

# PROJECT DOCUMENTATION



## 1 Abstract



**South side of the Passive house in Tickenham, a single family home.** Showing the overhanging roof that provides solar shading.

### 1.1 Data of building

Year of Construction	2021		
U-value External Wall	0.091 W/m <sup>2</sup> K	Space heating	11.33 kWh(m <sup>2</sup> a)
U-value Ground Floor	0.139 W/m <sup>2</sup> K	Primary Energy Renewable (PER) /	22 kWh(m <sup>2</sup> a)
U-value Roof	0.092 W/m <sup>2</sup> K	Generation of renewable energy	0
U-value window	0.83 W/m <sup>2</sup> K	Non-renewable Primary Energy (PE)	56 kWh(m <sup>2</sup> a)
Heat recovery	80%	Pressure test n <sub>50</sub> /	0.1 h-1
Special features			

All photographs and drawings in this report are courtesy of Shu Architects Ltd © 2024.

# 1. Brief Description

## Passive House in Tickenham

This is a single family house situated in Tickenham, a small village near to Nailsea in Somerset. This new house was built within an existing steel-framed agricultural barn in accordance with Class Q permitted development.


The house has a treated floor area of 265m<sup>2</sup> and this includes five bedrooms, a snug, two offices, a boot room, WC, gym, a plant room, and a combined kitchen, living and dining room.

The primary views are to the north and west so the design of the house had to balance these views with a sensible allocation of windows in order to manage energy losses and gains for the passivhaus calculations. The footprint of the heated area is set back from the steel roof to give solar shading towards the south and west.

As this building was single storey it was a big challenge to achieve the Passive House standard. Consideration was given to careful detailing to reduce thermal bridging, the location of windows and the inclusion of the external solar shading.

The house was built from a timber frame inside the existing steel barn and where possible the existing frame did not encroach on the new construction. Steel haunching positions were calculated as thermal bridges using a method agreed with the Certifier.

## 1.3 Project Participants

Architect:	Geoff Smith, Shu Architects ( <a href="https://www.shuarchitects.uk">https://www.shuarchitects.uk</a> )
Passivhaus Designer:	Geoff Smith, Shu Architects
Building Services Designer:	Greengauge Building Energy Constultants ( <a href="https://ggbec.co.uk">https://ggbec.co.uk</a> )
Structural Engineer:	Build Collective Structural Engineers ( <a href="https://www.buildcollective.co.uk">https://www.buildcollective.co.uk</a> )
Contractor:	MAKE Group ( <a href="https://www.makegroup.co.uk">https://www.makegroup.co.uk</a> )
Certifying Body:	Etude ( <a href="https://etude.co.uk">https://etude.co.uk</a> )
Certification ID:	6754 ( <a href="https://passivehouse-database.org/index.php?lang=en#d_6754">https://passivehouse-database.org/index.php?lang=en#d_6754</a> )
Author of Project Documentation:	Geoff Smith, Shu Architects
Date / Signature	<u>29/9/2024</u> 

## 2 Views of the Passive house in Tickenham

The south-facing side is shown on the cover page.



**West side of the Passive house in Tickenham** showing the overhanging roof that provides solar shading to the kitchen / dining / living room.



**North side of the Passive house in Tickenham** showing the bedroom windows and the picture window to the living room. The MVHR intake and extracts are visible in the centre.

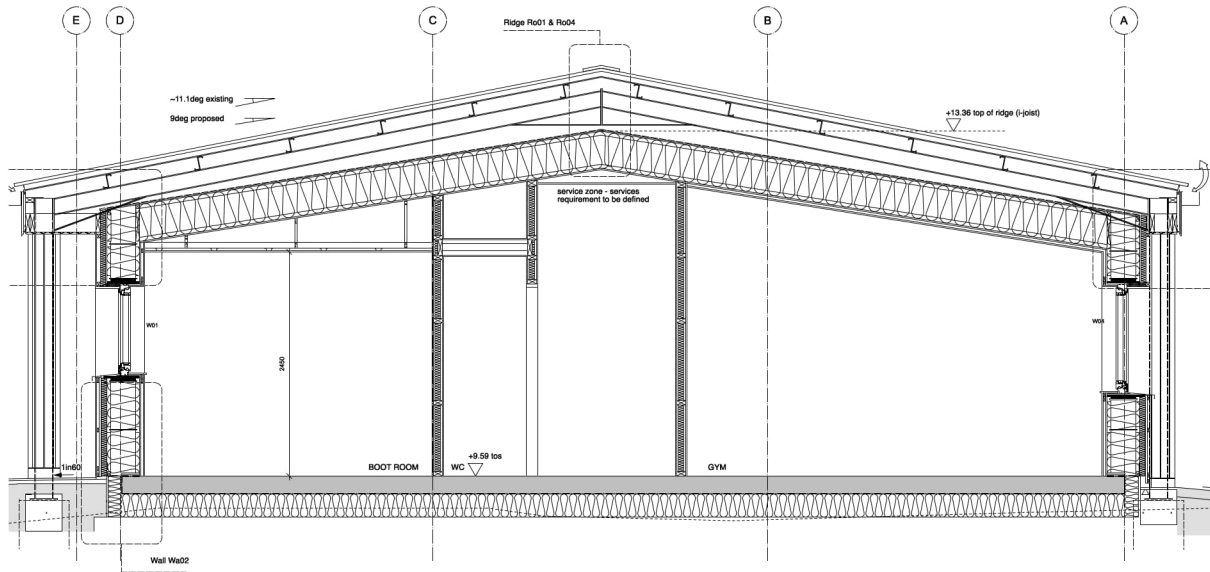


**East side of the Passive house in Tickenham** showing the single window to the Snug. This window provides borrowed light to the central corridor. The Air Source Heat Pump is visible on the right.



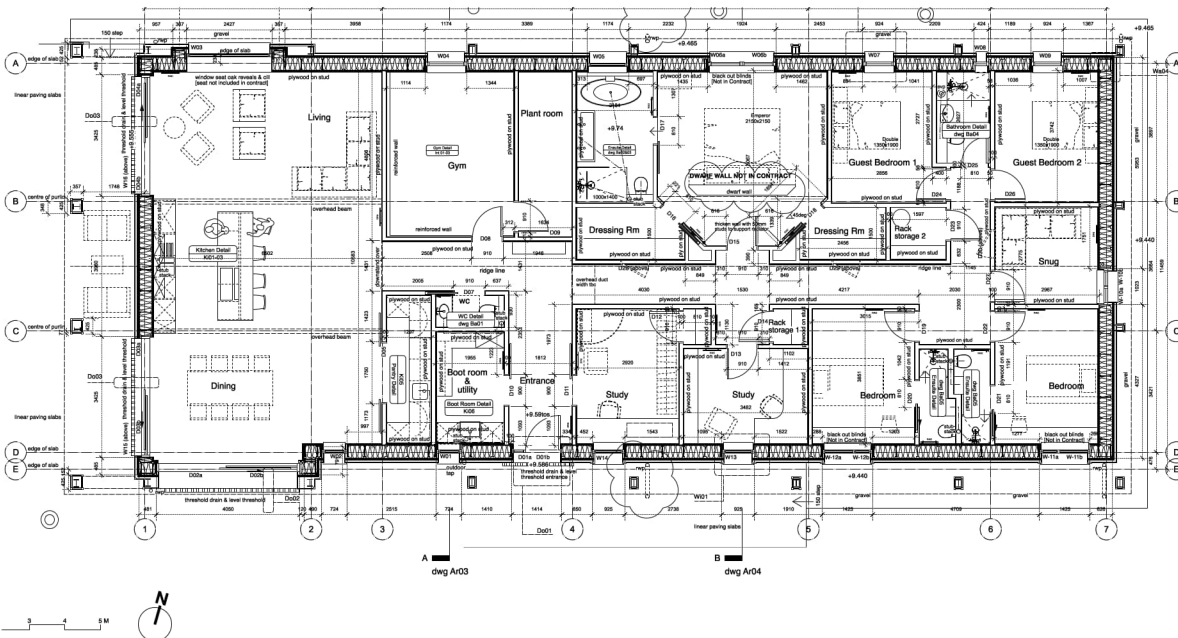
**Interior view from the dining room looking south-west.** The overhangs to the west and south are visible.

### 3 Sectional drawing of the Passive house in Tickenham



**Cross-section through the Passive House in Tickenham.** The uninterrupted thermal envelope is clearly recognisable. The strategy was to build a timber-frame house within the steel-framed barn in order to reduce the instances of thermal bridging from the existing structure. The existing roof provides protection from rain and snow etc, and the space between the two roofs is ventilated. A corridor runs down the centre of the plan and it is lit with borrowed light from the snug and one of the offices. The house is set back from the existing roof on the south side (to the left on this drawing) and this solar shading is supplemented with the deep reveals to the windows.

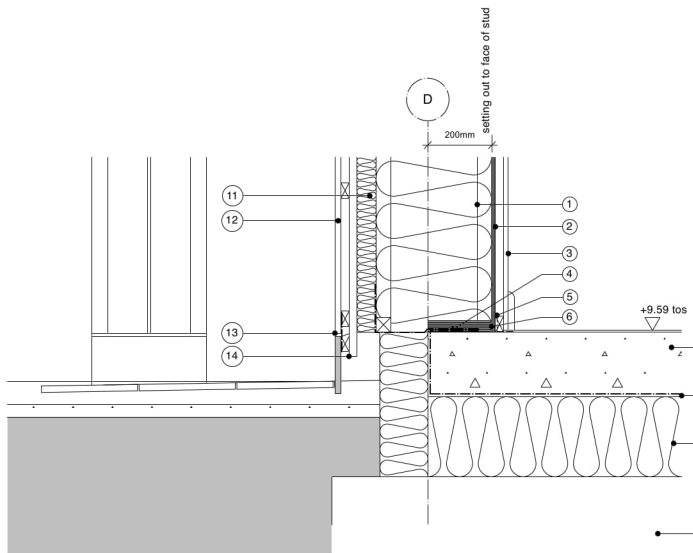
### 4 Floor plan of the Passive house in Tickenham



**Floor plan of the Passive House in Tickenham.** The house is divided around the entrance area into public areas to the west (living area, kitchen and associated rooms), and private rooms to the east. The entrance to the house is overlooked by the living areas and offices. Additionally, the plant room is buffered by both the gym and the ensuite bathroom.

## 5 Construction details of the envelope and Passive house technology of the Passive House in Tickenham

### 5.1 Construction including insulation of the floor slab with connection points of exterior and interior walls

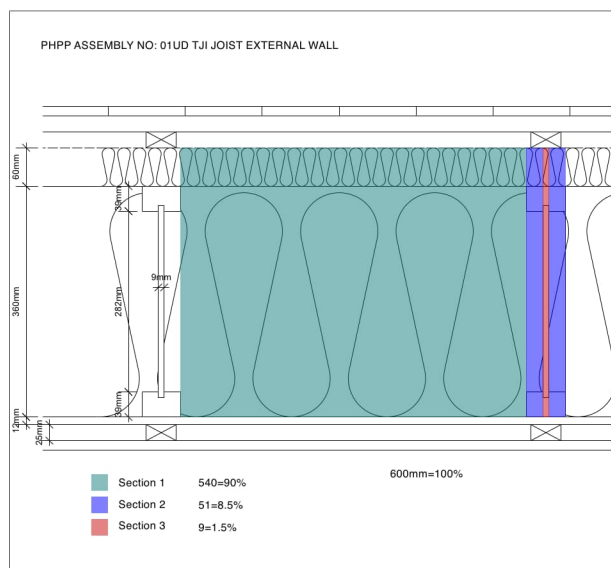


**Avoidance of thermal bridges at the base of wall and its junction with the ground floor slab.** In order to reduce the thermal bridging to the base of the wall, the house has an insulated raft slab. The rigid insulation is resistant to water-uptake and it will accept structural load. The timber I-joists in the wall sit on 2no layers of 18mm plywood and these act as a soleplate for the wall. The dpm wraps the slab and laps under the timber wall where it is sealed back to the inner osb racking board to aid airtightness. The photograph shows the perimeter insulation with the dpm in a vertical position before it is folded horizontally.

#### Floor build-up:

<b>Floor</b>	(Inside to outside)	U-value
	Vinyl flooring on 200mm deep reinforced concrete floor, radon barrier, 250mm rigid eps insulation, dpm.	0.139
		W/m <sup>2</sup> K

## 5.2 Construction including insulation of exterior walls

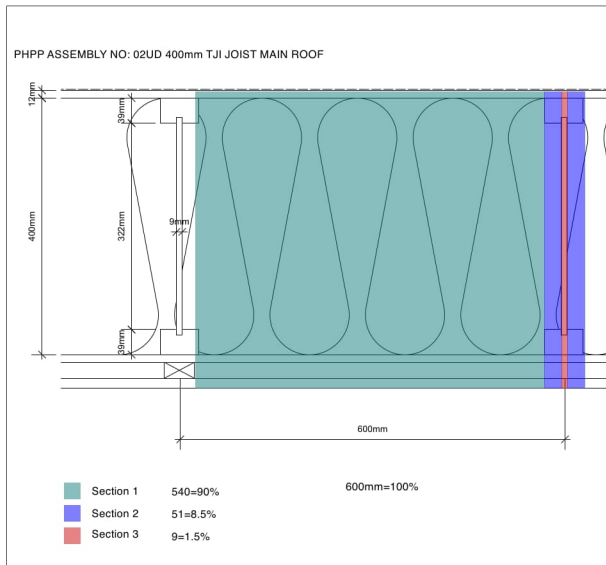


**Exterior wall assembly.** The I-joist assembly is quick to assemble and has the benefit of protection from the weather via the steel roof. Top right: The Type 3 OSB has an airtight coating (coloured green) the insulation between the joists is blown in via circular holes cut into the board. Bottom left: The timber studs are assembled first and boarded with the OSB that provides structural racking. Bottom right: The OSB is taped with airtight tape at the perimeter of individual boards and at the perimeter of the slab.

### Exterior wall build-up:

<b>Exterior Wall</b>	(Outside to inside)	
	20mm English cedar cladding on 25x50mm treated sw battens (ventilated cavity), 60 woodfibre insulation, timber I-joists at 600mm centres with 300mm blown insulation between, 12mm coated airtight Type 3 OSB, 25x50mm sw battens to service cavity, 12.5mm plasterboard and skim.	U-value
		0.09
		W/m <sup>2</sup> K

## 5.3 Construction including insulation of the roof

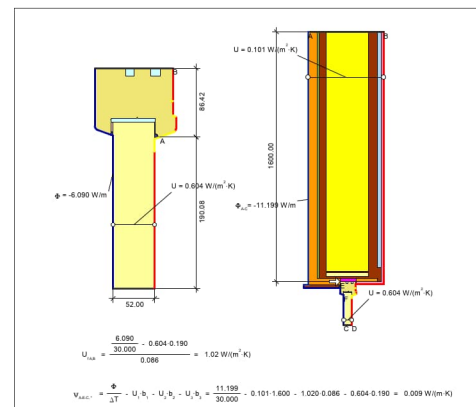
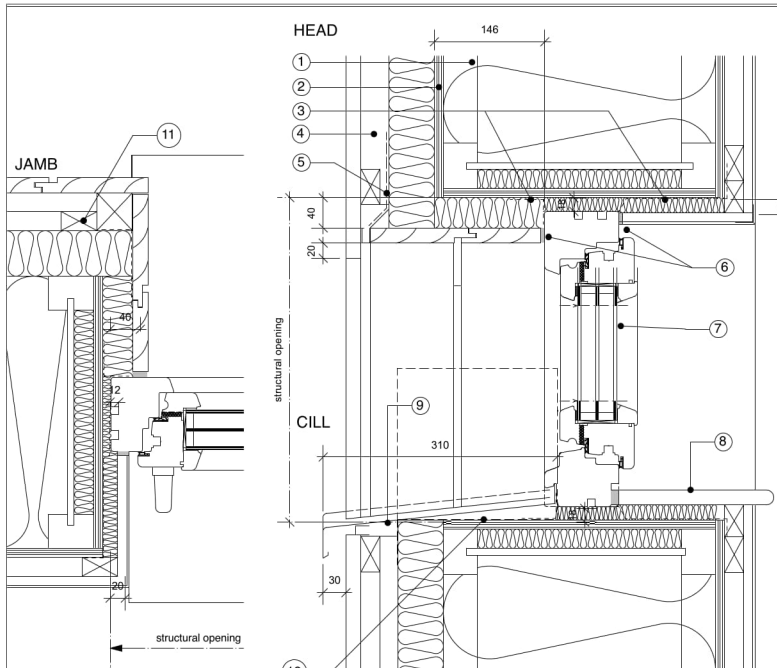


**Roof build-up of the Passive house in Tickenham.** The depth of the rafters was governed by the U-value requirements rather than structural requirements. Top right: The timber roof had to be installed rafter-by-rafter inside the existing steel roof. Bottom right: Airtight membrane was wrapped over the structural purlin and taped back to the airtight OSB. As this detail proved to be troublesome for airtightness it was redesigned by the structural engineer so that the board could abut a structural packer above the purlin, removing the need for the membrane.

### Roof build-up:

<b>Roof</b>	(Outside to inside)	
	Existing roof, ventilated cavity, breather membrane, racking board, 400mm deep timber I-joists at 600mm centres with 400mm blown insulation between, 12mm coated airtight Type 3 OSB, 25x50mm sw battens to service cavity, 12.5mm plasterboard and skim.	U-value
		0.09
		W/m <sup>2</sup> K

## 5.4 Window sections including installation drawing

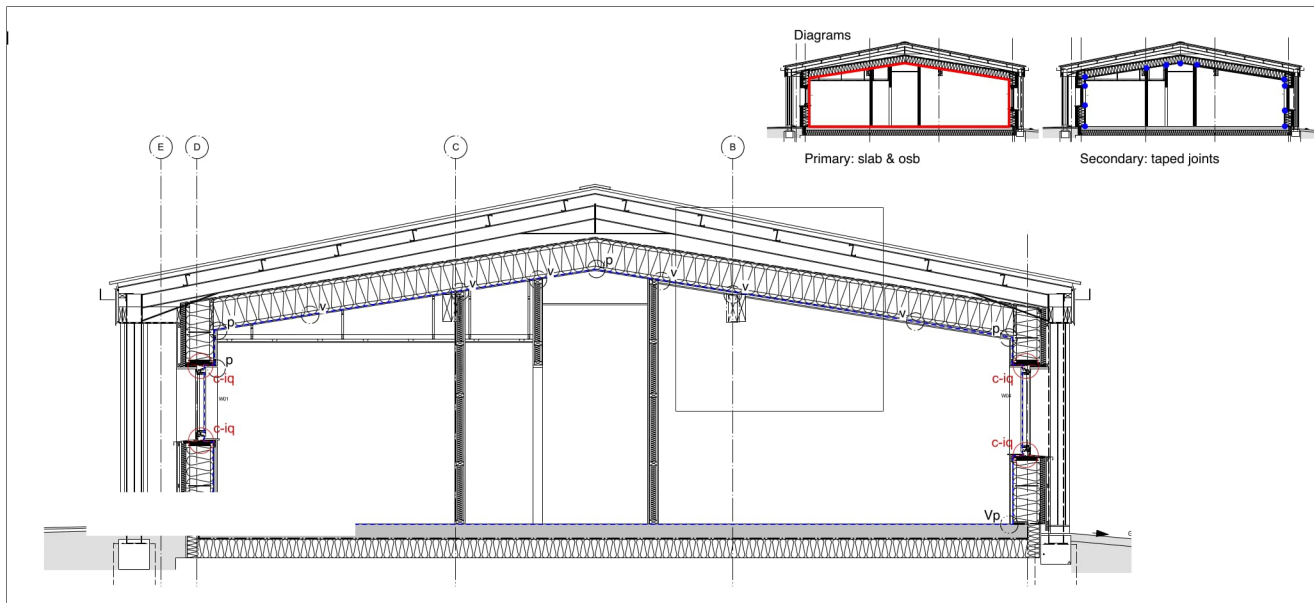


**Excellent glazing with three panes was used.** Left: Triple low-e glazed timber windows were used throughout, although the main living space also had timber lift and slide doors. The windows were positioned in the centre of the I-joint construction with additional insulation on the window reveals. The  $U_g$  value of the glass was  $0.7\text{W/m}^2\text{K}$ . Bottom right: the positioning within the wall resulted in very low psi-values ( $0.009\text{ W/mK}$ ).

### Window data:

<b>Exterior Wall</b>	Triple low-e glazing filled with Argon gas. Wooden window frames.	U-value 0.083 W/m <sup>2</sup> K
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## 6 Description of the airtight envelope; documentation of the pressure test result




There was a primary and secondary strategy for the airtightness. The exposed slab in conjunction with the coated airtight Type 3 OSB board were the primary layer, and this was supplemented with the use of airtightness tape at the perimeters, abutments and window openings.

**Roof:** An airtight coated Type 3 OSB was considered to be better than a membrane because it would be more convenient to install and was less prone to damage. A battened service void was provided to prevent fixtures from penetrating the airtight line.


**Exterior Wall:** The wall was protected in the same manner as the roof. In both locations an additional measure was employed by the contractor. This was the 'painting' with a liquid airtight membrane on the heads of all the nail fixings for the OSB and the battens (see photo on the right). Additionally the battens for the service void had a piping of silicon before they were nailed to improve the seal with the OSB substrate.



# 6 Description of the airtight envelope; documentation of the pressure test result



**BAT**  
BUILDING ANALYSIS & TESTING LIMITED



UKAS TESTING  
2612

5<sup>th</sup> August 2021

Tickenham, Clevedon, North Somerset,

Please find attached BAT Test Records for the final air leakage test undertaken on the above property on 19<sup>th</sup> June 2021. The ATTMA Lodgement Test Certificate (indicating both air changes and air permeability) has been produced and forwarded.

**Air Leakage Test to Passivhaus Standard**  
**Air Leakage Depressurisation Test**

Test Reference No: B5404-neg      Date: 19/06/2021  
Project:      Loc: IIC

Tickenham 0  
Driscoll 0

Client: MAKE Construction  
Test Start Time: 09:03

Environmental Conditions:  
Barom Pressure: 1014.2 mbar  
Internal Temperature: 21.4 °C  
External Temperature: 20 °C

Zero Flow Tests	Before	After
Ave $\Delta P_{0.1}$	0.4 Pa	0.6 Pa
Ave $\Delta P_{0.2}$	0.4 Pa	0.6 Pa


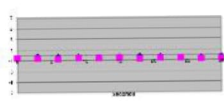
Test Average Static Pressure: -0.5 Pa Ave

Envelope Area	774.9 m <sup>2</sup>
Footprint Area	0.0 m <sup>2</sup>
Envelope Volume	996.0 m <sup>3</sup>
Building Height	3.33 m

Target Air Volume (Q <sub>50</sub> )	0.13 m <sup>3</sup> /s	Zero Flow Ave < ±5Pa (±1h < 250mK)	4.662 OK
Supplied Air Volume (Q <sub>50</sub> )	0.03 m <sup>3</sup> /s	Air flow Coeff C <sub>50</sub>	4.608 OK
Air Permeability (Q <sub>50</sub> /S)	0.12 m <sup>3</sup> /hr.m <sup>2</sup> Pass	Air flow Exponent n	0.777 OK
		Air Leakage Coeff C <sub>1</sub>	4.609 OK
		R <sup>2</sup> Better than 0.90	0.9915 OK
		Min Pressure >> $\Delta P_0$	34.9 OK
		Test pressure achieved	62.013626 OK

Notes  
Fan located in front door.  
Internal sensing tube located in the centre of the building out of the influence of the fan unit.

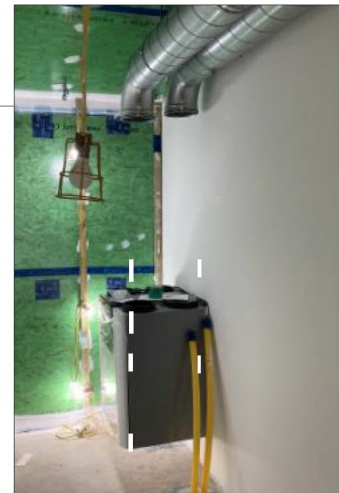
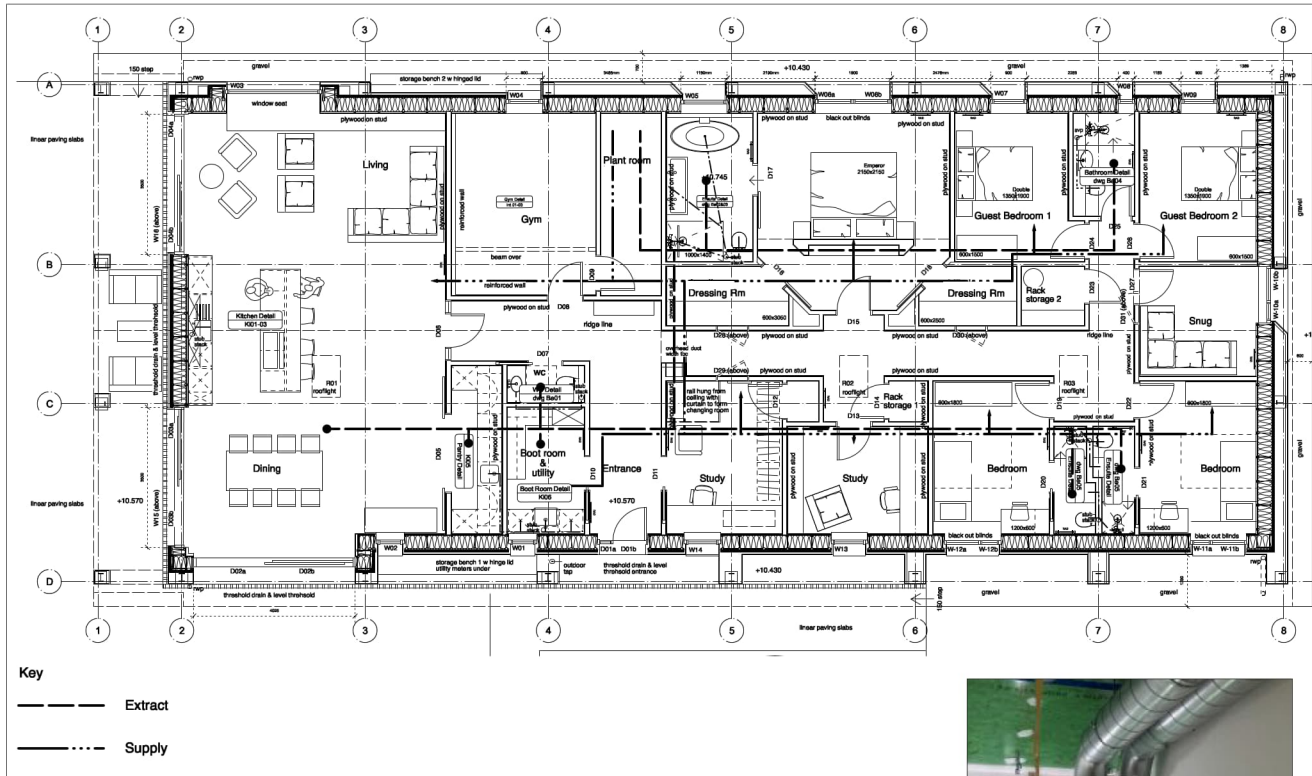
Software version: BAT-V111904-04903-202201-uk  
Test Operator: HC  
Checked by: Bob Lewis



**Windows:**The windows are taped to the OSB on the interior side and also, onto the woodfibre insulation on the exterior (see top and middle photos).

## 7 Planning of the ventilation ductwork



The strategy for the ventilation was determined by the architect/passivhaus designer and then the system was designed by the mechanical engineering consultant.

The intake and exhaust are situated on the north elevation and the MVHR is located in the Plant Room at the centre of the house. A Zehnder ComfoAir Q600 HRV MVHR with a heat recovery rate of 80% and electrical efficiency of  $0.24\text{Wh}/\text{m}^3$  was installed. This product was chosen because an optional add-on to provide cooling on the system was available.

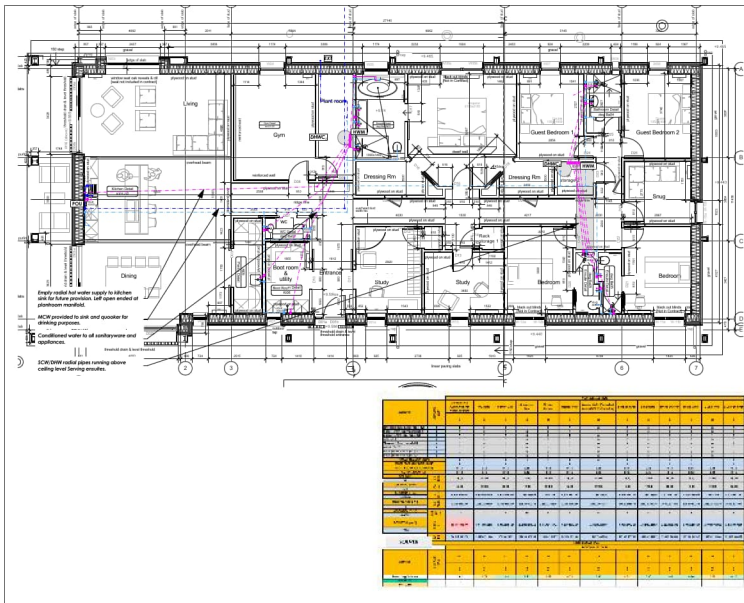
The ducts were located within the highest part of the pitched roof and co-ordinated to fit within the flat ceilings. As the house is divided in two with the long spine corridor the cross-over occurred in just one location near to the plant room.

Air is supplied to each of the bedrooms, the two studys and the main living space. It is extracted from the main living space, the WC and the en-suites. Additionally, there is a boot room adjacent to the entrance and this benefits from both a supply and extract to aid in the drying of clothes.

Inset photo: The MVHR in place before the intake and exhaust have been cut through the external wall.

## 8 Heat supply


An air source heat pump situated on the east elevation is the source of heat for the heating and hot water. Due to the length of the single storey building, there were two hot water cylinders. One located in the plant room and the other in the storage room adjacent to the guest bedrooms. This helped to reduce the size and therefore cost of one single cylinder, but also helped reduce heat losses/gains through the pipes serving the showers and hot water taps. The building was modelled using the AECB water standards and 'problem' pipe runs were flagged and mitigation considered.



Left: Drawing showing the pipe runs with inset calculation sheet for AECB Water Standard. Right: a photo of the Air Source Heat Pump.

# 9 PHPP Calculations

## Passive House Verification



**Architecture:** Shu Architects  
 Street: First Floor, 43-45 Park Street  
 Postcode/City: BS9 3EQ  
 Province/Country: Bristol GB-United Kingdom/ Britain

**Energy consultancy:** Shu Architects  
 Street: First Floor, 43-45 Park Street  
 Postcode/City: BS9 3EQ  
 Province/Country: Bristol GB-United Kingdom/ Britain

Year of construction: 2021  
 No. of dwelling units: 1  
 No. of occupants: 3.2

**Building:**  
 Street:  
 Postcode/City: Tickenham, Clevedon  
 Province/Country: GB-United Kingdom/ Britain  
 Building type: Conversion to Residential  
 Climate data set: GB0006a-Lyneham  
 Climate zone: 3: Cool-temperate Altitude of location: 9.59 m

**Home owner / Client:** CONFIDENTIAL  
 Street:  
 Postcode/City:  
 Province/Country: GB-United Kingdom/ Britain

**Mechanical engineer:** Greengauge Building Energy Consultants  
 Street: Suite 3, Second Floor, The Old Brewery  
 Postcode/City: BA15 1NF Newtown, Bradford on Avon  
 Province/Country:

**Certification:**  
 Street:  
 Postcode/City:  
 Province/Country:

Interior temperature winter [°C]: 20.0 Interior temp. summer [°C]: 25.0  
 Internal heat gains (IHG) heating case [W/m²]: 2.3 IHG cooling case [W/m²]: 2.3  
 Specific capacity [Wh/K per m² TFA]: 84 Mechanical cooling:

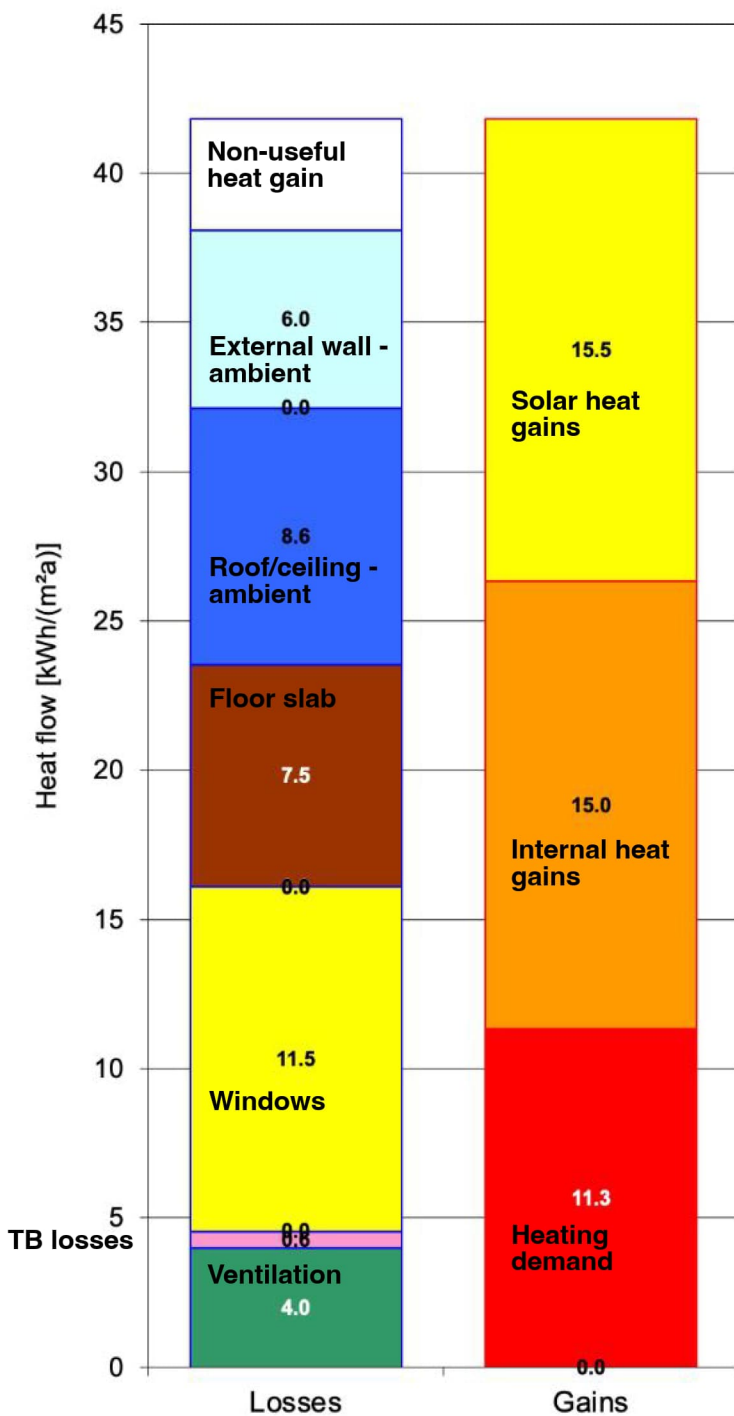
Specific building characteristics with reference to the treated floor area				Alternative criteria		Fulfilled? <sup>2</sup>
	Treated floor area m²			Criteria	Alternative criteria	
Space heating	Heating demand kWh/(m²a)	264.8	≤	15	-	yes
	Heating load W/m²	7.0	≤	-	10	
Space cooling	Cooling & dehum. demand kWh/(m²a)	-	≤	-	-	-
	Cooling load W/m²	-	≤	-	-	-
	Frequency of overheating (> 25 °C) %	0.04	≤	10		yes
	Frequency of excessively high humidity (> 12 g/kg) %	0	≤	20		yes
Airtightness	Pressurization test result n <sub>50</sub> 1/h	0.1	≤	0.6		yes
Non-renewable Primary Energy (PE)	PE demand kWh/(m²a)	56	≤	-		-
Primary Energy Renewable (PER)	PER demand kWh/(m²a)	22	≤	60	60	yes
	Generation of renewable energy (in relation to projected kWh/(m²a) building footprint area)	0	≥	-	-	

<sup>2</sup> 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 Classic?** yes

The heating demand of a detached passive house in Tickenham, calculated using the PHPP. The designers involved are also mentioned here.

### Energy balance heating (monthly method)



The heating demand of a detached passive house in Tickenham, calculated using the PHPP.

The windows account for the greatest heat losses and the external walls are half of these.

The shallow pitch of the roof means that the roof losses are only slightly more than those from the slab.

Despite the solar shading, solar heat gains are over a third of the total heat gains.

## 10 Construction Costs

As this was a private house for a single family home the costs remain Confidential.