Passivhaus Project Documentation

Step by step refurbishment to Enerphit Standard

4, Bowman's Lea, London, UK

Abstract

Single family, mid-terraced four bedroom home in London, England

Building data

Year of Construction	1978	Space Heating	**22** kWh/(m²a)
Year of start of Enerphit	2016		
Year of Pre Certification	2018		
Year of Completion	2023	Heating Load	12.9 W/m²
U-Value external wall	0.284 W/(m2K)	Primary Energy Demand	85.5 kWh/(m²a)
U-Value floor	0.387 W/(m2K)	Treated Floor Area	97.1 m²
U-Value roof	0.119 W/(m²K)	Heat Recovery Efficiency	81.9%
U-Value window	0.842 W/(m²K)	Air Leakage Audit (2018)	n_{50} = c.1.0 h^{-1}
Special Features	First Step by Step retrofit project in UK with emphasis on health and wellbeing and resource efficiency in specification and construction processes.		

Harry Paticas
Architect, RIBA, ARB, Certified Passivhaus Designer,
Retrofit Action for Tomorrow (RAFT)

1.0 Brief description

The project is a whole-house deep retrofit of a 1978 mid-terrace townhouse and is the first certified step-by-step EnerPHit retrofit in the UK. The 3 storey property was purchased in 2016 though only a very small budget was available to carry out building work. The first step in the phased renovation was completed in May 2018 with a resulting reduction in the space heat demand of 53%. The building work on the project has been largely carried out by the architect Harry Paticas and has focussed on exploring the complexity and difficulty of step-by-step retrofit, on learning by doing as a way of informing best building practice, on specifying materials with low embodied carbon, on reducing construction waste, and on improving indoor air quality.

This purpose of this report is to provide documentation of the works carried out for the Step by Step refurbishment to Passivhaus Enerphit Standard of 4, Bowman's Lea. The refurbishment of the building started in July 2016 with the following steps carried out over time. The items in italics are planned future works as outlined in the (ERP) Enerphit Retrofit Plan.

Step 01: 2016
Jun 2016 - Purchase of existing house

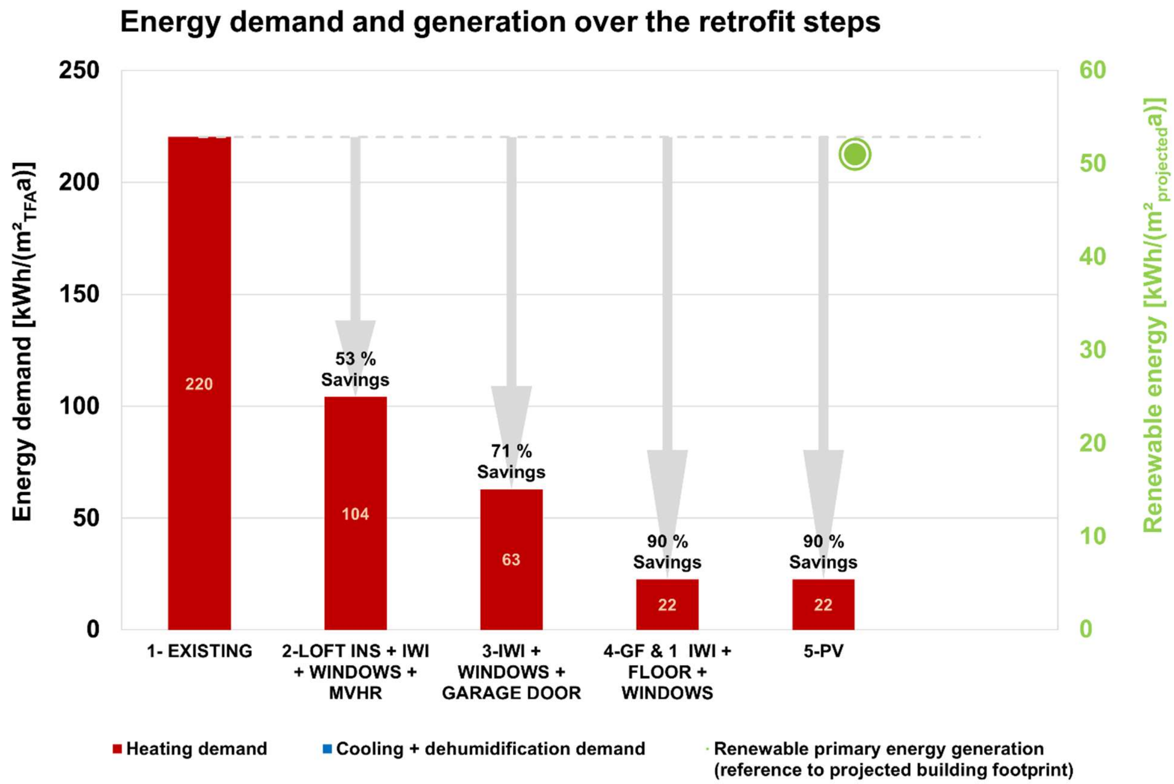
Step 02: 2016- 2017
Aug 2016 - Strip out
Aug 2016 - CWI to front and rear walls
Sep 2016 - Airtightness to loft and walls
Oct 2016 - Windows at front on 1st and 2nd floors
Oct 2016 - Fakro loft hatch added
Oct 2016 - Insulation to loft
Oct 2016 - New boiler radiators and electrics installed
Nov 2016 - Family moved in
Dec 2016 - Porch wall insulated between studs
Jan-Dec 2017 - Airtightness measures and IWI to front wall

Step 03: 2017-2018
Nov 2017 - Windows to rear on 2nd floor
Dec 2017 - MVHR installation commenced
Mar 2018 - IWI to rear 2nd floor bedroom
Jun 2018 - MVHR commissioned
Jul 2018 - Registraion for Step-by-Step Enerphit
final 40mm IWI layer to to 2nd floor bedroom
temporary IWI Insulation to garage door and wall
EWI to porch ceiling
Additional insulated panel above loft hatch

Step 04
Windows to rear 1st floor and ground floor
Window and door to front ground floor
Insulation to ground floor
IWI to rear 1st floor
IWI to party wall (neighbours garage)
EWI to planter ceiling
GF Porch wall insulation
IWI to exposed east brick wall

Step 05
PV installation

The retrofit steps to finally achieve the Enerphit standard are shown in the below diagram



1.1 Responsible project participants

Architect:	Harry Paticas
Structural Engineer:	Martin Long – Lawson Martin Long
Services:	Harry Paticas
Building Physics and PHPP:	Harry Paticas
Certifier:	Kym Mead (MEAD Ltd)
Project manager	
CDM Coordinator	
Certification body:	Passivhaus Institut, Darmstadt
Certification ID:	
Passive House Database ID,	ID: 5838
Author	Harry Paticas

2.0 Views of the Building

Front entrance elevation, site context facing east.

Front entrance elevation, site context facing west.

Front elevation facing south with larger windows. Bespoke external blinds are used in summer.

Rear elevation facing north prior to purchase and removal of ivy and leylandii tree.

Living room facing south. Black cork is the internal finish.

Bedroom window looking south.

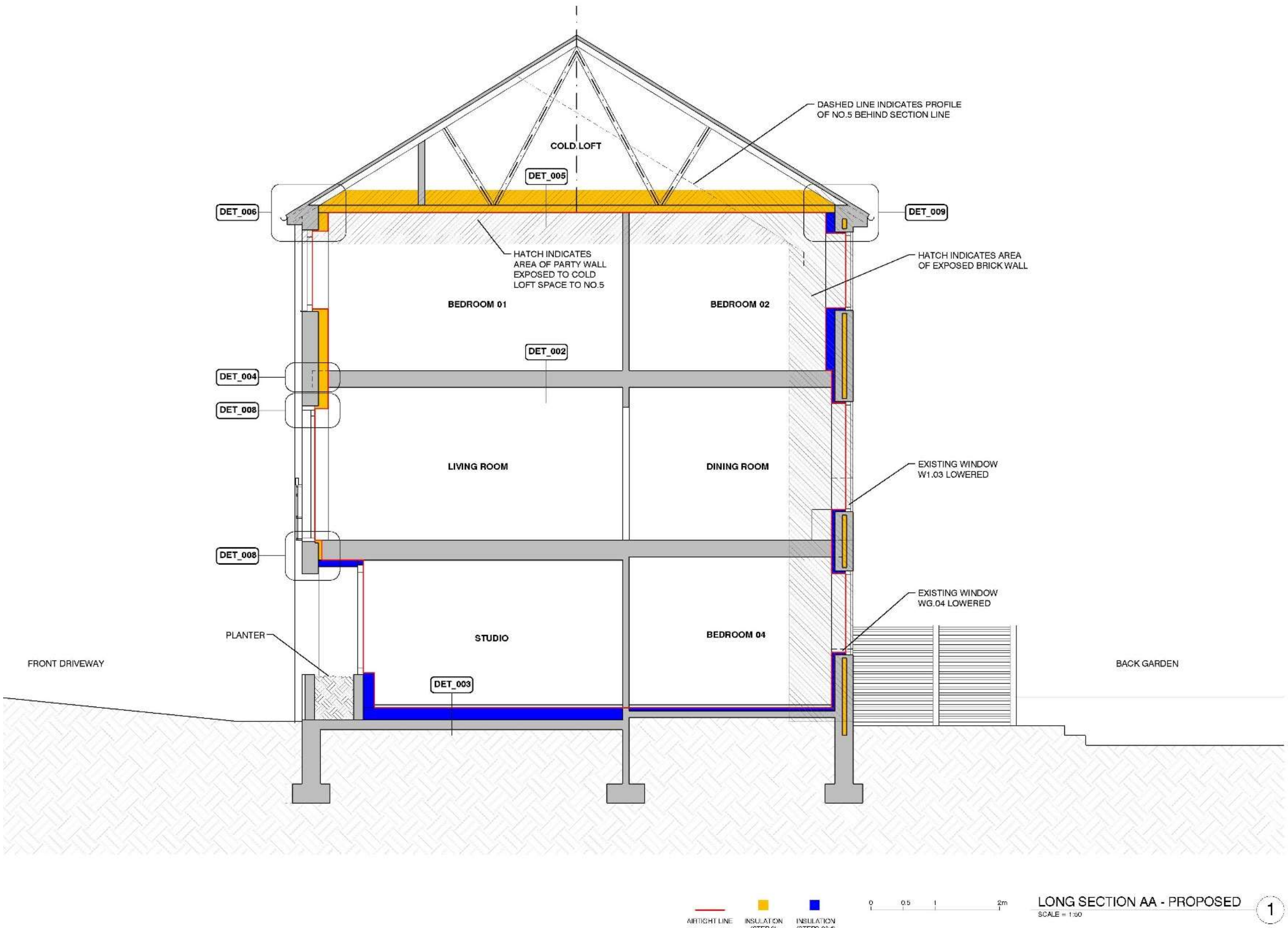
Cork Insulation being applied in living room.

IWI and airtightness.

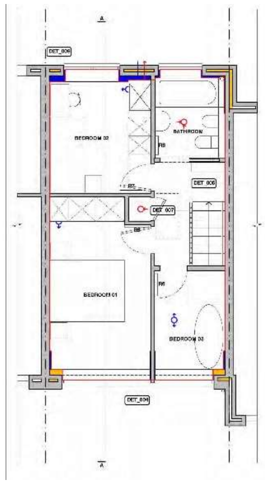
Further interior views, showing the application of cork IWI and the airtightness tapes being applied.

3.0 Sectional drawing

This typical section, this shows the continuous layer of insulation around the building,and the air tightness layer on the inside in red.

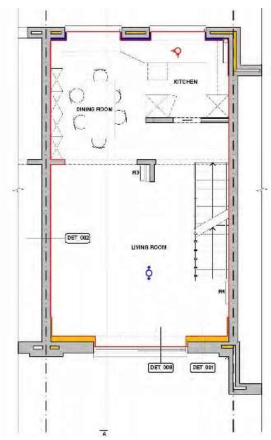


4.0 Floor plans



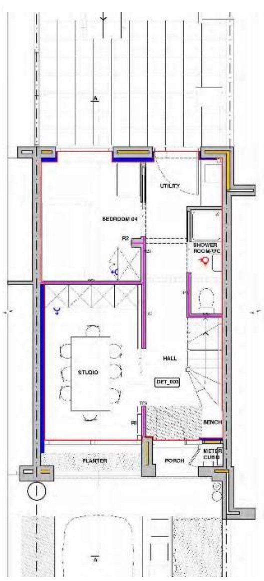
Second Floor Plan

The second floor provides 3 bedrooms, storage and shower room. The rear bedroom also contains the MVHR unit with intake and extract through the wall.



First Floor Plan

The first floor has the living room, dining room and the kitchen. The living room has the larger south facing Juliet balcony and the kitchen and dining area have smaller windows facing north.

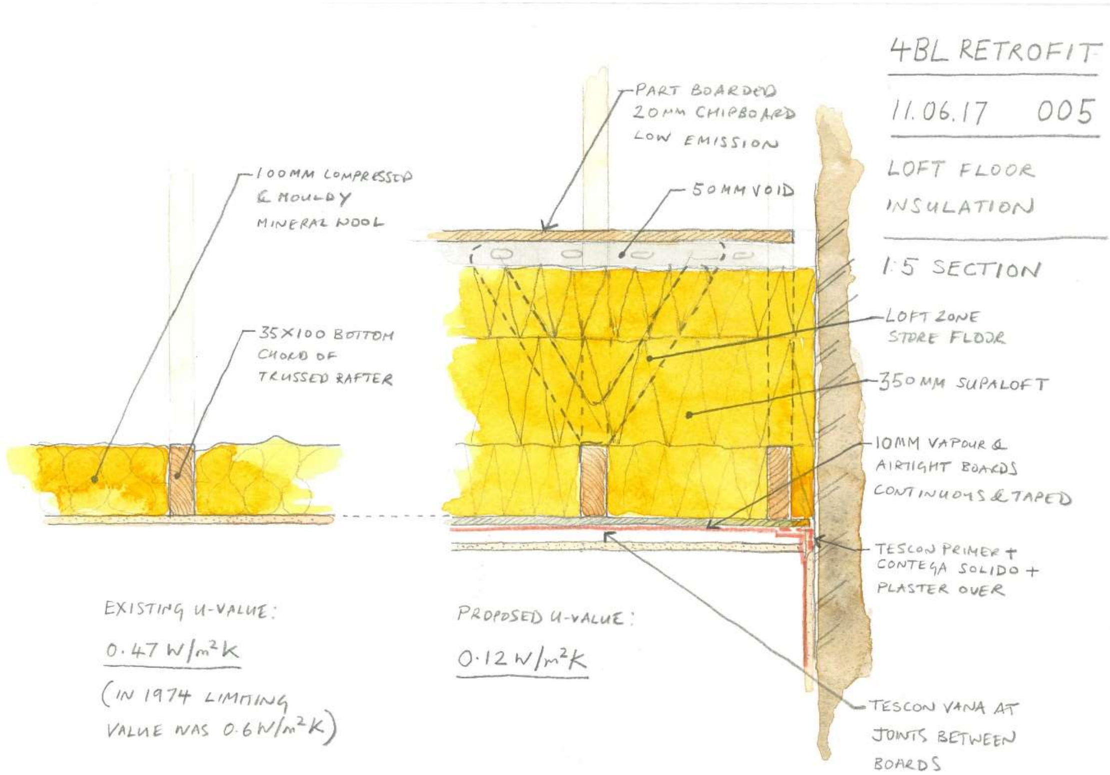


Ground Floor Plan

The ground floor plan contains studio space, a further bedroom and bathroom and a utility area. The studio space in the former garage is set back in line with the entrance with a planter at the front of the house.

5.0 Description of the construction

5.1 Loft Insulation (Completed)



The existing loft has 100mm of mineral wool installed in between the timber rafters. Another 250mm of Supaloft is added on top by raising the loft floor. Airtightness is provided by vapourblock airtightness board taped at joints.

Installation of supaloft insulation between rafters with subsequent layers added at 90 degrees

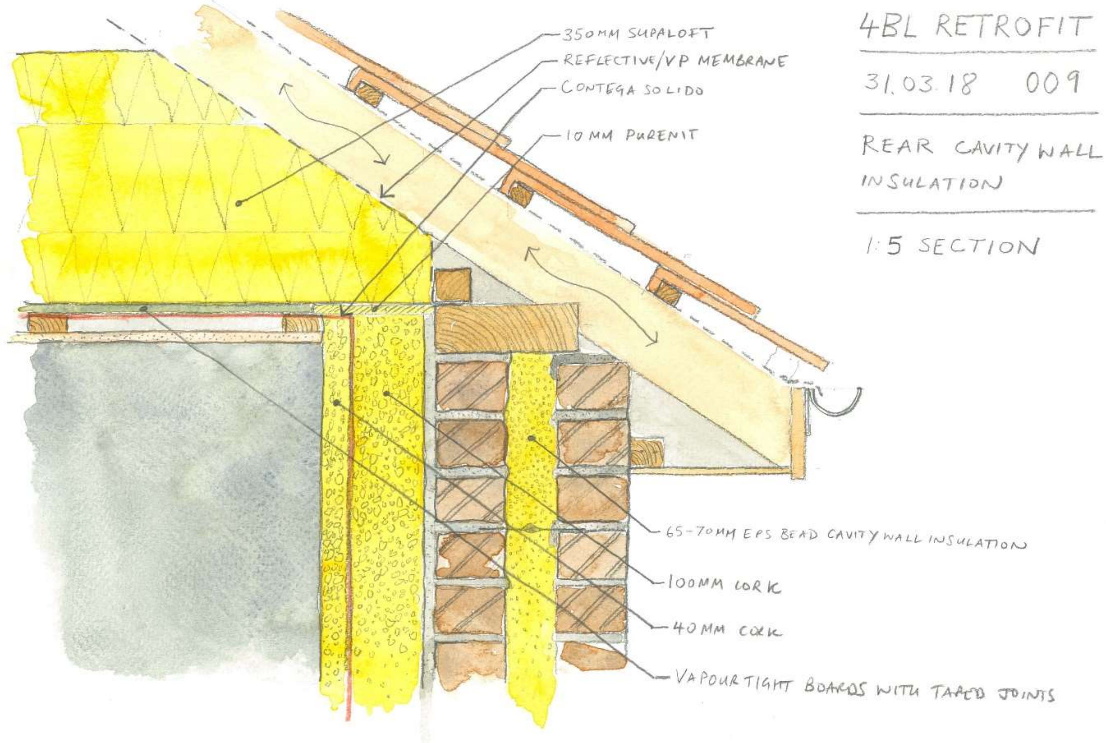
Vapour block board with taped joints

Construction Build up:

Chipboard	20mm
Void	50mm
Supaloft Insulation	350mm
Vapourblock	10mm
Void	20mm
Plasterboard	13mm

U-value = 0.12 W/(m²K)

5.2 Exterior walls rear (Completed)

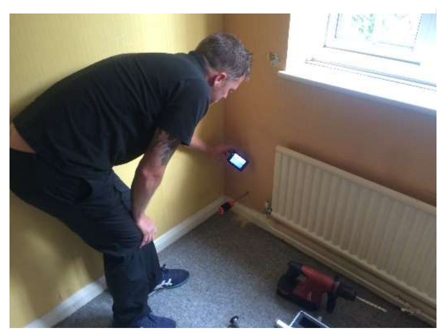


The existing external walls are cavity walls with uninsulated cavities. In the first step of retrofit these were filled with blown EPS bead insulation. The walls have received further IWI of 140mm cork insulation.

CWI

Typical Construction Build up:

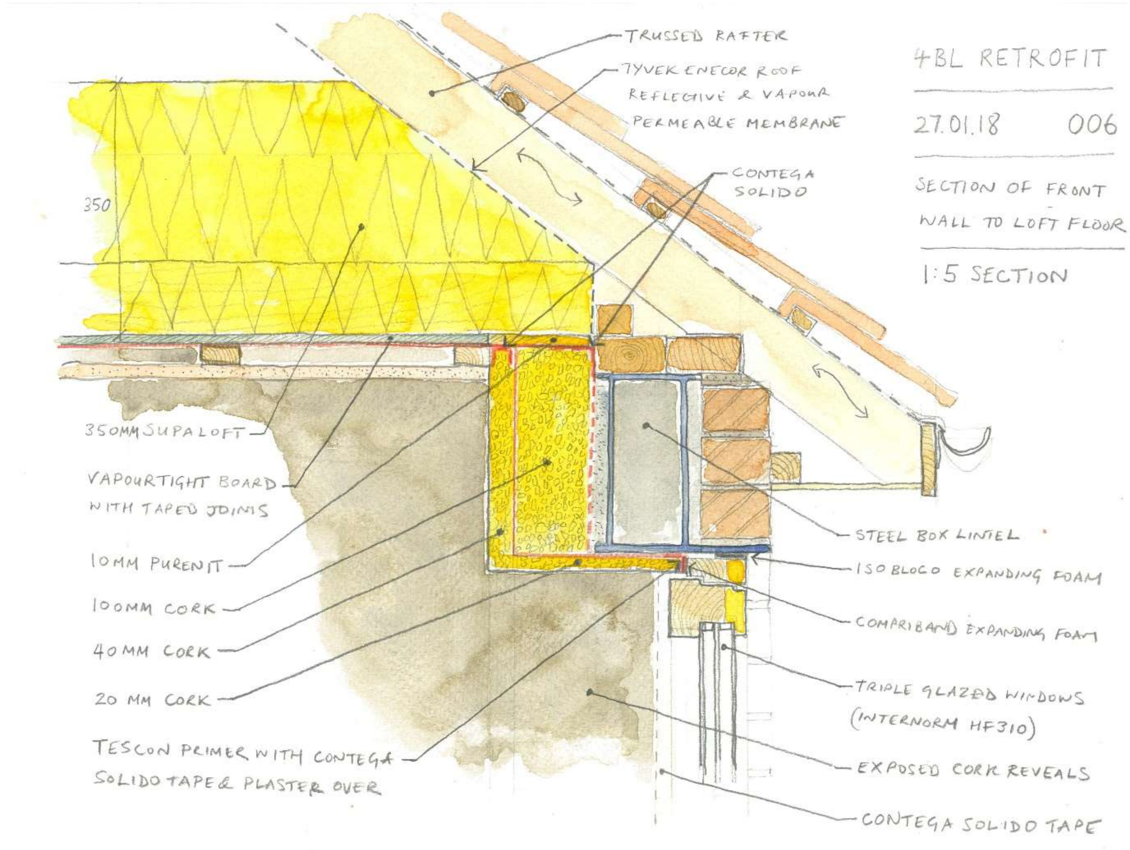
Brick	103 mm
CWI EPS bead	60 mm
Block	100 mm
Plaster	15 mm
Adhervit plaster	6 mm
Cork IWI	100 mm
Adhervit plaster	3 mm
Cork IWI	40 mm



CWI Inspection

U-value = 0.169 W/(m²K)

5.3 Exterior walls front (Completed)



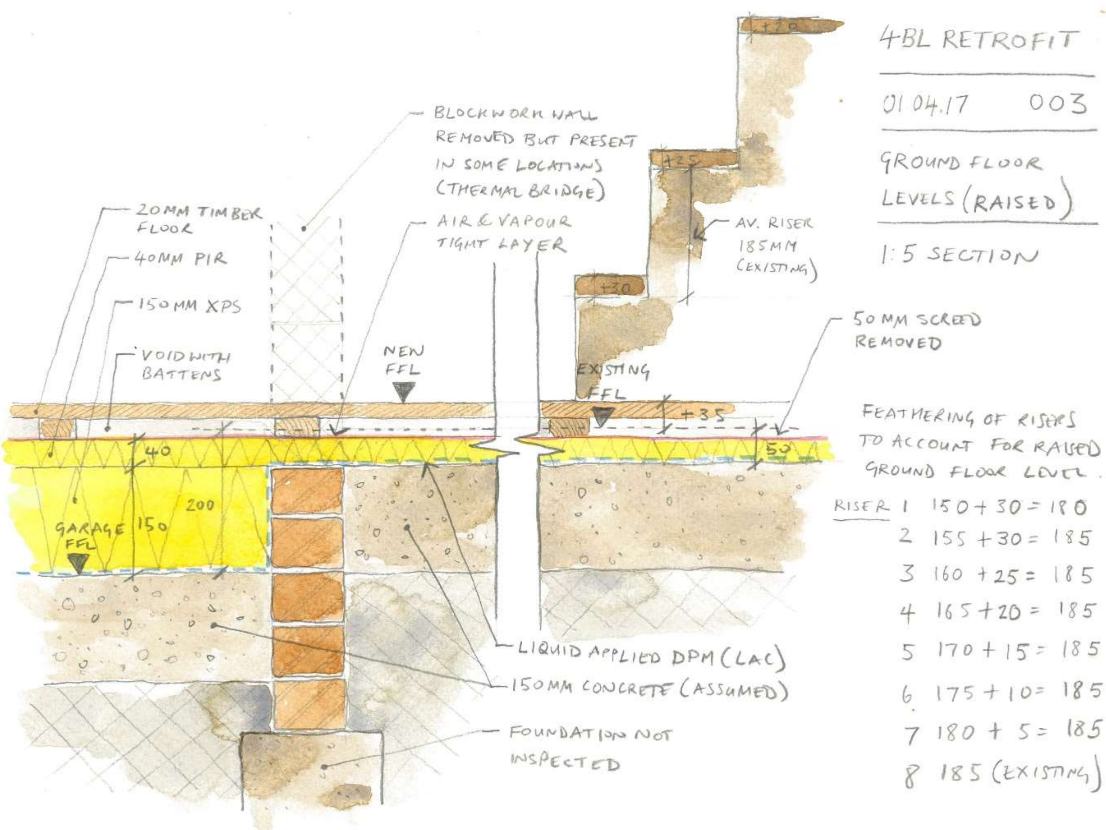
The existing external walls are cavity walls with uninsulated cavities. In the first step of retrofit these were filled with blown EPS bead insulation. The walls have received further IWI of 140mm cork insulation.

Typical Construction Build up:

Brick	215 mm
CWI EPS Beads	60 mm
Block	100 mm
Plaster	15mm
Adhervit plaster	6 mm
Cork	100 mm
Adhervit plaster	3 mm
Cork	40 mm

U-value = 0.171 W/(m²K)

5.4 **Garage Floor** (to be carried out in Step 3)



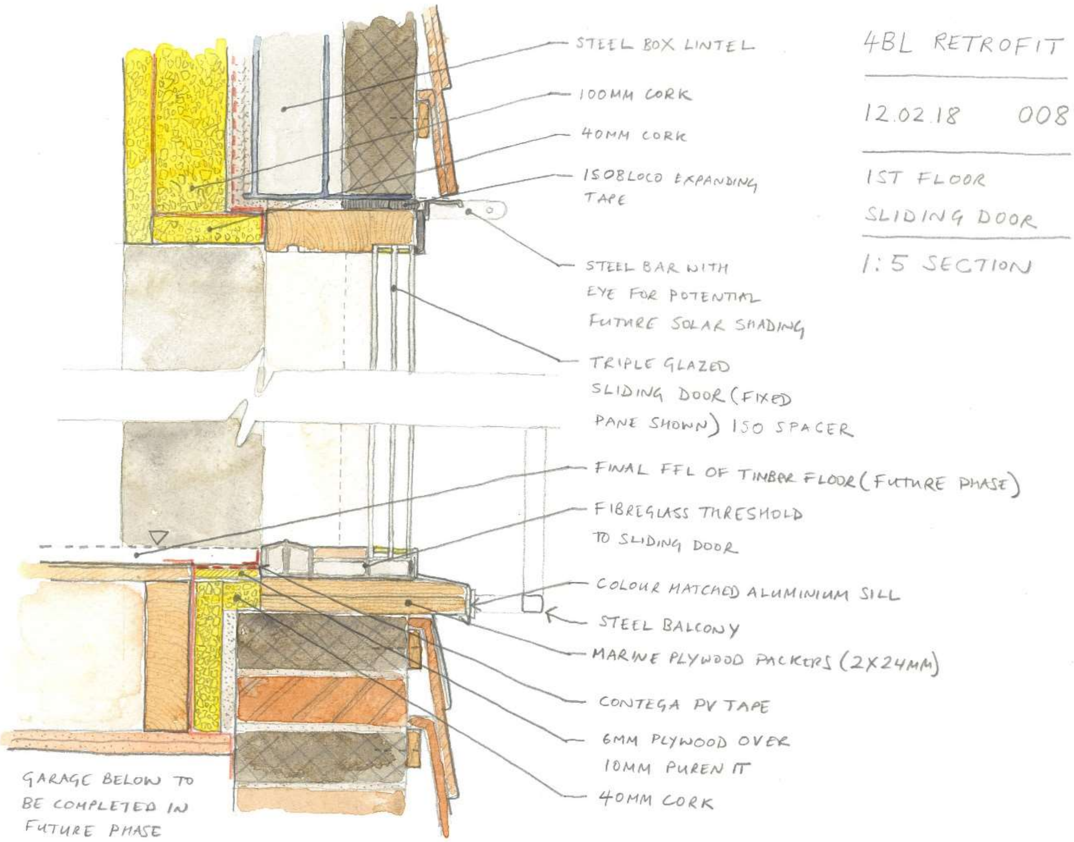
There is a level difference between the garage floor and the hallway/rear bedroom on ground floor. Hence the floor build up in the rear bedroom and the garage space at the front is different as shown above in the detail sketch above. The existing structure is assumed to be 150mm concrete. The garage floor will be raised with 150 mm XPS insulation. There will be 40 mm PIR insulation on top of this through out the ground floor. *Since the pre-certification was submitted these specifications have been changed to reduce off-gassing and fire risk to become 80mm XPS with an insulating screed and 20mm aerogel blanket insulation.*

Typical Construction Build up (revised as per above :

Rubber tiles	3 mm
Plywood	12 mm
Aerogel blanket	20 mm
Diathonite screed	50 mm
XPS	80mm
Concrete	150 mm

U-value = 0.187 W/(m²K)

5.5 Windows & Sliding doors



The windows selected for this project were the Internorm HF310 and HF330 with thermally broken frames, the U value of the frame was 0.86 W/(m²K). The Ug is 0.50 W/m²K with a g value of 0.50.

The windows selected open to the inside. The reveals have been insulated on the inside, reducing the area of visible frame and consequential heat losses considerably. Internal comfort around the windows is high enabling siting and reading by them even on the coldest days.

The overall average U value for the windows was 0.842 W/(m²K).

Tripple glazed Internorm sliding door and cork IWI on the reveals

6.0 Airtight envelope

Summary of airtightness measures carried out so far:

Airtightness to front elevation: (see 4BL_004)
• 10-15mm lime plaster on masonry wall (wind tightness)
• Plaster adhesive on inside face of 100mm cork internal wall insulation is the airtight layer – see attached drawing.
• All joists taped
• Junctions of insulation to walls and ceiling taped
• Timber dowel in orcon F to create airtightness between doubled-up joists into front wall

Airtightness to 2nd floor ceiling (see 4BL_005)
• continuous 10mm spanodurelis "vapourblock" boards with tescon taped joints and contega PV to edges
• vapourblock boards installed between top of existing blockwork walls and underside of existing rafters
• proclima grommets used for services penetrations
• Fakro LWT insulated and triple-sealed loft hatch taped to vapourblock boards

Insulation to 2nd floor ceiling
• 350mm suplaloft – u-value of 0.12W/m2K (from existing U=0.47)

Windows in front elevation:
• 1no. HS330 Internorm sliding door – Uw=0.73w/m2K
• 2no. HF310 windows – Uw=0.73w/m2K

An air leakage audit was carried out in early 2018 to check the effectiveness of the measures already implemented. The methodology and the results are documented in the Air Leakage Detection Report dated 21.01.18. The audit revealed that the majority of the measures implemented have been successful. It also highlighted a few isolated leaks that have since been rectified.

Airtightness products delivery

EPDM grommet in ceiling for single cable penetration

Vapourblock board delivery pre-installation

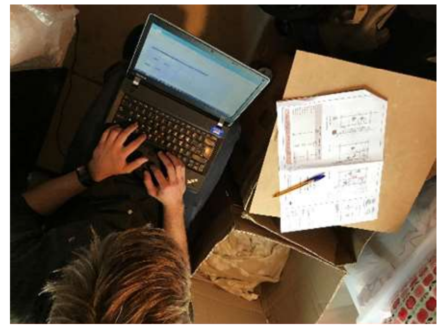
Airtightness of floor to front wall and sliding door: insertion of membrane and tape on outside face of joist with insulation between joist and brickwork

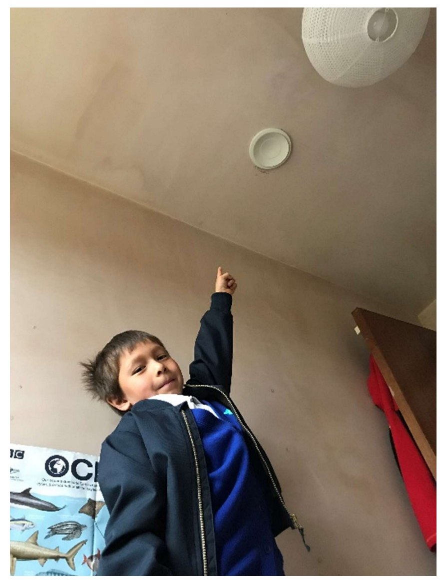
7.0 Ventilation System

7.1 Ventilation ductwork

The ventilation ductwork was designed in collaboration with Enhabit and installed by the author himself. Enhabit commissioned the system.







7.2 Ventilation Unit

Ventilation is provided by the Passivhaus Institute certified Zehnder, Comfoair 350. Located in a cupboard in the second floor rear bedroom.

This supply and extract heat recovery system, has an effective heat recovery efficiency of 81.9% and an electrical efficiency of 0.29Wh/m³.

The comfoair app states that the total energy savings to date (13.01.21) are 4341kWh.

8.0 Heat supply system

Heating is provided by a 35KW Vaillant Ecotec plus boiler fitted with vsmart self-learning and wireless weather compensating thermostat. It is planned that as soon as step 4 is complete with all fabric measures in place this will be replaced with direct electric infrared ceiling mounted panels and an electric immersion cylinder with a PV diverter.

9.0 PHPP Key results

The results of the PHPP show that it meets the EnerPHit requirements.

EnerPHit Verification (step-by-step)

calculated step:
4-GF & 1 IWI + FLOOR + WINDOWS

Building:	4		
Street:	Bowman's Lea		
Postcode/City:	SE23 3TL	London	
Province/Country:	London	GB-United Kingdom/ Brit	
Building type:	Mid-terrace townhouse		
Climate data set:	GB0003a-London Gatwick		
Climate zone:	3: Cool-temperate	Altitude of location:	67 m
Home owner / Client:	Harry Paticas & Xueli Chen		
Street:	4 Bowmans Lea		
Postcode/City:	SE23 3TL	London	
Province/Country:	London	GB-United Kingdom/ Brit	

Architecture:	Harry Paticas		**Mechanical engineer:**		
Street:	4 Bowmans Lea		Street:		
Postcode/City:	SE23 3TL	London	Postcode/City:		
Province/Country:	London	GB-United Kingdom/ Brit	Province/Country:		
Energy consultancy:	Harry Paticas		**Certification:**	MEAD: Energy & Architectural Design Ltd	
Street:	4 Bowmans Lea		Street:	3 Harvey Road	
Postcode/City:	SE23 3TL	London	Postcode/City:	N8 9PD	10-Dwelling
Province/Country:	London	GB-United Kingdom/ Brit	Province/Country:	London	GB-United Kingdom/ Brit

Year of construction:	1978	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]:	2.6	IHG cooling case [W/m²]:	2.6
No. of occupants:	2.3	Specific capacity [Wh/K per m² TFA]:	132	Mechanical cooling:	

Specific building characteristics with reference to the treated floor area

					Criteria	Alternative criteria	Fullfilled?[2]
	Treated floor area	m²	97.1				
Space heating	Heating demand	kWh/(m²a)	22	≤	25	-	yes
	Heating load	W/m²	13	≤	-	-	
Space cooling	Cooling & dehum. demand	kWh/(m²a)	-	≤	-	-	-
	Cooling load	W/m²	-	≤	-	-	
	Frequency of overheating (> 25 °C)	%	0	≤	10		yes
	Frequency of excessively high humidity (> 12 g/kg)	%	0	≤	20		yes
Airtightness	Pressurization test result n_{50}	1/h	1.0	≤	1.0		yes
Non-renewable Primary Energy (PE)	PE demand	kWh/(m²a)	97	≤	144		yes
Primary Energy Renewable (PER)	PER demand	kWh/(m²a)	85	≤	-	-	-
	Generation of renewable energy (in relation to projected building footprint	kWh/(m²a)	0	≥	-	-	

[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 Classic? yes

Task:	First name:	Surname:	Signature:
1-Designer	Harry	Paticas	
	Issued on:	City:	
	19.09.18	London	Harry Paticas

10.0 Construction Costs

The construction costs are summarised as follows:
Steps 1-3 (inc. PV) - £60k
Step 4 (inc. finishes, kitchen and WC) - £75k

11.0 Architect & Building Physics

The Architect and Building Physics consultant for the project is the author himself – Harry Paticas. Harry initially qualified as Passive House Designer in 2013. Harry also carried out the design and installation of the MVHR himself.

12.0 User satisfaction

The measured energy use after step 3 has resulted in an actual 58kWh/m^{2}a space heat demand which is under the 63kWh/m^{2}a as estimated by PHPP. This is underpinned by the comfortable internal temperatures and air quality that have been monitored through a wireless system (Omnisense Hygrotrac) with relative humidity in the range of 50-55%.

13.0 References

The project won both the ASBP Overall and People's Awards in 2019 and is currently listed on the UK Passivhaus Trust website.

- ASBP website: https://asbp.org.uk/awards-shortlist/bowmans-lea
- PHT website: https://www.passivhaustrust.org.uk/projects/detail/?cId=99

Harry Paticas has talked about the project at various conferences including the following:

- November 2018 – UK Passivhaus Trust Conference (Leeds)
- July 2019 – Wales Low Carbon Conference (Cardiff)
- February 2020 – ASBP Awards (London)
- February 2020 – Futurebuild (London)