bere:architects
73 Poets Road
London N5 2SH
T +44(0)20 7359 4503
www.bere.co.uk

AECB Conference 2012, Goldsmiths University

Retrofit of Mayville Community Centre

Sarah Lewis of bere:architects email: sarah.lewis@bere:architects | www.bere.co.uk

bere:architects

The Muse - first intuitive experiment in passivhaus design (2002)

AECB, London, 2012

bere:architects

The Muse - included ecological planting for biodiversity (2002)

AECB, London, 2012

bere:architects

1900

- Originally built in the early 1900's to house generators for the tram network, the massively constructed building became derelict in the late 1960s

- It became a community centre after local residents lobbied Islington Council for possession of the building in the 1970s

bere:architects

2006

- The community centre is transferred to Mildmay Community Partnership

- MCP objectives: “...to develop the capacity and skills of beneficiaries in such a way that they are better able to identify, and help meet their needs and to participate more fully in society”

- Energy bills of £10,000 per year

- Uncomfortably cold and draughty

- Poor internal layout and facilities

bere:architects

Mayville Community Centre

1. Holistic environmental design decisions

2. Designing for comfort

3. Designing for ease of construction

4. Techniques on site

5. Performance in-use

6. Investment and return

Short Film

Questions

bere:architects

1. Holistic environmental design decisions

bere:architects

Before refurbishment

- Difficult to achieve comfortable conditions in winter. Office spaces were hot in winter, while main hall was often too cold for sedentary activities, particularly for the elderly
- Total energy demand 581 kWh/m^2/yr (if 21°C winter temps maintained but 272 kWh/m^2/yr in reality)
- Echo made hearing or engaging in conversation difficult - particularly for the elderly
- Bad layout and shortage of space

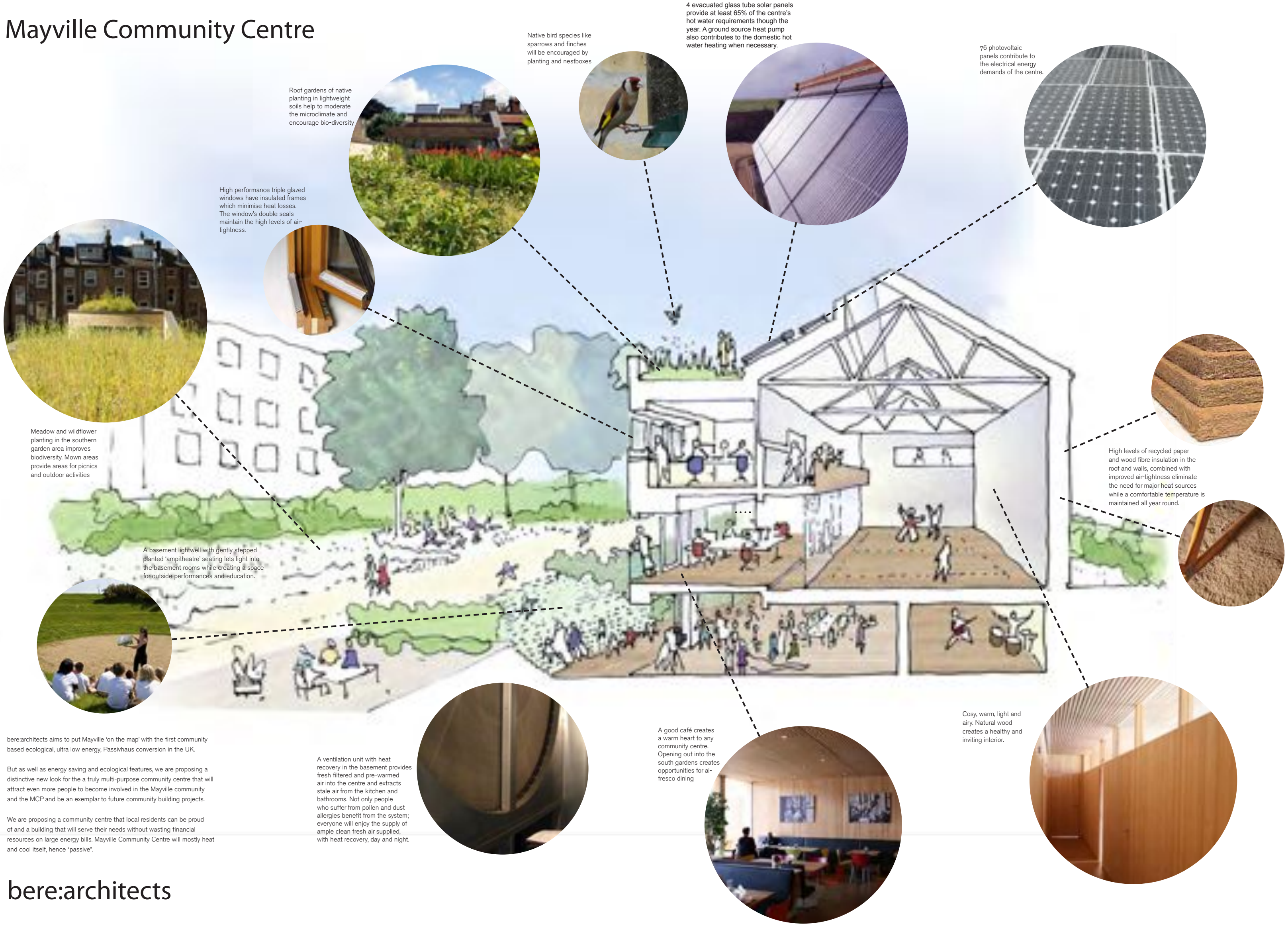
South elevation before refurbishment

bere:architects

Holistic environmental design decisions

bere:architects

Mayville Community Centre



bere:architects aims to put Mayville 'on the map' with the first community based ecological, ultra low energy, Passivhaus conversion in the UK.

But as well as energy saving and ecological features, we are proposing a distinctive new look for the a truly multi-purpose community centre that will attract even more people to become involved in the Mayville community and the MCP and be an exemplar to future community building projects.

We are proposing a community centre that local residents can be proud of and a building that will serve their needs without wasting financial resources on large energy bills. Mayville Community Centre will mostly heat and cool itself, hence "passive".

bere:architects

AECB, London, 2012

Fundraising

- Fundraising was secured in 2010 for this pioneering, ultra low-energy passivhaus certified retrofit, costing £2 million including fees

- Funders:

  Big Lottery;
  London Borough of Islington;
  Community Builders Fund;
  City Bridge Trust;
  Dept. of Energy and Climate Change via EST and Carbon Trust.

bere:architects

Design Team

Bere:architects: Architects

E-Griffin: Cost consultant

Alan Clarke: Services engineer

Conisbee: Structures

Contractor:

Buxtons

Detail of south elevation, air inhale and exhaust ducts

bere:architects

Holistic environmental design decisions

AECB, London, 2012

bere:architects

After refurbishment

- Designed for comfort at all times for active or sedentary activities (summer & winter).
- Designed to use 90% less energy than before refurbishment.
- Building re-orientated with new offices facing south to enjoy winter sunshine.
- New windows in basement, adding 35% more usable floor space, as well as helping to heat the building in winter.

Entrance area after refurbishment

Holistic environmental design decisions

The UK's first fully certified non-domestic passivhaus refurbishment

The refurbished Mayville Community Centre South Facade

AECB, London, 2012

bere:architects

2. Designing for comfort

bere:architects

Technical Design Strategy

- External insulation, 300mm EPS above ground & 200mm XPS below ground.
- New zinc covered roof with 400mm mineral fibre insulation.
- Passivhaus triple glazed, insulated wood-framed windows.
- Heat recovery ventilation, constant pressure system, de-coupled from heat supply & running only when occupied.
- CO_2 sensors in main hall and dining room open supply-air dampers at 1100ppm and close them again at 900ppm. Fixed ventilation rates to offices.
- Summer/winter ventilation switch to extract-only in summer months in combination with natural ventilation.
- 8.4kW ground Source Heat Pump supplying low temp radiators.

South garden and south elevation of the rennovated centre

bere:architects

Technical Design Strategy

Floor area:

- Gross internal area: 800m²
- Treated floor area: 665m²

Air test result:

- 0.42ach@50pa

Fabric performance:

- Wall U-value below ground 0.15
- Wall U-value above ground 0.12
- Pitched roof U-value 0.11
- Flat roof U-value 0.13
- Passivhaus triple glazed windows

Ventilation:

- 2000m²/hr max, 1.86W/l.s at max flow

Design Energy Demand:

- 116kWh/m²/yr primary energy demand
- 11kWh/m²/yr specific heat demand

Renewables:

- PV 18kWp
- Solar thermal 2kWh/m²/yr

ALDAS
...towards a sustainable future

Air Leakage Certificate

In accordance with BS EN 13829 & ATTMA TSL2 (2010)

Dwelling tested: Mayville Community Centre, Stoke Newington, London N18 8NA
Test Date: 30th June 2011
Test Engineer: Paul Jennings
Site Contact & Company: David Ironside, Buxton Group
Certificate No: ALD10-05-0221

This is to certify that the above named structure has been tested for air tightness in accordance with the BS EN 13829:2001 methodology.

The average Leakage Characteristics of the building were recorded as follows:

Airflow @ 50 Pa:		1212 m³/hr
Air Change Rate @ 50 Pa:		0.42 ACH^{-1}
Air Permeability Rate @ 50 Pa:		0.83 m³/(hr.m²)
	Correlation of results, R^2:	0.996
	Slope, n:	0.64
	Intercept, C_L:	99.4 m³/(hr.Pa^n)
Test Parameters:		
	Envelope Area, A_E:	1455 m²
	Volume, V:	2895 m³
	Env. Calc Prepared by:	Rachel Witherick, Bere Architects
	Env. Calc Verified by:	Paul Jennings, ALDAS Limited

Initial Offset Pressure:	- 0.1 Pa	Final Offset Pressure:	- 0.1 Pa
Initial Inside Temperature:	20 °C	Final Inside Temperature:	20 °C
Average Outside Temperature:	18 °C	Barometric Pressure:	101,300 Pa

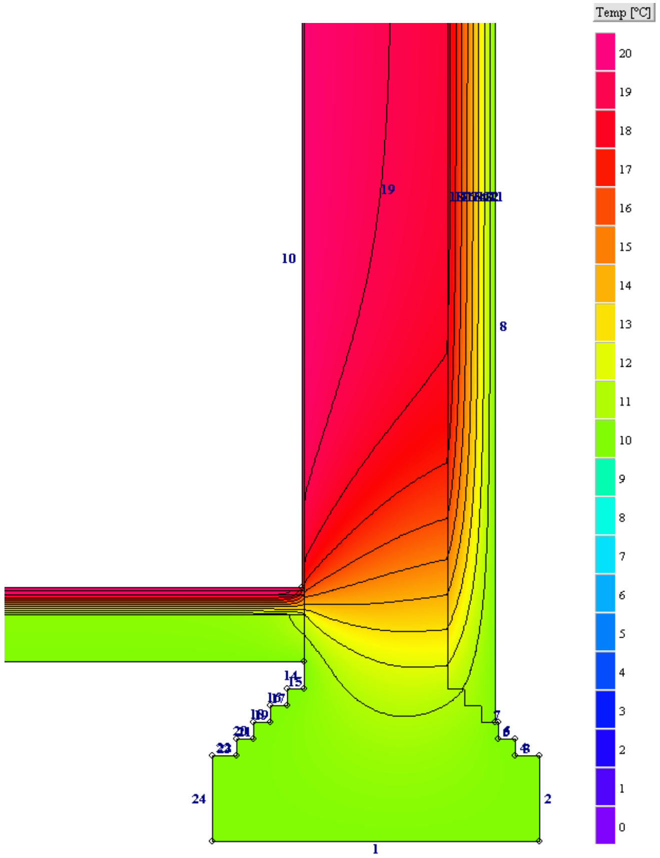
This certificate should be read in conjunction with the report ALD10-05-0221 and associated test method statement.

Paul Jennings

bere:architects

Thermal bridge analysis

- External basement insulation:
200mm XPS insulation
- External above ground insulation:
300mm EPS insulation



AECB, London, 2012

bere:architects

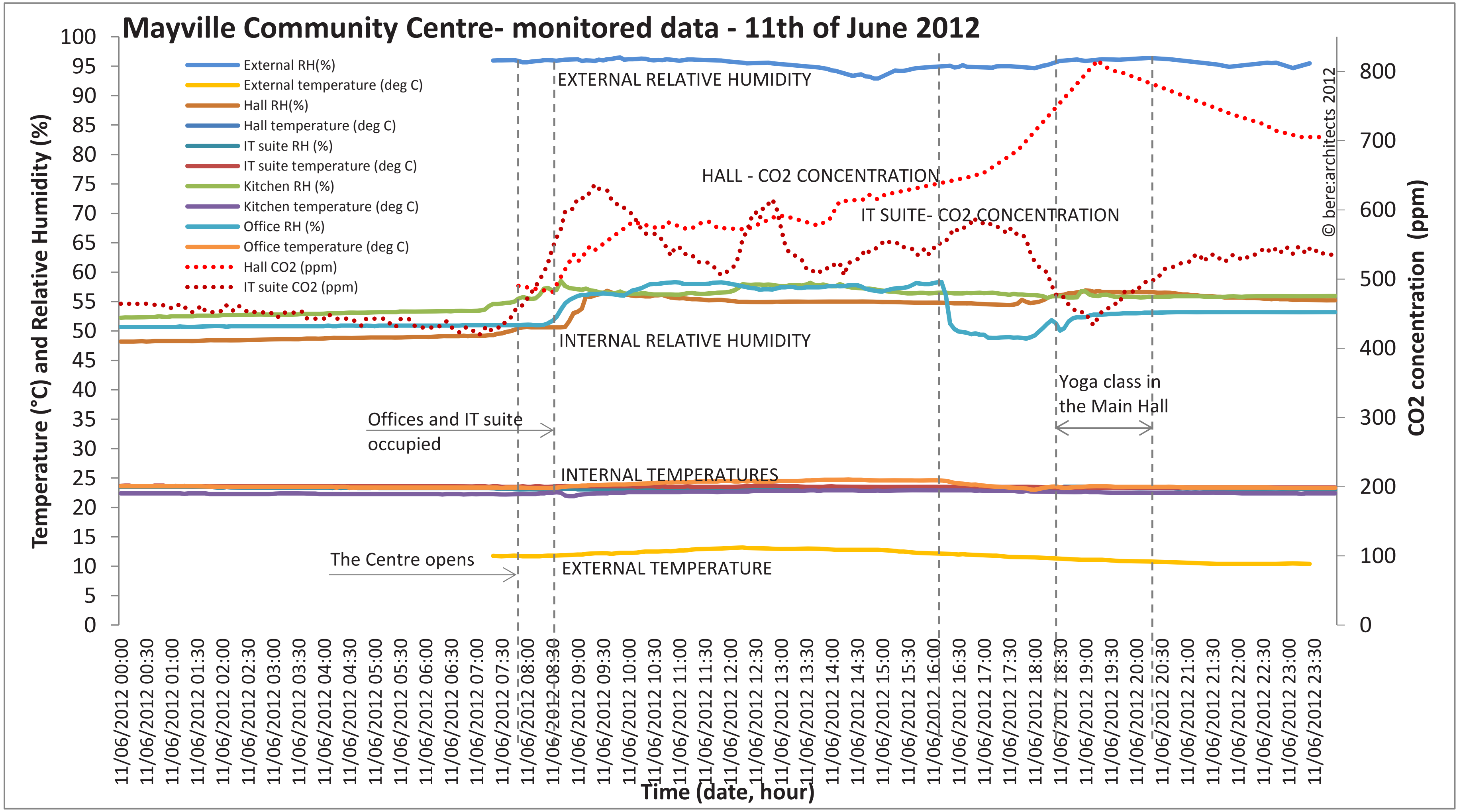
Comfort in-use

- Has exceeded user expectations
- Comfort conditions are significantly better than users' own homes
- "Never too cold and never too warm"
- Affordable comfort

The refurbished Mayville Community Centre Main Hall

bere:architects

Comfort in-use



bere:architects

Usability and softlandings!

bere:architects

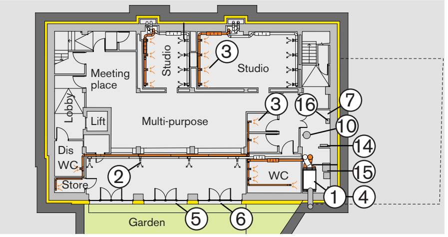
User Guide

Mayville Community Centre

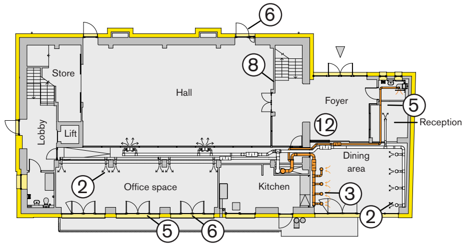
This building is a Retro-fit Passivhaus.

The term passivhaus refers to an advanced low energy construction standard for buildings, which have excellent comfort conditions in both winter and summer. They typically achieve a heating saving of 90% compared to existing housing. Passivhaus buildings are easy to live in and require little maintenance, but they do have some important features, which are explained in this guide. The features are simple to operate, but a full understanding will help you get the lowest energy consumption and best comfort. This guide has been design by Alan Clarke and bere:architects for you (the user) to understand how a passivhaus works and how to operate the controls in this house.

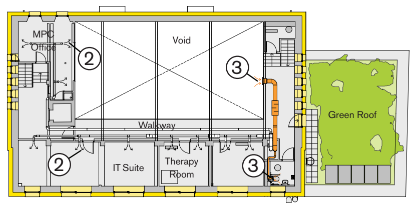
Each feature is labelled on the drawings below, highlighting their locations and briefly explaining how to operate them in the corresponding text. Please take the time to read this guide and familiarise yourself with the controls.



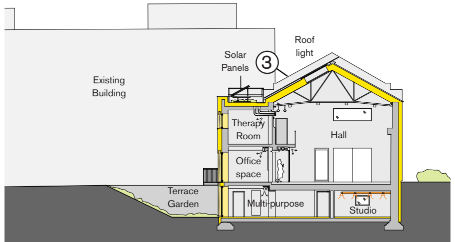
Lower Ground floor plan



Ground floor plan



First floor plan



Section B-B

1 Heat recovery ventilation unit

Provides continuous fresh air to the community centre, and saves heat from WCs and kitchens to warm fresh air for the office, main hall, dining room IT suite etc. The system saves about 10 times more energy than it uses! It is located in the plant room. The filter needs changing every 3 months in London air.

5 External blinds control (for summer cooling)

In summer the outside blinds minimise solar gains from the sun. These are manually controlled by the centre manager from reception.

9 Radiators and thermostatic valves

Simple, easily understood thermostatic radiator valves give individuals control of their space temperatures

13 Lighting control

These dimmer switches provide a choice of light levels in some rooms. However dimmable lighting was removed from some spaces to save capital costs.

2 Fresh air vents

The heat recovery ventilation unit keeps the air fresh and pre-warmed in winter, using these fresh air vents.

6 Night cooling

To keep cool in the summer take advantage of colder night time temperatures outside by leaving the windows open in the "tilt" position overnight (subject to site security). If it's hotter outside in the day you can shut the windows and external blinds.

10 Hot water storage

Hot water is always ready in the tank this is due to the tank being very well insulated so that the water will not cool down overnight.

For bathroom + kitchen use

A smaller Tank for radiator use

14 Heat pump

To provide heat for domestic hot water tank and heating tank.

3 Extract air vents

These vents remove possible stale and damp air from the kitchen, main hall and WC's. The ventilation runs 7am - 7pm. The extract air vent filter in the kitchen needs to be vacuumed about every 3 months depending on how much cooking is done.

7 Timer for ventilation

Currently set to run ventilation from 7am - 7pm, 7 days a week

11 Hot water from the sun

A solar themal vacuum tube panel supplies 60-80% of the annual hot water usage. In winter the panel can heat the bottom half of the tank and the boiler is used to top up the temperature. This means there is always hot water available in the tank even on a cloudy day.

15 Rain water (grey water)

Pump to recycle rainwater for WCs. 6500 litres of water is saved under the south garden for WCs. An additional 5000 litres of water is saved for the garden.

4 Heat recovery ventilation control panel

To control air flow. this should not be altered under any circumstance

8 CO2 Sensor for main hall ventilation

Due to the large air volume in the main hall, it is only necessary to add fresh air when larger groups of people raise the CO2 level to around 1000ppm

12 Fire alarm control

This is the central fire alarm control, located in the entrance hall.

16 Electrical sub metering

These submeters can be illuminated by pressing a button on the face. We are measuring data every monday for research purposes.

bere:architects

For further information about these features: Alan Clarke (Energy Consultant and Building Services Engineer)
Tel: 01594 563356
E-mail: alan@arclarke.co.uk

or

bere:architects (Passivhaus Specialists)
Tel: 020 7359 4503
E-mail: bere@bere.co.uk

Delivered with 'Details form passive Houses' by IBO Book

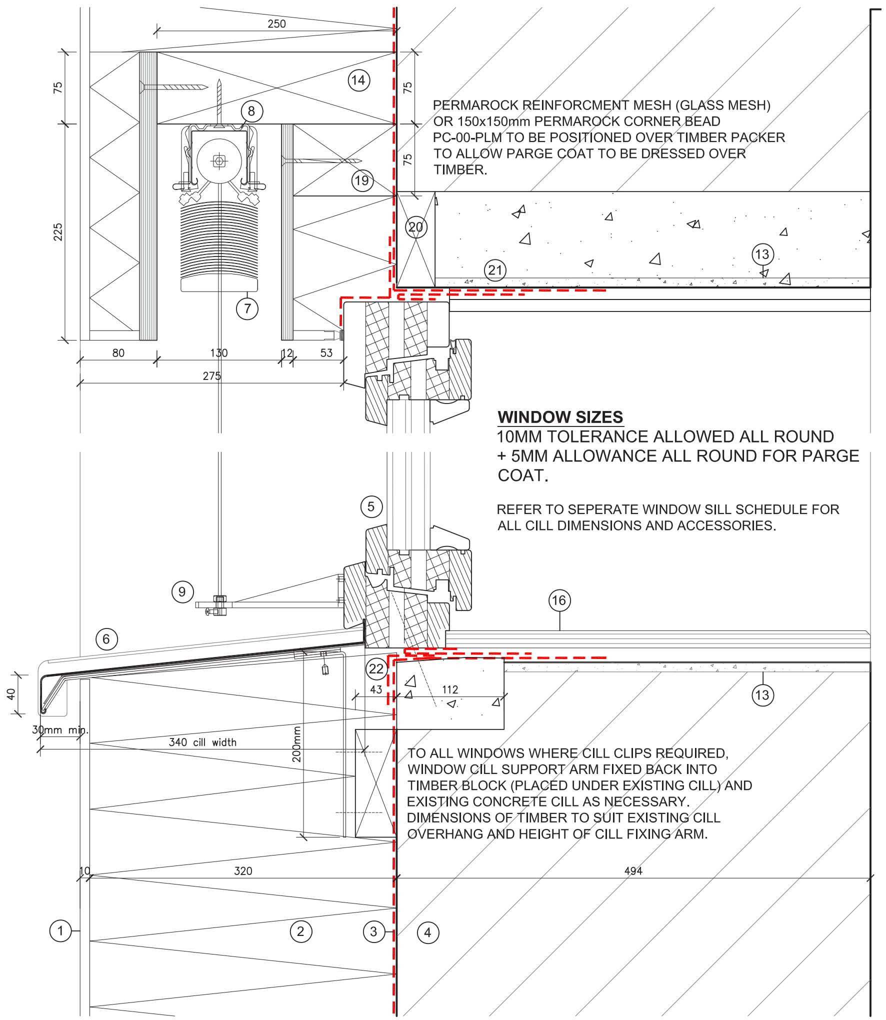
AECB, London, 2012

3. Designing for ease of construction

Passivhaus Techniques on the drawing board

bere:architects

- bere:architects produced detailed design and production information drawings to help convince fundraisers that the project was real, working for a year without fees since at this stage there were promises for only a small amount of ‘matched funding’ and nothing available to draw down until all the funding was in place!



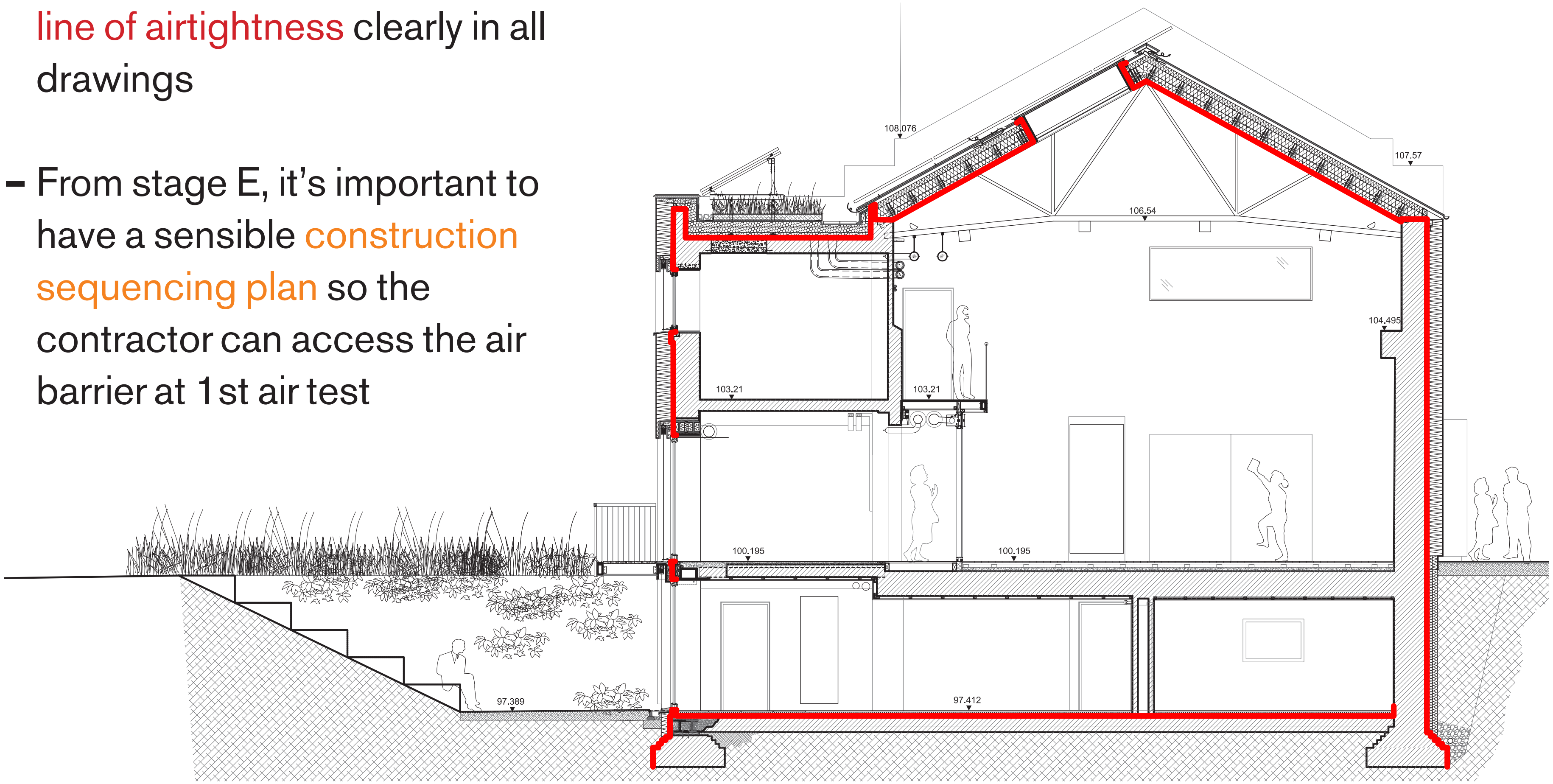
AECB, London, 2012

Passivhaus Techniques on the drawing board

- Final preparations of tender package

- Architects' drawings show the line of airtightness clearly in all drawings

- From stage E, it's important to have a sensible construction sequencing plan so the contractor can access the air barrier at 1st air test



AECB, London, 2012

bere:architects

Programming

- The contractor demonstrates, in their proposed programme of works, that they understand sequencing the work to facilitate two mid-construction air tests; (1) after window installation (2) after M&E installation

- Buxtons were contractually required to achieve the first air test target of 0.6h-1 at 50pa before continuing. A visible air barrier at this stage ensures they can address any problems which the air tester finds

- Air test result: 0.42 h-1 @50pa

49	**Superstructure**
50	Erect perimeter scaffold/ temporary roof over
51	Clean off external walls (vegetation/ M&E equipment etc)
52	Erect single storey steelwork
53	Prepare walls/ wrap steelbeams etc for insulation
54	Brick up upstand walls etc
55	Fit windows/ doors/ louvres
56	Install external membrane
57	Install insulation system
58	Strengthen roof trusses
59	Roof carcassing (single storey roof)
60	Roof Caracassing (pitched)
61	Roof fall arrest sytsem
62	Lightning Protection
63	Ashphalt (inc insulation)
64	Roof Insulation & metal sheet Coverings (inc copings etc)
65	Air pressure test - NO1
66	Weather tight
67	Remove temporary roof covering
68	Velux roof lights ! !
69	Kitchen extract
70	Water tight
71	Paving
72	Solar panel (inc pipe connections)
73	Photovoltaic panels (Inc cabling)
74	Rain Water Goods
75	External venetian blind louvre system
76	Install green roof
77	Strike Scaffold (progressive to suit works)
78	Entrance canopy/ vertical (Cedar) timber lining
79	**Fit Out & Finishes**
80	Excavate/ install pump station
81	Builders work/ chases etc
82	Flexible tanking
83	Install glazed screen tracks
84	Install floor insulation - basement
85	Make good screeds/ Screed floors (50mm, 70mm and unbonded scree
86	Mechanical First Fix (inc plantroom)
87	Electrical First Fix
88	Carpenter First Fix
89	Fire Stopping/ air tight sealing penetrations (Passivhaus spec)
90	Air pressure test no 2
91	Dry lining to walls
92	Ceiling Boarding

bere:architects

4. Techniques on site

bere:architects

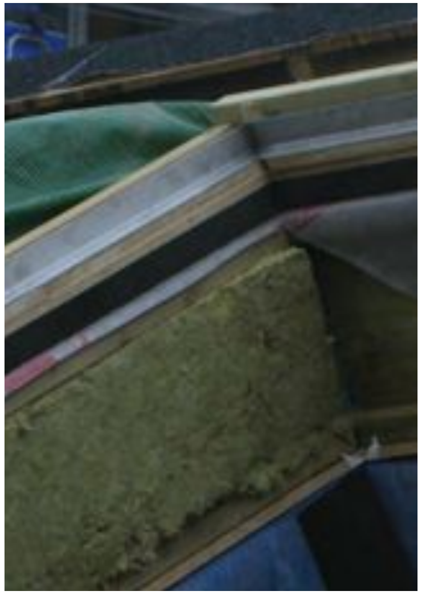
Passivhaus Techniques on site

bere:architects

1. Basement wall insulation
2. Ground floor wall insulation
3. Thermal bridge free installation
4. Roof membrane detailing
5. Window tape training
6. Windows in line of insulation


1


2


3


4


5


6

AECB, London, 2012

Ground wall insulation

- External basement insulation:

  300mm expanded polystyrene insulation glued and mechanically fixed over airtight parge coat

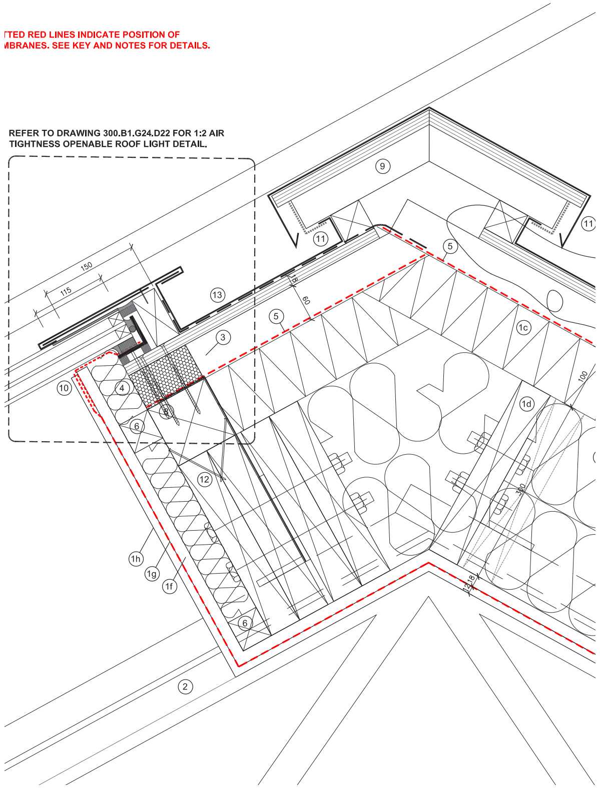
bere:architects

Thermal bridge free installation

- Installing rooflights without cold bridging:

    (1) Velux windows with insulation kits

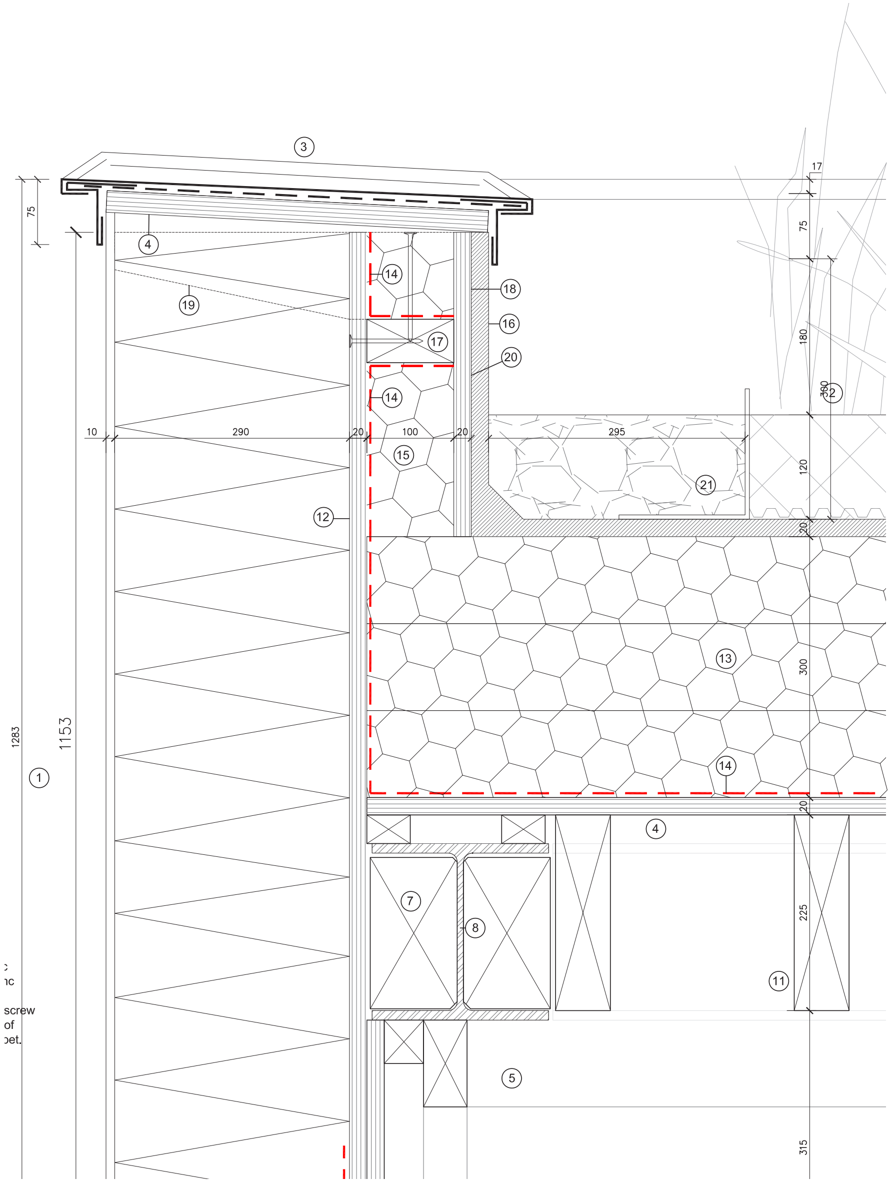
    (2) Fixed rooflights on Foamglas



bere:architects

Thermal bridge free installation

- Foamglas for parapet walls without cold bridging



AECB, London, 2012

Thermal bridge free installation

- Schock thermal isolators against cold bridging, located in line of floor insulation
- Avoiding cold bridging
- Avoiding condensation
- Avoiding mould growth
- Protecting healthy air quality

bere:architects

Roof membrane detailing

- Preparing the existing roof trusses for new roof covering - Buxtons site manager attending to air tightness details before fixing purlins

bere:architects

AECB, London, 2012

Windows 1-2-3

- Training the site carpenters in the passivhaus method of fitting of windows

- Making ‘rabbit ears’

bere:architects

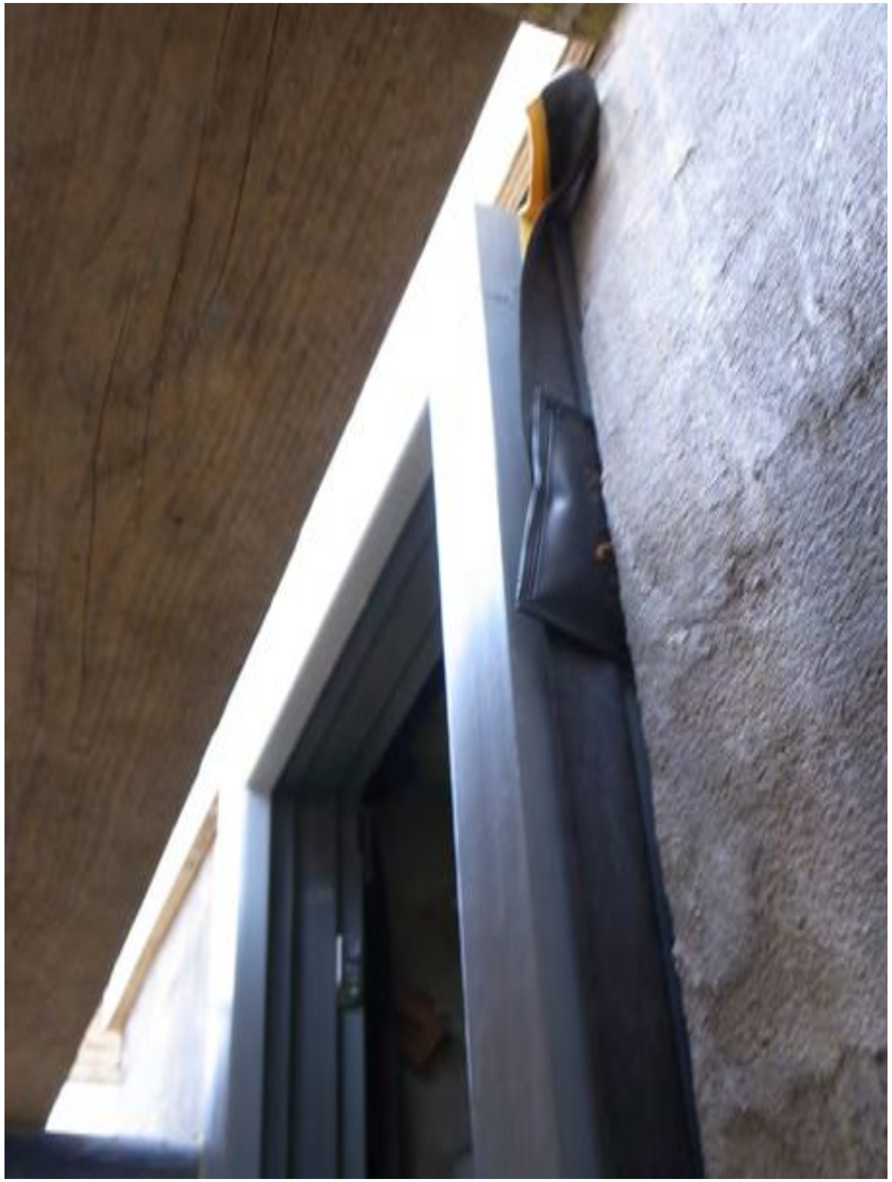
Windows 1-2-3

- ...and how to fold the rabbit ears
- Inner and outer tapes for vapour and moisture respectively

bere:architects

Windows 1-2-3

- Inflatable window bags
- German headless screws
- Screws do not require plugs
- Suspend the window without distortion



bere:architects

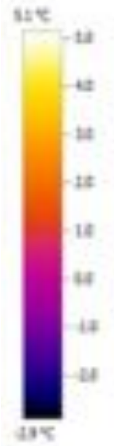
Windows 1-2-3

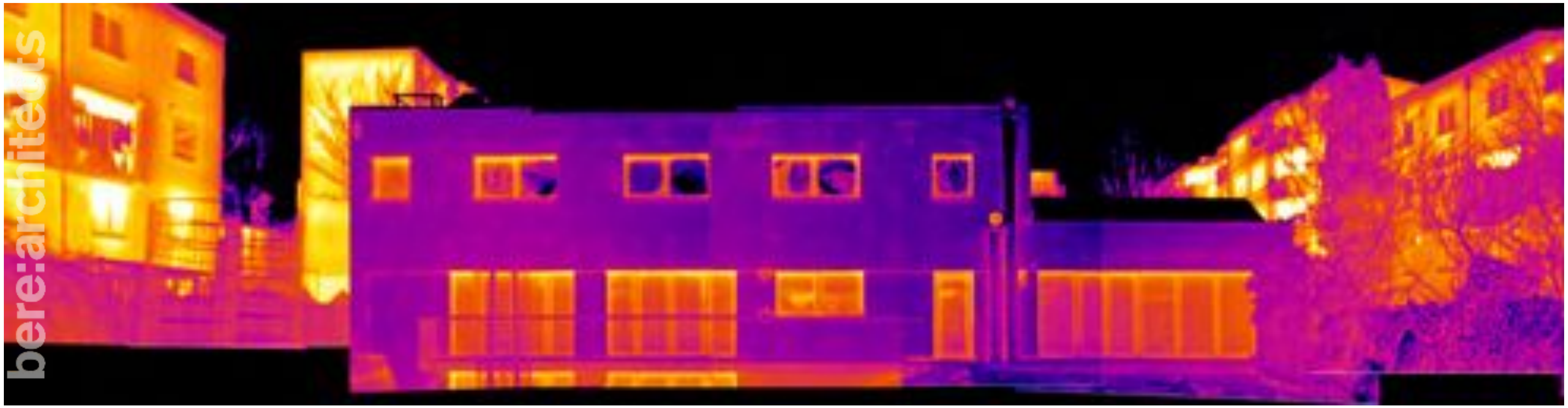
- Line of airtightness maintained by correctly folded tapes to form a good quality connection between windows and parge coat on walls
- Cill tapes are fixed separately
- EPS insulation will follow, with deep window cills and insulation part-covering the window frames
- Non-opening windows are fixed by means of metal tabs

bere:architects

Mayville Community Centre

bere:architects





AECB, London, 2012

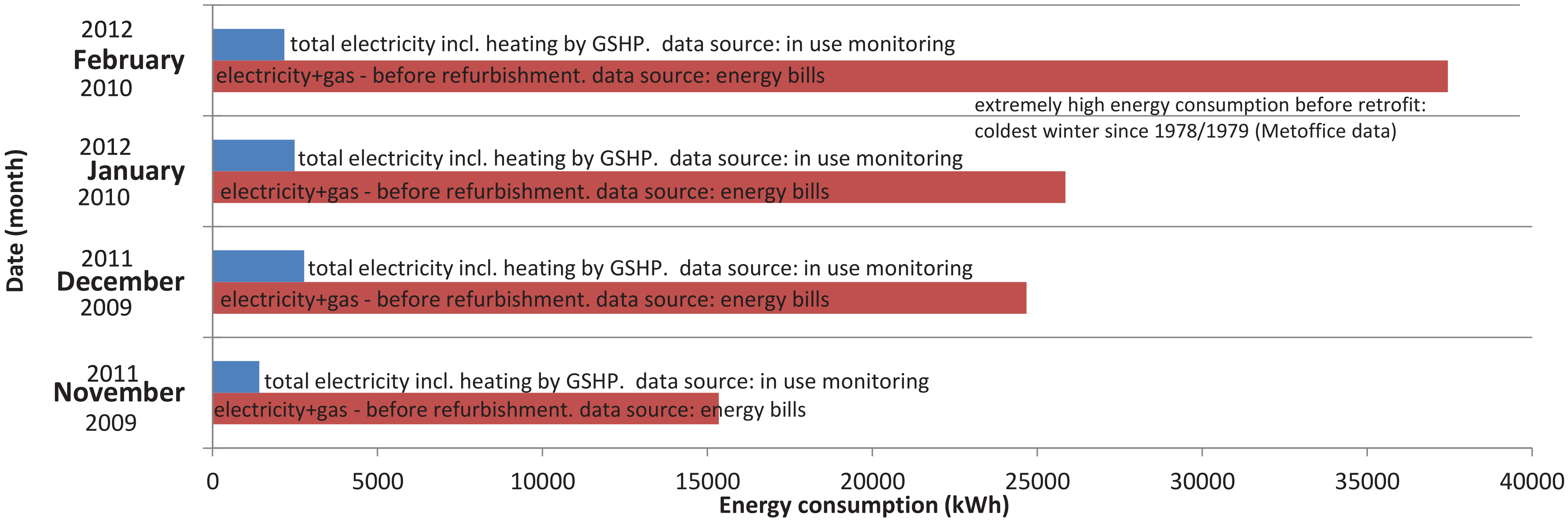
5. Performance

Performance

Comparison between total Winter energy use BEFORE and AFTER refurbishment

Up to 95% reduction in total operational energy consumption after refurbishment

Mayville Passivhaus Community Centre - Energy consumption during winter months before retrofit (gas +electricity bills - Nov 2009- Feb 2010) and after refurbishment (preliminary sub metering data: EDF+PVs*- Nov 2011 - Feb 2012)



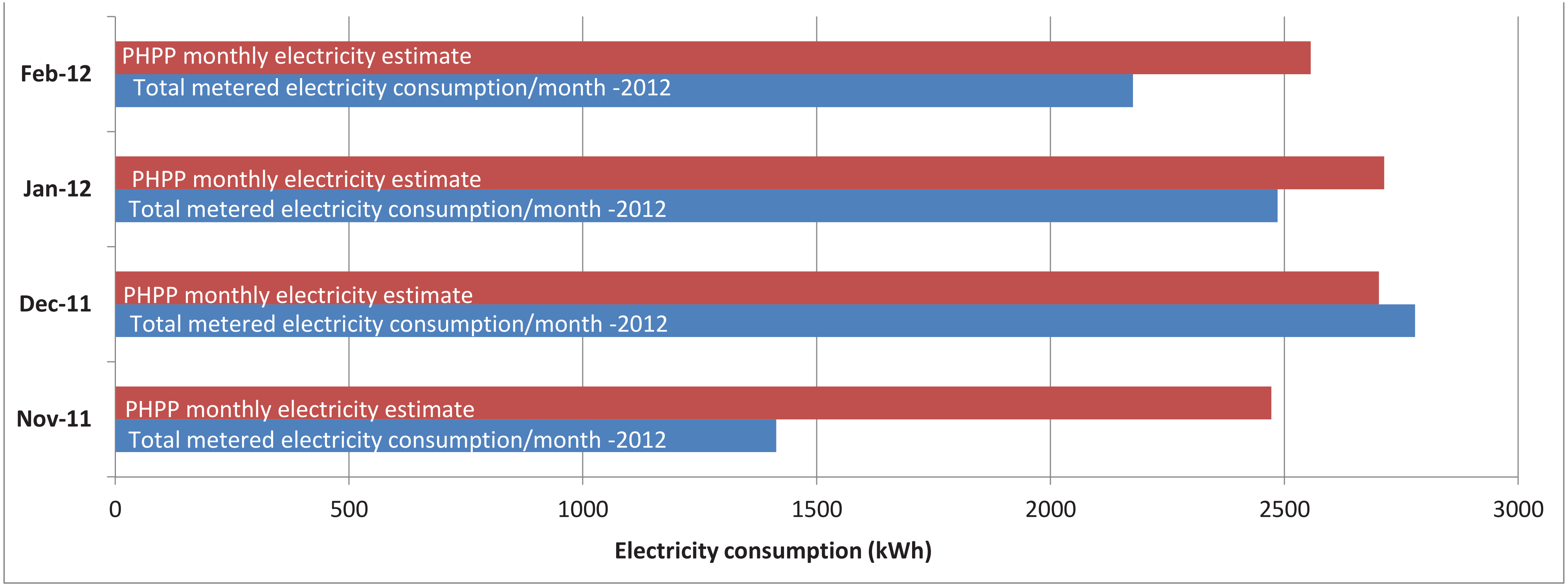
* data collected before PV export sub-meter installed; assumes all electricity generated by PVs was used in the building, nothing exported back to grid

AECB, London, 2012

Performance

Comparison between total energy use design estimate and actual use

- The first Winter's operational performance is even better than the PHPP design prediction.
- The building used less energy than designed each month apart from December where the building thermostat was accidentally turned up very high over the Christmas holiday.

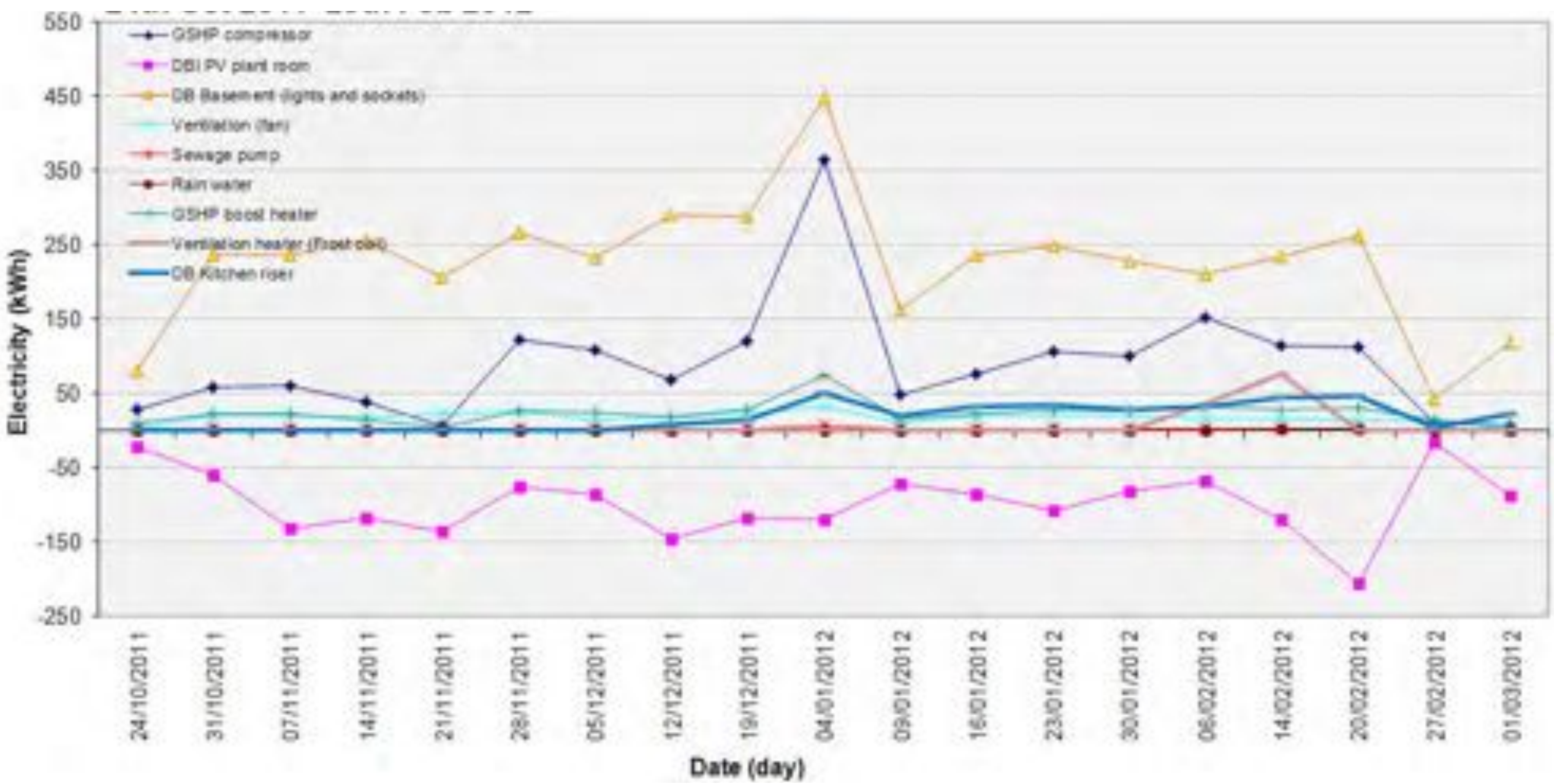


bere:architects

Performance

Winter 2012, energy use and energy generation

Note Christmas holiday heating spike caused by accidentally leaving the thermostat set at a very high temperature throughout the holiday period after an elderly persons' Christmas party.



AECB, London, 2012

6. Investment and Return

Investment & Return

(Comparison between passivhaus & minimum standard)

STEP (1): finding & comparing design energy consumption for each option

(a) Headline list of changes in accordance with Building Regs Part L and ventilation rates

(b) Four different PHPP documents were created (PH with gas boiler, PH GSHP, PH with GSHP & PV)

(c) Old energy bills (before refurb) were also analysed

(a)

Changes to PHPP:

U-Values:

1. Lower ground wall
Insulation Styrofoam floormate A = 0 (100)
Insulation Styrofoam perimate = 90 (100)

3. Basement Slab
Insulation Kingspan TF70 = 75 (75)

4. Ground Slab
Foamglass T4+ = (300)

5. North Elevation External wall GF
Insulation Permarock EPS = 90 (290)

6. South Elevation External wall 290mm insulation
Insulation Permarock EPS = 100 (290)

7. West Elevation External wall 290mm insulation
Insulation Permarock EPS = 100 (290)

8. West Elevation External wall 320mm insulation
Insulation Permarock EPS = 100 (320)

	U-Values (W/m2K) Building Regs (as in Part L)	Building Regs (as in PHPP)	Passivhaus (as in PHPP)
Existing Elements:			
Existing Walls (External insulation)	0.30	0.28-0.30	0.12
Basement slab	0.25	0.26	0.26
Ground slab	0.25	0.24	0.13
Sloping Roof (insulation at after level)	0.18	0.18	0.11
New elements:			
Windows	2.20	1.24-2.09	0.8-1.0
Roof lights	2.20	1.55-1.84	1.06
Velux openable rooflights	3.50	1.84	1.45
Huge-usage entrance doors	3.50		
Wall to single storey extention	0.28	0.27	0.11
Flat Roof (with integrated insulation)	0.18	0.18	0.13
Air permeability	10.0 m3/hm2 at 50 Pa	10.0 m3/hm2 at 50 Pa	0.93 m3/hm2 at 50 Pa

(b)

ENERGY	Before refurbishment (with gas boiler, without PV and solar thermals): Electricity OTHER	GAS	Space heating only	2010 Building Regs* + gas boiler (with gas boiler, without PV and solar thermals, *using Part L Approved Document U-Value and Ventilation requirements): Electricity OTHER	GAS	Space heating only	Initaial investment
Total Energy demand, kWh/a	28979		189197	25820		48855	
ENERGY TOTAL, kWh/a			218176			74675	
GAS Cost per unit	£0.0877	£0.0000	£0.0298	£0.0877	£0.0000	£0.0298	
Energy priced, kWh	28979	0	189197	25820	0	48855	
Energy cost	£2,541	£0	£5,646	£2,264	£0	£1,458	
Standard charge	£87		£265	£87		£265	
	£2,628		£5,911	£2,351		£1,723	
COST TOTAL, £		£8,539			£4,074		£0
CO2							
CO2 GEMIS 3.0, kg/kWh	0.68	0.25		0.68	0.25		
CO2 level	19706	47299		17558	12214		
CO2 TOTAL		67005			29771		
ENERGY Assamptions	Space heating and cooking is supplied by gas boiler only. Electricity supplied by grid only. Data taken from annual set of bills for			Space heating is supplied by gas boiler only. Electricity supplied by grid only. Data taken from PHPP. Energy contribution by renewable sources account for energy saved not alternative energy produced, like in case of PVs			

ENERGY	PH + gas boiler (with gas boiler, without PV and solar thermals): Electricity OTHER	GAS	Space heating only	PH + heat pump (with heat pump, without PV and solar thermals): ELECTRICITY HEAT PUMP used	ELECTRICITY OTHER used	Contribution HEAT PUMP contribution
Total Energy demand, kWh/a	25835		13821	4051	26015	-8605
ENERGY TOTAL, kWh/a			39656		30066	-8605
GAS Cost per unit	£0.0877	£0.0000	£0.0298	£0.0877	£0.0877	£0.0877
Energy priced, kWh	25835	0	13821	4051	26015	-8605
Energy cost	£2,266	£0	£412	£355	£2,282	-£755
Standard charge	£87		£265	£87		
	£2,353		£677			
COST TOTAL, £		£3,030		£2,724		
CO2						
CO2 GEMIS 3.0, kg/kWh	0.68	0.25			0.68	
CO2 level	17568	3455		20445		-5852
CO2 TOTAL		21023			20445	
ENERGY Assamptions	Space heating is supplied by gas boiler only. Electricity supplied by grid only. Data taken from PHPP			Space heating supplied by heat pump only. Electricity supplied by grid only. Data taken from PHPP		

ENERGY	PH + heat pump + PV + solar heating (with heat pump, with PV* and solar thermals, *using existing building data. Calculations include XXKwp solar PV system): ELECTRICITY HEAT PUMP used	ELECTRICITY OTHER used	Contribution HEAT PUMP contribution	Contribution SOLAR contribution	PV
Total Energy demand, kWh/a	3664	25881	-7784	-1342	-14400
ENERGY TOTAL, kWh/a		29545			15145
GAS Cost per unit	£0.0877	£0.0877	£0.0877	£0.0877	£0.0877
Energy priced, kWh	3664	25881	-7784	-1342	-14400
Energy cost	£321	£2,270	-£683	-£118	-£1,263
Standard charge	£87				
		£2,678			
COST TOTAL, £			£1,415		
CO2					
CO2 GEMIS 3.0, kg/kWh		0.68			0.43
CO2 level	20091		-5293 -6206	-913	-6192
CO2 TOTAL			13899		
ENERGY Assamptions	Space heating supplied by heat pump and solar thermals. Electricity supplied by grid and PV panels. Data taken from PHPP				

AECB, London, 2012

bere:architects

Investment & Return

(Comparison between passivhaus & minimum standard)

STEP (2): finding the Cost of an otherwise identical Min. Standard community centre

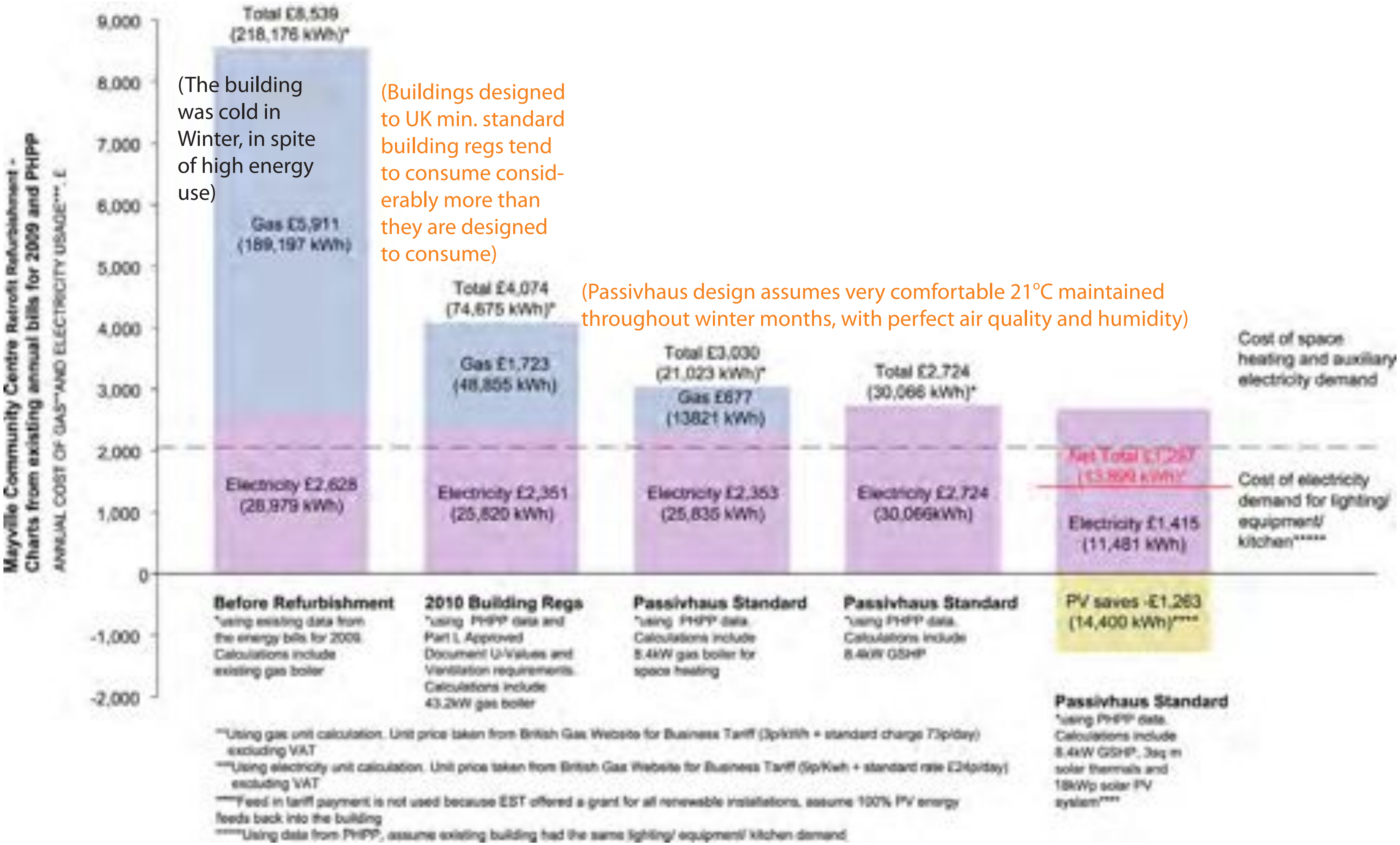
Take detailed Bills of Quantities (As Built) and convert to Building Regs spec, item by item

Mildmay Community Partnership Alteration and Improvements to Community Centre Mayville Community Centre, Woodville Road, London N16 8NA BILLS OF QUANTITIES				Tenderer: Option 1 - Buxton Building Contractors Contract Sum - Passivhaus with Heat Pump, Solar Thermal and PV Installations Date: 09-Mar-10		Tenderer: Option 2 - As Option 1 with Heat Pump Installation but excluding Solar Thermal and PV Installations Date: 09-Mar-10		Tenderer: Option 3 - As Option 1 but with a 8.4kW Gas Boiler and excluding Heat Pump, Solar Thermal and PV Installations Date: 09-Mar-10		Tenderer: Option 4 - Building Regulations with a 43.2kW gas boiler, additional radiators excluding Heat Pump, Solar Thermal and PV installations Date: 09-Mar-10	
					£		£		£		£
				847.74							
457	overall size 1100 x 2708; reference W117H	1	nr	2,525.25	2,525.25	2,525.25	2,525.25	2,525.25	2,525.25	2,525.25	2,525.25
A11	Reduction for double glazed windows	(1)	nr							628.20	- 628.20
				1,052.47							
458	overall size 2751 x 890; reference W117E; added since quotation	1	nr	2,408.25	2,408.25	2,408.25	2,408.25	2,408.25	2,408.25	2,408.25	2,408.25
A12	Reduction for double glazed windows	(1)	nr							599.09	- 599.09
				654.66							
459	overall size 2470 x 1180; reference W107F, W108F, W109F, W110F	5	nr	1,908.08	9,540.40	1,908.08	9,540.40	1,908.08	9,540.40	1,908.08	9,540.40
A13	Reduction for double glazed windows	(5)	nr							474.67	- 2,373.34
					22,072.14		22,072.14		22,072.14		16,581.31
	Windows and window frames, obscured glazing; tilt and turn opening mechanism										
				902.95							
460	overall size 1250 x 1180; reference W106E,W111E	2	nr	1,331.85	2,663.70	1,331.85	2,663.70	1,331.85	2,663.70	1,331.85	2,663.70
A14	Reduction for double glazed windows	(2)	nr							331.32	- 662.64
	Screens, borrowed lights and frames, clear glazing; fixed lights										
				763.92							
461	overall size 3572 x 2434; pair of glazed doors each overall size 900 x 2325; reference D005D, D006D, D007D	3	nr	6,641.70	19,925.10	6,641.70	19,925.10	6,641.70	19,925.10	6,641.70	19,925.10
A15	Reduction for double glazed windows	(3)	nr							1,652.24	- 4,956.72
				739.90							
462	overall size 3572 x 2513; pair of glazed doors each overall size 900 x 2404; reference DB01G, DB02G, DB03G	3	nr	6,641.70	19,925.10	6,641.70	19,925.10	6,641.70	19,925.10	6,641.70	19,925.10
A16	Reduction for double glazed windows	(3)	nr							1,652.24	- 4,956.72

Investment & Return

(Comparison between passivhaus & minimum standard)

STEP (3): Graph comparing Annual Energy Consumption derived from step (1)

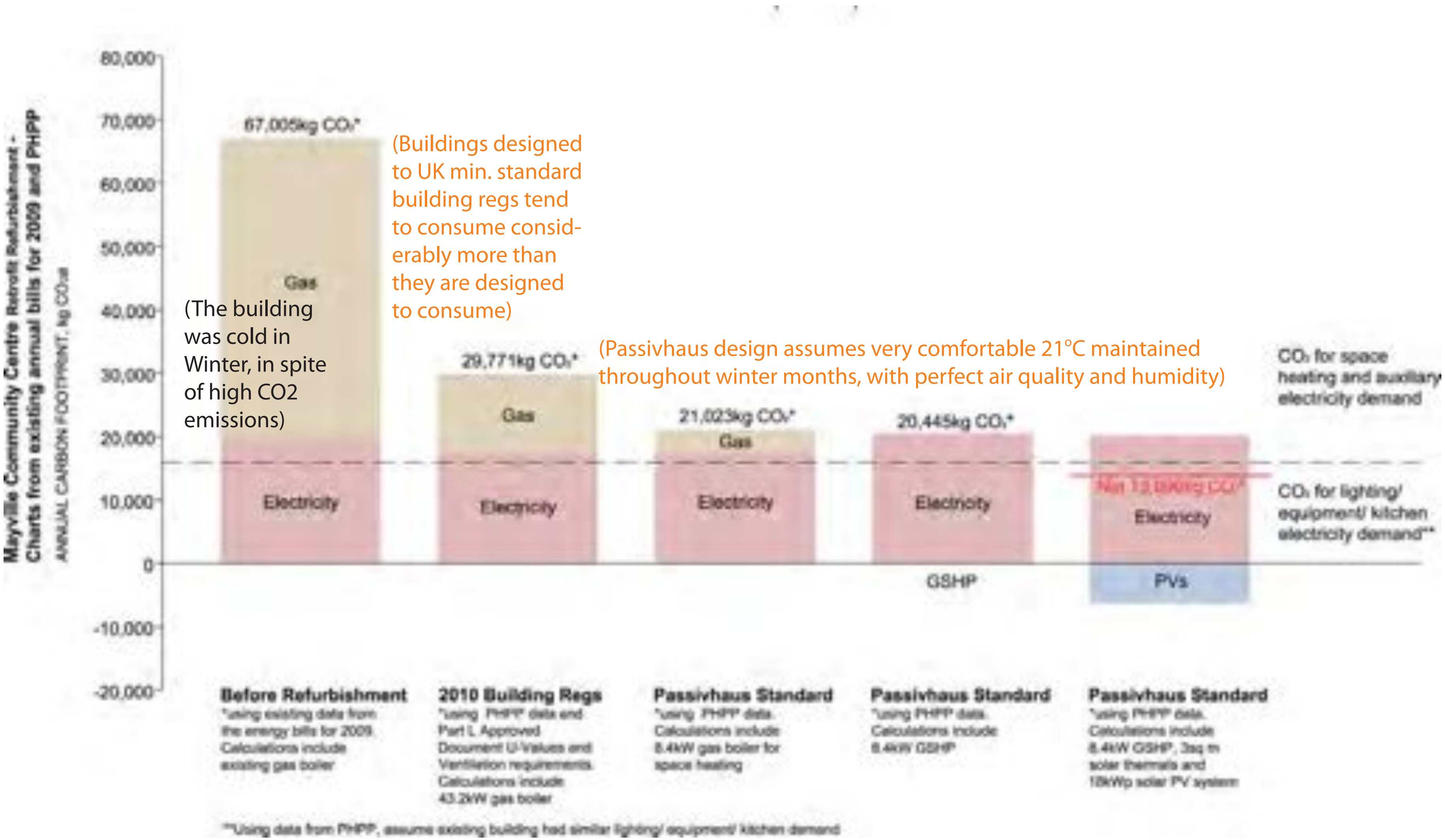


bere:architects

Investment & Return

(Comparison between passivhaus & minimum standard)

STEP (4): Graph comparing Annual CO_2 emissions derived from step (1)



bere:architects

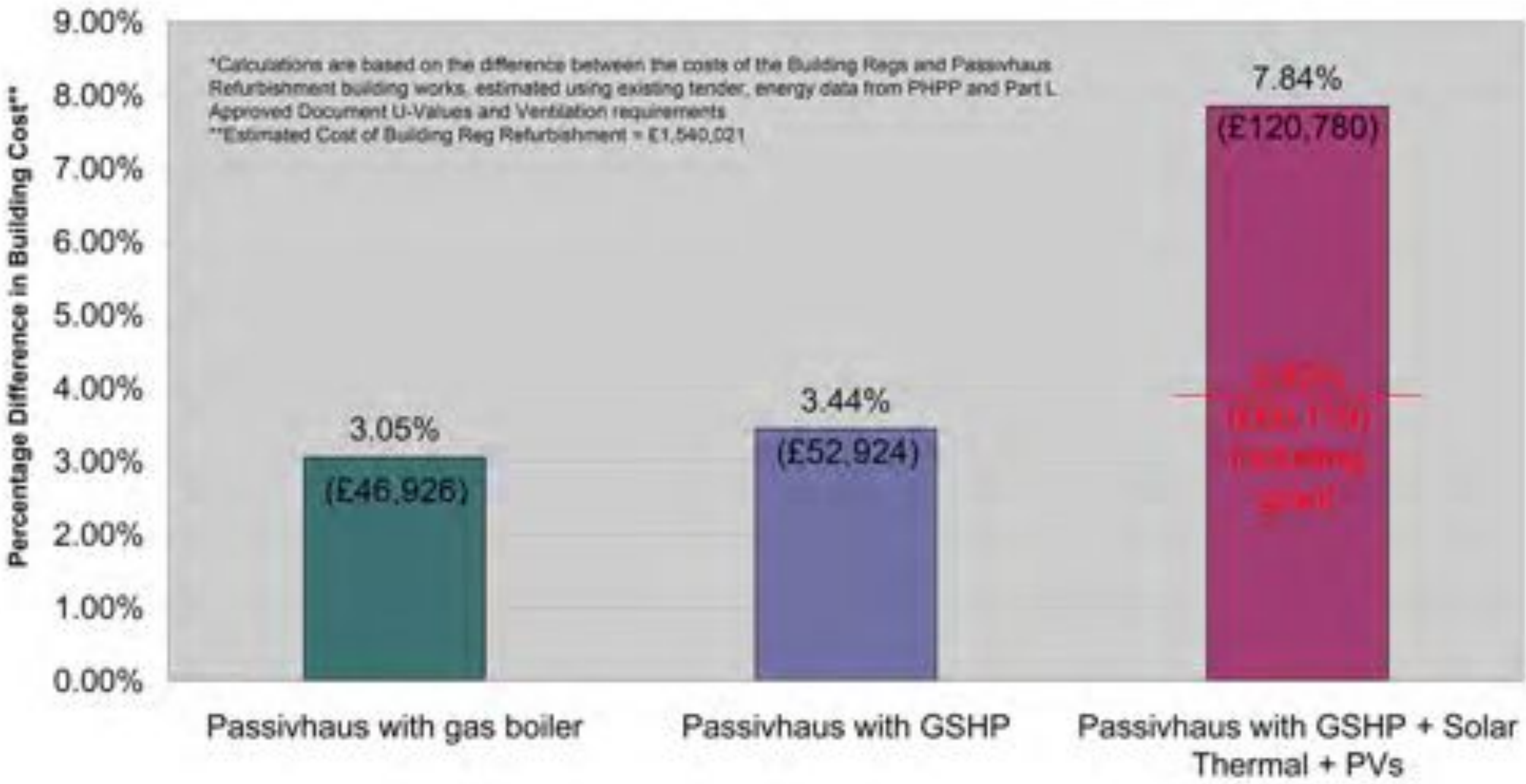
Investment & Return

(Comparison between passivhaus & minimum standard)

STEP (5): Graph showing the extra investment cost of PH derived from step (2)

Percentage difference investment to achieve passivhaus standard*

The additional investment was found to be just 3% without renewables or 8% with renewables



AECB, London, 2012

bere:architects

THANK YOU FOR LISTENING

Sarah Lewis
email: sarah.lewis@bere:architects
web & blog: www.bere.co.uk

bere:architects

AECB, London, 2012