Passive House

Project documentation

Architecture:	CadViz:	Building physics:	eHaus, Cyril Vibert
Building Services:	eHaus, Cyril Vibert	Craftsperson:	eHaus

A compact two level family home with 4 bedrooms and three living areas, influenced by European Passive House designs. Most of the glazing are oriented to the north.

See also www.passivehouse-database.org, Project ID: **4369**

Special Features: Rain water harvesting. All led installation with 3 kW solar PV installation.

U-value of the exterior walls:	0.261 W/(m²K)	**PHPP Space heating demand: 9 kWh /(m²a)**
U-value of the floor slab:	0.240 W/(m²K)	**PHPP Primary energy: 84 kWh /(m²a)**
U-value of the roof:	0.145 W/(m²K)	Pressurisation test n_{50} = 0.47/h
U-value of the windows:	1.48 W/(m²K)	Heat recovery efficiency : 81%

2.2 Short Description of the construction task:

This compact two level family home was built in 2014 with a “built-it-once and once only” approach, designed to amortise the embodied energy of its materials over a long life-span. With 4 bedrooms and three living area, it is spatially efficient. One of the great success of this home is that it accommodates a wide range of activities in a relatively small-footprint; well suited to the owners’ lifestyle. Although there is plenty of space to grow their family, any room can be converted to a home-office or an extra living area.

The main approach to designing the house was to concentrate the glazing area on the North side of the house. Besides harvesting some useful solar gain, the windows capture the amazing view of the mountains. Moreover, as a form of challenge, the owner didn’t want any window on the south side. Thus the design of this house could easily be presented as audacious and radical.

2.3 Elevations:

The shading on the elevations below is

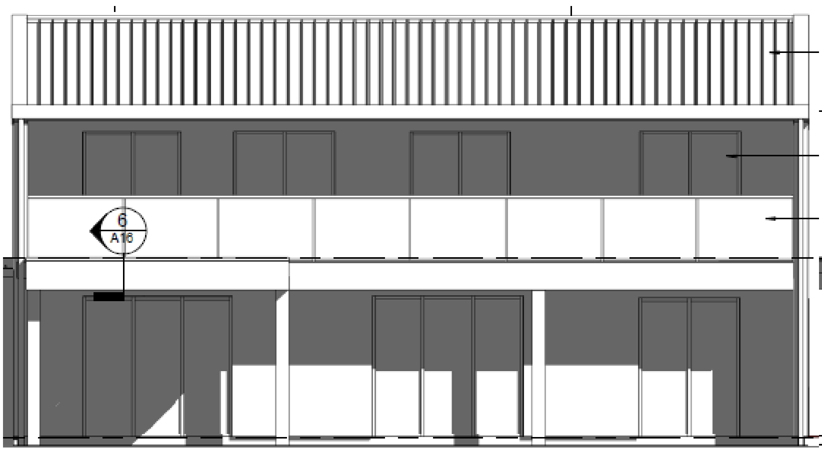

Figure 1 : North Elevation

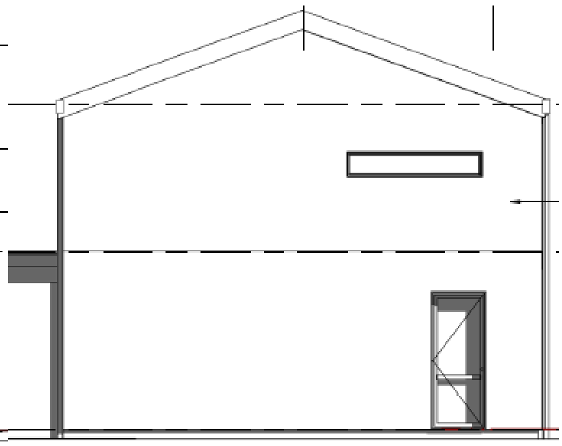

Figure 2 : West Elevation

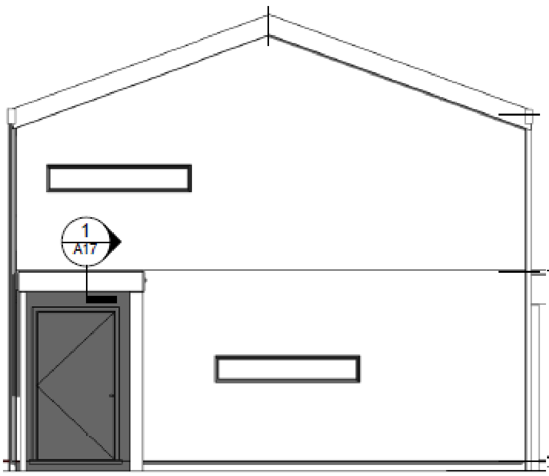

Figure 3 : East Elevation

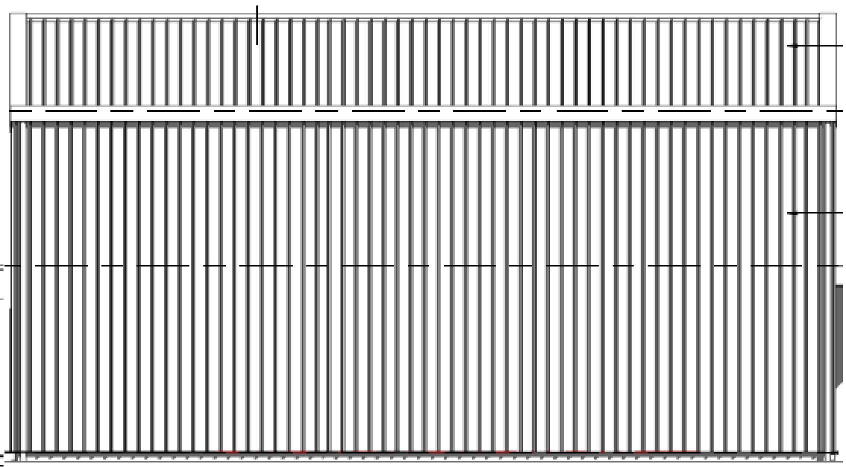

Figure 4 : South Elevation

Figure 5 : South Elevation

Figure 6 : North Elevation

2.4 Pictures of the interior

Figure 7: Picture of the kitchen, the bedroom and the funky toilet

2.5 Cross section of the implementation plan:

The figure 8 illustrates the general layout of the house. The cathedral ceiling provides a nice feeling of space in the master bedroom. The bedrooms and the living area are situated on the north side of the house. On the south side we can find all the services areas, the stairs and the bathrooms. The red line represents the airtightness layer and the limits of the thermal space.

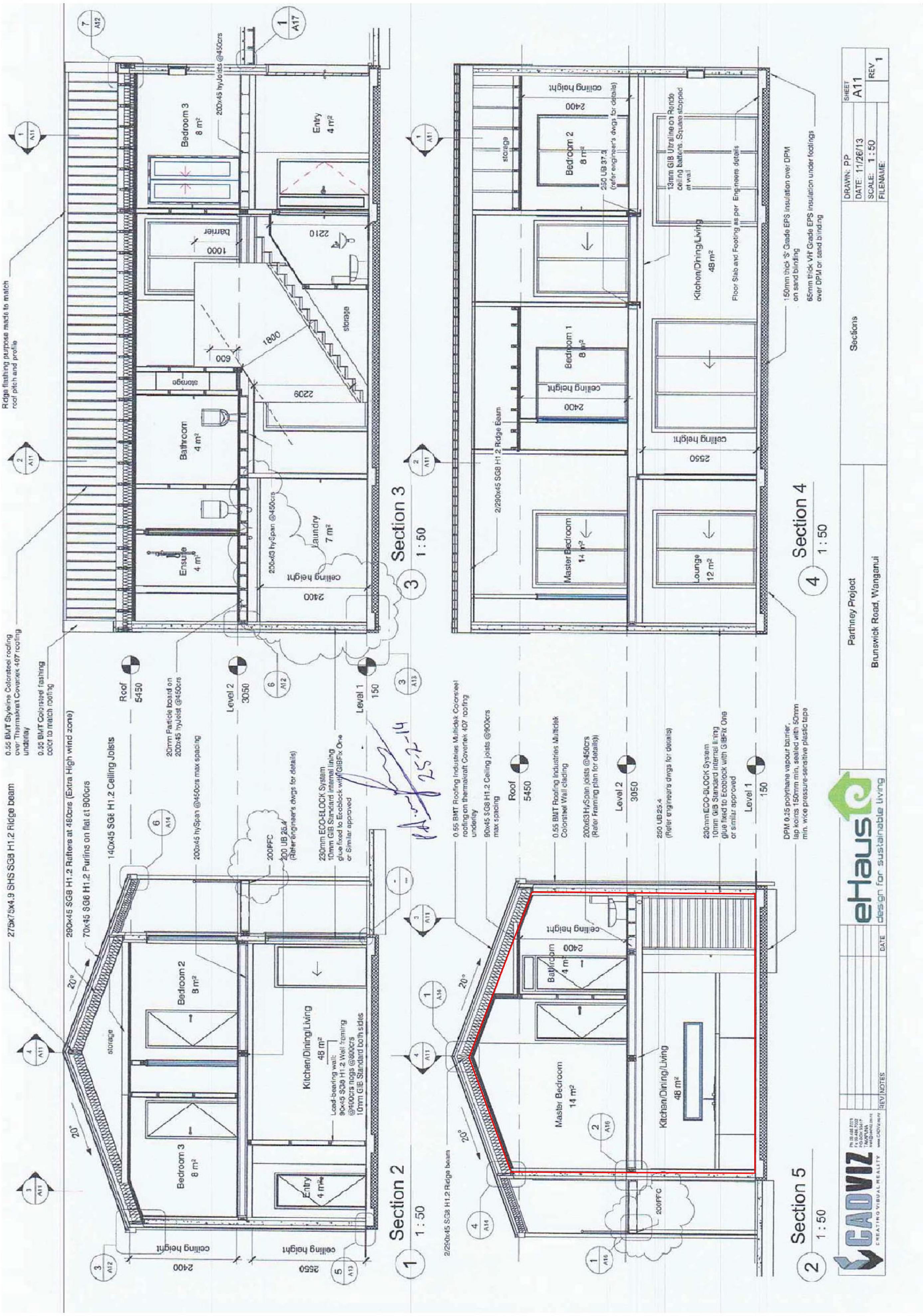

Figure 8: Sections

2.6 Floor plans

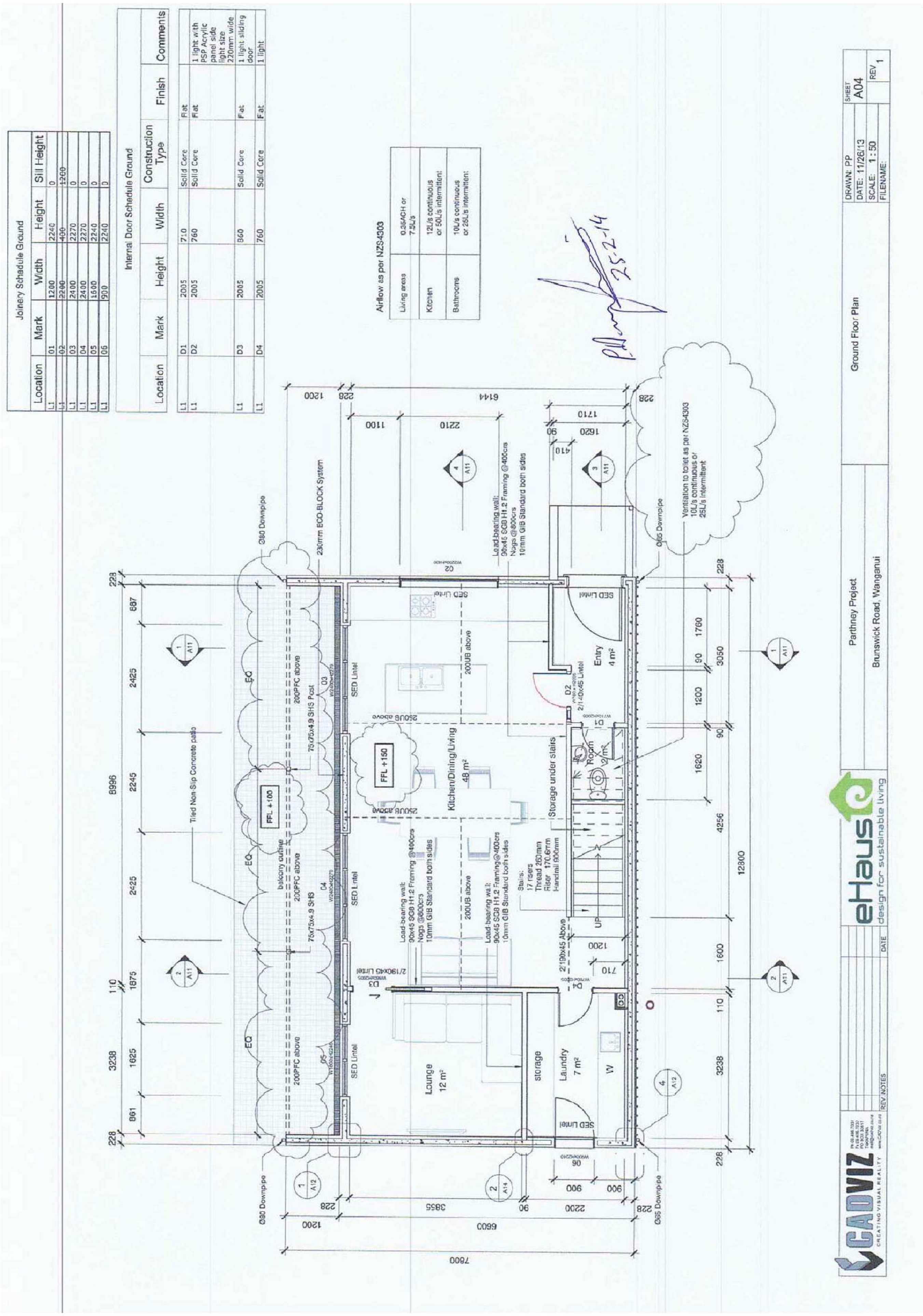

Figure 9: Ground Floor Plan

Joinery Schedule Upper

Location	Mark	Width	Height	Sill Height
L2	07	2200	400	1200
L2	08	1600	2040	0
L2	09	1600	2040	0
L2	10	1600	2040	0
L2	11	1600	2040	0
L2	12	2200	400	1200

Internal Door Schedule Upper

Location	Mark	Height	Width	Construction Type	Finish	Comments
L2	D5	2005	760	Solid Core	Flat	
L2	D6	2005	760	Solid Core	Flat	
L2	D7	2005	760	Solid Core	Flat	
L2	D8	2005	760	Solid Core	Flat	
L2	D9	2005	760	Solid Core	Flat	
L2	D10	2005	710	Solid Core	Flat	Fan Light

Airflow as per NZS4303

Living areas	0.35ACH or 7.5L/s
Kitchen	12L/s continuous or 50L/s intermittent
Bathrooms	10L/s continuous or 25L/s intermittent

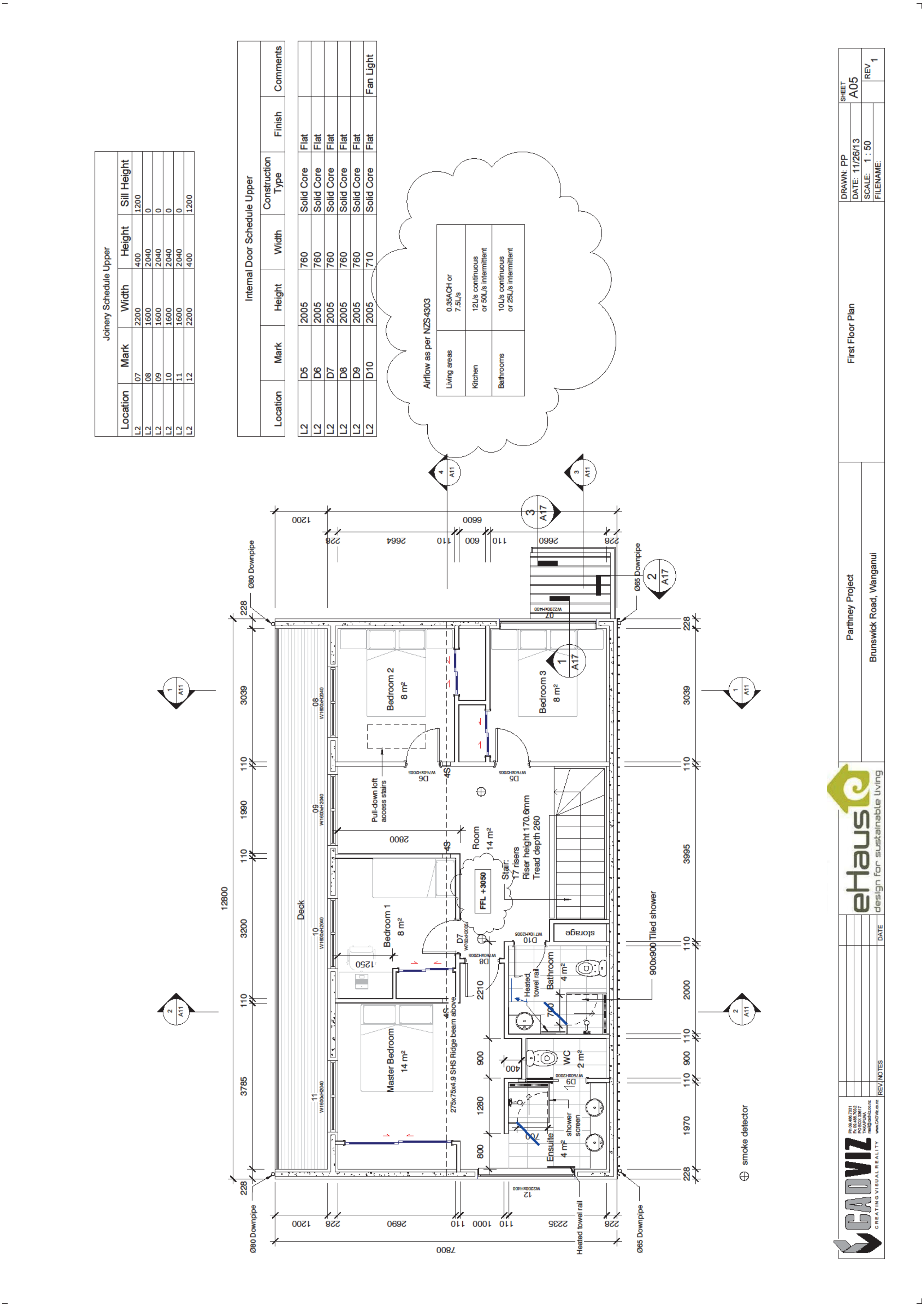

Figure 10: First Floor Plan

2.7 Construction details

2.7.1 Footings and slab:

- DPC 1mm
- EPS (038) 150mm
- Reinforced Concrete 125mm

U-value = 0.24 W/(m2K)

The U-value of the floor slab of 0.24 W/(m^2.K) was achieved by using some expanded polystyrene insulation. The concrete floor slab is floating on top of the structural insulation and links to the ICF block used for the walls.

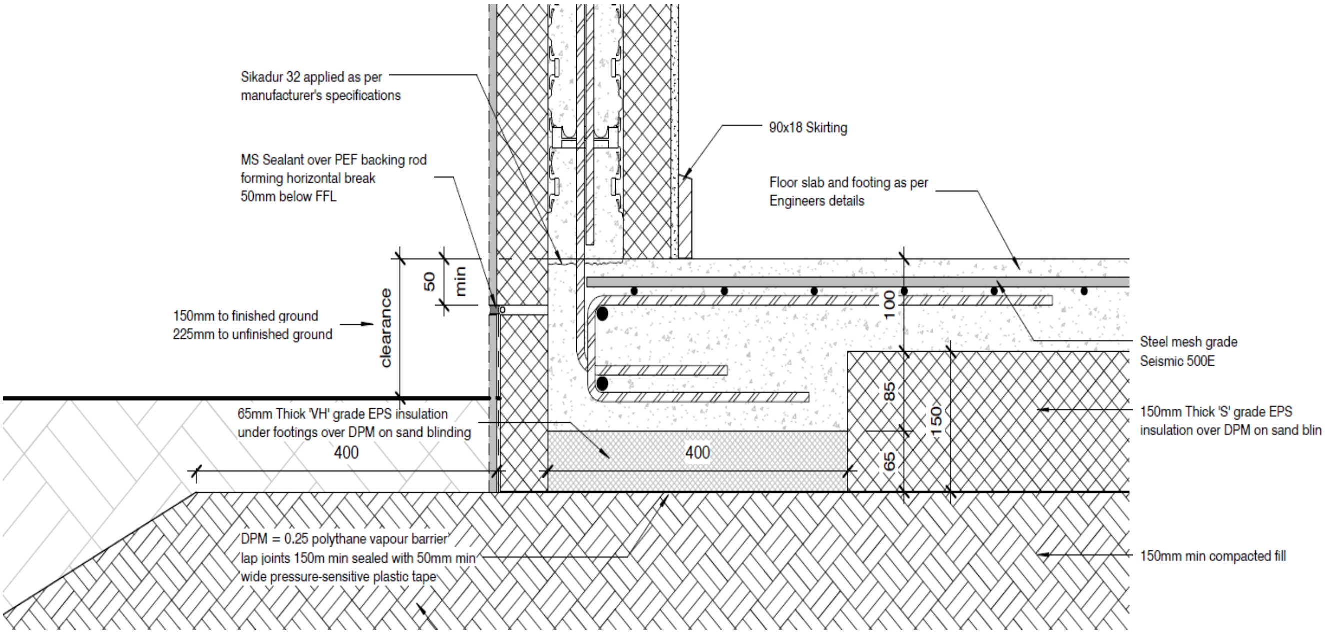

Figure 11: Photo of the footing

2.7.2 Exterior walls:

- Rockcote Plaster System 8mm
- EPS (037) 65mm
- Reinforced Concrete 100mm
- EPS (037) 65mm
- Plaster Board 10mm

U-value = 0.261 W/(m^{2}K)

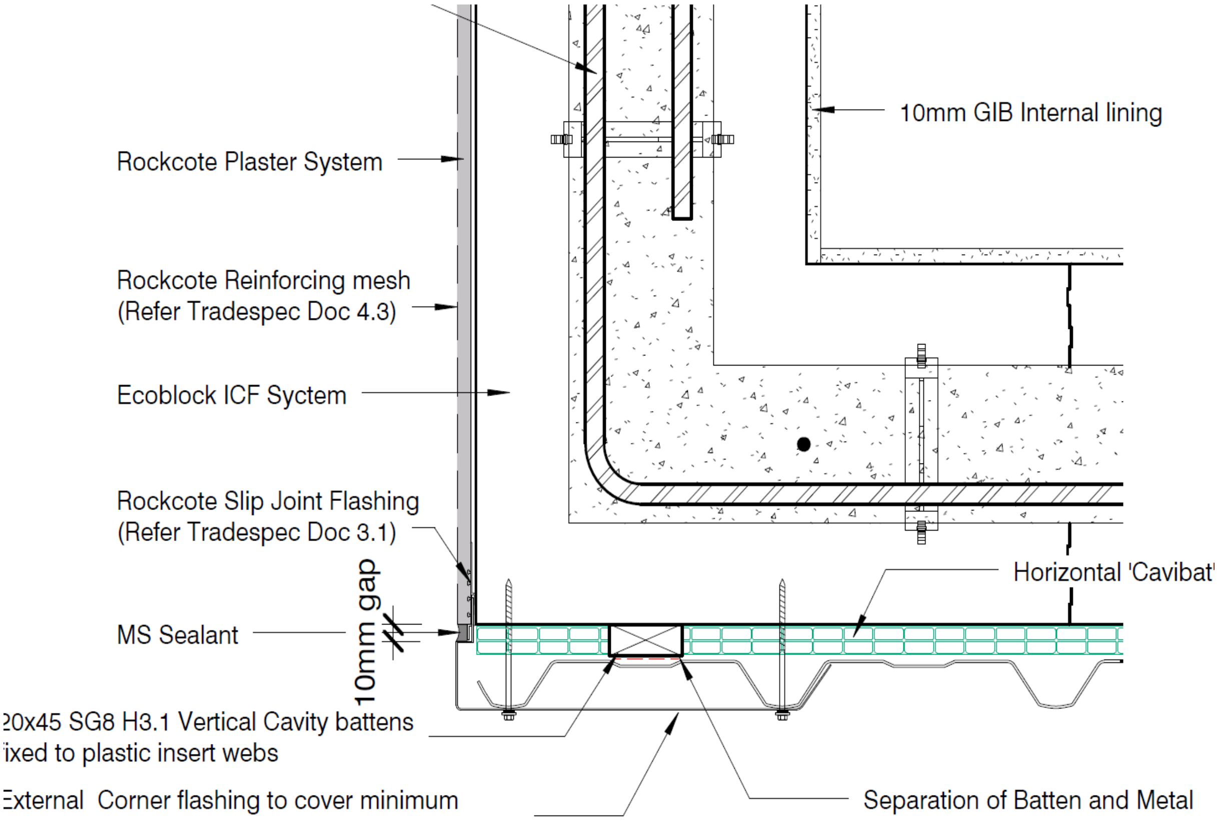

Figure 12: Corner detail

The exterior walls are made from of Insulated Concrete Forms (ICF) and have a U-value of 0.261 W/(m^{2}K). The ICF block technology was chosen for its convenience and the quick implementation it requires. The insulated forms are interlocking modular units that are dry-stacked (without mortar) and filled with concrete. As we can see on the figure 12, this system limits the thermal bridges. Besides, the concrete layer offers thermal inertia and airtightness.

2.7.3 Intersection Wall/Floor

Figure 13 shows the junction between the first floor and the exterior walls, as well as the magnificent landscape.

Figure 13: Photo of the junction between the first floor and the walls

2.7.4 Insulation of the Roof

- Colour Steel roofing .55mm
- Fibreglass Layer 1 (042) 210mm
- Fibreglass Layer 2 (053) 95mm
- Air tight membrane 1mm
- Rondo battens 35mm
- Plaster Board 10mm

U-value = 0.145 W/(m2K)

The U-value of the roof of 0.145 W/(m^2K) was achieved by using two layers of high efficiency fiberglass insulation. The overhang created by the eaves provide additional shading and also prevent any overheating in summer.

Figure 14: Photo of the insulation in the roof space

Figure 15: North facade

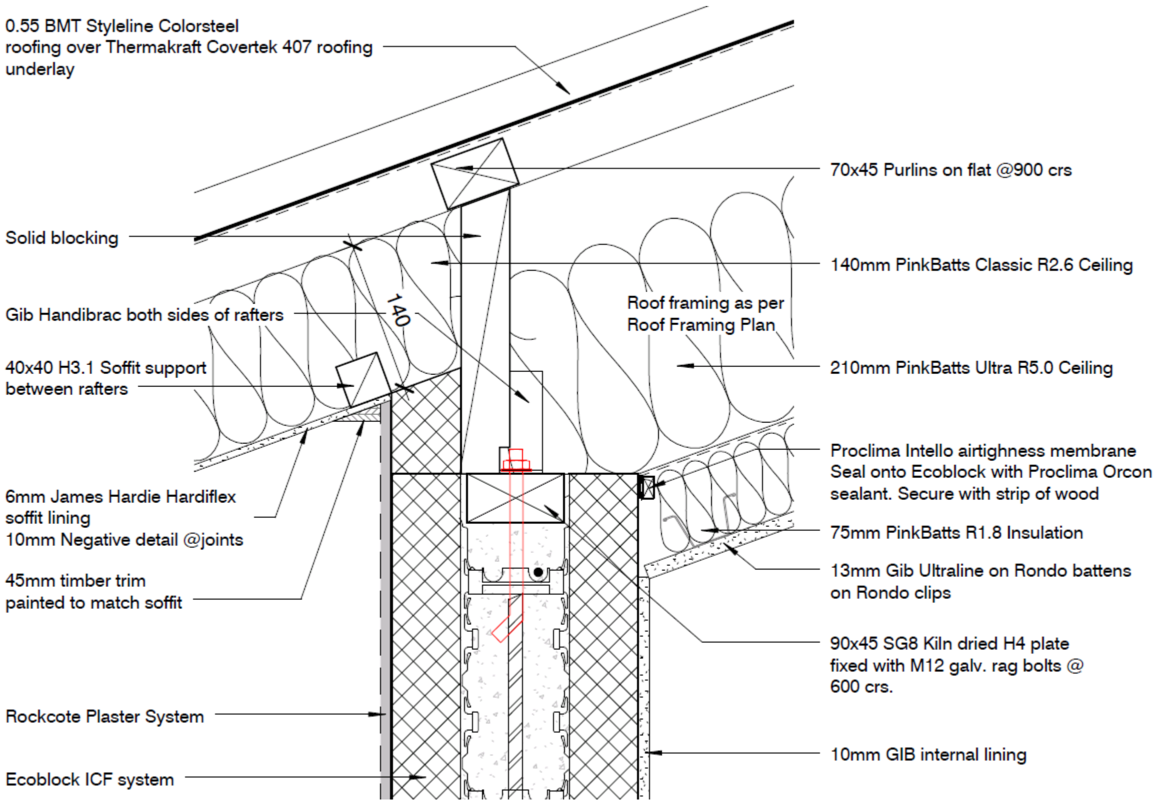

Figure 16: Soffit detail

2.7.5 Windows installation details

To achieve the passive house standard, the windows were imported from a recognised German company Schüco. The frames 'WoodAlu' are German made laminated timber with an aluminium outer façade. (U_f-Value: 1,5 W/(m²K)). The glazing is Nutralux 4mm Clr Tou /16mm argon/4mm Clr Tou-low E. In other words the windows are double glazed, filled with 16mm of argon. Their U_g-value is 1.1 W/(m²K) and their g–value is 61 %. The main door is also double glazed with a total U-value of 1.1 W/(m²K). EcoWindows is the New Zealand based company in charge of the import and the distribution of those high efficiency windows.
The implementation of the windows was one of the most delicate point in the building. To ensure a minimal thermal bridge between the frame and the wall we overlapped a layer of insulation on top the frame.

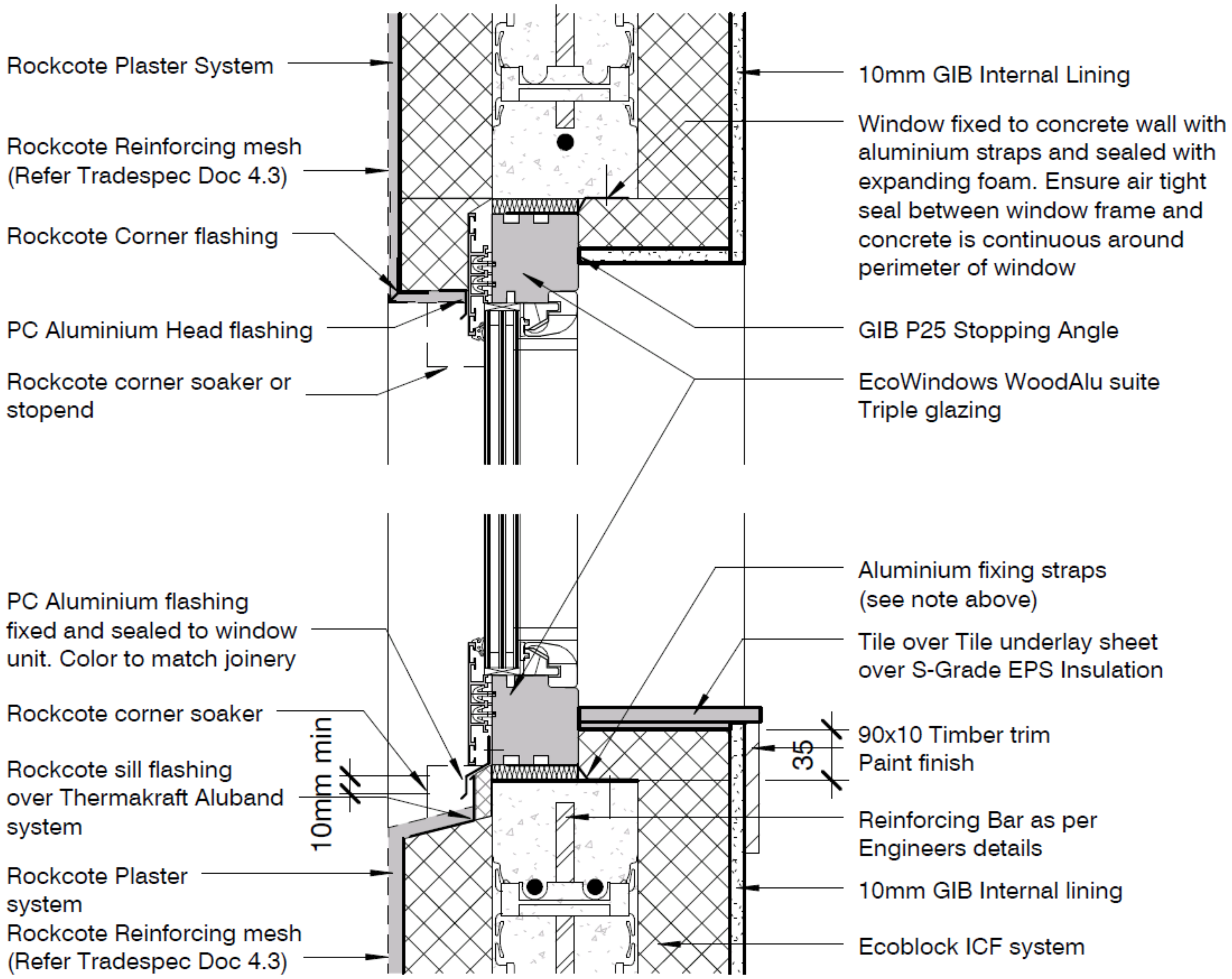

Figure 17: Typical Window Head/Sill detail

2.7.6 Airtightness and pressure test documentation

The exterior walls made of ICF blocks and concrete are naturally airtight. So the delicate zones were the junctions between the exterior walls and the windows or the roof. As you can see on figure 18, the junction between the roof and the exterior walls has been achieved with the help of an airtightness membrane (Pro-Clima Intello) sealed onto the ICF block with some sealant tape (single-sided Intello Uni tape). Then it is secured with a strip of wood. Otherwise, the tape pre-fixed to the windows and doors was carefully overlapped with some sealant tape..

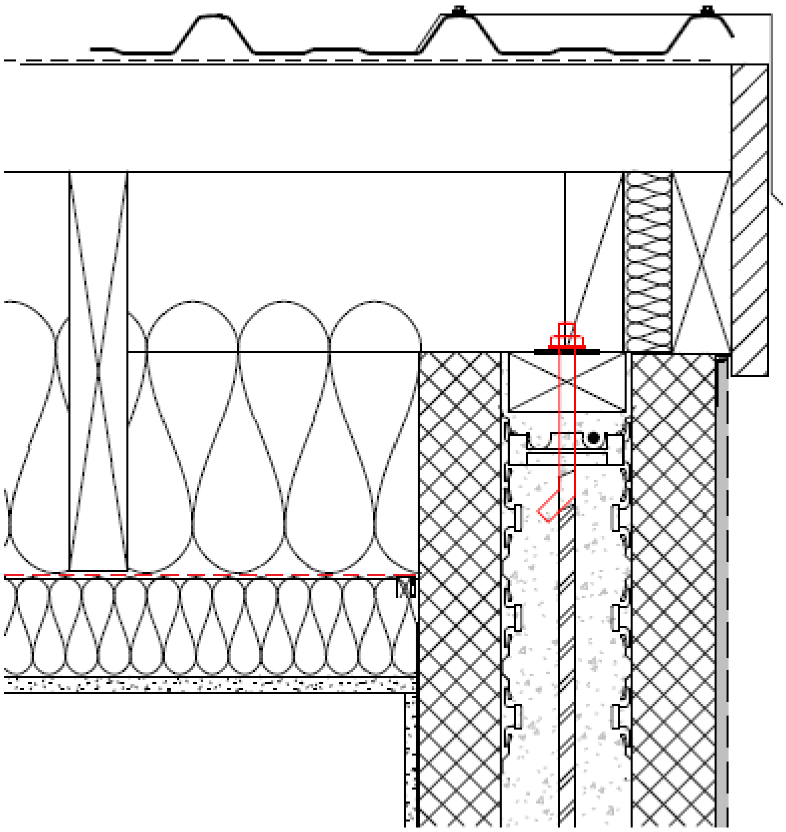

Figure 18: Airtightness detail

The figure 19 shows the results of the pressure test performed by eHaus.

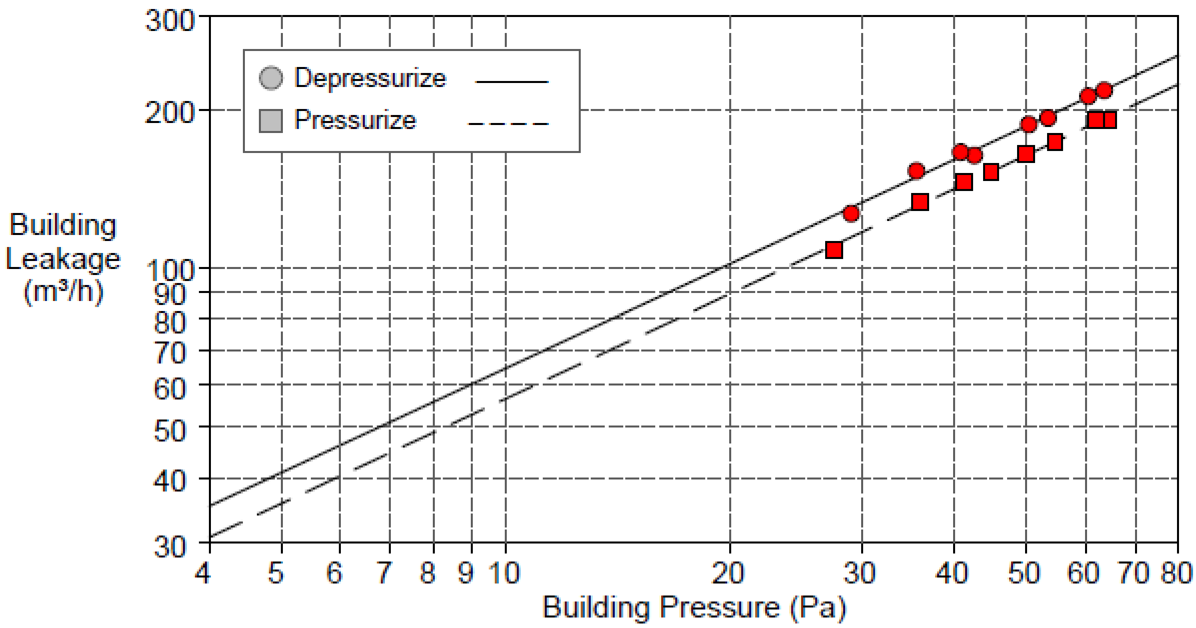

Figure 19: Result of the pressure test

2.7.7 Ventilation unit and ductwork

The mechanical ventilation heat recovery unit in charge of the ventilation is a wall mounted Zehnder, ComfoAir 350 with a heat recovery coefficient of 81% and a power consumption at 100Pa of 0.29Wh/m^3. The unit is located in the laundry and served the whole house. The unit supply air (in green on figure 20&21) to the living areas (hallways, living room and bedrooms) and extract air (in red on figure 20&21) from the kitchen, the bathrooms and the laundry. A few doors are slightly cropped to let a free movement of air throughout the house. The outdoor air intake is located on the west wall at a height of 2.5 m above ground level. The extract air is located on the roof above the ventilation unit

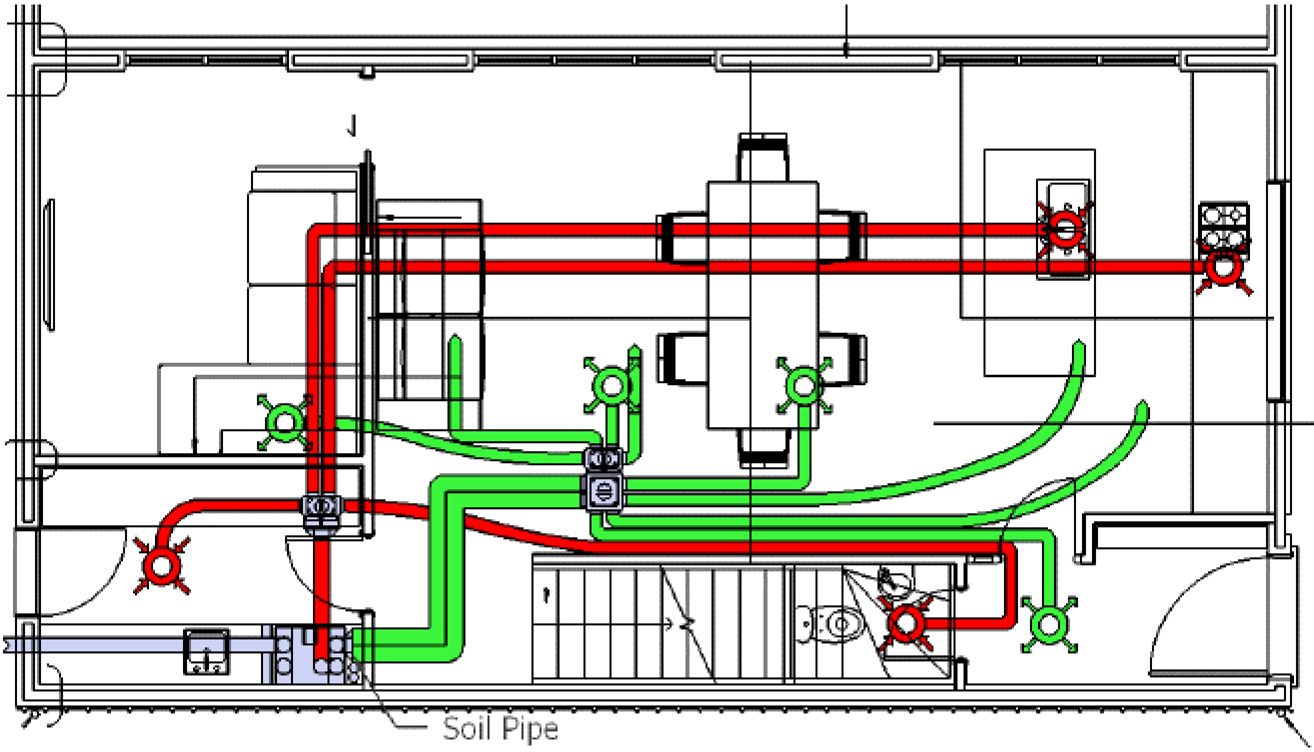

Figure 20: Ventilation layout - Ground floor

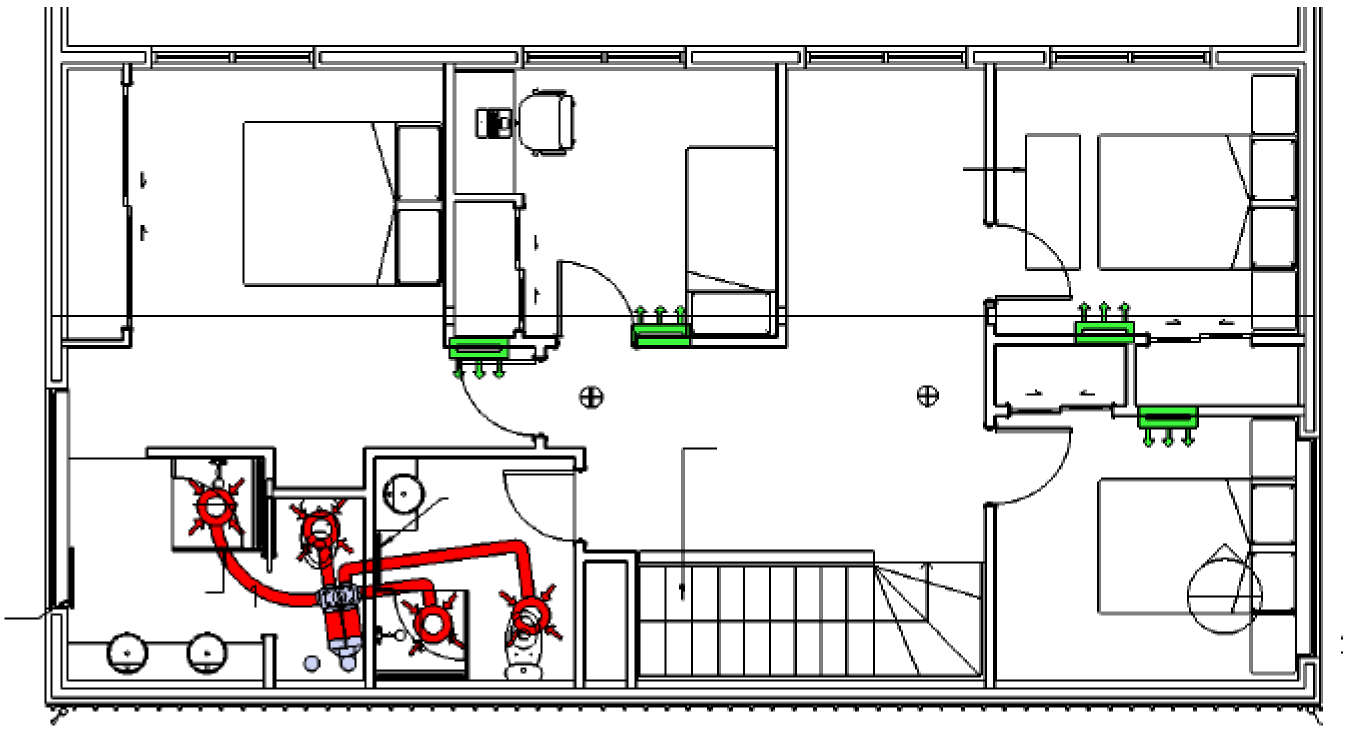

Figure 21: Ventilation layout - First floor


Figure 22: Ventilation unit

2.7.8 Heat Supply

The heat is provided by a 1.5kW Electric portable heater. A heat pump with 275 litre Tank storage takes care of the domestic hot water.

2.8 PHPP results

Passive House verification

Building:	New Residence
Street:	
Postcode / City:	
Country:	New Zealand
Building type:	Single Residential building
Climate:	New Plymouth — Altitude of building site (in [m] above sea level): 165
Home owner / Client:	Jon & Liza Iliffe
Street:	
Postcode/City:	
Architecture:	Cad Viz
Street:	Unit 5a, 80 Paul Matthews Rd, Rosedale
Postcode / City:	Auckland
Mechanical system:	ecoBuild Developments Ltd
Street:	120 Blueskin Road
Postcode / City:	Wanganui

Year of construction:	2014	Interior temperature winter:	20.0	°C	Enclosed volume V_e m³:	383.0
No. of dwelling units:	1	Interior temperature summer:	25.0	°C	Mechanical cooling:	
No. of occupants:	4.0	Internal heat sources winter:	2.1	W/m²		
Spec. capacity:	180 Wh/K per m² TFA	Ditto summer:	2.7	W/m²		

Specific building demands with reference to the treated floor area

				Requirements	Fulfilled?*
	Treated floor area	138.5	m²		
Space heating	Heating demand	9.2	kWh/(m²a)	15 kWh/(m²a)	yes
	Heating load	11.0	W/m²	10 W/m²	-
Space cooling	Overall specif. space cooling demand		kWh/(m²a)	-	-
	Cooling load		W/m²	-	-
	Frequency of overheating (> 25 °C)	0.0	%	-	-
Primary energy	Heating, cooling, dehumidification, DHW, auxiliary electricity, lighting, electrical appliances	83.8	kWh/(m²a)	120 kWh/(m²a)	yes
	DHW, space heating and auxiliary electricity	48	kWh/(m²a)	-	-
	Specific primary energy reduction through solar electricity		kWh/(m²a)	-	-
Airtightness	Pressurization test result n_{50}	0.5	1/h	0.6 1/h	yes

* empty field: data missing; '-': no requirement

Passive House? yes

Figure 23: PHPP Verification Page

The maximum space heating and cooling is largely achieved through the provision of efficient fabric elements.

The airtightness of the building has been checked frequently during the building process. Particular attention to the implementation of the windows was still necessary.

Overheating risks were managed on this project by the introduction of large eaves overhangs on the north side of the building. They passively shade the large north facing windows during summer but still allow sun gains in winter.

The house was designed to be functional, cost effective and have low maintenance. All the materials have been chosen with the client for both their look and their time resistance. eHaus ran many early PHPP simulations and was in close dialogue with the architects firm CADViz in order to get the design right as early as possible. Most of the details have been developed by ehaus with the help of the software THERM.

In this project the orientation of the house was relatively easy because the view id due north. Thus, the client did not have to choose between solar gains and beautiful landscape. However thanks to the PHPP, we decided to rotate slightly the house to the east to avoid any overheating due to the late afternoon sun.

The client was quite keen on the idea of having an autonomous house but still simple to use for the whole family. eHaus, which was also in charge of the building services and the building physics, advised the installation of photovoltaics panels on the north side of the roof. Besides, we also installed a rainwater harvesting system which collects the rain from the roof and stores it in underground tanks. The harvested water can in New Zealand be used for both domestic purpose and irrigation use. The tanks have a back-up supply in times of low rainfall but the family did not use it last summer.

The buildings services have been designed by eHaus.

2.09 Year of Construction and costs

The house took around 6 months to build and the family moved in at the end of 2014. The building cost was around 450k NZ dollars.

2.10 Experiences

The house has been monitored since the end of the build. Here are the temperature data of the month of January, one of the warmest in New Zealand. As we can see the temperatures are even and stay in the comfort zone.

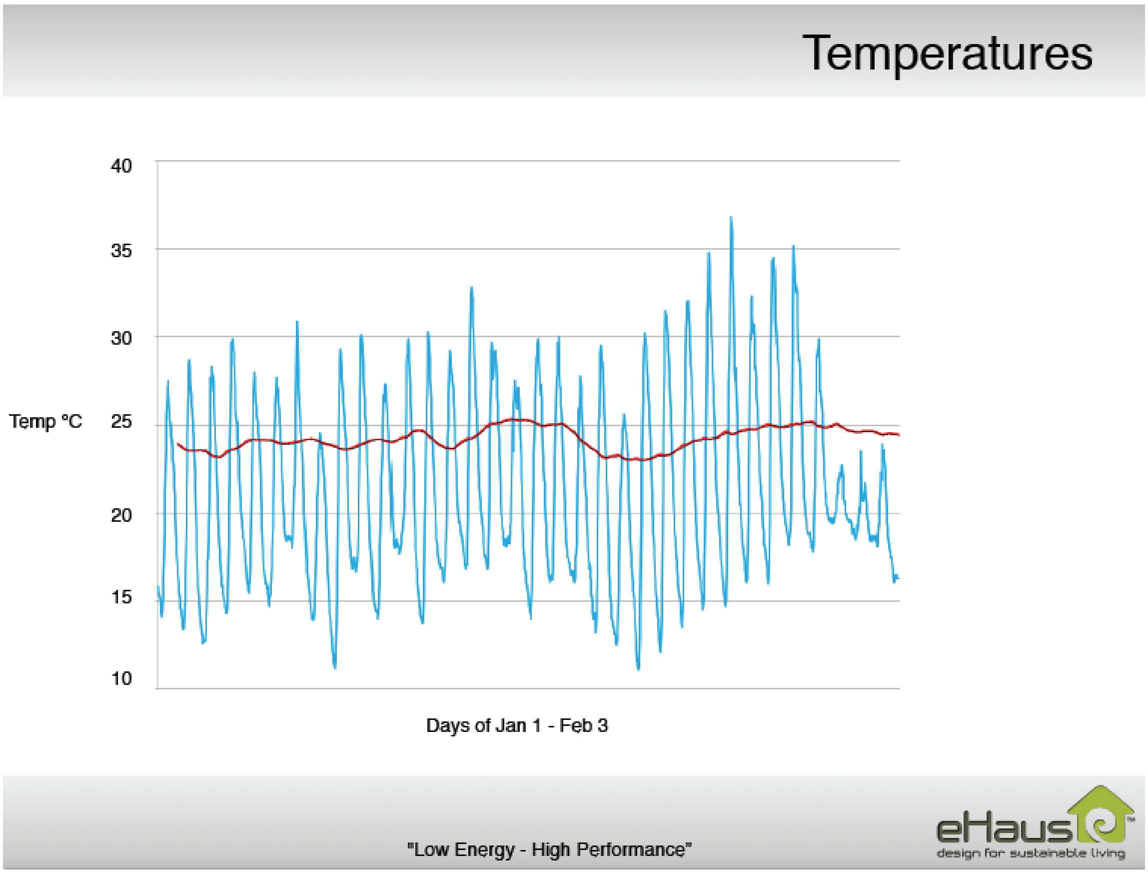

Figure 24: Temperature Data