Passivhaus Project Documentation
Hob Moor Passivhaus, York, UK

Abstract

Single-family detached dwelling off Little Hob Moor, York, North Yorkshire

Building Data

Year of construction	2017	Space Heating	14kWh/m^{2}a
U-Value external wall	0.106W/m^{2o}k		
U-Value floor	0.104W/m^{2o}k	Primary Energy Renewable	63kWh/m^{2}a
U-Value roof	0.096W/m^{2o}k	Generation of renewable energy	54kWh/m^{2}a
U-Value window	0.81W/m^{2o}k	Non-renewable primary energy	123kWh/m^{2}a
Heat recovery	80%	Pressure test n_{50}	0.5/h
Special features	Full south-facing roof solar PV installation.		

Information on the web at www.constructiveindividuals.co.uk

Phil Bixby BA Dip Arch Architect

Brief Description

The project was interesting in a number of ways.

Firstly, the clients weren't living in the UK at the time the house was built. Tim Shepherd was a teacher at an international school in Singapore, and he was building for his planned retirement, moving back to the UK and bringing his Singapore-born wife JJ with him. He had told JJ that the Yorkshire climate was pleasant (this is not entirely true) and so wanted a home that would be comfortable in all weathers, along with a guarantee of quality and performance. Briefing and contract management was done largely via email and WhatsApp, with only occasional physical visits.

Secondly it was one of two Passivhaus projects built concurrently. The other was the Derwent Road Passivhaus (Project ID 5432) – both built by the same contractor but with different site management and using different forms of construction.

The clients were in many ways "model" clients. The most important element of the briefing process was a "day in my future life" which Tim wrote. This set out in some detail how he wanted to be able to live, what he wanted to be able to do and the way he wanted the house to function in support of that, but said nothing about the actual design, leaving me as architect with pretty much complete freedom to propose design solutions.

The site was identified after about nine months of searching. Vacant sites were impossible to find in York, and so a plot with a poorly-constructed bungalow was found, and design proceeded on the assumption this would be demolished. Planning application was submitted and approval obtained with only minor local concerns – the fully-solar roof and the render finish raised eyebrows among neighbours but they were quickly reassured. Consent was obtained in June 2016.

Image from the planning application…

…and paste-up view on site.

The house is a fairly straightforward rectangular footprint, on two storeys with the upper floor utilising all available volume beneath the pitched roof. The house has a single-storey lean-to addition on the north side accommodating a small "endless" swimming pool – this is not part of the heated envelope. The house sits to the north boundary of the site allowing the main rooms to face south across a pleasant, wildflower-planted garden.

Through a twist of fate, the architect / Passivhaus Designer now lives in the neighbouring property – an existing Victorian end-terrace house that has been retrofitted and extended.

Responsible project participants

Architecture and building physics: Phil Bixby of Constructive Individuals

Building services

MVHR design and supply: ADM Systems, 1st Floor East Suite, The Waterfront, Salts Mill Road, Shipley, West Yorkshire, BD17 7TD

Renewables: Solar array, Immersion control unit and electrics: The Phoenixworks

Structural engineer: Robert Thew (substrucures). Timber frame design by supplier Buildakit (UK) Ltd, Part Manor Mill, Hallam Road, Nelson, BB9 8DN

Craftsperson / parties involved:

Contractor: Kent Building Developments Ltd, Threshers Barn, Low Moorgate, Rillington,

Malton, North Yorkshire, YO17 8JW.

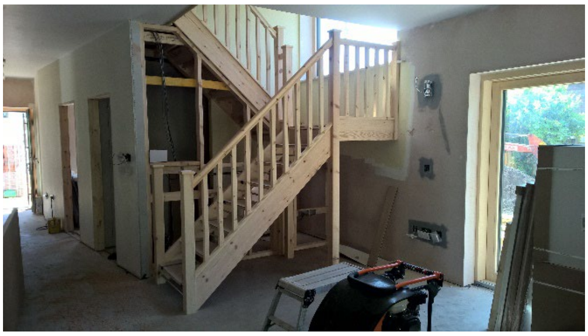
Certifying body: Passivhaus Institut, Darmstadt via MEAD Energy & Architectural Design Ltd

Certification ID: 5433 (Passive House Database)

Views of the building

Overhead drone photo from south side.

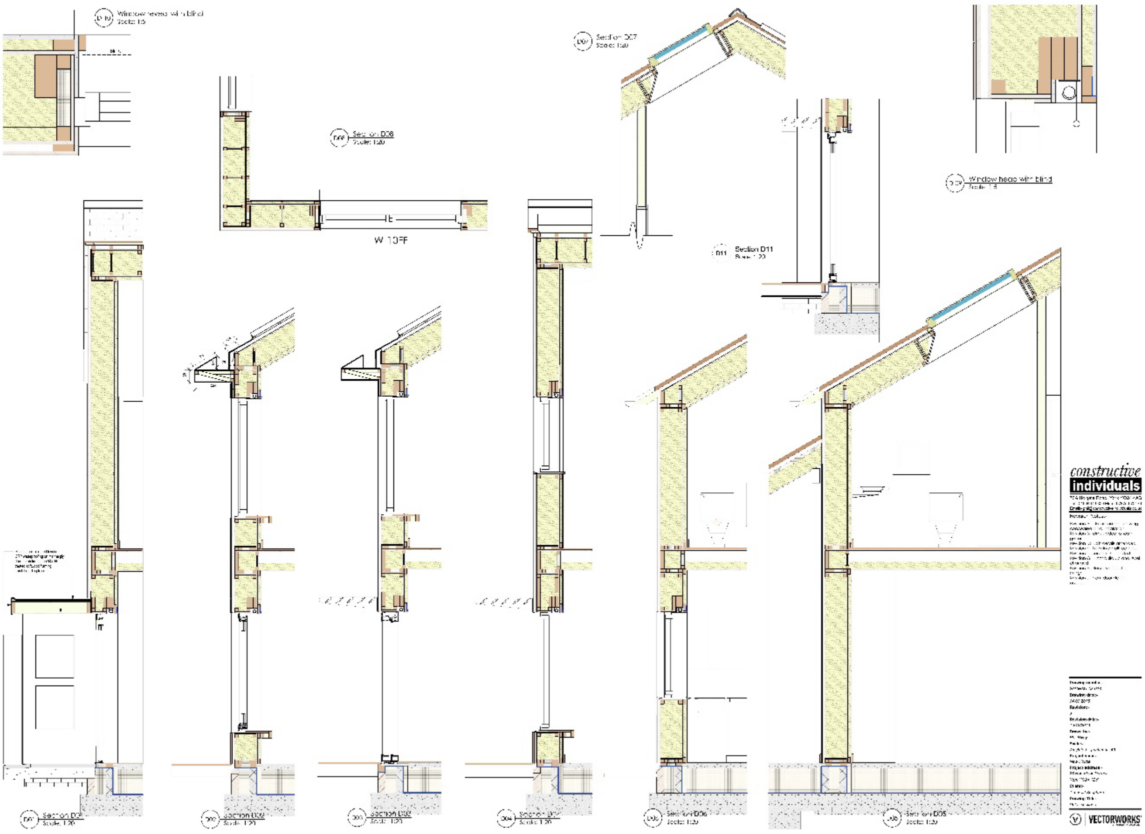
Overhead drone photo showing west elevation and pool room to rear.

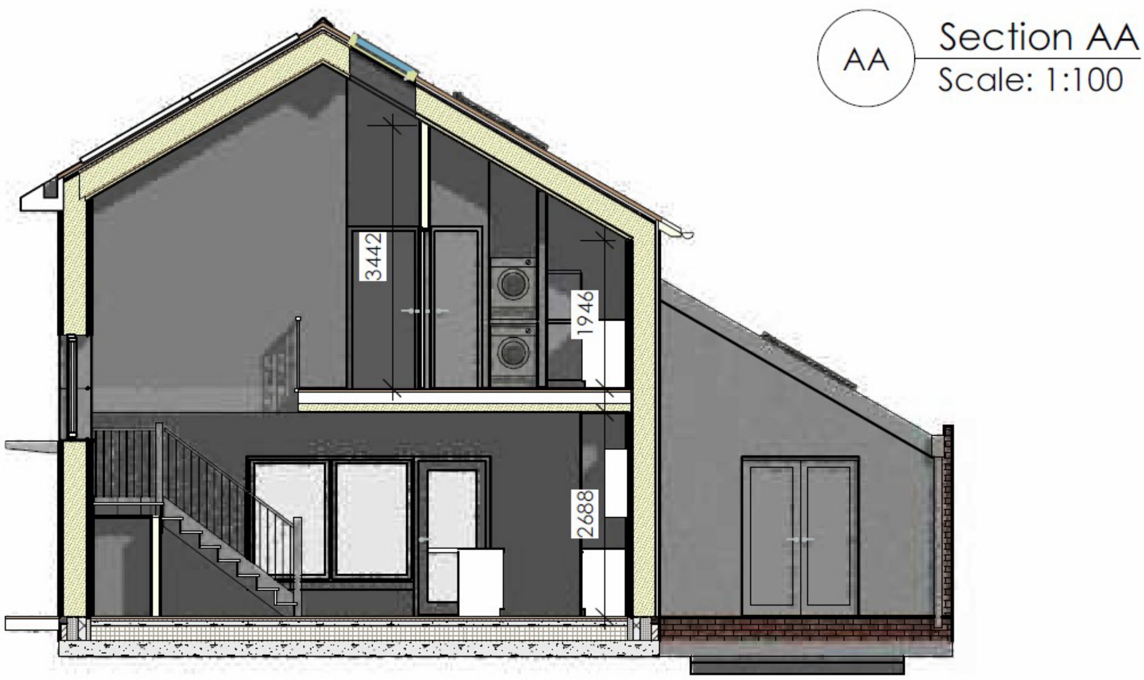


Internal view prior to completion showing stair from living room.

Internal view prior to completion showing kitchen area.

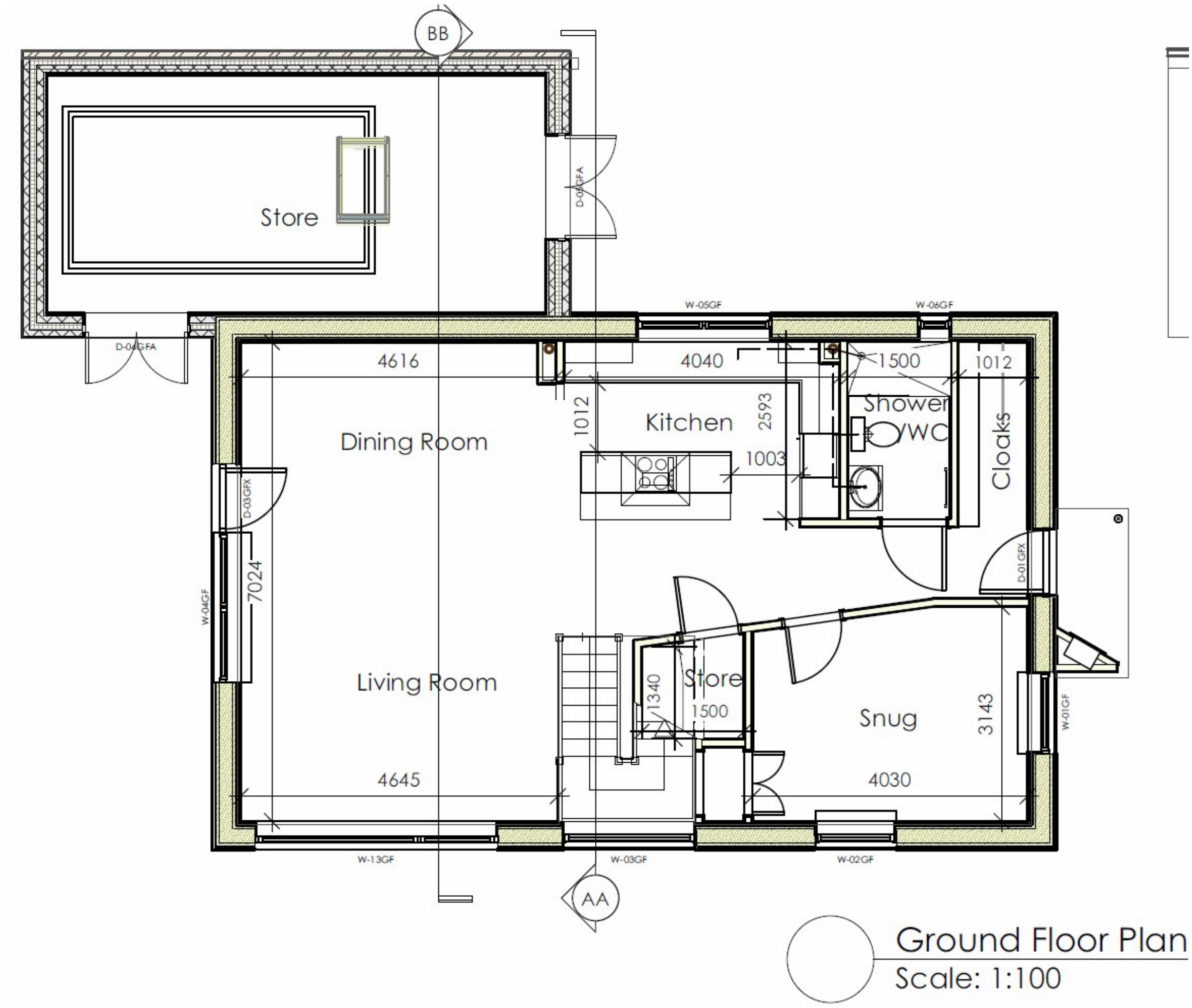
Sectional drawings



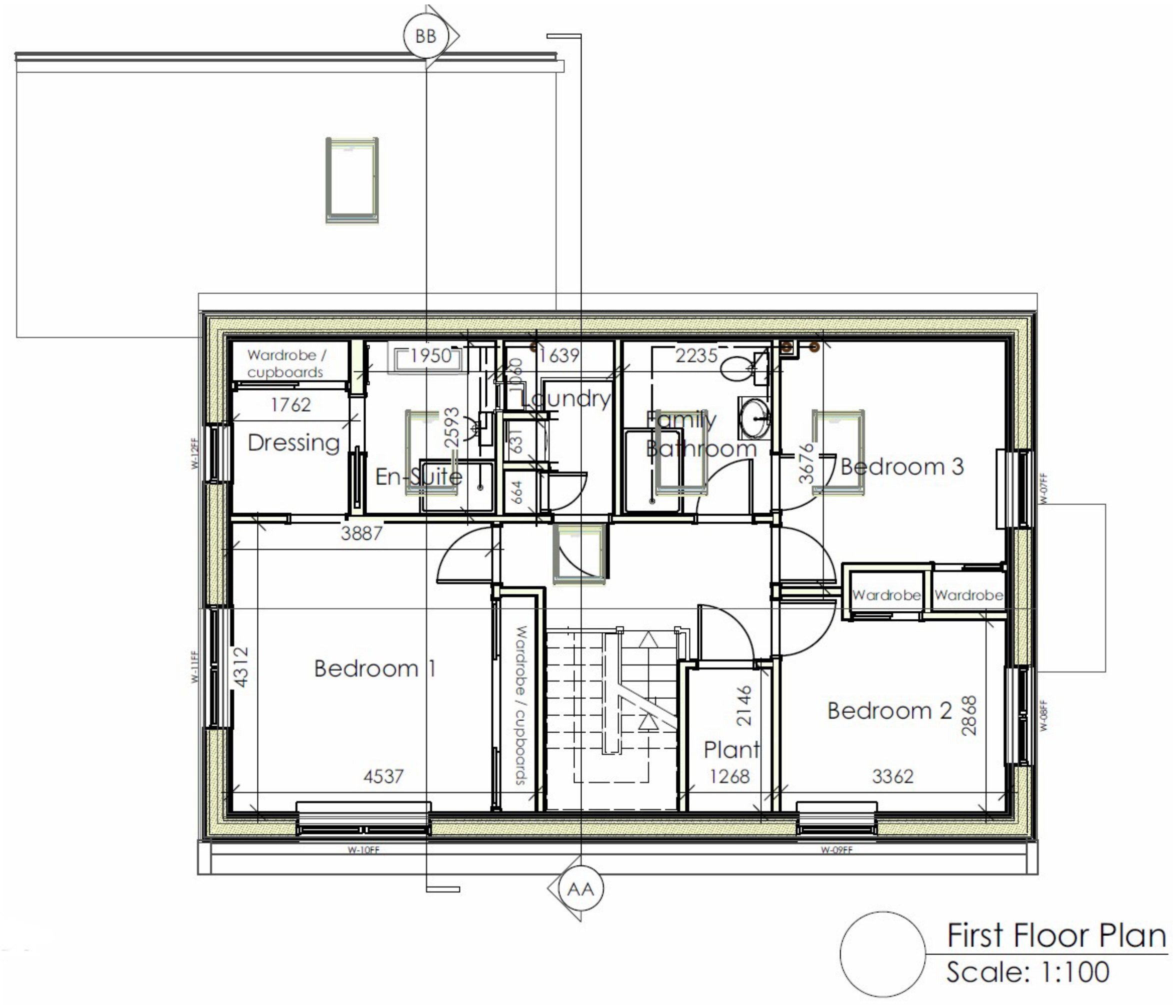


The building section is asymmetric, with the south face size and pitch optimised to PV panels, and the north face brought down to reduce the ridge height and impact of the building mass. All rooflights are north-facing to avoid uncontrolled solar gains, and shading is incorporated above south-facing windows, including a continuous press-aluminium concealed gutter to the south-facing roof. External walls, roof and intermediate floor are all constructed using timber I-joists. The superstructure sits on an insulated raft.

Floor plans



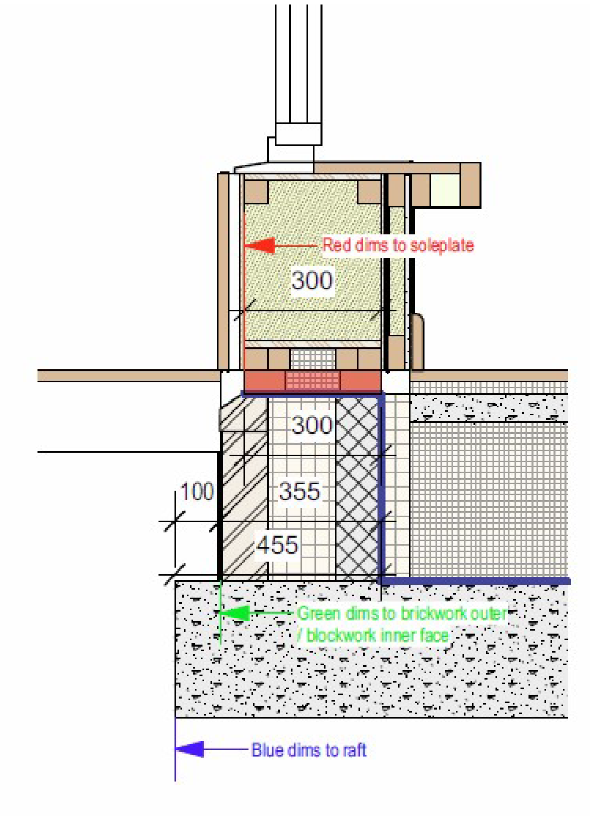
The ground floor plan is entered from the street at the eastern end, with a cloaks area and shoe rack, and access to a shower/WC. The hallway wall splays so that the space opens up as one moves into the combined living / dining / kitchen area, with a doorway off this passage to a compact snug, and the stair leading off the main room. The living area has extensive south-facing (shaded) glazing, and the dining area faces the evening sun, with retractable shading and existing mature tree planting.



The first floor layout arranges the rooms around a central landing space with a heigh ceiling and overhead rooflight. The main bedroom suite with dressing and shower/WC has windows looking over the garden and nearby woods, with the guest bedrooms, bathroom and laundry to the north and east. The laundry has a chute which enables clothing to be deposited into the laundry basket from the adjacent en-suite.

Description of the construction

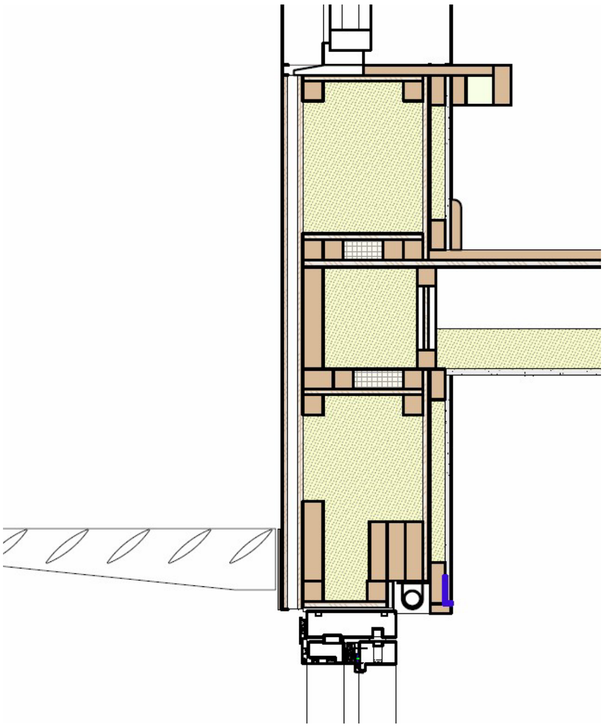
Ground floor

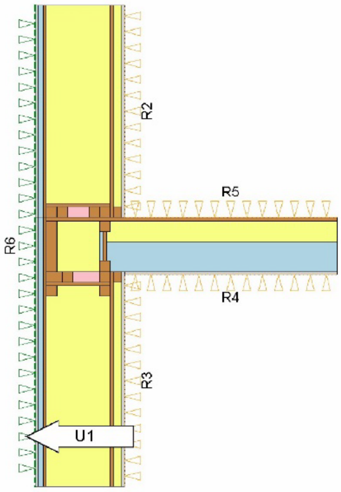


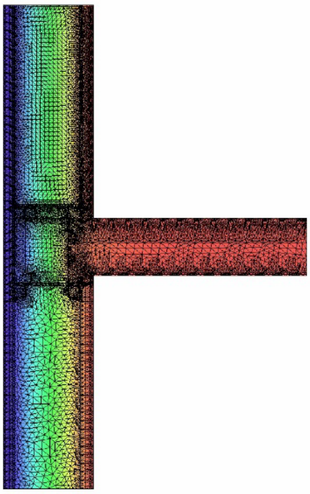
The ground floor is a fairly simple reinforced raft foundation, with cavity plinth walls enclosing insulation and screed. A gas membrane is incorporated due to concerns over a nearby former landfill site.

Build-up:-	75mm Gyvlon poured screed with fibre reinforcement 200mm Kingspan insulation (k=0.020W/mk) Gas membrane as airtightness layer 200mm reinforced concrete raft Hardcore and blinding **U-value = 0.097 W/(m2K)**

External walls



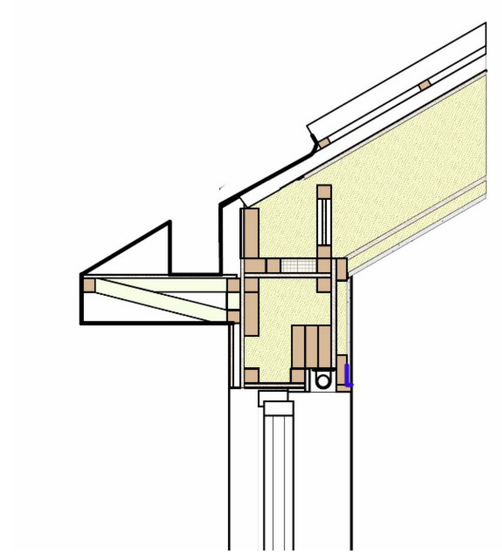




The walls are of timber frame panel construction, with the studs being timber I-joists giving a 300mm internal depth between internal and external sheathing. All junctions were modelled using Psitherm software and the detailing was designed in liaison with the frame manufacturer to enable the complex and accurate connections while minimising thermal bridging.

Build-up:-	12.5mm Plasterboard 38mm Service void with mineral wool insulation (k = 0.035W/mk) Airtightness membrane 15mm OSB 300mm panel depth between I-joists, fully-filled with mineral wool (k=0.035W/mk) 13mm Panelvent sheathing Breather membrane 25mm ventilated airgap Cladding of proprietary Parex render system on board or vertical larch boarding, to layout as shown on elevations. U-value = 0.106 W/(m2K)

Roof



The roof is constructed using cassettes which are broadly the same as the wall panels – using 300mm timber I-joists as rafters which span between a glulam ridge beam and the wallplate at eaves level. Both the eaves and ridge join are custom made to ensure tight fitting between panels (individual timbers are cut to tolerances of 1mm each end, giving panel connection tolerances of around 4mm) and, as with the wall panel connections, timer in the junction is minimised to reduce thermal bridging, and connections were modelled using Psitherm.

Build-up:-	12.5mm Plasterboard 38mm Service void with mineral wool insulation (k = 0.035W/mk) Airtightness membrane 15mm OSB

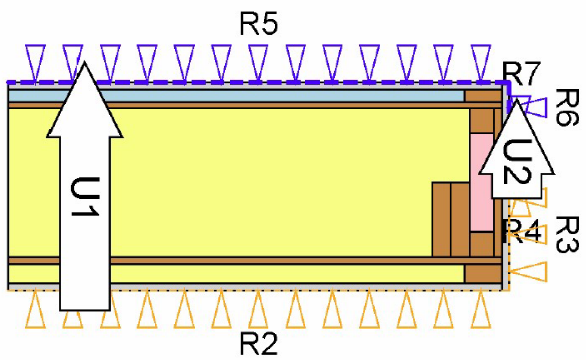
	300mm panel depth between I-joists, fully-filled with mineral wool (k=0.035W/mk) 13mm Panelvent sheathing Breathable underlsating Treated 25x38mm counterbattens Treated 25x50mm tiling battens Concrete interlocking tiles (On south side tiles and battens omitted and PV panels fixed using mounting trays/flashings). **U-value = 0.096W/(m2K)**

Windows

Windows are Gaulhofer Fusionline 108 Pure units supplied by Ecowin. Generally:-

- Internal colour: Clear Laquer
- External colour: RAL 7016 (anthracite Grey) & 3000 (Fire Engine Red – front door)
- Ironmongery: Concealed Hinging, Standard Gaulhofer Handles
- Glass Ug: 0.5 W/m2K
- Frame Uf Laterally: 0.91 W/m2K
- Frame Uf Bottom: 1.01 W/m2K
- Psi Value: 0.028
- G Value: 0.52
- Average whole window U Value: 0.77W/m2K

Glazing units are generally:- 4mm toughened/coated-18mm-4mm toughened-18mm-4mm toughened/coated. The window position within reveals was fine-tuned using Psitherm.



Rooflights are Fakro FTT-U6 units with thermal flashing kit.

The airtight envelope

The airtightness strategy was to ensure a single layer of airtightness by the use of proprietary airtightness membrane, and tapes / grommets / fittings etc from Proclima where required. In general the two site managers of the two concurrent Passivhaus projects were both briefed on general principles and key areas where extra care was required. In the case of Hob Moor Passivhaus the timber frame from Buildakit came with internal airtightness membrane already fitted and protected with internal battening / mineral wool insulation, held in place using plastic straps.

Within the ground floor the gas membrane was used as the airtightness layer. This was brought up and turned beneath the timber frame sole plates, with a strip of gas membrane taped to bridge across the junction internally, taped to the gas membrane and internal breather membrane on the timber frame above. All penetrations through the gas membrane were taped or sealed using proprietary fittings.	
Within the walls, the Glidevale Protect BarriAir proprietary airtightness membrane was pre-fixed inboard of the internal sheathing and outboard of the service void and battening. This was wrapped and fixed to all joining faces and these were thoroughly mastic sealed during the erection process. Additional taping was carried out by site staff to ensure that absolutely all junctions were taped, whether already mastic sealed or not. At first floor level the airtightness membrane was taken outside of the floor cassettes and brought back in at first floor level.	
The arrangements at roof level are basically identical to the wall panels, with an internal service void. Reveals to all rooflights were sealed using membrane and tape (rather than proprietary components). As can be seen at right, the airtightness membrane was lapped into all joints to allow mastic sealing.	

Airtightness testing

Testing was carried out by Northern Airtightness Testing Services. Tests were conducted after first fix of all services (earlier testing was not possible due to programming of works being less than optimal, due to lead times on components – see photo at right taken in April 2017) and at completion.

The final test was carried out in June 2017, and pressurisation / depressurisation results are shown below.

retrotec FanTestic	version: **5.9.14**	licensed to: **Northern Air Tightness Testing Services Ltd**
Test date: **2017-06-05**	By: **Phil Ramshaw**	
Customer:	**Kent Build**	
Building Lot Number:		
Building address:	**26** **Hobmoor Terrace** **York, North Yorkshire** **England** **YO24 1EY**	

Building and Test Information	
Test file name:	**Hobmoor Terrace Pressurisation Test 3**
Building volume [m³]:	**540**
Envelope Area [{m²]:	**399**
Floor Area [{m²]:	**82**
Building Height (from ground to top) [m]:	**0**

Results	
Air flow at 50 Pa, Q_{50} [m³/h]	**259.0**
Air changes, n_{50}	**0.48**
Equivalent leakage area at 50 Pa [cm²]	**129.1**
Permeability at 50 Pa [m³/h/m²]	**0.649**

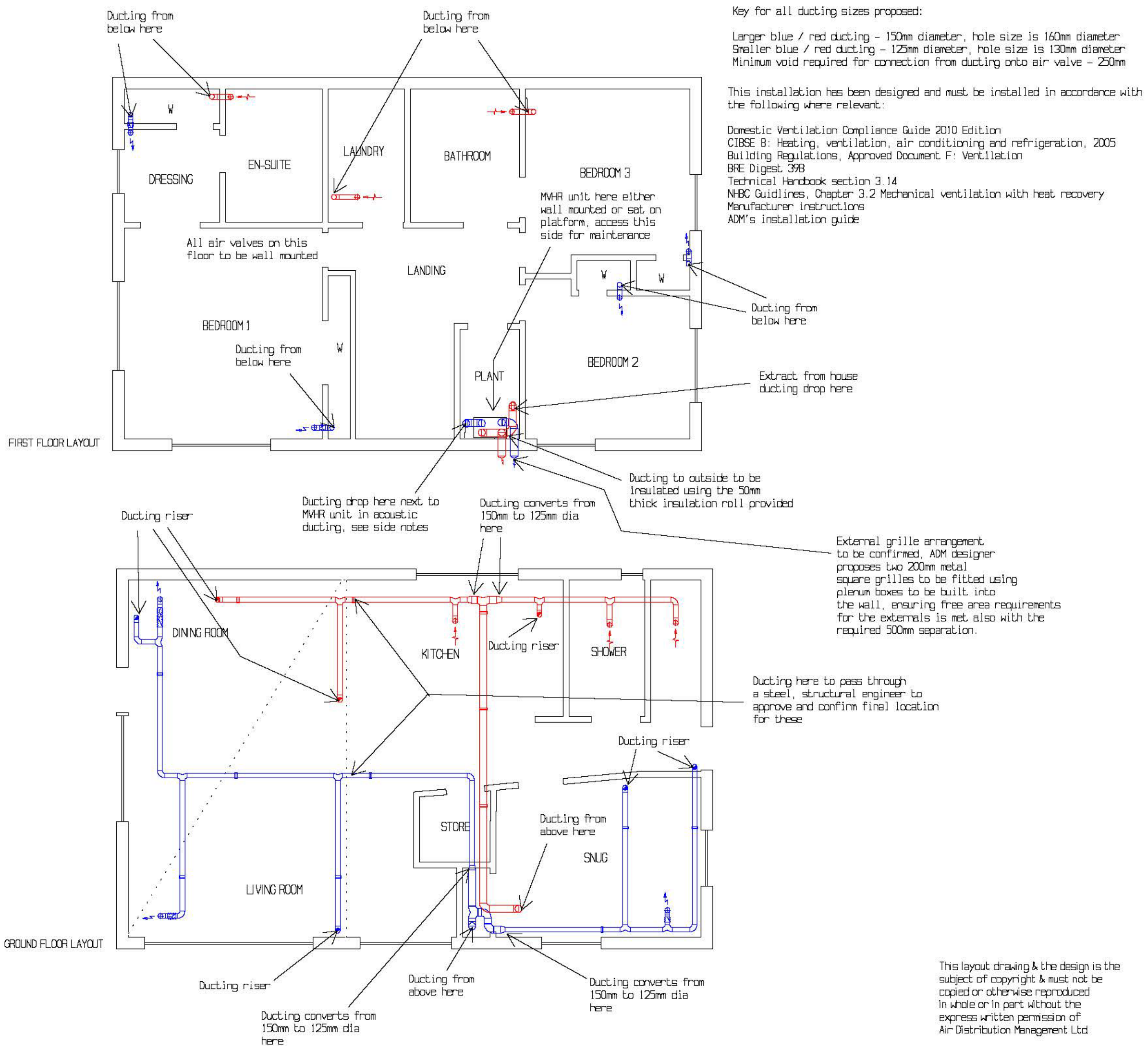
Building and Test Information	
Test file name:	**Hobmoor Terrace Depressure 3**
Building volume [m³]:	**540**
Envelope Area [{m²]:	**399**
Floor Area [{m²]:	**82**
Building Height (from ground to top) [m]:	**0**

Results	
Air flow at 50 Pa, Q_{50} [m³/h]	**274.5**
Air changes, n_{50}	**0.51**
Equivalent leakage area at 50 Pa [cm²]	**137.0**
Permeability at 50 Pa [m³/h/m²]	**0.688**

Ventilation system

The MVHR system has been supplied and designed by ADM Systems who describe themselves as “Independent Heat Recovery Ventilation Specialists”. ADM have supplied and fitted MVHR in a number of the designer’s projects and have been helpful in offering consultancy services on one or two problematic projects with historic buildings. They have also been very helpful in revisiting jobs after a period of occupation to fine-tune flow rates to suit actual occupancy – UK Building Regulations tend to lead to major over-ventilation as they address condensation issues which don’t actually exist in Passivhaus projects.

The system here comprises a main Zehnder ComfoAir-Q unit accommodated at first floor level in a dedicated plant cupboard. The unit feeds supply air through an electric post-heater, and the system uses rigid spiral-wound galvanised steel ducting.



The system works well, maintaining good air quality. A minor but annoying error was locating the remote control unit in the plant cupboard rather than somewhere more remote from the unit – for example in the kitchen.

Heat supply

The low heating requirement of the house and the substantial photovoltaic installation led to an early decision that the house would be all-electric, and an existing gas supply to the site was removed (**still** unusual in UK at the time of construction). The PV array is setup to put spare output into the DHW cylinder via an Immersion control unit. Following this, output is available for domestic use and for space heating.

Space heating comprises a 1kW post heater on the supply air, and three electrically-heated towel rails in the three bathrooms/showers, each on thermostatic control. The house performs as per predicted demand so this generally works well; on occasions where it has been unused for a while due to travelling away, and temperatures have fallen, a simple plug-in electric fan heater is deployed until temperatures are back to normal.

In practice there has been a learning curve in respect of settings for the immersions and immersion control unit. The fact that there is no one single control unit for heating nor for hot water, led to a need to bring together advice from a number of sources. An email thread was set in motion by the designer, becoming known as The Reservoir Dogs Thread as each participant (PV installer, plumber, electrician, MVHR company, client etc) colour-coded their contributions. This was helpful (and was broadened to include the clients on the concurrent Derwent Road Passivhaus as similar issues existed there).

PHPP

The project was designed from scratch with the intention of being certified Passivhaus. All design work was carried out in 3D on Vectorworks, with Artlantis being used as a visualisation tool and to model sun and shading accurately. Psitherm was used for thermal bridging calculations and modelling of options.

Building:	New Dwelling		
Street:	26 Hob Moor Terrace		
Postcode/City:	YO24 1EY	York	
Province/Country:	North Yorkshire	GB-United Kingdom/ Britain	
Building type:	Single family dwelling		
Climate data set:	GB0011a-Leeming		
Climate zone:	3: Cool-temperate	Altitude of location:	14 m
Home owner / Client:	Tim & JJ Shepherd		
Street:	26 Hob Moor Terrace		
Postcode/City:	YO24 1EY	York	
Province/Country:	North Yorkshire	GB-United Kingdom/ Britain	

Architecture:	Constructive Individuals / Phil Bixby			Mechanical system:			
Street:	70A Holgate Road			Street:			
Postcode/City:	YO24 4AB	York		Postcode/City:			
Province/Country:	North Yorkshire	United Kingdom		Province/Country:			
Energy consultancy:	Constructive Individuals / Phil Bixby			Certification:			
Street:	70A Holgate Road			Street:			
Postcode/City:	YO24 4AB	York		Postcode/City:			
Province/Country:	North Yorkshire	United Kingdom		Province/Country:			

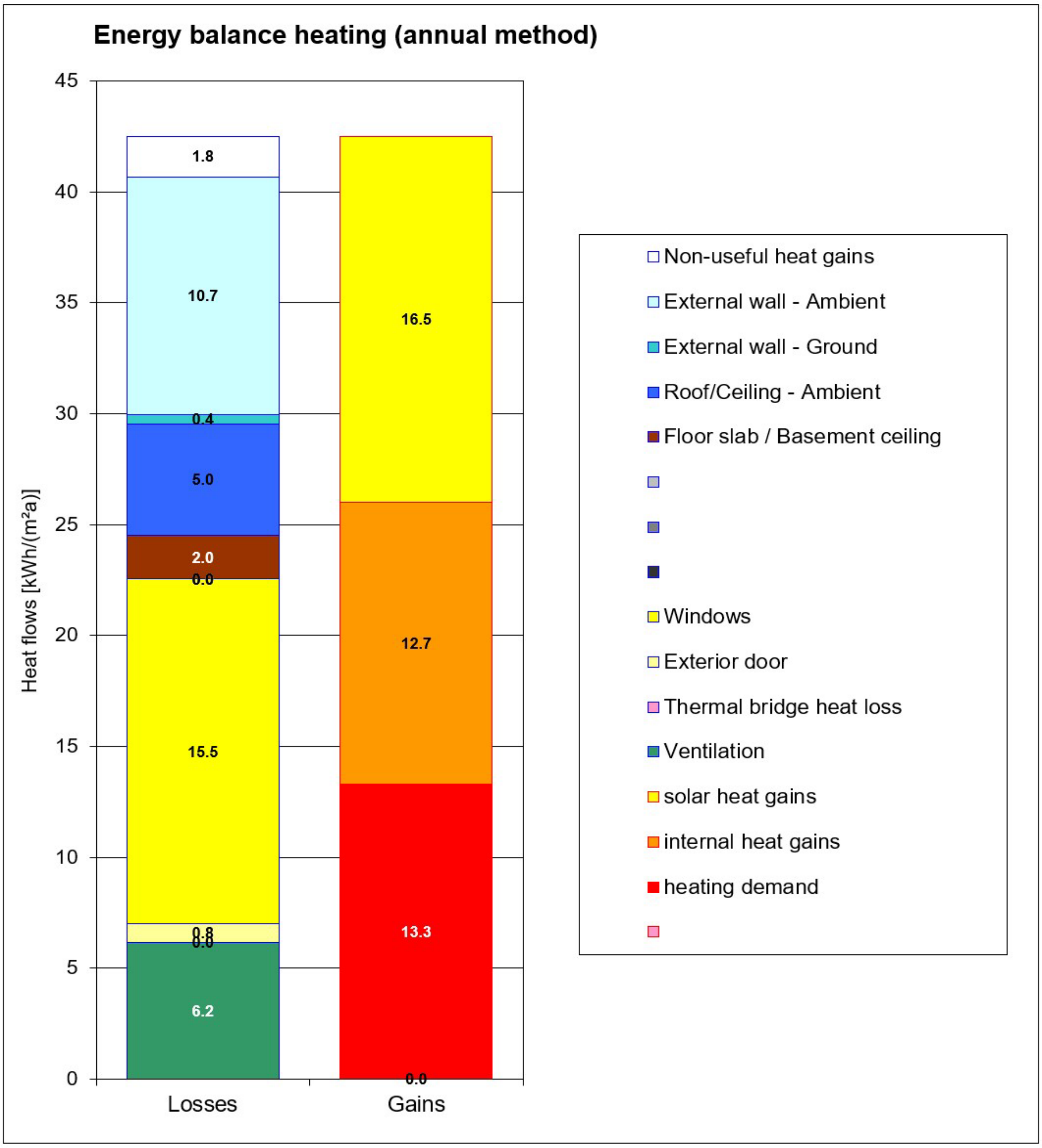
Year of construction:	2016	Interior temperature winter [°C]:	20.0	Interior temp. summer [°C]:	25.0
No. of dwelling units:	1	Internal heat gains (IHG) heating case [W/m²]:	2.4	IHG cooling case [W/m²]:	2.4
No. of occupants:	2.9	Specific capacity [Wh/K per m² TFA]:	60	Mechanical cooling:	

Specific building characteristics with reference to the treated floor area

		Unit	Value		Criteria	Alternative criteria	Fullfilled?[2]
	Treated floor area	m²	145.6				
Space heating	Heating demand	kWh/(m²a)	14	≤	15	-	yes
	Heating load	W/m²	10	≤	-	10	
Space cooling	Cooling & dehum. demand	kWh/(m²a)	-	≤	-	-	-
	Cooling load	W/m²	-	≤	-	-	
	Frequency of overheating (> 25 °C)	%	0	≤	10		yes
	Frequency excessively high humidity (> 12 g/kg)	%	0	≤	20		yes
Airtightness	Pressurization test result n_{50}	1/h	0.5	≤	0.6		yes
Non-renewable Primary Energy (PE)	PE demand	kWh/(m²a)	123	≤	-		-
Primary Energy Renewable (PER)	PER demand	kWh/(m²a)	63	≤	60	63	yes
	Generation of renewable energy	kWh/(m²a)	54	≥	-	5	

As noted above, although formal monitoring equipment hasn't been fitted, checking of bills suggests that performance is in line with PHPP predictions. Possibly the only time when we have been taken by surprise was during an unusually warm spell early in the spring. External temperatures were high and the combination of this and low sun angles led to internal overheating. The client has, to some extent, also had to overcome the "don't open the windows" advice which seems to come from anyone and everyone who doesn't understand Passivhaus; during hot spells a regime of purge ventilation at each end of the day along with keeping windows/doors closed during the peak temperatures has maintained comfort levels.

As the graph below shows, windows are the largest heat loss component but provide much-loved views of the garden and adjacent woodland, and contribute to summer life split indoors and outdoors. The clients would not wish things different.



Costs

The final contract sum for the project was just over £445,000, which works out as £3,056/m2 of TFA. This, though, includes external landscaping (driveway and extensive decking, site fencing etc and also the substantial costs of the endless pool and the room it occupies. Although this is not part of the heated volume, it is built to similar standards of insulation, and on the same reinforced/insulated raft). The house also incorporates complex control wiring as the client wanted to be able to control everything from room lighting to hi-fi via phone app. A more realistic view of costs would be in the region of £2500-2600/m2.

User satisfaction

The clients are very happy with the house – which is doubly good as (noted earlier) the designer now lives next door. They have eregularly taken part in Passivhaus Open Days (including recording a video for the Covid lockdown event) and the local Open Eco Homes scheme, together with events organised as part of York Environment Week. The house was featured in the local paper shortly after completion.

NEWS

7th September 2017

Is this the home of the future?

By Stephen Lewis

17 comments

STEPHEN LEWIS visits a 'home of the future' which costs almost nothing to heat

ON a quiet residential street near Hob Moor stands what just could be the house of the future.

Tim and JJ Shepherd's three-bed detached home doesn't look particularly unusual.

It is obviously new, and contemporary in design. Downstairs, there's a huge open-plan living area combining sitting room, dining room and kitchen. Huge windows on three sides allow the light to pour in. There's also a small snug, for anyone who wants to be private.