Project Documentation

1 Abstract

8 detached and 6 semi-detached homes in Hellesdon, Norwich, UK

1.1 Data of building – Plot 3 (detached 4 bed home)

Year of construction	2016	**Space heating**	**14 kWh/(m²a)**
U-value wall - timber U-value wall - render	0.100 W/(m²K) 0.095 W/(m²K)		
U-value ground slab	0.112 W/(m²K)	**Primary Energy Renewable (PER)**	86 kWh/(m²a)
U-value roof - sloping U-value roof - flat	0.092 W/(m²K) 0.101 W/(m²K)	**Generation of renewable energy**	0 kWh/(m²a)
U-value window (average)	0.77 W/(m²K)	**Non-renewable Primary Energy (PE)**	99 kWh/(m²a)
Heat recovery	89.8 %	Pressure test n_{50}	0.539 h-1
Special features	Connection point for PV (so occupants can install), electric car charging points, rainwater butts in gardens.		

1.2 Brief Description ...

Carrowbreck Meadow, Hellesdon, Norwich, UK

Carrowbreck Meadows is a development of 14 detached and semi-detached Passivhaus homes, creating the largest Passivhaus development in Greater Norwich. This landmark scheme sets new benchmarks for sustainable development, not only meeting the demanding requirements of full Passivhaus certification but also by providing 43% of the site as affordable homes, an over provision of 13%.

This innovative modern development has been designed and delivered by certified passivhaus architects at Hamson Barron Smith for Broadland Growth Ltd, a company set up by Broadland District Council and the NPS Group to provide

- positive intervention in the marketplace driving up the quality of the housing product through design, space and material selection
- income generation to support local community needs and protection of front line services
- environmental excellence.

The design response at Carrowbreck Meadows is a contemporary rendition of a well-established and local typology, a ‘Norfolk style’ – defined by a number of references to the historic barn vernacular seen throughout the county. A material pallet of white render, black stained timber cladding and either slate or plain red roof tiles also reflects the materials used in the adjacent Carrowbreck House.

The properties have been carefully grouped so the development sits comfortably in its woodland setting. The positioning and orientation of the homes maximises the access to solar gain in winter and prevents over heating in summer, with brise soleil and venetian blinds reoccurring across the design to provide solar shading.

1.3 Responsible project participants

Architect	Sarah Lewis, Hamson Barron Smith http://www.hamsonbarronsmith.com
Implementation planning	Richard Smith, NPS http://www.nps.co.uk
Building systems	NPS with MVHR design by Greenwood http://www.nps.co.uk / http://www.greenwood.co.uk
Structural engineering	Robson Liddle, NPS Group http://www.nps.co.uk
Building physics	Sarah Lewis, Hamson Barron Smith http://www.hamsonbarronsmith.com
Passive House project planning	Sarah Lewis, Hamson Barron Smith http://www.hamsonbarronsmith.com
Construction management	R G Carter – main contractor http://www.rgcarter-construction.co.uk/
Certifying body	WARM www.peterwarm.co.uk
Certification ID	5148 (www.passivehouse-database.org
Author of project documentation	Sarah Lewis, Hamson Barron Smith http://www.hamsonbarronsmith.com

Date, Signature/
13th March 2017

2 Views of development and elevations of Plot 3

Overall development (Photograph: Jefferson Smith)

South – with main entrance door (Photograph: Jefferson Smith)

East – not accessible as private garden

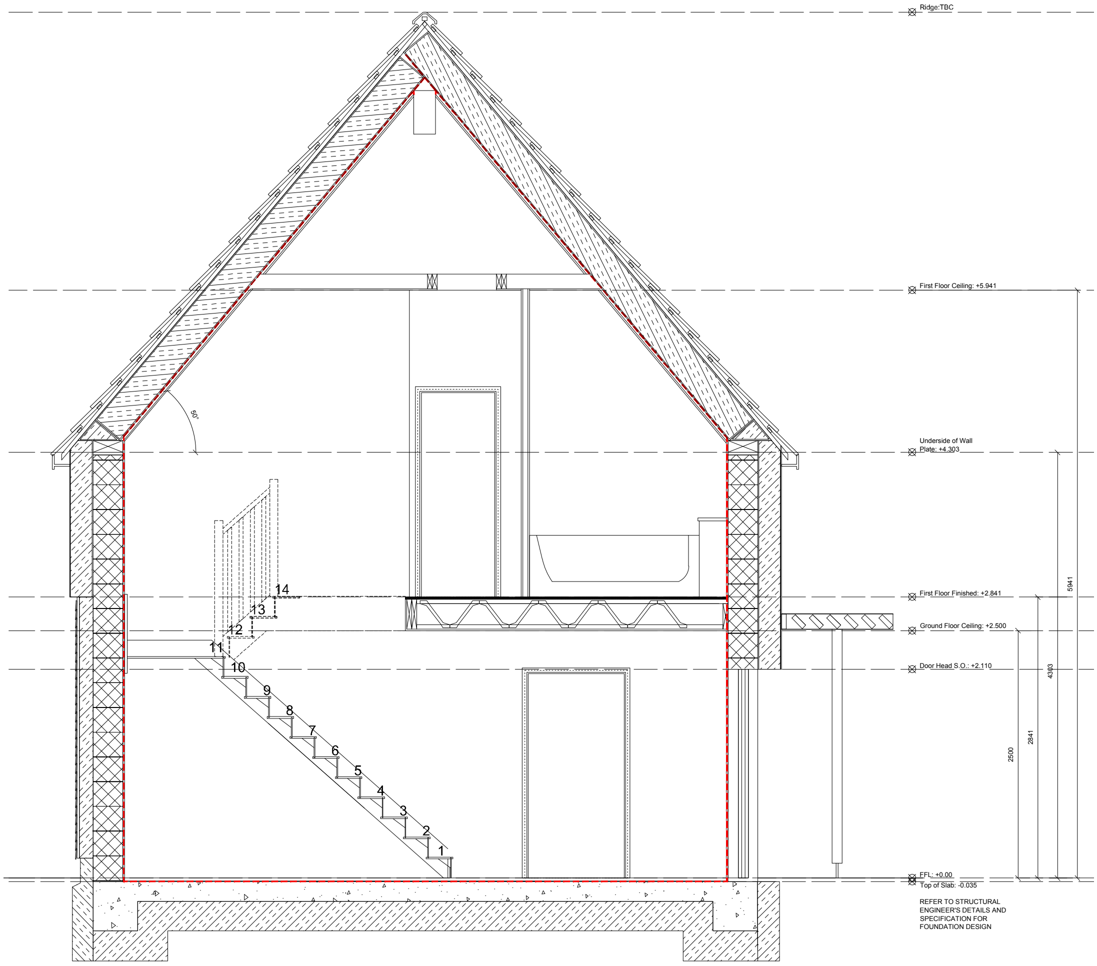
West – with first floor terrace from master bedroom (Photographs: Jefferson Smith)

North – limited fenestration, the MVHR outlets and electric meter are visible (Photograph: Sarah Lewis)

Interior view in living/dining room (Photograph: Jefferson Smith)

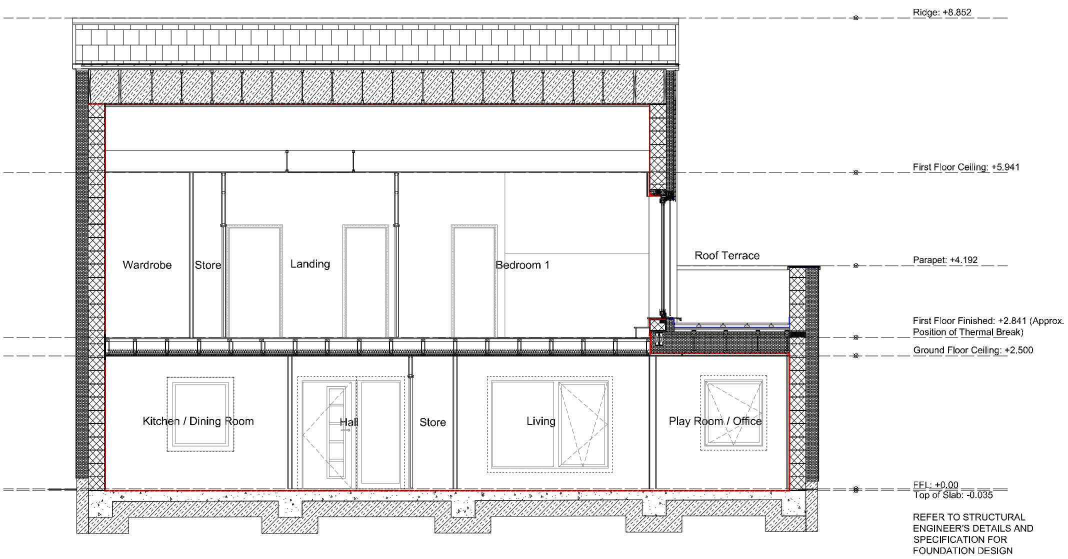
Interior view in children’s bedroom (Photograph: Jefferson Smith)

3 Sectional drawings of Plot 3



Section F

The continuous thermal envelope is clearly visible in this section. The load bearing walls are 300mm wide hollow clay blocks and bear directly onto the ground slab. There are two solutions for the wall insulation, where the facades are rendered the walls are insulated with a vapour open expanded polystyrene (EPS) insulation. Where the facades have timber cladding the walls are insulated with PUR insulation. The ground slab is floated over styrofoam insulation. At roof level the space between the I-joist rafters is filled with a blown recycled newspaper insulation.

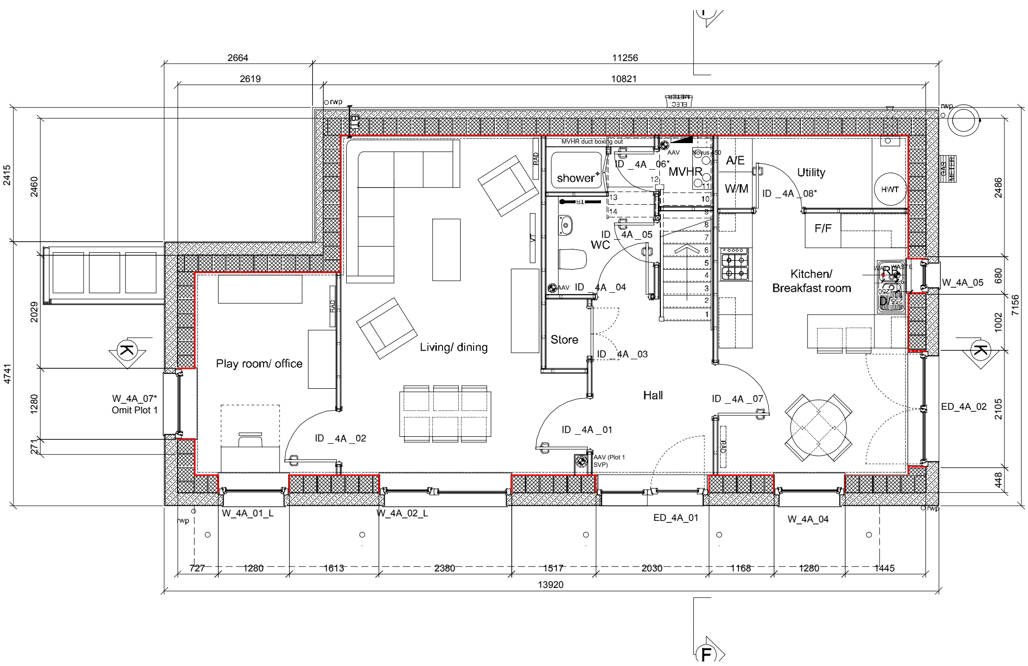


Section K

This section illustrates the ground beams, which were necessary due to the soil conditions on site. As shown the insulation layer is wrapped around these. In the PHPP files the additional area of the ground beams was noted on the Areas worksheet, rather than adding a thermal bridge factor.

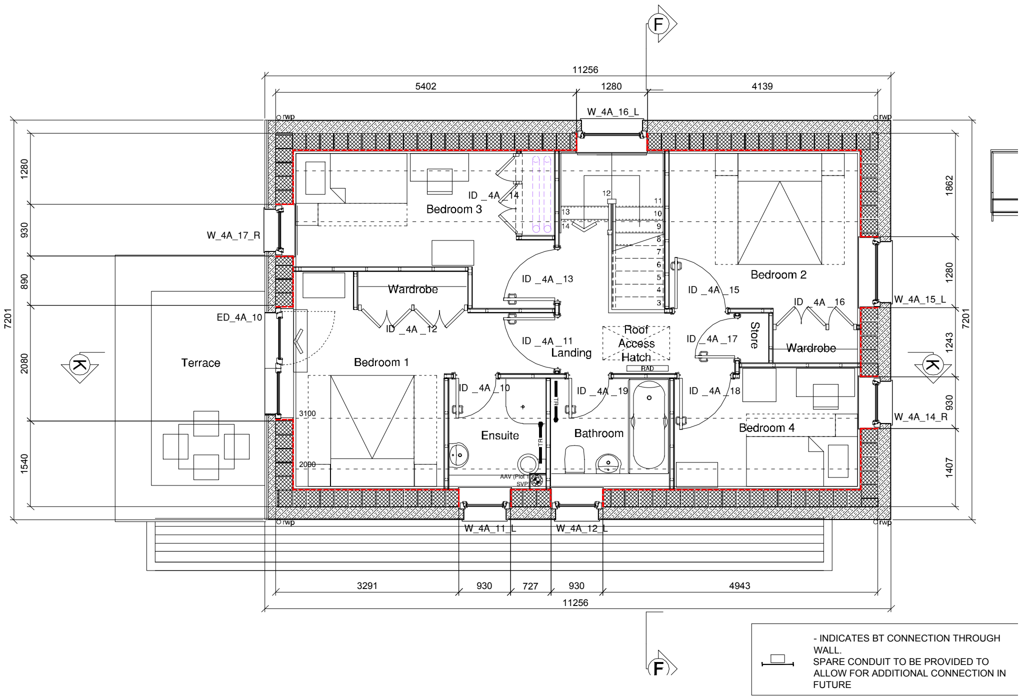
This section also shows how an insulating porous glass foam block was used to create a thermal break in the terrace balustrade. Further blocks were installed under all ground floor doors and the first floor terrace doors.

4 Floor Plans of Plot 3



Ground Floor Plan

The home is entered centrally to an entrance hall with the kitchen/ breakfast room to the east and the main living room and small study to the west. It is possible to convert the study into a single bedroom if necessary in the future, if one of the residents becomes unable to use the stairs. There is also a cloak cupboard in the entrance hall and a downstairs shower room. The MVHR unit is located in a cupboard in the shower room, which extends under the stair. The boiler and hot water tank are located in the utility room, accessed through the kitchen.

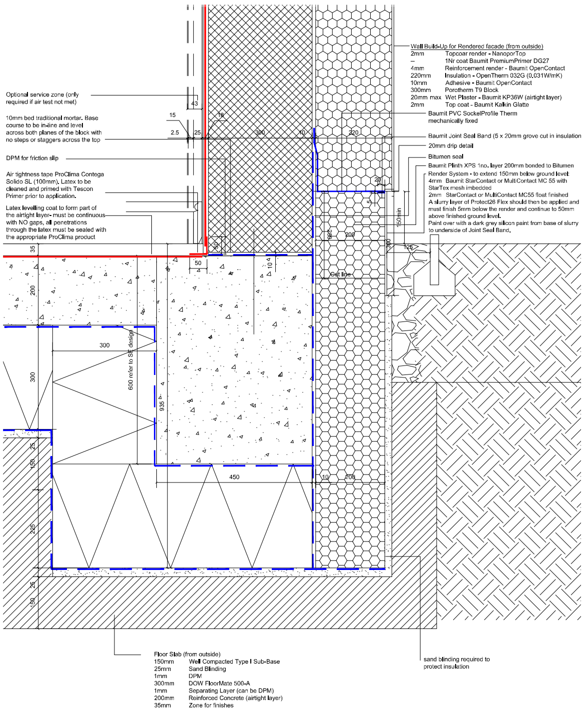


First Floor Plan

On the first floor there are four bedrooms, one family bathroom with a bath and shower and one ensuite with a shower. Three of the bedrooms have large built-in wardrobes and the mater bedroom has access to a private terrace. The ceiling on the first floor slopes as shown in section F.

5 Construction details of the envelope of Plot 3

5.1 Construction including insulation of the floor slab and walls



(left) Foundation and wall detail (right) Site photo of plinth insulation being cut and installed, below slab insulation partially visible and first layer of clay blocks installed

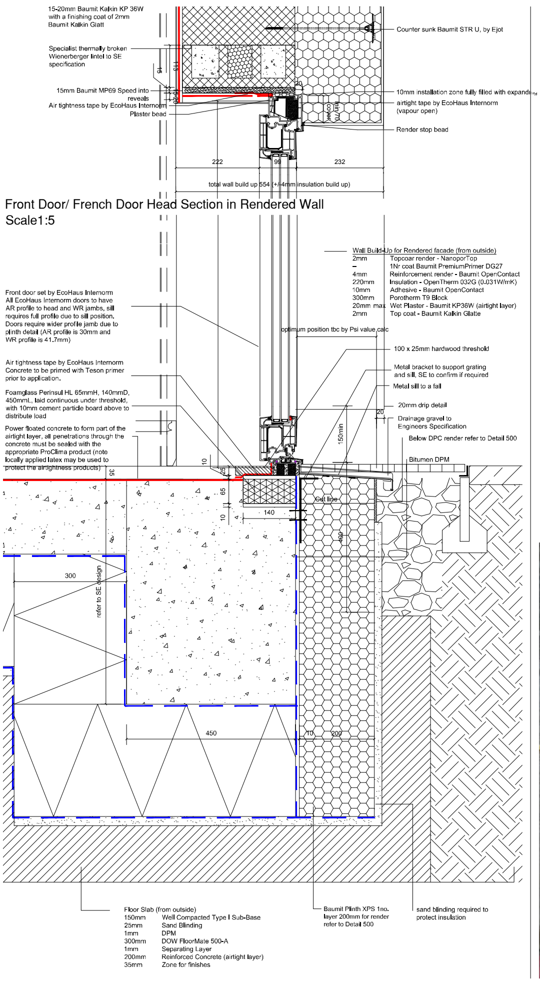
The foundation design was developed to address site-specific ground conditions. It was important to HBS that the slab float over the insulation to bring the thermal mass of the ground slab into the building. In addition, the load bearing clay walls were externally insulated with EPS insulation and by extending the insulation below ground level using an XPS product HBS was able to achieved a thermal bridge free foundation detail. The ground floor doors, both front doors and French doors, required a thermal break in the ground floor slab, see section 5.2.

It was a key design aspiration to achieve a fully breathable wall construction. This was made possible by pairing the clay blocks with a vapour open EPS insulation and lime plaster systems.

A driving force behind all of our detailing at HBS is making sure the airtightness layer is clearly identified and easy to construct with high quality products to ensure longevity. This layer and all of the airtightness products, which contribute to its continuity, are shown on all drawings in red.

Ground Floor build-up (from outside)	150mm well compacted sub-base, 25mm sand blinding, DPM, 300mm rigid insulation, separating layer, 250mm reinforced concrete, 30mm zone for floor finishes	U-value 0.112 W/(m²K)
Wall build-up **render** (from outside) Wall build-up **timber clad** (from outside	2mm finishing coat, 4mm reinforcement render, 220mm EPS insulation, 10mm adhesive, 300mm clay block, 20mm wet lime plaster, 2mm top coat Breather membrane, 2x70mm Insulation boards, 10mm adhesive, 300mm clay block, 20mm wet lime plaster, 2mm top coat	U-value 0.095 W/(m²K) U-value 0.100W/(m²K)

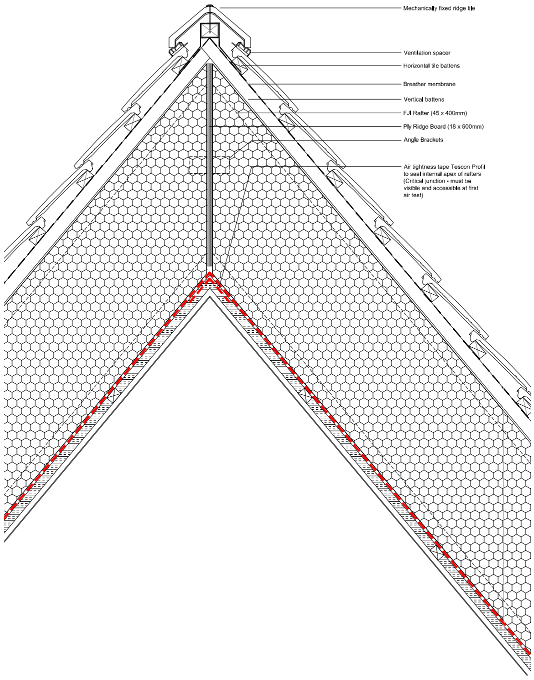
5.2 Construction around ground floor doors



(left) Ground floor door detail, (right) Site photo showing cut in slab for thermal break

This section and site photo show how an insulating porous glass foam block was used to create a thermal break under the ground floor doors.

5.3 Construction including insulation of the roof



(left) Ridge detail

(right) Site photo showing rafters in place

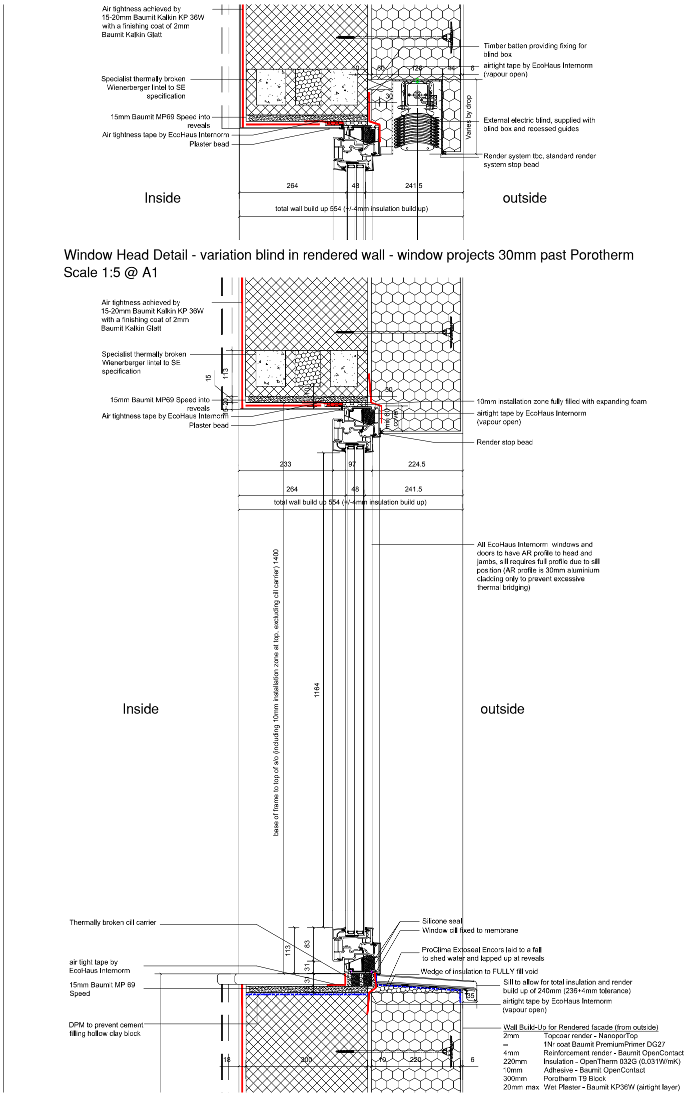
The timber used in the roof construction is 100% traceable wood from sustainable northern forests, which fit with the overall sustainable and ethical ambitions of the project. The design was developed using a laminated timber beam for the purlins. Combined with I-Beam rafters, manufactured from high quality oriented strand board (OSB3) web. This system allowed the roofs to create the depth required for the Passivhaus U-value, the roof was filled with blown recycled newspaper insulation. One of the challenges of blown insulation can be ensuring the full extents of all voids are filled. Thermography was used on the first roof to identify if there were any areas missed. In this instance the thermography did not identify any areas for rectification.

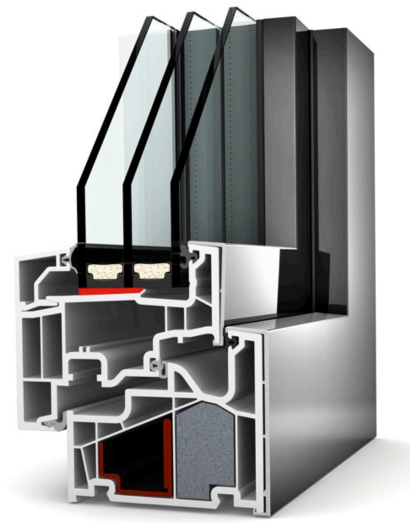
The airtightness layer was installed as an OSB3 board, with taped joints. Special care was required to ensure a good connection from the OSB boards back to the clay block walls, ProClima airtightness products were used throughout.

Sloping roof build-up	Breather membrane, 11mm OSB board, 400mm I-joist filled with recycled newspaper blown insulation, 18mm OSB board, mineral wool	U-value 0.092 W/(m²K)

(from outside)	between 25mm timber battens, 12.5mm plasterboard and 2.5mm skim finish.	

5.4 Window sections including installation drawing





(left) Window installation detail

(right) Triple glazing used – Internorm KF410

A high quality triple glazed window was selected for the project to ensure that the interior surface temperatures do not fall below ca. 17°C.

Windows are all Internorm KF410 (values on next page)

Window Data	Glazing standard- 3N2 Lux Glass g-Value 0.62 Ug-Value 0.51W/(m^{2}K) Glazing Laminated- Lam Lux Glass g-Value 0.59 Ug-Value 0.54W/(m^{2}K) Frames- KF410 Uf-Value 0.85 W/(m^{2}K) all sides Frame width 113mm opening, 76mm fixed Spacer Psi values- 0.031 W/(mK) Installation Psi values range 0.011-0.109W/(mK), higher values relate to windows with external blind boxes	Average window U-value - 0.77W/(m²K)

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

On the external walls – The airtightness layer was the internal 20mm lime parge coat. A finishing 2mm topcoat was installed over this after the first air test. Special coordination was necessary to make sure that the airtightness layer was completed as early as possible, so that the first air test could be completed before any of the areas contributing to the airtightness layer were concealed.

A special detail was developed to ensure the integrity of the airtightness layer around the wall hangers for the first floor joists, see photos below.

At roof level - The airtightness layer was installed as an OSB3 board, with taped joints. The contractor assigned a site based airtightness champion, who took on this role with great enthusiasm and dedication and played a key role, along with the site foreman, in the excellent air pressure tests on all of the homes. Special care was required to ensure a good connection from the OSB boards back to the clay block walls, ProClima airtightness products were used throughout. Photo of the taped OSB ceiling boards below.

At floor slab level – the airtightness was the ground slab, with tapes connecting this to the clay walls, which were then coated in the lime parge coat on the walls. Levelling latex was installed locally along the perimeter of the slab to protect the tapes. This was important as the new occupants arranged for the floor finishes to be installed, the latex prevented this tape becoming damaged before the floors were in place. All penetrations through the slab were sealed with airtightness grommets.

Photo showing taping of windows/ doors above

Results of pressure test (average of pressurisation and depressurisation):

Plot number	Date of test	Test Result (ACH @50Pa)
1	9th August 2016	0.3466
2	9th August 2016	0.3733
3 (house in this report) Further details below table	9th August 2016	0.5395

4	9th August 2016	0.4189
5	9th August 2016	0.3996
6	9th August 2016	0.5715
7	9th August 2016	0.4728
8	9th August 2016	0.3640
9	24th August 2016	0.5147
10	24th August 2016	0.5421
11	24th August 2016	0.5503
12	24th August 2016	0.5990
13	24th August 2016	0.5343
14	24th August 2016	0.5218

Plot 3 air test further details:

Pressurisation result – 0.533

Depressurisation result- 0.546

Average result (as noted in the above table) - 0.5395

Organisation carrying out the pressure testing - Anglia Air Testing (ATTMA registered)

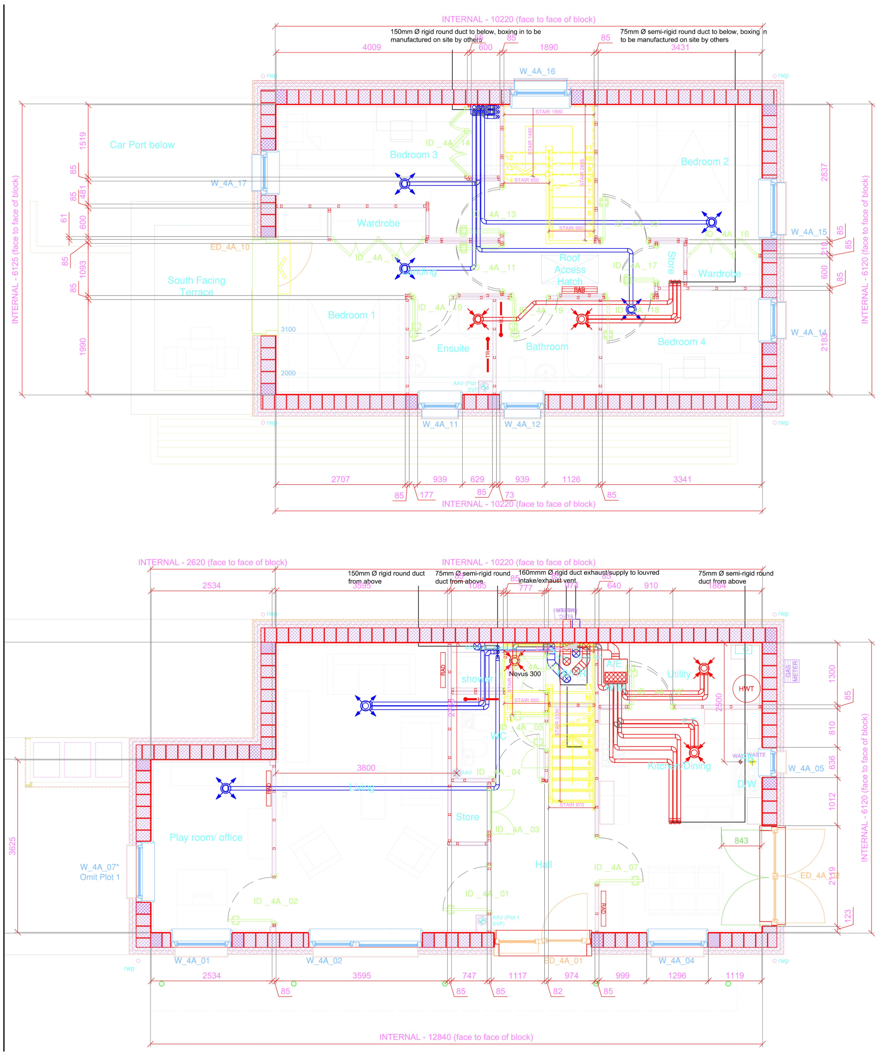
7 Planning of ventilation ductwork

In order to greatly reduce the ventilation losses, a balanced supply air/extract system was designed and installed.

The heat recovery rate of the PHI certified unit is 93%, and taking into account the length and insulation of the supply and extract ducts in the PHPP, a calculated in-use efficiency of 89.8% should be achieved.

Go to ventilation units list Sortierung: WIE LISTE	Heat recovery efficiency	Humidity recovery efficiency	Specific efficiency [Wh/m³]	Application [m³/h]	Frost power input
0302vs03 novus 300 - PAUL	**0.93**	**0.00**	**0.24**	**121 - 231**	**yes**

The image above is a summary of the MVHR unit specification from the PHPP



Ductwork layouts, (top) first floor layout (bottom) ground floor layout

Supply air rooms include all main living areas (above in blue: supply air duct): ground floor study and living room and first floor bedrooms.

Extract air rooms (above in red: extract air ducts) ground floor kitchen, utility and shower room and first floor bathrooms

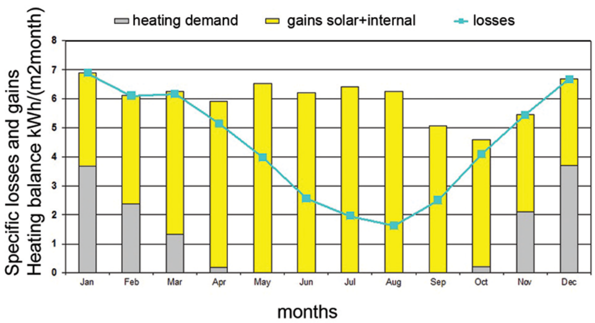
Installation Photo

8 Heat supply

A traditional gas condensing boiler is used to supply heating and hot water (DHW). There is a hot water storage tank in the utility room adjacent to the boiler.

Installation Photo in the utility room

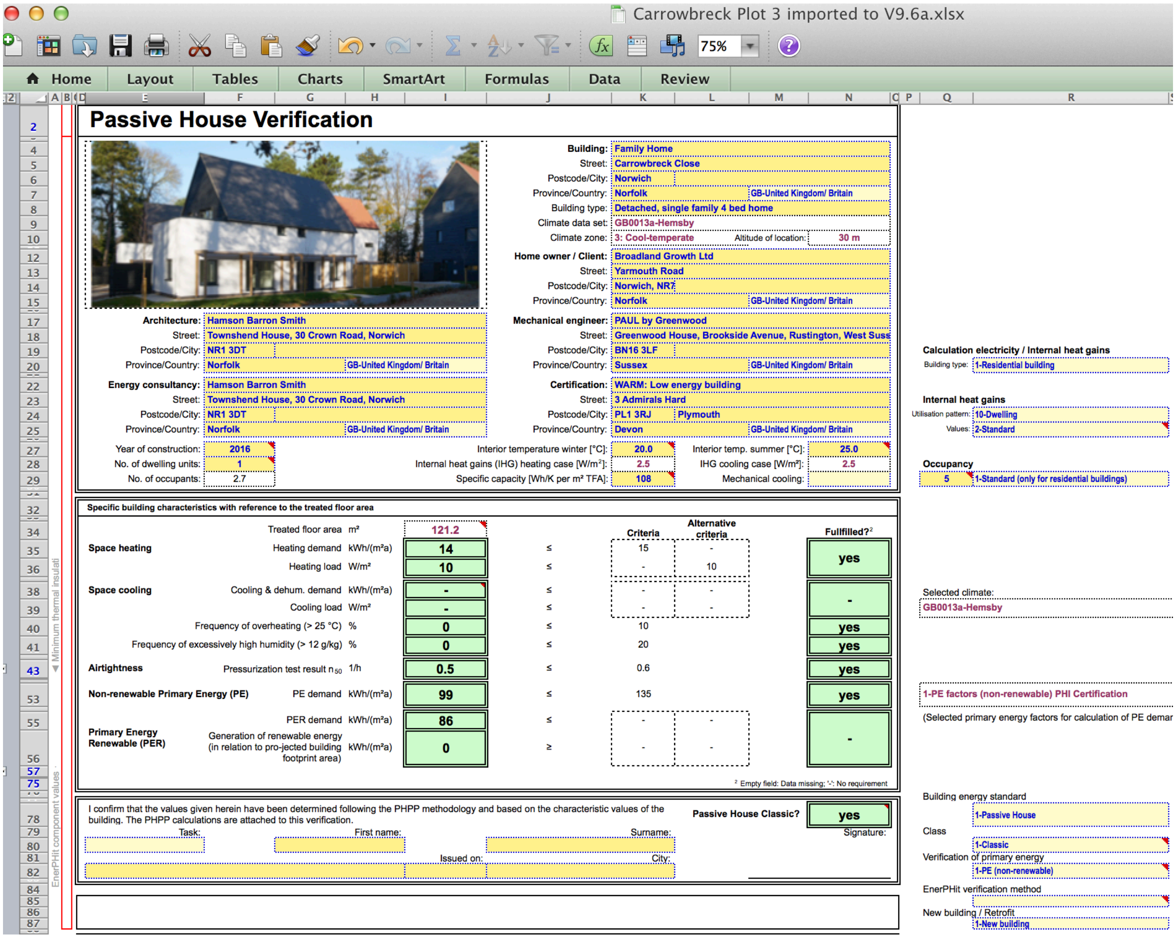
There are radiators located in the kitchen/breakfast room, living room, study and first floor landing.



Heating Balance graph from PHPP
Shows very low heating demand eliminating fuel poverty

9 PHPP calculations

The Passive House Planning Package (PHPP)



10 Construction costs

Total construction contract for this development of 14 homes including all landscaping, construction, fit-out and associated works £2.8m. More detailed costing is confidential.

11 On going Monitoring

Hamson Barron Smith are providing full Soft Landings on this project and have installed enhanced web based monitoring in one of the homes to monitor comfort and energy parameters. Occupant surveys are also being conducted at intervals to better understand how the occupants are using their homes and gauge their perceptions regarding living in their Passivhaus homes.

Satisfied end user testimonials:

"We chose Carrowbreck Meadow as it was set in a lovely woodland environment and built to Passivhaus standards. It's aesthetically pleasing, modern, and a very spacious family home."

New resident

"The air quality in the house is in general amazing…we all now have amazingly wonderful sleeps at night which we believe is due to the air quality. The consistent temperature of this house is perfect."

Shared equity purchaser

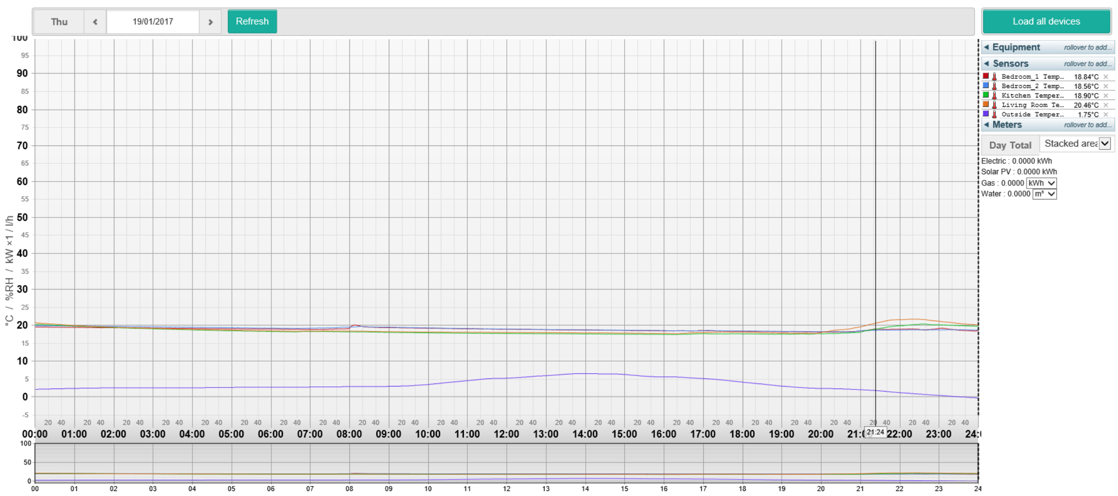
"We both absolutely love the house and the surrounding area set in the woodland. We're sure our daughter (now 11 weeks old already!) will love growing up here."

Shared equity purchaser

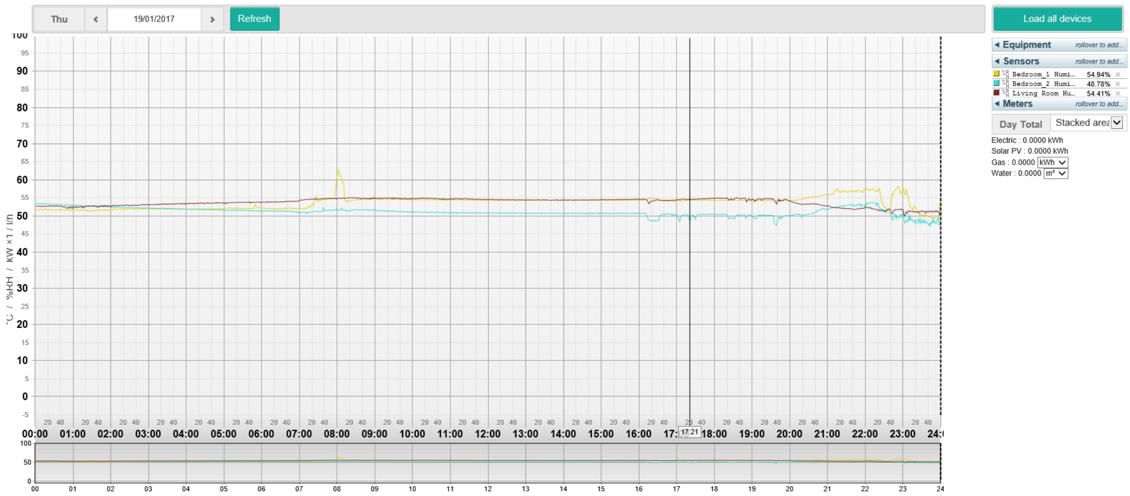
"Yesterday I received my first gas bill -for the period 4 October to 26 November, total charges are £14.88!…So far -very happy with the cost of heating."

New resident

Sample data collected in January 2017:



Temperature Graph from one of the homes showing the internal and external temperature profile over a 24hr period – outside temperatures hover around 5°C, while internal temperatures maintain an almost constant 20-21°C in the bedrooms, living room and kitchen



Humidity Graph from one of the homes showing the MVHR is maintaining a perfect indoor environment for the occupants- humidity is generally within 45-56%, well within the best practice range of 40-60%.

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