

marion baeli

residential retro fit

20 case studies

RIBA # Publishing

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:

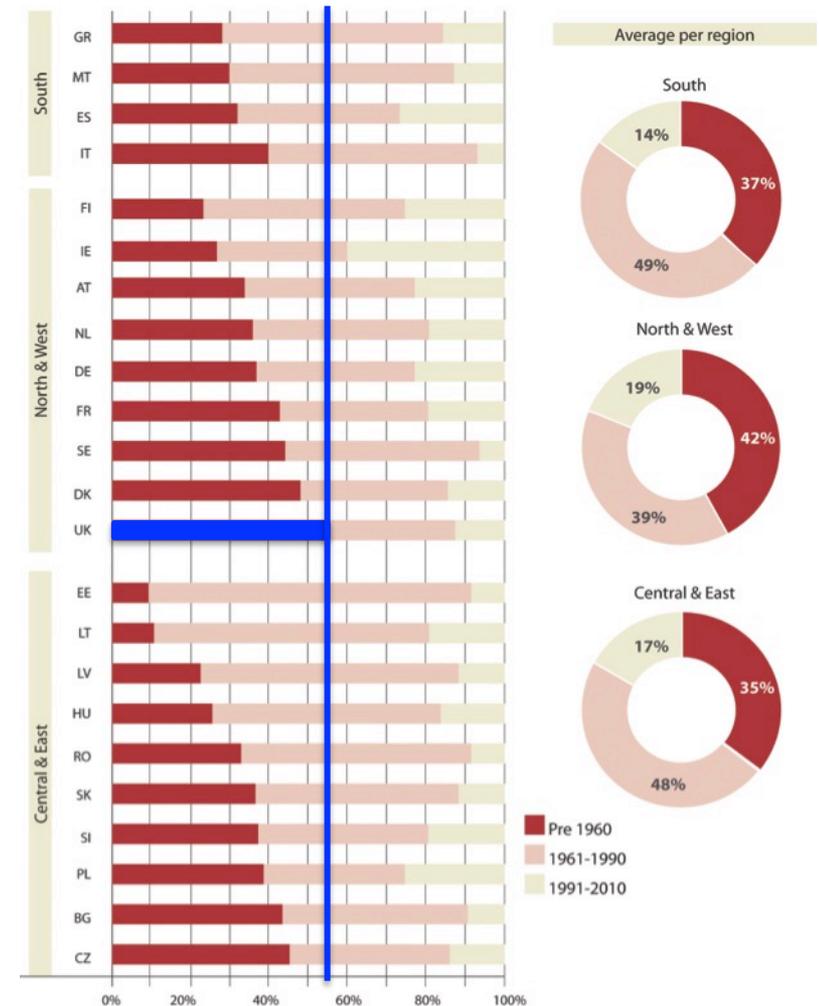
1. Introduction
2. Background to the programme
3. Book and main results
4. Case studies pre-1919 (Princedale, Midmoor)
5. Case study post-1919 (Penzance)
6. Airtightness

1. introduction



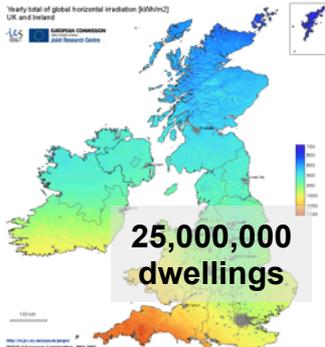
UK ageing stock

- 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

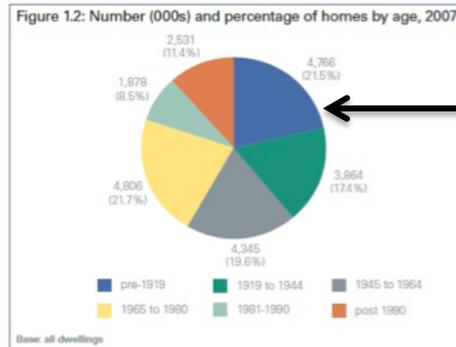




UK ageing stock



European Communities PVGIS



English House Condition Survey 2007

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

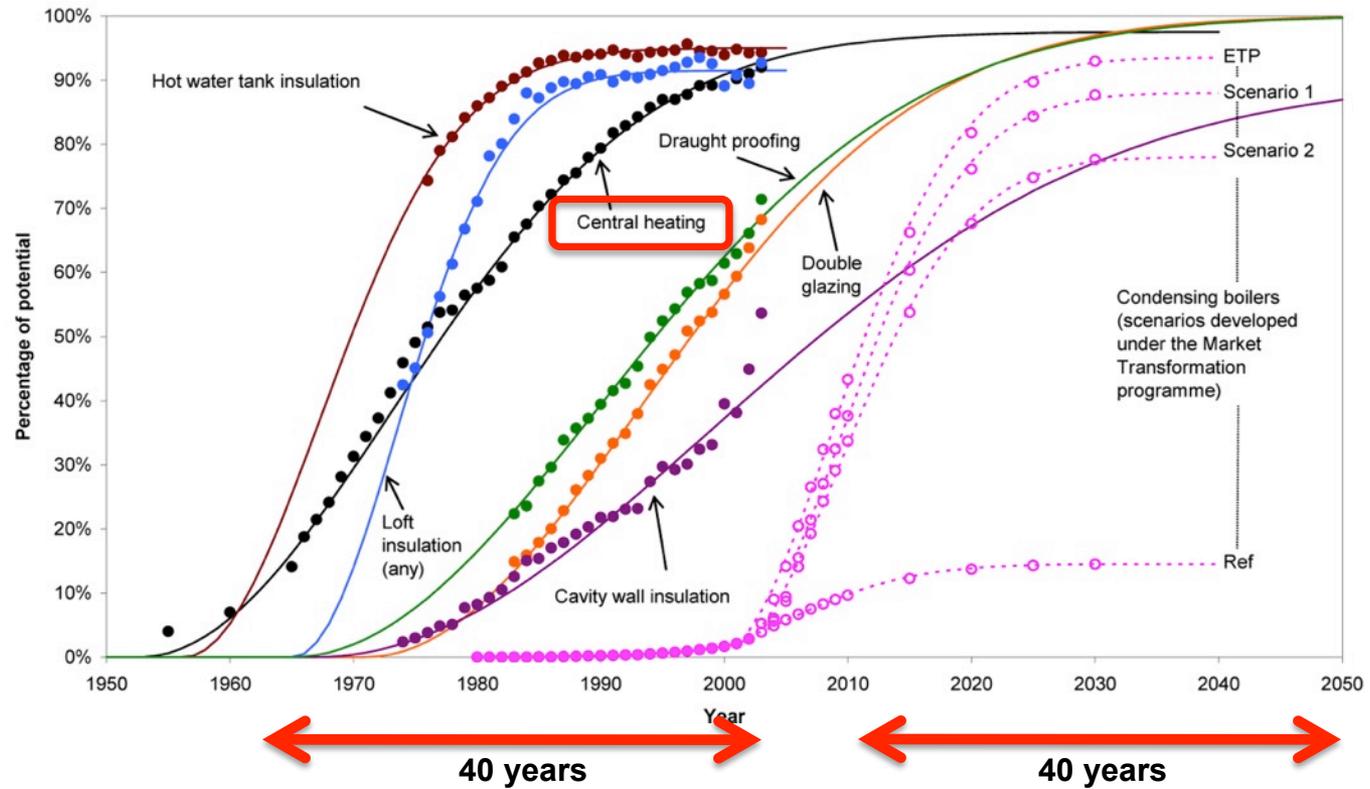
480 kWh/m²/yr
9 t/yr

English House Condition Survey 2007



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]

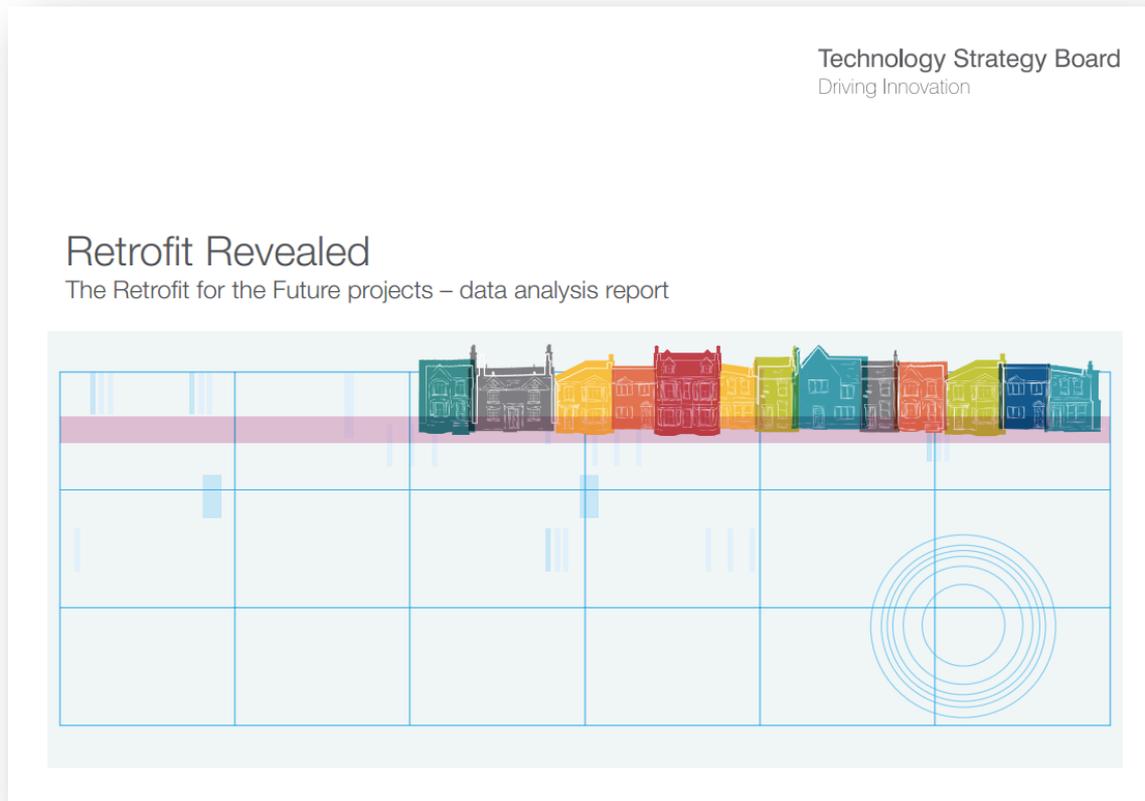
RftF Programme comfort monitoring:

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



Programme official results:

www.retrofitanalysis.org



3. Book and main results

residential retrofits, 20 case studies

Technology Strategy Board
Driving Innovation

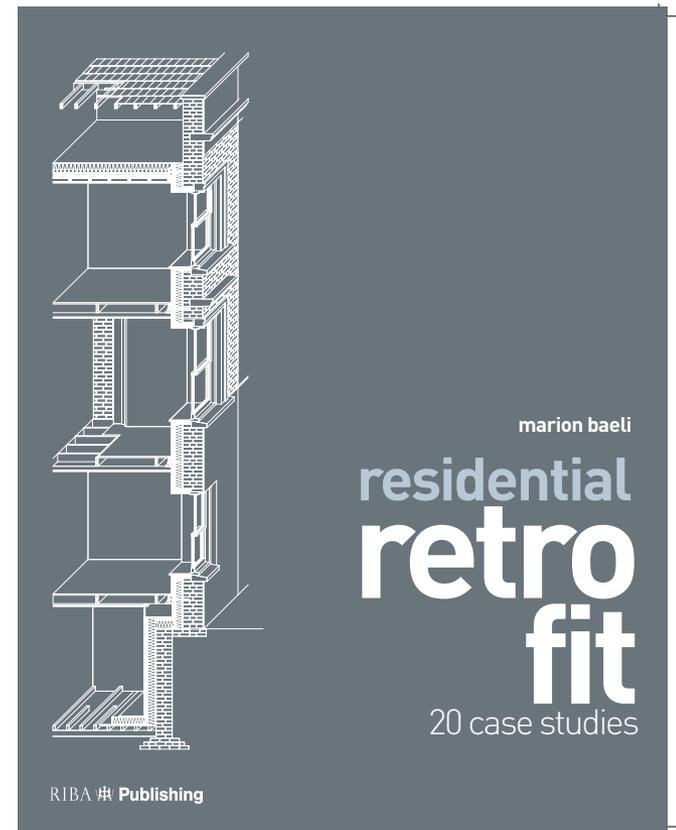
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RIBA  Publishing



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

PRINCEDALE ROAD
1910-18

Interior floor area: 115 m²

Primary energy per month calculated: 100 kWh/m² per month measured: 120 kWh/m² per month

Client: Social Housing

Architect: Paul Davis + Partners

Construction: Private Social Housing

Construction: Eight Apartments, Green Thermal Energy Storage Unit

The project is the first residential retrofit in the UK to be certified to the Passive House standard. It is a typical mid-19th century London terraced house located in a conservation area. The project features an internal insulation strategy, with external walls, roof and thermal grounds, primary air glazing with low U-value windows, and an air-tight envelope. The overall performance of the house has been monitored and one year of energy data has been presented.

From the outset of the project, the client had set the target to achieve full Passivhaus certification (Space Heat and Hot Water) and to ensure that the project had an air-tight envelope. The project has been monitored and one year of energy data has been presented. The project has been monitored and one year of energy data has been presented.

STRATEGY

The whole house strategy depends fundamentally on a combination of internal insulation and airtightness. The project is a typical mid-19th century London terraced house located in a conservation area. The project features an internal insulation strategy, with external walls, roof and thermal grounds, primary air glazing with low U-value windows, and an air-tight envelope. The overall performance of the house has been monitored and one year of energy data has been presented.

VITAL STATISTICS

This project achieved a remarkable performance. It was certified to the absolute simplicity of the air barrier strategy made of a single 100 mm layer of mineral wool insulation. The project team at Paul Davis + Partners used a range of measures to achieve the target of 100 kWh/m² per month. The project team at Paul Davis + Partners used a range of measures to achieve the target of 100 kWh/m² per month.

FURTHER DATA

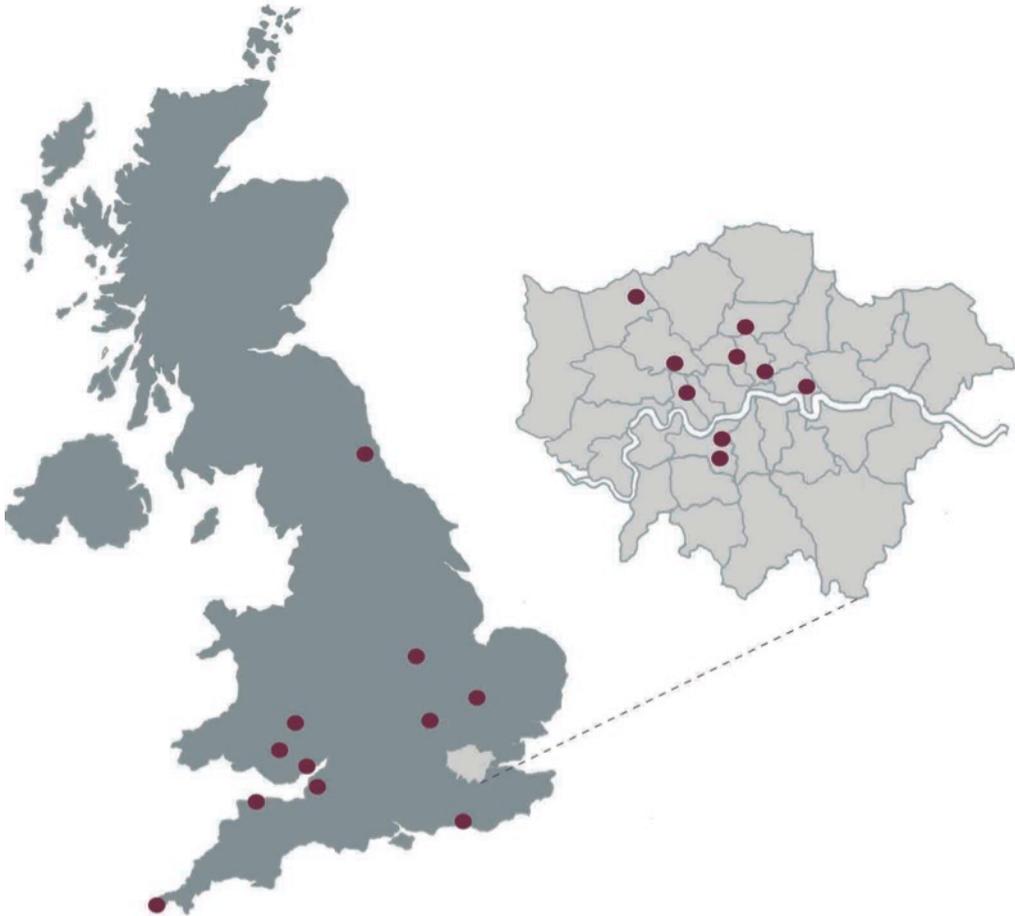
Category	Value
Primary energy per month calculated	100 kWh/m ²
Primary energy per month measured	120 kWh/m ²
CO ₂ emissions per month calculated	100 kg/m ²
CO ₂ emissions per month measured	120 kg/m ²

INTERNAL FEATURE

The project was part of a comparative study for the certification of the 'Passive House' standard. The project team at Paul Davis + Partners used a range of measures to achieve the target of 100 kWh/m² per month.

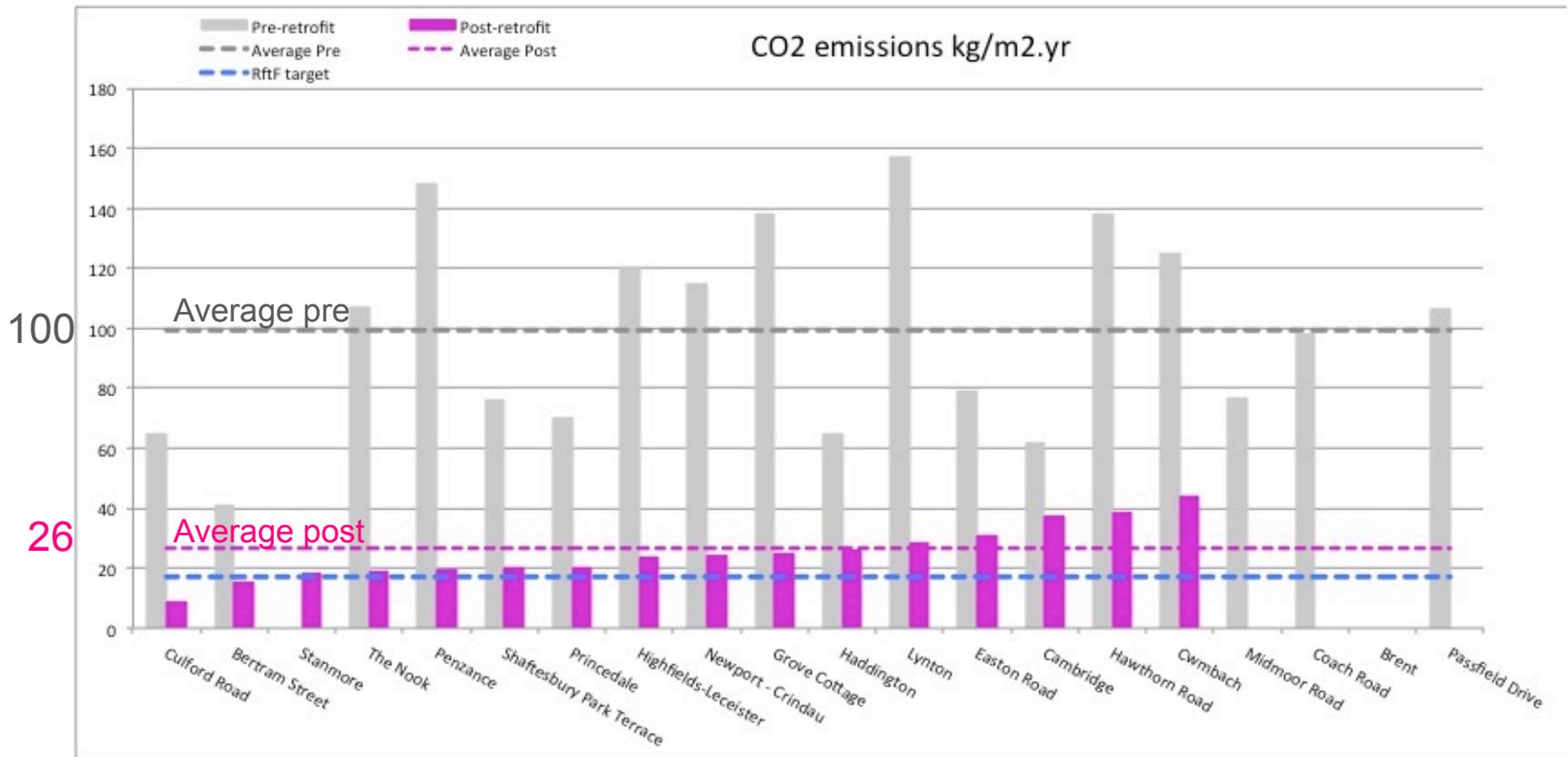


20 project locations



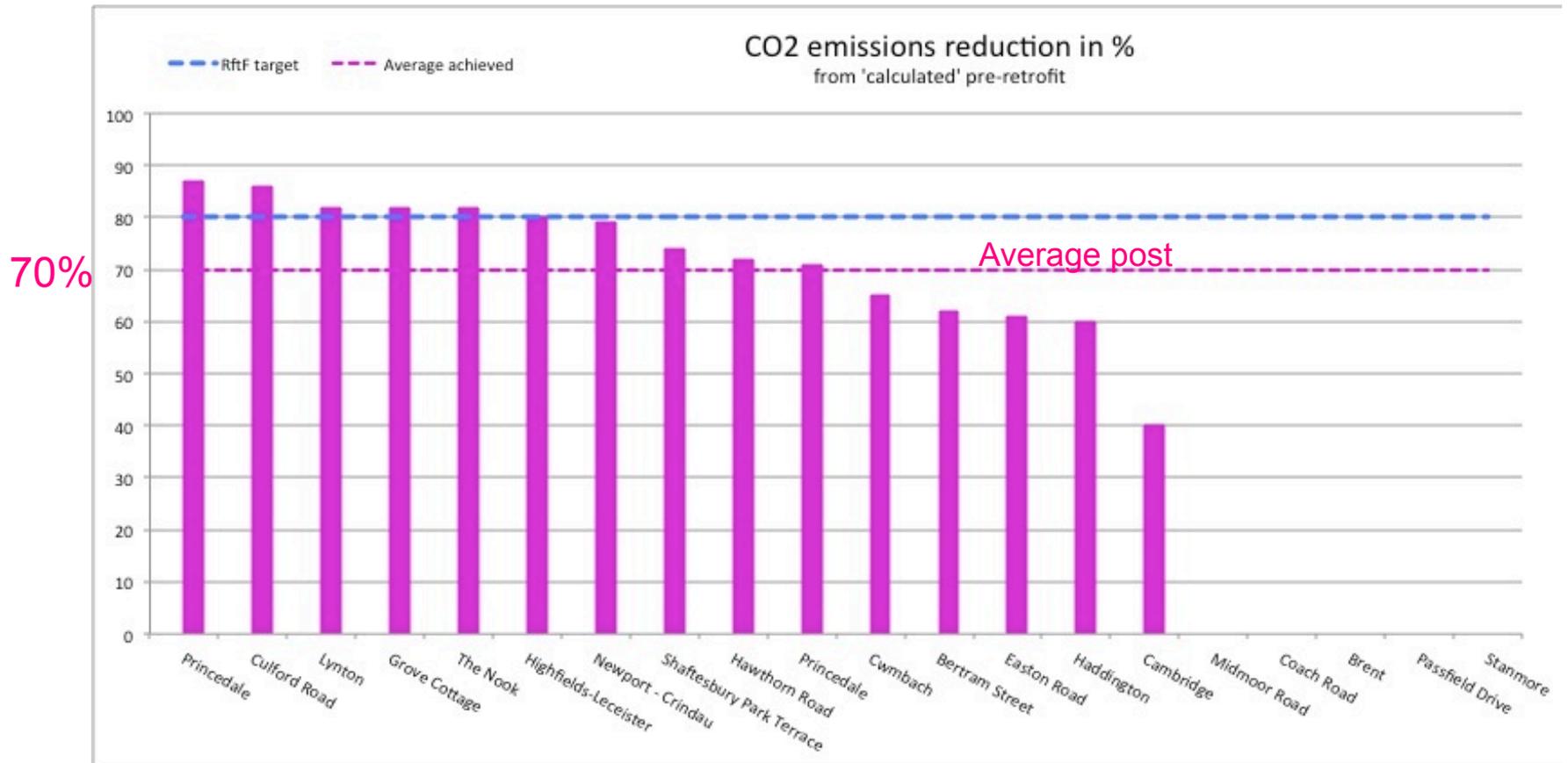


Results CO2 emissions



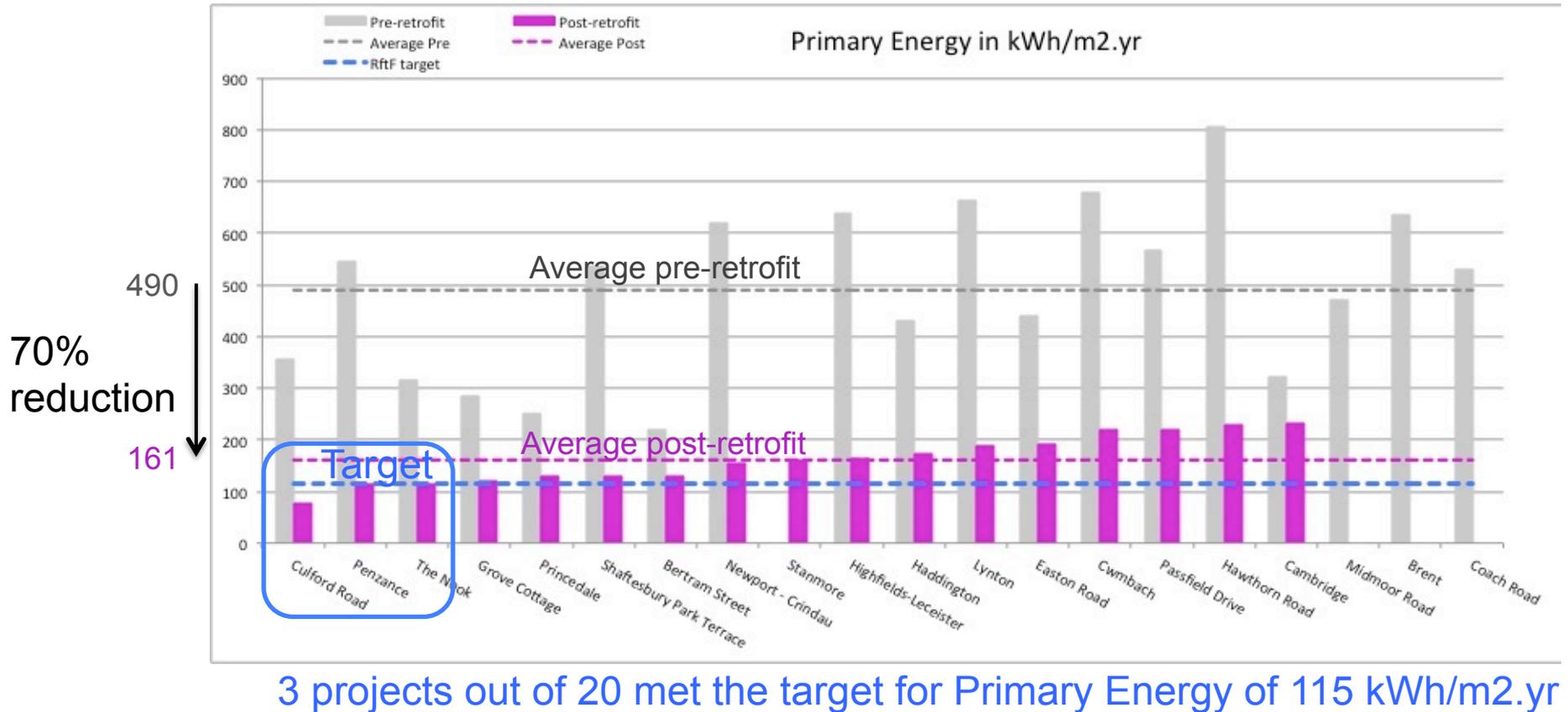


Results CO2 emissions reduction



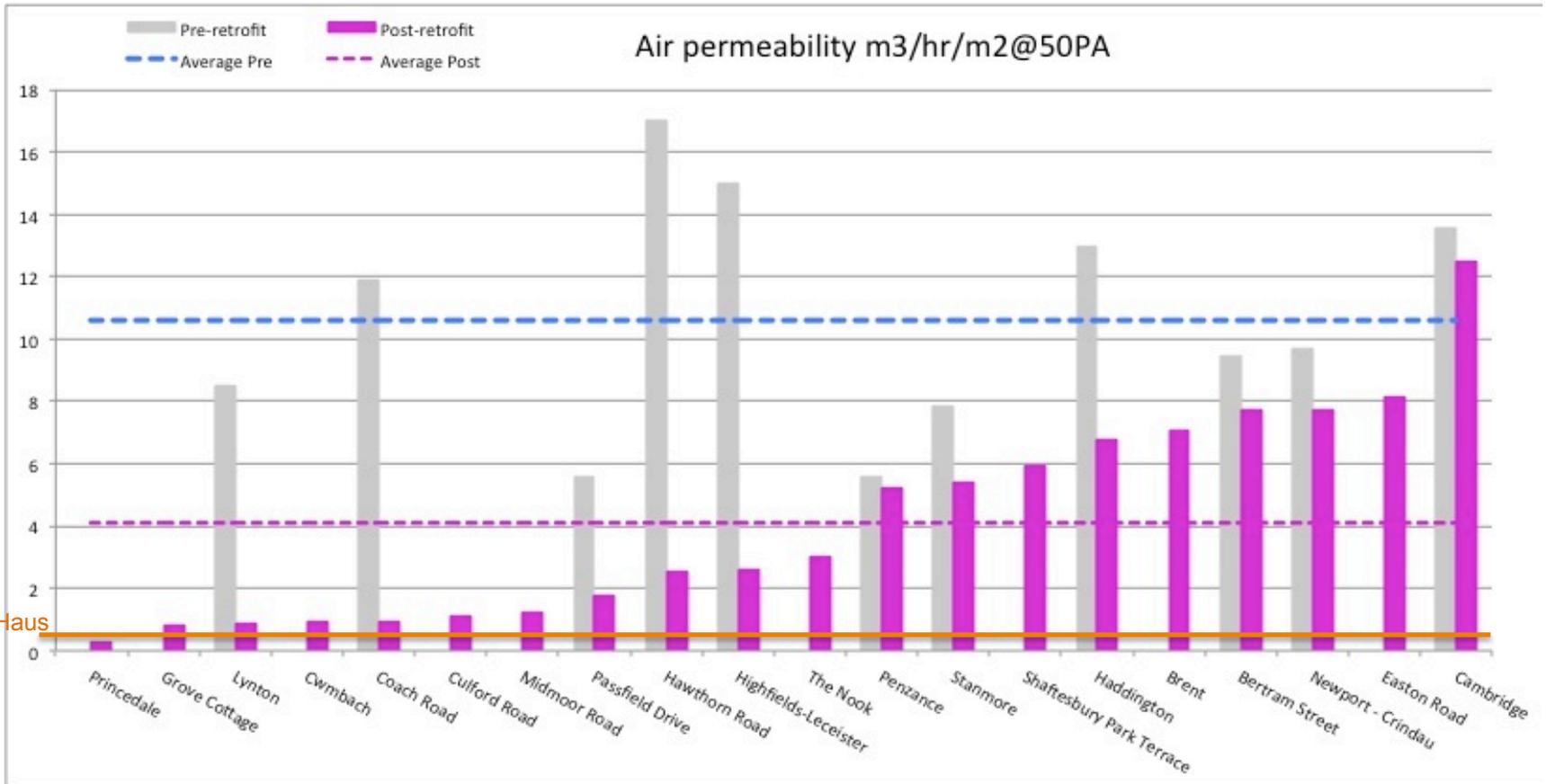


Primary energy demand





Air permeability



4. Case studies pre-1919



Princedale Road

Client: Octavia Housing
Architect: Paul Davis + Partners
Contractor/engineer: Philip Proffitt / Princedale EcoHaus

Construction: **Pre-1919 Solid masonry**

Total cost Material & labour: **£180,683**
Of which energy saving measures: **£69,870**

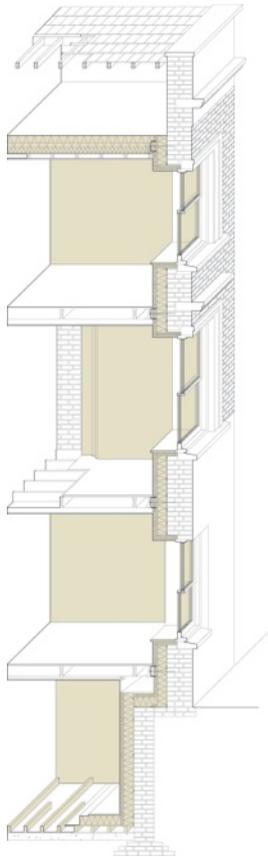
Victorian

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

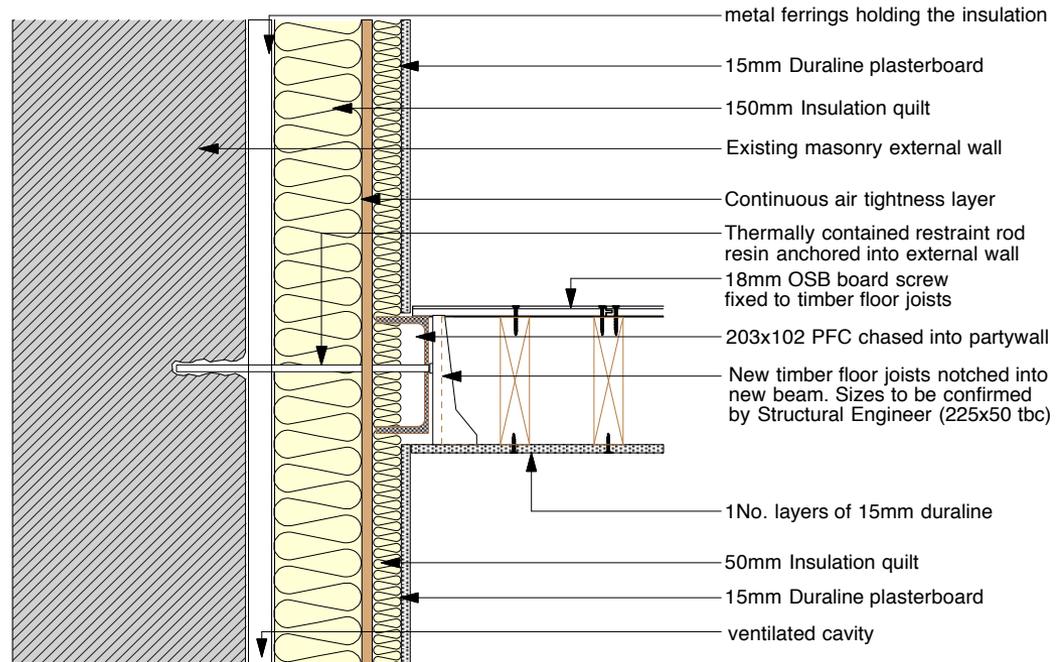
0.34 m³/m²h@50Pa

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



Foam Glass

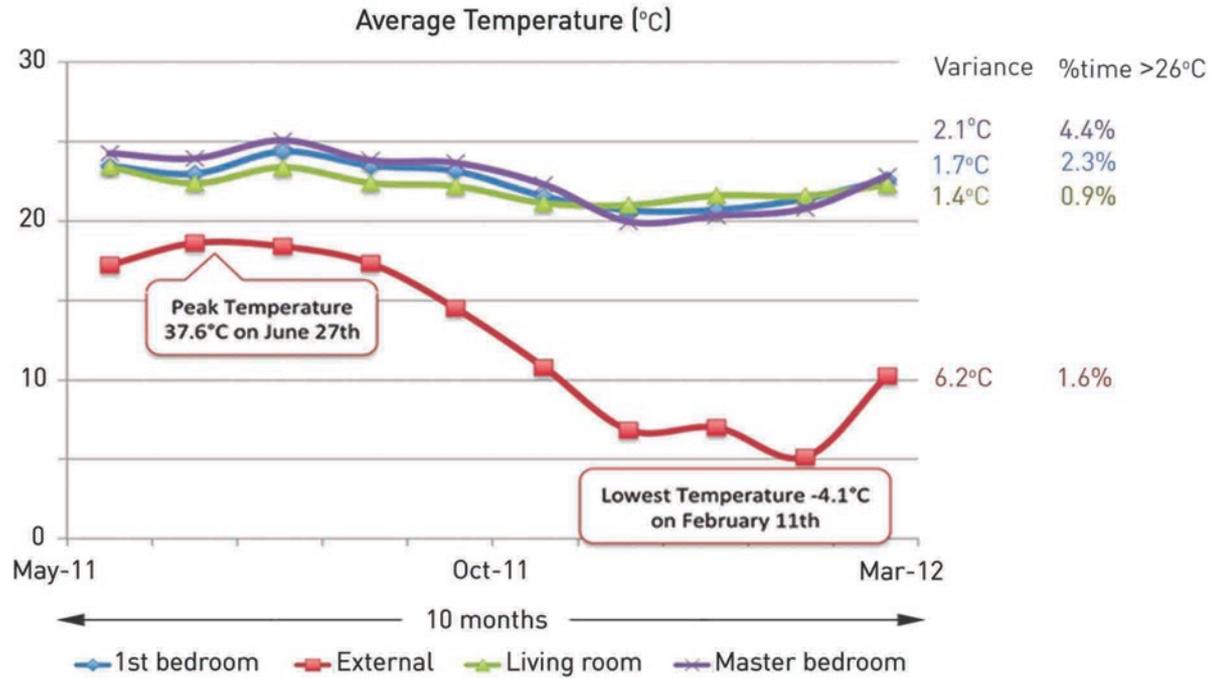
OSB airtight layer

Insulation



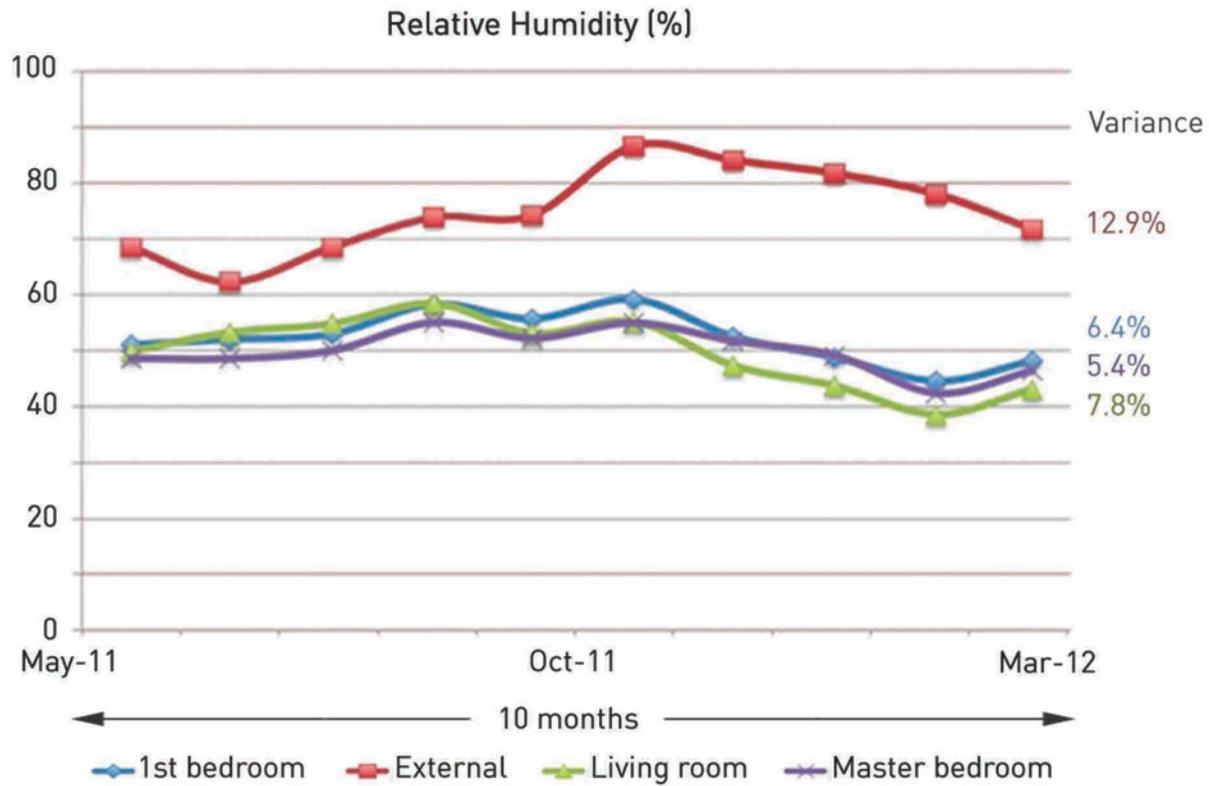


Temperatures



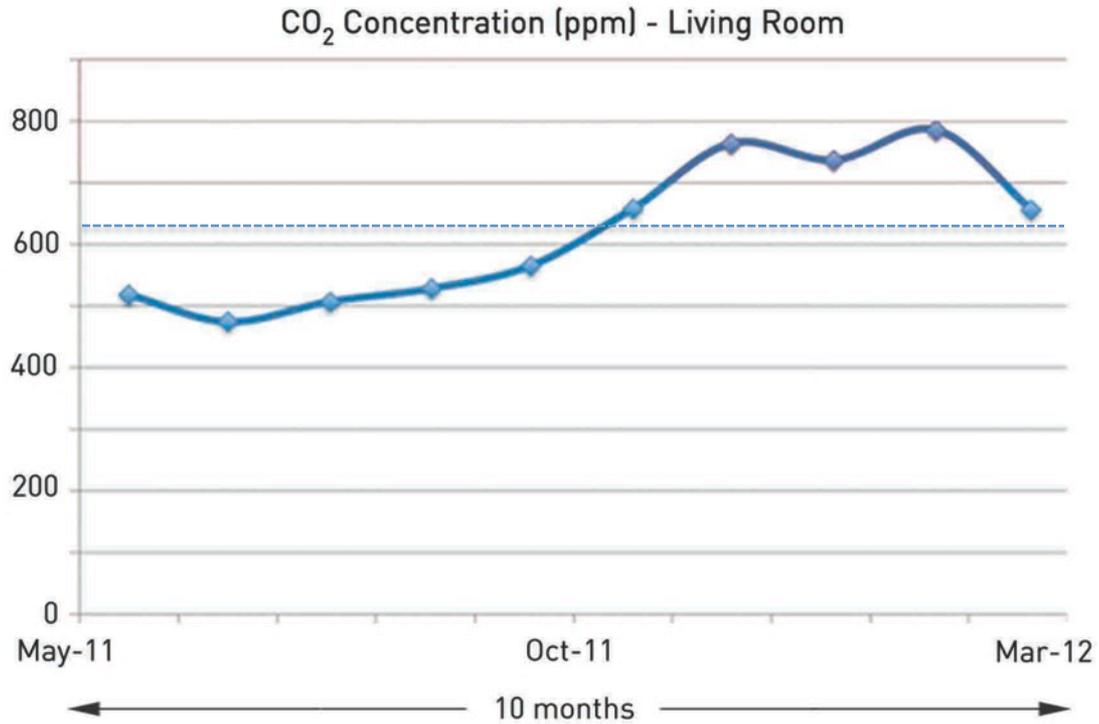


Relative Humidity





CO2 concentration





Midmoor Road

Client: Family Mosaic

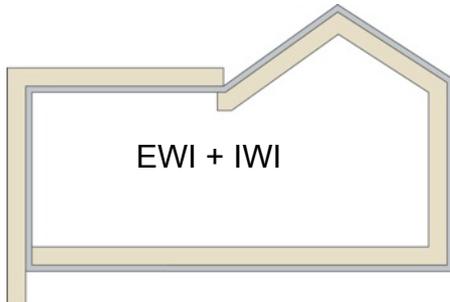
Architect: Prewett Bizley

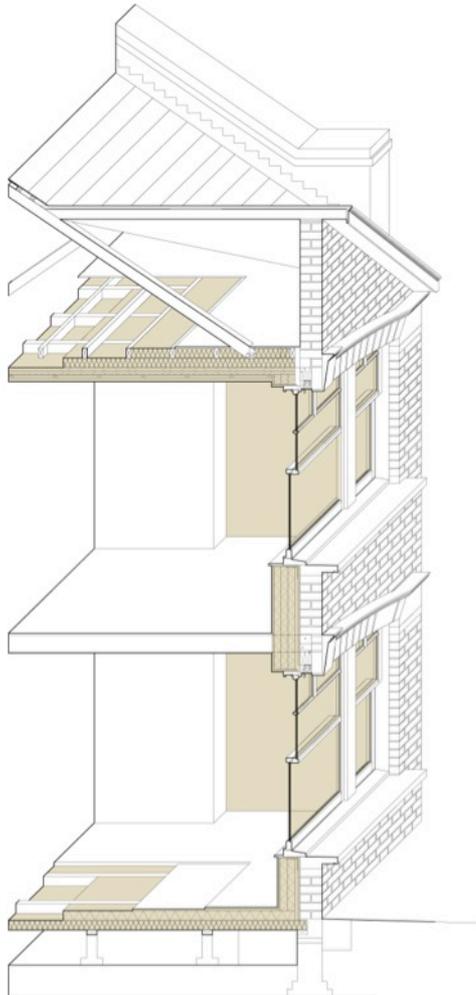
Contractor: Manby

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	–

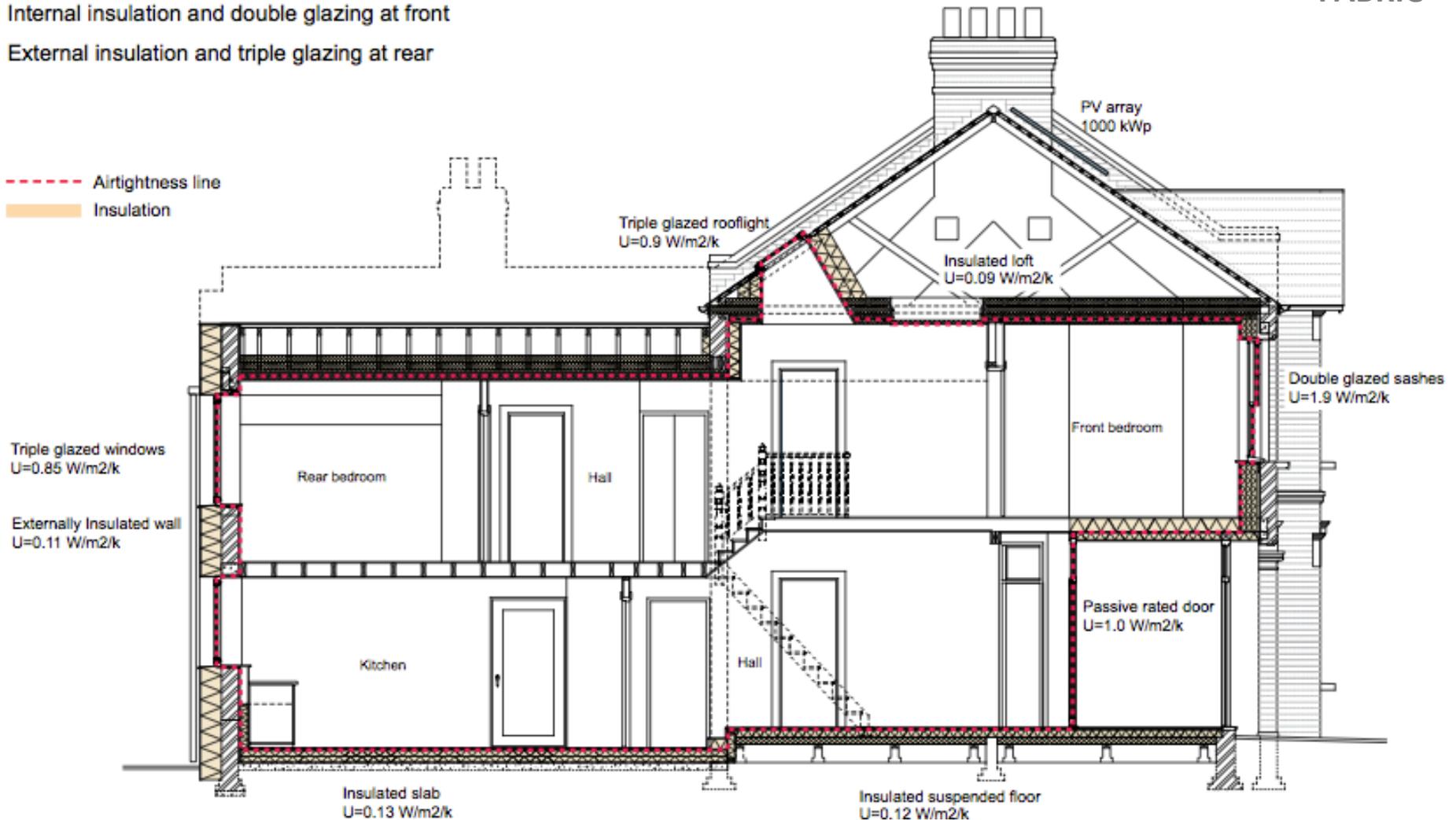


FABRIC

Internal insulation and double glazing at front

External insulation and triple glazing at rear

--- Airtightness line
■ Insulation



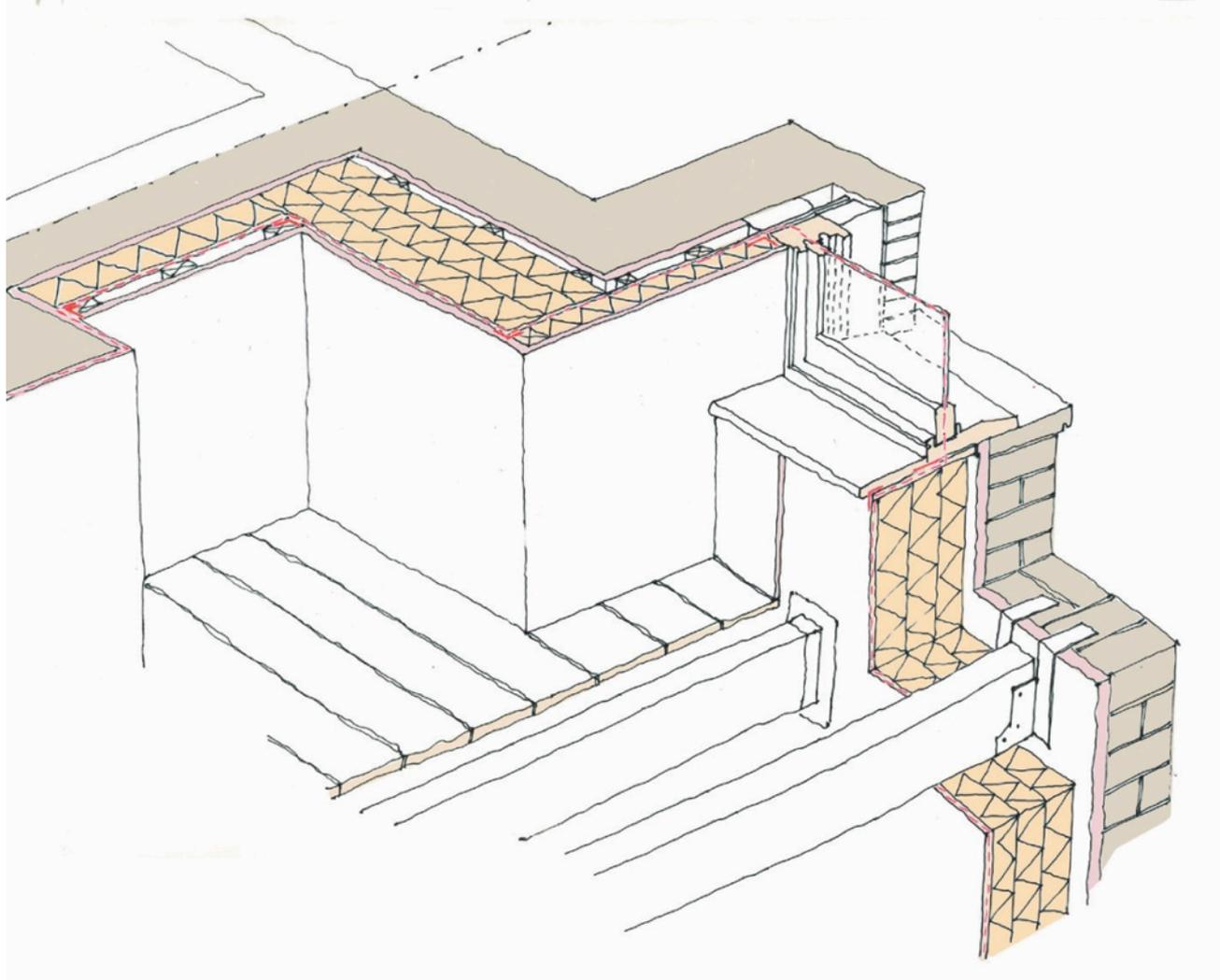


FABRIC



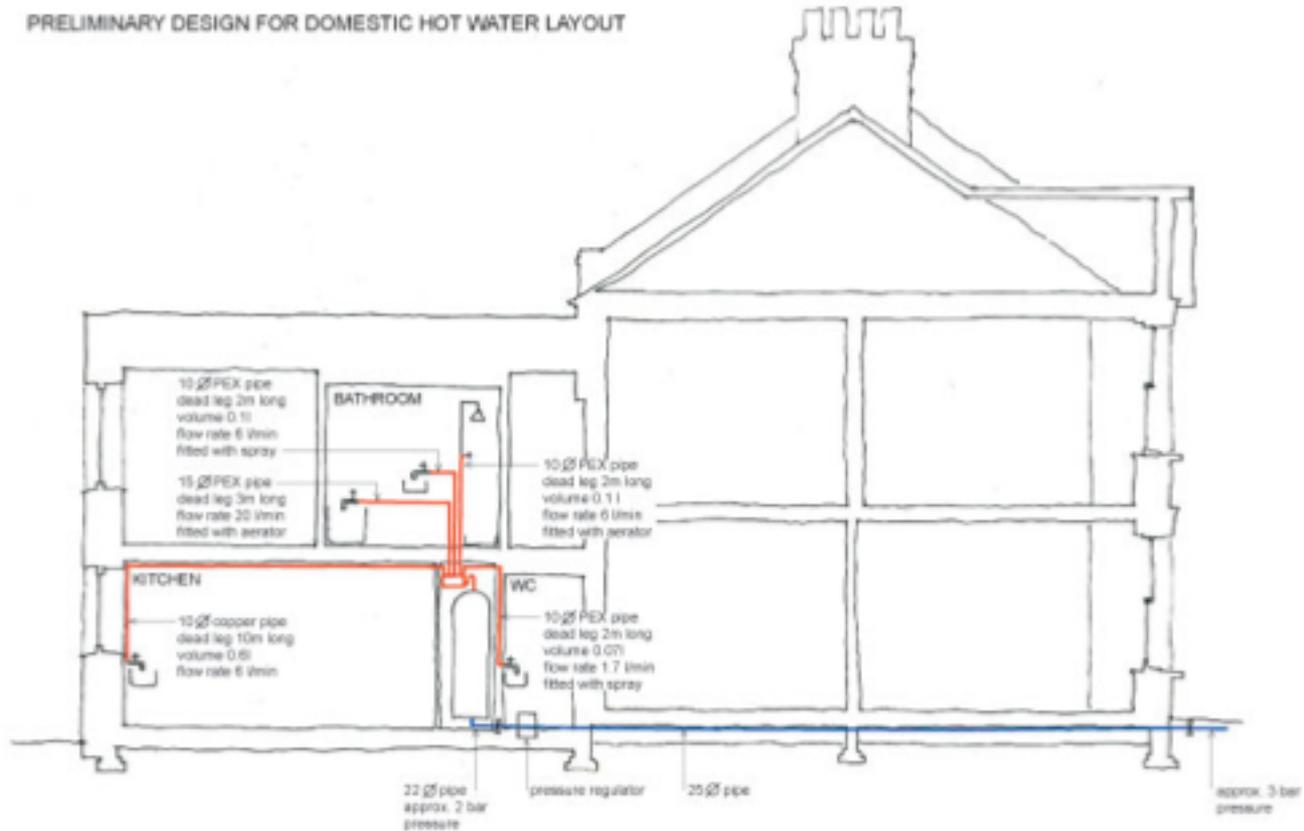


Fabric



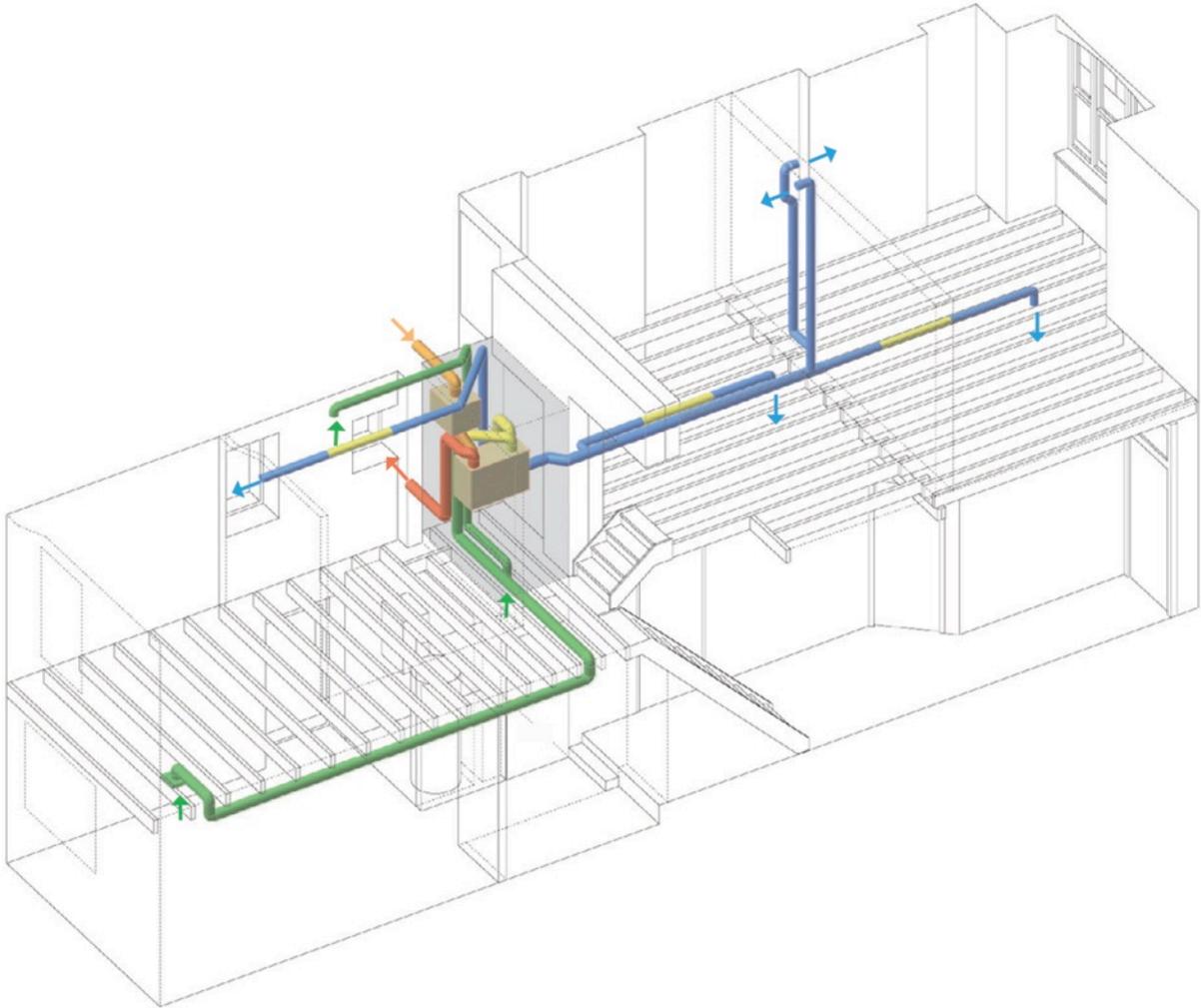


Domestic hot water





Ventilation



5. Case study post-1919



Penzance

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

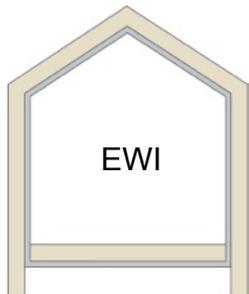
Construction: **Post-1919 - 1950's**

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

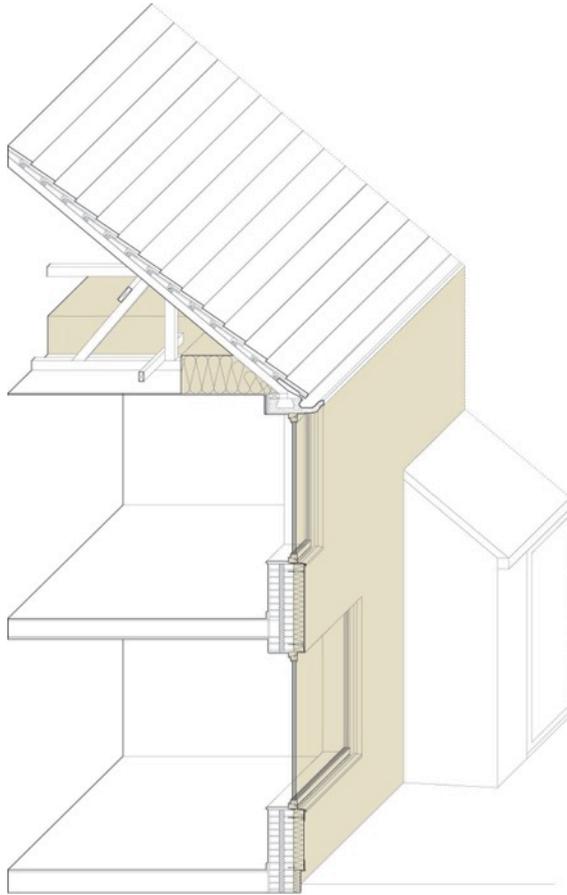
1950's

Semi-detached house

2 occupants







Fabric:

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

Services:

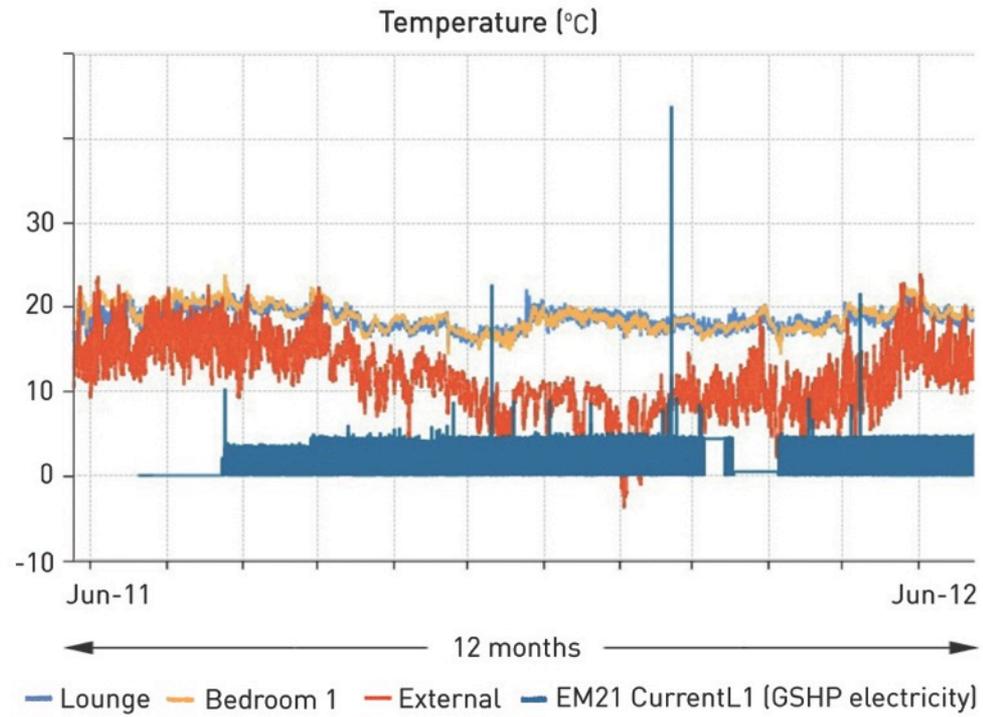
- MVHR
- Ground source heat pump (Calorex 3.5 kW) & pressurised cylinder
- 'Heat pod' extension
- Photovoltaic panels

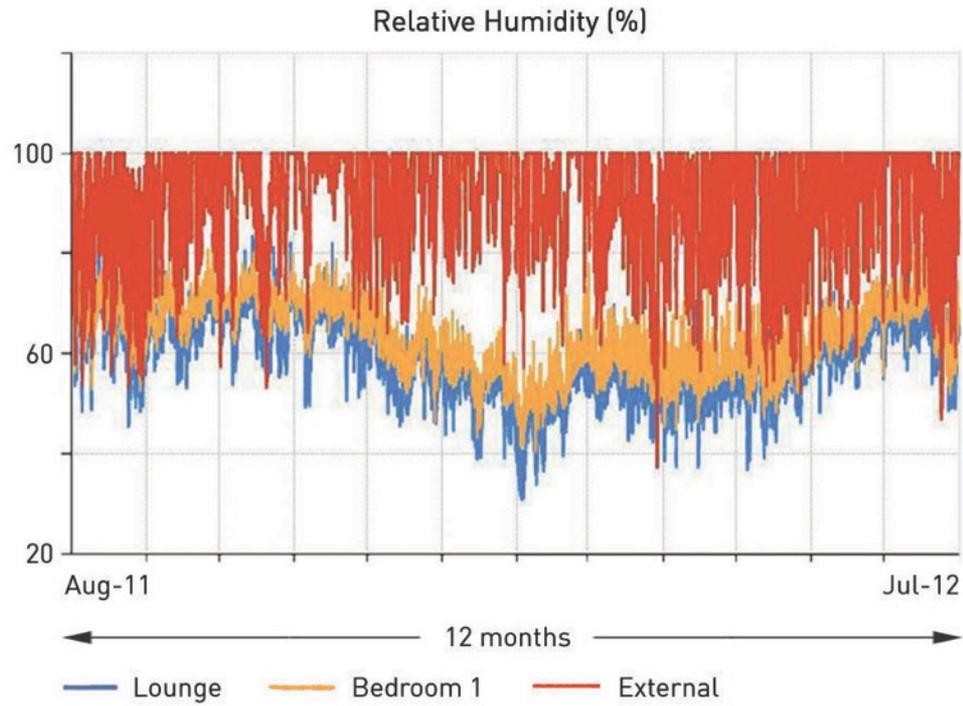
Airtightness:

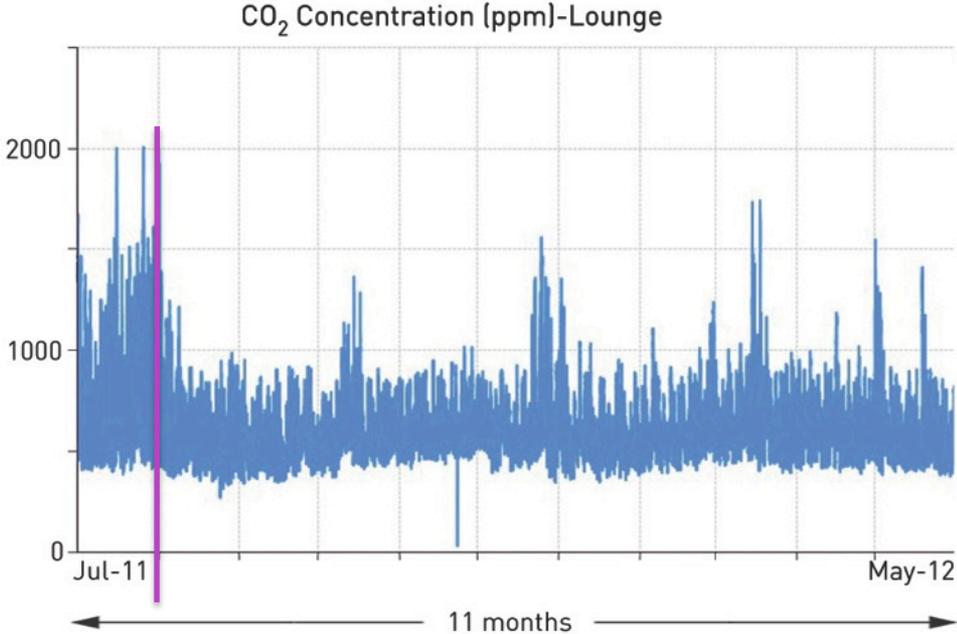
5.25 m³/m²h@50Pa

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



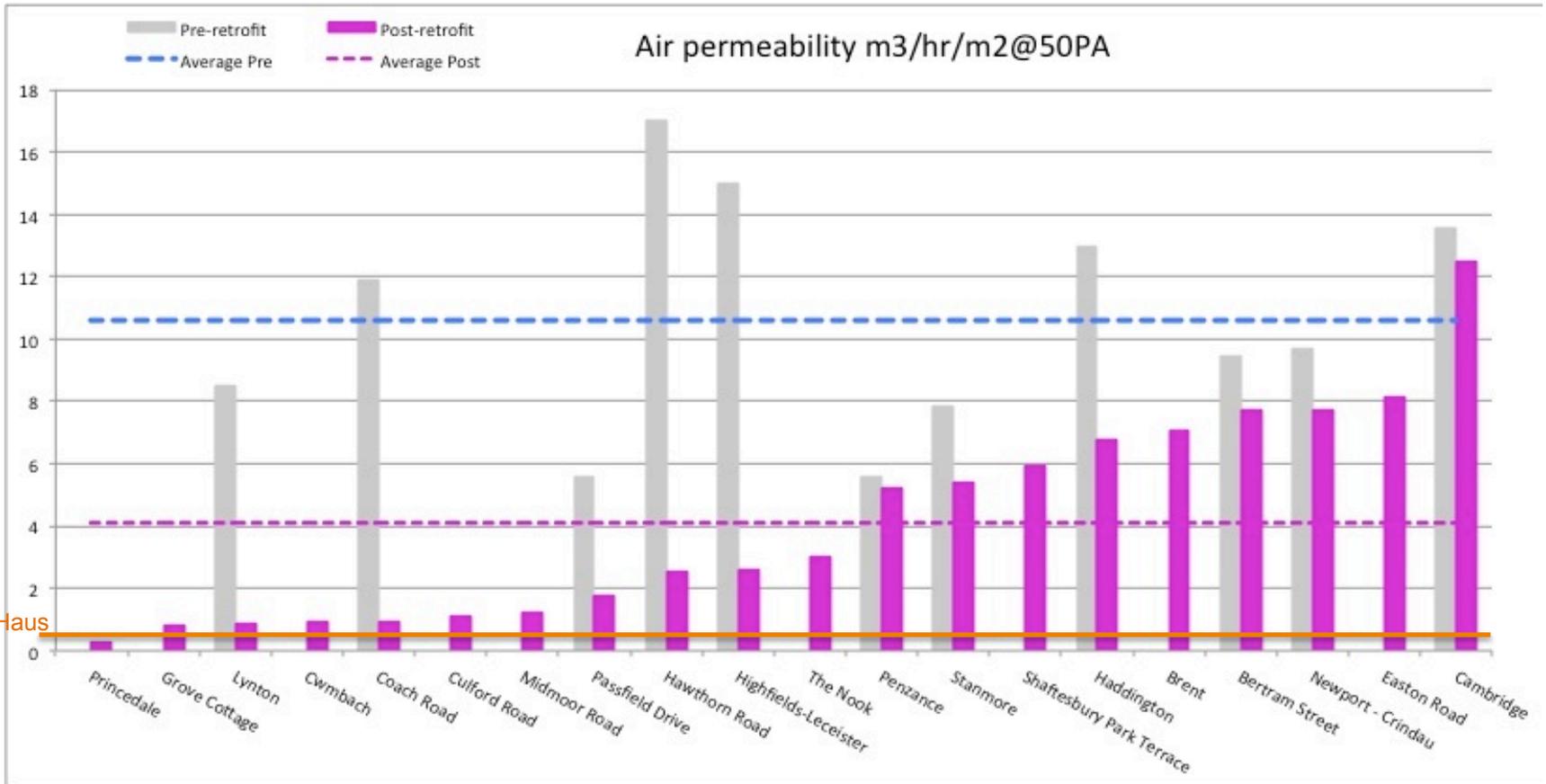




6. Airtightness



Air permeability



~11

4

PassivHaus



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



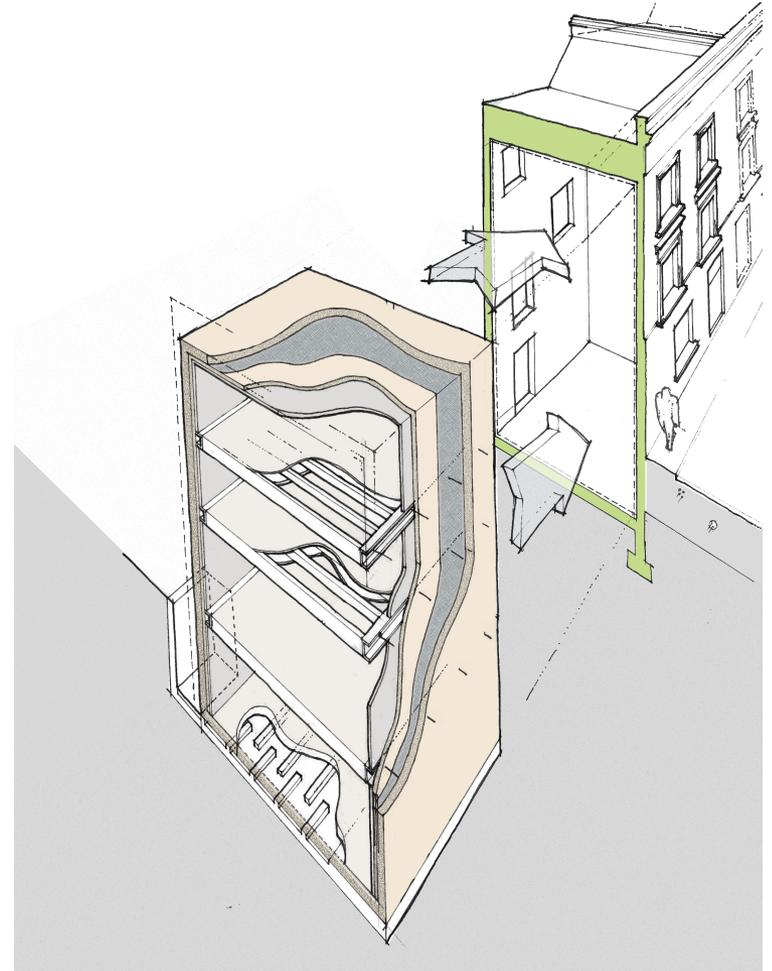


Simple strategy gets best results

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

Airtightness

0.34 m³/m²h@50Pa





Difficult junction

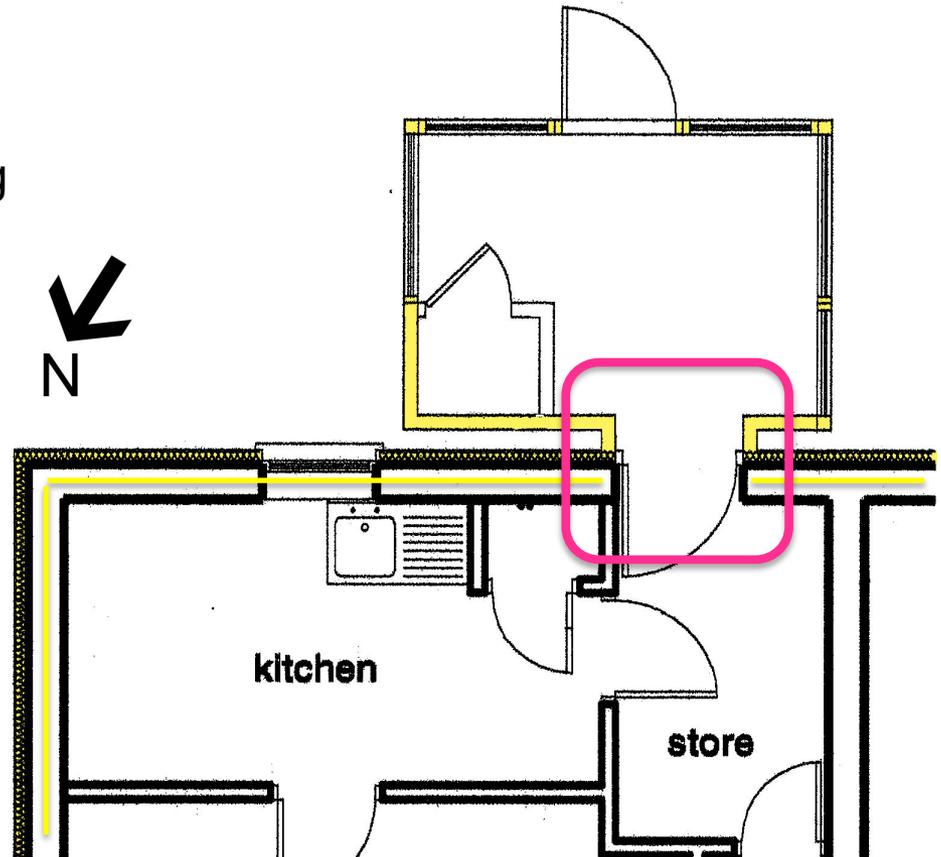
- New volume attached to an existing construction
- External airtight layer
- Mitigation of penetrations

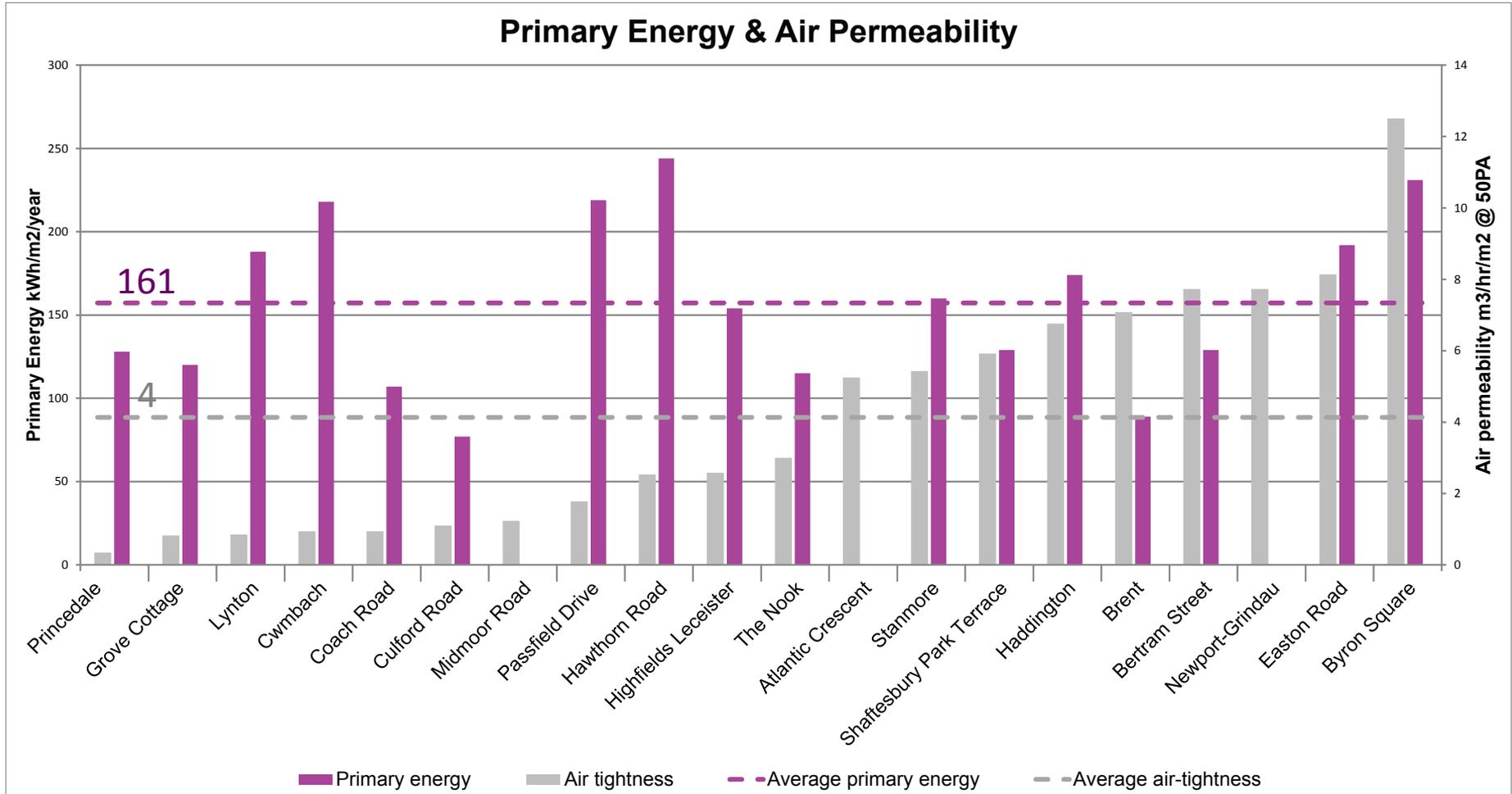
Airtightness figures

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

