Residential Retrofit
Review of evidence about performance

Marion Baeli

Passivhaus Trust & paul davis + partners architects urban designers

paul davis + partners
architects urban designers

Passivhaus Trust
The UK Passive House Organisation

Content:

1. Retrofit for the Future
2. Book
3. Review of evidence about performance

1. 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

  100 projects have been completed

  £150,000 funding per dwelling

- **Aim**:

  Look for a response to the UK Government's target to reduce greenhouse gas (GHG) emissions by 80% by the year 2050.

CO2 emissions reduction

Targets:	**Results from 20 case studies**
Reduction in CO_2 **80**% →	**70**% reduction in CO_2 from pre-retrofit
CO_2 emissions **17** kg/m^2/yr →	**26** kg/m2/yr CO_2 emissions average
Primary energy **115** kWh/m^2/yr →	**161** kWh/m2/yr Primary energy average (67% reduction from the primary energy demand average pre-retrofit)

- **Results**:

  www.retrofitanalysis.org

2. book

residential retrofits, 20 case studies

Technology Strategy Board
Driving Innovation

paul davis + partners
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RIBA Publishing

Author:	Marion Baeli
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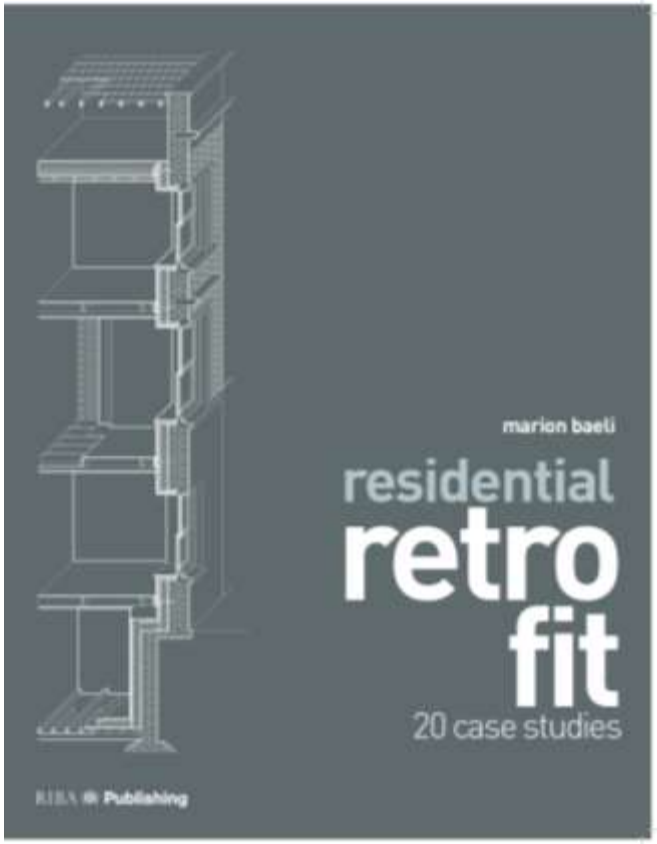
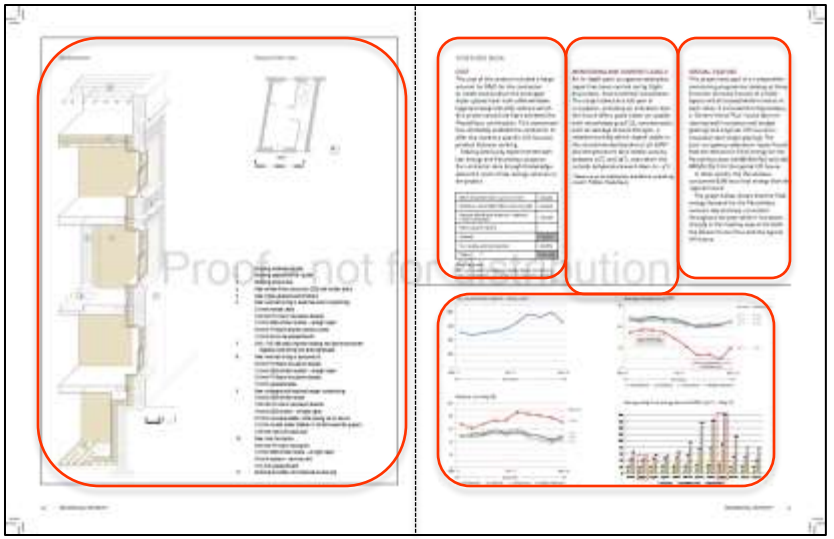


Content:

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



3. review of evidence about performance

CO2 emissions

energy

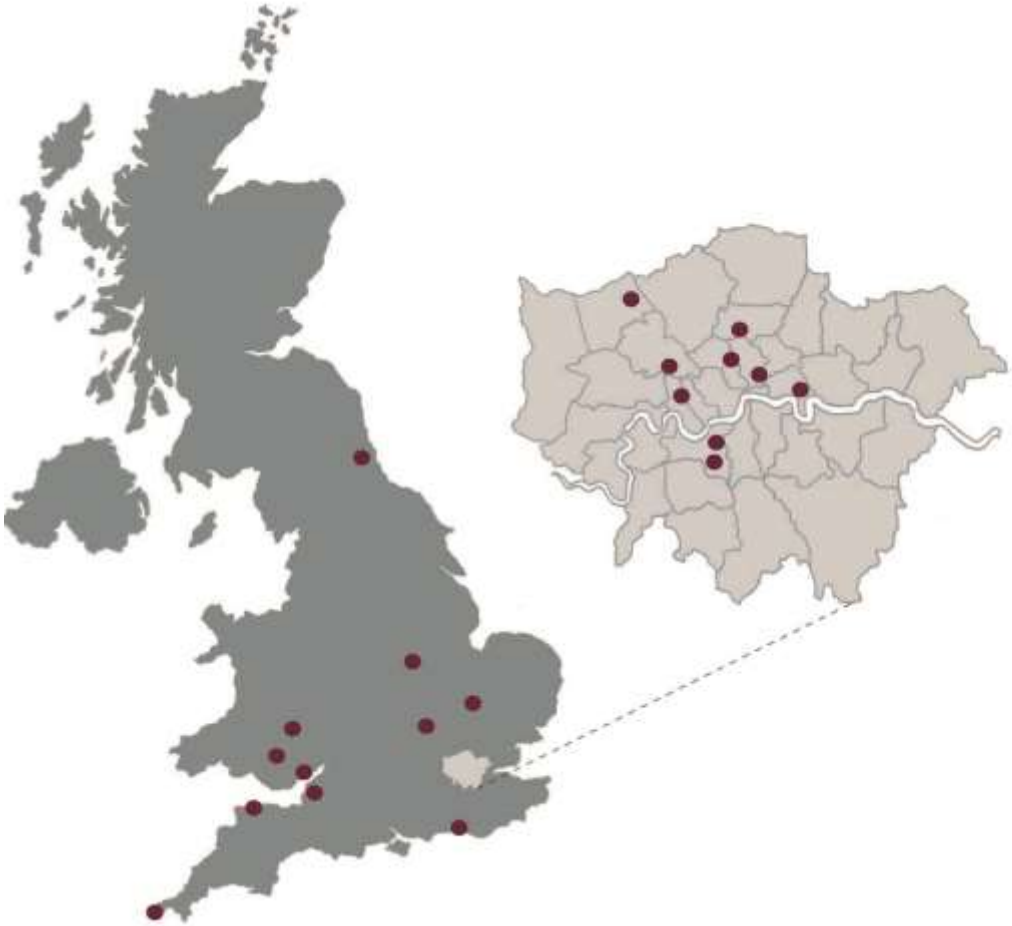
airtightness

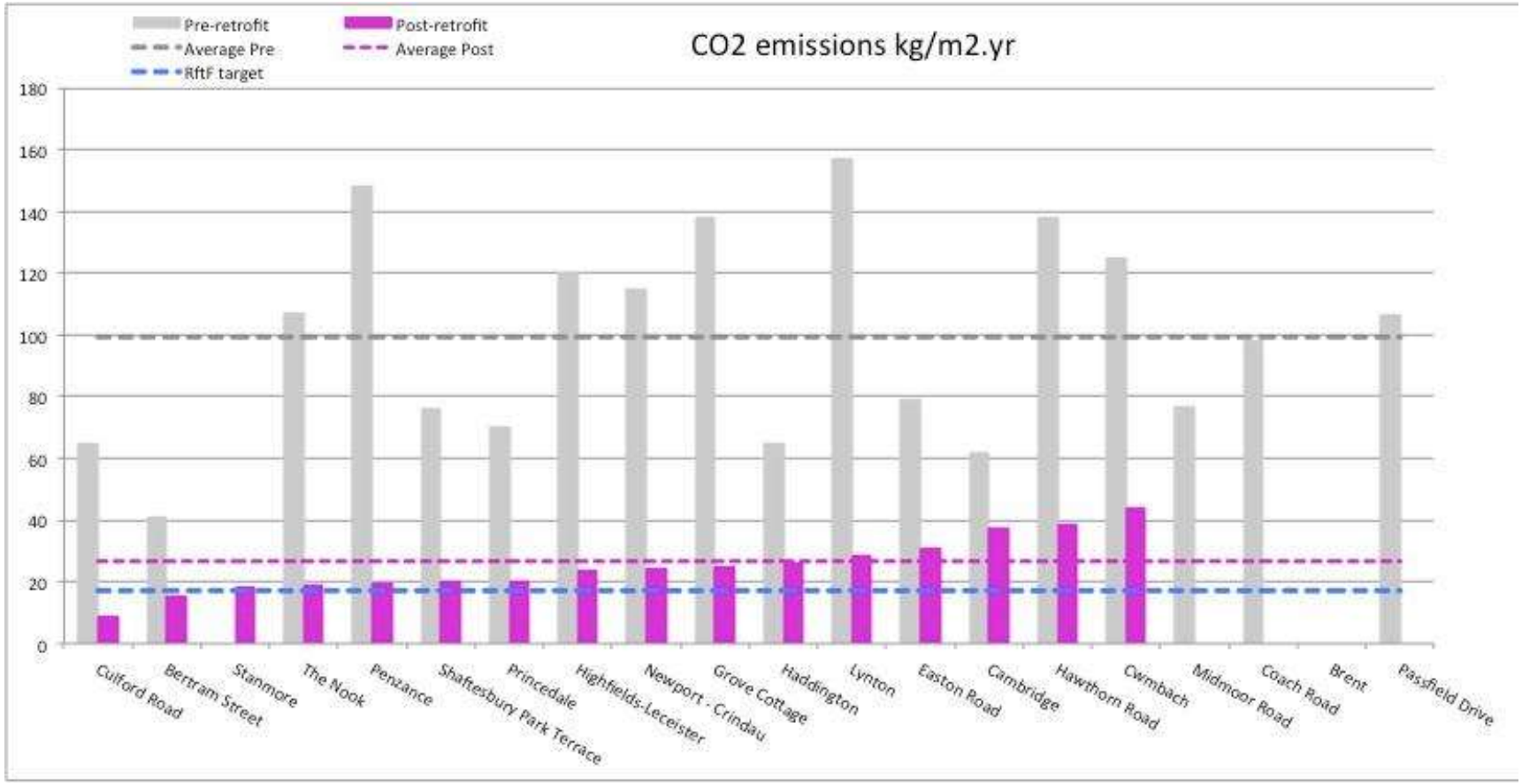
CO2 concentration

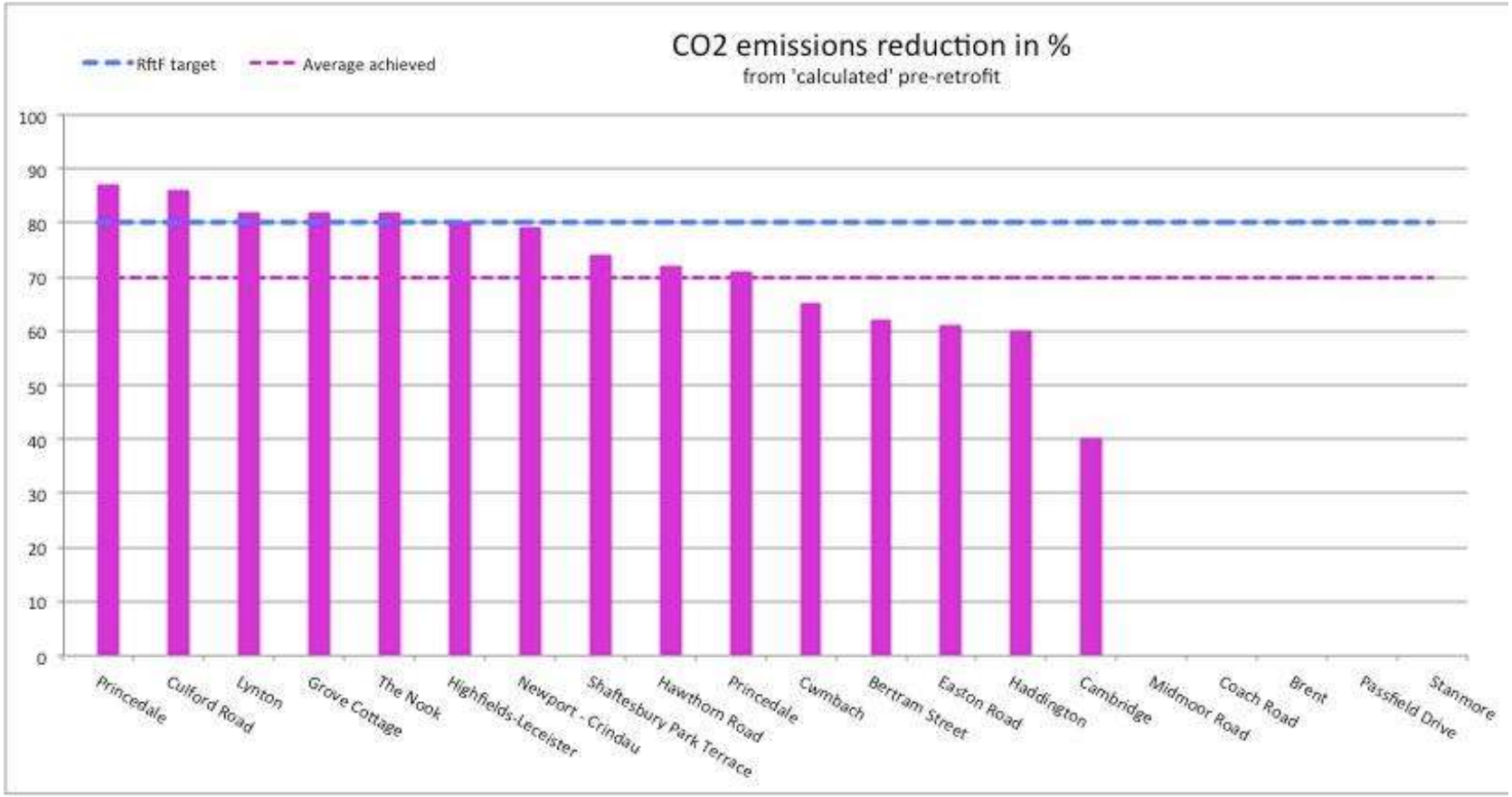
relative humidity

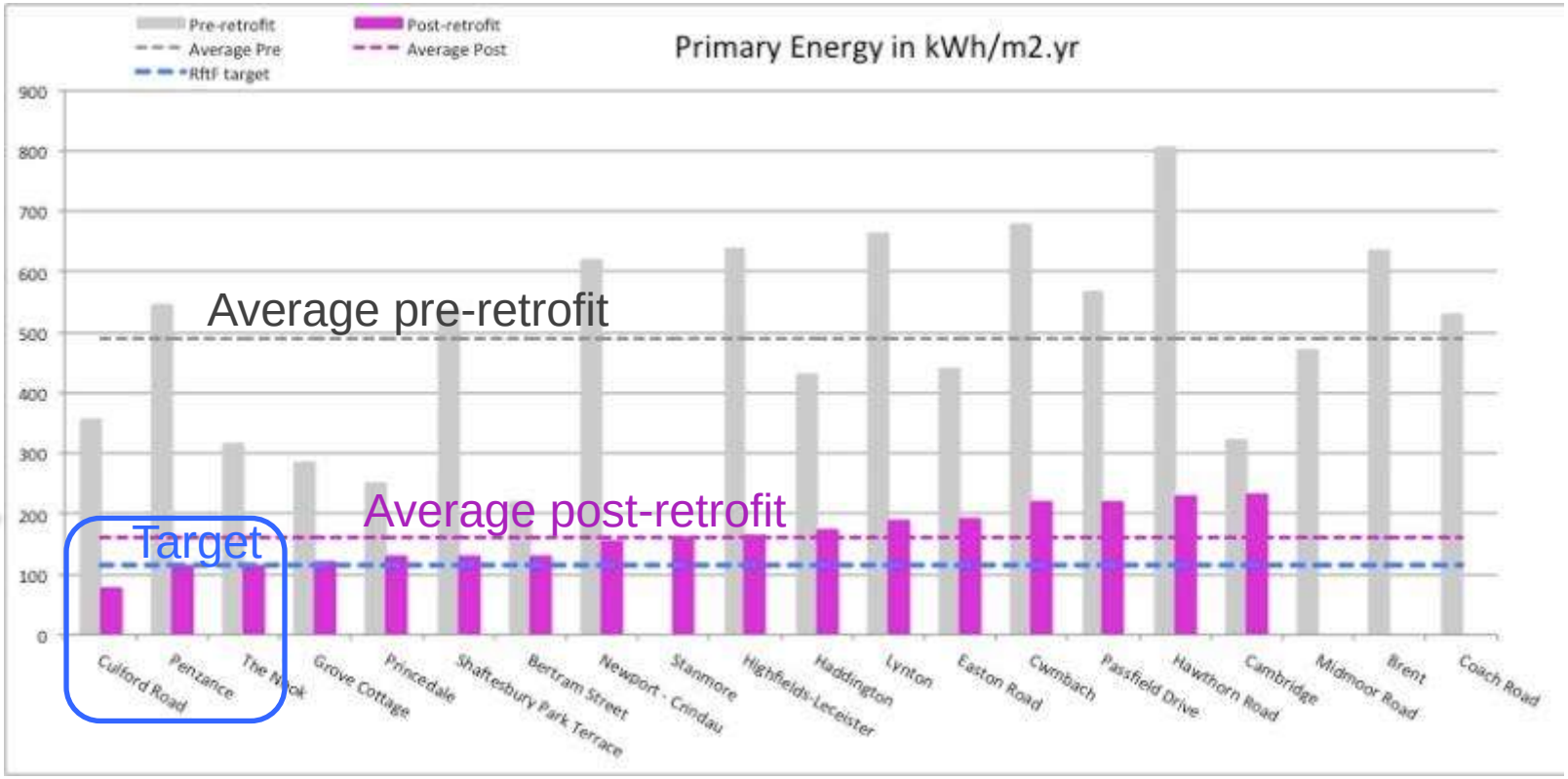
temperatures

20 project locations



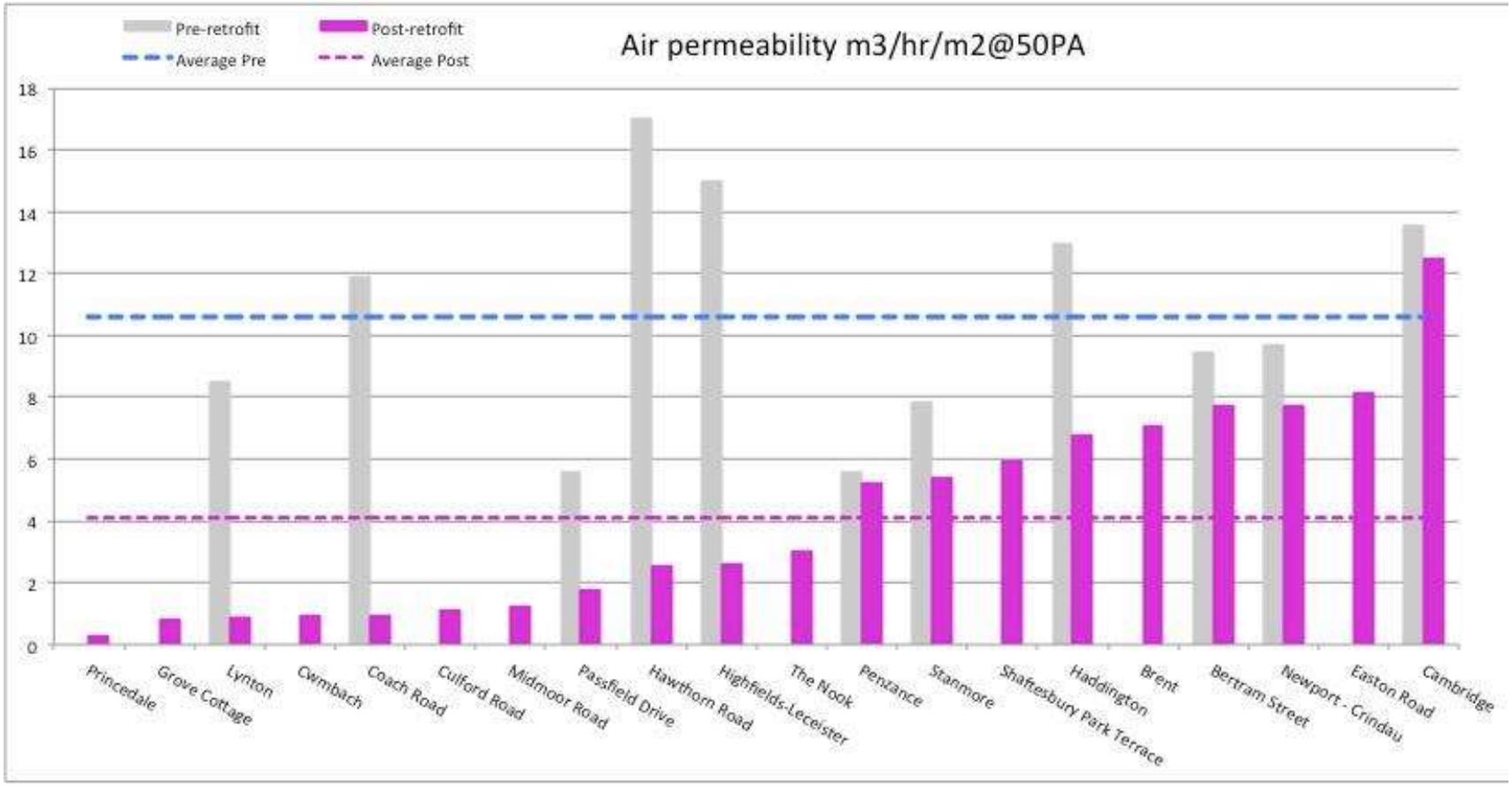

Pre-retrofit
Post-retrofit
Average Pre
Average Post
RftF target
CO2 emissions kg/m2.yr
180
160
140
120
100
80
60
40
20
0
Culford Road
Bertram Street
Stanmore
The Nook
Penzance
Shaftesbury Park Terrace
Princedale
Highfields-Leceister
Newport - Crindau
Grove Cottage
Haddington
Lynton
Easton Road
Cambridge
Hawthorn Road
Cwmbach
Midmoor Road
Coach Road
Brent
Passfield Drive


CO2 emissions reduction in %
from 'calculated' pre-retrofit
RftF target
Average achieved
100
90
80
70
60
50
40
30
20
10
0
Princedale
Culford Road
Lynton
Grove Cottage
The Nook
Highfields-Leceister
Newport - Crindau
Shaftesbury Park Terrace
Hawthorn Road
Princedale
Cwmbach
Bertram Street
Easton Road
Haddington
Cambridge
Midmoor Road
Coach Road
Brent
Passfield Drive
Stanmore



70% reduction

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


Pre-retrofit
Post-retrofit
Average Pre
Average Post
Air permeability m3/hr/m2@50PA
18
16
14
12
10
8
6
4
2
0
Princedale
Grove Cottage
Lynton
Cwmbach
Coach Road
Culford Road
Midmoor Road
Passfield Drive
Hawthorn Road
Highfields-Leceister
The Nook
Penzance
Stanmore
Shaftesbury Park Terrace
Haddington
Brent
Bertram Street
Newport - Crindau
Easton Road
Cambridge

RftF Programme main targets:

- 80% reduction in CO_2 compared to 1990 emissions
- CO_2 emissions limited to 17 kg/m^2.yr [20 kg/m^2.yr for PHPP]
- Primary Energy limited to 115 kWh/m^2.yr [PassivHaus is 120kWh/m^2.yr]

RftF Programme comfort monitoring:

- Temperature
- Relative Humidity
- CO_2 concentration
- (Occupant interviews)

- Temperature:

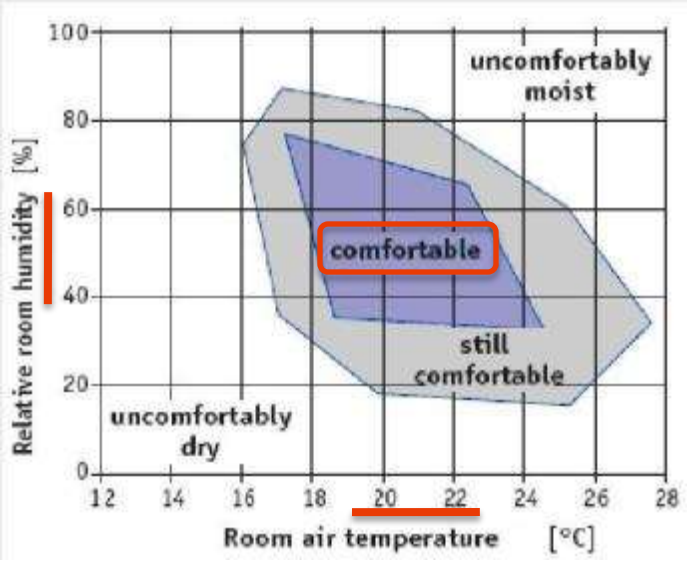
  ~21ºC

- Relative Humidity

  ~40 – 60%

- CO2 concentration

  ~1000 – 1500ppm



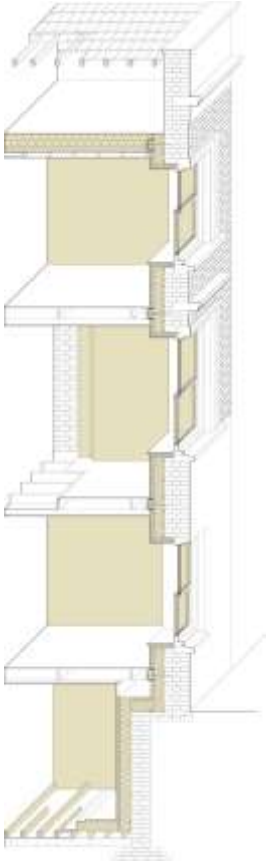
Property 1 (Princedale Road)

Victorian

Mid-terrace house

5 occupants

Property 1 (Princedale Road)



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

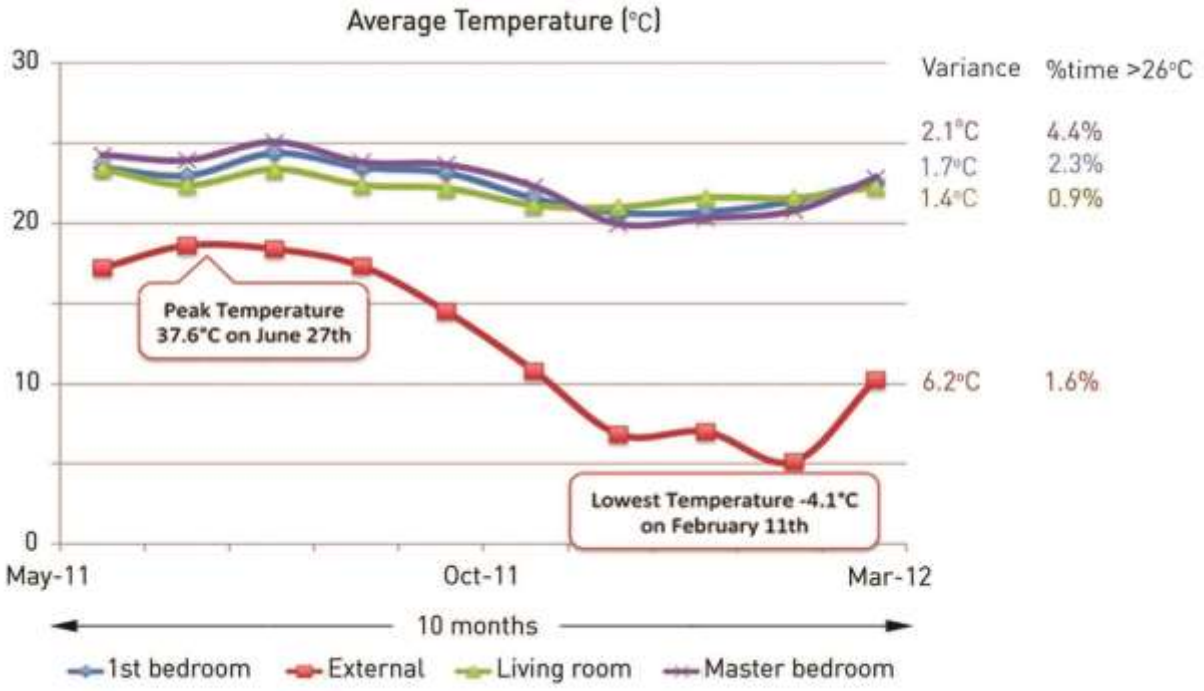
Services:
- MVHR (Genvex Combi)
- Solar thermal
- Below ground heat exchanger

Airtightness
0.34 m3/m2h@50Pa

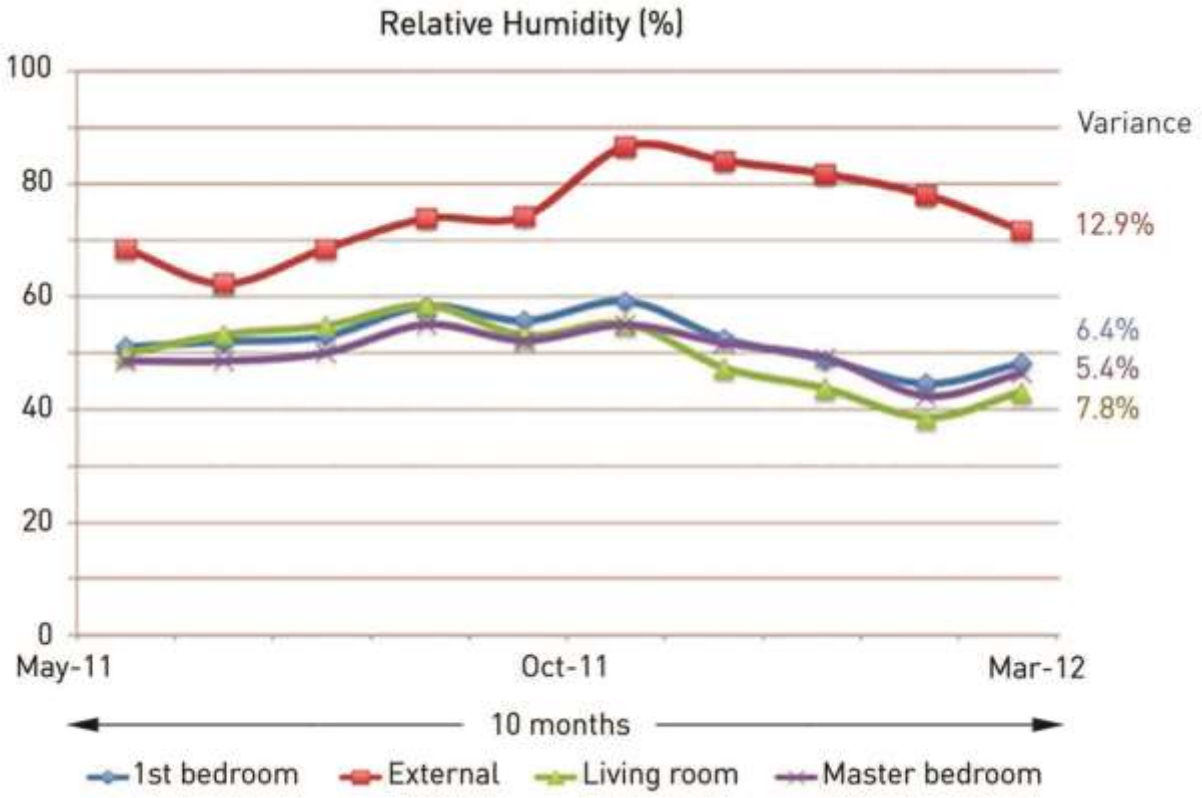
Vital statistics table

Characteristics	Before	Target	Measured
Primary energy (kWh/m²/year)	250	120	128
Space heating (kWh/m²/year)	120	15	10
Airtightness (m³/m²h @ 50 Pa)	–	0.6	0.34
Type of glazing	single	triple	triple
CO_2 emissions (kg CO_2/m²/year)	70	17	20

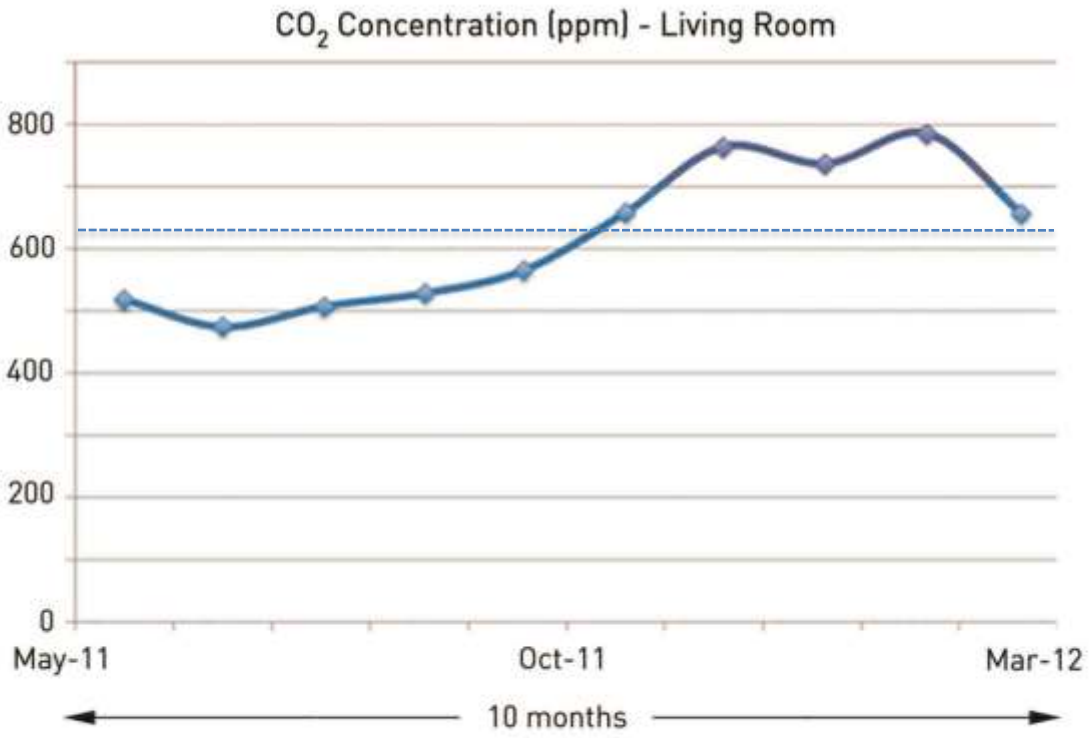
Property 1 (Princedale Road)



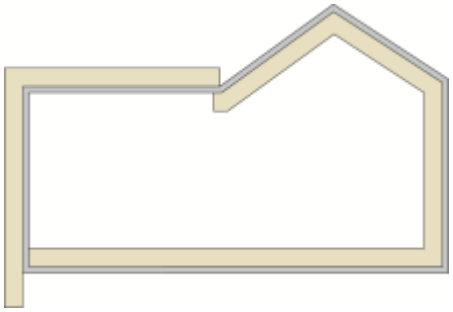
Property 1 (Princedale Road)



Property 1 (Princedale Road)



Property 2 (The Nook)

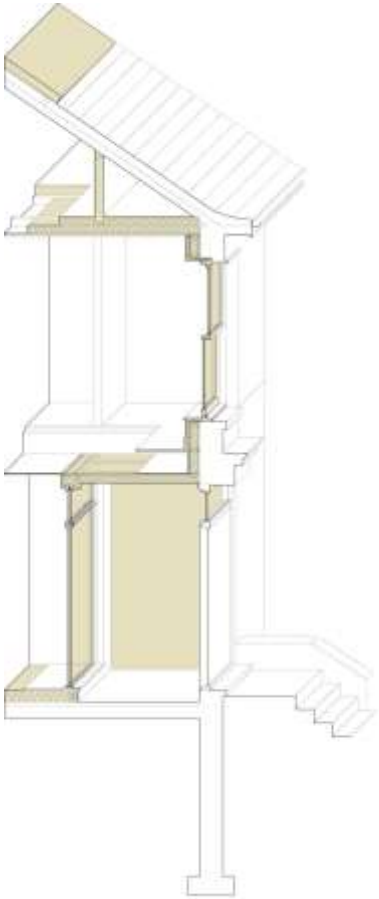


Victorian

Detached house

6 occupants (all adults)

Property 2 (The Nook)



Fabric:
- IWI & EWI
- Triple & Double glazing
- Some cold bridges (joist ends)

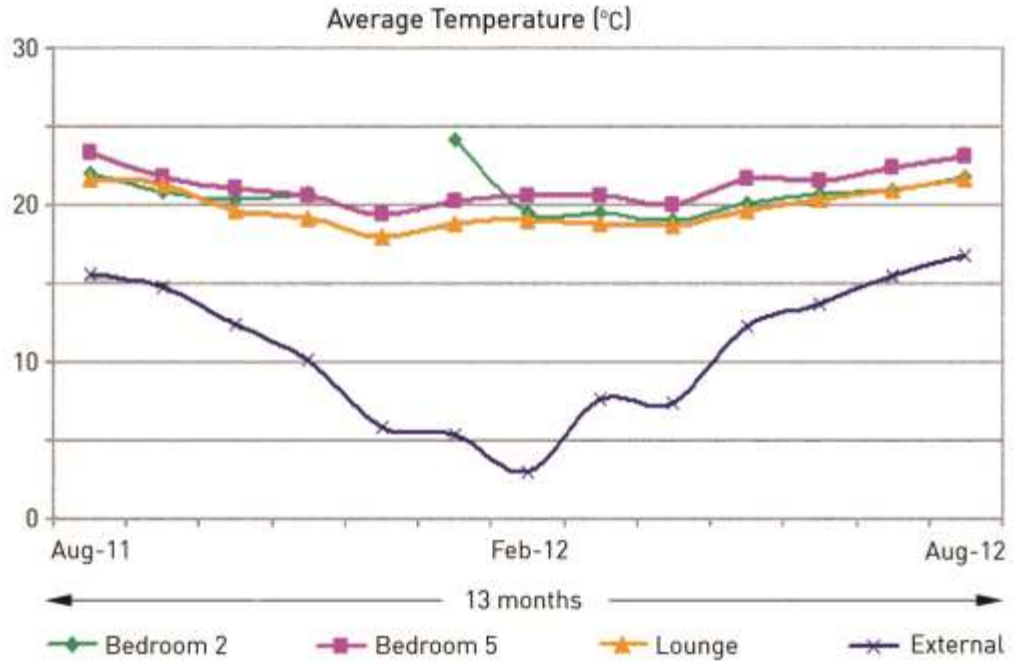
Services:
- MVHR (Paul)
- Gas boiler
- Solar thermal

Airtightness:
3 m3/m2h@50Pa

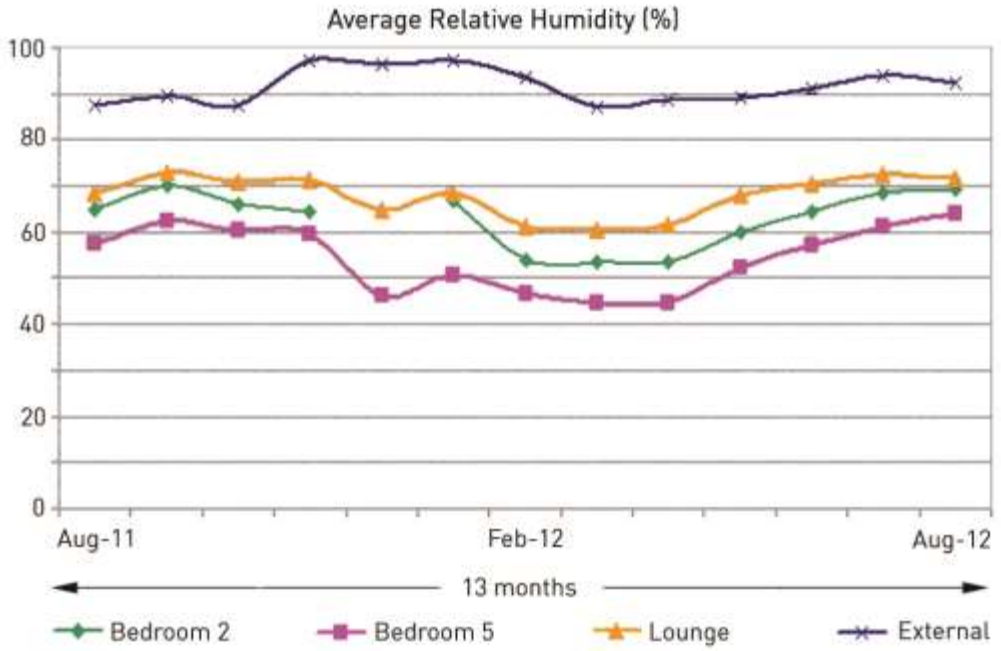
Vital statistics table

Characteristics	Before	Target	Measured
Primary energy kWh/m²/year	316	114	115
Space heating kWh/m²/year	–	40	–
Airtightness (m³/m²h @ 50 Pa)	–	–	3
Type of glazing	single	double/ triple	double/ triple
CO_2 emissions (kg CO_2/m²/year)	107	23	21

Property 2 (The Nook)



Property 2 (The Nook)



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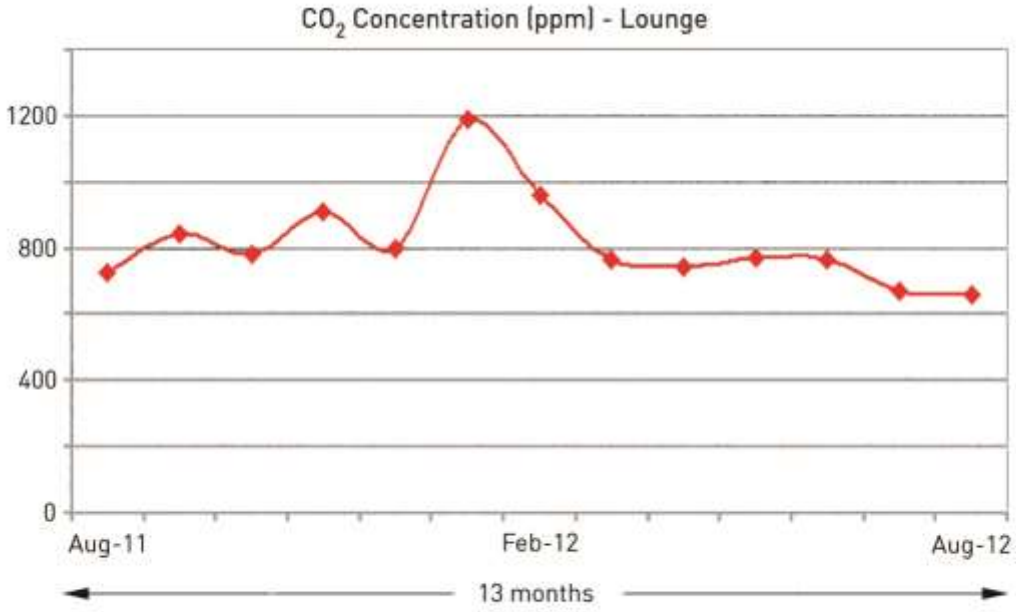


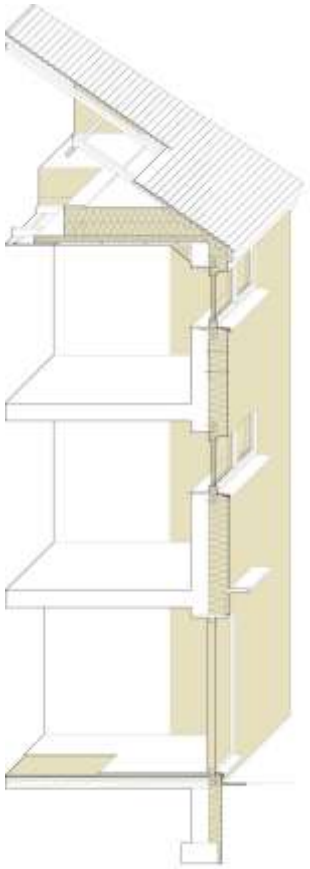
Property 3 (Passfield Drive)

1950’s

Terraced house

8 occupants (family)

Property 3 (Passfield Drive)



Fabric:
- EWI
- Triple glazing
- Minimal cold bridges (floor/wall)

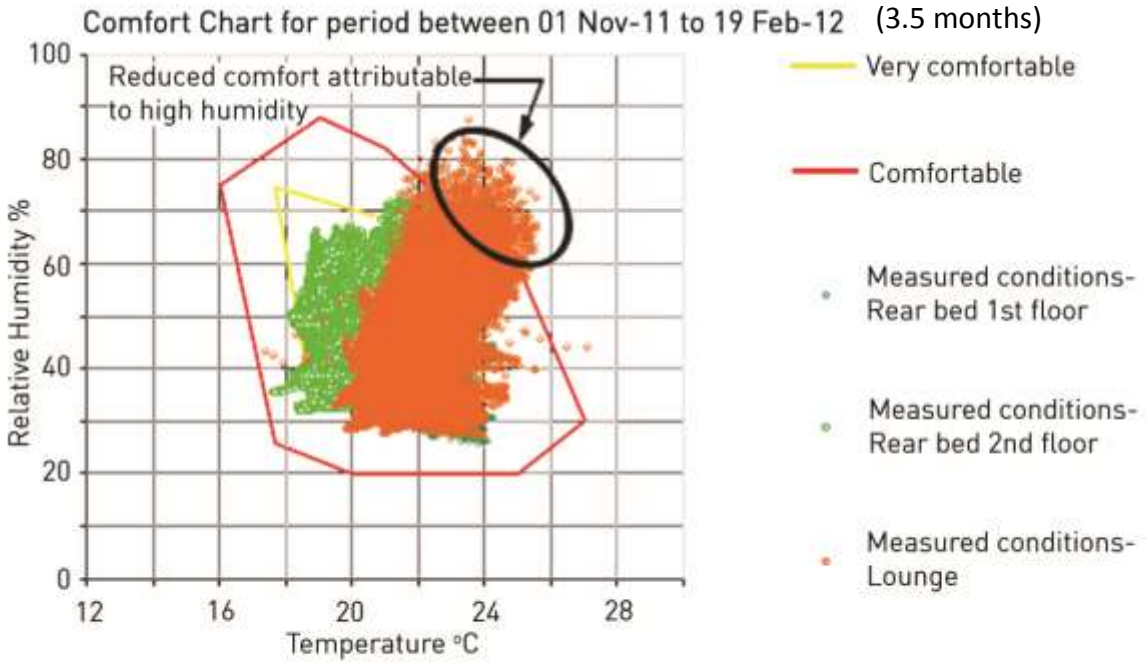
Services:
- MVHR (Paul)
- Gas boiler
- Solar thermal

Airtightness:
1.4 m3/m2h@50Pa

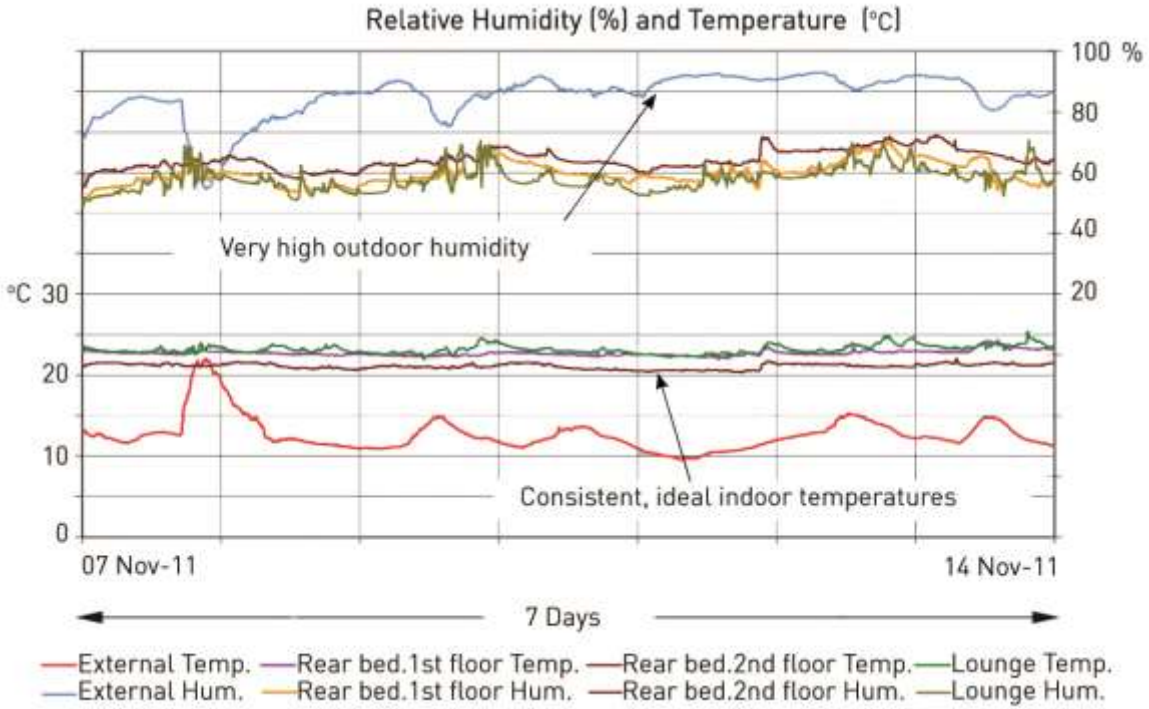
Vital statistics table

Characteristics	Before	Target	Measured
Primary energy (kWh/m²/year)	566	119.2	219
Space heating kWh/m²/year	303	25	–
Airtightness (m³/m²h @ 50 Pa)	5.6	1	1.4
Type of glazing	double	triple	triple
CO_2 emissions (kg CO_2/m²/year)	106.5	25.2	–

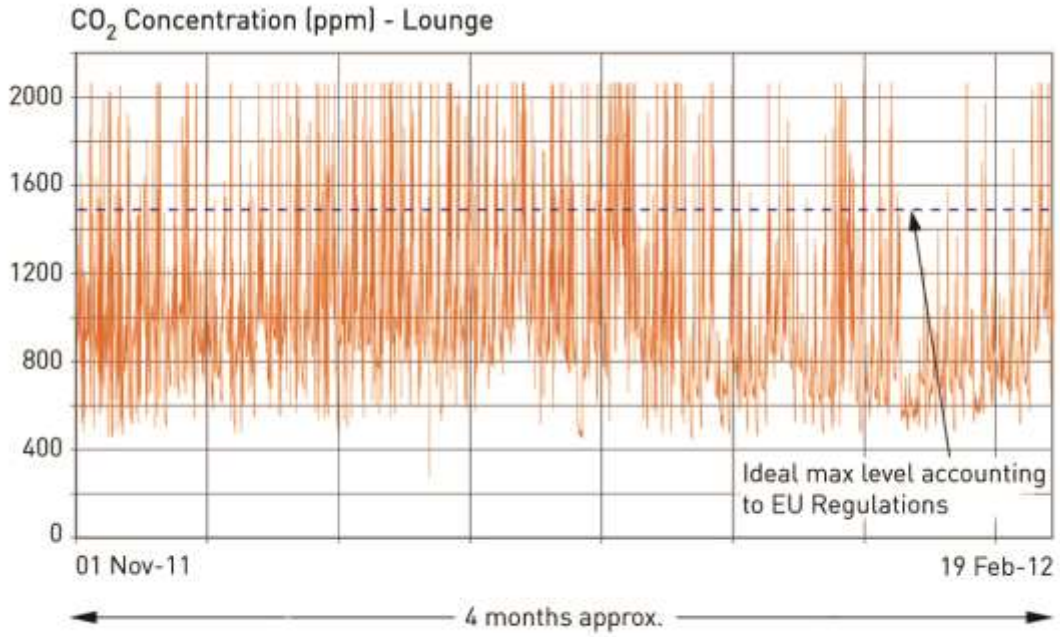
Property 3 (Passfield Drive)



Property 3 (Passfield Drive)



Property 3 (Passfield Drive)



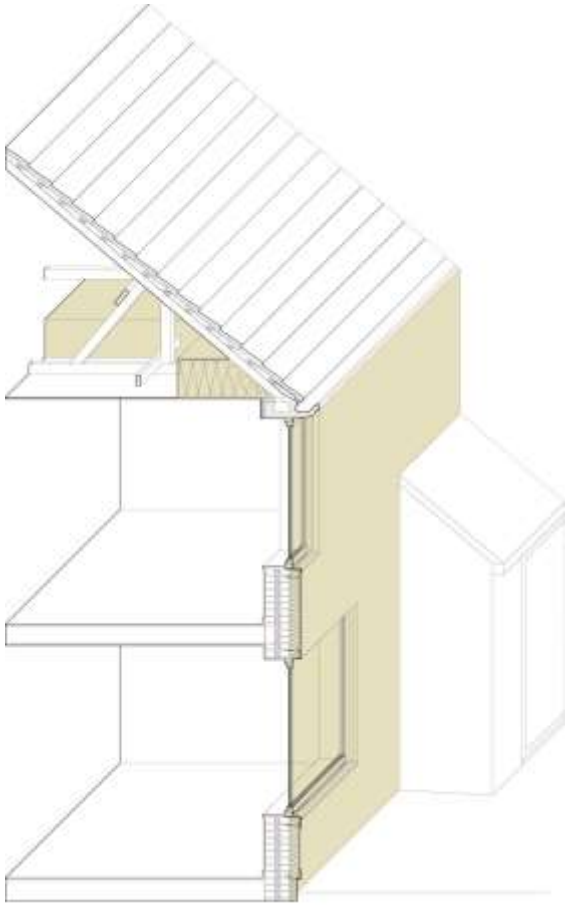
Property 4 - Penzance

1950’s

Semi-detached house

2 occupants

Property 4 - Penzance



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

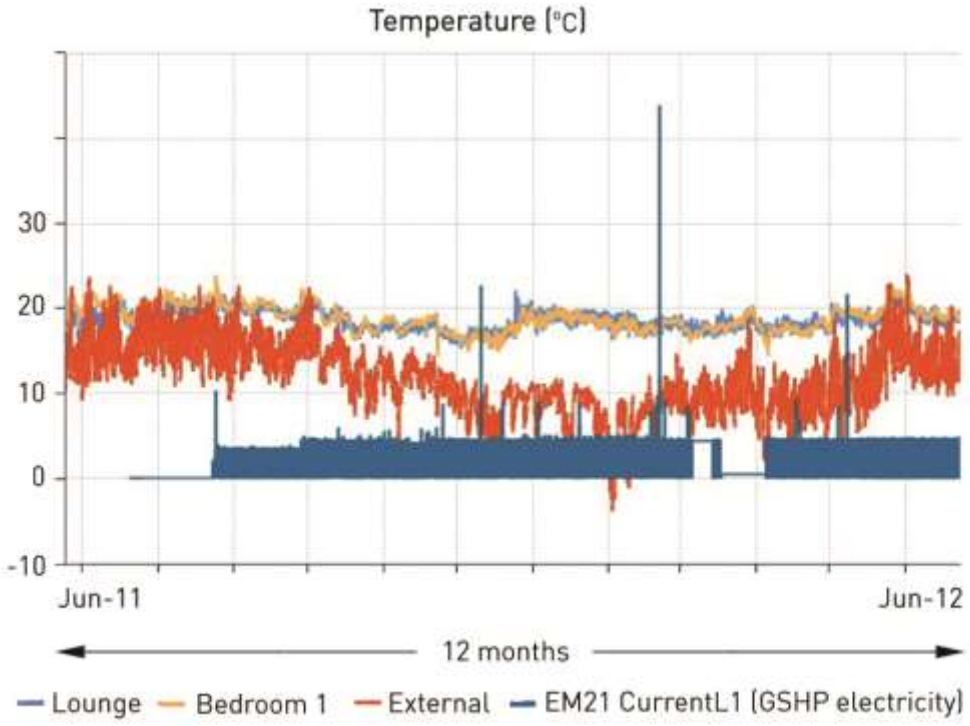
Services:
- MVHR
- Ground source heat pump (Calorex 3.5 kW) & pressurised cylinder
- ‘Heat pod’ extension
- Photovoltaic panels

Airtightness:
5.25 m3/m2h@50Pa

Vital statistics table

Characteristics	Before	Target	Measured
Primary energy (kWh/m²/year)	544	110	113
Space heating kWh/m²/year	152	64.6	36
Airtightness [m³/m²h @ 50 Pa]	5.57	3	5.25
Type of glazing	double	triple	triple
CO_2 emissions (kg CO_2/m²/year)	148	17	16.87

Property 4 - Penzance



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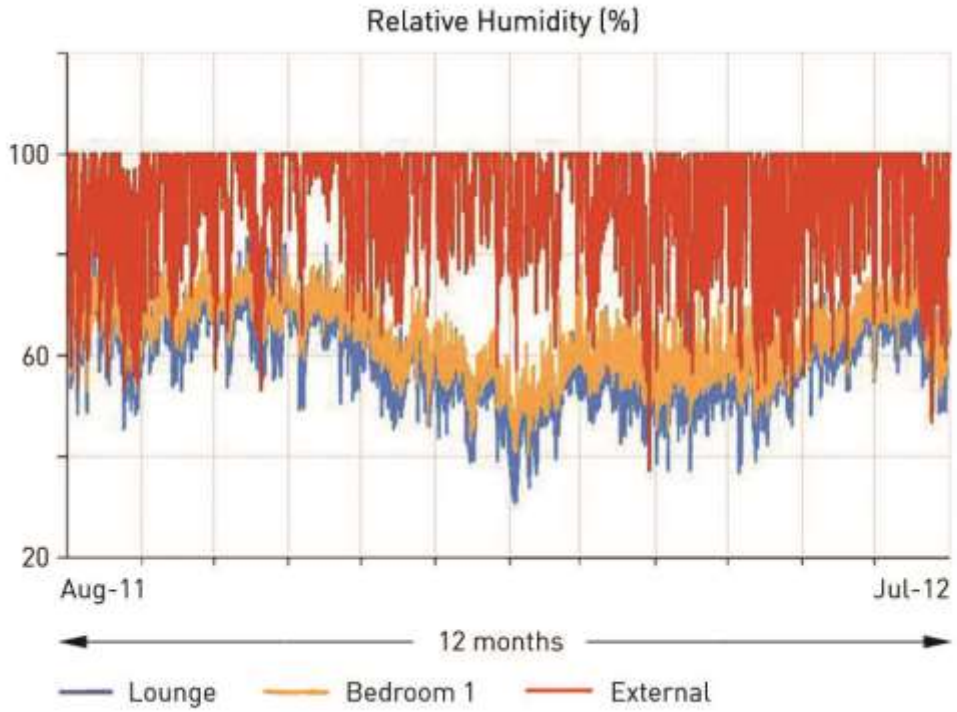

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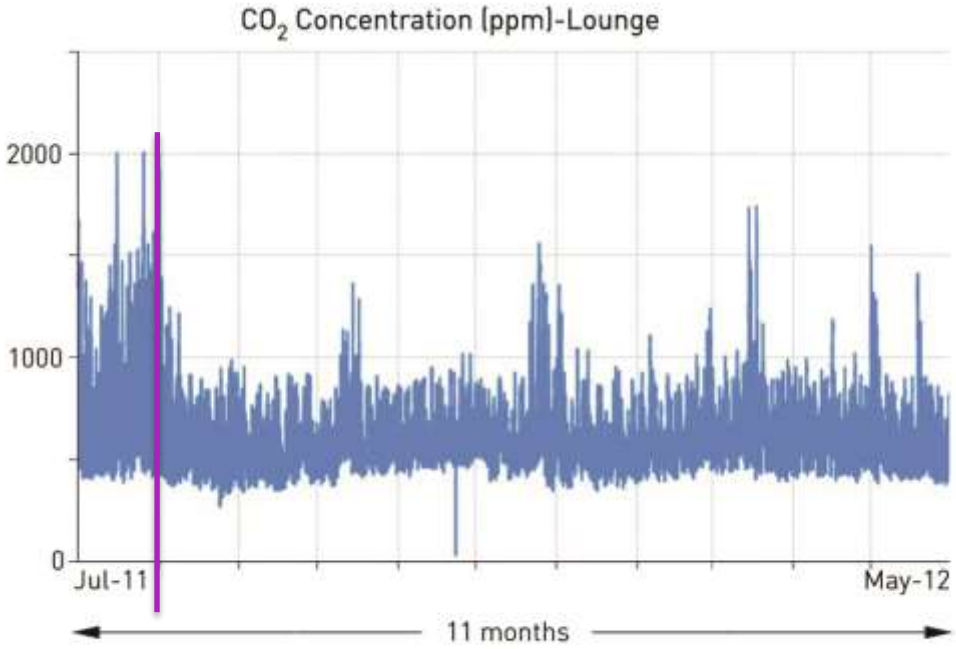

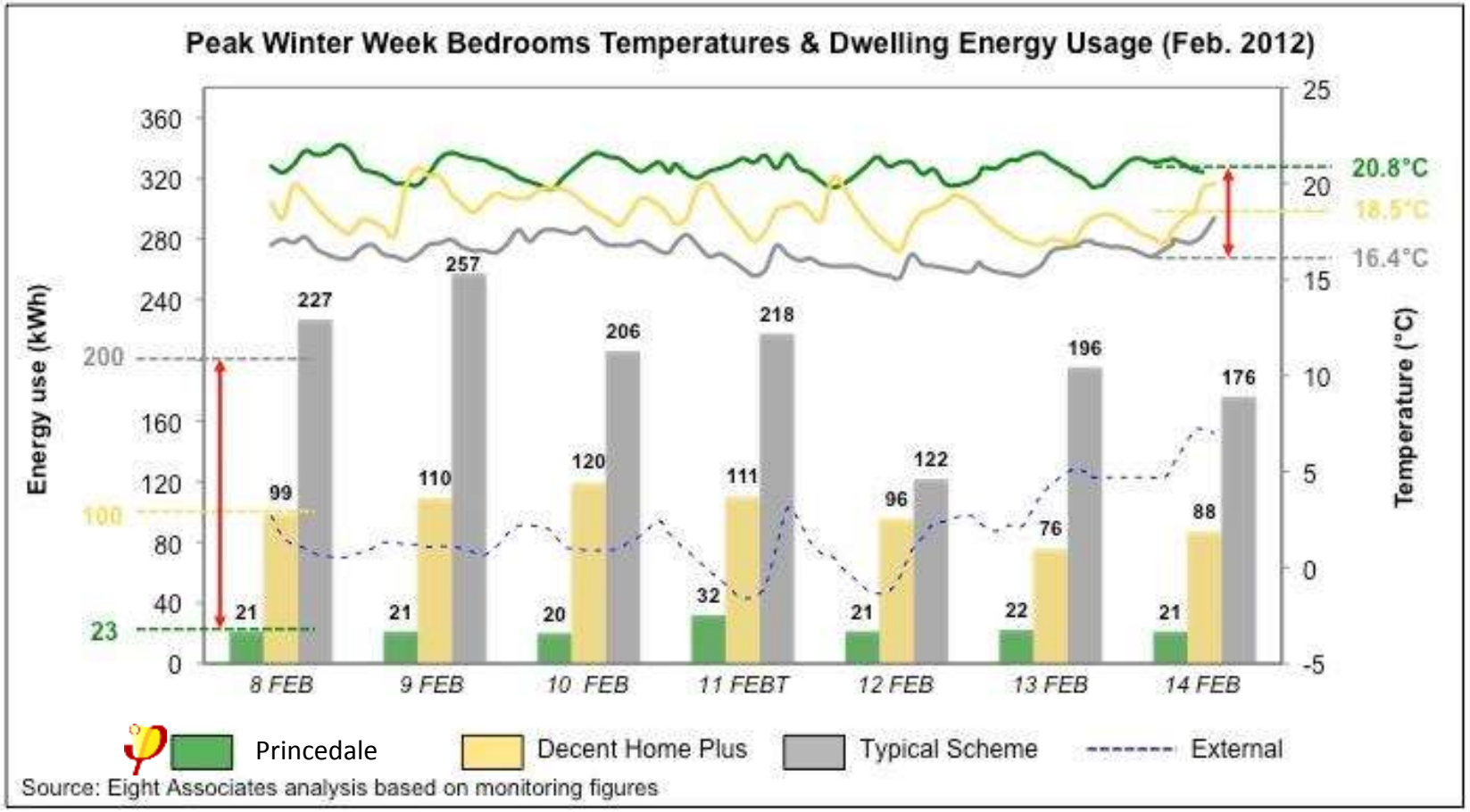

More on → ‘2012 Conference Presentations’

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Passivhaus Trust
The UK Passive House Organisation

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

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