Project Documentation
Gebäude-Dokumentation

Abstract | Zusammenfassung

Harpenden EnerPHit Plus

Data of building | Gebäudedaten

Year of construction Baujahr	2021	**Space heating** **Heizwärmebedarf**	**23** **kWh/(m²a)**
U-value external wall U-Wert Außenwand	0,129/0,109 W/(m²K)		
U-value basement U-Wert Kellerdecke	N/A W/(m²K)	Primary Energy Renewable (PER) Erneuerbare Primärenergie (PER)	35 kWh/(m²a)
U-value roof U-Wert Dach	0,135/0,103 W/(m²K)	Generation of renewable Energy Erzeugung erneuerb. Energie	57 kWh/(m²a)
U-value window U-Wert Fenster	0,86 W/(m²K)	Non-renewable Primary Energy (PE) Nicht erneuerbare Primärenergie (PE)	84 kWh/(m²a)
Heat recovery Wärmerückgewinnung	81.2 %	Pressurization test n_{50} Drucktest n_{50}	0,4 h^{-1}
Special features Besonderheiten	8.10kW solar pv array and 10kW battery for on-site generation, 5kW air-to-water heat pump, showersave wastewater heat recovery		

Brief Description

Harpenden EnerPHit Plus

1960s 4 bedroomed detached property of cross-wall construction in the Harpenden conservation area, which has been retrofitted to EnerPHit Plus standard. Home to 2 people and 2 cats.

The original house was a typical cross-wall construction with cavity brick/block flank walls. The ground floor slab was removed and replaced with a new insulated slab. The external flank brick walls were externally insulated, the original infill structure to front and back was replaced with site constructed timber insulated framing. The triple glazed windows have additional glazing with integrated blinds on the front elevation, to avoid overheating. The roof was insulated over the existing frame, with tiling to the rear and a complete roof integrated solar PV system forming the entire front roof slope.

The use of sustainable materials was very much to the fore, with most insulation being cellulose, or woodfibre based and using timber glulam beams instead of steel for structural elements. 8.10kW solar pv array and 10kW battery for on-site generation, 5kW air-to-water heat pump, showersave wastewater heat recovery and native planting to improve local biodiversity.

Passivhaus certified windows, doors, rooflights and MVHR system throughout.

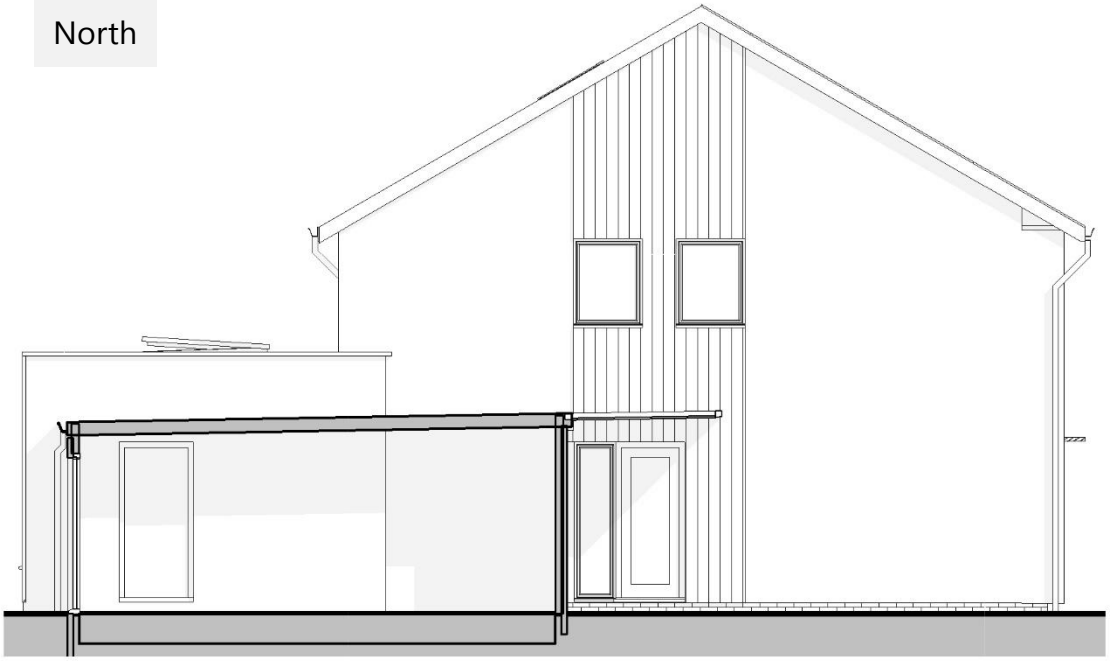
Kurzbeschreibung

Responsible project participants Verantwortliche Projektbeteiligte	
Architect Entwurfsverfasser	Heather McNeill https://www.adpractice.co.uk/
Implementation planning Ausführungsplanung	Heather McNeill https://www.adpractice.co.uk/
Building systems Haustechnik	Enhabit Ltd https://www.enhabit.uk.com/
Structural engineering Baustatik	Phil Harvey and Pat Roberts
Building physics Bauphysik	Heather McNeill https://www.adpractice.co.uk/
Passive House project planning Passivhaus-Projektierung	Heather McNeill https://www.adpractice.co.uk/
Construction management Bauleitung	Jigsaw Design & Construction Ltd https://jigsawconstruction.co.uk/
Certifying body **Zertifizierungsstelle**	
MEAD: Energy & Architectural Design Ltd http://www.meadconsulting.co.uk/	
Certification ID **Zertifizierungs ID**	
6766	Project-ID (https://passivehouse-database.org/index.php?lang=en#d_6766)

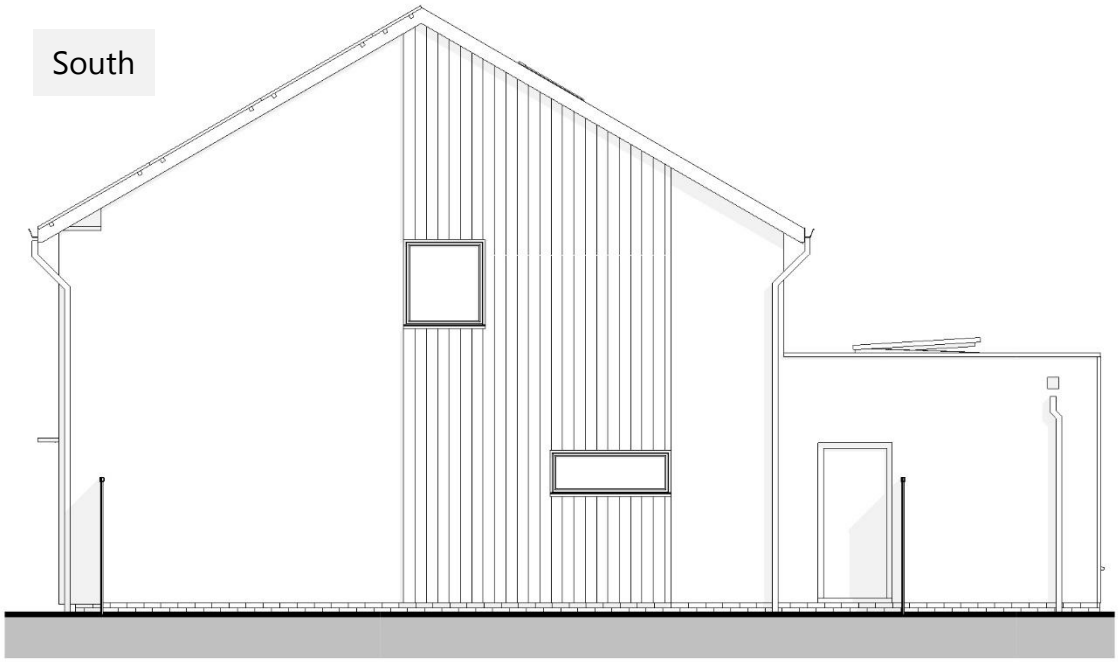
Author of project documentation Verfasser der Gebäude-Dokumentation	
Heather McNeill https://www.adpractice.co.uk/	
Date Datum	Signature Unterschrift
26.07.2023	

1. Photos

North

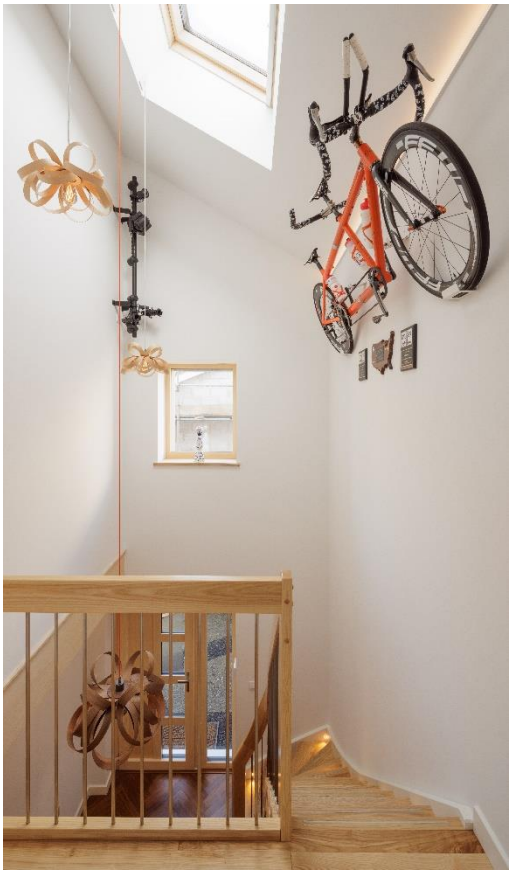


South



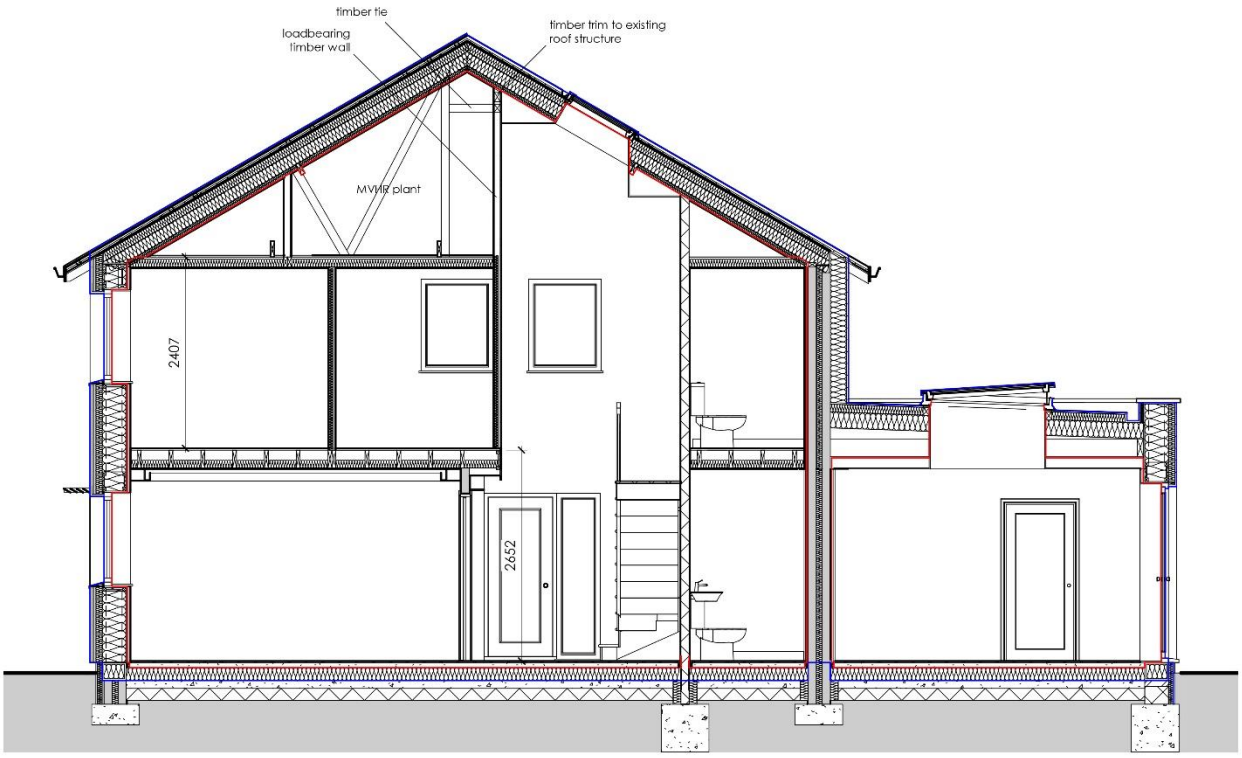
2. Innenfoto exemplarisch

Interior view from the kitchen towards the dining area with the rooflights above to allow incoming air for the stack ventilation strategy

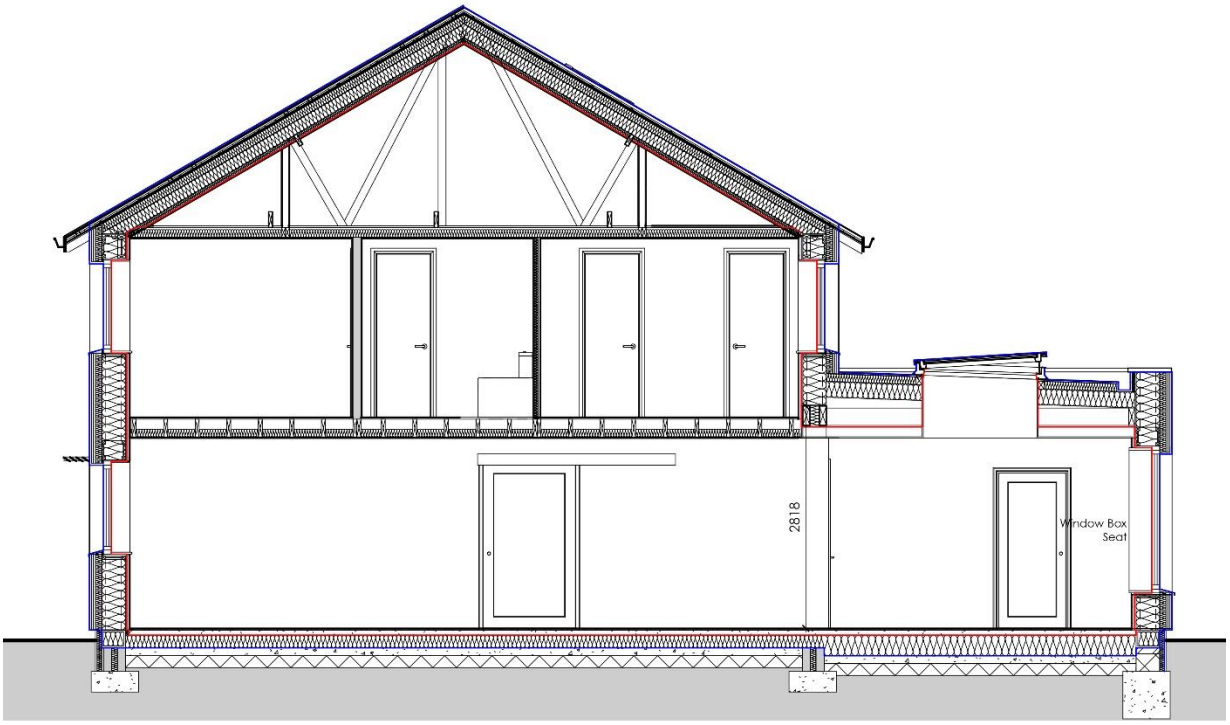


Interior view of vaulted stairwell with rooflight at the top to increase natural light in the centre of the property and allow the hot air to purge out of the building within the stack ventilation strategy

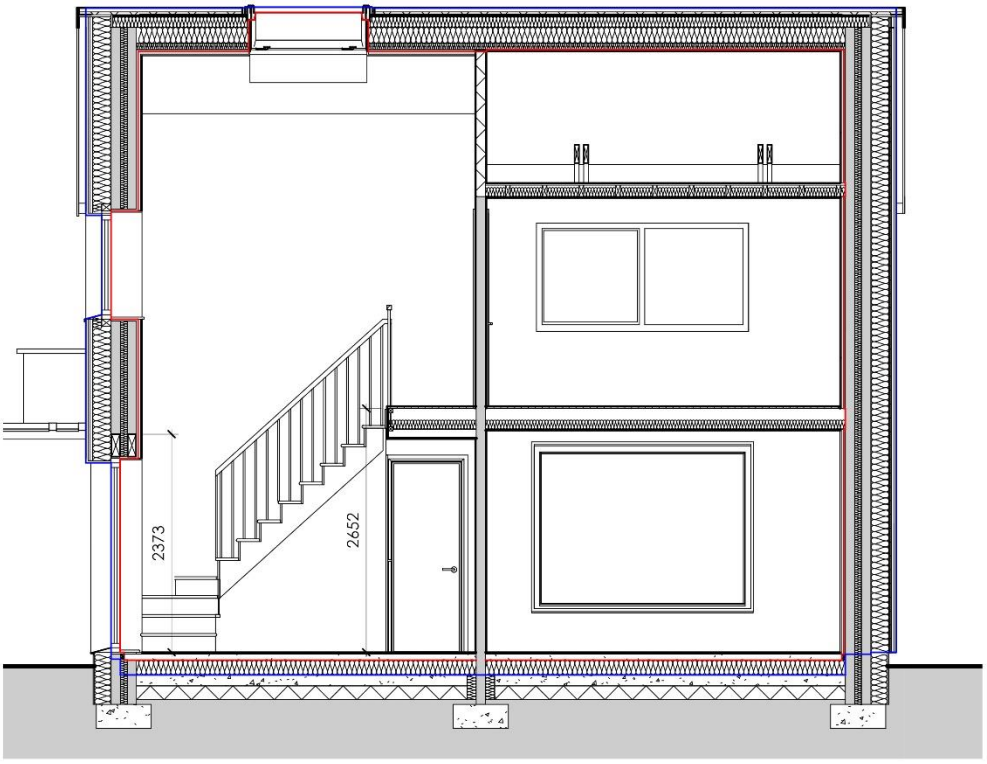
3. Sections



The thermal envelope with uninterrupted insulation is clearly visible, as is the tall stairwell to aid with the purge stack ventilation strategy. The MVHR is located in the loft space to allow easy access to the upstairs bedrooms with a service riser behind the shower in the ensuite (visible in the floor plan).

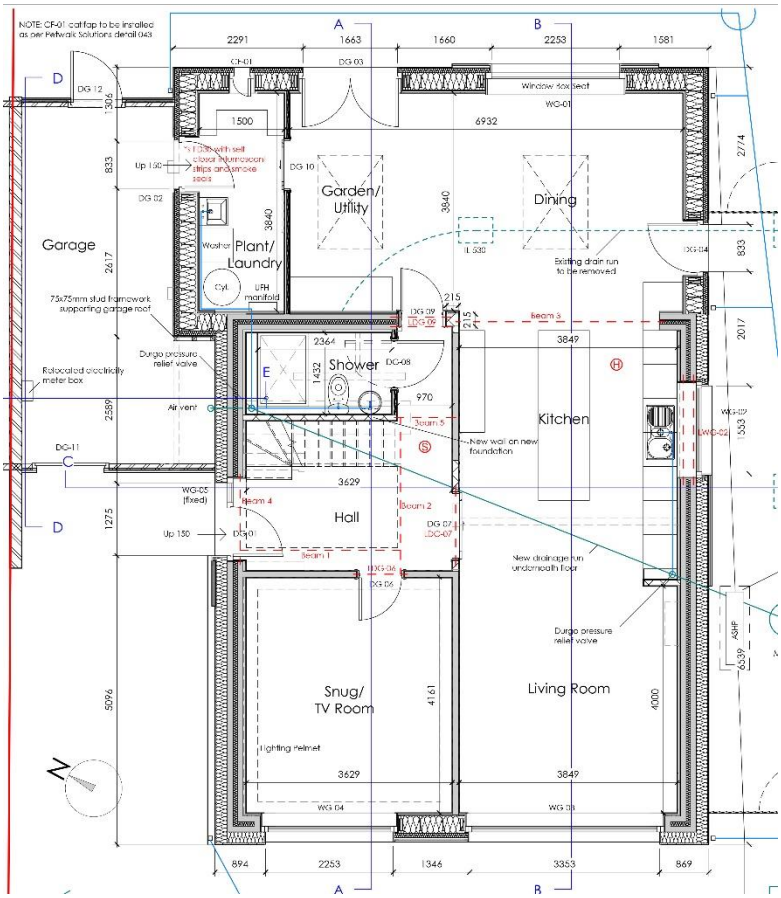


Open plan living area visible with opening ground floor rooflight to rear and solar pv array to the front.

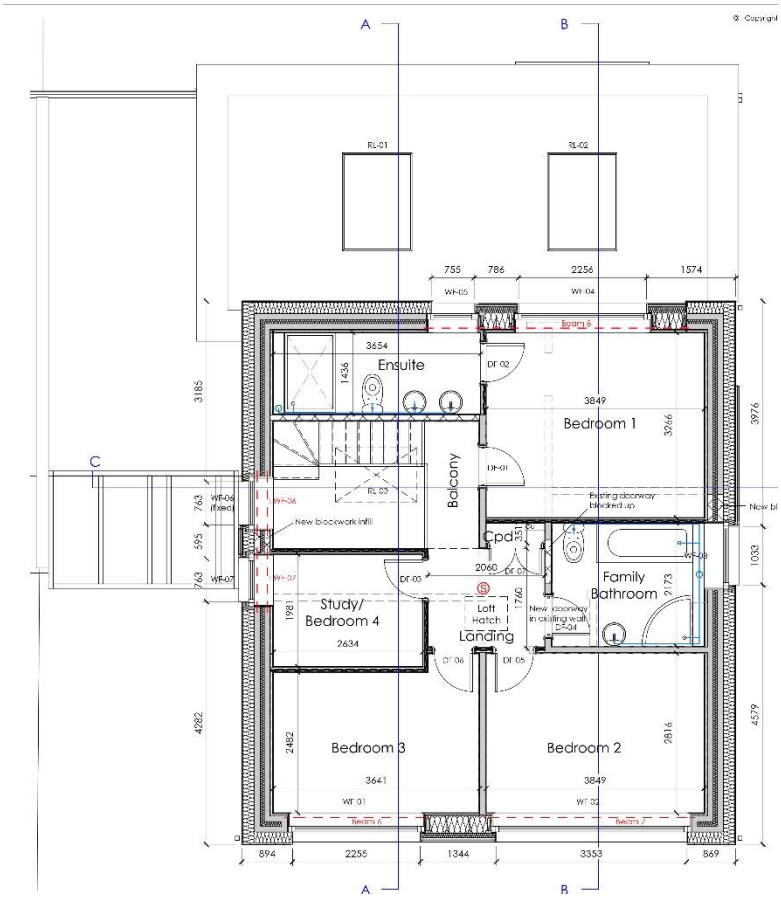


Long section through dwelling emphasising stairwell void

4. Floor plans

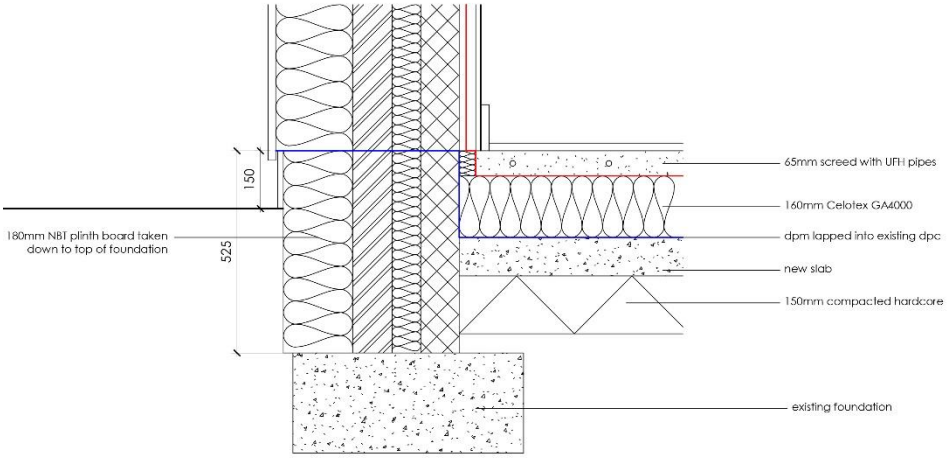


Ground floor plan showing the open plan living/kitchen/dining space with rooflights over the rear and service riser behind the shower room with easy access to the plant room which houses the Showersave wastewater heat recovery unit. The large vaulted hallway provides stack ventilation and floods the middle of the house with light aided by the new opening in the kitchen, existing windows and door openings were retained to the front and side.

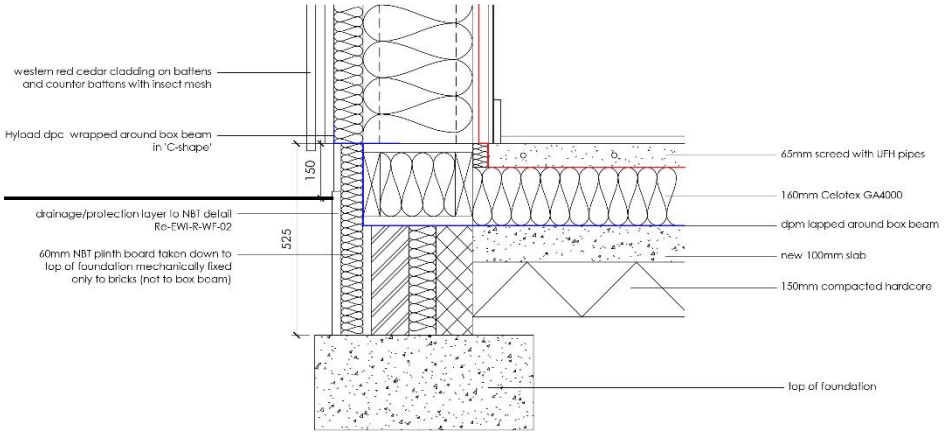


First floor plan showing rooflight over staircase and the main bedroom and home working spaces with service riser behind shower in master ensuite connecting into the loft space which houses MVHR unit, accessed via loft hatch on landing.

5. Construction details – floor slab



GF-01 EWI Retrofit Wall and Existing Ground Floor Junction



GF-02 New Curtain Wall and Existing Ground Floor Junction

Insulated box beam construction on site

Avoidance of thermal bridges and ground floor junctions with two different wall types: retrofitted cavity wall and new infill curtain wall panels/rear extension.

The existing wall was topped up with cavity wall insulation where required and externally insulated with woodfibre insulation above DPC. Below DPC, the insulation was switched to XPS and is continued down to the top of the foundation. The floor slab has between 160 and 260mm of PIR insulation with insulated upstand.

In the new curtain wall panels and in the extension, this runs into an insulated timber box beam to eliminate the thermal bridge at the junction with the timber frame, externally tanked with DPM and covered in XPS insulation, again running down into the top of the foundation. The new walls were constructed from 300mm I-joists, infilled with cellulose insulation and externally sheathed with a woodfibre insulation board, joining into the XPS below DPC.

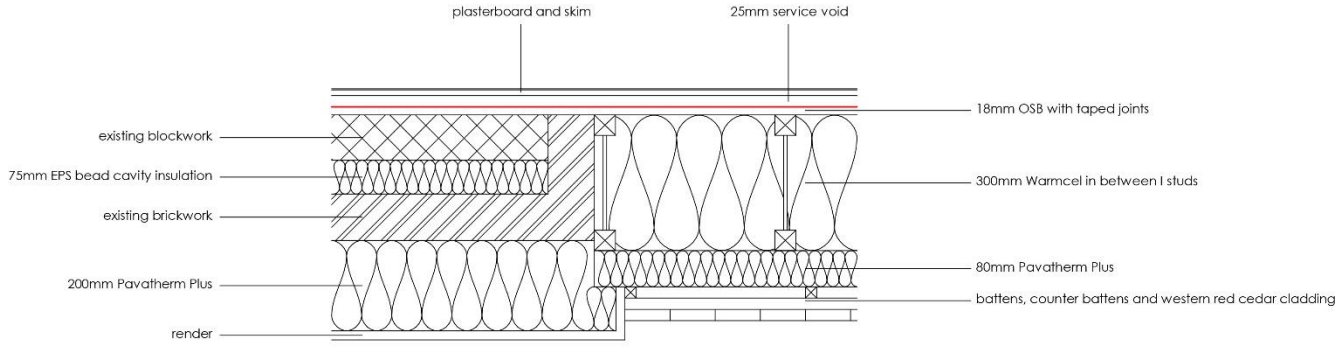
Assembly no.						Interior insulation?
04ud	Floor					
		Heat transmission resistance [m²K/W]				
Orientation of building element	3-Floor	interior R_{si}	0.17			
Adjacent to	2-Ground	exterior R_{se}	0.00			
Area section 1	λ [W/(mK)]	Area section 2 (optional)	λ [W/(mK)]	Area section 3 (optional)	λ [W/(mK)]	Thickness [mm]
Timber Floorboards	0.130					25
Concrete Screed	1.401					65
Celotex GA4000	0.022					160
Concrete	0.500					100
Percentage of sec. 1		Percentage of sec. 2		Percentage of sec. 3		Total
100%						35.0 cm
U-value supplement		W/(m²K)		U-value:	0.127	W/(m²K)

Retrofitted floor slab U-value

Assembly no.						Interior insulation?
06ud	Extension Floor					
		Heat transmission resistance [m²K/W]				
Orientation of building element	3-Floor	interior R_{si}	0.17			
Adjacent to	2-Ground	exterior R_{se}	0.00			
Area section 1	λ [W/(mK)]	Area section 2 (optional)	λ [W/(mK)]	Area section 3 (optional)	λ [W/(mK)]	Thickness [mm]
Timber Floorboards	0.130					25
Concrete Screed	1.401					65
Celotex GA4000	0.022					260
Concrete	0.500					100
Percentage of sec. 1		Percentage of sec. 2		Percentage of sec. 3		Total
100%						45.0 cm
U-value supplement		W/(m²K)		U-value:	0.080	W/(m²K)

Extension floor slab U-value

6. Construction details – exterior walls



W-01 EWI Retrofit Wall and New Curtain Wall Junction

Existing cavity walls had the cavity wall insulation topped up with EPS beads and were externally insulated with Isolair woodfibre insulation above dpc. Below dpc they were insulated with 180mm XPS insulation down to the top of the foundation. The Isolair was finished with silicone render or battens, counter battens and timber cladding. Internally the walls were sheathed with Smartply OSB for airtightness, battened off to form a service void and finished with plasterboard and skim.

Assembly no.	Building assembly description					Interior insulation?
01ud	Retrofit External Wall					
		Heat transmission resistance [m²K/W]				
Orientation of building element	2-Wall	interior R_{si}	0.13			
Adjacent to	3-Ventilated	exterior R_{se}	0.13			
Area section 1	λ [W/(mK)]	Area section 2 (optional)	λ [W/(mK)]	Area section 3 (optional)	λ [W/(mK)]	Thickness [mm]
Isolair	0.041					200
Brickwork	0.840					102
EPS Cavity Beads	0.039					75
Concrete Blockwork	0.510					100
OSB	0.130					18
Service Void	0.136					25
Plasterboard	0.190					13
Plaster Skim	0.350					3
	Percentage of sec. 1		Percentage of sec. 2		Percentage of sec. 3	Total
	100%					53.5 cm
U-value supplement		W/(m²K)		U-value:	0.129 W/(m²K)	

Retrofitted external wall U-value

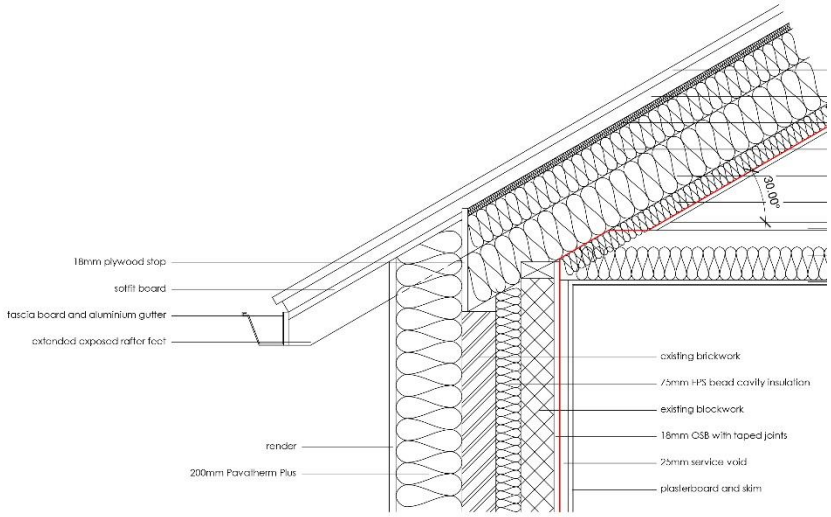
New curtain wall infill panels and walls to the rear extension were constructed from 300mm timber I-studs with Warmcel cellulose insulation in between. The walls were externally sheathed with Isolair and either rendered with silicone render or battened, counter battened and timber clad. Internally the walls were lined out with Smartply OSB for airtightness, battened off to form a service void and finished with plasterboard and skim.

Extension walls on insulated box beam with XPS insulation below dpc

Assembly no.						Interior insulation?
02ud	New External Wall					
		Heat transmission resistance [m²K/W]				
Orientation of building element	2-Wall	interior R_{si}	0.13			
Adjacent to	3-Ventilated	exterior R_{se}	0.13			
Area section 1	λ [W/(mK)]	Area section 2 (optional)	λ [W/(mK)]	Area section 3 (optional)	λ [W/(mK)]	Thickness [mm]
Isolair	0.044					80
Warmcel	0.038	I Stud	0.130			300
OSB	0.130					18
Service Void	0.136					25
Plasterboard	0.190					13
Plaster Skim	0.350					3
Percentage of sec. 1		Percentage of sec. 2		Percentage of sec. 3		Total
91%		9.0%				43.8 cm
U-value supplement		W/(m²K)		U-value:	0.109	W/(m²K)

New wall U-value

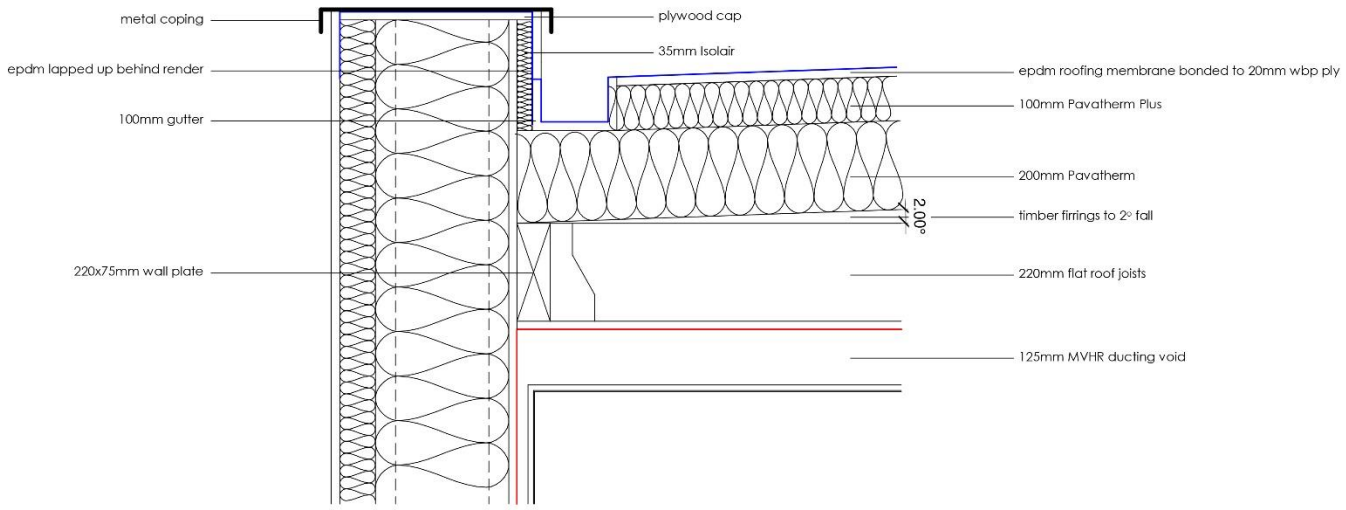
7. Construction details - roof



PR-1 EWI Retrofit Wall and Roof Junction

The rafters of the existing house were retained with additional timbers set out over the top to create enough depth for the 240mm Pavaflex insulation in between. Isloair was laid over the top and underneath was finished with Pavatherm Combi. Underneath this was a airtight membrane, battened off service void, plasterboard and skim. Airtight tape was carefully applied around existing trusses in the roof to ensure no air leakage occurred here.

Assembly no.						Interior insulation?
03ud	Pitched Roof					
		Heat transmission resistance [m²K/W]				
Orientation of building element	1-Roof	interior R_{si}	0.10			
Adjacent to	3-Ventilated	exterior R_{se}	0.10			
Area section 1	λ [W/(mK)]	Area section 2 (optional)	λ [W/(mK)]	Area section 3 (optional)	λ [W/(mK)]	Thickness [mm]
Isolair	0.044					30
Pavaflex	0.038	Rafter	0.130			240
Pavatherm Combi	0.041					60
Plaster Skim	0.350					3
Percentage of sec. 1		Percentage of sec. 2		Percentage of sec. 3		Total
88%			12.5%			33.3 cm
U-value supplement		W/(m²K)			U-value: 0.135	W/(m²K)

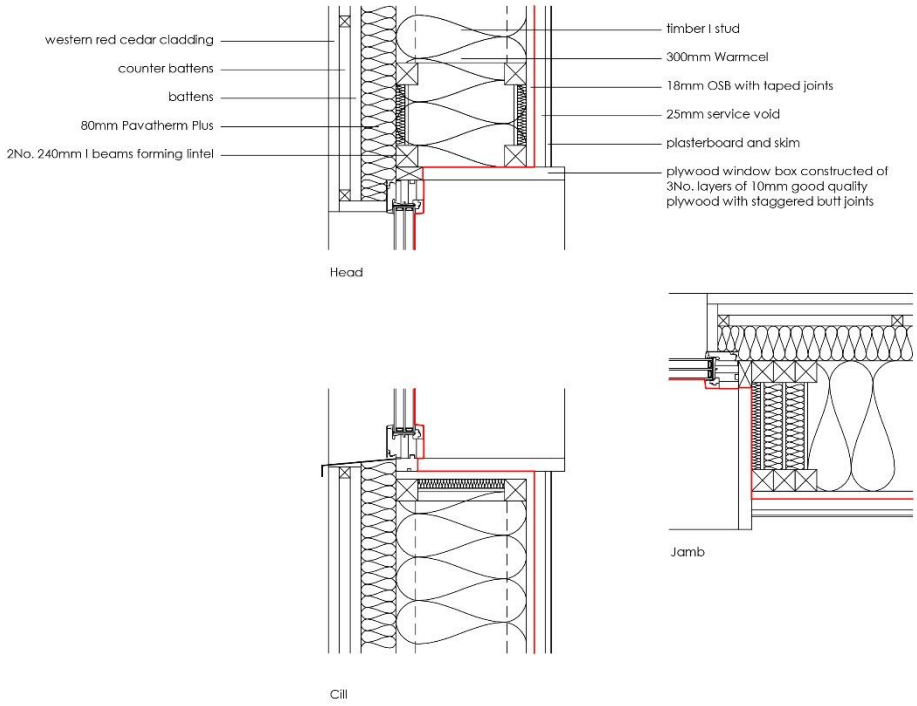


FR-01 New Wall to Flat Roof Junction

The new flat roof to the extension was a warm deck build up with 200mm Pavatherm laid over the structural deck on firrings with a further 100mm of Isolair laid over the top. A wbp ply deck was laid over this with an EPDM roof finish bonded to it. Below the roof structure was Smartply OSB to provide airtightness and a 125mm service void to accommodate the MVHR ducting. This was finished with plasterboard and skim.

Assembly no.						Interior insulation?
05ud	Flat Roof					
		Heat transmission resistance [m²K/W]				
Orientation of building element	1-Roof	interior R_{si}	0.10			
Adjacent to	1-Outdoor air	exterior R_{se}	0.04			
Area section 1	λ [W/(mK)]	Area section 2 (optional)	λ [W/(mK)]	Area section 3 (optional)	λ [W/(mK)]	Thickness [mm]
Isolair	0.041					100
Pavatherm	0.038					200
Flat Roof Joist	0.130					220
OSB	0.130					18
Service Void	0.000					25
Plasterboard	0.190					13
Plaster Skim	0.350					3
Percentage of sec. 1		Percentage of sec. 2		Percentage of sec. 3		Total
100%						57.8 cm
U-value supplement		W/(m²K)		U-value:	0.103	W/(m²K)

8. Window details



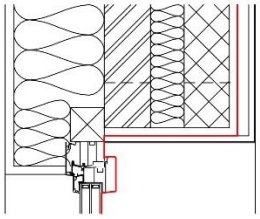
Triple glazed aluminium clad windows and glazed doors throughout with the front windows and master bedroom units having integrated blinds behind a further pane of glass externally. Fakro quadruple glazed rooflights used in both the pitched roof and flat roof extension.

We have two installation variations: existing brickwork openings and new timber framed openings.

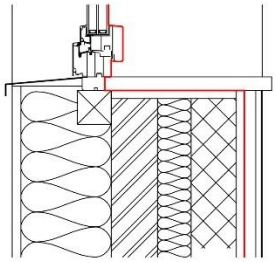
Window installed in rear extension timber frame

Window area orientation	Global radiation (main orientations)	Shading	Dirt	Non-vertical radiation incidence	Glazing fraction	g-Value	Solar irradiation reduction factor	Window area	Window U-Value	Glazing area	Average global radiation
Standard values →	kWh/(m²a)	0.75	0.95	0.85				m²	W/(m²K)	m²	kWh/(m²a)
North	104	0.63	0.95	0.85	0.61	0.36	0.31	7.30	0.85	4.43	119
East	213	0.83	0.95	0.85	0.73	0.53	0.49	12.37	0.79	8.99	151
South	399	0.39	0.95	0.85	0.64	0.50	0.20	4.50	0.82	2.88	371
West	232	0.27	0.95	0.85	0.67	0.61	0.15	14.16	0.94	9.49	306
Horizontal	337	1.00	0.95	0.85	0.63	0.37	0.51	4.31	0.80	2.72	309
Total or average value for all windows.						0.51	0.32	42.64	0.86	28.50	

Window and door data



Head/Jamb



Cill

Window installed in existing brickwork wall

9. Description of airtight envelope and air test

Floor

The floor has a dpm which is taped up into the Smartply OSB airtight layer of the walls and all service penetrations were made tight with proprietary grommets taped to cleaned and primed surfaces. The floor screed laid over the insulation adds further airtightness to the build-up.

Walls

All external walls were lined with Smartply Propassiv which was taped into the airtight membrane in the floor and roof. Care was taken to tape around existing joists, some of which had to be doubled up for structural reasons. A service void was formed to ensure that plumbing and electrical services etc did not breach the airtight layer.

Windows/Doors

Windows and doors were installed within the insulation layer and carefully taped to the surround Smartply to retain good airtightness. Brackets were also carefully taped.

Roof

The roof is predominately airtighted with a membrane in the loft area. In the vaulted hallway area Smartply was used for structural and practical reasons. The biggest challenge in the loft area was airtight taping around the existing truss structures.

Air test result

8th November 2021

Testing carried out by:	Test Engineer: Paul Jennings
Target Air Changes, AC/hr @ 50 Pa:	≤1.0 AC/hr @ 50 Pa (EnerPHit)
Achieved Air Changes, AC/hr @ 50 Pa:	0.59
Achieved Air Permeability, $m^3/hr/m^2$ @ 50 Pa:	0.59
Data consistency, r^2 (requirement, $r^2 > 0.98$):	0.995
Slope, n (requirement, $0.5 < n < 1.0$):	0.72

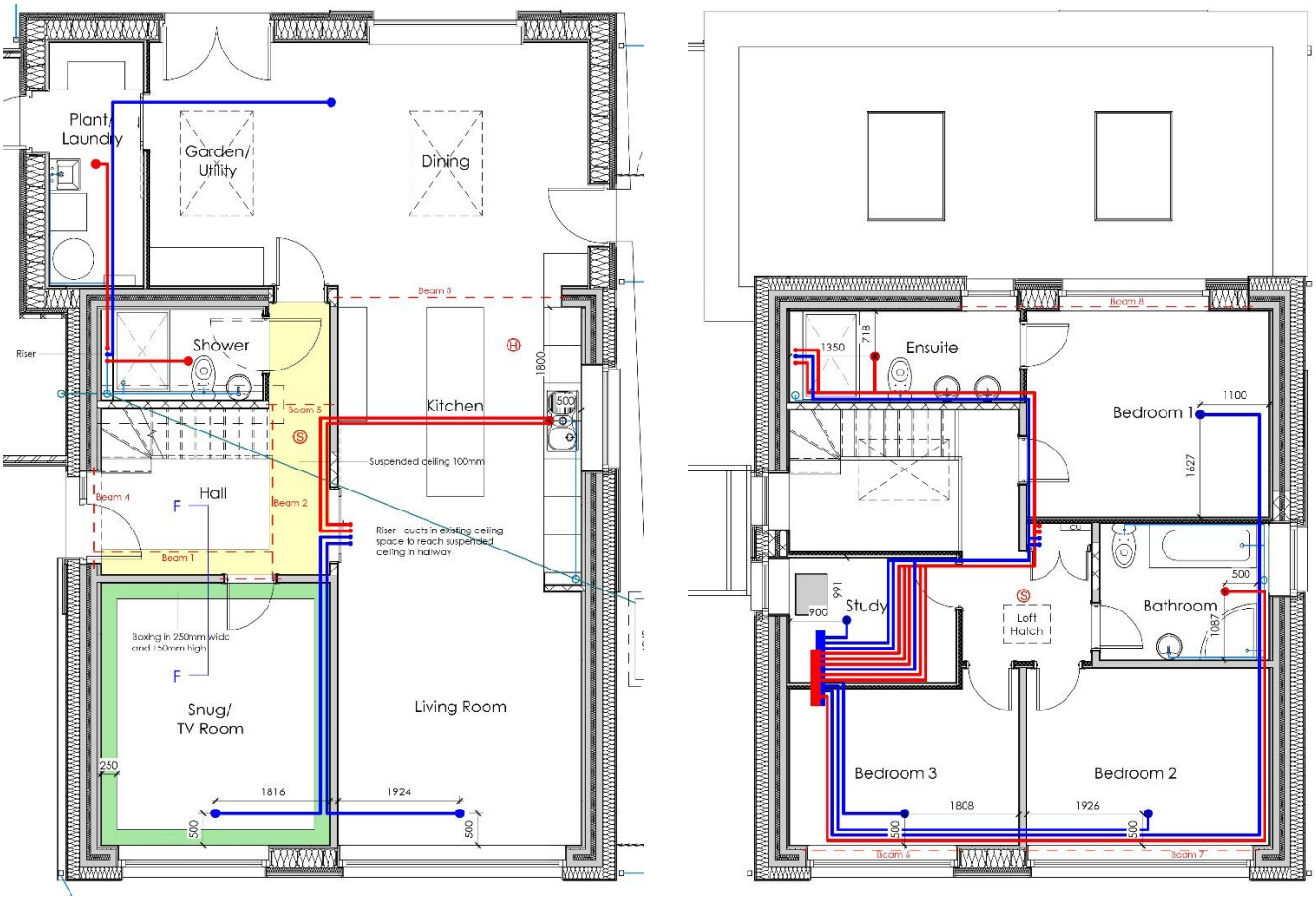
10. Ventilation unit

A Passivhaus certified Zehnder ComfoAir Q350 Enthalpy heat exchanger unit was selected to run the MVHR system.

It has an effective heat recovery efficiency of 86%, humidity recovery efficiency of 73% and electric efficiency of 0.22Wh/m^3.

The unit is located in the loft space in order to make running ducts to the upstairs rooms easier as the existing solid timber joists were retained. Inlet and exhaust ducts were located high up on the northern gable wall.

11. Ventilation ductwork



Supply air rooms ducts are shown in blue and extract ducts are shown in red. Service risers are in the master ensuite and landing cpd. A recirculating downdraft fan is located in the kitchen island to remove the grease from the air created by cooking.

12. Heat supply

An air source heat pump (air-to-water) provides space heating and domestic hot water. the heating is provided by underfloor heating downstairs and dual fuel radiators in the bathrooms. Domestic hot water provision has been carefully designed to reduce system losses.

13. Costs and performance

Build costs
The construction cost including all finishes etc was £2385/m^2

The house is significantly outperforming predictions as can be seen below. The owners are thrilled with the way the house regulates temperature all year round.

Running costs
Pre-retrofit: £2,490.84 (£19.60/m^2) per year
Post-retrofit: £ 746.30 (£ 4.71/m^2) of which heating was £93.56 (£0.59/m^2) per year

Energy use
Pre-retrofit: 3,360 kWh electricity and 10,967 kWh gas for a GIA of 127m^2
Post-retrofit: 8,056 kWh electricity and no gas for a GIA of 158.5m^2
6,630 kWh electricity generated
1,426 kWh difference

This covers all heating, hot water, washing, cooking and running costs of the house including 2No. occupants working from home full time, one in software engineering with several high-powered PCs and servers running

Performance

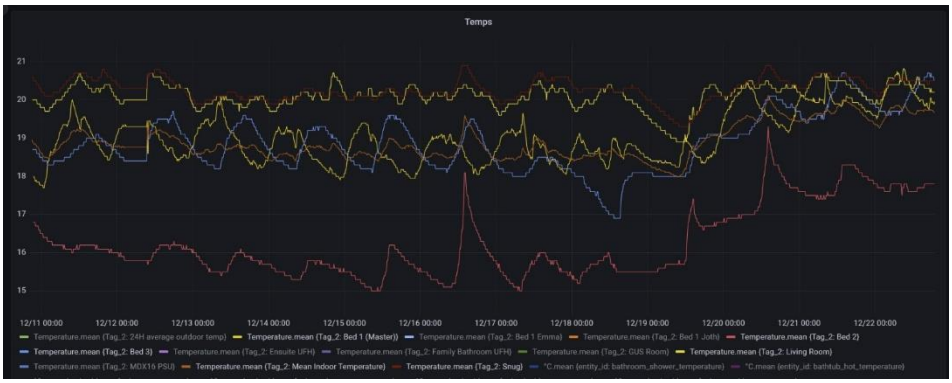
Predicted		Actual	
Heating demand:	23 kWh/m^2/yr	Heating demand:	8 kWh/m^2/yr
Primary energy demand:	84 kWh/m^2/yr	Primary energy demand:	45 kWh/m^2/yr
Primary energy generation:	57 kWh/m^2/yr	Primary energy generation:	55 kWh/m^2/yr

User satisfaction
"We are delighted we got the house we always wanted, and following the PH process was absolutely central to achieving this."

"The 1930s house we previously owned in London was always damp and we were always opening and closing windows. With this we wanted to keep the noise out, keep the dirt out and have better air quality. There's so little dust in the house it's something we never think about and obviously there's no damp. It doesn't build up from even internal sources."

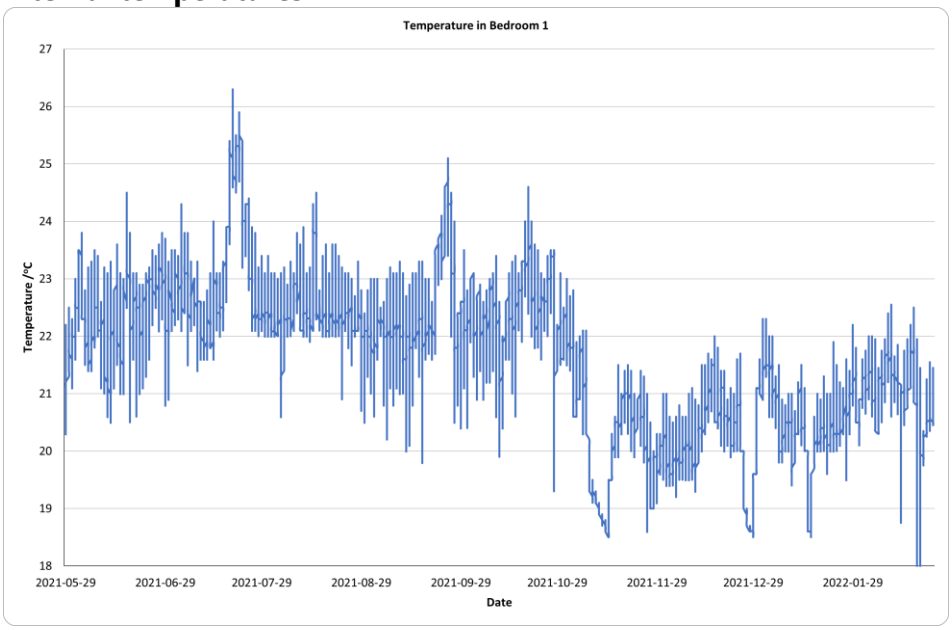
Heating over winter 11 Dec – 22 Dec

External temperature: -8 to 11ºC fluctuation
Green line = daily mean ext. temp.; blue line = ext. temp

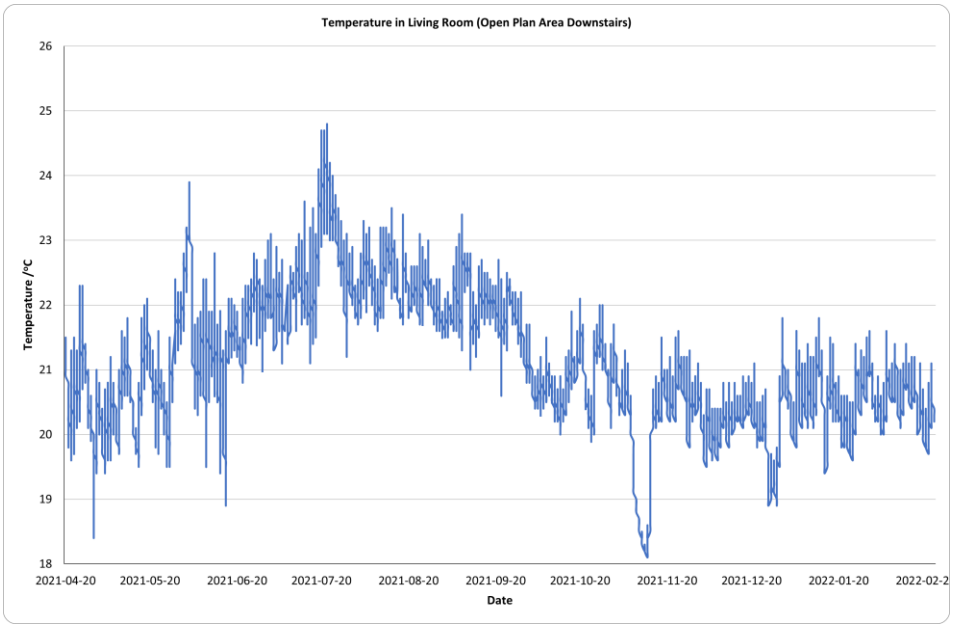


Internal temperatures: 18 to 21ºC fluctuation (except unused guest room in red)

Internal temperatures



Temp in Living Room (Open Plan Area Downstairs)



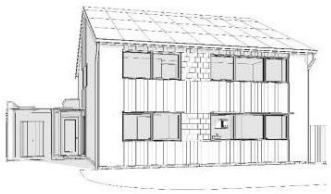
Temp in Master Bedroom

14. Literature

- Passivhaus Trust: https://www.passivhaustrust.org.uk/projects/detail/?cId=129
- Passive House Plus magazine: https://issuu.com/passivehouseplus/docs/ph_uk_issue_43_digital
- Premier Construction magazine: https://online.fliphtml5.com/xahs/pkpk/#p=87
- The Times: https://www.thetimes.co.uk/article/retrofitting-has-cut-our-energy-bills-by-90-per-cent-sr26brjsc
- Passivhaus Database: https://passivehouse-database.org/index.php?lang=en#d_6766
- Low Energy Building Database: https://www.lowenergybuildings.org.uk/viewproject.php?id=761
- BBC Newsnight: https://twitter.com/BBCNewsnight/status/1679875640978178048?s=20
- The Planner magazine: https://www.theplanner.co.uk/2022/01/11/news-brief-ealing-approves-next-phases-acton-gardens-enerphit-plus-secured-house?fbclid=IwAR3OSFj8YVyuG4r7dMZwpMS1ghf98H8RP_k2ouYYadsrsp34aUZEIG4OsXc

15. PHPP calculations

EnerPHit Verification



Building:	34 Southdown Road		
Street:	34 Southdown Road		
Postcode/City:	AL5 1PF	Harpenden	
Province/Country:	Hertfordshire	GB-United Kingdom/ Britain	
Building type:	Detached House		
Climate data set:	GB0002a-Silsoe		
Climate zone:	3: Cool-temperate	Altitude of location:	108 m
Home owner / Client:	Jonathan and Emma Dixon		
Street:	34 Southdown Road		
Postcode/City:	AL5 1PF	Harpenden	
Province/Country:	Hertfordshire	GB-United Kingdom/ Britain	

Architecture:	Heather McNeill, A D Practice Ltd		
Street:	2 Mill Walk, Wheathampstead		
Postcode/City:	AL4 8DT	St Albans	
Province/Country:	Hertfordshire	GB-United Kingdom/ Britain	
Energy consultancy:	Heather McNeill, A D Practice Ltd		
Street:	2 Mill Walk, Wheathampstead		
Postcode/City:	AL4 8DT	St Albans	
Province/Country:	Hertfordshire	GB-United Kingdom/ Britain	

Mechanical engineer:	Carlo Stramacci & Kaspar Bradshaw, Enhabit Limited		
Street:	Sustainable Bankside, 105 Summer Street		
Postcode/City:	SE1 9HZ	London	
Province/Country:	Greater London	GB-United Kingdom/ Britain	
Certification:	Kym Mead, Mead: Energy & Architectural Design Ltd		
Street:	3 Harvey Road		
Postcode/City:	N8 9PD	London	
Province/Country:	Greater London	GB-United Kingdom/ Britain	

Year of construction:	2020	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:	2.9	Specific capacity [Wh/K per m² TFA]:	60	Mechanical cooling:	

Specific building characteristics with reference to the treated floor area

					Criteria	Alternative criteria	Fullfilled?[2]
	Treated floor area	m²	151.4				
Space heating	Heating demand	kWh/(m²a)	23	≤	25	-	yes
	Heating load	W/m²	12	≤	-	-	
Space cooling	Cooling & dehum. demand	kWh/(m²a)	-	≤	-	-	-
	Cooling load	W/m²	-	≤	-	-	
	Frequency of overheating (> 25 °C)	%	3	≤	10		yes
	Frequency of excessively high humidity (> 12 g/kg)	%	0	≤	20		yes
Airtightness	Pressurization test result n_{50}	1/h	0.4	≤	1.0		yes
Non-renewable Primary Energy (PE)	PE demand	kWh/(m²a)	84	≤	-		-
Primary Energy Renewable (PER)	PER demand	kWh/(m²a)	35	≤	54	39	yes
	Generation of renewable energy (in relation to projected building footprint area)	kWh/(m²a)	57	≥	60	41	

EnerPHit (retrofit): Component characteristics

				Criteria	Fullfilled?[2]
Building envelope to exterior air[1] (U-value)	W/(m²K)	0.12	≤	-	-
Building envelope to ground[1] (U-value)	W/(m²K)	0.11	≤	-	-
Wall w/int. insulation in contact w/exterior air (U-value)	W/(m²K)	-	≤	-	-
Wall w/interior insulation in contact w/ground (U-value)	W/(m²K)	-	≤	-	-
Flat roof (SRI)	-	19	≥	-	-
Inclined and vertical external surface (SRI)	-	37	≥	-	-
Windows/Entrance doors ($U_{W/D,installed}$)	W/(m²K)	0.86	≤	-	-
Windows ($U_{W,installed}$)	W/(m²K)	-	≤	-	-
Windows ($U_{W,installed}$)	W/(m²K)	0.80	≤	-	-
Glazing (g-value)	-	0.54	≥	-	-
Glazing/sun protection (max. solar load)	kWh/(m²a)	259	≤	-	-
Ventilation (effective heat recovery efficiency)	%	81	≥	-	-
Ventilation (humidity recovery efficiency)	%	73	≥	-	-

[1] Without windows, doors and external walls with interior insulation
[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.

EnerPHit Plus? yes

Task:	First name:	Surname:	Signature:

Issued on:	City: