatures has been carried out over a full seasonal cycle. The internal temperatures on a hot summer day are up to 12ºC cooler than outside at 26ºC inside and 38ºC outside. On a cold winter morning, the internal temperature is up to 10º warmer than outside at 14ºC inside and 4ºC outside.

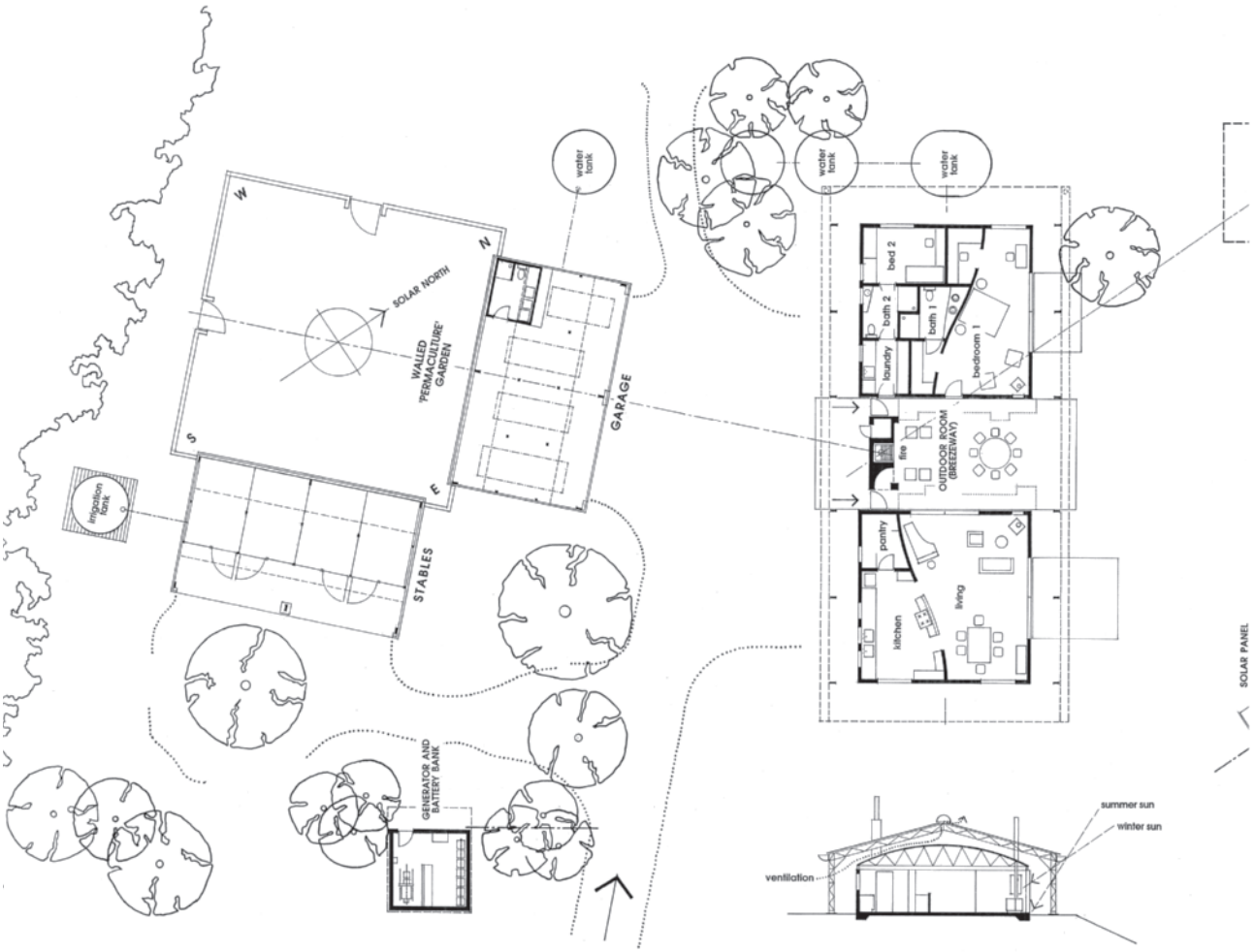
Energy Consumption and Greenhouse Gas Emissions

Total 1.5 tonnes CO_2 e / annum

It is impossible to calculate “energy” consumption due to the fact that (a) electricity is produced on site from solar photovoltaic panels, (b) solar energy is used to heat water, (c) diesel is used for back-up electricity generation, (d) bottled gas is used for back-up water heating, cooking and fridges and (e) waste wood collected from the forest floor is used for space heating. Calculation of greenhouse emissions is used as a measure of assessing environmental performance.



THERMAL GRAPHS LOGGING ACTUAL INSIDE AND OUTSIDE TEMPERATURES - TOP LIVING AREA, BOTTOM MAIN BEDROOM, SUMMER LEFT AND WINTER RIGHT



SITE PLAN SECTION

Four Horizons is in the range 20% to 30% of a "typical" Australian house. This could be improved by investment in more capital equipment – more solar panels and a wind turbine.

Embodied or Embedded Energy

An embodied energy audit of the completed Four Horizons house was carried out.

The embodied energy in the house, excluding the outbuildings (stable and garage and walled garden), is 492 GJ, which calculates at 2.0 to 2.7GJ / m^2 (See above about how you measure the area of the house). This embodied energy in the house is comparable with a standard Australian timber frame and brick "veneer" project home at around 2.5 to 2.7 GJ / m^2. The embodied energy translates into 60 tonnes CO_2 greenhouse gas emissions total. Taken over a 40 year life cycle this translates as 1.5 tonnes CO_2 e / annum.

Over a 40 year life cycle, the breakdown on emissions is 35% embodied energy emissions and 65% utilisation energy emissions. A figure of 20/80 is often quoted, but when one gets the utilisation energy emissions down to lower levels, the embodied energy emissions become more significant, and worthy of closer attention.

Material Choices & Private Transport

The potentially controversial choice of steel for structure and cladding and aluminium in small quantities in the windows arose from need to withstand bushfires and termites and avoid toxic chemical treatments. Both steel and aluminium are durable and recyclable. An analysis was done on the comparative embodied energy in the steel and aluminium compared to the energy used in private transport (at the time when Lindsay Johnston travelled 55 km each way to the University every day).

Embodied energy in aluminium amortised over 40 years = 0.7 GJ / annum
Embodied energy in steel amortised over 40 years = 7.0 GJ / annum
Decision to park V8 Sports Car and drive a 650 cc 2 cylinder Subaru = saved 70 GJ / annum