Rise and shine

Elegant simplicity rules at 177 Pacific Highway.
Net-zero homes are often viewed as expensive. Yet by adopting a simple design approach and doing it themselves, Jonathan and Robyn Rich have managed to build at below the average per square metre construction cost, and create a lovely home that is comfortable year-round. It also boasts a large energy surplus.

Built in the Melbourne bayside suburb of Frankston, the home has two bedrooms, a total area of 150m², and was built with an 8-star home energy rating. Costs have been minimised by using a simple square design, a single-pitch roof, an exposed slab, recycled red brick walls internally and in much of the exterior, and the use of second-hand materials where available. Construction required focused hard work over a six-month period.

PASSIVE DESIGN

Walls are a mixture of cavity brick and reverse brick veneer, insulated to R4.6 with 100mm polystyrene foam. The roofing system is insulated to R6, with an R1.5 heavy-duty foil blanket immediately under the metal roof sheeting, the wrap, then R4.5 batts underneath. A conventional slab is used with waterproofing and sealing at ground level.

ACTIVE ELEMENTS

From an HVAC&R perspective, what is most interesting about this house is the use of a ground loop to precondition air from outside entering the heat recovery ventilator (HRV).

A loop of 40mm poly pipe buried at a depth of 1.2m, and with a length of 65m running up and down the driveway and under the slab recirculates a water-glycol brine at 8 litres/minute through a coil in the HRV, with the pump motor and HRV fans drawing a combined maximum of 70W.

A glycol/water mix has been used to prevent fouling of the water.

“We were the first to commission such a unit in Australia,” Jonathan says.
“We had to base our implementation on European experience, where glycol is also used to prevent freezing.”

In winter this system is preheating the outside air to between 15 to 16°C before it enters the HRV. In summer it pre-cools air down to around 25°C (pre-HRV), with a 30°C ambient. By doing this the HRV has enhanced heat recovery.

The HRV also has a bypass, which essentially enables an economy cycle.

The HRV operates all the time. The unit is operated at low speed overnight and medium during the day (around 50L/sec). It’s configured to deliver 0.5 air changes per hour to the living and sleeping areas, and two air changes/hour to the kitchen and bathroom at medium speed.

Power draw when the HRV is on low speed is 11W, and 44W on medium. Although it has EC motors, and the controller enables fan speeds to be changed in increments of 1 per cent, for practical operation just three speeds have been configured. Acoustic isolation is achieved via dampers.

A standard in-line acoustic damper is also used on the exhaust-air duct adjacent to the main bedroom.

Both the bathroom and kitchen vent air to the HRV. A rangehood discharging to the internal kitchen space is fitted with activated carbon filters to capture grease to minimise fouling of the heat exchanger element in the HRV.

The internal temperature has a variation of 2 or 3°C most days. It is warmer in summer and cooler in winter (based on seven months of temperature logging, refer to Table 1).

The small reverse-cycle split system (3.2/2.5kW heating/cooling capacity) is only switched on for heating on cloudy winter days, and in summer only during a heatwave.

A 5kW solar PV system more than offsets the energy used by the home. The square shape of the building and simple roof construction means that the solar system blends in well with overall design of the building.

The heat pump domestic hot water unit, dishwasher and washing machine are all set to run during daylight hours when the solar system is operating.

All lighting is LED.
The house uses electricity only; annual energy exported to the grid is about 2.5 times energy imported. The energy surplus over the first 12 months of having the solar system connected is expected to be around 3,000kWh.

Should Jonathan and Robyn choose to purchase an electric car in the future, this sort of annual surplus would be enough to power the car for around 17,000km, more than they would normally drive.

The solar system was installed in October 2016 but only connected by the distributor in January 2017, (as shown in the graph). Without the solar system, annual energy use would be around 4,000kWh, corresponding to an average daily energy consumption of about 13 kWh/day. This is low considering that no gas is used.

**ENERGY PERFORMANCE**

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LESSONS LEARNT

The simple industrial-type design approach adopted by Jonathan and Robyn made the house both cheaper and faster to build than it otherwise would have been. Putting effort into achieving good levels of insulation and sealing has paid off in terms of comfort.

The acoustically isolated HRV is extremely quiet, and inaudible at low speed, warranting the effort to achieve this. The addition of the ground loop has made it extremely efficient, and with a lot of thermal mass the house is stable in temperature.

On the other hand, there have been a couple of things Jonathan and Robyn would do differently if they were building again. The house was built with a split-level roof; making the roof a single level would have further simplified the build. And although the wall-mounted split system isn’t obtrusive, a cleaner solution would have been to include this into the ventilation system.

The design focused on four key areas: simplicity and ease of construction; no compromises with insulation and sealing; a high-efficiency HRV made even more efficient with the ground loop; and high-efficiency heat pump units for hot water, as well as space heating and cooling.

This home and the approach taken by its owners is a great example of comfortable and affordable sustainable housing.

PROJECT AT A GLANCE

The equipment

- **Heat-recovery ventilator:** Zehnder Comfoflow 350
- **Hot water heat pump** Sanden 250 litre
- **Sub-soil heat exchanger:** Zehnder ComfoFond-L-Eco 350
- **Ventilation ducts and registers:** Zehnder
- **Split system:** Daikin Zena (smallest unit made) FTXJ25PVMA/RXJ25PVMA
- **Windows and doors:** uPVC Certainteed
- **Wrap:** Pro Clima

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