Surrey Hills VIC

RENOVATION
ZONE 6: Mild temperate

Topics covered	
Passive heating and cooling	
Efficient envelope design	
Renewable energy use	
Efficient appliance use	
Rainwater harvesting	
Greywater treatment/re-use	
Reducing embodied energy	
Greenhouse gas reductions	
Sustainable materials use	
Waste minimisation/recycling	
Indoor air quality	
AccuRate (thermal comfort)	5.1 (regulatory)

This extensive renovation of a 1930s duplex in Surrey Hills, Melbourne, incorporates the latest technology in solar efficient design, water collection, greywater re-use, and photovoltaic grid-interactive power systems. It also uses forest friendly timber products and low toxicity finishes.

The owners, a young couple, wanted to renovate their 1930's brick duplex. The existing home was a maze of small pokey rooms.

Their brief called for the existing home to be upgraded to a solar efficient 2-bedroom home with large living areas, two separate studies and two bathrooms. They were keen to incorporate the latest technologies in sustainable home design.

The climate is cool temperate. The prevailing winds come from the southwest in winter and from the northwest in summer. The diurnal (day/ night) temperature range normally exceeds 8°C. [See: 4.2 Design for Climate]

The site is a long urban block, 48 x 10m wide, running east-west. Northerly access was limited by the presence of the neighbouring half of the duplex, situated directly north and sharing a party wall. The neighbours' proposed extension also had to be taken into account. [See: 2.2 Choosing a Site; 4.3 Orientation]

DESIGN SOLUTIONS

General planning

The existing home was partly demolished and re-planned. The front living room was converted to a master bedroom with ensuite attached, and the rear of the building was removed and rebuilt. Only two rooms remained intact by the completion of the project.

Maintaining the streetscape and the connection to the neighbouring duplex was seen as important by the owners. This was achieved by leaving the street facade of the house intact to match the neighbouring duplex and to fit in with the character of the street. [See: 2.3 Streetscape]

The extension was built with a suspended concrete slab for thermal mass and an AAC blockwork party wall for its excellent fire rating and good sound insulation properties.

The pitch of the north-facing roof was designed to accommodate solar panels and a solar hot water service. [See: 6.7 Photovoltaic Systems]

Courtyards were located to the north of the building to maximise solar gain, with an extensive area of double glazing in the roof over the dining/ living area. [See: Passive Solar Heating]

The open-plan kitchen, dining and living spaces opening onto an external north-facing deck and internal courtyard which facilitates natural ventilation and is conducive to a relaxed lifestyle.

Maximum cross-flow ventilation was achieved with carefully positioned windows. A window was placed above the stairs to create a thermal chimney for stack ventilation. [See: 4.6 Passive Cooling]

A basement is located below the living room to accommodate a battery room (for the photovoltaics), storage, a dog shower and a cellar.

Cladding

External walls are a combination of rendered fibre cement sheet and AAC blockwork. Both products were chosen on an environmentally preferred basis for their low embodied energy and more sustainable manufacturing processes. [See: 5.1 Material Use]

Boundary walls are AAC (autoclaved, aerated concrete) blockwork. The fire rating and insulating properties of this material made it an ideal choice for a boundary wall.

Thermal mass and insulation

A new suspended concrete floor slab at the rear of the house and the brick walls which have been retained at the front of the house provide the majority of the thermal mass required to even out day/night temperature variations. [See: 4.9 Thermal Mass; 5.12 Concrete Slab Floors]

Concrete slab insulation is provided by 50mm thick RMAX L grade foam insulation with an R-value (insulating value) of at least R1.0. This insulation was placed on the underside of the entire suspended slab. [See: 4.7 Insulation]

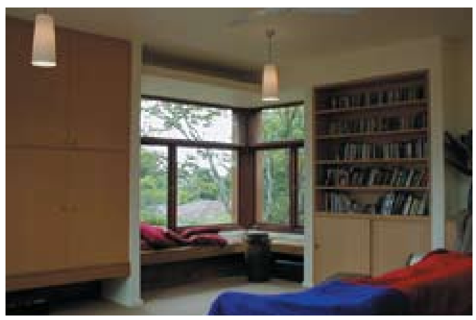
AAC walls in the dining area provide reasonable thermal insulation (R1.5 for 200mm thickness) due to the trapped air bubbles within the blocks. They also contribute moderately to the thermal mass of the structure due to the masonry component. [See: 5.5 Construction Systems]

Wool/ polyester bulk insulation batts were installed in the walls and ceiling. The R-value of the batts was R1.5 to walls and R3.0 to ceiling.

'Air-cell' (an innovative insulation product that combines the benefits of reflective and bulk insulation by trapping bubbles of still air inside reflective foil) was used in addition to bulk insulation in the roof. This increases the total summer roof R-value by around R2.2 and provides a sarking layer.

Glazing

Double glazing (insulating glass units or 'IGU') is used for all windows and glazed doors.



Roof glazing is an argon-filled double glazed assembly with a low-e coating on the inside face of the glass. A 12mm spacer bar is used between the glass sheets to increase the R-value and minimise heat loss. [See: 4.10 Glazing]

There are no west-facing windows in the new extension.

Shading

An acrylic canvas shade sail protects the north facing courtyard and deck from summer sun. It is removed in winter to allow maximum solar penetration into the building.

This adjustable shading system allows maximum flexibility in Melbourne's unpredictable climate. It is particularly useful in spring and autumn when fixed shading is unable to respond adequately to hot or cold snaps.

Roof glazing is shaded by blinds on auto spring loaded rollers. As the roof glazing can allow serious overheating in summer, the designer experimented with the unique method of using a version of Air-cell for the blind. This should reduce heat gain by up to 95 per cent in summer.

Additionally, photovoltaic panels on the roof will provide significant heat reduction by shading large areas of the roofing material from direct sun. In effect, this creates a partial fly roof for the building. [See: 4.4 Shading]

Natural ventilation

Windows have been carefully placed to facilitate maximum cross-flow ventilation.

Casement mechanisms, which increase the openable area of the window, assist ventilation on the majority of the windows.

Stack ventilation (drawing rising hot air out of the building) is facilitated via a high window above the stairwell. This is also known as a 'thermal chimney' effect. [See: 4.6 Passive Cooling]

Recycled materials

Existing materials were re-used wherever possible: [See: 5.1 Material Use Introduction; 5.3 Waste Minimisation]

> Timber framing and flooring were salvaged during demolition for re-use in the renovations.

> Bricks were salvaged from the demolished garage, cleaned, and re-used in the basement walls and base brickwork.

> Recycled timber was used for internal flooring to the second story, overlay flooring to the first floor and external decking. Refer to the section on 'timber usage' for further information.

> Slab reinforcement was 100 per cent recycled Smorgons ARC steel.

> GB Slag Blend concrete was chosen for its recycled content.

> Recycling bins were built into the back of the pantry unit with sliding doors to enable easy removal of recycling.

> A Kitchen King recycling system is installed in the kitchen for composting and general garbage.

> The existing gas heating system was serviced and retained.

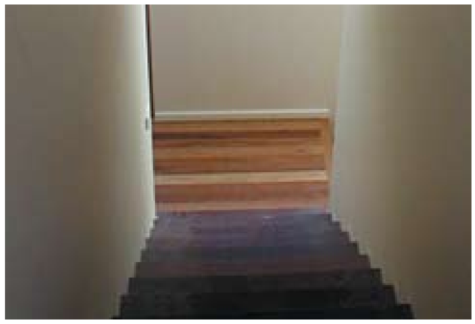
Timber usage

Plantation pine was used for framing. External stairs are constructed from treated plantation pine.

All cabinet timber veneers were made from New Age Veneers, produced in Europe from refigured plantation poplar.

Recycled ash or jarrah were used for flooring. Recycled jarrah was used for internal stairs and external decking. Recycled ash was used for internal timber posts.

Western red cedar (WRC) sourced from Canada was used for doors and windows. WRC is a high- grade joinery timber with high durability (durability class 1). Whilst this timber comes from old-growth source, the Canadian government reports that the producers have a reasonably managed harvest program in place and new plantations are being cultivated. [See: 5.4 Biodiversity Off-site]



Timber joinery was environmentally preferred for windows and doors for the following reasons:

Aluminium frames have very high embodied energy and, unless thermally separated, conduct heat. This reduces the overall energy performance of the window.

PVC frames provide adequate thermal separation because the material has good insulation properties. [See: 5.1 Material Use Introduction]

Low toxicity finishes

Flooring was sealed with Feat Watson Floor Seal which is Tung Oil-based. It has very low levels of di-isocyanate compared with 2-pack polyurethane finishes.

Internal walls and ceilings were painted with Berger low VOC water-based paint, and Limewash was used on feature walls.

Air infiltration and ventilation is tightly controlled in a well designed and built passive solar design during the winter months. This places even greater importance on reducing the level of toxins emitted by finishes and materials.

APPLIANCES AND SERVICES

Space heating

Supplementary heating is by a gas central heating system. No supplementary cooling is required for summer. The study has been provided with ceiling fans for airless days. [See: 4.6 Passive Cooling; 6.2 Heating and Cooling]

Appliances

A gas cooker was selected by the owners because gas cooking generates approximately 33 per cent less greenhouse gas than electric cooking. [See: 6.1 Energy Use Introduction]

The dishwasher is water efficient and 4.5 Star energy-rated. It is connected to the hot water tap to avoid use of electric heating elements.

The washing machine is a 4 Star Galaxy award-winning model.

The refrigerator is 6 Star energy rated, and uses 1080 watt-hours per day at 32° ambient temperature. This is only 1/3 of the energy use of an average refrigerator, particularly significant because a refrigerator can contribute to around 25 per cent of a house's energy consumption.

No electric clothes dryer has been installed. A drying rack has been provided for natural drying of clothes internally. [See: 6.4 Appliances]

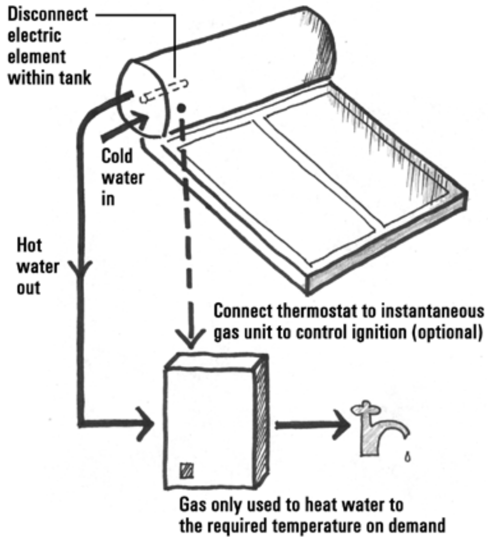
Lighting

Natural daylight levels are high throughout the house interior, reducing energy use.

For night lighting, surface-mounted and pendant lights were selected exclusively, to eliminate holes in the insulation necessitated by low voltage transformers. 98 per cent of lights have energy efficient compact fluorescent or circular fluorescent globes. [See: 6.3 Lighting]

Hot water heating

A solar hot water unit with 2 panels was installed, boosted by an instantaneous gas unit.



The electric element has been removed from the solar hot water service to reduce greenhouse gas emissions. The solar hot water service and the instantaneous gas unit have been connected in series so that gas is only used to boost water temperature when it is actually required. [See: 6.5 Hot Water Service]

PHOTOVOLTAIC SYSTEM

A grid-interactive photovoltaic electricity generating system was installed, including 20 75watt BP modules and a 3kVA PSA inverter.

The system utilises a two-way meter that allows electricity to be drawn from the grid when the system is not producing enough, and to be fed into the grid during times of excess production. The grid is effectively used as a battery system.

A battery backup system is also installed to eliminate the inconvenience of grid supply interruptions. A solar / grid / battery interactive sinewave inverter controls this process. [See: 6.6 Renewable Energy; 6.7 Photovoltaic Systems; 6.9 Batteries and Inverters]

How the system works:

Non-essential loads are wired as grid interactive (ie. with no battery backup).

Essential loads are grouped in the switchboard and are wired to the inverter, so that in the event of a main grid failure the inverter will drive these loads from batteries. The larger the battery system, the greater the load the system can supply.

Typical essential loads would include, but not be limited to: lights, water pumps, gas hot water electronics, alarm and intercom systems, computer equipment and equipment with digital clocks (to avoid re-setting).

Under normal operation with mains supply available:

- During the night (no solar power), all loads are running from the main grid supply. The inverter is in an idle state synchronised to the grid, with a battery charger maintaining the batteries in a charged state for essential systems.
- During the day (with solar power), the solar power generated will raise the battery voltage above that set by the inverter battery charger. The energy thus created is converted to 240V and fed into the switchboard. If it is not used within the house it is fed back into the grid. A solar regulator is required for the sole purpose of protecting the batteries from overcharge in the event of the grid failing.
- In the event of main grid failure the inverter will disconnect itself within two seconds from the grid (this is a legal requirement). Essential loads then run off the battery supply. Non-essential loads are in blackout until the grid supply is restored. The inverter senses when the grid is restored and reconnects these circuits.

WATER USE

Rainwater harvesting

Two 4,500L water tanks have been installed under the deck to supply showers, vanity basins, toilets, laundry taps, the washing machine and the hot water service.

Town water is used for drinking in the kitchen only. There is a switch-over from town supply to rainwater supply by the appropriate check valves should this be required. Tanks are fed from all roofs and augmented by town supply. A third tank of 13,500L has been installed in the rear of the garden to handle the overflow.

An electric pump powered by the PV panels is used to supply water at adequate pressure to the house. [See: 7.3 Rainwater]

Greywater collection

Greywater is collected from showers, basins, and the bath.

Note: Whilst less likely to contain pathogens than greywater from laundry and kitchen wastes, it must be assumed that pathogens may still be present. Ideally, all greywater should be disinfected before storage or re-use.

A 2,000L polyethylene septic tank is used for storage, and an electric pressure pump powered by the photovoltaics delivers greywater to toilet cisterns for re-use. Greywater is also used for sub-surface irrigation in the garden.

Note: In many local government jurisdictions, strict rules apply to the collection and re-use of greywater. Direct application of untreated greywater onto inaccessible garden areas is permitted by some health authorities.

Check with your Council before installing a system. When stored, greywater can degrade quickly due to the presence of bacteria and pathogens and high levels of nutrients from detergents and soaps.

A small reed bed or wetland will aerate the water and remove some of the nutrients. These wetlands are quite small, don't require fencing (there is no exposed water) and can be made into a garden feature.

A sand filter further aerates and removes contaminants.

An ultraviolet filter will finally disinfect water ready for re-use for garden watering or toilet flushing. [See: 7.4 Wastewater Re-use]

Landscaping

An inner-city permaculture-based garden is being established by the owners at the rear of the property. [See: 2.4 Sustainable Landscapes]

Low-water planting and porous surfaces (to minimise stormwater run-off) have been used in the internal courtyard. [See: 7.5 Stormwater; 7.6 Outdoor Water Use]

Greywater will be the sole source of water for the garden.

PROJECT EVALUATION

This project is a stand out example of how home owners with a strong commitment to sustainable ideals can significantly reduce the environmental impact of their home whilst increasing comfort levels and reducing operating costs.

No cost benefit analysis has been performed on the project to date and, whilst this would be of great interest to many, the owners of this home have clearly decided to take a whole of life cycle approach to their home.

The owners realise that the small additional investment in the sustainable features of their home will continue to deliver economic and environmental benefits, long after the initial cost has been made insignificant by appreciation in the value of their property.

This outstanding success has been achieved through the strong commitment of the owners and their choice of a design team with specialist skills in sustainable design and construction.

Many of the principles described in *Your Home* have been applied with great skill in this project, and as a result the house is a good model of how sustainable design and construction can be considered 'mainstream' rather than a specialist skill.

PROJECT DETAILS	
Designer:	Andreas Sederof and Ryan Strating, Sunpower Design
Builder:	David Smith, SolarCon
Engineer:	Andreas Sederof, Sunpower Design