

RIBA Publishing

marion baeli

residential retro fit

20 case studies

TITLE Session XII: EuroPHit – Step-by-Step Retrofits - Lessons learned from 20 UK retrofits

DATE 18.04.2015

paul davis + partners
architects urban designers



CONTENT:

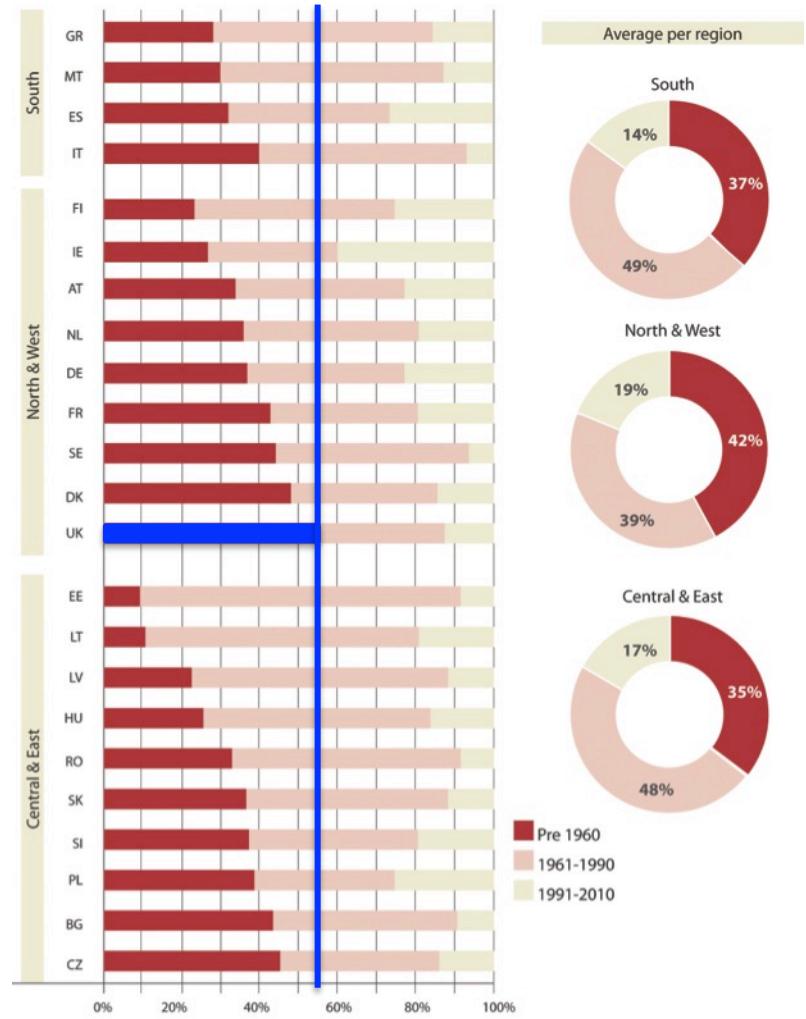
1. Introduction
2. Background to the programme
3. Book and main results
4. Case studies pre-1919 (Princedale, Midmoor)
5. Case study post-1919 (Penzance)
6. Airtightness

1. introduction



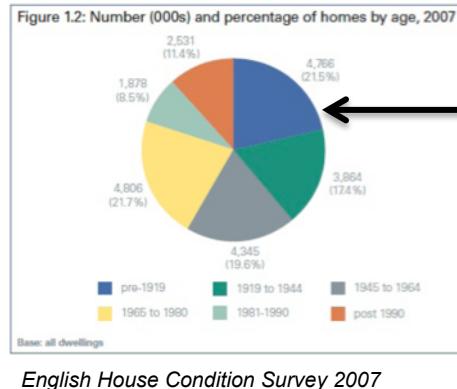
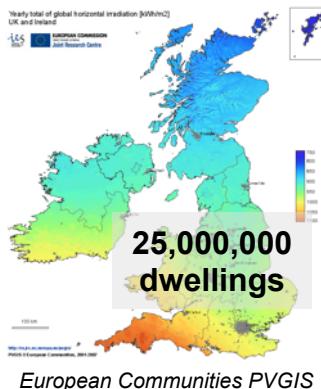
UK ageing stock

- Strong identity and cultural significance
- Not built with energy efficiency in mind
- One of the oldest in Europe with 55% of its dwellings dating from before 1960





UK ageing stock



21% of the stock
Dates from Pre-1919

That's 4.7 million houses...



dwelling age	mean energy use (kWh/m ² per year)	mean energy cost (£ per year) ⁽³⁾	mean CO ₂ emissions (tonnes/year)	all dwellings in group (000s)
pre-1919	480	853	9.0	4,766
1919-44	441	678	7.2	3,864
1945-64	410	598	6.2	4,345
1965-80	383	558	5.7	4,806
1981-90	359	508	5.1	1,878
post 1990	271	457	4.5	2,531

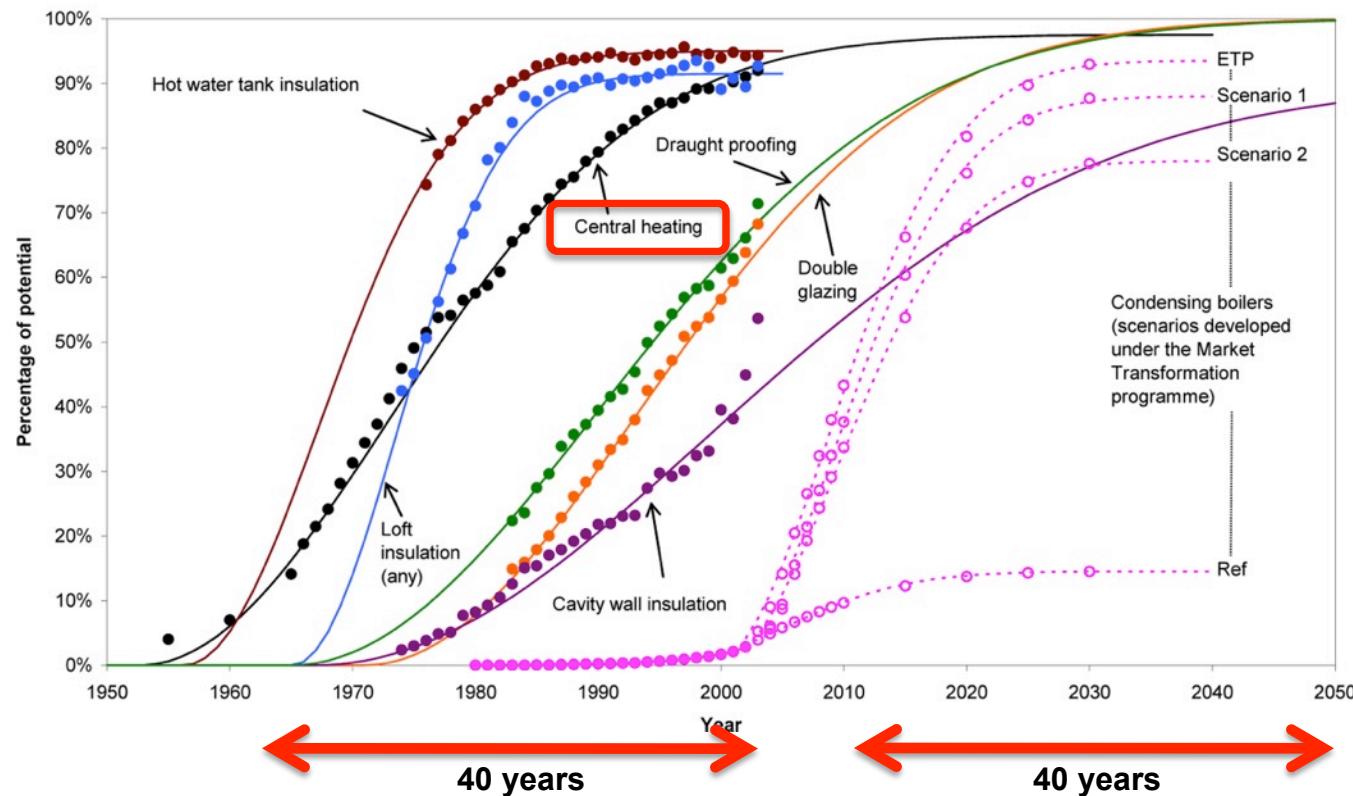
30% of total emissions from pre-1919 stock

480 kWh/m²/yr
9 t/yr



Is it feasible?

Figure 46. Market penetration of home energy-efficiency related measures



Carbon emission reductions from energy efficiency improvements to the UK housing stock BRE report BR435. 2001.

2. retrofit for the future programme

Initiative from: Small Business Research Initiative (SBRI)

With: Local Government – Homes and Community Agency

Delivered by: Technology Strategy Board





Programme:

- Launched in 2009
- 2 phase competition
- 100 projects have been completed
- £150,000 funding per dwelling



RftF Programme main targets:

- 80% reduction in CO₂ compared to 1990 emissions
- CO₂ emissions limited to 17 kg/m².yr [20 kg/m².yr for PHPP]
- Primary Energy limited to 115 kWh/m².yr [PassivHaus is 120kWh/m².yr]

RftF Programme comfort monitoring:

- Temperature
- Relative Humidity
- CO₂ concentration
- (Occupant interviews)



Programme official results:

www.retrofitanalysis.org

Technology Strategy Board
Driving Innovation

Retrofit Revealed

The Retrofit for the Future projects – data analysis report

The infographic features a grid of buildings at the top, each with a different color gradient (blue, purple, pink, grey, orange, red, green, blue, yellow, teal). Below the grid is a large, light blue square divided into a 4x4 grid. A small blue square is positioned in the second column of the second row from the bottom. To the right of the grid is a circular graph with concentric rings.

3. Book and main results

residential retrofits, 20 case studies

Technology Strategy Board
Driving Innovation

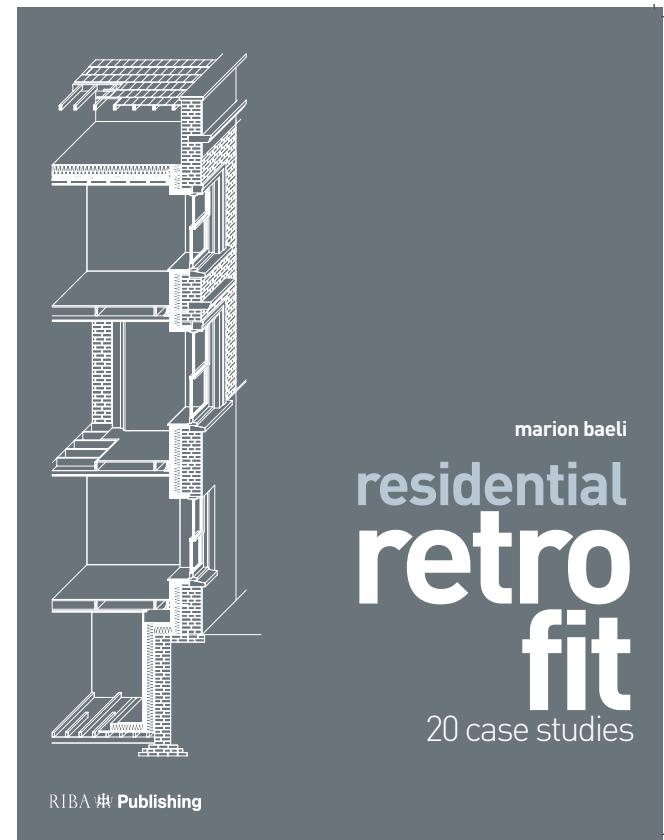
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Publication

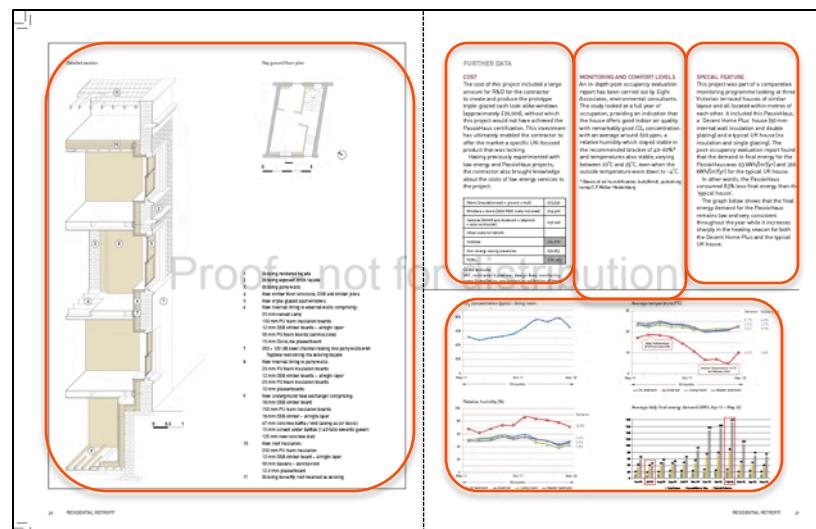
Author: Marion Baeli
Co-Author: Technology Strategy Board
Publisher: RIBA
Funding & Copyright: Paul Davis + Partners





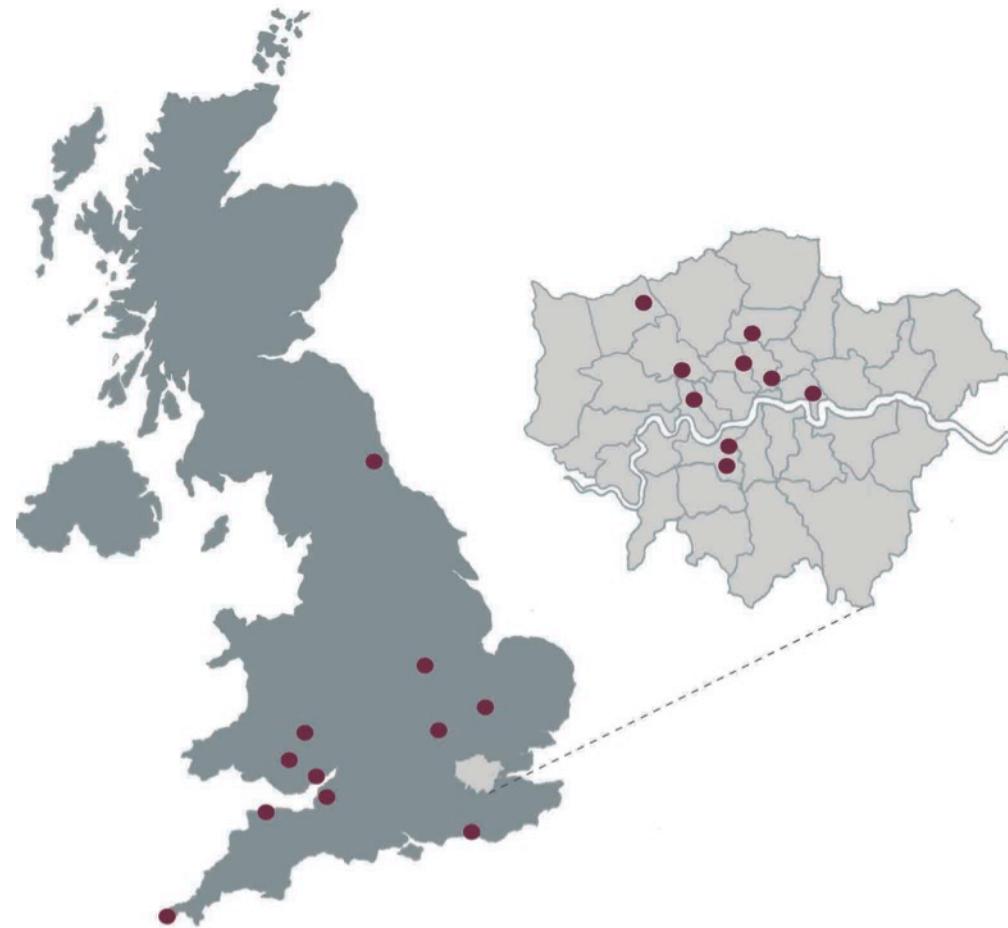
Content:

- ID card + summary of measures
- Description of each strategy
- Vital statistics
- Detailed isometric section
- Costs (material & labour)
- Monitoring data:
Energy & Internal comfort
- Special feature



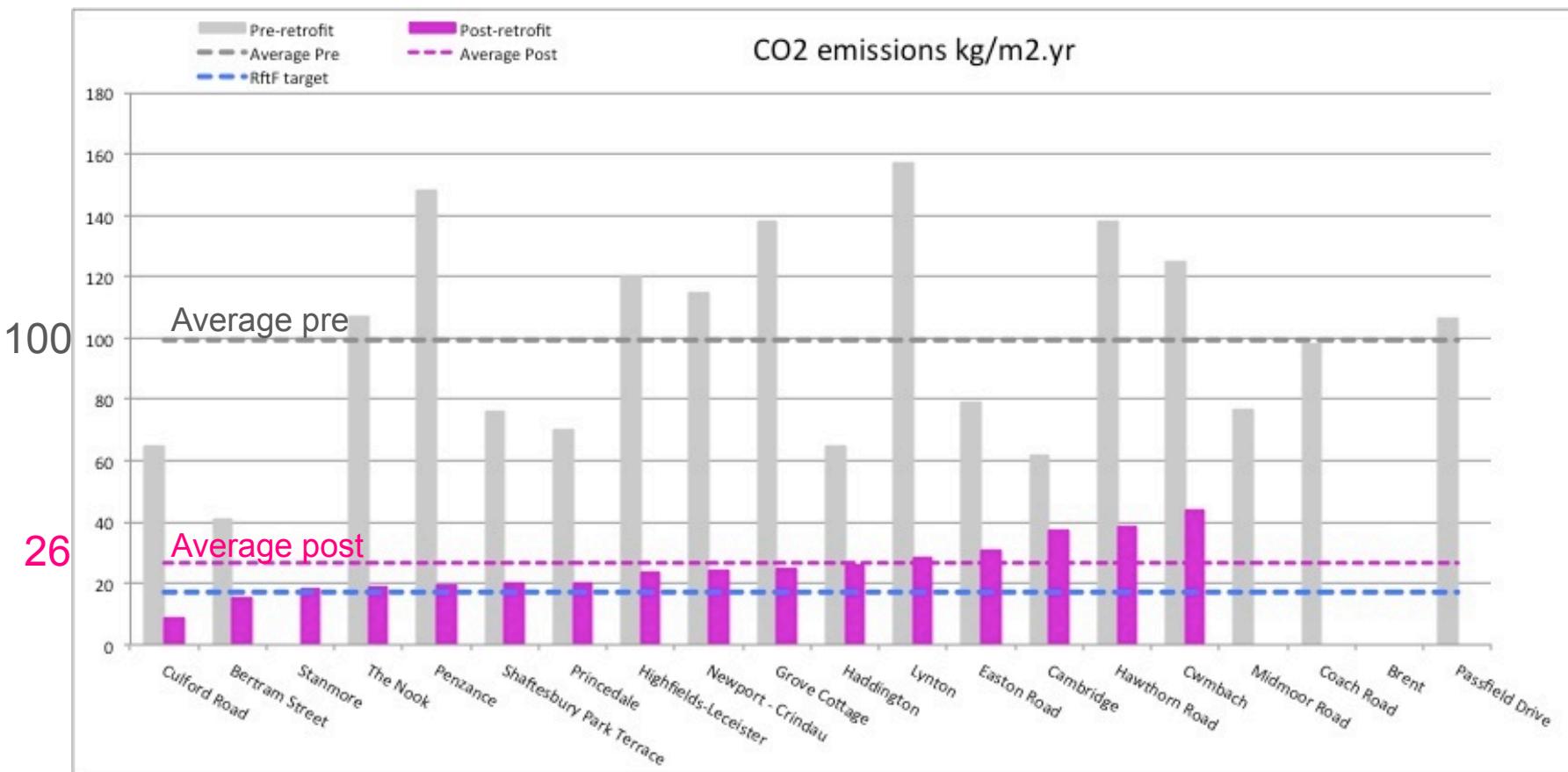


20 project locations



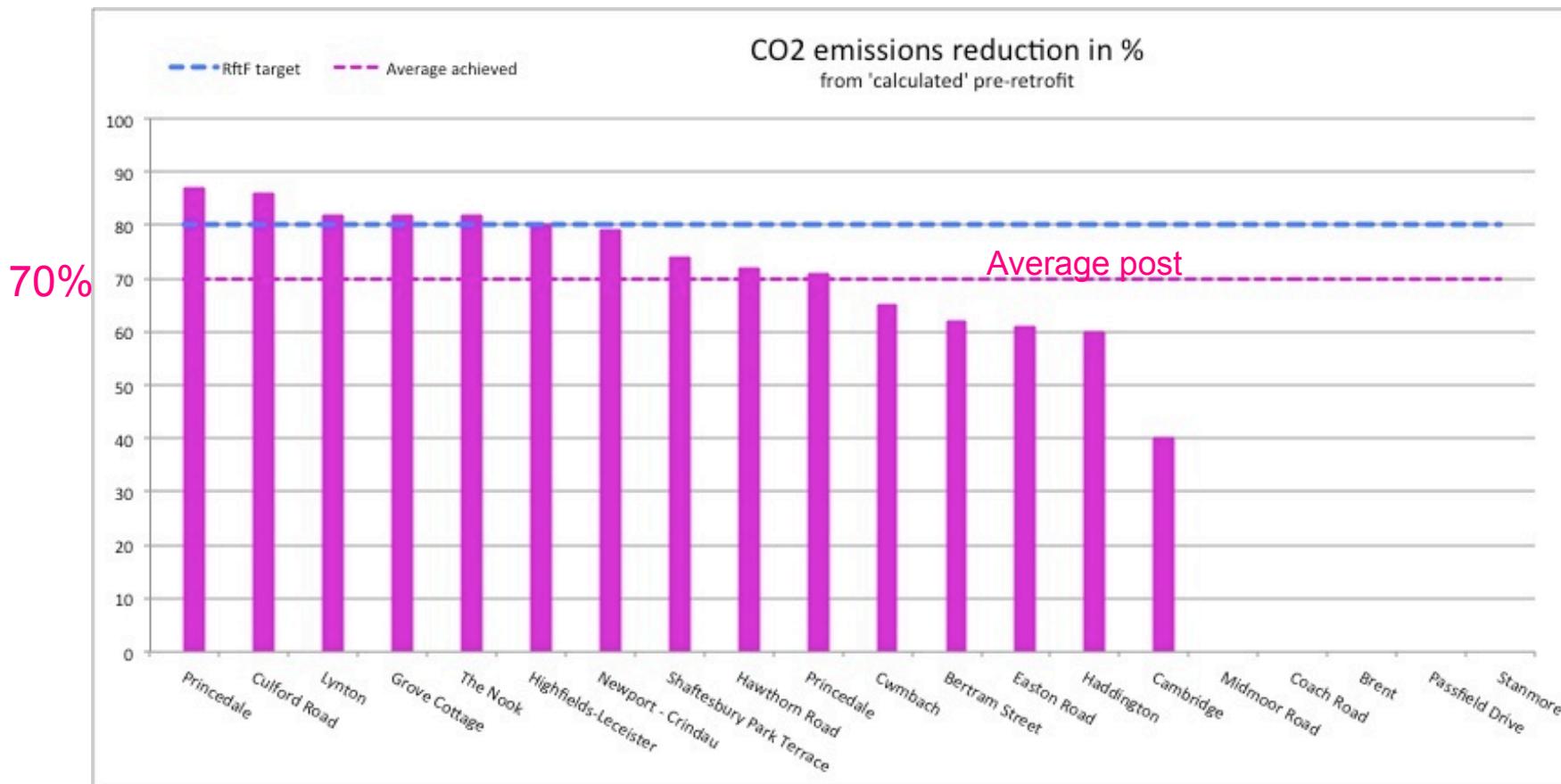


Results CO2 emissions



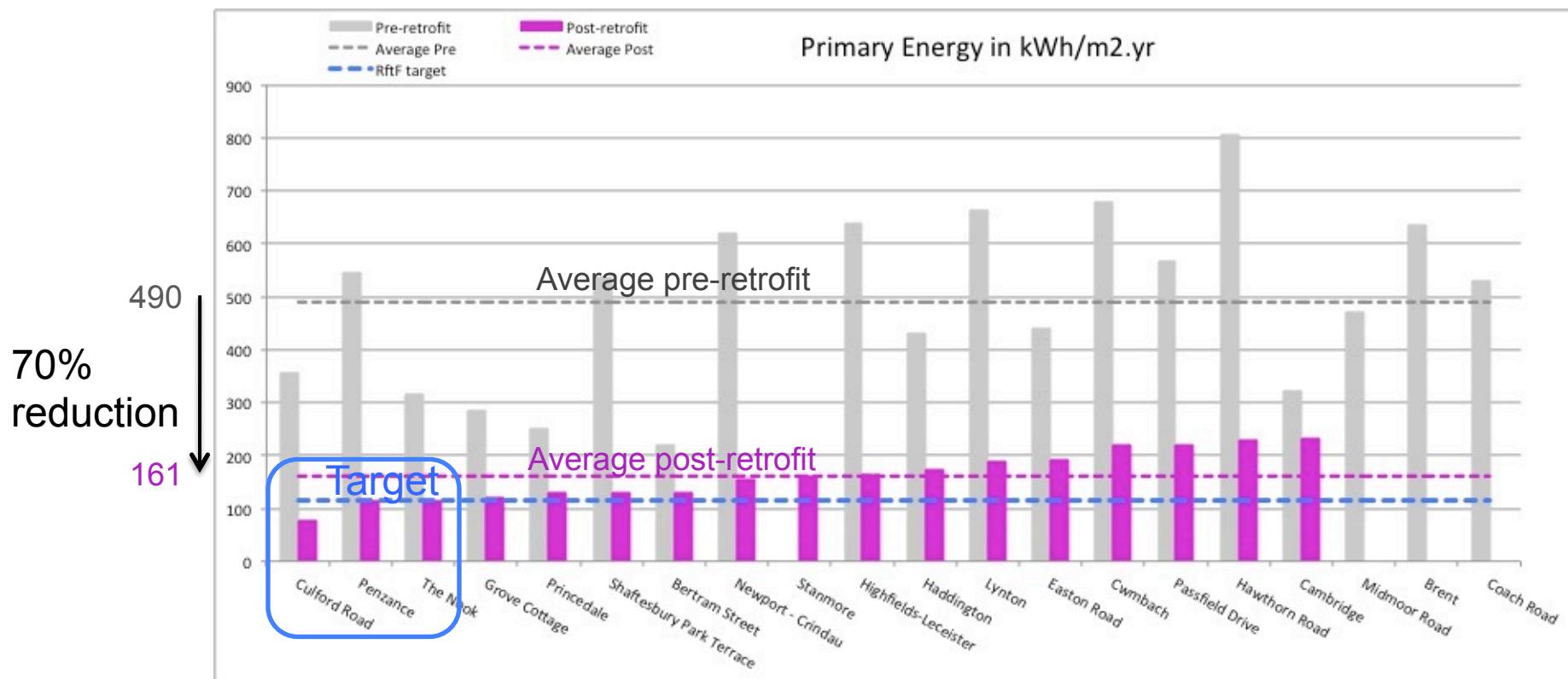


Results CO2 emissions reduction





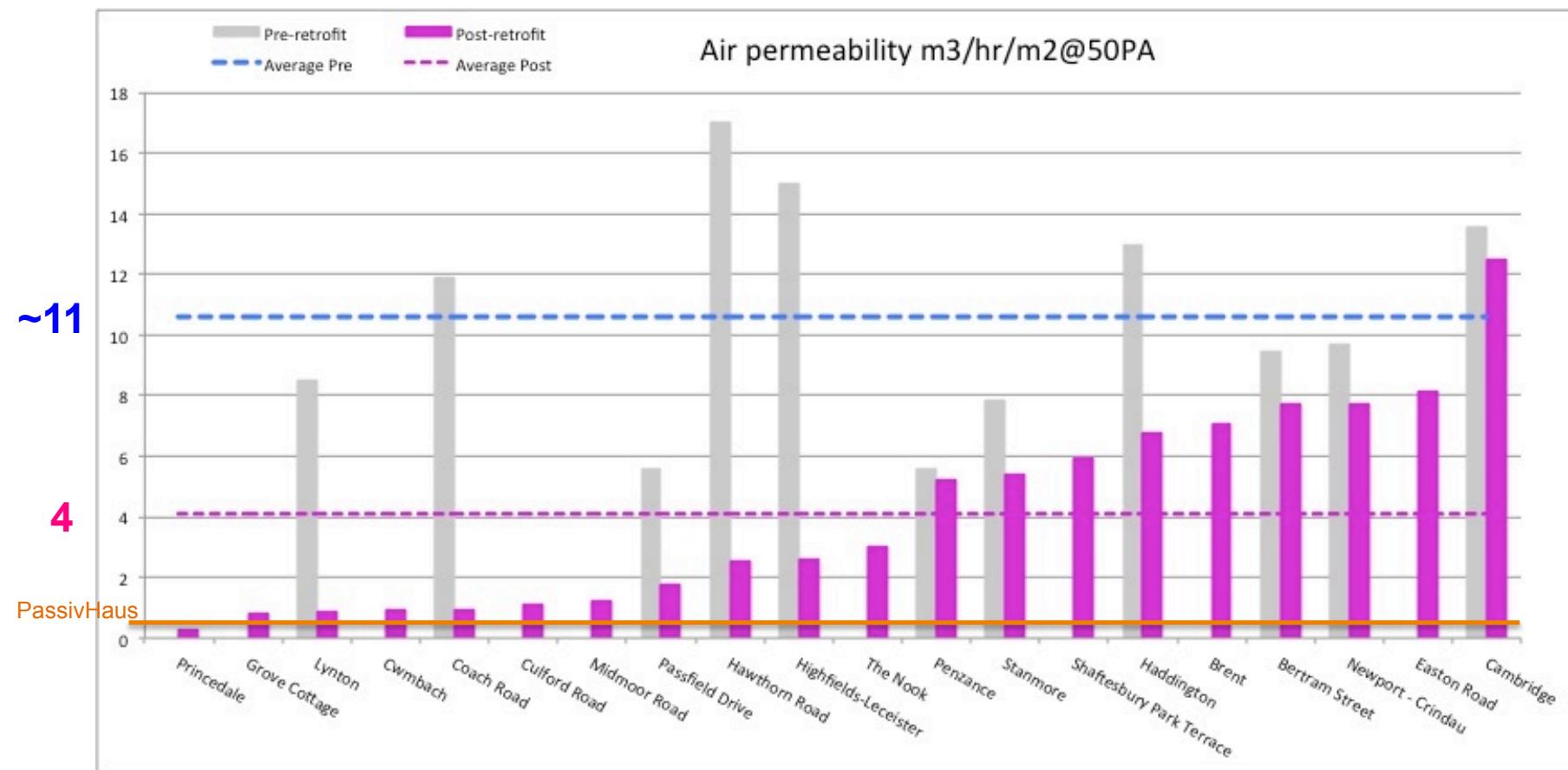
Primary energy demand



3 projects out of 20 met the target for Primary Energy of 115 kWh/m².yr



Air permeability



4. Case studies pre-1919



Princedale Road

Client: Octavia Housing

Architect: Paul Davis + Partners

Contractor/engineer: Philip Profitt / Princedale EcoHaus

Construction: **Pre-1919 Solid masonry**

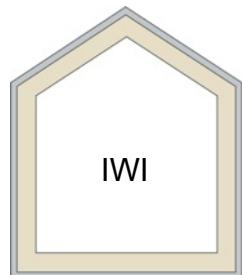
Total cost Material & labour: £180,683

Of which energy saving measures: £69,870

Victorian

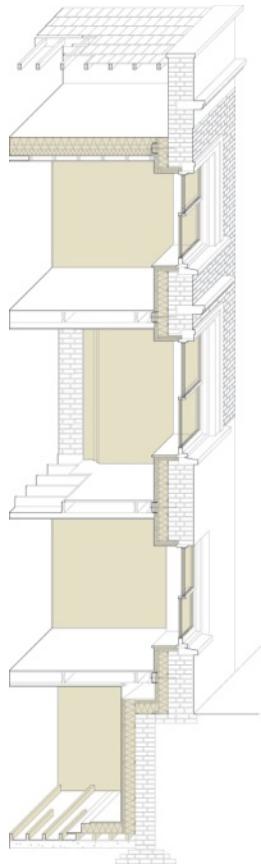
Mid-terrace house

5 occupants



PassivHaus certified



**Fabric:**

- Continuous internal insulation
- Triple glazing
- No cold bridges (joist ends detached)

Services:

- MVHR (Genvex Combi)
- Solar thermal
- Below ground heat exchanger

Airtightness

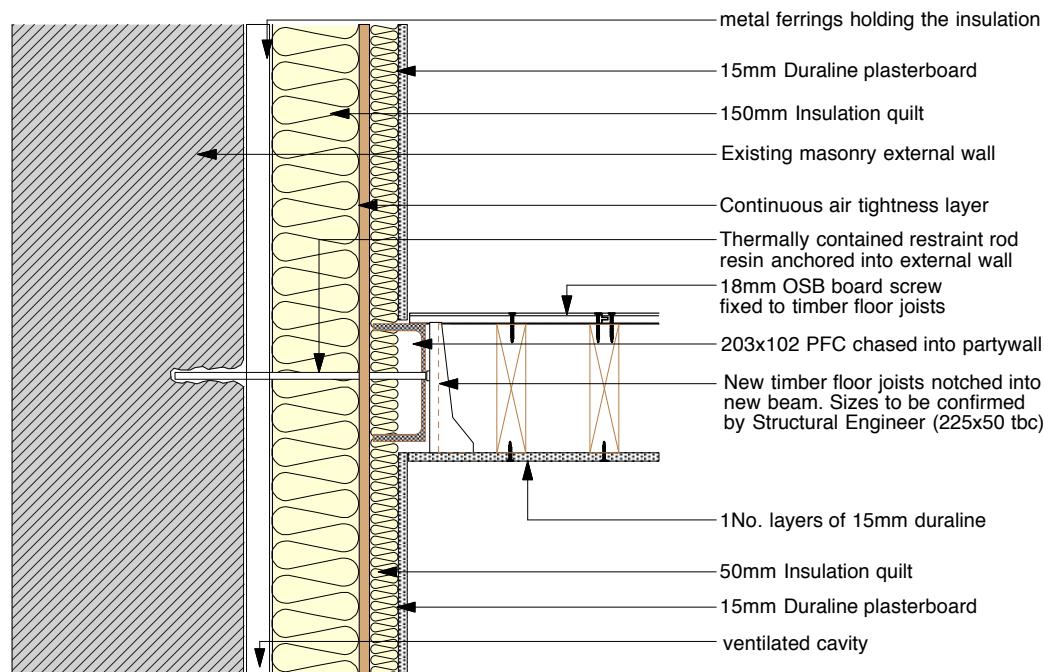
0.34 m³/m²h@50Pa

Vital statistics table

Characteristics	Before	Target	Measured
Primary energy (kWh/m ² /yr)	250	120	128
Space heating (kWh/m ² /yr)	120	15	10
Airtightness (m ³ /m ² h @ 50 Pa)	-	0.6	0.34
Type of glazing	single	triple	triple
CO ₂ emissions (kg CO ₂ /m ² /yr)	70	17	20



Joist end





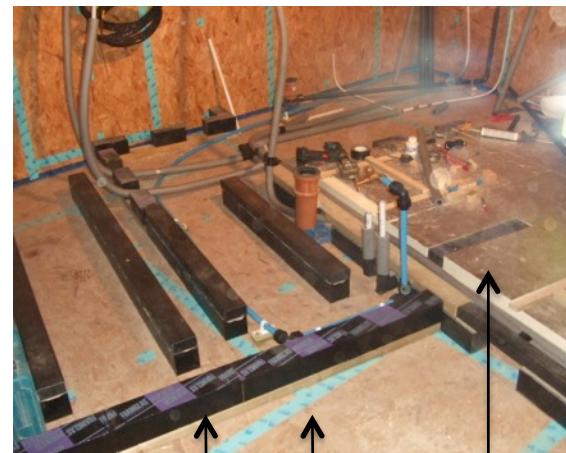
Windows





Ventilation

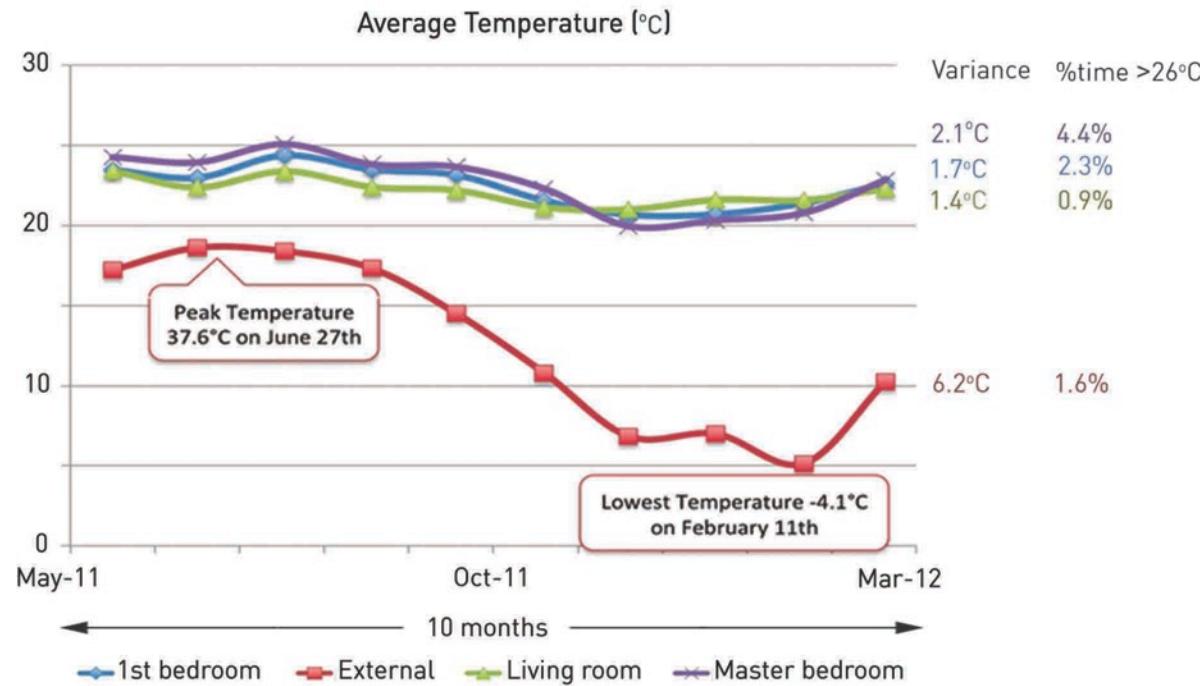
Underground Heat Exchanger



INNOVATION

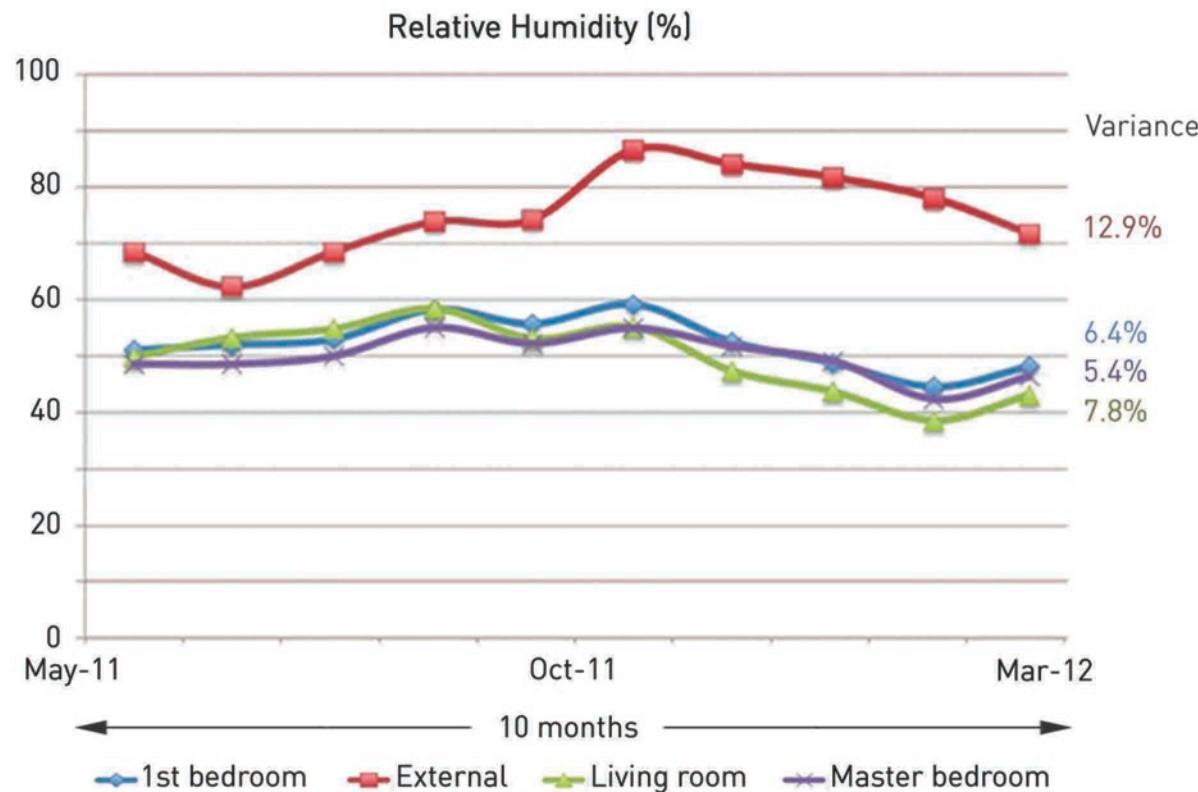


Temperatures



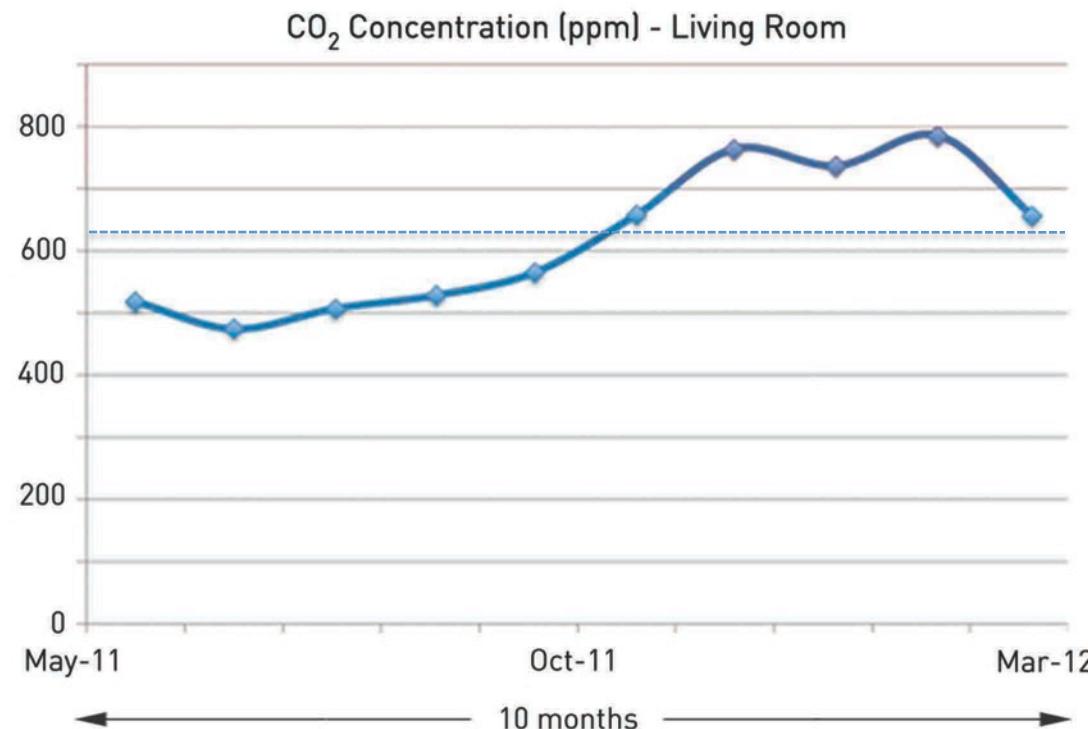


Relative Humidity





CO2 concentration





Midmoor Road

Client: Family Mosaic

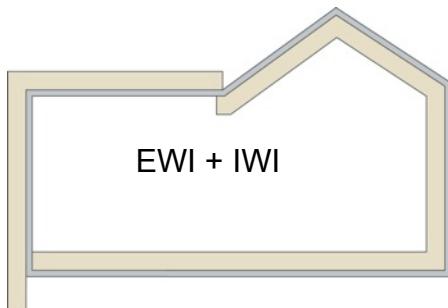
Architect: Prewett Bizley

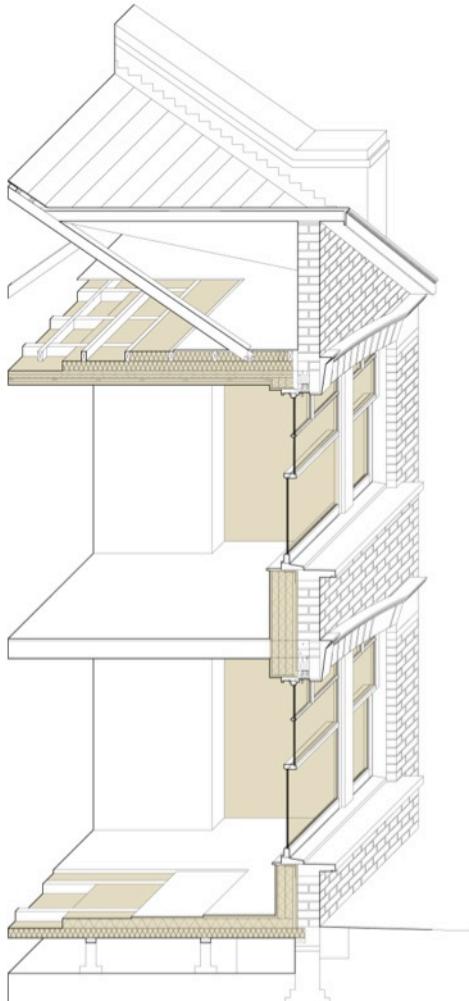
Contractor: Manby

Construction: **Pre-1919 Solid masonry**

Total cost Material & labour: **£127,400**

Of which energy saving measures: **£63,200**





Fabric:

- Internal insulation
- External insulation
- Triple & double glazing
- No cold bridges (joist ends detached)

Services:

- MVHR (Paul Novus)

Airtightness

1.2 m³/m²h@50Pa

Vital statistics table

Characteristics	Before	Target	Measured
Primary energy (kWh/m ² /yr)	470	155	-
Space heating (kWh/m ² /yr)	-	25	-
Airtightness (m ³ /m ² h @ 50 Pa)	-	1	1.2
Type of glazing	single	double/triple	double/triple
CO ₂ emissions (kg CO ₂ /m ² /yr)	77	32.5	-

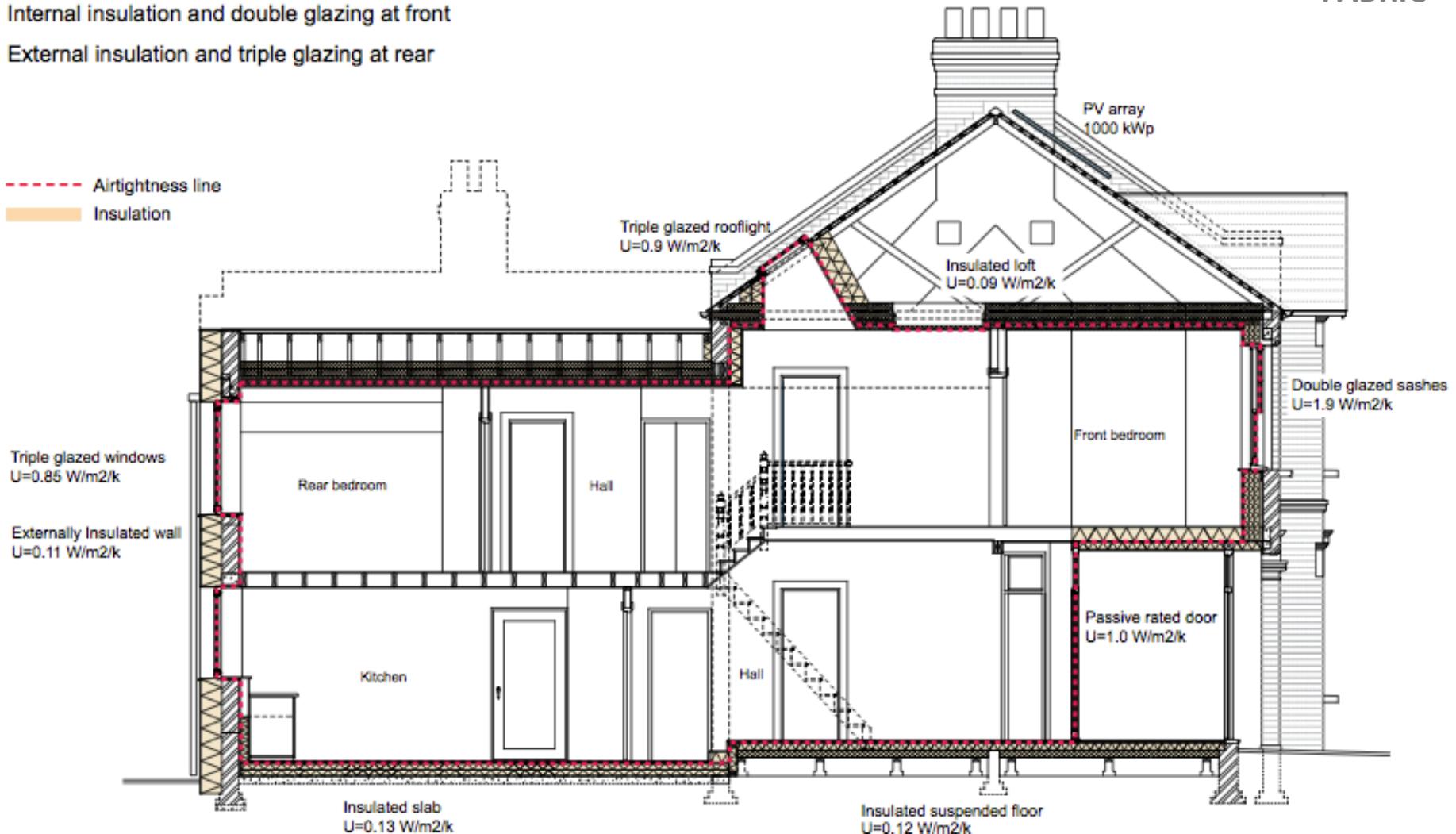


FABRIC

Internal insulation and double glazing at front

External insulation and triple glazing at rear

Dashed red line: Airtightness line
Orange shading: Insulation



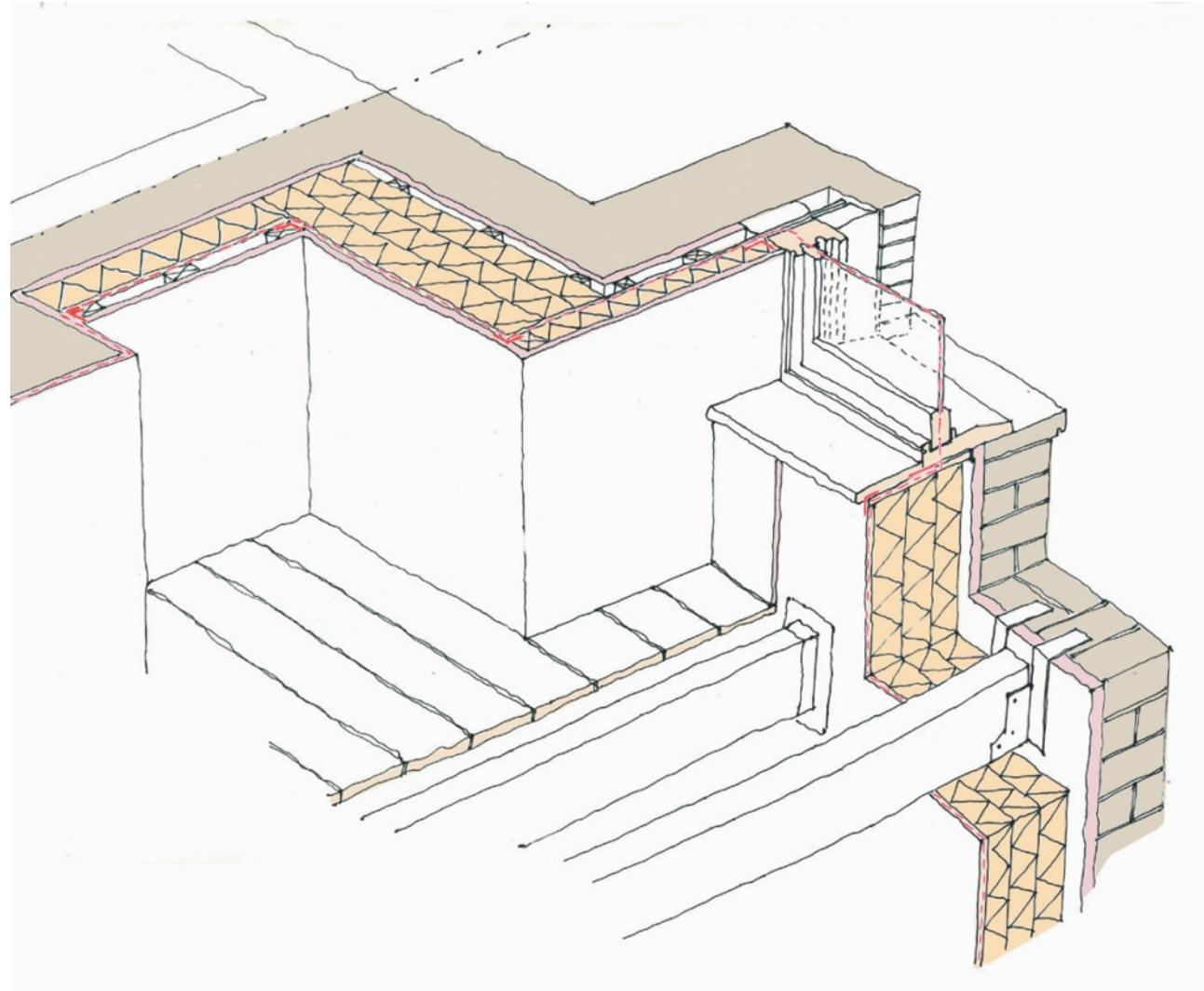


FABRIC



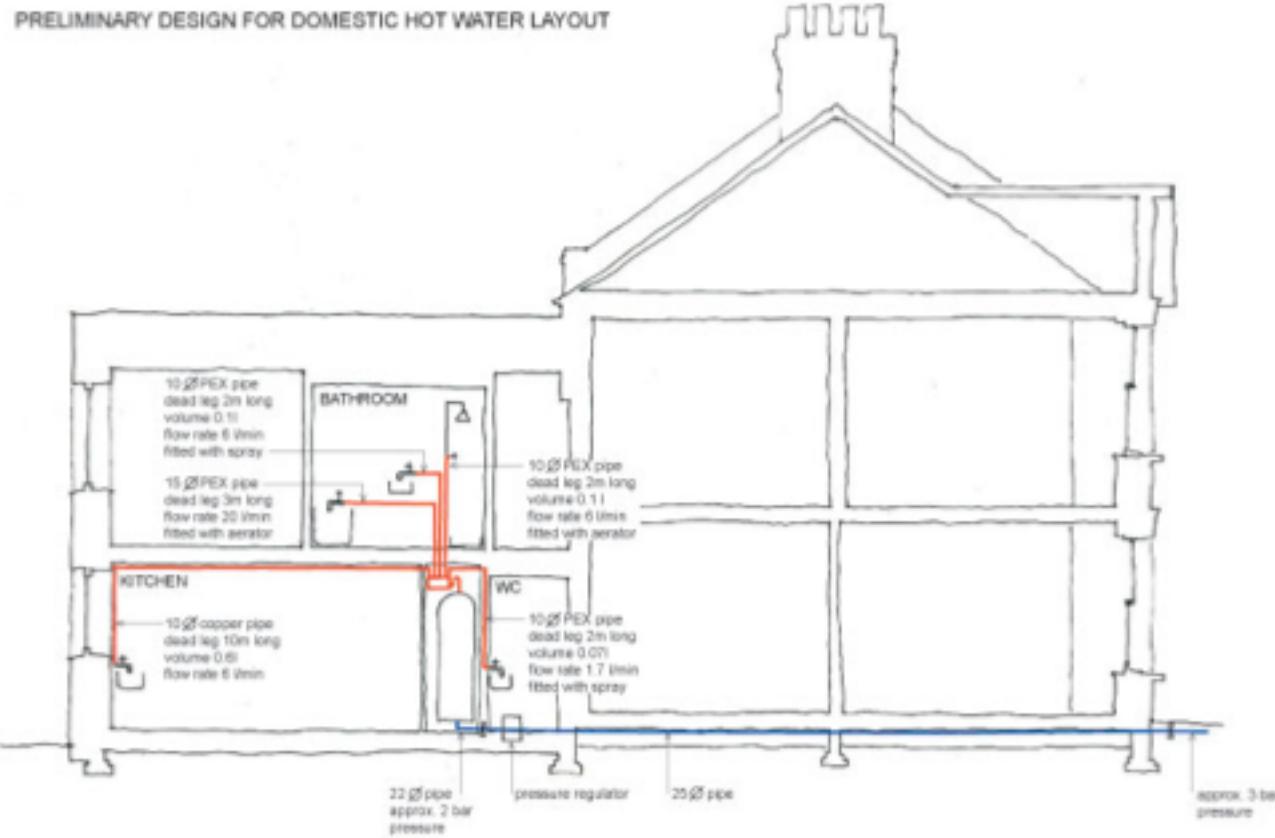


Fabric



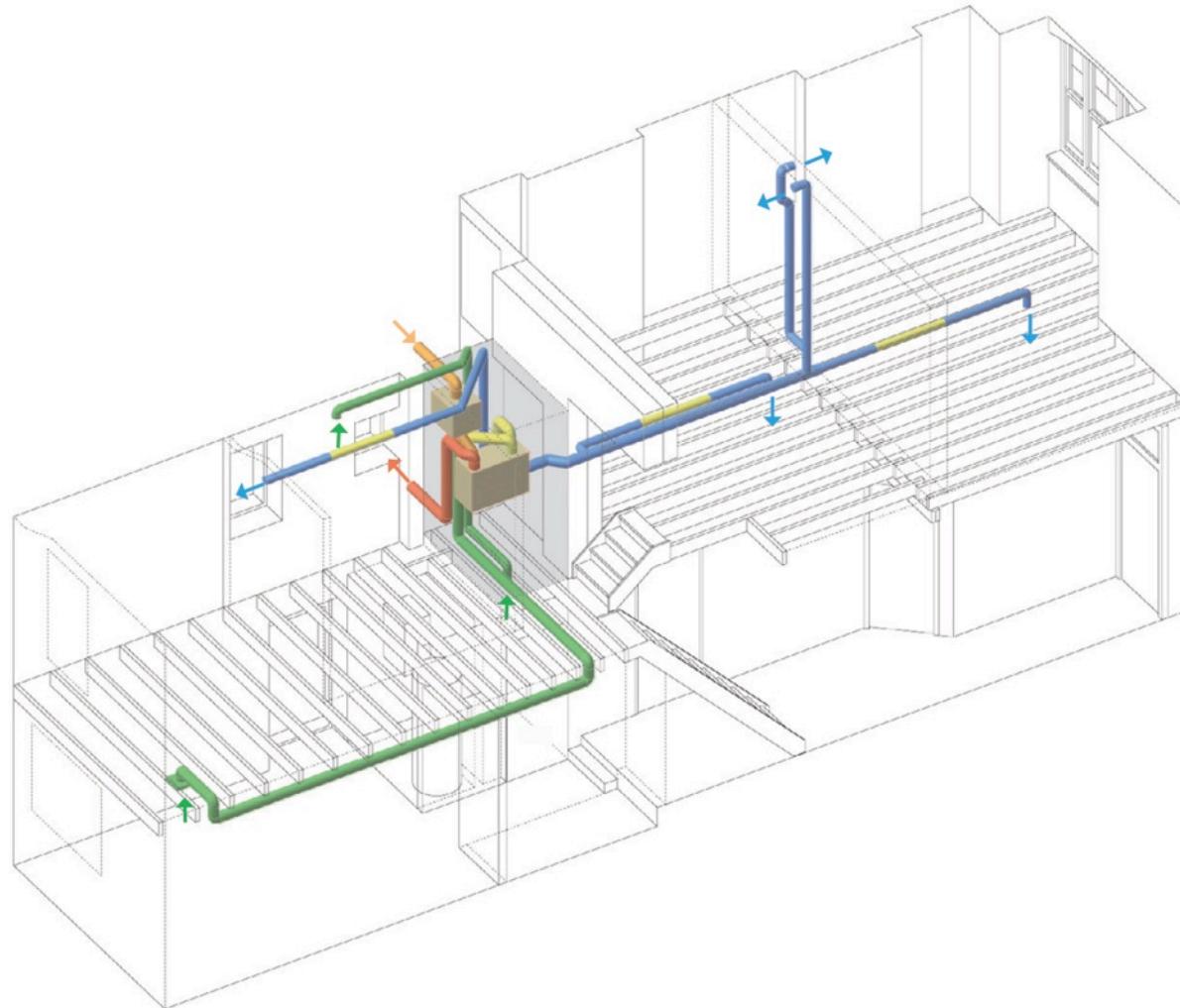


Domestic hot water





Ventilation



5. Case study post-1919



Penzance

Client: Penwith Housing Association
Lead designer Penwith HA
Contractor: Mears Ltd.

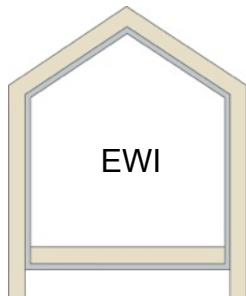
Construction: **Post-1919 - 1950's**

Total cost Material & labour: **£61,521**
Energy saving measures: **£58,567**

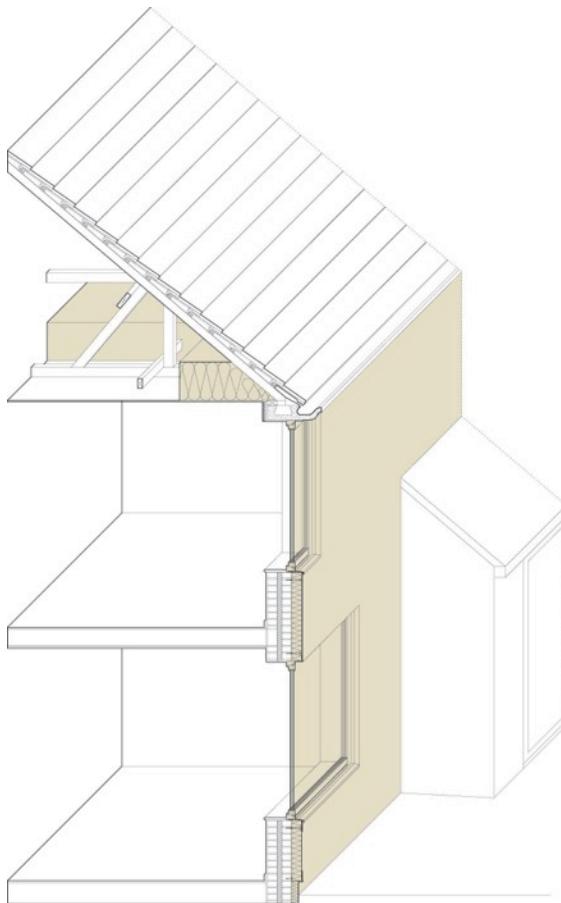
1950's

Semi-detached house

2 occupants





**Fabric:**

- EWI
- Triple glazing
- Minimal cold bridges (ground/wall)

Services:

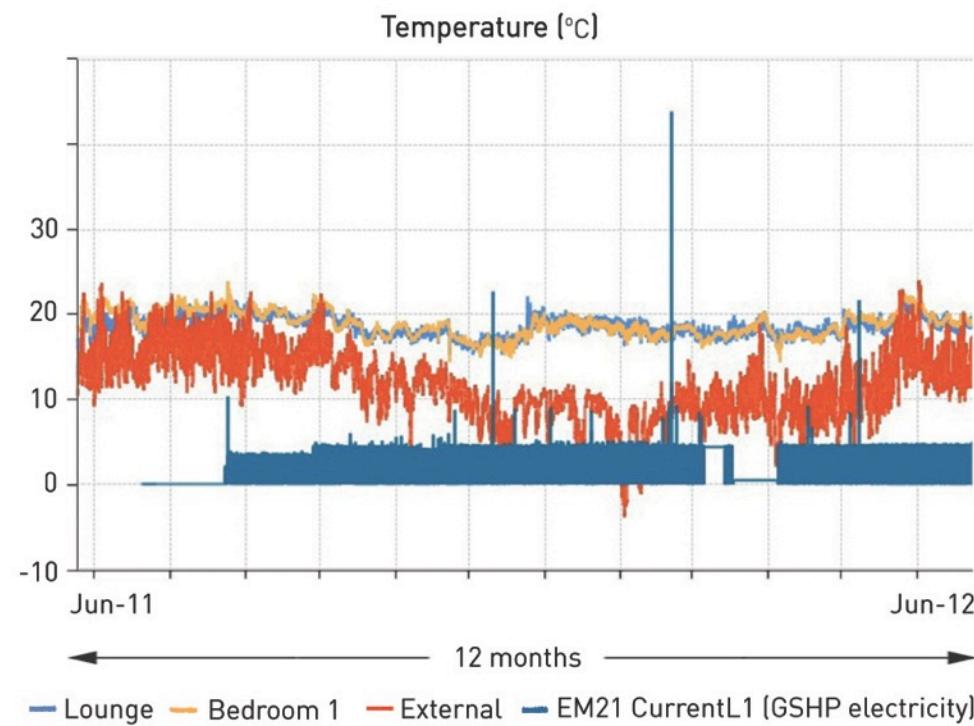
- MVHR
- Ground source heat pump (Calorex 3.5 kW) & pressurised cylinder
- 'Heat pod' extension
- Photovoltaic panels

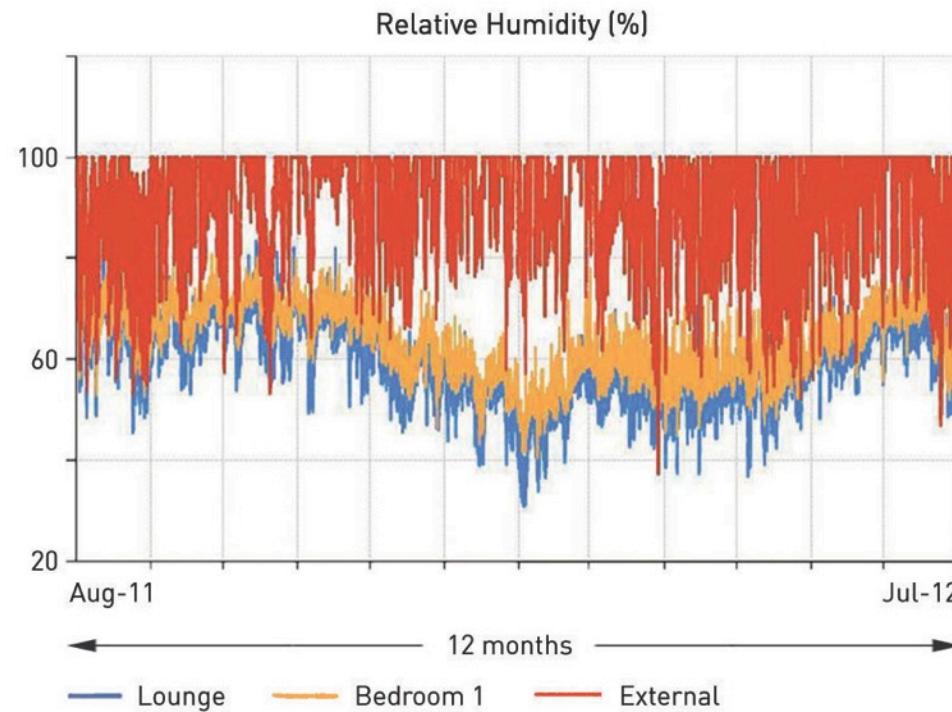
Airtightness:

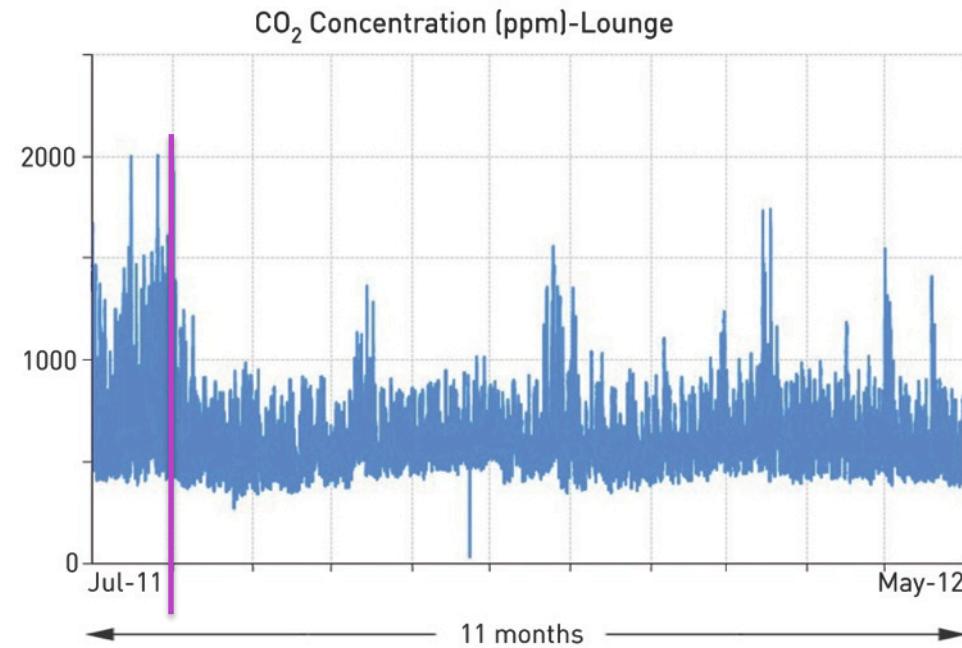
5.25 m³/m²h@50Pa

Vital statistics table

Characteristics	Before	Target	Measured
Primary energy (kWh/m ² /yr)	544	110	113
Space heating (kWh/m ² /yr)	276	14.05	8.98
Airtightness (m ³ /m ² h @ 50 Pa)	5.57	3	5.25
Type of glazing	double	triple	triple
CO ₂ emissions (kg CO ₂ /m ² /yr)	147.6	16.6	16.9



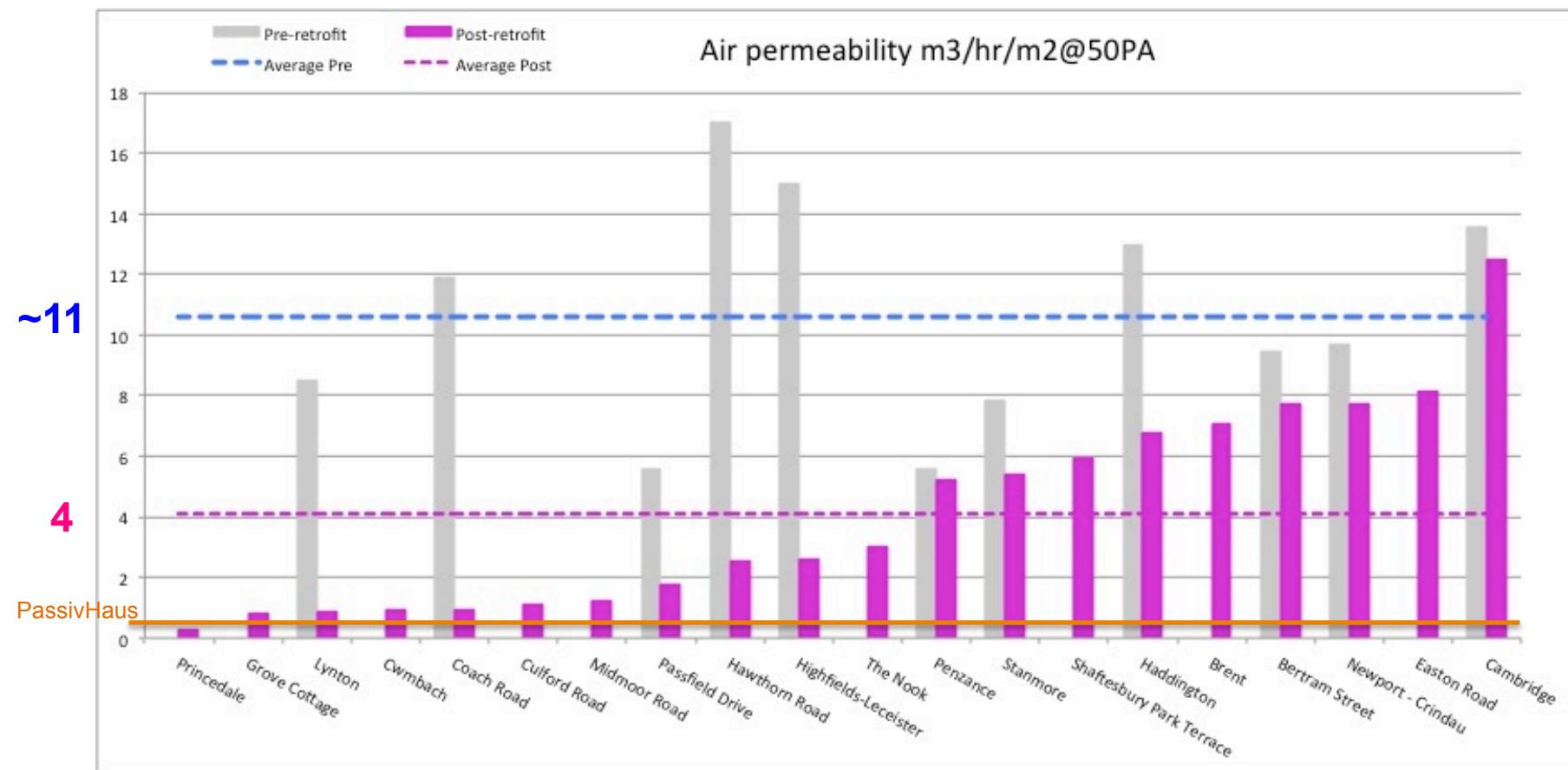




6. Airtightness



Air permeability





Some reasons for largely missing the target:

- Lack of experience from architect
in designing robust airtight details
- Lack of experience from contractors
- Complex strategies
- Multiple penetrations of the airtight layer



Complex strategies – areas to look out for



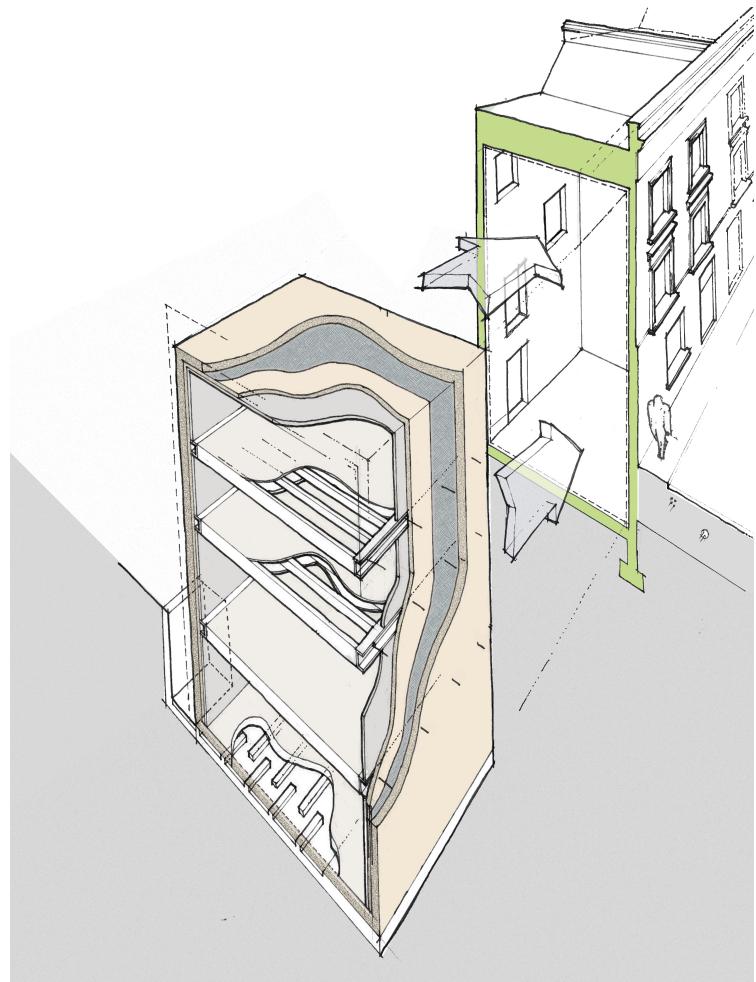


Simple strategy gets best results

- Single material: OSB board
- Continuous airtight layer line
- Mitigation of penetrations
- Same face of building envelope

Airtightness

0.34 m³/m²h@50Pa





Difficult junction

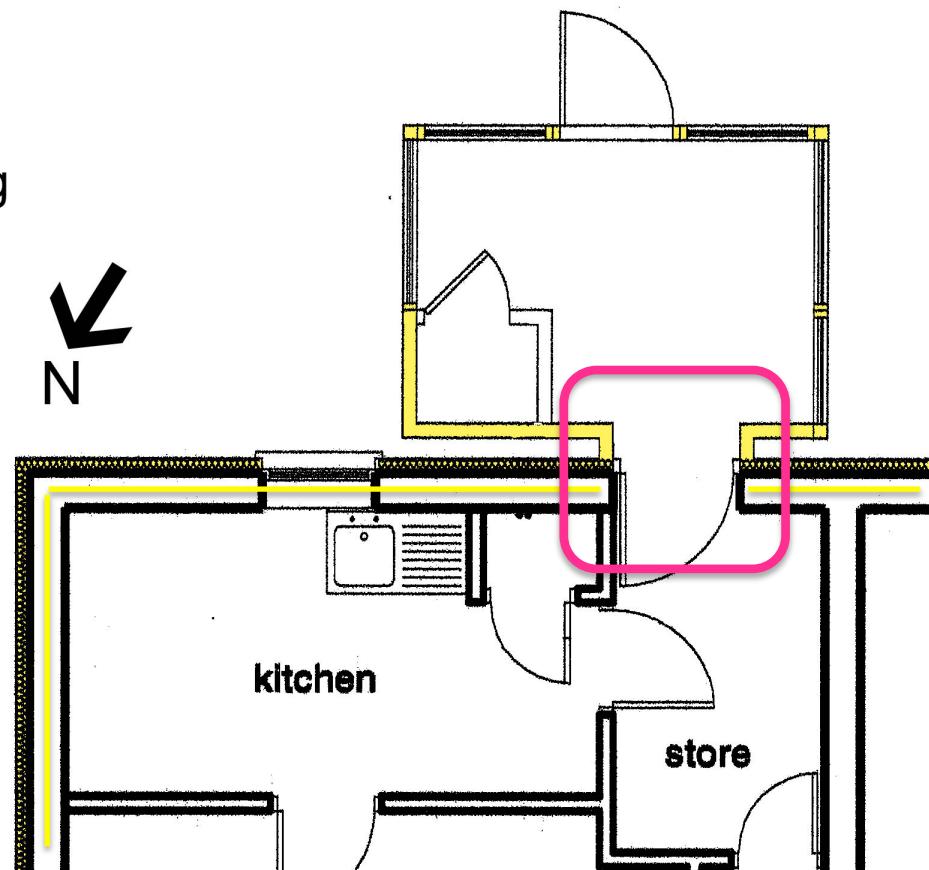
- New volume attached to an existing construction
- External airtight layer
- Mitigation of penetrations

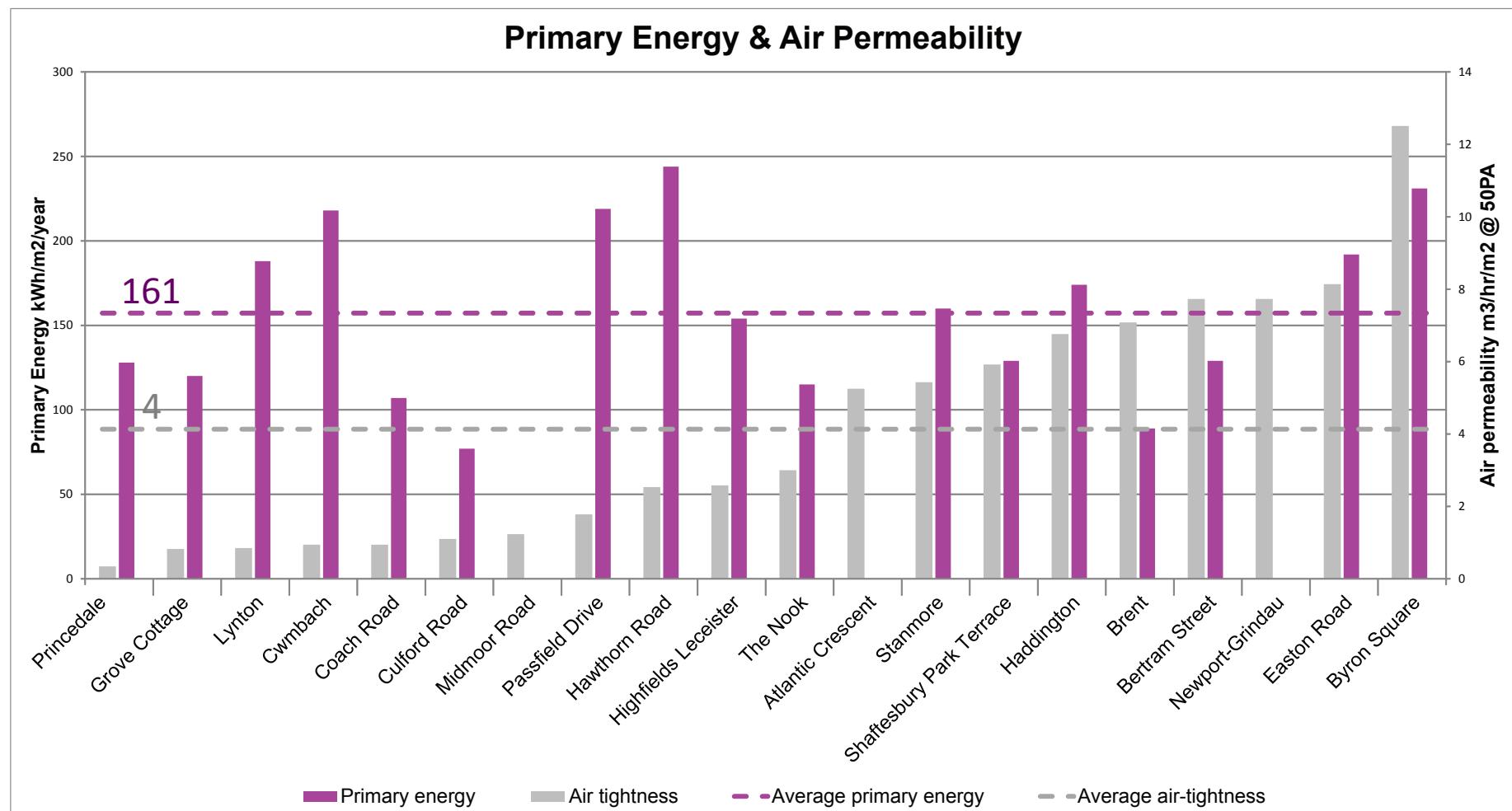
Airtightness figures

Pre-retrofit **5.57** m³/m²h@50Pa

Target **3** m³/m²h@50Pa

Post-retrofit **5.23** m³/m²h@50Pa





conclusion



- Results on quality of internal comfort in these retrofits are good and encouraging
- More research needs to be undertaken on **airtightness**, costs, procurement, training, methodology...
- Urgency of retrofitting the UK Housing Stock
- Retrofit for the Future programme
A platform for engaging the industry into retrofits
- The 20x case studies are a source of information and inspiration for others

thank you

