

Project Documentation Gebäude-Dokumentation

Abstract | Zusammenfassung



Single family home in Nedlands, Perth, Australia

Data of building | Gebäudedaten

Year of construction Baujahr	2023	Space heating Heizwärmebedarf	9 kWh/(m²a)
U-value external wall U-Wert Außenwand	0,351 W/(m ² K)		
U-value basement U-Wert Kellerdecke	5,556 W/(m ² K)	Primary Energy Renewable (PER) Erneuerbare Primärenergie (PER)	24 kWh/(m ² a)
U-value roof U-Wert Dach	0,198 W/(m ² K)	Generation of renewable Energy Erzeugung erneuerb. Energie	62 kWh/(m ² a)
U-value window U-Wert Fenster	1,26 W/(m ² K)	Non-renewable Primary Energy (PE) Nicht erneuerbare Primärenergie (PE)	56 kWh/(m ² a)
Heat recovery Wärmerückgewinnung	86 %	Pressurization test n ₅₀ Drucktest n ₅₀	0,4 h ⁻¹
Special features Besonderheiten	CLT construction with external mineral wool insulation		

Brief Description

Nedlands Passive House

This single-family home was built on a site overlooking the Swan River in metropolitan Perth. The architect owner designed the residence to capture the views of the river and to incorporate pre-fabrication using cross-laminated timber (CLT) for the walls and roof. The CLT was a key part of the design aesthetic and is fully exposed internally.

The dwelling extends across three levels along a relatively narrow site, with a northern courtyard and street frontage to the northwest. The climate in Perth is evenly balanced between winter heating and summer cooling demand, while winter maximum temperatures are rarely below 15°C, during summer the temperature regularly exceeds 40°C for prolonged periods. During much of the year an afternoon sea breeze can bring cooler weather; windows and doors within the dwelling can be readily opened across multiple levels to benefit from this purge ventilation.

The CLT forms the airtight layer along with the concrete slab. The windows and doors are uPVC frames with high-performance triple glazing. The CLT panels are protected externally with a peel-and-stick vapour permeable membrane and insulated with rigid mineral wool insulation. The concrete slab is ground-coupled to provide some passive cooling potential in summer.

Kurzbeschreibung

Passivhaus Nedlands

Dieses Einfamilienhaus wurde auf einem Grundstück mit Blick auf den Swan River im Großraum Perth gebaut. Der Architekt hat das Haus so entworfen, dass es die Aussicht auf den Fluss einfängt und die Wände und das Dach aus Brettsperrholz (CLT) vorgefertigt sind. Das CLT war ein wesentlicher Bestandteil der Designästhetik und ist im Inneren vollständig sichtbar.

Das Haus erstreckt sich über drei Ebenen auf einem relativ schmalen Grundstück mit einem nördlichen Innenhof und einer Straßenfront im Nordwesten. Das Klima in Perth ist ausgeglichen zwischen Heiz- und Kühlbedarf im Winter. Während die Höchsttemperaturen im Winter selten unter 15 °C liegen, übersteigt die Temperatur im Sommer regelmäßig über längere Zeiträume 40 °C. Während eines Großteils des Jahres kann eine nachmittägliche Meeresbrise kühleres Wetter bringen; Fenster und Türen innerhalb der Wohnung können auf mehreren Ebenen leicht geöffnet werden, um von dieser Spüllüftung zu profitieren.

Die CLT-Platten bilden zusammen mit der Betonplatte die luftdichte Schicht. Die Fenster und Türen bestehen aus PVC-Rahmen mit leistungsstarker Dreifachverglasung. Die CLT-Paneele sind von außen mit einer dampfdurchlässigen Schälmembran geschützt und mit einer starren Mineralwolldämmung isoliert. Die Betonplatte ist erdgekoppelt, um im Sommer ein gewisses passives Kühlpotenzial zu bieten.

Übersetzt mit DeepL.com (kostenlose Version)

Responsible project participants Verantwortliche Projektbeteiligte

Architect Entwurfsverfasser	Siew-Fung Then, Ewert Leaf
Implementation planning Ausführungsplanung	Cameron Munro, Passive Analytics https://www.passiveanalytics.com.au
Building systems Haustechnik	Cameron Munro, Passive Analytics https://www.passiveanalytics.com.au
Structural engineering Baustatik	Vistek Structural + Civil Engineers https://www.vistek.com.au
Building physics Bauphysik	Cameron Munro, Passive Analytics https://www.passiveanalytics.com.au
Passive House project planning Passivhaus-Projektierung	Cameron Munro, Passive Analytics https://www.passiveanalytics.com.au
Construction management Bauleitung	Evans Builds https://evansbuilds.com.au/

Certifying body Zertifizierungsstelle

Luc Plowman, Detail Green
<https://www.detailgreen.com.au>

Certification ID Zertifizierungs ID

7449

Project-ID (www.passivehouse-database.org)
Projekt-ID (www.passivhausprojekte.de)

Author of project documentation Verfasser der Gebäude-Dokumentation

Cameron Munro, Passive Analytics
<https://www.passiveanalytics.com.au>

Date
Datum

19.06.2024

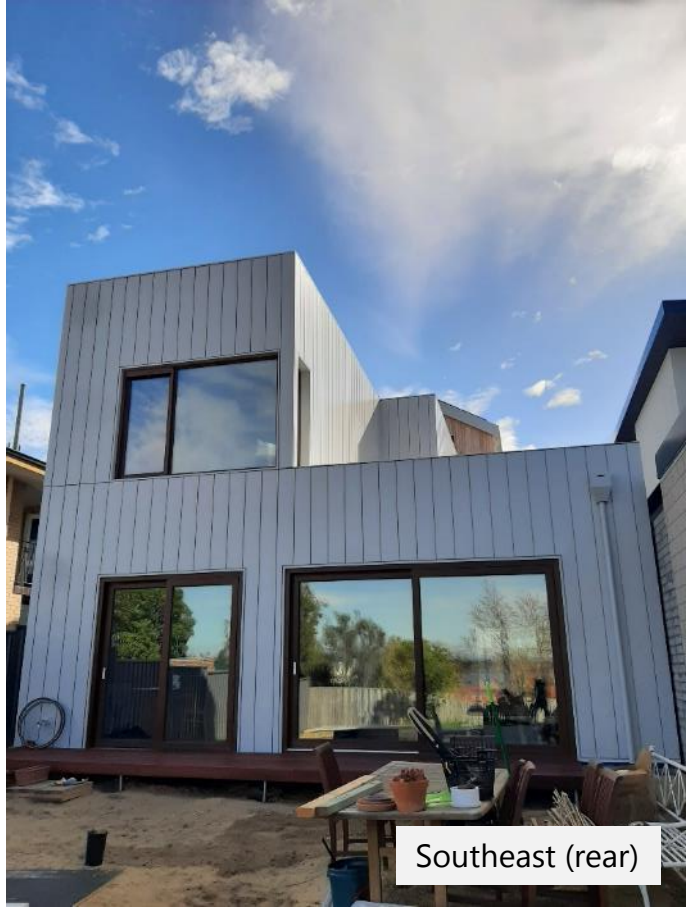
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1. Exterior photos



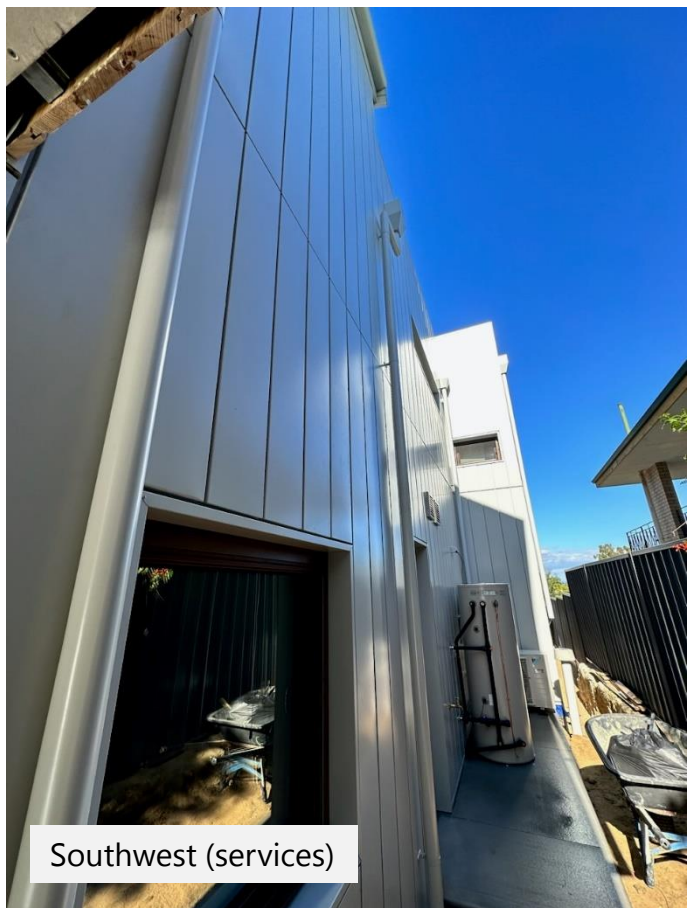
Northwest (front)



Southeast (rear)

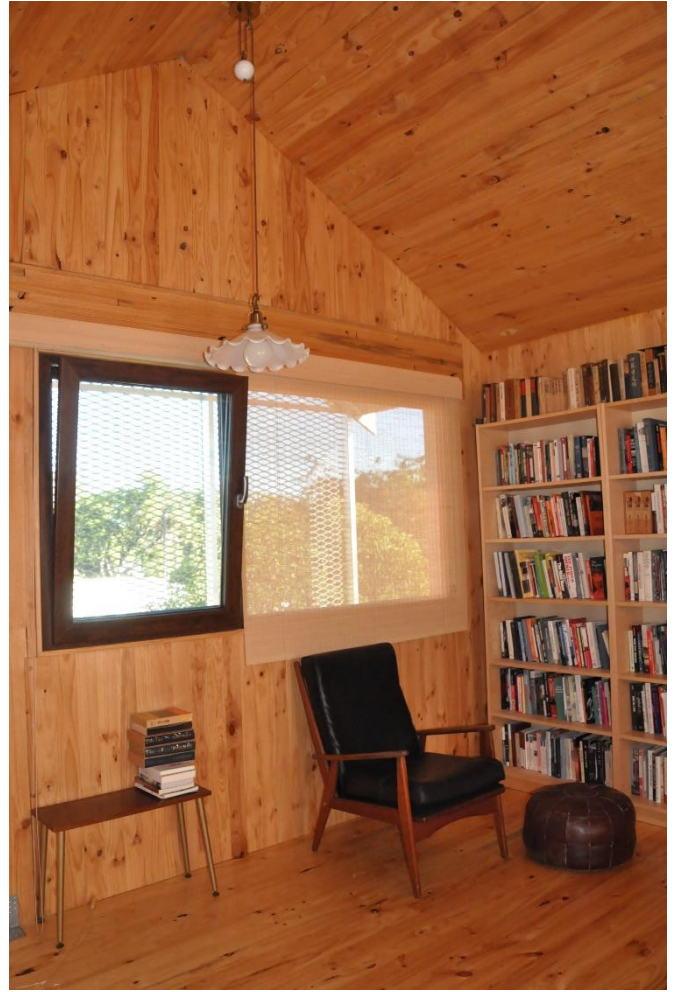
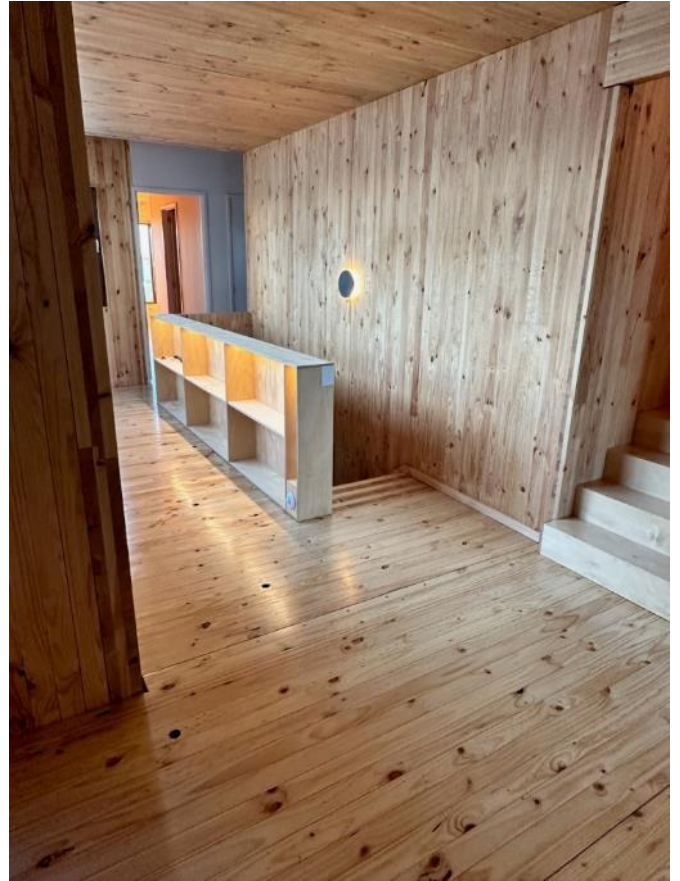


Northeast (courtyard)

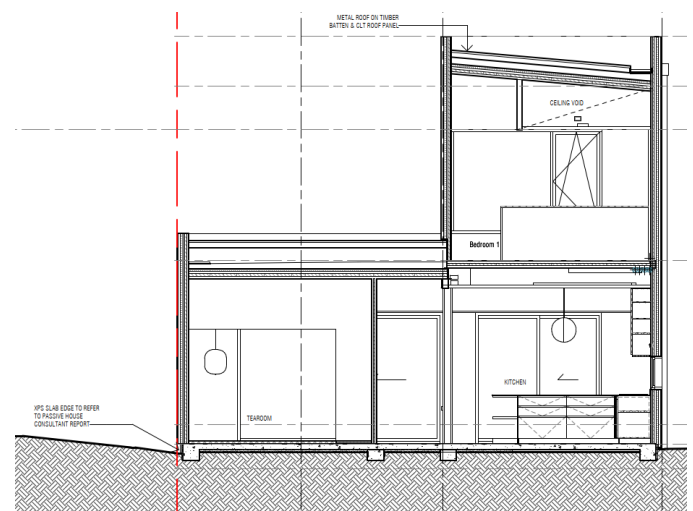
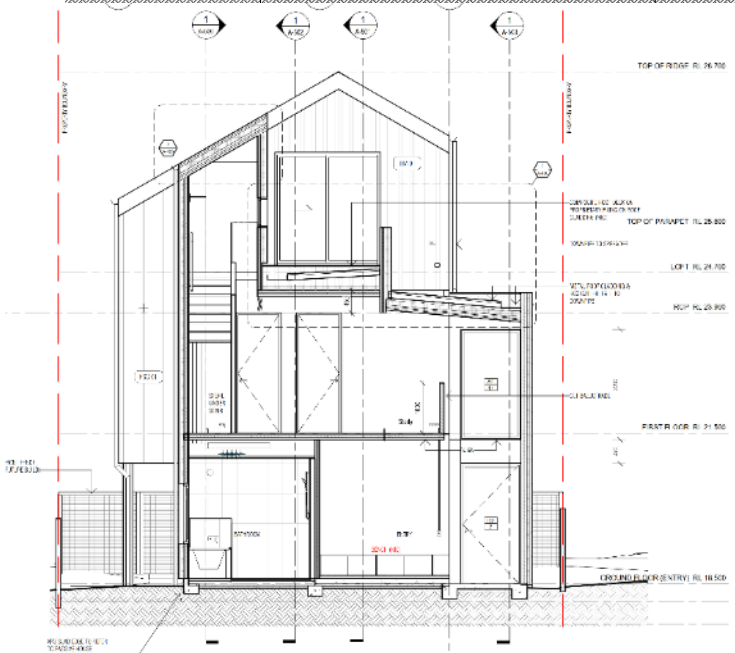
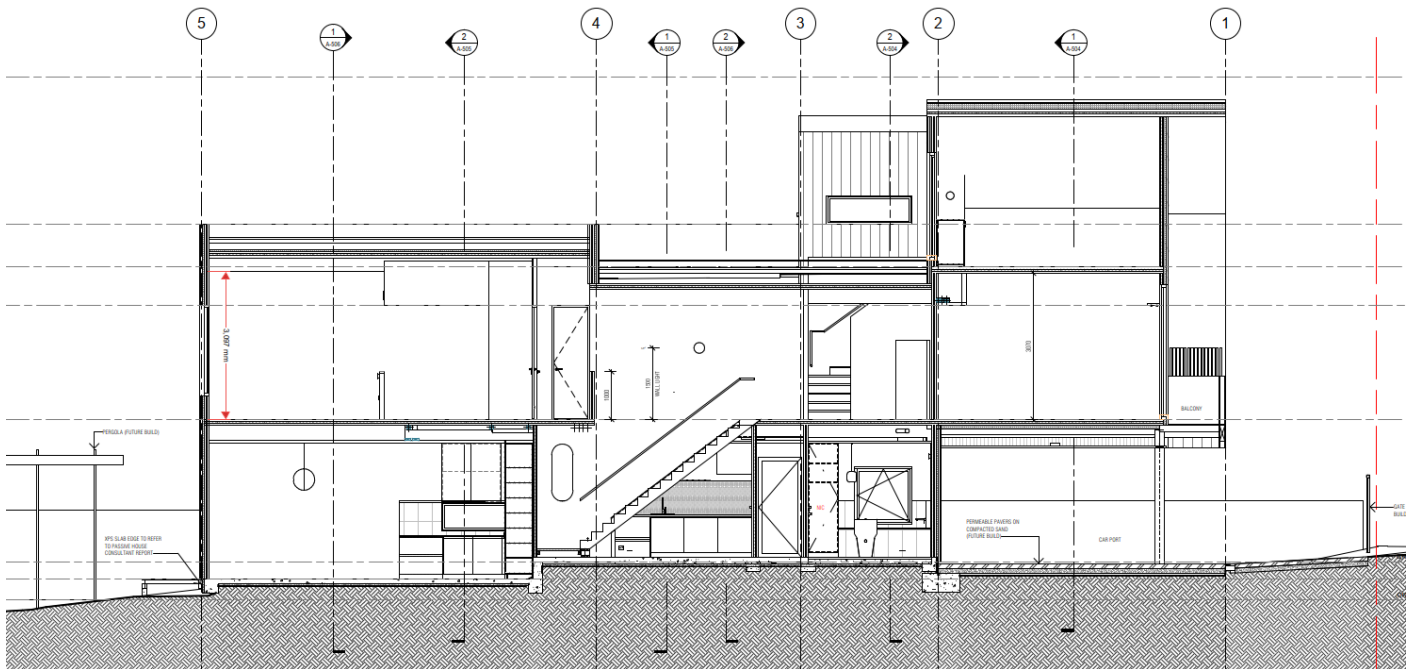
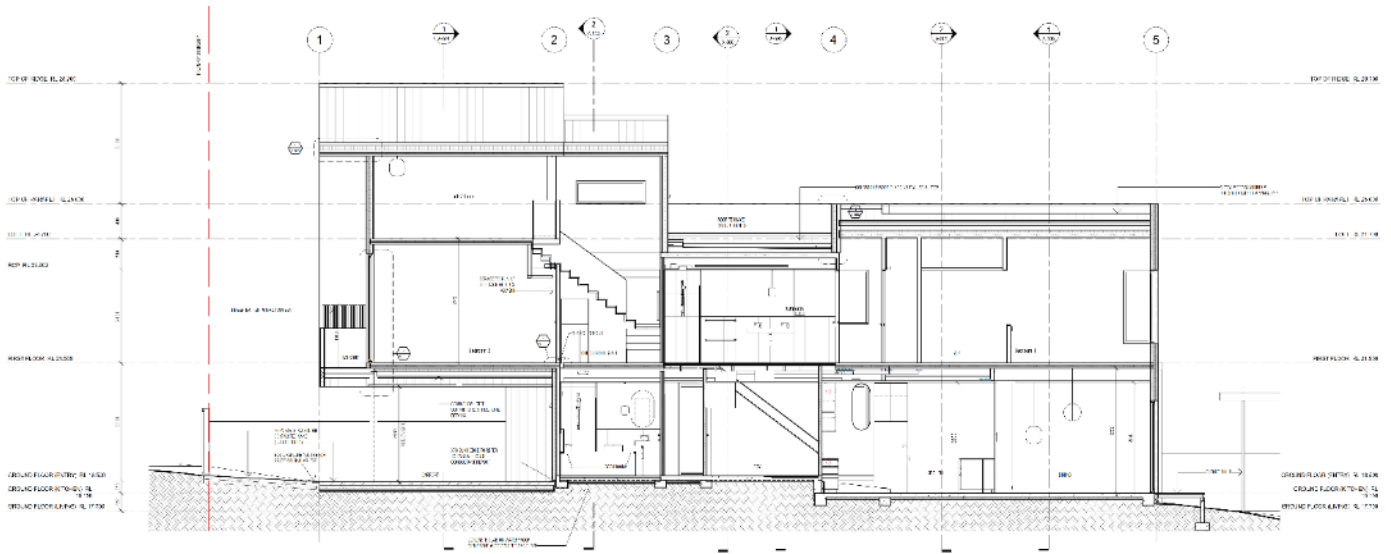


Southwest (services)

2. Interior

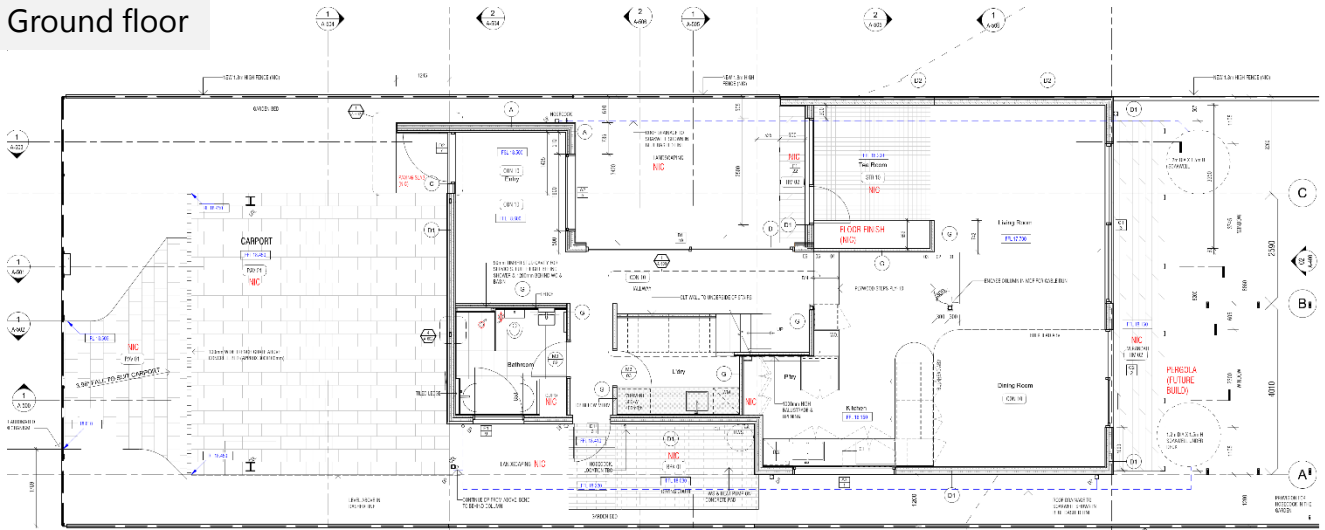


3. Sections

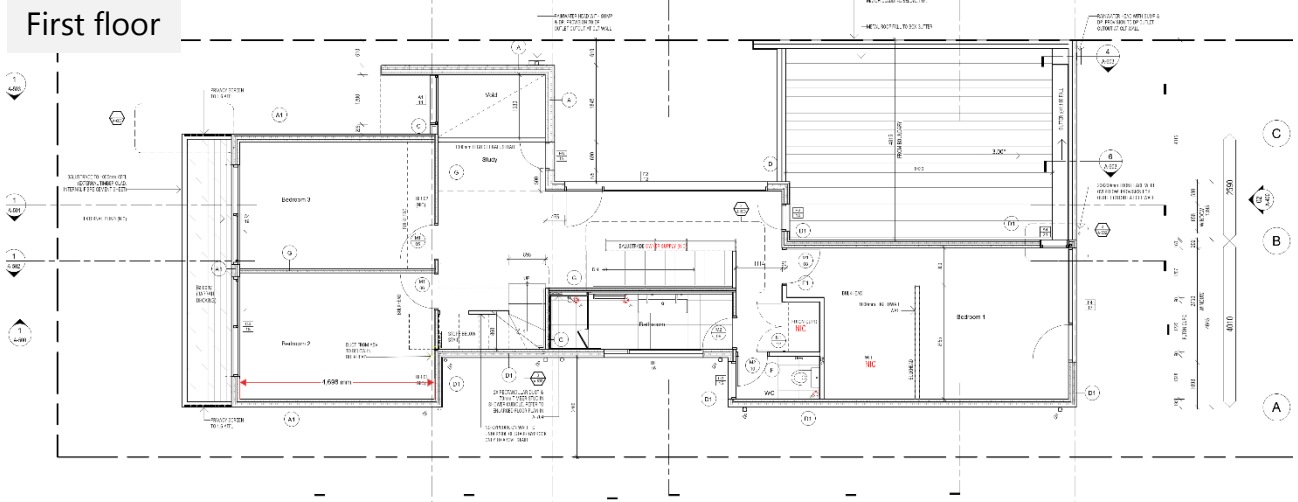


4. Plan

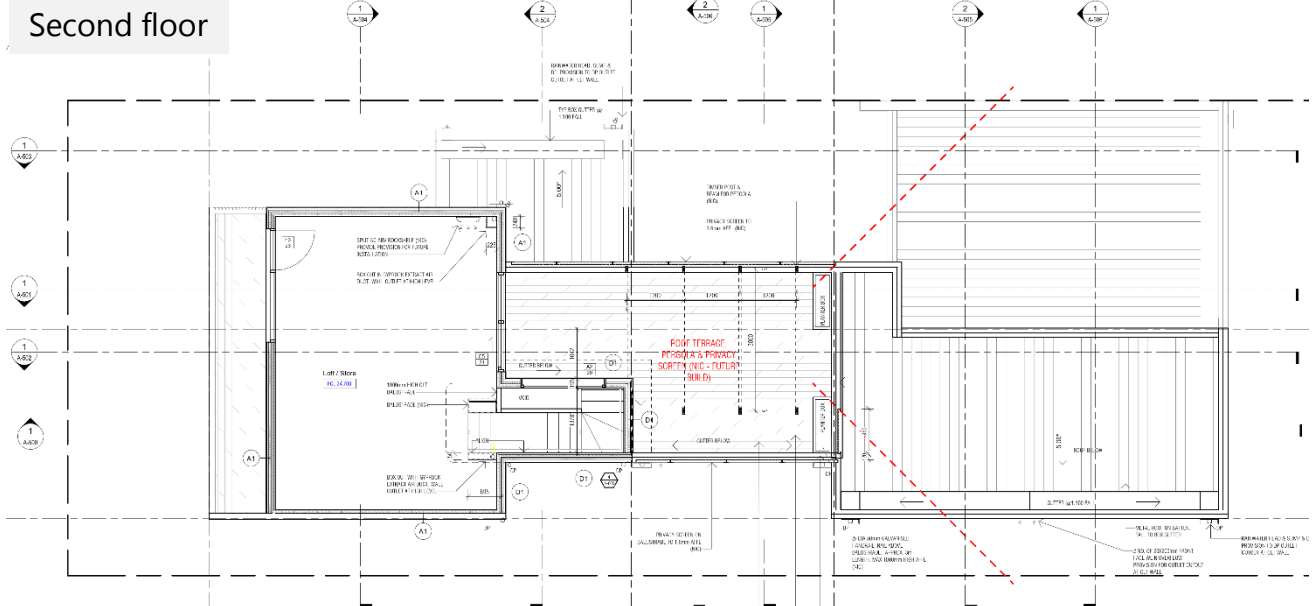
Ground floor



First floor



Second floor



5. Construction Concept

The dwelling is in an inner suburban location in Perth. The block is 10 m wide and 43 m deep and oriented towards the northwest. The primary views are towards the southwest and the Swan River. The block is towards the south of a two-block subdivision; a two-storey dwelling to the north of the subject dwelling was constructed at the same time; this neighbouring dwelling adds significant shading to the north courtyard during winter.

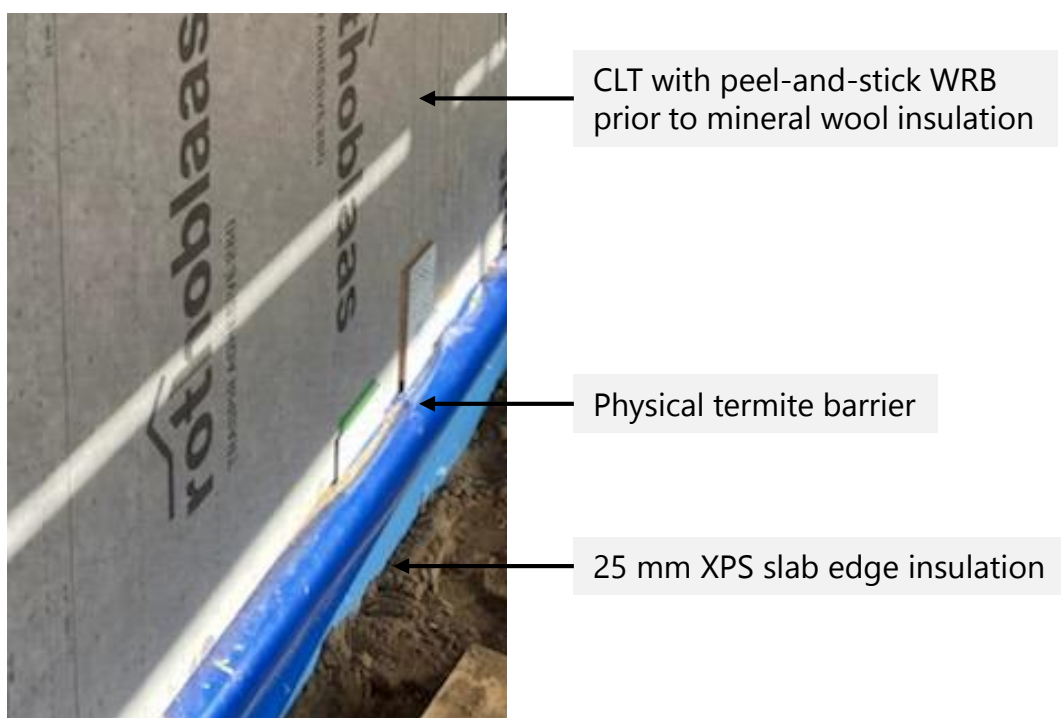
The dwelling was entirely constructed from CLT as the structural element, aside from the concrete slab. The CLT was protected externally using a vapour permeable peel-and-stick membrane which was installed in the factory of the CLT fabricator. Construction of the walls and roof took two days once the panels arrived onsite.

The CLT was left exposed internally. An external insulation strategy was adopted whereby varying thicknesses of mineral wool rigid insulation was applied to the exterior face of the CLT. Timber battens were then affixed to the mineral wool to retain the mineral wool in place and to provide attachment for the fibre cement lightweight cladding.

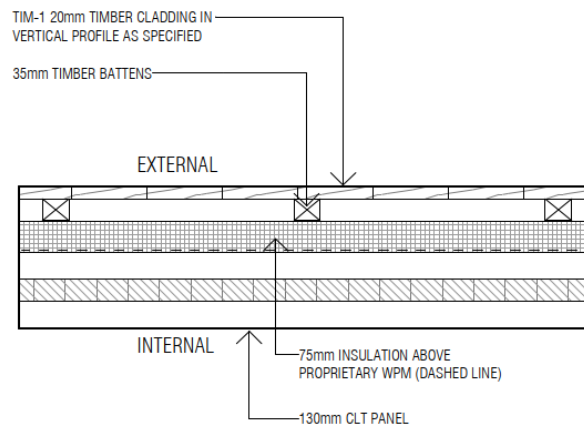
6. Construction Assemblies

As the Passive House consultant on the project, my role was primarily to assist the architect and builder in detailing the thermal and airtightness envelope in order to achieve the Passive House criteria. While the architectural form of the building was largely fixed, the insulation strategy (and amount of insulation), as well as the windows and glazing were guided by the PHPP and thermal bridge modelling. This extended also to the external shading strategy.

FLOOR: The slab was 100 mm of reinforced concrete and uninsulated aside from 25 mm of slab edge insulation. This insulation was required primarily to achieve the hygiene criterion; that is, to avoid condensation at the floor-wall junction.

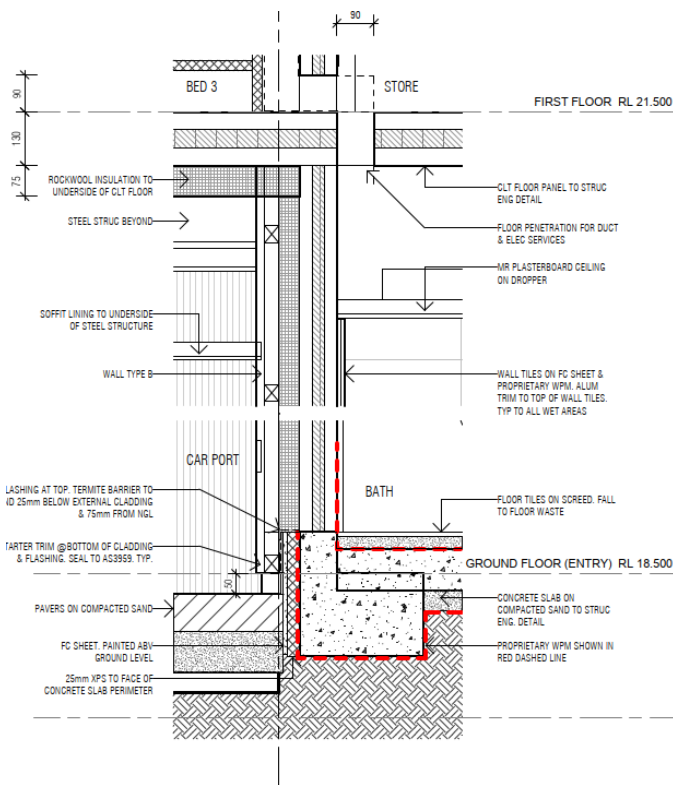


WALL: The walls consisted of 90-120 mm CLT panels insulated on the exterior with 50-100 mm mineral wool insulation. The wall CLT panels were affixed to the slab with mass timber brackets. The mineral wool was fixed to the CLT with screws with plastic washers, and then timber battens were installed to affix lightweight cladding and provide a ventilation and drainage plane. As the mineral wool is hydrophobic no WRB was required between the cladding and insulation.

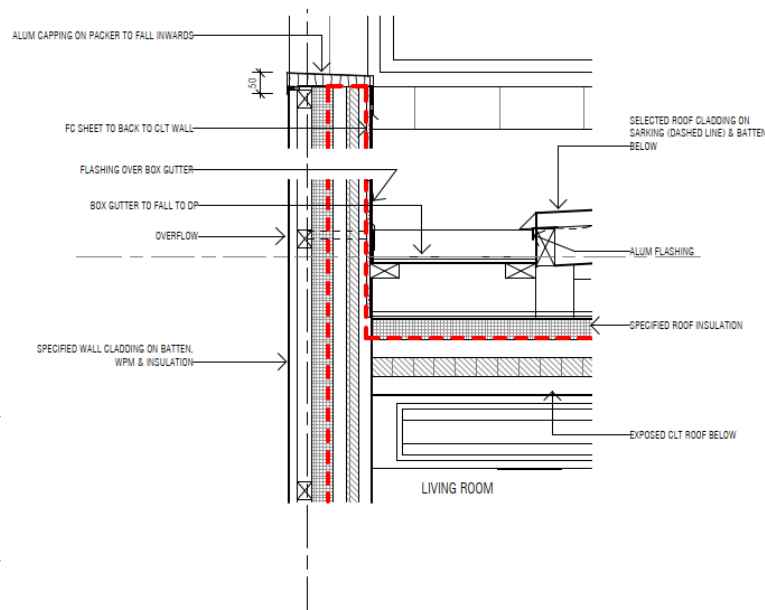


WALL TYPE: A
 EXTERNAL CROSS LAMINATED TIMBER WALL (LOAD BEARING)
 [CLT FIRE-RATED FRL: 60/60/60]
 SYSTEM No: -
 ACOUSTIC RATING: -

Typical wall buildup shown external water-resistant membrane and mineral wool insulation



Typical wall and slab detail showing slab edge insulation aligning with exterior mineral wool insulation.



Parapet and box gutter detail.

ROOF: The roof consisted of 100-130 mm CLT panels with 50-100 mm mineral wool and, where space allowed between roof rafters, 90 mm high-density glasswool insulation. On the pitched roof the insulation from the wall and roof butted into one another, eliminating the thermal bridge. On the flat roof the insulation terminated at the CLT parapet, creating a small thermal bridge between the roof insulation and the exterior wall insulation; in this climate the resulting thermal bridge had a negligible effect on the overall energy balance.

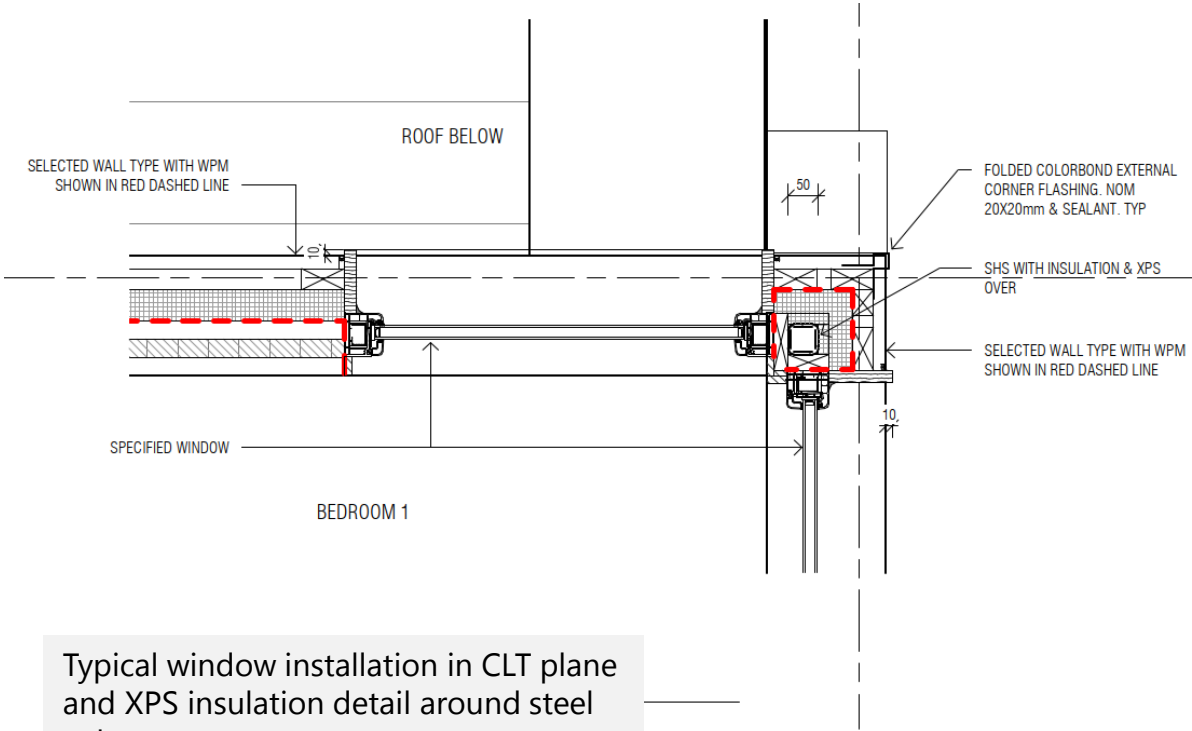
Flat roof sections under construction; CLT parapet in grey WRB and mineral wool installed below battens in distant roof



Mineral wool on pitched roof with roof battens



WINDOWS AND DOORS: The windows and doors were Deceuninck Zendow uPVC profiles with argon-filled triple glazing with warm edge spacers. The centre-of-glass U-value was 1.0 W/m²K with g=0.52. The typical frame thermal transmittance (U_f) was 1.4 W/m²K with an overall average window thermal transmittance (U_w) of 1.26 W/m²K. The windows and doors were installed in the CLT plane with external reveals. The cavity between the frames and CLT panels was filled with low-expansion polyurethane foam. The WRB on the exterior face of the CLT formed the airtightness layer and so was taped to the window frames.



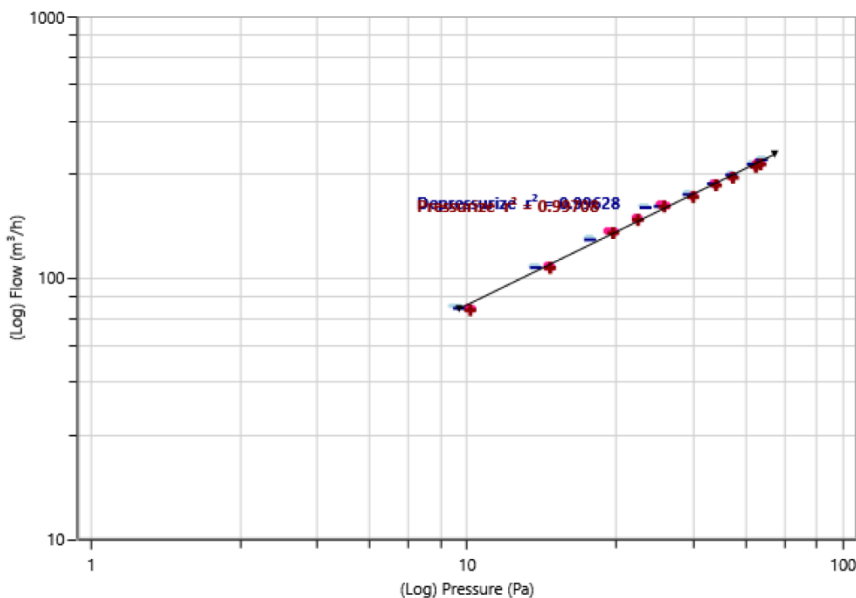
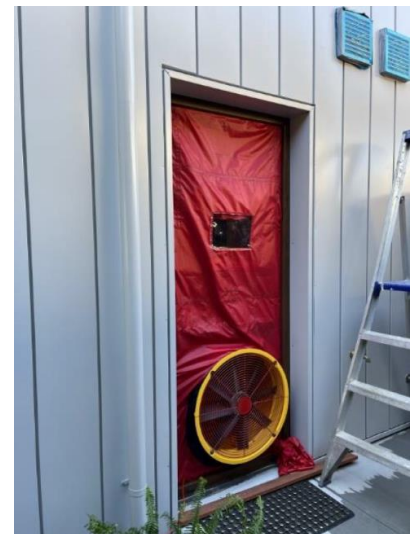
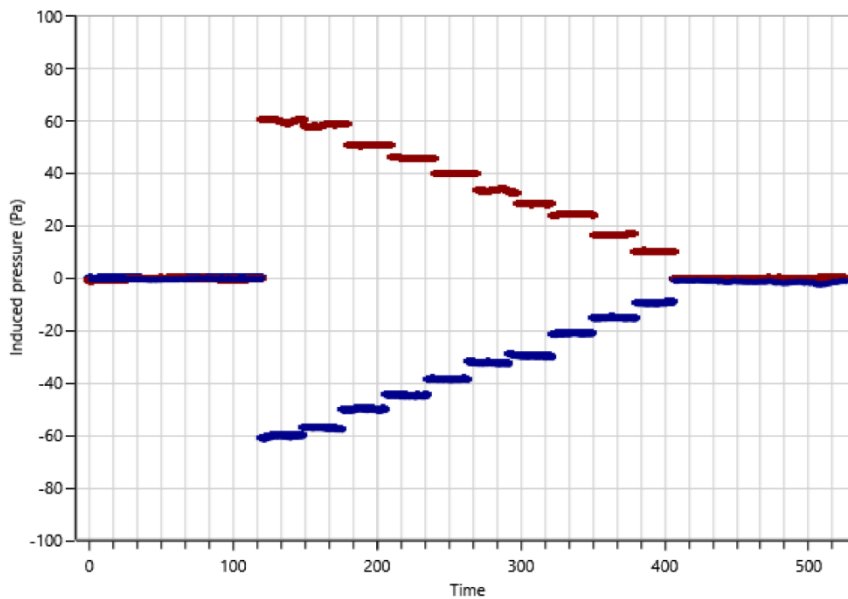
Typical window installation in CLT plane and XPS insulation detail around steel column.

AIRTIGHTNESS: The concrete slab and CLT panels in combination with the peel-and-stick WRB provided the airtightness, all junctions and penetrations were sealed with tapes, adhesives and expanding foam tapes that are vapour permeable and are adequately durable to provide very long adhesion. The WRB was pre-applied in the CLT factory, ensuring the CLT panels were not exposed to weather onsite.

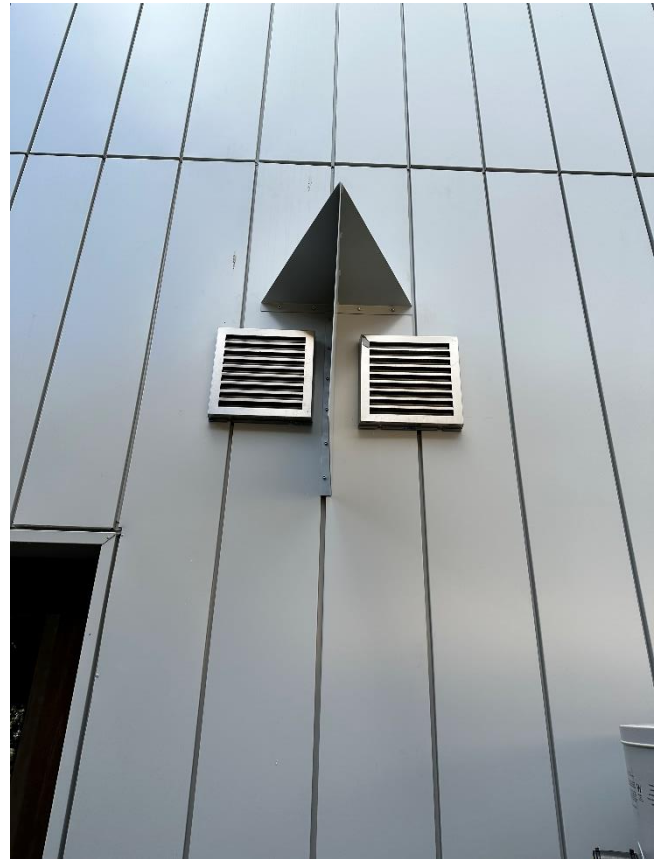


Combined Test Data (Average Values)

	Results	95% Confidence Interval		Uncertainty
Air flow at 50 Pa, [m ³ /h]	250.05	244.15	256.15	+/-2.4%
Air changes at 50 Pa, n_{50} [/h]	0.40	0.3872	0.4079	+/-2.6%
Specific leakage rate (envelope) at 50 Pa, [m ³ /h/m ²]	0.3290	0.320	0.338	+/-2.6%
Specific leakage rate (floor) at 50 Pa, [m ³ /h/m ²]	2.283	2.223	2.342	+/-2.6%
Effective leakage area at 50 Pa, [cm ²]	76.22	74.41	78.07	+/-2.4%
Specific effective leakage area (envelope) at 50 Pa, [cm ² /m ²]	0.10029	0.098	0.103	+/-2.6%
Specific effective leakage area (floor) at 50 Pa, [cm ² /m ²]	0.696	0.678	0.714	+/-2.6%

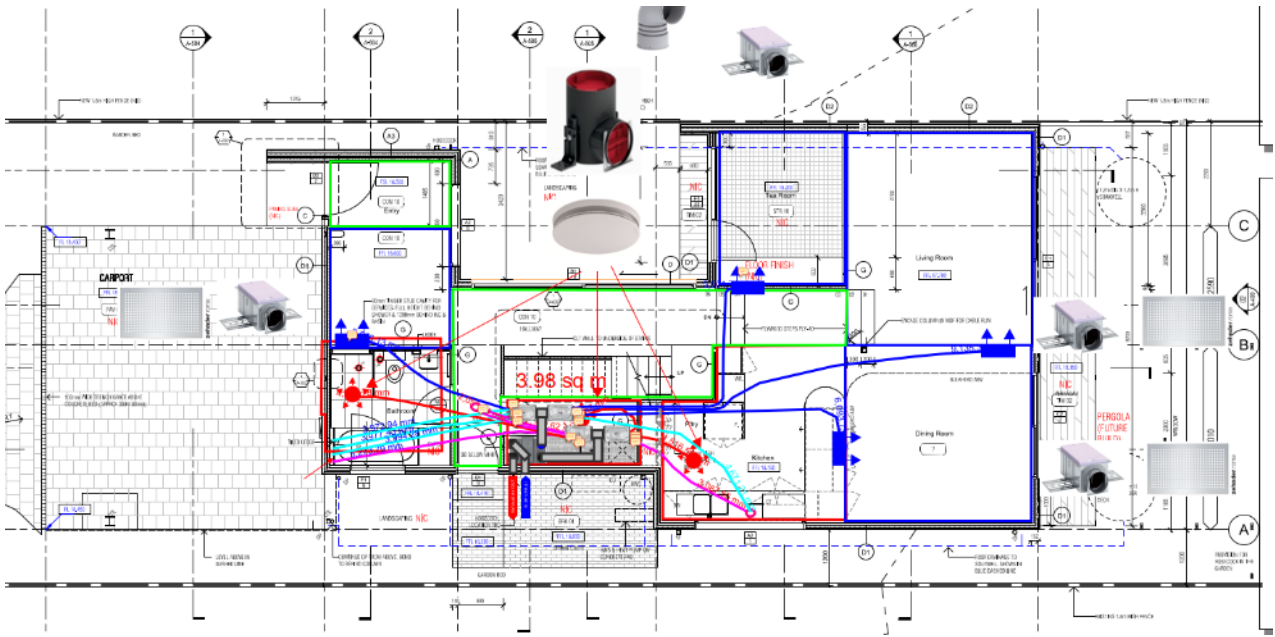


VENTILATION: A Zehnder Q350 centralised ventilation system with heat recovery was installed to all habitable spaces and extracting from the kitchen, laundry and bathrooms. The HRV was located along an external wall to minimise the length of the outdoor and exhaust ducts. The effective heat recovery efficiency was 86.3% with specific power of 0.24 Wh/m³. The kitchen rangehood is internally recirculating so as not to impact the thermal performance. The HRV outdoor and exhaust ducts are located next to one another in the facade; to avoid cross-contamination a baffle was installed between the vents.

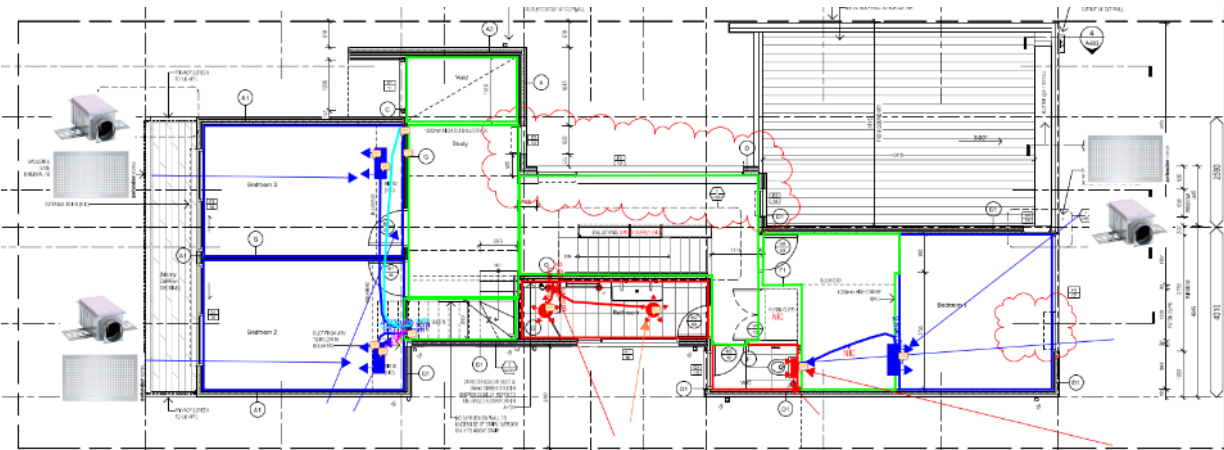


Mechanical ventilation layout

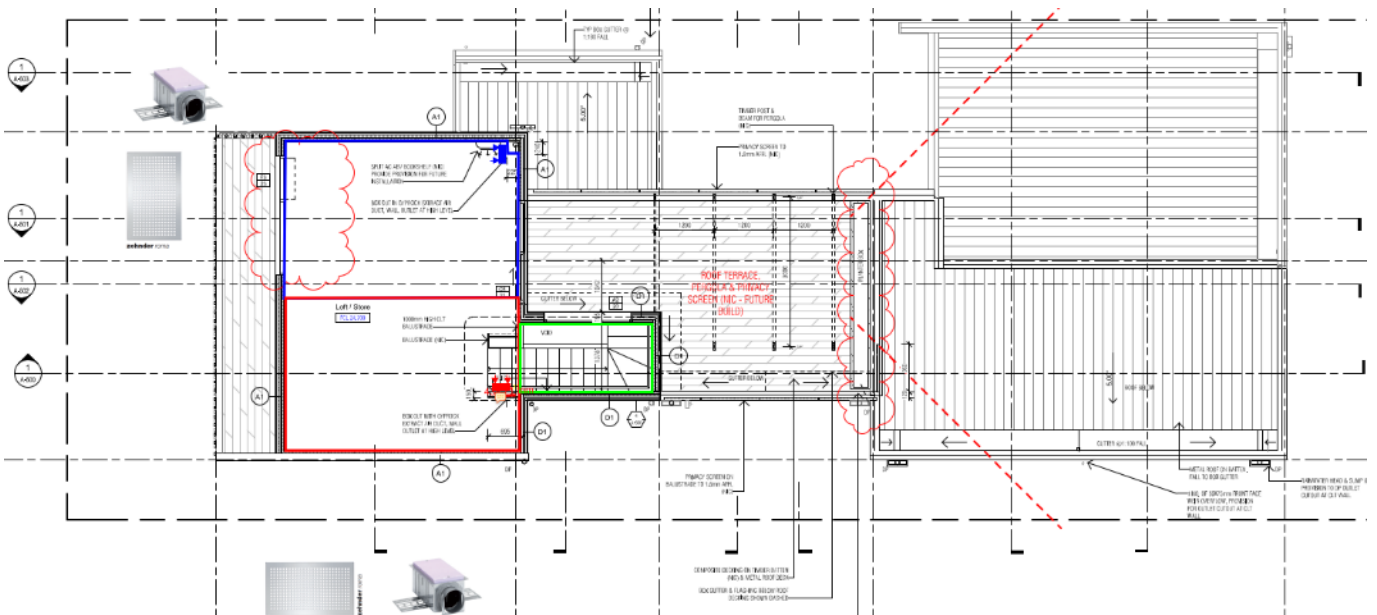
Ground floor



First floor



Second floor



7. Mechanical services

All services at the dwelling are electrified. Cooking uses an electric oven and induction cooktop with recirculating rangehood with carbon filtration. The domestic hot water supply is a very efficient CO₂-based air-to-water heat pump (Reclaim Energy). The heat pump is on a timber such that it operates almost exclusively for 1 – 2 hours during the middle of the day. In this way most of the electricity required is met by the onsite solar PV system, and the hot water storage tank effectively acts as a thermal battery.

Space heating and cooling demands are modest given the performance of the building envelope. Nonetheless, what heating and cooling that is required is met by two multi-head air-to-air heat pumps. The system sizing is dictated by the cooling load of around 5.7 kW. This reflects the mild winters but extremely hot summers often experienced in Perth. The condensers are oversized compared to the predicted peak cooling load; the ground floor and master bedroom are serviced by an 8 kW condenser and the other bedrooms and loft by an additional 6.8 kW condenser. The three storey layout posed challenges in ensuring adequate *distribution* of heating and cooling throughout the dwelling, hence the 8 kW unit has two indoor heads and the 6.8 kW unit has three indoor heads distributed across the main rooms. Efficient heat pumps were chosen using lower GWP refrigerant (R32).



DHW storage tank and heat pump, with air-to-air heat pump across back wall (right of image).



Typical indoor A/C head and upstairs air-to-air heat pump on roof

8. PHPP-Results

Passive House Verification



Building: RESIDENTIAL
 Street:
 Postcode/City:
 Province/Country: Perth AU-Australia
 Building type: RESIDENTIAL
 Climate data set: AU0002a-Perth
 Climate zone: 5: Warm Altitude of location: 18 m

Home owner / Client:
 Street:
 Postcode/City:
 Province/Country: Perth AU-Australia

Architecture: Evert Leaf
 Street: 49-51 Palmerston Crescent
 Postcode/City: 3205 South Melbourne
 Province/Country: Victoria AU-Australia

Mechanical engineer: Evans Builds
 Street: PO Box 7371
 Postcode/City: 6173 Secret Harbour
 Province/Country: Western Australia AU-Australia

Energy consultancy: Passive Analytics
 Street: 60 Union St
 Postcode/City: 3143 Armadale
 Province/Country: VIC AU-Australia

Certification: Detail Green
 Street: 18 Fletcher Road
 Postcode/City: 3747 Beechworth
 Province/Country: Victoria AU-Australia

Year of construction: 2022 Interior temperature winter [°C]: 20.0 Interior temp. summer [°C]: 25.0
 No. of dwelling units: 1 Internal heat gains (IHG) heating case [W/m²]: 2.4 IHG cooling case [W/m²]: 2.4
 No. of occupants: 3.1 Specific capacity [Wh/K per m² TFA]: 84 Mechanical cooling: x

Specific building characteristics with reference to the treated floor area

Criteria	Treated floor area m²	Value	Comparison	Alternative criteria		Fulfilled?²
				Criteria	Alternative criteria	
Space heating	Heating demand kWh/(m²a)	199.8	≤	15	-	yes
	Heating load W/m²	11.4	≤	-	10	yes
Space cooling	Cooling & dehum. demand kWh/(m²a)	14.6	≤	15	15	yes
	Cooling load W/m²	29.0	≤	-	10	-
	Frequency of overheating (> 25 °C) %	-	≤	-	-	yes
	Frequency of excessively high humidity (> 12 g/kg) %	0	≤	10	-	yes
Airtightness	Pressurization test result n ₅₀ 1/h	0.4	≤	0.6	-	yes
Non-renewable Primary Energy (PE)	PE demand kWh/(m²a)	56	≤	-	-	-
	PER demand kWh/(m²a)	24	≤	45	30	yes
Primary Energy Renewable (PER)	Generation of renewable energy (in relation to projected building footprint area) kWh/(m²a)	62	≥	60	39	yes

² Empty field: Data missing; "-": No requirement

I confirm that the values given herein have been determined following the PHPP methodology and based on the characteristic values of the building. The PHPP calculations are attached to this verification. **Passive House Plus?** yes

Task: I-Designer First name: Cameron Surname: Munro
 Issued on: City:
 Signature: _____