

# Suburban eco house

*The use of structurally insulated panels (SIPS) resulted in a quicker and easier build*

After looking for three years, a block in Birkenhead South Australia that was the right orientation, in the right location and for the right price came on the market. Within a few days Karina and myself had our name on the contract and 'the build' that we had been planning for so long was about to become a reality. As an added bonus the lemon tree fell on our side of the subdivision!

## Design options

We undertook our build as we wanted to live in a healthier building that worked with the local environment and to demonstrate that a sustainable house can be built on a comparable budget to a project home builder. We were continuously being told that an 'Eco House' is expensive, so we wanted to prove it didn't have to be, by thinking about orientation and designing to the location and local climate.

SUHOstudio (a division of Sustainability House) took our concept design to working drawings, dealing with the documentation. The final design was modelled using First Rate 5 software, and then run through a tool called *RoboRater* in order to identify the most efficient building fabric within the budget.

## BY MARK CLAYTON

The design incorporates basic passive design principles; bedrooms to the east, to wake with the sun and be cool in the evenings; living areas to the north with good northern glazing, to allow winter sun deep into the building envelope; and utility areas to the west, so they can absorb the strong summer sun in an area that we will spend little time in. Shadow modelling allowed us to optimise eave depth and offset so in summer the sun stays outside the house. If you visit our house during the middle of the day in summer all the walls are in shade!

Our house, at 125m<sup>2</sup> on a 330m<sup>2</sup> block, is small by Australian standards but sufficient for the two of us. Building larger means more expense upfront and more expense to run the finished home. We designed the house layout around how we live our life, resulting in a reasonably sized open plan kitchen/living area, which leads onto a large deck to create an indoor/outdoor living space.

*L-R: All SIP wall panels were erected in three days; internal plastering was the biggest job.*

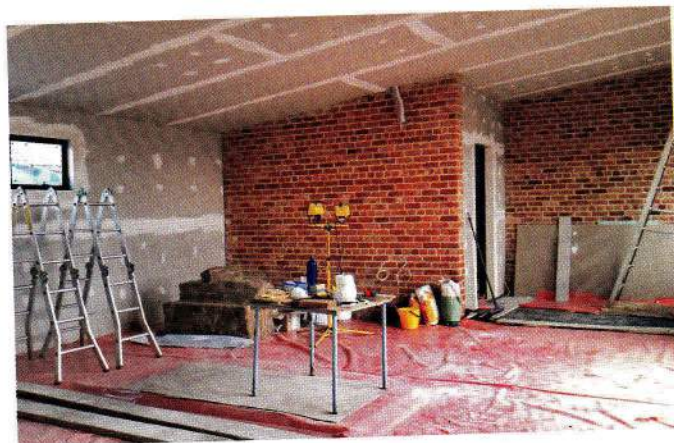
## Becoming owner builders

We then approached several builders with our design requesting quotes. Only one got back to us but their price was too high, as a couple of the specifications were not the norm so the price started to increase. Faced with this situation we decided to embark on an owner build, project managing the trades and doing as much as possible ourselves using that one quote to give us a bench mark as to what our build may end up costing.

It was at this point we decided to use a structurally insulated panel (SIP) walling system, to make the build simpler and quicker. Some contractors simply weren't interested in what we were doing – perhaps it was outside their comfort zone? Despite this, most were still enthusiastic about these amateur first-time owner builders who were doing something different.

We found that by breaking the tasks down into what seemed familiar worked really well, keeping it simple and not complicating the issues with the science behind the build.

We had no hold-ups with council approval; although our plans were to build outside the norm, we were not trying to get permission to build something visually unacceptable to the local area or outside







of planning guidelines. For example, the use of corrugated metal is common in our area with many older buildings, which would have originally been built with a tight budget. So, although the design was striking, the material was familiar to planners and the local environment.

### Two weeks to laying roof

Getting started took a little longer than we thought; weather held up the slab guys on their previous build and each time we called the answer was 'it may be next week.' In hindsight we think they actually did us a favour – delaying the start until winter passed! The morning they arrived we remember seeing the truck come around the corner, lights blazing in the sun, and from that day the weather improved.

Birkenhead is prone to flooding, so fill was brought on site and we opted to raise our slab slightly higher than necessary for peace of mind. My partner Karina's father has been owner building houses in NSW for four decades and was on site for the first two weeks to help get us off the ground. He helped ensure the bottom plate was bolted down precisely, which is crucial

for everything that goes above it as the walls, being pre-fab, were already made.

In those first two weeks, we went from bottom plate to being ready to lay the roof cladding. Internal and external walls were up, windows in, breathable membrane in place, roof trusses, tie downs and bracing all done. It was amazingly fast!

We quickly got up to speed with the Building Code of Australia (BCA) requirements and when in doubt we went over and above with various intricacies to guarantee sign off from our licensed builder at each of the required stages. This was legally required in SA as we were owner builders. The builder worked with us to make sure that what had been done met the BCA. In total, this involved five inspections, including bottom plate tie downs, wall and roof bracing along with truss tie downs, waterproofing of wet areas, internal wall construction and room sizes, with the final inspection for general quality of the build, making sure that it was complete and habitable.

*Editor's note: In SA, owner builders are required to have a licensed builder sign off on each stage of their build.*

The whole experience was simple and straightforward. Insurance for the build was easy to purchase and was organised over the phone.

### Materials

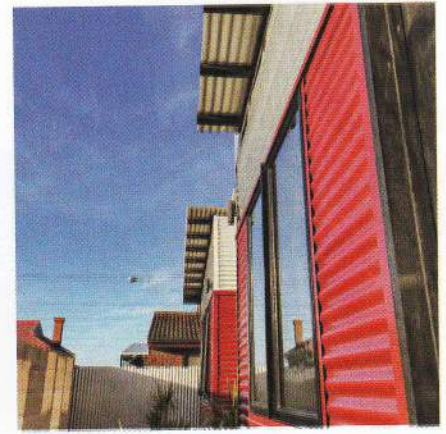
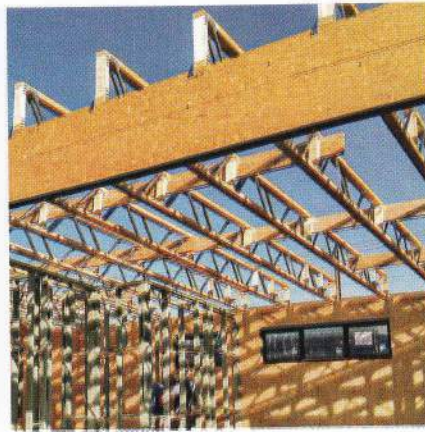
#### WALLS

The SIP walling system came from WA prefabricated, which resulted in the building being locked up in less than three weeks. We chose this panel because it made the build very simple and after a visit to a progress build in WA to see how they went together, we were confident we could do it.

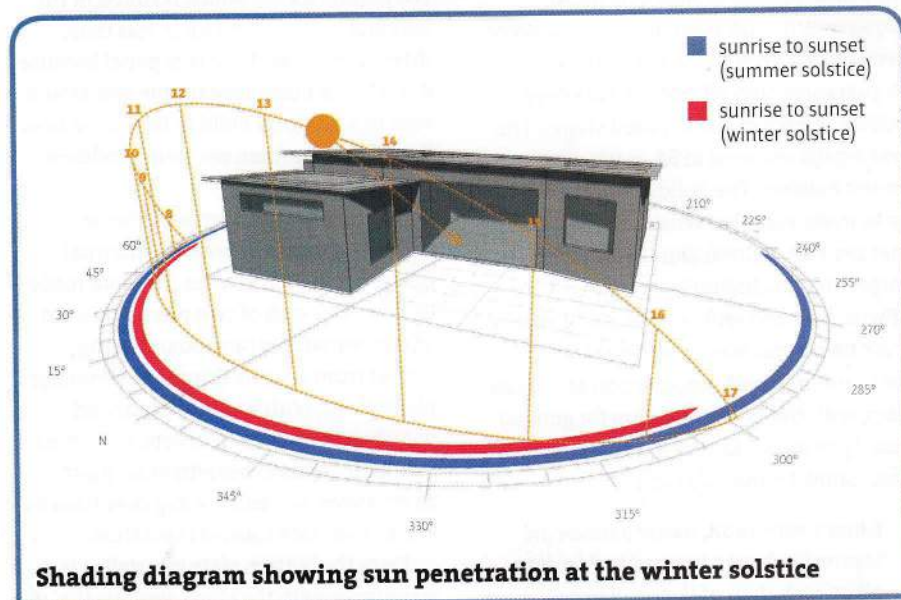
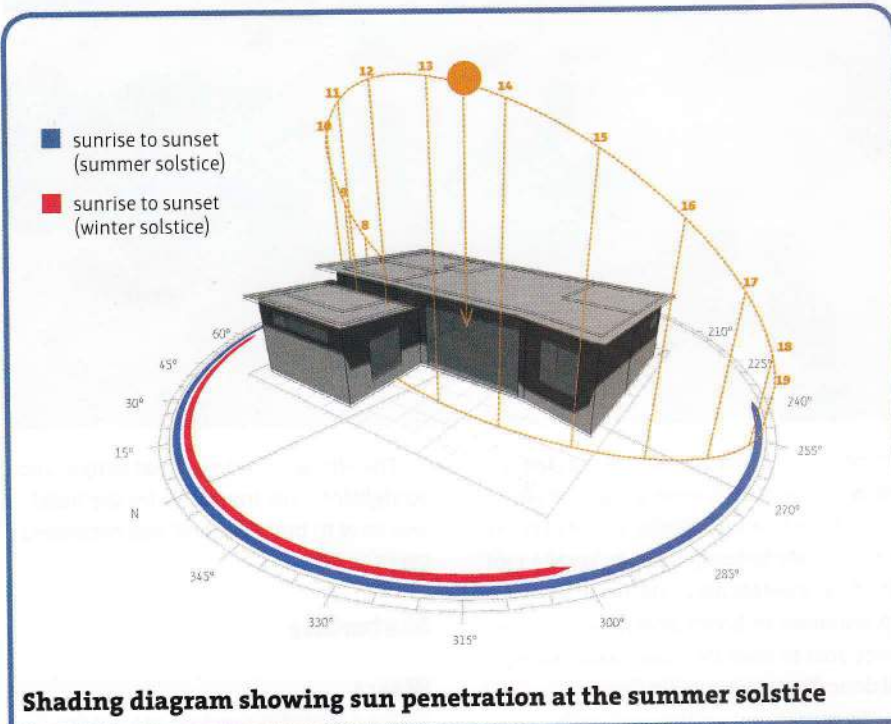
The SIPs we used were timber as we were concerned with the thermal bridging of metal frames. They are made up of a sandwich of two pieces of 11mm OSB (orientated strand board) using timber from routine thinning of managed plantations, with a 93mm expanded polystyrene (EPS) central core. EPS offers greater insulation benefits than most alternatives and will not sag over time as it is a solid state form of insulation.

Once the bottom plate is installed in accordance with the plans given by the





L-R: Cutaway showing wall structure; Posi Strut trusses; Zincalume external cladding.



SIP manufacturer, each panel is then glued and nailed into place in numbered order. When discussing the installation with the supplier, we were told that one of his teams (four people) could build our external walls in two days. We took this with a pinch of salt but to their credit it took our untrained team of four, who had not used the product before, just three days!

The panels come with a pre-chased hole running horizontally at 300mm, 450mm and 1200mm to run electrical cables. As we put the panels together we ran a chasing string through the holes so when the sparky arrived on site to install the cabling all that needed to be done was tie a wire to the string and pull. Our electrician was surprised how well this worked and the fact he didn't need to drill through the studs to run the external cables.

SIPs are available as internal walls and roofs panels but we chose to use traditional stud internal walls with R2 *Earthwool* insulation for all but one. The reason for this was it made life a lot easier with the wiring of the building as all switches are located on internal walls, and secondly, it means the building fabric is not compromised with chasing out insulation for the wiring.

The reason why one internal wall is SIPs was so we could break the building into two structural boxes.

R6 *Earthwool* insulation was used in the ceiling and one wall was filled with phase change material as an experiment.

*Editor's note: Phase change materials change state, for example from liquid to solid, storing and releasing energy.*





## ROOF

The roof truss structure was designed to make building easier. We used a Posi Strut system, which spans the whole building meaning that no internal walls are loadbearing. While installing the trusses we were surprised how detailed some of the documentation was, right down to the size, length, number and direction of the nails required for the triple grips.

*Editor's note: Posi Struts are open web designed trusses that allow for lighter material to be used, with the ability to span wider distances.*

## WINDOWS

All our windows are double glazed low-E units, apart from the large sliding door, which is single glazed with EnergyTech glass. The main reason for this was weight, as double glazed sliding doors can be very heavy, making the opening of the doors difficult.

The location of the windows allow for prevailing summer breezes to enter from the south and vent heat from the high windows in the hallway and optimise winter heat gains.

## BRICK WORK

Internal thermal mass was added in the form of two recycled brick walls in the kitchen/living area on the western wall. This wall is reverse brick veneer, which is predicted to reduce heat gain in summer. The section (from inside out) is 90mm brick/30mm air gap/11mm



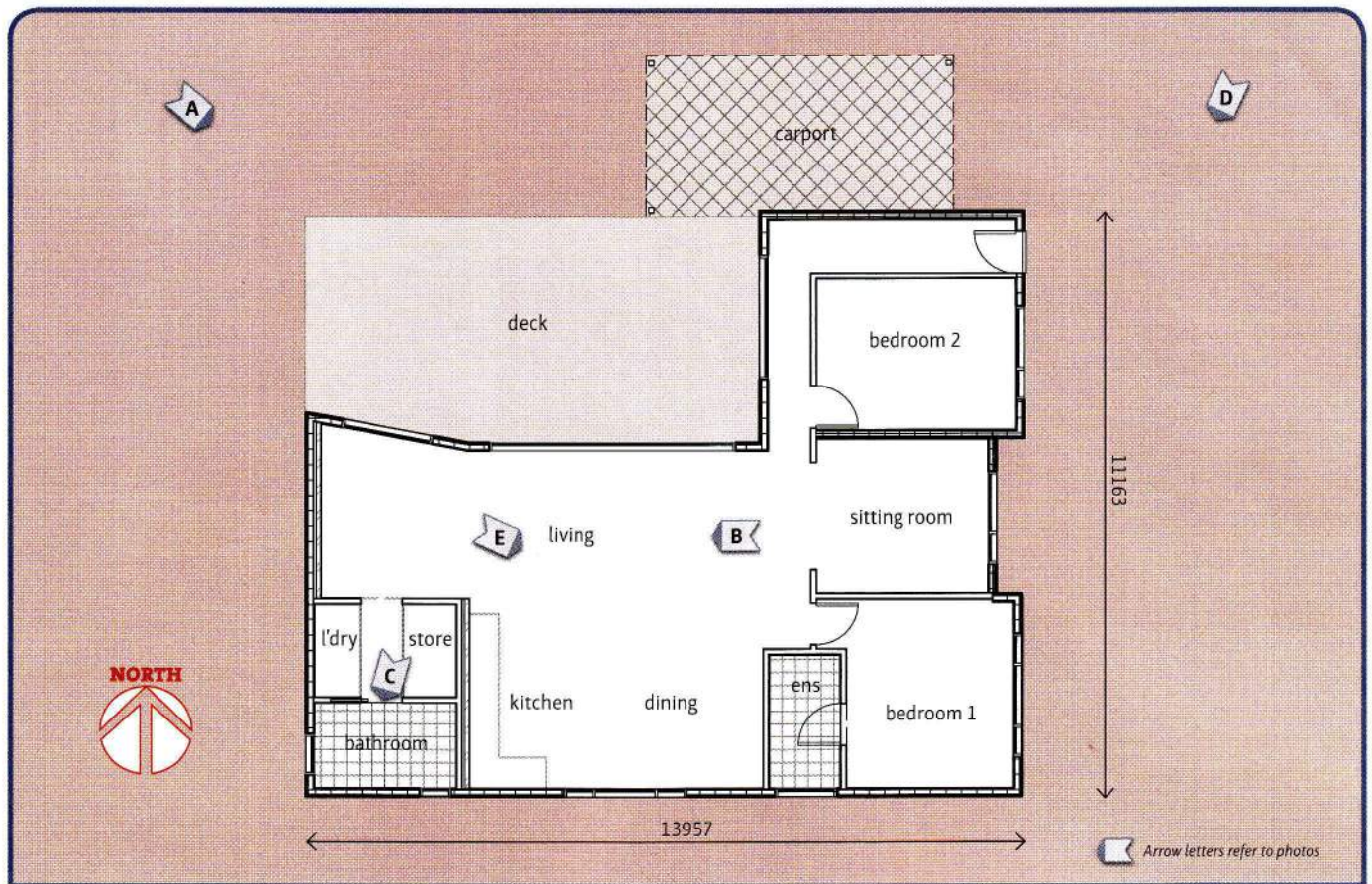
*Clockwise from top L: Thermal mass was added by including reverse brick veneer; the living area basks in winter sun; patterned tiles in bathroom; contrasting corrugated cladding makes for a visually striking exterior.*

OSB/93mm EPS/11mm OSB/breathable membrane/15mm air gap/Zincalume.

We were lucky to find a local semi-retired brickie or 'Brickician' (as his business card reads), who was experienced in heritage brickwork. Using recycled red bricks and cut and struck lime mortar, the walls not only add thermal performance but look great, with a very subtle American bond pattern worked in.







## FLOORS

Sisal covers the floor in the two bedrooms, with concrete floors throughout the rest of the house. These were sealed with a non-VOC oil from *Livos Australia*. We used non-VOC paints, primer, undercoats and sealers on the ceilings, walls and woodwork to eliminate toxins and improve air quality.

Our deck is made from bamboo, chosen for its renewable aspect and aesthetics. We have used this product before and have been impressed with its hardwearing nature.

## KITCHEN

The kitchen, bathroom and laundry bench tops are *PaperStone* made by Paperock, which is a recycled paper product sealed with a non-VOC glue. Once again we went for the pre-fab option with the kitchen units and after designing the kitchen, the supplier gave us the option of flat pack or constructed units at no extra cost.

The answer was a no brainer so the kitchen units were delivered already made up, so all we needed to do was set the height, fix them together and to the wall.

## Utilities

Two slimline rainwater tanks totalling 7,000 litres in capacity are located to the south of the building and have been plumbed into all cold water outlets, with a heat pump for the hot water. Based on roof area we estimate we will be on tank water about nine months of the year.

We didn't want any drain pipes visible at the front of the building so we managed to get all downpipes to drop at the back, which become a wet system feeding into the rainwater tank. There is a PVC pipe going through the slab to enable this. The zinc downpipes are purely aesthetic as there are PVC pipes inside them.

To avoid the extra expense of a gas supply charge we opted not to get gas connected to our block and chose an induction cooktop for efficiency. No gas also makes disconnecting from the grid at a later date easier and helps from day one to create a carbon neutral occupancy for energy.

LED lighting is used in most areas of the house with second-hand lamp shades in the main living area sourced from the old wool stores in nearby Port Adelaide.

A 3.5kW solar system is on the roof along with a weather station. We are on the wait list for a *Tesla* battery predicted to be available in Australia early 2016. Our intention for the future is to go off-grid.

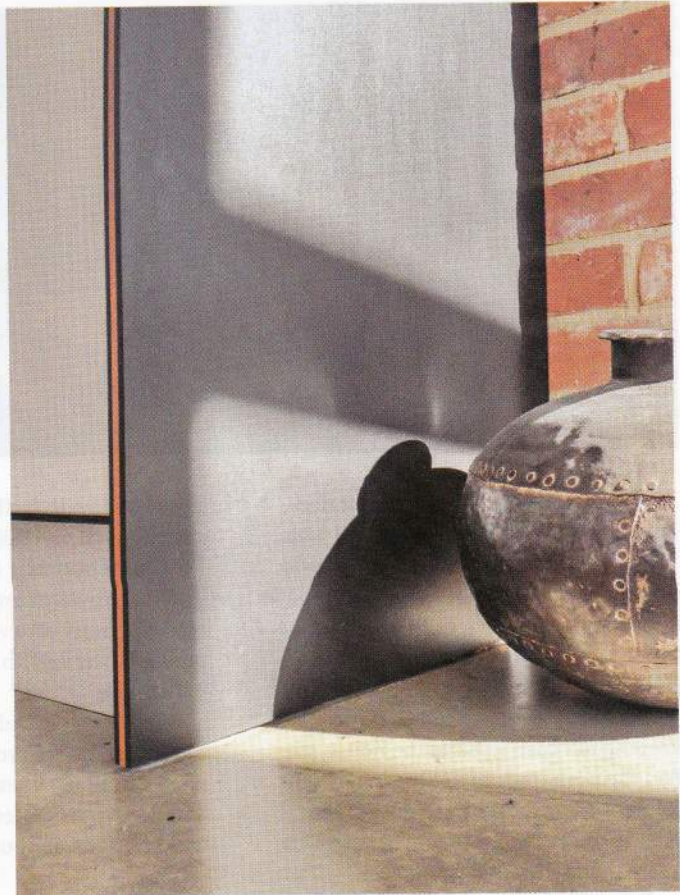
## Finishing

The most time consuming job we undertook was installing the plasterboard, jointing and sanding. The ceiling sheeting we put up in one day on a 13 hour shift with two friends. The walls however seemed to take ages and once it is sheeted you then need to perform the laborious task of jointing!

We were lucky to find another local semi-retired tradie this time in the form of a plasterer who gave me a crash course in jointing and square setting corners. The sanding was done in the majority by a friend of ours who seemed to not mind doing it; we count ourselves lucky to have a pal like that!

One of our important goals was to minimise waste. Throughout the entire build we did not have a skip on site. Ordering the external walls prefabricated helped greatly to achieve this and leftover





*Clockwise from above: Limestone block wall provides privacy; textures abound; Paperrock makes an unusual kitchen benchtop.*

building materials such as plasterboard were given to a friend who was renovating.

An error on the roofer's part meant we used otherwise waste tin on the carport. We took one load of metal to the scrap recyclers and one trailer of general waste to the tip.

### Costs

There is no mechanical heating or cooling in the house other than ceiling fans, so electricity bills are significantly reduced and the 3.5kW solar system means the building is carbon neutral from a day-to-day energy use perspective. We use approximately 7.5kW hours per day to run our house, low even for a two person house, but that is because we are mindful of energy usage.

The end result is a very comfortable, well designed and well built home that cost \$30,000 less than the quote from a local project home builder. We ended up with the total build cost of \$150,000 for the







house with another \$15,000 for the deck, landscaping, solar system and front wall.

The SIPs walling system was \$21,000, slab \$15,000, roof trusses \$6,500, windows \$7,500 and the sliding door \$9,000 – due to the large size (3 x 4.8m) we needed commercial framing.

We took a mortgage on the land, keeping our cash to build the house, so had the advantage of not having to wait for periodic inspections to release the next section of money from a bank. This again made the build go quicker.

From the day the slab was poured to sign off to occupancy took only five months, with both of us still working full-time at our professional jobs. The trades we had to outsource were electrical (\$8,000) and plumbing (\$9,000) as Certificates of Compliance need to be issued by a licensed person.

We also opted to outsource tiling and roofing, as we believed we would be better off focusing on our professional jobs while paying a professional in their field to do a job in a fraction of the time and with a superior end result.

## Assessments

We were very keen to make sure the building was built well, as a well-designed building is irrelevant if not built properly. Once completed we had thermography analysis done on the building fabric and an air pressure test undertaken with the building achieving 3.6 ACH (air changes per hour) at 50 pascals. From what we understand, the average project house in Adelaide achieves around 14 ACH, which makes ours one of the best sealed houses in South Australia and possibly the country.

We have done a lot of renovating previously and the skills we already

possessed were further expanded by our research and talking to people. We unintentionally seemed to gravitate towards engaging with older tradespersons who were willing to pass on their wealth of knowledge and experience.

We also had regular visits from lots of locals who had heard about our build and were genuinely interested in learning about the passive design principles we were using in our build.

## Monitoring

We have installed several monitoring systems in the building. We are tracking internal temperature and humidity, energy consumption and solar energy production. Externally our weather station on the roof monitors external temperature, humidity, wind direction, speed and rainfall.

Additional data loggers (Onset *Hobo MX1011*) are located in the kitchen/living area and bedrooms to track internal temperature and humidity with a reading taken hourly. These simple loggers connect via Bluetooth to a smart phone making downloading data very easy.

It can then present data in a spreadsheet or graph format allowing easy comparison with the temperature graphs generated by the NatHERS software (which also works on hourly temperature readings). This gives an example of how close the predictive modelling used for compliance is to real life occupancy patterns.

The first two full months of data coming into winter (April and May) show that the internal temperature is a minimum of seven degrees above the outside temperature in the morning

and 10 degrees at the end of the day. This is a direct result of orientation, building design and the specifications used including double glazed windows, thermal mass, eaves and shading. Almost everyone that walks into the house comments on how warm and comfortable it is.

## Outside

The garden is low maintenance with lots of native and drought tolerant plants, with plans for a vegie and herb garden later in the year. Our street front privacy has been realised with a limestone block wall. There are 60 blocks in total and due to the size and weight of the blocks we have been able to dry stack them resulting in a very clean look at the joints. This only took six hours with an excavator.

Fixed shading devices to the east and an adjustable shade sail over the deck will be completed in August ready for the Adelaide summer. As we finish the last bits of landscaping we have come a long way from the *Portaloo* that was the ultimate under construction feature. It is very rewarding to now sit back and appreciate what we have achieved and observe the building performing as it was designed to do.

Many people have asked when will we start our next house but our focus now is to educate others in what we have done – the how and why. Hopefully this will encourage others to do the same and start to build better buildings that work with the climate in which they are situated.

## Advice

The main advice we would give to anyone looking to undertake a build would be good planning, understanding the work flow and being prepared! Keep your contractors in the loop as to where





Top: Garden has been kept simple and uses drought resistant plants.

Above: Other than the bedrooms (where sisal has been laid), the floors throughout the house are of polished concrete.

you are heading as the last thing you want is to get too far ahead, which then makes their job harder.

Go with recommendations – if you have used a good contractor and they recommend someone, then chances are they will share the same quality of work. We were very lucky with the contractors we found and have already recommended them to others looking to build. ♦

*Our house will be open for Sustainable House Day on 13 September 2015 as we are keen to share our experience and the outstanding result that can be achieved on a small budget.*  
[www.sustainablehouseday.com](http://www.sustainablehouseday.com)



## Links & resources

### ◆ Sustainability House

Sustainability House is a nationally recognised provider of energy efficiency assessments and ecologically sustainable design (ESD) services for commercial and residential buildings.

1300 308 525, [www.suho.com.au](http://www.suho.com.au)

### ◆ SIPs Industries

Structural insulated panels are strong, pre-manufactured, highly insulated and high performance building components.

08 9494 2211  
[www.sipsindustries.com.au](http://www.sipsindustries.com.au)

### ◆ Livos Australia

Eco friendly oils and paints.

03 9762 9181, [www.livos.com.au](http://www.livos.com.au)

### ◆ Trussworks

08 8283 1166

## Build budget and costs

	Proposed	Actual
<b>PRE BUILD</b>		
Land Purchase	\$241,100	\$227,193
Design and regulations	\$5,900	\$6,380
Power connection	\$4,000	\$2,020
<b>PRE BUILD TOTAL</b>	<b>\$251,000</b>	<b>\$235,593</b>
<b>BUILD</b>		
Slab pour	\$15,000	\$15,749
Walls (external)	\$31,750	\$23,392
Roof	\$16,800	\$23,155
Electrical	\$6,000	\$9,231
Plumbing	\$4,000	\$9,365
Walls (internal)	\$8,500	\$10,962
Insulation	\$3,000	\$1,529
Windows - double glazed	\$14,500	\$17,433
Kitchen cupboards incl oven	\$10,000	\$10,425
Wet areas	\$13,000	\$9,985
Internal finishing	\$12,500	\$6,751
Waste & hot water, misc	\$6,000	\$8,653
Wages	0	\$4,355
<b>BUILD TOTAL</b>	<b>\$141,050</b>	<b>\$150,985</b>
<b>OTHER</b>		
Solar panels		\$3,823
External and garden		\$14,156
<b>OTHER TOTAL</b>		<b>\$17,979</b>
<b>TOTAL</b>	<b>\$392,050</b>	<b>\$404,557</b>

### ◆ Paint Naturally

Specialises in natural, environmentally conscious ways to paint and decorate your home.

08 8272 6886  
[www.paintnaturally.com.au](http://www.paintnaturally.com.au)

### ◆ Paperock

Paper is transformed into an extremely strong and durable solid surface material with longevity and resistance to water.

02 9518 0520  
[www.paperock.com.au](http://www.paperock.com.au)

### ◆ Jaffa Limestone

Crafted from reconstituted limestone.

08 7131 1127  
[www.jaffalimestone.com.au](http://www.jaffalimestone.com.au)

### ◆ Natural Floors Adelaide

Stock coirs, sisal, jute and seagrass natural floor coverings.

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Top: Garden has been kept simple and uses drought resistant plants.

Above: Other than the bedrooms (where sisal has been laid), the floors throughout the house are of polished concrete.

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