



Photo by Simon Matzinger on Unsplash

Passivhaus: What's it worth?

Passivhaus

Passivhaus is a building standard that delivers healthy, comfortable buildings that are also energy efficient.

It delivers very high levels of indoor air quality, stable temperatures and a peaceful environment.

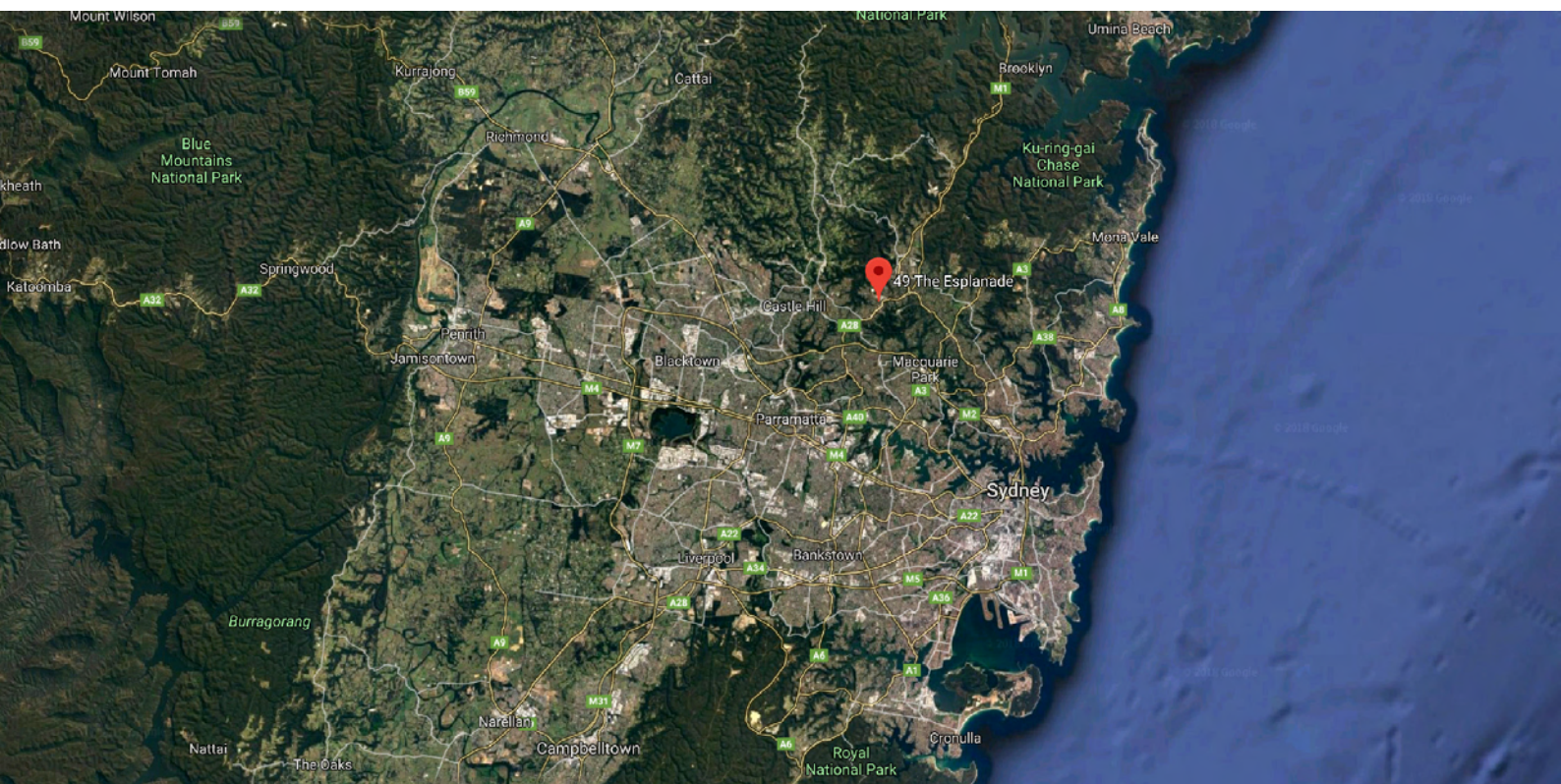
The standard requires the shell, or thermal envelope, of the building to provide adequate protection from the elements to ensure both occupants and building remain healthy over time.

The principles that underpin every Passivhaus regardless of size, type or location are:

- appropriate insulation
- solar control
- quality windows
- air tight construction
- reliable ventilation with heat recovery

The rigorous design process and quality assurance during construction ensure that passivhaus buildings perform as designed; comfortable, quiet and efficient.

A certified passivhaus is an unrivalled mark of quality.



Passivhaus in Australia

In recent years passivhaus has taken off in Australia. From zero certified buildings in 2012 to 14 in 2018 there are now over 180 projects nationwide.

There are over 600 dwellings in design or construction in addition to office buildings, a museum and a school.

Similar stratospheric growth has occurred in other comparable countries and looks set to continue. The UK went from 0 to 500 buildings in 8 years!

The attractiveness of passivhaus is well understood and desired by many. However at this relatively early stage of development in Australia, cost is often perceived as an insurmountable hurdle.

We have been working on a number of passivhaus projects over the last few years. This short paper outlines our learnings about the cost of passivhaus, specifically in the current Sydney housing market.

It doesn't have to cost more!

- The cost premium for passivhaus in Sydney is negligible, or nonexistent, for custom builder projects, if strategic decisions are taken to prioritise passivhaus. If it is considered a non-negotiable part of the brief, then it will be delivered within budget.
- The cost of passivhaus windows is comparable to good quality, Australian made, thermally improved aluminium windows with double glazing.
 - Panelisation can be cost effective, however the proximity of the manufacturing location to the site is influential.
- Refining a design with a single builder has cost advantages.
- Working with Certified Passivhaus Tradespeople is helpful in avoiding the risk premium.

The Project

Our clients owned a drafty, cold, uninsulated weatherboard cottage in northern Sydney. They approached us to design a new home on the site.

One half of the couple is a scientist who had been monitoring the temperatures in the house over several years.

The graphic below shows the swings in temperatures over the year. Given the close correlation between indoor and outdoor temperatures, the original house was akin to living in a tent.

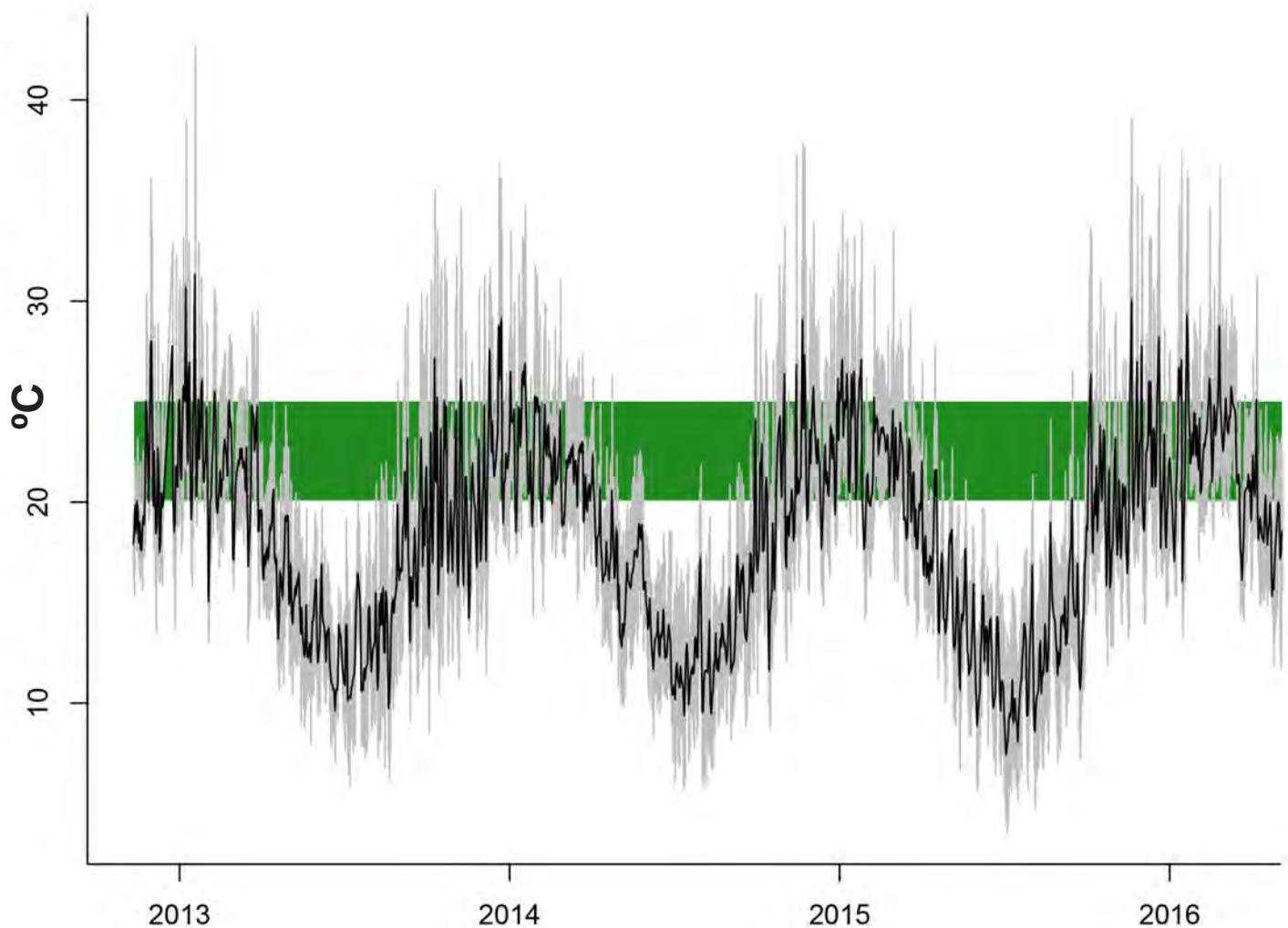
The green bar represents the 20-25°C comfort band of a passivhaus.

The Brief for the new home included the following:

- Beauty through function
- Want to be warm
- Low running costs
- No draughts
- Not a large house
- High ceilings
- Keep the gum tree
- Music to move through the house

The gum tree is a gorgeously inconvenient Tallowood that sits right in the centre of the block.

The design response was based on traditional passive solar principles. At this stage passivhaus was not on our radar.



The Starting Point

The site constraints forced a two storey design solution squeezed in between the front setbacks and the tallowood.

In order to protect the tree, a suspended timber floor was necessary as a concrete slab would kill the tree over time.

The lightweight construction presented a challenge in terms of thermal mass. Translucent internal water tanks were incorporated into the design to create some thermal storage.



The Design

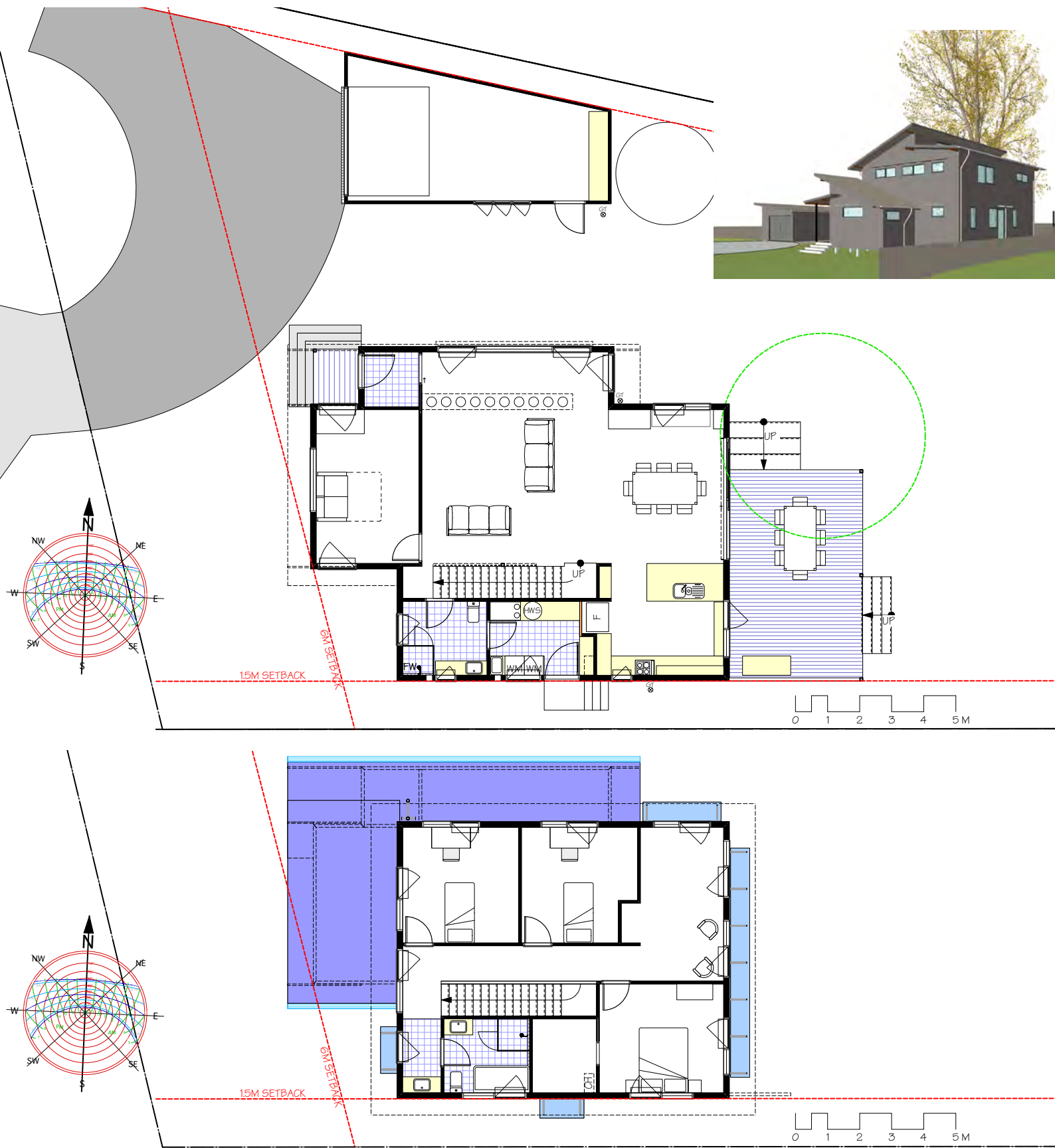
The building form is reasonably compact. It has good solar access with relatively few windows to the west (street frontage).

There are some large doors to the eastern deck that sits adjacent to the shade of the tallwood.

The water tanks frame the entry where the large north facing windows capture the warming winter sun. An external operable blind protects the window in summer.

A separate garage is located on the side boundary.

The second storey is compact with one bathroom shared between the three bedrooms. The second living space is reminiscent of a mafraj, a sitting space common in Yemeni homes where the clients lived for several years.



The Money Story

As is common in design, especially when pushing boundaries, the process has been a journey.

The home is now under construction and has presented an opportune moment to evaluate the avenues that were explored.

Over its gestation the project has been priced by four builders using a variety of construction systems.

All of the following pricing information is based upon the same building geometry. All prices include the garage and driveway too.

The design was locked in early. The clients loved it, it met their brief and worked well on a highly constrained site.

The real work is was making it happen!

Builder #1

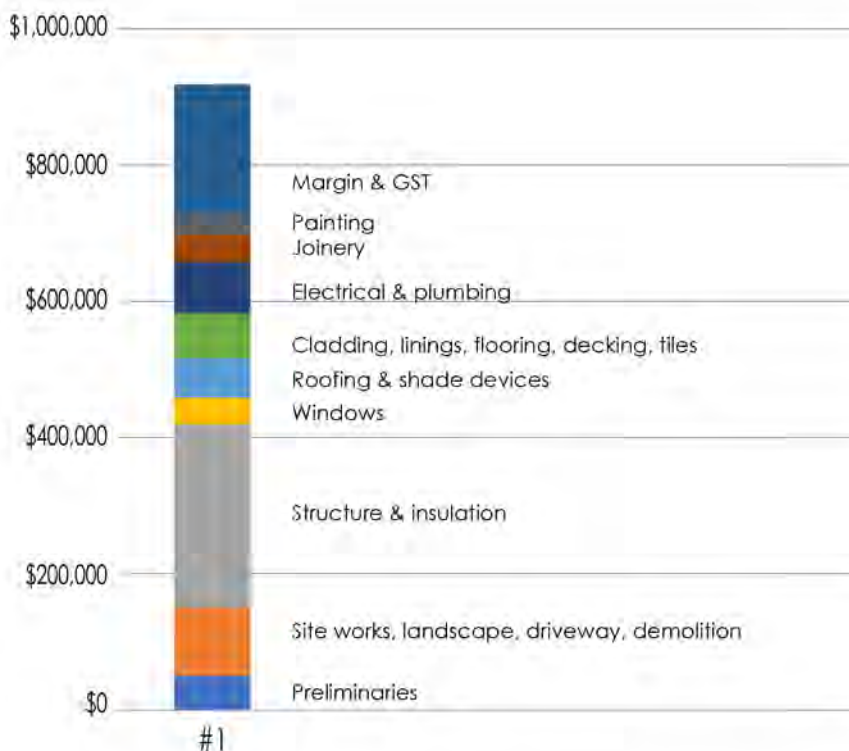
The first builder involved was working on his own approach to prefabrication. The system involves machine cutting stick framing in a factory with assembly happening on site.

The promised cost savings through design optimisation (done by us to their specifications), minimal wastage and speed on site did not emerge.

In fact the tendered price was significantly more than the eyeball estimate given to us and the client.

Little follow up occurred with Builder #1 due to the highly negative perception left by the wild inaccuracy of the initial eyeball number.

At this stage the project was Passive Solar and not Passivhaus.



Not a Passivhaus

Pre-cut stick frame

On-site construction

Builder #2

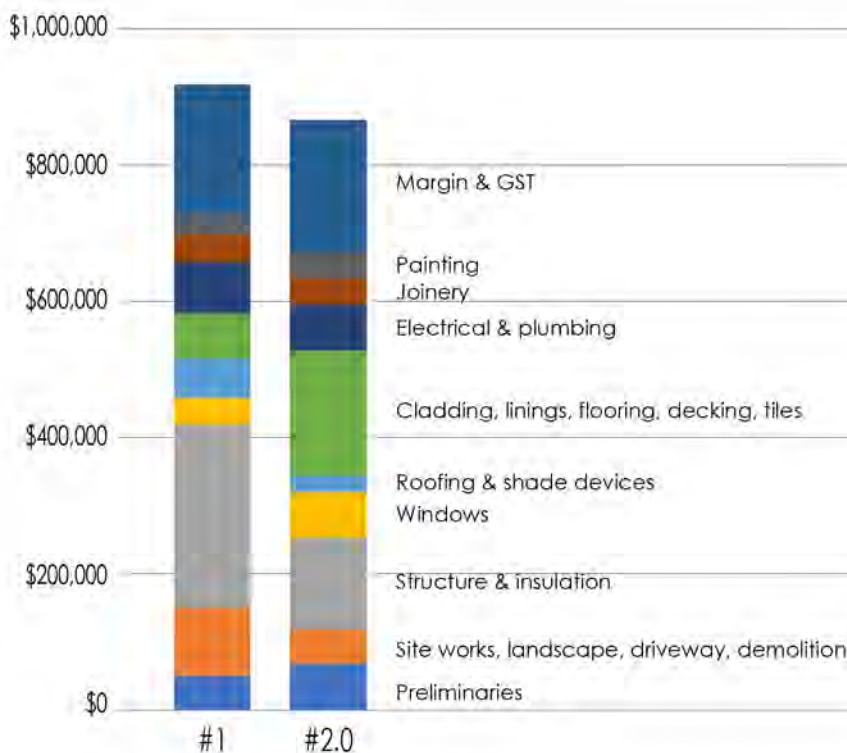
This is a custom builder experienced in passive solar design.

The construction was entirely timber framed with good levels of insulation. The windows were specified as good quality Australian made aluminium with double glazing.

The decrease in price came primarily from a decrease in structure costs.

In our view the pre-cutting and site assembly added the costs of manufacturing (plant, equipment, additional freight) without bringing the benefits of speedy erection.

The leap in cladding costs seems to be due to differing assumptions.



Still not a Passivhaus

Timber frame

On-site construction

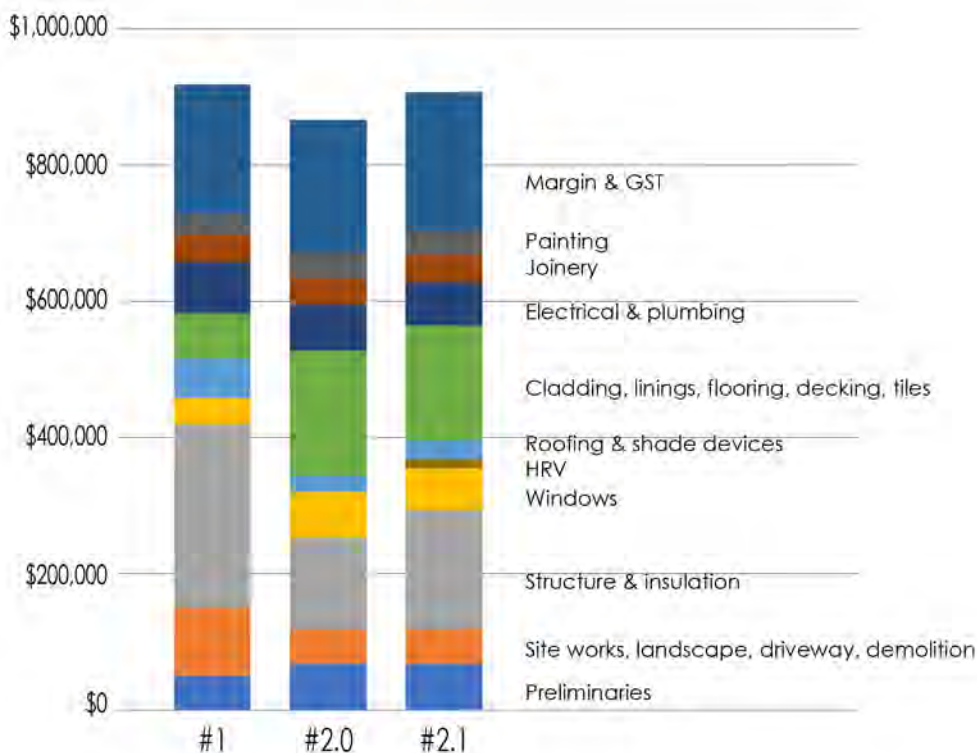
Builder #2.1

As time passed we had discovered Passivhaus, the client was on board and the construction systems were changed.

We had become Certified Passivhaus Designers and Builder #2 had become a Certified Passivhaus Tradesperson i.e. we all knew what we were supposed to do and how to do it.

In an attempt to de-risk the air tightness requirements of Passivhaus we looked at using a prefabricated panelised system.

It resulted in a slight price increase overall. This is partially due to the panels but also the addition of a mechanical heat recovery ventilation (MHRV) system to the project. The MHRV added around \$15,000 including installation.



Passivhaus

Off-site panelisation

Certified PH Tradesperson

Panelisation

Panelised systems were investigated for both their speed and quality aspects.

Panel systems from Melbourne and New Zealand were actively pursued. The European panels were only investigated due to an enthusiastic sales person, It was not likely they would be a sensible choice.

The Melbourne and New Zealand panels were similar construction. 90mm timber framing with an OSB (orientated strand board) bracing board, lined externally with a weather membrane, lined internally with a air membrane and service cavity battens.

Freight was a significant cost in both cases due to the distances involved.

Installation and craneage was also taken into account.

The final cost of panels when delivered and installed was almost exactly the same.

The builders preliminaries did not change. Upon reflection, and discussion since, this should have occurred. Preliminaries reflect the builders on-going costs so a 6-8 week reduction in project time should see a decrease.

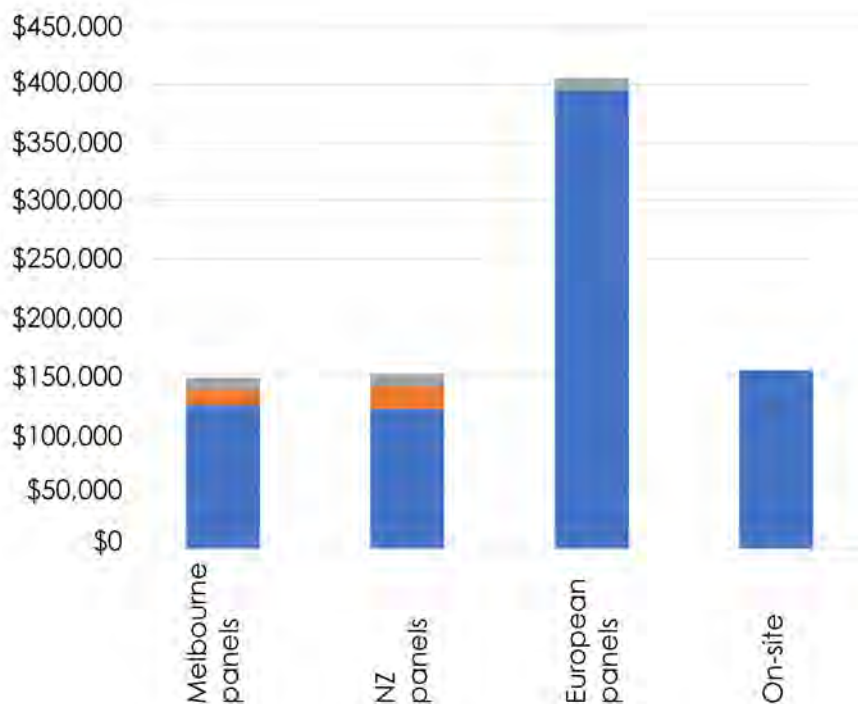
This project is located on a busy road and there was also concern around the practicalities of crane and truck access. In urban environments this is always a consideration, but can add to costs if additional traffic management is required.

The European panels were priced by a firm attempting to sell a similar system that was manufactured in Estonian. Their price included windows too.

The European panels were significantly more expensive, presumably due to the increased freight costs.

If good quality locally made panels were available they would be the most cost effective way to deliver Passivhaus.

While framing on site is currently the most cost effective way to deliver Passivhaus in Sydney, this will not be the case for long.



Quick Site access

Freight

Windows

The additional cost for passivhaus windows is often cited as a massive barrier to the uptake of passivhaus in Australia.

In our experience, this is only the case if your starting point is minimum compliance, single glazed windows.

Our original passive solar design incorporated good quality, locally made thermally improved aluminium windows.

Our designs have used similar products for many years and we (and our previous clients) understand these cost more than the 'industry standard' but for good reason.

In order to meet the passivhaus standard, we needed doors and windows that needed both better (lower) U values and were also air tight.

Several Australian window manufacturers import uPVC extrusions to assemble here. These products ended up being more expensive primarily due to glass being significantly more expensive in Australia than Europe.

There are an increasing number of firms now importing doors and windows from overseas.

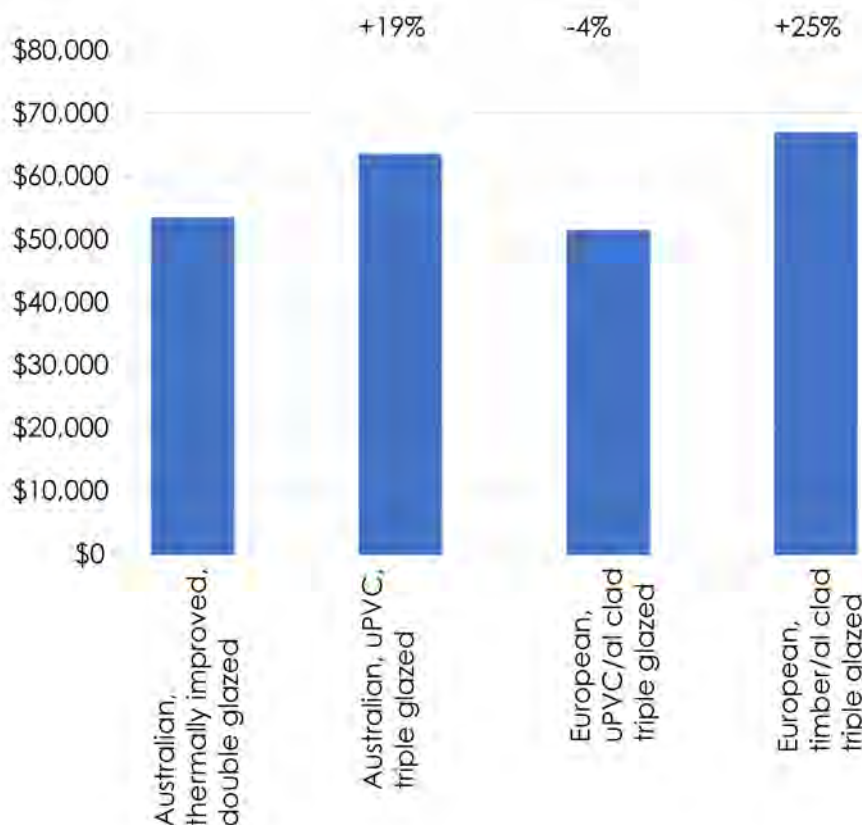
The company we deal with has both a uPVC and a timber window system. Both have an aluminium facing on the outside. This not only alleviates peoples concerns over uPVC in the Australian sun but also allows design flexibility in terms of colour choices.

In an interesting lesson in market economics, the uPVC are cheaper as triple glazed units than as double glazed because *"we don't make those anymore, they're now a special order"*.

Unsurprisingly timber windows are more expensive than uPVC.

One identified risk is that the window cost is dependent on exchange rate fluctuations. While generally not huge if a project evolves over a long period this may become a factor (possibly a good one).

Imported windows have significantly longer lead times. We have found this to be manageable and, in some ways, useful as it drives quality documentation earlier. There is little room for *'she'll be right, mate'* in passivhaus, even less so when you order windows before you break ground.



Imported

Glazing costs

Exchange rates

Builder #2.2

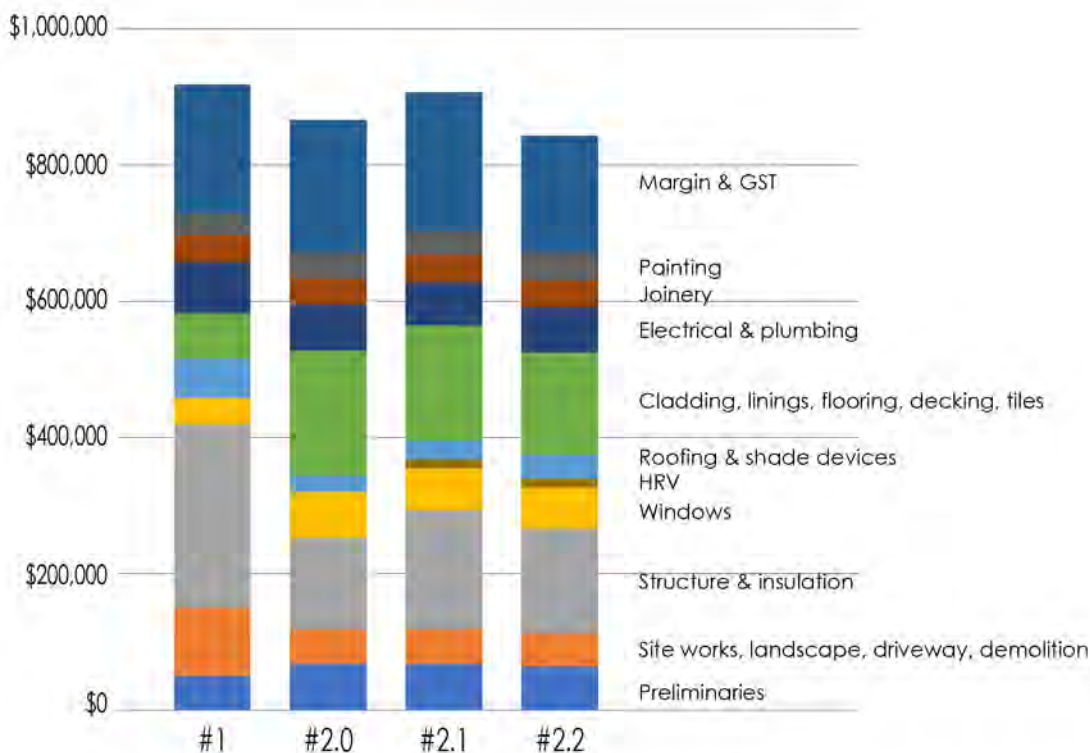
Continuing to work with the same builder, we reverted to on-site construction.

Rather than replicate the off-site panelisation system on site, we developed a different wall system and paired it with a Structurally Insulated Panel (SIP) roof..

The overall project cost decreased, partly due to the on-site construction changes but also due to other cost savings found in other areas of the project.

The client was keen to see the construction costs reduced, which is not unusual. What was unusual was their willingness to compromise on other items in order to do that, without compromising on the passivhaus elements that would embed quality in their home. In this case, changes to cladding materials bought a significant saving.

The other noticeable difference is the lack of an en suite bathroom. The clients had always understood that higher quality would mean less quantity if the budget was to be met; they chose quality.



Passivhaus

On-site construction

Savings

Builder #3

The client was keen to confirm that the pricing from Builder 2 was fair and accurate. A third builder was asked to quote.

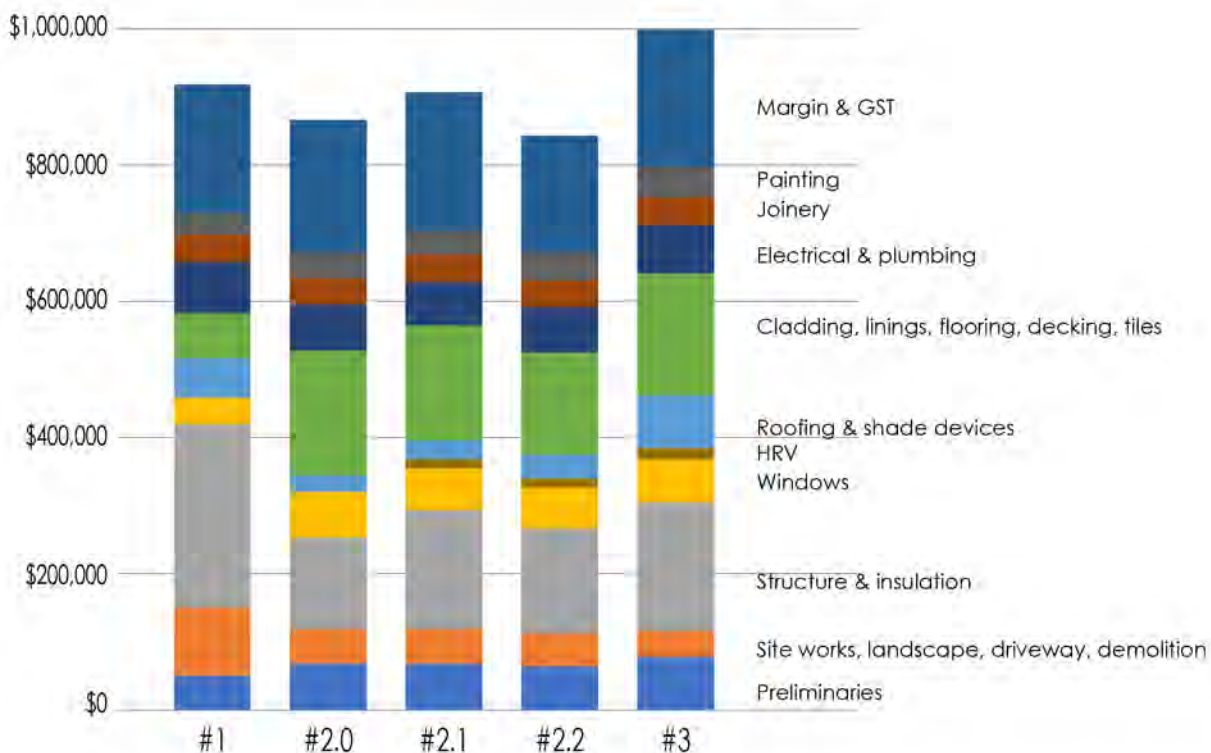
Builder 3 does similar work to Builder 2 and we knew him quite well.

He had no prior knowledge of passivhaus, but is a thinking builder who always asks questions when he is unsure (surprisingly uncommon).

He priced from the same documentation and a reasonable amount of time was invested in explaining and discussing the construction system and air tightness specifically.

This price was significantly more. In follow up conversations it became apparent that there had been a significant risk premium added.

I was scared by the air tightness requirement. Then I looked at the detailing and it looked simple. But I was scared by the air tightness. I think I over-cooked it.
(Builder #3)



Risk premium

On-site construction

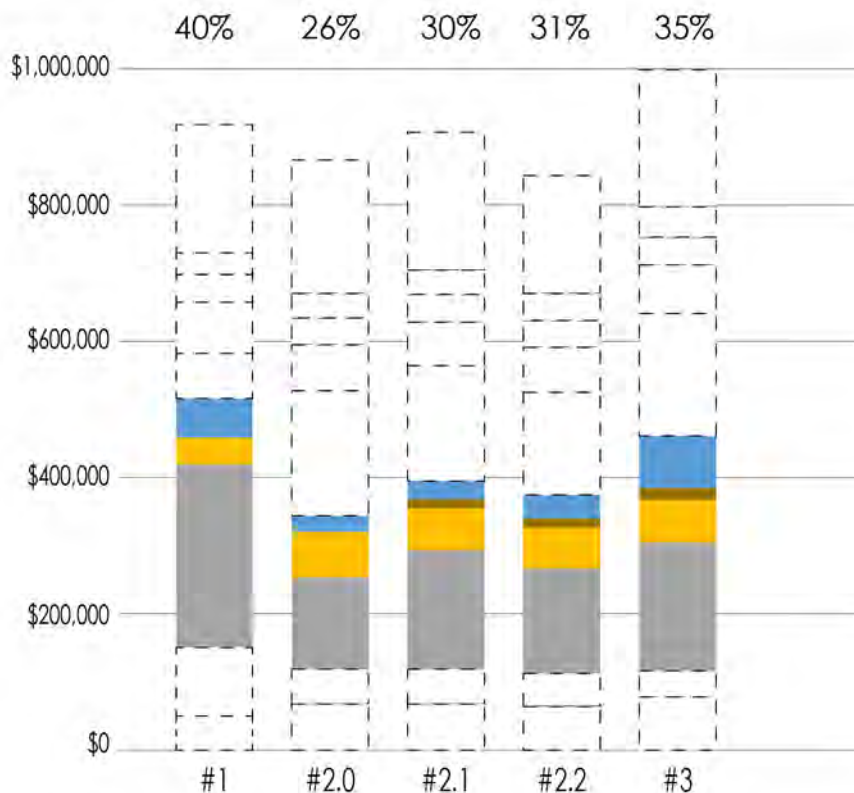
Passivhaus

Building envelope

A large portion of construction costs are driven by factors that have little to do the thermal performance of a building, or in lay mans terms, comfort.

The graphic below looks at the costs of structure, insulation, membranes, windows, shading devices and, in passivhaus, MHRV. These are the critical components to achieving passivhaus.

The other 60-75% of building costs are related to other things; builders overheads, site works, internal fitouts, kitchens, all the whizz bangery that make buildings work.



Comfort

Warmth in

Weather out

Passivhaus-specific premium

The requirement to make a building air tight will always be more time consuming than not.

The different membrane currently costs more, although if like triple/double glazing this may not be the case in future when passivhaus is the new normal.

Installing a guaranteed source of fresh filtered air 24/7 will always be more expensive than not.

The graphic shows the extent of that cost premium.

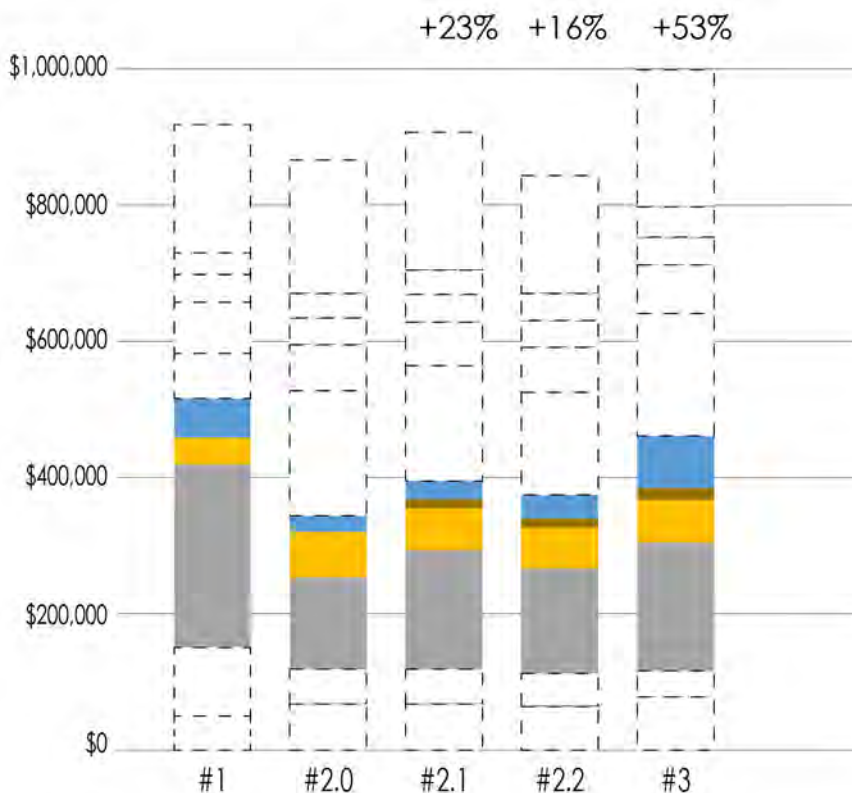
#2.1 is for the panelised system. For an inexperienced passivhaus builder this increase may be worthwhile as the panels de-risk the need to deliver on air tightness.

As panelisation, generally, becomes more common the costs associated with it will also decrease.

Price #3 clearly shows the risk premium that was applied.

The 16% cost uplift in achieving passivhaus is mostly derived from needing a MHRV system.

In all Sydney passivhaus projects we have found that insulation levels are similar to those we were specifying in our passive solar designs. i.e. passivhaus is not adding to these costs



At what cost?

Air tightness

MHRV

Delivering passivhaus

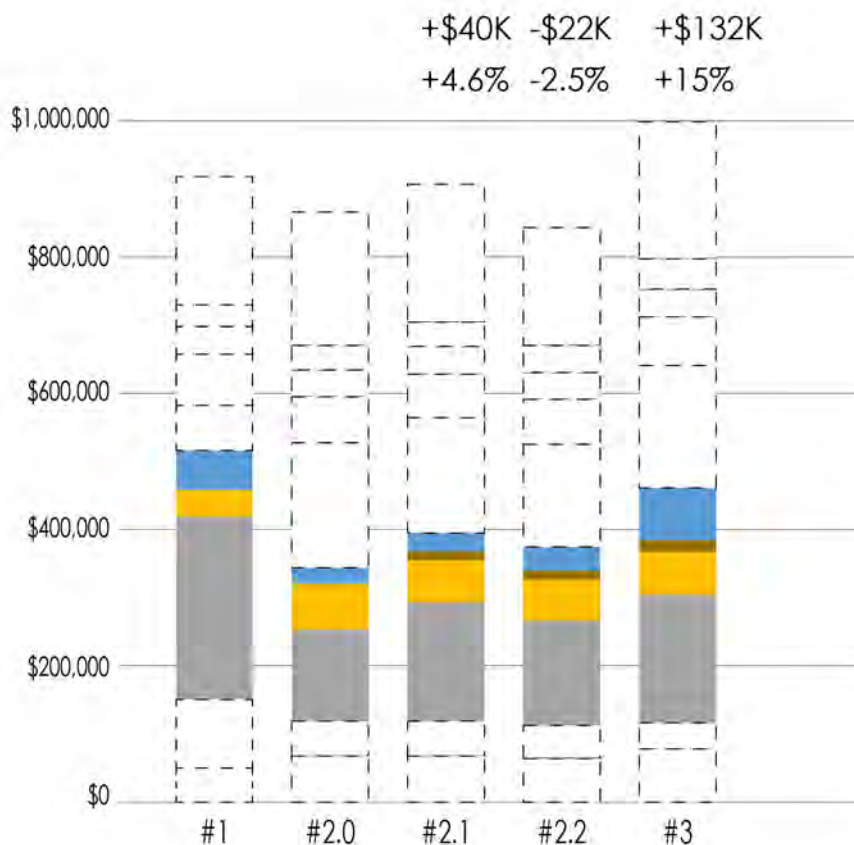
The project went from passive solar to passivhaus. The geometry remained unchanged. The construction systems were optimised although you'll never be able to tell once it's finished.

This passivhaus will be delivered for \$22,000 less than it's original passive solar cousin.

The cost decrease has been achieved through strategic decision

making by designers, builder and client.

The collaboration with the builder has allowed the system to be tailored to their preferences. This manifests in the pricing differences between builders 2 & 3 illustrating the benefits of early engagement with builders.



Cheaper

Better

Just do it

Passivhaus versus Project Home

Before the custom builders came the project home company. They were a halfway house, not one of the huge well known brands but a firm doing 10+ homes a year with a focus on speed and cost.

The firm quoted on the original passive solar design. Their costings were significantly cheaper than any of the custom builders.

However as is common with this type of builder there is no breakdown of costs provided just a lump sum figure. While this is ultimately all that matters, it always comes with concern over whether everything specified in the design is included.

In this case, there were several significant exclusions at this stage which meant that initial quote was not the full picture. \$700,000 was probably a realistic number.

More importantly, when we approached them to quote on the passivhaus version, they declined.

We have recently had a similar experience with a similarly structured building company. Conversations have revealed that each of their site supervisors has anywhere from 7-30 projects to manage at any one time.

While it is possible to calculate the cost uplift from a project home to a passivhaus we do not currently believe that is useful.

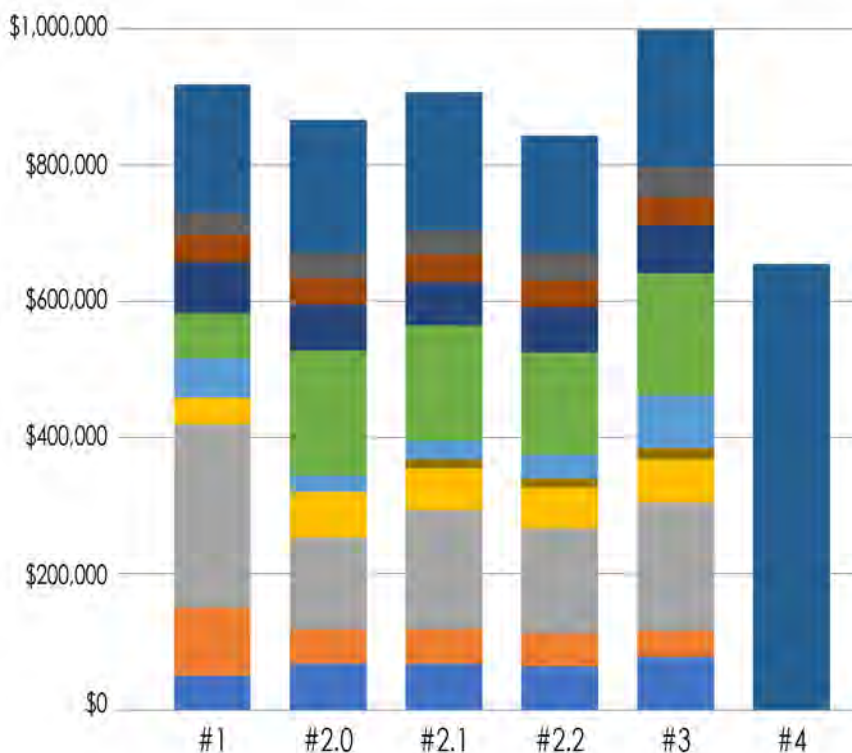
The current business model of volume home builders relies on minimal site supervision. Even allowing for increased buying power and repetitive designs, the lower contract prices must result from savings in other areas too. How else can they afford the display homes, sales force and advertising budgets?

At this moment in time in the Australian construction sector, it seems unlikely that the trade skills exist widely enough to deliver passivhaus without increased levels of site supervision from knowledgeable and experienced staff.

Several colleagues have also attempted to persuade volume builders to build passivhaus so far with no success.

We are heartened by the large scale passivhaus projects, such as the Monash University student accommodation building. This demonstrates that large contractors can deliver passivhaus and that change is possible when the market asks for it.

We look forward to the volume home builders making the transition too.



Incomparable Supervision Trade skills

Progress

This passivhaus is now under construction. It is one of twelve we currently have on the books.

We're continuing to work with Builders 2 and 3 to optimise the details for future projects. We are also still pursuing panelisation; it is the future



**Our aim:
passivhaus is
the new normal**