

Design journey to Passive House Premium - a client perspective?

For a person new to building their own home, what would that journey of discovery and learning look like for the client and what would be the result?

This is an owner's perspective of understanding how to engage fully in the design process from selecting an architect to shaping the concept design through to achieving a design capable of Passive House Premium certification.

What is a sustainable design and build in Central Otago, New Zealand?

What is beyond "Net Zero Energy"?

What influenced the client's thinking during the design process?

How is a design capable of Passive House Premium certification?

How realistic is it to aspire to building a Passive House Premium new build in New Zealand?

Background

What is Sustainability?

1792 to the present day – the discipline of sustainability first became a focus in 1792 with regard to the use of timber for ship building and the realisation that without the re-planting of trees, the resource could not be depended upon into the future. This led to the various sustainable practices around forest management. But, it was not until 1987 when the Brundtland Commission defined Sustainability in the "Our Common Future Report" as "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Turbo Charging the Sustainability Conversation

For 11,000 years earth's climate remained pretty much unchanged with an average temperature of about 14 degrees. However, since the Industrial Revolution the levels of CO2 increased by over 40% to limits not seen for at least 800 years. The result, a dramatic rise in temperature with impacts on energy, water and material resources. Global average temperature has already increased by 1 degree since 1850 and may well continue to do so for a considerable time.

How has New Zealand been doing on Emissions?

Not particularly well with an increase of 111% between 1990 and 2012.

Climate Change and Construction

The built environment contributes significantly to both the use of energy, water and materials with associated approx. 50% of global carbon emissions; it is also affected by the changing climate.

RIBA comment: "Ethically unacceptable to ignore the challenge of global warming".

PassivHaus is recognised as a means to achieving lower carbon emissions from construction by lowering the energy demands of a building (ongoing operation of a building which account for 60% of the emissions).

Client Background in Solar PV

Having worked in the energy sector in New Zealand an interest in self generation using photovoltaics developed; the installation of a 6.6kw solar system and 9.6kwh battery storage was made. Given Hawea Flat depends on electricity to provide not only power, but also pump stored water sourced from a bore (and potentially operation of an onsite sewerage system); the self-generation along with emergency and backup power had it's obvious appeal making the household more resilient in the event of a grid outage.

“Lipstick on a Pig”

The installation of solar panels is a very visible demonstration of individual responsibility, yes? Well kind of. It seemed more efficient and logical to build in energy efficiency rather than bolt on solar PV generation. Kind of prevention is better than cure. So, when the opportunity came up to subdivide their property, Nikki and Jonathan Holmes starting learning about PassivHaus. Just simple physics and entirely logical that heat losses are constrained and an effort is made to balance the available energy gains from the sun, appliances, occupants, etc with the losses and then generate the required power renewably.

Key learnings

- Complexity drives up costs – potentially every corner of a house adds \$15,000, more corners, more cost
- Passive House is recognised as being the gold standard for energy efficiency, but have numerous other benefits of comfort and health derived from a fabric first approach
- There are significant learnings for individuals involved in design and build until at least the third building
- New Zealand is the second most expensive country in the world to build & building second largest new homes after the USA; all-in-all this means new homes are unaffordable
- Electricity Everything and then use Renewable Energy, e.g. cooking, space heating, water heating, ventilation, refrigeration, transport, etc. and then install solar PV

Getting up to speed before engaging an architect

To be an active contributor to the design process in the belief that a team approach is best, Jonathan attended the Passive House Institute conference in 2017 in Christchurch, read various text books and articles to a point Nikki and Jonathan knew their goal for a new house design would be to achieve Passive House Certification.

At about this time the original certification level was refined and ‘Plus’ and ‘Premium’ were established; ‘Plus’ equating to Net Zero Energy and ‘Premium’ an aspirational standard of greater energy efficiency and greater renewable energy generation to ‘green the grid’. Given the background and interest in renewable energy it was logical to strive for ‘Premium’

The Journey begins

To understand what the process is for the creation of a design required more research. From a knowledge acquired from selecting a new Point of Sale, Marketing and eCommerce system and working with software company Green4; Jonathan learned any creative process from brainstorming to marketing starts really wide, “no idea is a bad idea” and then over time, refine and refine the ideas until going into more detail. Therefore when a video tutorial (<https://youtu.be/k4dVgbuxBAw>) series by an American Architect called 30x40 Workshop on the concept design process described this same approach for a creative

concept, did it feel like we understood how we would arrive at our preferred design for our new house. PassivHaus of course.

Jonathan's cousin Christine Bathgate is a qualified Architect in the UK designing new homes for his uncle and aunt, Mary and John. A recent project to restore and convert a stone barn in Scotland captured many of the ideas Jonathan and Nikki liked:

- 1) Cathedral landing
- 2) Natural materials (stone and timber floors, exposed timber joinery)
- 3) 1 ½ to 2 storey building
- 4) Central large glazed area

Play exert from youtube video on Concept Design. Taking this approach and using Pinterest boards were established for the following design themes:

- 1) Farmhouse / Barn
- 2) Simplicity
- 3) Modern
- 4) PassivHaus

Initially, any image that was liked was posted onto the applicable digital image board (with a note as to what appealed to them in the image). From time to time images were discarded and new images added. Additional boards were setup using the same approach for other areas of the design.

Engaging a PassivHaus Designer and Architect

Any project lasting more than a couple of months requires the right team of people to come together, our principle objective was to select a local professional with PassivHaus design experience and if possible a person that combined the skills of both Architect and PassivHaus Designer.

At about the same time of interviewing various architects, Jonathan and Nikki came across the Cat Hill Barn conversion by British Architects Snook of Manchester that was nominated for and winning two category RIBA design awards. This design also like Jonathan's cousin's design included many of the features they liked.

To assist the architect, Rafe Maclean navigate the numerous images of kitchens to bathrooms to overall concept, a Summary Design Board was setup and shared detailing the 'best of the best' images distilling Nikki and Jonathan's design preferences.

Using the Simple Stick - Insanely Simple: The Obsession That Drives Apple's Success (Book by Ken Segall)

"Ken Segall has literally captured lightning in a bottle. *Insanely Simple* reveals the secret of Steve Job's success with such clarity, even we non-geniuses can make use of it. Ken shows us how to cut through the cobwebs of fuzzy thinking, bureaucracy and mediocrity, and clearly see what's essential – and therefore most important" Steve Hayden, former vice chairman, Ogilvy and author of Apple's legendary 1984 Super Bowl commercial.

Keeping things simple inherently leads to beauty, elegance, attractiveness and lower cost; but isn't necessary easy.

What is simplicity of concept, simplicity of detail and simplicity of specification?

The core design was to use extensive natural materials and utilise the typology of a 16th century Yorkshire barn converted into a residential dwelling.

A two storey rectangular building with large double height space in the centre of the building with the upper floor mirroring the layout of the ground floor as much as possible. Services to be placed as centrally as possible and immediately above/below each other, the number of doors and complexity of walls reduced, ventilation ducting exposed and a layout permitting upstairs or downstairs living, a bathroom incorporated into the laundry or utility room in the event of incapacity or old age. So, we did OK we think on keeping the concept simple.

Simplicity of detail, jury is still out on this as we test the complexity of detailed design through the activity of construction and the final product. Detailed design features such as negative detailing behind posts and beams leads to the use of non-standard timber sizes and additional labour, multiple levels of flooring leads to multiple concrete foundation setup/unpack and pours, etc. However, we also have repeated the use of flooring materials (e.g. timber floor or tiled floor), wall finishes (e.g. GIB board), construction method (e.g. use of SIPs), common cladding materials (e.g. Siberian larch) and standardised form and sized glazing (e.g. make openings fit standard glazing from Thermadura). Maybe we've done Ok keeping the specification simple.

Integrated Design and Team Construction

With the appointment of Timberworks, a Nelson based company to manufacture the exposed internal framing, Timberworks provided detailed and extensive concept design and detailed design input to develop a 16th century exposed oak frame. A structural engineer was selected with extensive knowledge of this historic form of post and beam construction. Carpenter Oak was approached in the UK to provide example detailed designs for wall, floor and window details utilizing SIP panel construction and exposed oak framing with timber packers.

Getting to Premium

Common with other PassivHaus Classic certified buildings in New Zealand, NZSIP panels are used (165mm for walls and 215mm for roof) and Thermadura PassivHaus certified glazing either DesignLine or NatureLine. Other building components used are:

- 1) Stiebel Eltron Heat Pump Hot Water system
- 2) Zehnder Q450 mechanical ventilation heat recovery system

So, what extra was required apart from compact design, good orientation, controlled level of glazing per elevation, elimination of thermal bridges, efficient appliances, LED lighting, etc:

- 1) An efficient form of heating and cooling, i.e. a small Mitsubishi HyperCore air source heat pump rather than less efficient forms of heating such as panel heaters
- 2) Shower Waste Water Heat Recovery systems, as per many PassivHaus Premium building overseas (Wagner Solar EcoShower Waste Water Heat Recovery drain and downpipes specified, supplied by AloAqua in Christchurch)
- 3) 10kw solar PV system (30 commercial grade 340w panels and transformer less grid tied inverters)

And the data provided by Jason Quinn:

Passive House Metrics

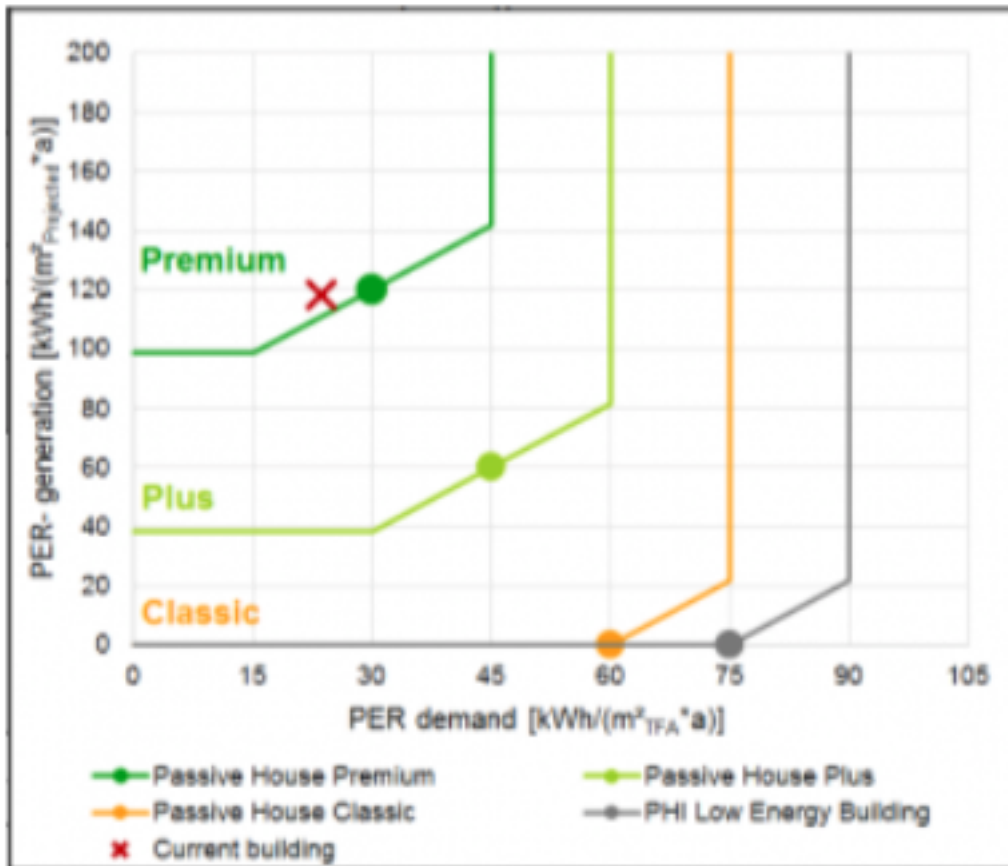
| | |
|--|--|
| Heating Demand 12.7 kWh/m ² /year | Heating Load 12.5 W/m ² |
| Cooling Demand 9 kWh/m ² /year | Cooling Load 9 W/m ² |
| TFA 163.6 m ² | Form Factor 3.2 |
| Air leakage @ 50Pa 0.6 ACH | PER demand 24 kWh/m ² /year |
| Renewable Energy Generation 118 kWh/m ² /year | |

Under construction - these numbers are not yet certified

Construction Details

Average Values

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|--|--|
| U-value External Walls 0.15 W/(m ² K) | 140mm NZSIP / 45mm TerraLana Service Cavity |
| U-value Floor 0.21 W/(m ² K) | Timber flooring / 60mm XPS / 100mm Slab / 60mm XPS |
| U-value Roof 0.12 W/(m ² K) | 190mm NZSIP / 45mm TerraLana Service Cavity |
| U-value Glass 0.52 W/(m ² K) | Silverstar EN2plus (4:/20/4/20/:4 90% Ar) |
| U-Windows 0.79 W/(m ² K) | ThermaDura Designline 90 Passive |
| Ventilation Efficiency 77.3% | Zehnder Comfoair Q450 |



From Jason Quinn: "This is potentially New Zealand first Passive House Premium.

Designed by the experienced Certified Passive House Architect Rafe Maclean the design is optimized for efficiency as well as lifestyle.

This was accomplished with a two storey compact design which has a small footprint along with a 29 panel PV array such that the panels alone are 50% of the footprint area of the building.

Using a heat pump for hot water generation and a separate heat pump for the very small remaining heating and cooling requirements of the home, minimized the demand for electricity allowing the building to target the Passive House Premium standard.”

Affordability

But doesn't it cost more to get to Premium.

The heat pump selected for efficiency and cold temperature performance was the Mitsubishi HyperCore (smallest capacity model available in NZ) costing \$2,000 and the Eco Shower Waste Water Heat Recovery drains and downpipes from Wagner-Solar costing \$2,000 and \$950 respectively. The large renewable energy system is greater than needed, but was sourced directly from LonGi and ArtSign in China and inverters at an estimated cost of \$20,000. The surplus power from which will be sold to Ecotricity NZ at 8c/kWh and re-purchased at 8c/kWh for electric vehicle charging generating savings of \$400 per month in petrol and more in lower maintenance bills associated with electric transport.

So, no, going Premium doesn't require a Premium and also very little extra effort.

With sourcing of timber from Germany for cladding and framing, cabinetry from IKEA UK and others, the cost of the project is estimated to be approx. \$2,800/m².

PHPP Modelling and Data

I've asked Jason Quinn for the key data contained within the PHPP modelling for our design which has been reviewed and certified by him, along with his views on the most influential elements of the design to achieve PassivHaus Premium.

Now onto Construction - the journey of discovery and learning continues

As part of setting themselves up to engage in the design process, attending the Passive House conference and an appetite to learn more, the client signs up for a MSc in Architectural Technology and Design at Leeds Beckett University. Why the UK and not New Zealand? Two reasons were at the heart of the decision:

- 1) Ability to undertake study from home
- 2) Learn how to design and build beyond the New Zealand building code

So, as part of reading about PassivHaus and furthering their knowledge of Sustainable Construction the client made an attempt to distill sustainable construction into an easy to understand and use standard, something along the lines of PassivHaus with the careful selection of building components and materials. We are in essence talking about 'The Elrond Burrell standard', PassivHaus + Low Embodied Energy + Non-toxic; perhaps PassivHaus meets the Living Building Challenge.

Many of the most common building materials from uPVC windows to paints contain harmful products damaging to human health and/or the environment during their lifecycle of creation, use and end of life. Hence, for example, use modified timber

windows with their twice the life of uPVC performance, lower embodied energy and none of the dioxin issues during manufacture or disposal.

It was this exposure to the Living Building Challenge at a talk by Camp Glenorchy that this additional element came into focus, so as we proceed through the build, the client will favour the selection of DECLARE products avoiding chemicals and materials on the RED LIST as far as possible. So, the journey of learning continues.

Thank you and I hope you're enjoyed my presentation. Any questions.