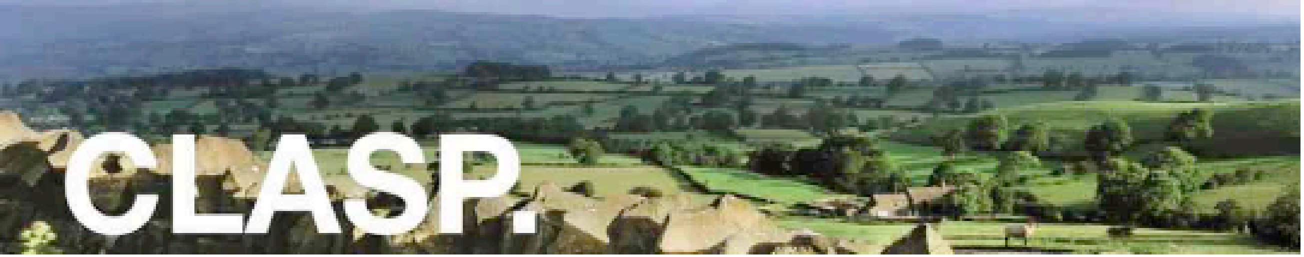


European Union
European Social Fund
Investing in jobs and skills

GREEN WAYS to WORK

A Natural Materials Approach to the new Passivhaus Enerphit Refurbishment Standard

30th March 2011

CLASP.

Delivered by

CAfS

CPTS
Cumbria Planning Training Service

Passivhaus Trust

Workshop Content

- The Passivhaus Trust
- What is Passivhaus?
- What is EnerPHit?
- Why is EnerPHit needed?
- How? - EnerPHit criteria
- Passivhaus retrofit - testing EnerPHit
- Cost benefit
- Passivhaus retrofit UK Case Study
- What’s next?

The Passivhaus Trust

The Passivhaus Trust is:

1: A not-for-profit organisation

2: A subsidiary company of the AECB

3: The UK affiliate of the PassivHaus Institute, through the International Passive House Association (iPHA)

Aims & Objectives

The Passivhaus Trust aims to:

1: Preserve the integrity of Passivhaus standards and methodology

2: Promote Passivhaus principles to the industry and Government

3: Undertake research and development on Passivhaus standards in the UK



Activities

The Passivhaus Trust runs a core programme:

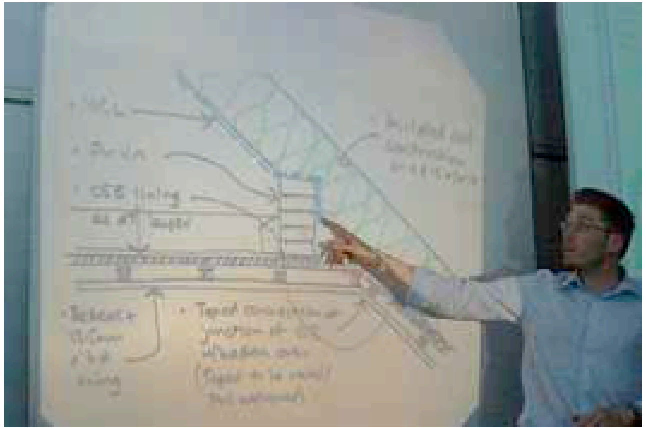
1: Research and guidance
- technical working groups

e.g. Passivhaus Refurb Group

2: Education and training
- introductory events, site visits & technical masterclasses

3: Policy, lobbying & promotion
- relationship of PH to UK policy

e.g. zero carbon definitions

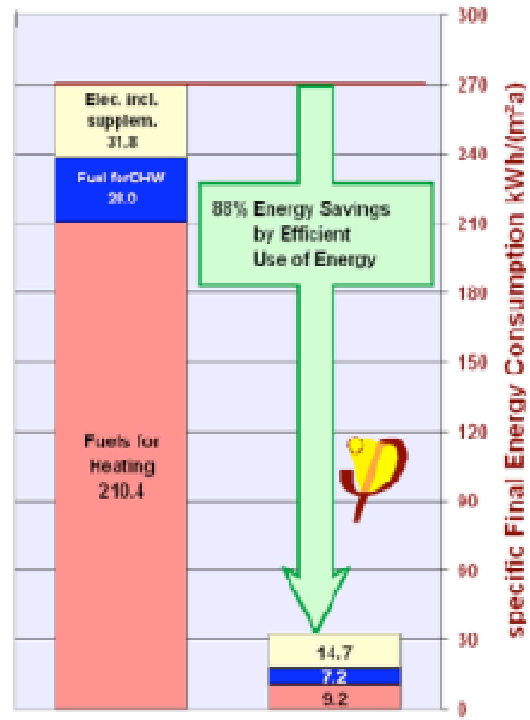


What is Passivhaus?

< 15 kWh/sqm/yr
Space Heat Demand → Warm & Cosy!

< 1.0 h-1
Air-Tightness → No Draughts!

< 120 kWh/sqm/yr
Primary Energy → Reduced Fuel Bills!
Tackles Fuel Poverty



Dramatically Reduced Heat Demand!

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Passivhaus Build Standards

Highly Insulated & Airtight Fabric

Wall U-Value = Max. 0.15 W/(m_K)

Roofs = Max. 0.15 W/(m_K)

Floors = Max. 0.15 W/(m_K)

Thermal Bridge Free

Continuous Air-tight Layer

Triple Glazed Windows

Window U-Value = Max. 0.8 W/(m_K)

Heat Recovery Ventilation System

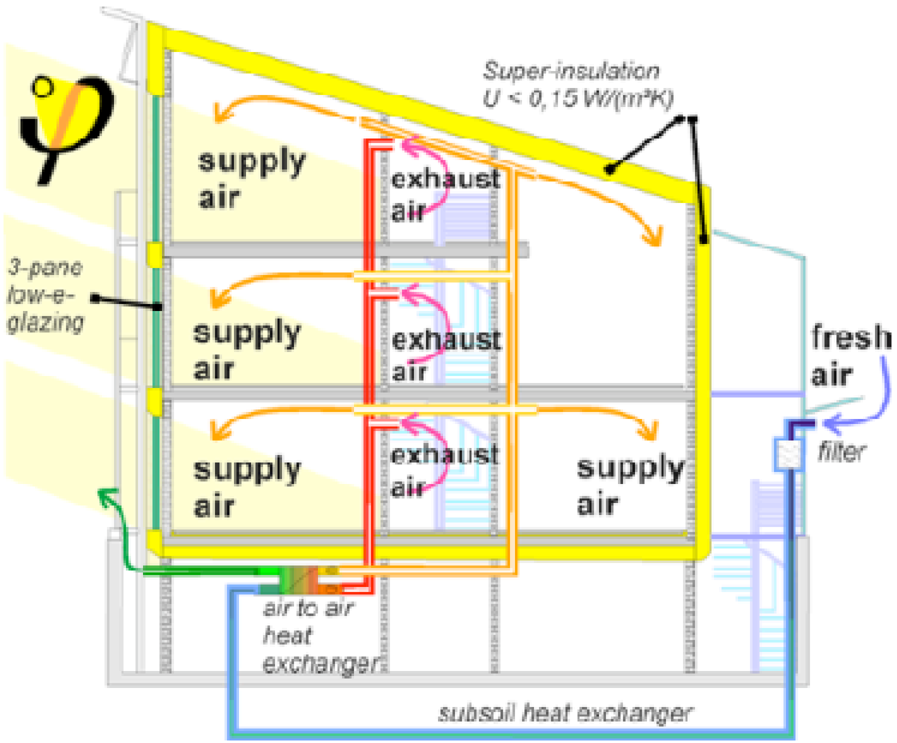
Min. 75% efficient heat recovery

Supplys fresh, warm air

Low Energy

Solar Thermal Hot Water

AAA+ Energy efficient electrical appliances



What is EnerPHit?

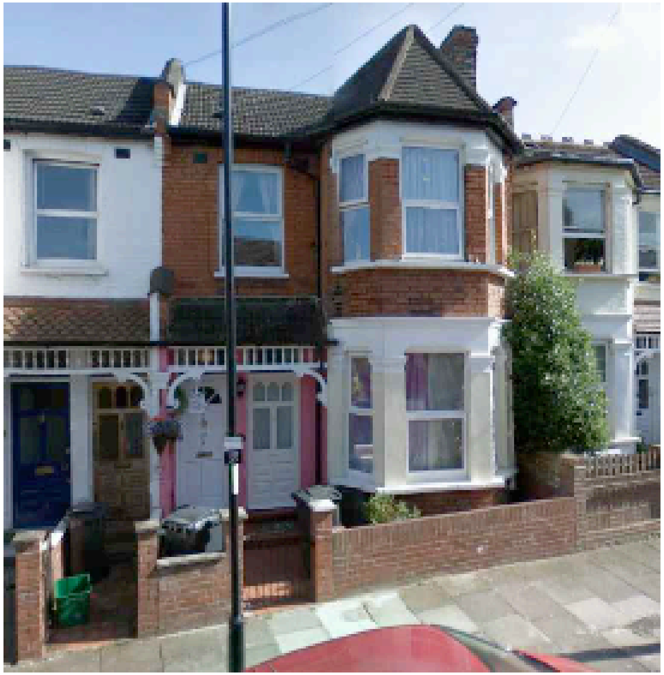
"Quality-Approved Energy Retrofit with Passive House Components"

The goal was to create a standard for an economically and ecologically optimal energy retrofit, for old buildings that cannot achieve Passive House Standard with reasonable effort. (PHI)

Simmonds.Mills / Thermal Inspections Ltd.

Why is EnerPHit needed?

Fixed Aspects of Existing Buildings



- Existing architecture
- Fixed form
- Fixed orientation
- Windows
- Existing occupants
- Neighbouring houses
- Planning and conservation issues

Benefits & Challenges of EnerPHit

Benefits of Passivhaus refurbishment

Increased insulation and airtightness improve thermal comfort and reduce risk of surface condensation and mould growth, by increasing surface temperatures and controlling moisture.

Challenges of PH refurbishment

Conservation issues and external insulation

Space requirements of internal insulation

Space requirements for ventilation systems

Risks of interstitial condensation

Airtightness and thermal bridges (particularly floor to external wall junction)

Passivhaus & EnerPHit Performance Criteria

Criteria	New build	Retrofit
Specific Space heat demand	max. 15kWh/(m ^{2}a)	max. 25kWh/(m ^{2}a)
Pressurisation test result n_{50}	max. 0.6h $^{-1}$	max. 1.0 $^{-1}$
Primary Energy Demand	max. 120kWh/(m ^{2}a)	max. 120kWh/(m ^{2}a)
Frequency of overheating (over 25 degrees)	max. 10%	max. 10%
Water activity of interior surfaces a_w		max. 80%

EnerPHit Component Criteria

Building Component	Retrofit criteria
External wall	External insulation $U \leq 0.150 W/(m^2K)$ Internal insulation $U \leq 0.300 W/(m^2K)$
Roof or top floor ceiling	$U \leq 0.120 W/(m^2K)$
Windows	$U_{W\,installed} \leq 0.85 W/(m^2K)$ $g - 1{,}6 W/(m^2K) \leq U_g$
External door	$U_{D\,installed} \leq 0.80 W/(m^2K)$
Thermal bridges	No linear thermal bridges with $\Psi > +0.01 W/(m^2K)$ or punctiform thermal bridges with $\chi > +0.04 W/(m^2K)$
Heat Recovery Ventilation Electrical efficiency of ventilation system	$\eta_{HR,eff} \geq 75\%$ $\leq 0.45 Wh/m^3$

Testing Passivhaus Refurbishment

Gunzburg (Bayern)

Detached family house

Annual heat requirement: 15kWh/m^2/a

Airtightness: n_{50} = 0.45/h

Primary energy requirement 83kWh/m2/a

Testing Passivhaus 'EnerPHit' Standard

Hoheloogstraße Luwigshafen

Renovation of two multi family blocks

Renovation of one using Passivhaus component, almost achieves new build standard.

Calculated heating demand: 16kWh/m2/a

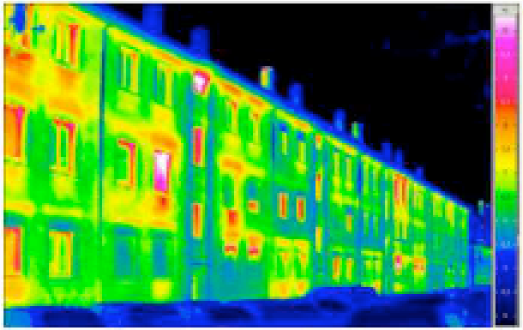
Measured consumption: 14kWh/m2/a

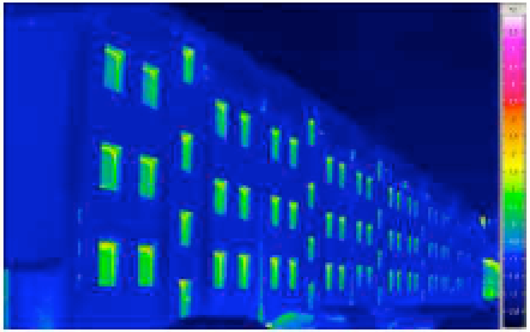
Testing Passivhaus 'EnerPHit'

Tevesstraße Frankfurt

Renovation of two multi family blocks

Renovation using Passivhaus components.





Energy

Calculated heating demand of existing building: **290**kWh/m^2/a

Calculated heating demand of refurbished building: **17**kWh/m^2/a

Measured consumption of refurbished building: **20**kWh/m^2/a

Cost Benefit of Passivhaus

108m² wall	Typical old external wall (only renewal of plaster)	Moderately insulated external wall	PH insulation levels
Annual energy costs	786 €/a	277 €/a	71 €/a
Production costs	4320 €	6480 €	8640 €
Annual repayment with interest	164 €/a	246 €/a	328 €/a
Annual total costs	950 €/a	523 €/a	399 €/a

Table from Passipedia article 'Don't save on the insulation' available at http://passipedia.passiv.de/passipedia_en/

Insulation without attention to airtightness and thermal bridges risks interstitial condensation!!

It is important to consider the starting point of a retrofit.
Will you fully gut a property or work around existing occupants?

Passivhaus Refurbishment UK

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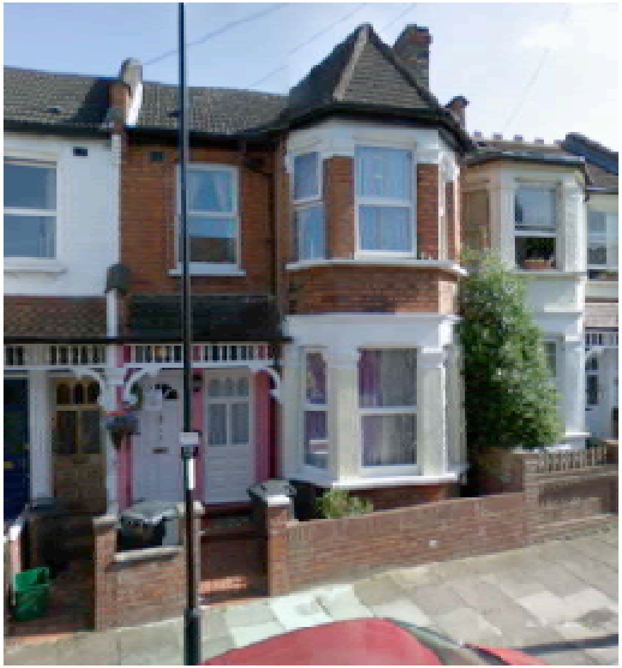

North London Edwardian Terrace

- Conservation Area
- Large North-Facing Bay Windows
- Suspended Timber Ground Floor
- Rear Extension at Lower Level

Victorian Mid-Terrace in Stoke

- Part of a Unified Terrace
- East/West Orientation
- Un-insulated Solid Ground Floor
- Tight for space internally

Retrofit for the Future Targets

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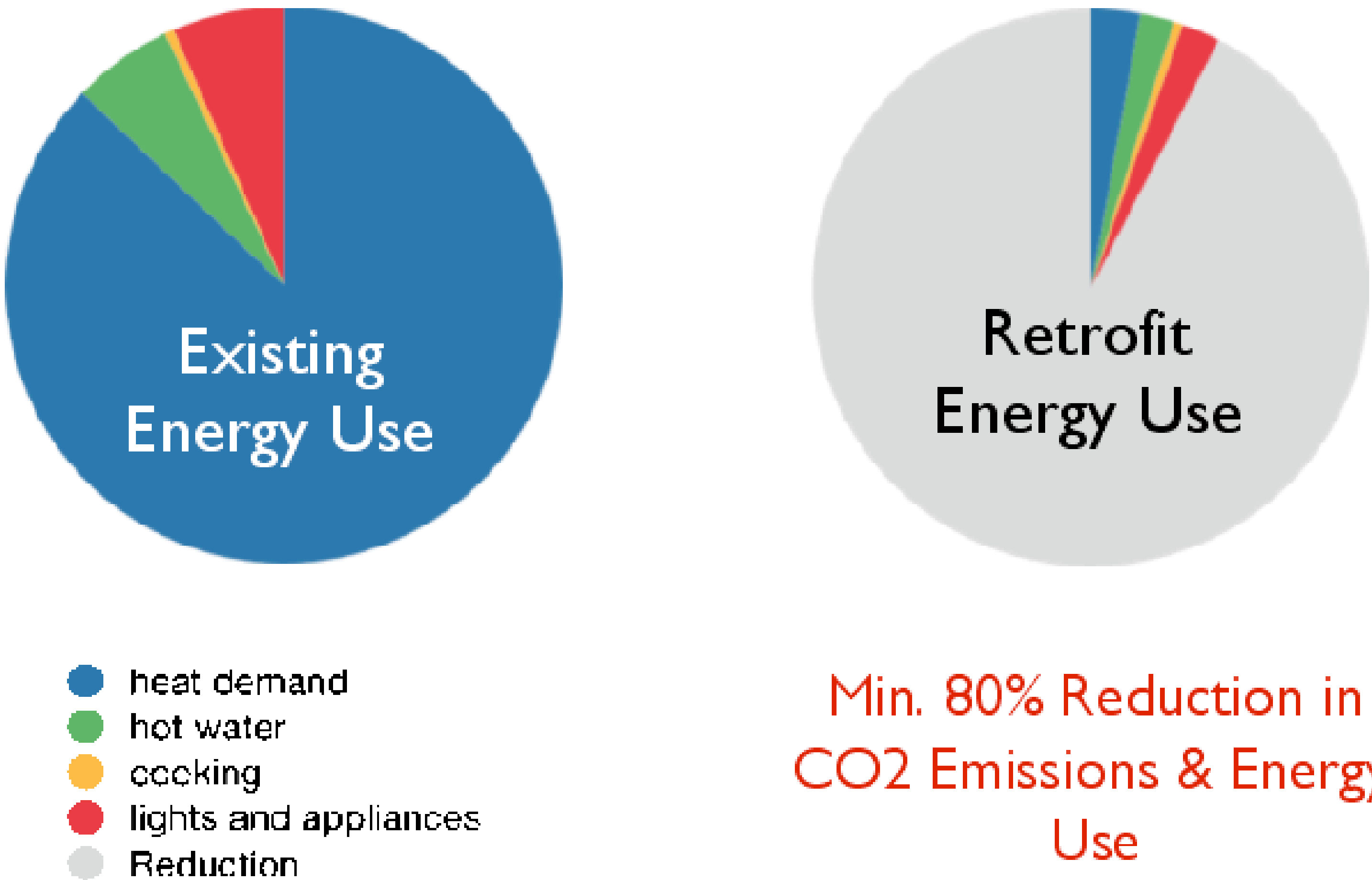

Min. 80% Reduction in CO_2 Emissions & Energy Use

Whole House Approach
Passivhaus = Fabric First

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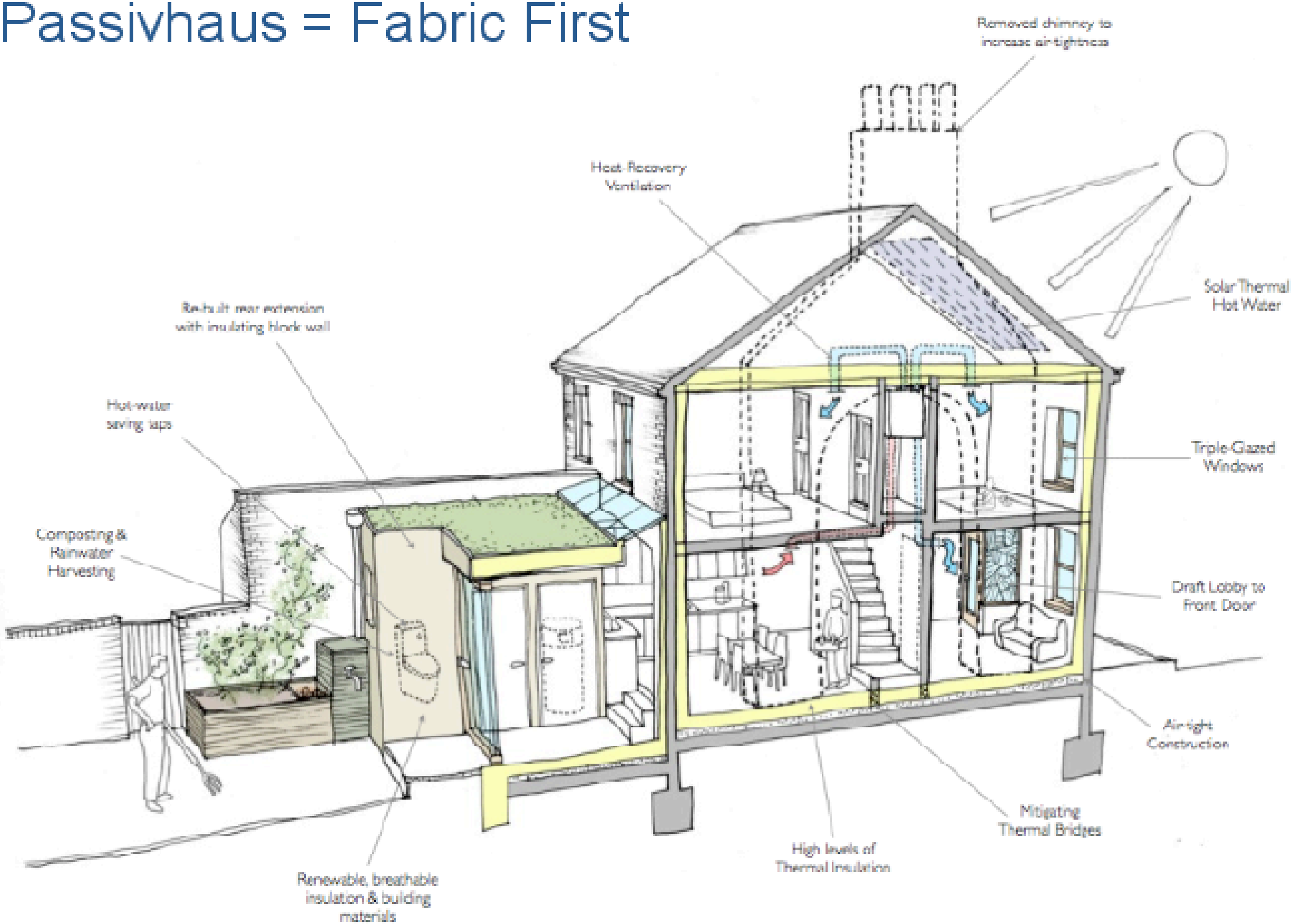
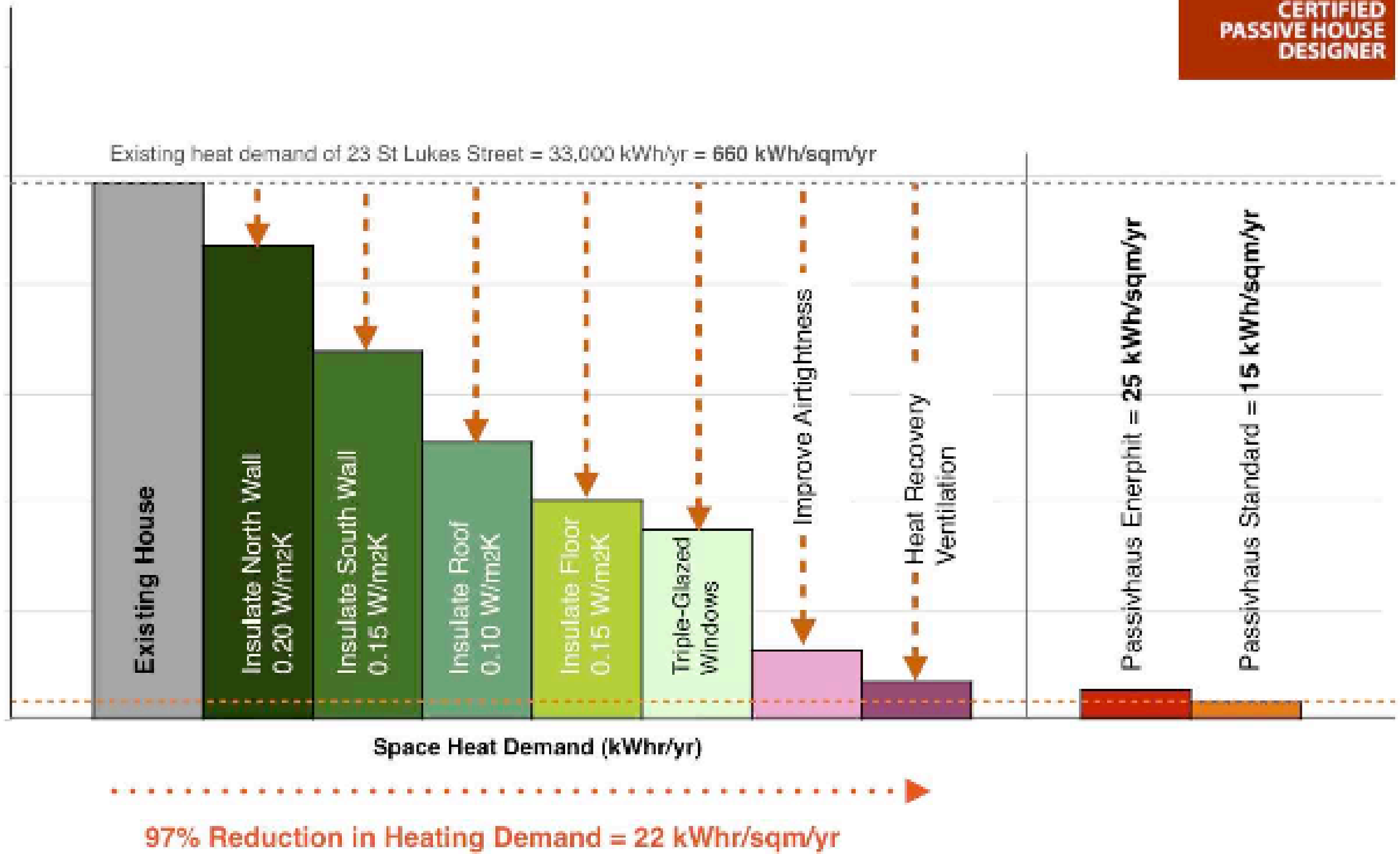


Passivhaus Approach

at ANNE THORNE ARCHITECTS LLP

DESIGNER
CERTIFIED PASSIVE HOUSE DESIGNER



London Retrofit

ANNE THORNE ARCHITECTS LLP

Specific Demands with Reference to the Treated Floor Area

Treated Floor Area: 108.9 m^2

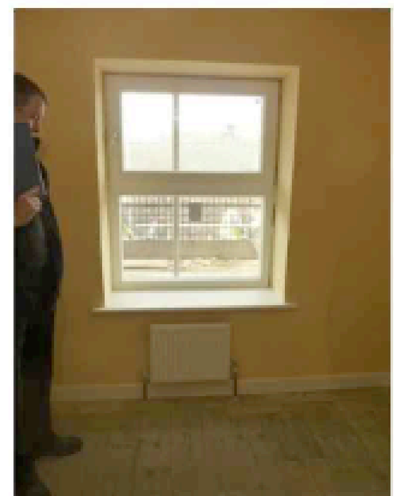
	Applied:		PH Certificate:	Fulfilled?
Specific Space Heat Demand:	37	$kWh/(m^2a)$	15 $kWh/(m^2a)$	No
Pressurization Test Result:	2.0	h^{-1}	0.6 h^{-1}	No
Specific Primary Energy Demand (DHW, Heating, Cooling, Auxiliary and Household Electricity):	93	$kWh/(m^2a)$	120 $kWh/(m^2a)$	Yes
Specific Primary Energy Demand (DHW, Heating and Auxiliary Electricity):	50	$kWh/(m^2a)$		
Specific Primary Energy Demand Energy Conservation by Solar Electricity:	0	$kWh/(m^2a)$		
Heating Load:	19	W/m^2		
Frequency of Overheating:	0	%	over 25 °C	
Specific Useful Cooling Energy Demand:		$kWh/(m^2a)$	15 $kWh/(m^2a)$	
Cooling Load:	4	W/m^2		

Stoke Retrofit

at ANNE THORNE ARCHITECTS LLP

Specific Demands with Reference to the Treated Floor Area

Treated Floor Area:	63.9	m²		
	Applied:		PH Certificate:	Fulfilled?
Specific Space Heat Demand:	22	kWh/(m²a)	15 kWh/(m²a)	No
Pressurization Test Result:	3.5	h^{-1}	0.6 h^{-1}	No
Specific Primary Energy Demand (DHW, Heating, Cooling, Auxiliary and Household Electricity):	89	kWh/(m²a)	120 kWh/(m²a)	Yes
Specific Primary Energy Demand (DHW, Heating and Auxiliary Electricity):	46	kWh/(m²a)		
Specific Primary Energy Demand Energy Conservation by Solar Electricity:		kWh/(m²a)		
Heating Load:	12	W/m²		
Frequency of Overheating:	0	%	over 25 °C	
Specific Useful Cooling Energy Demand:		kWh/(m²a)	15 kWh/(m²a)	
Cooling Load:	0	W/m²		



Internal Insulation Issues

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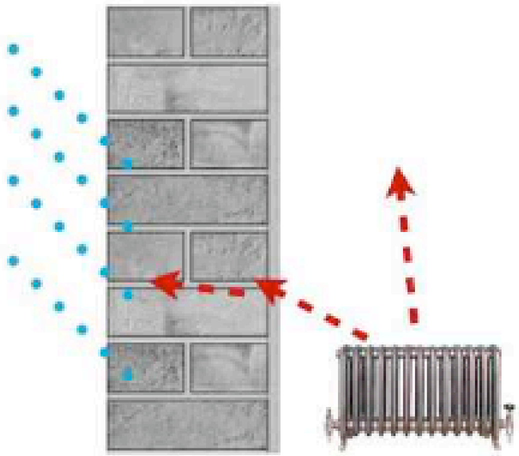
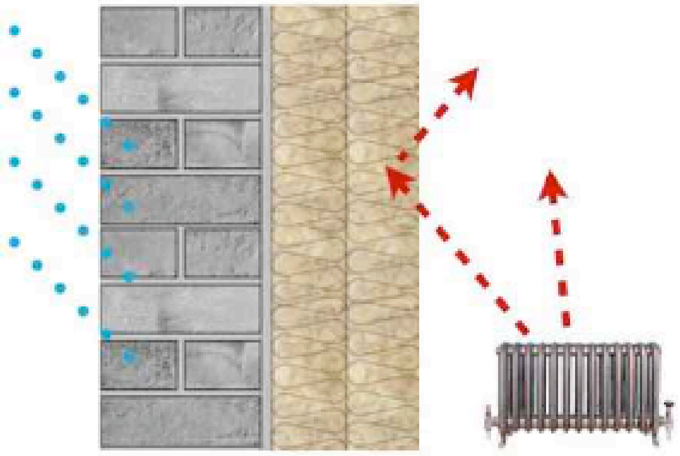


Un-insulated Wall:
Any moisture from outside was released by evaporation internal heating of house



Internally Insulated Wall:
Wall no longer dried out by house heating system as insulation reduces heat transfer - water within walls does not get chance to evaporate from cold wall

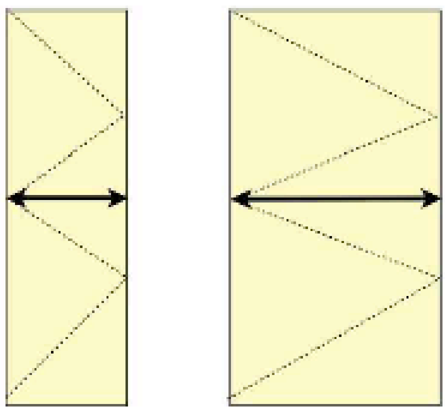
Potential Interstitial Condensation & Damp Problems!

Natural Insulation Materials

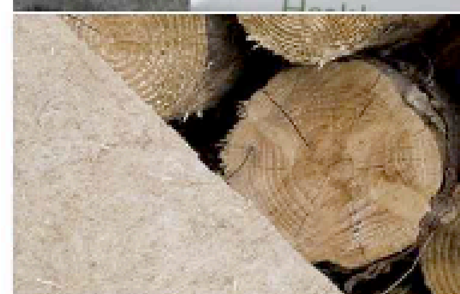
at ANNE THORNE ARCHITECTS LLP

cellulose / recycled paper	0.04 W/m.K
sheepswool	0.039 W/m.K
wood / hemp fibre batts	0.038 W/m.K
hempcrete	0.070 W/m.K
rigid phenolic insulation	*0.024 W/m.K*

150mm Phenolic Foam = 0.15 W/mK



250mm Sheepswool = 0.15 W/mK



Natural Insulation Materials

1. Health

non-toxic production / disposal

no off-gassing

minimise allergies

2. Low Embodied Energy

carbon sequestering

bio-degradable

renewable materials

3. Better Indoor Air Quality

naturally balances humidity

exothermic - ‘phase change’

4. Protect Existing Fabric

hygroscopic

vapour permeable (‘breathing’)

prevent trapped moisture

Internal Wall Insulation

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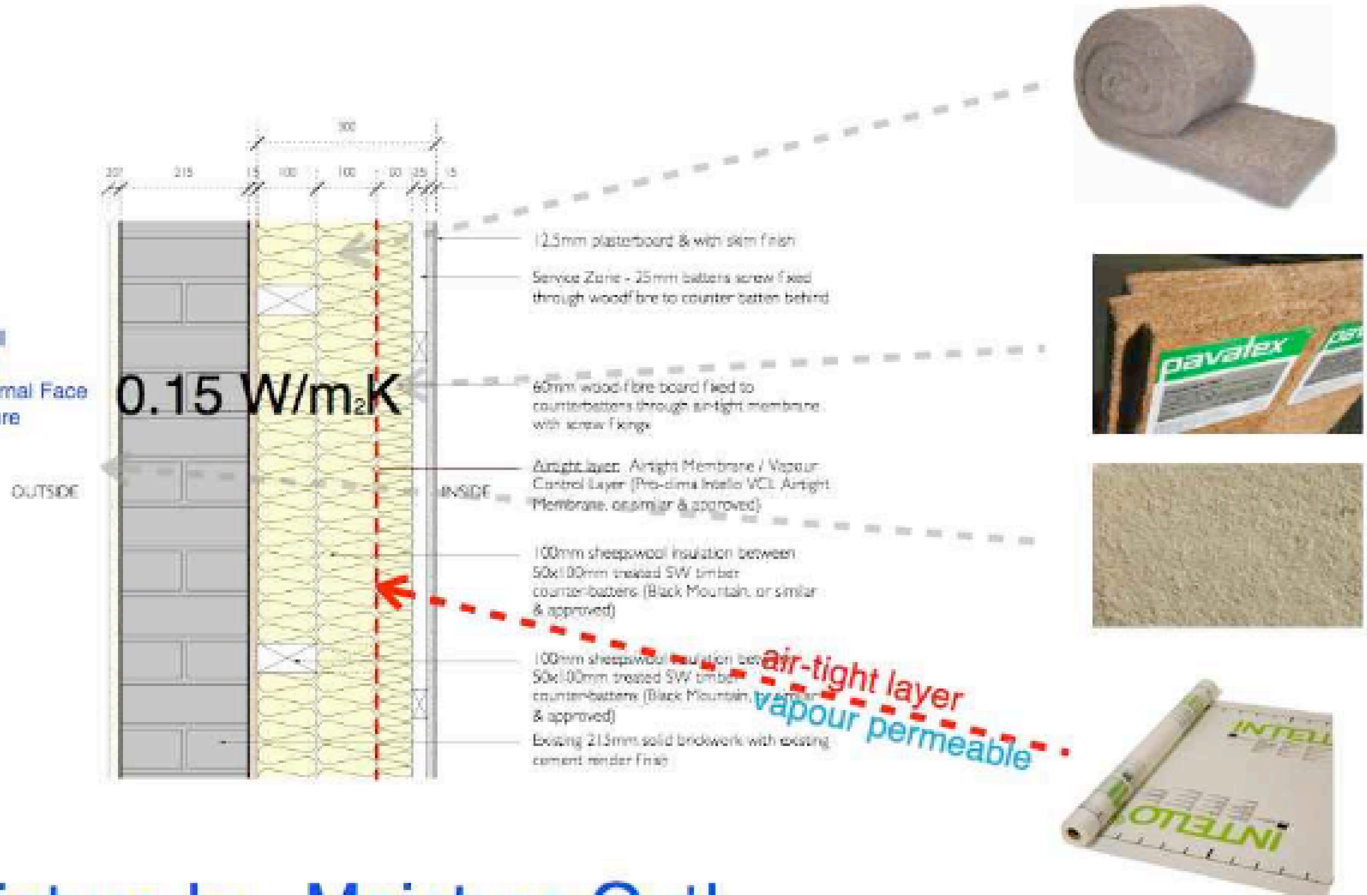
Improve Wall Breathability
Protect External Face from Exposure



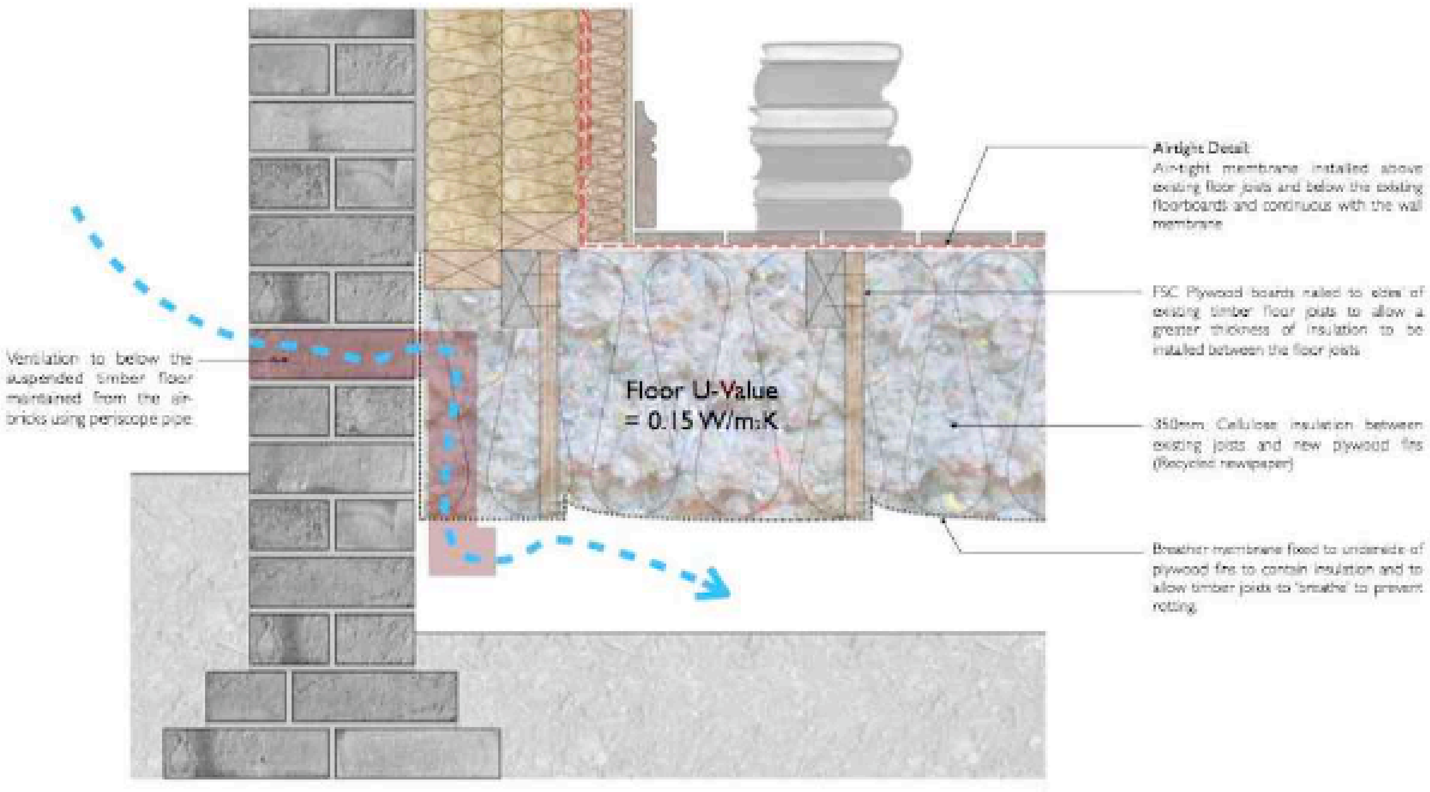
Moisture In - Moisture Out!

Hygroscopic Materials reduce the amount of vapour that passes from the room to the cold wall.
The vapour can be slowed and held in the insulation until it can be harmlessly released into the room again

Insulation Installation

Suspended Floor Detail

at ANNE THORNE ARCHITECTS LLP



Solid Floor Detail

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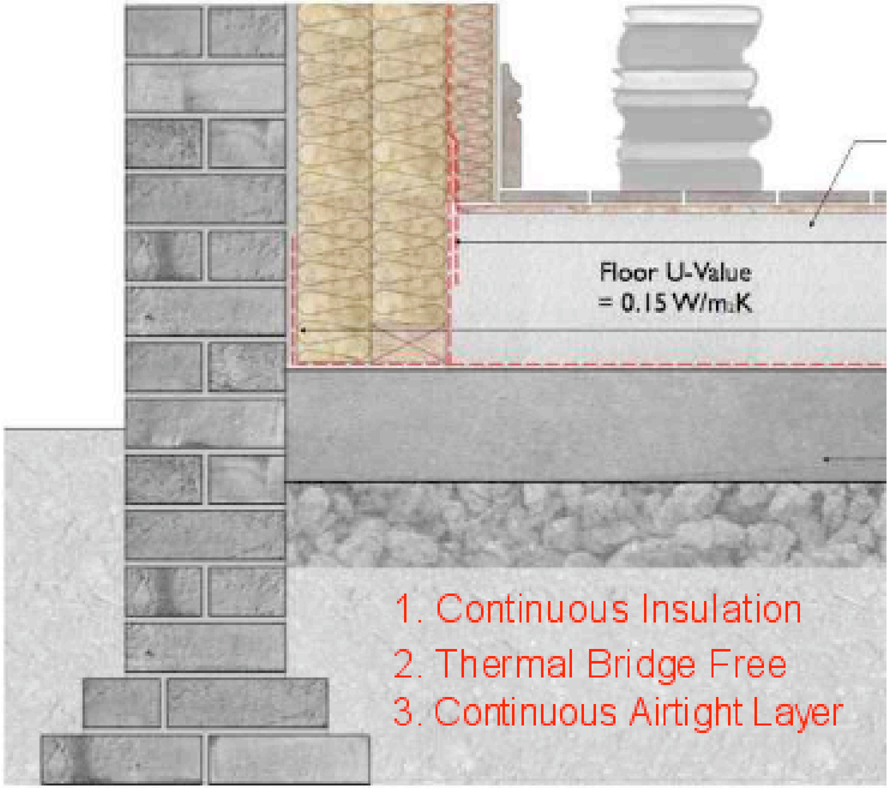

Existing Solid Floor

Could not add insulation on top as would raise floor level, affect doors and reduce ceiling height

Window & Joist Detail

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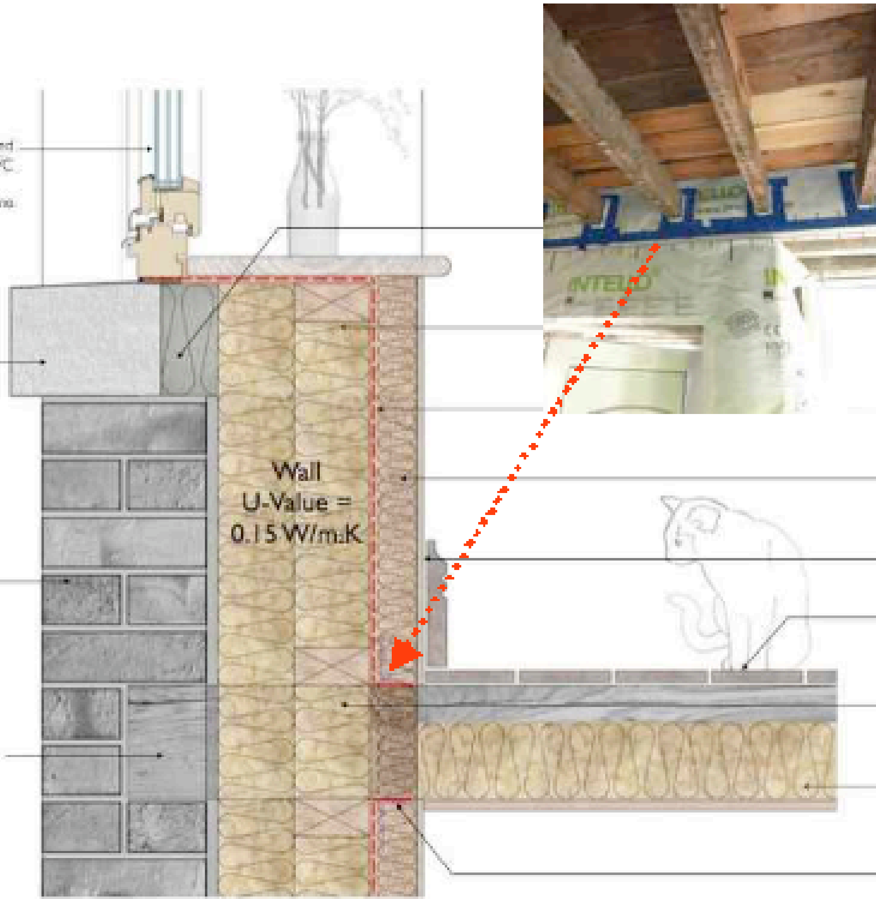

Eaves Detail

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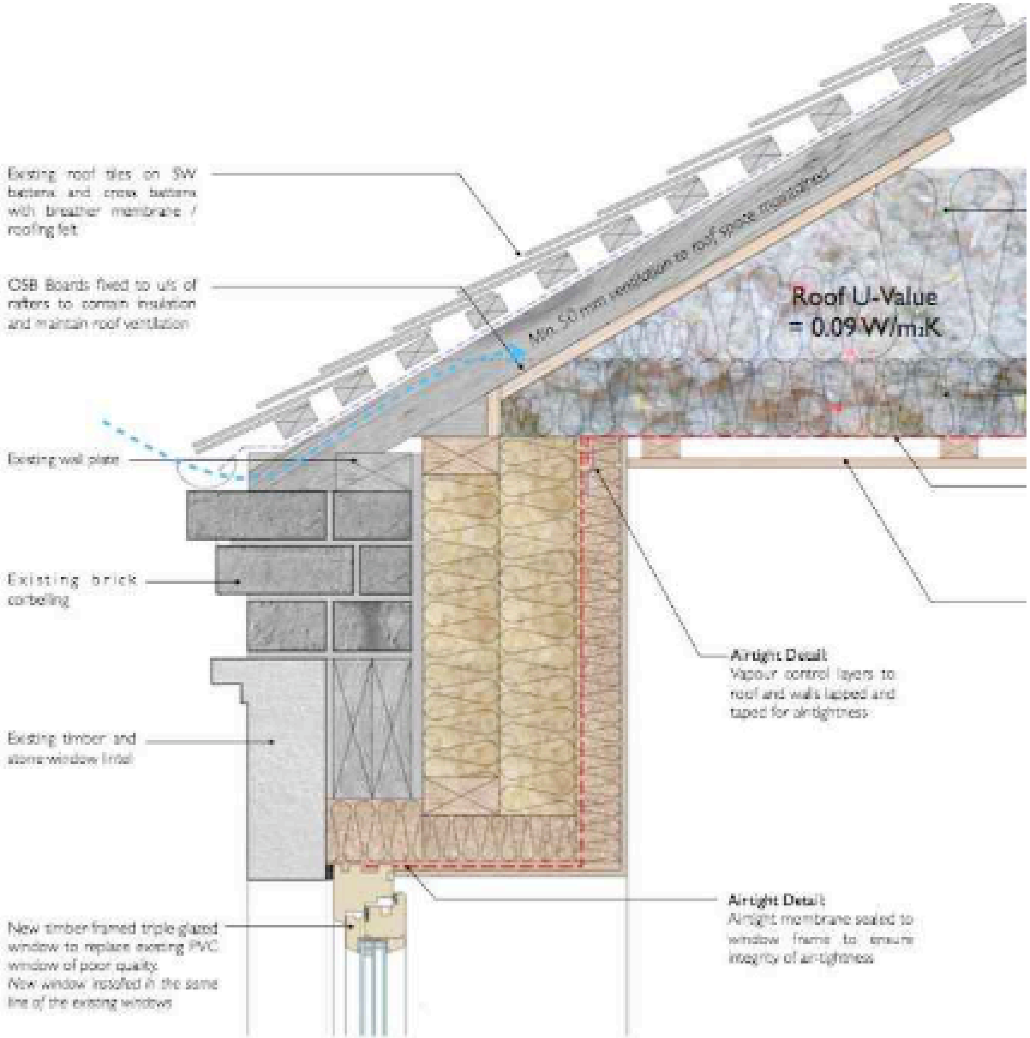

Balancing Lost Space

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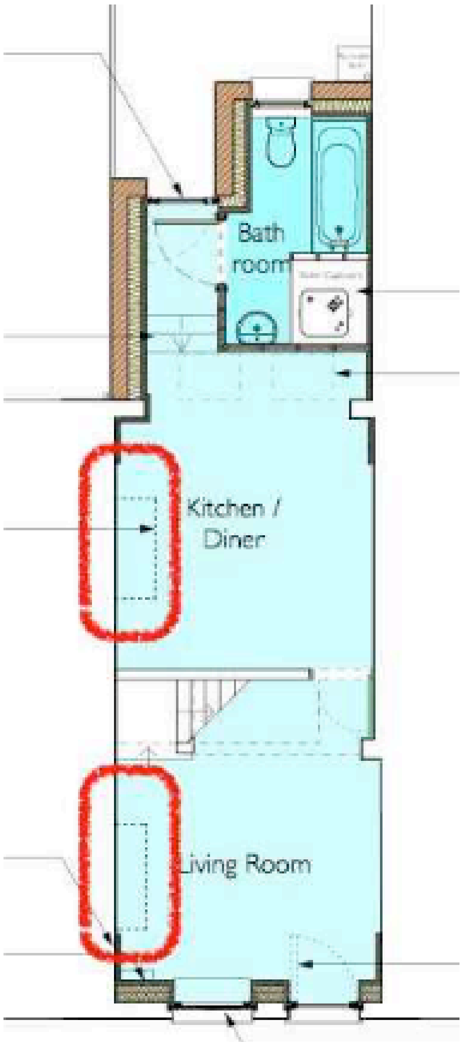

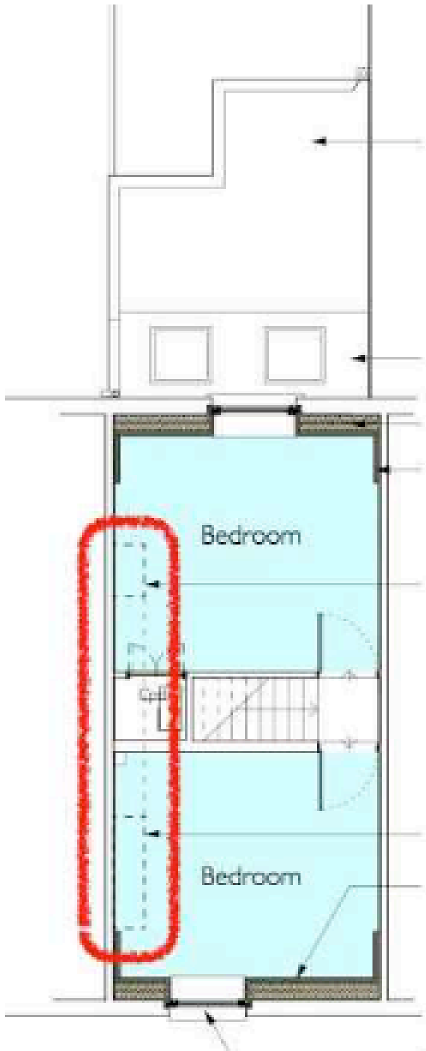

Identifying Thermal Bridges

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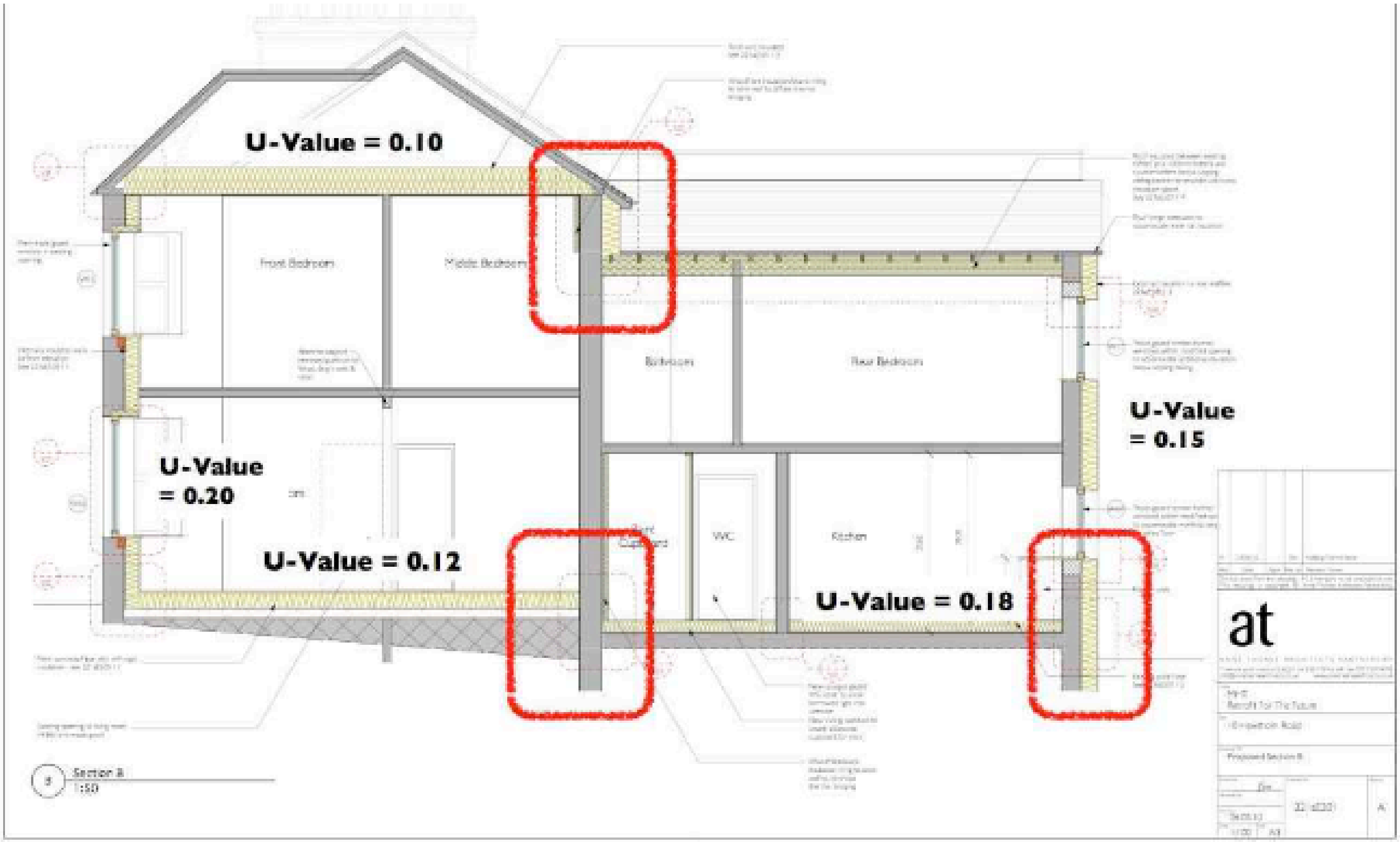
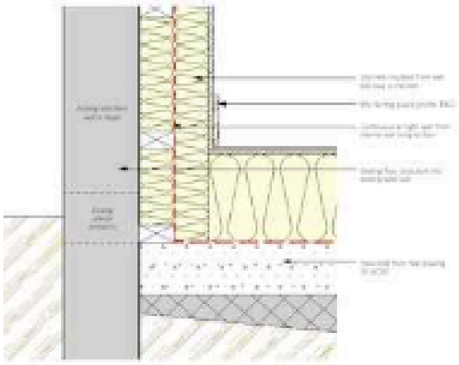


Identifying Thermal Bridges



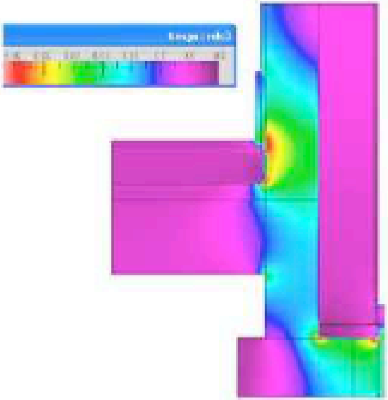
AVOID!
Thermal bridges increase the heat load, so first step is to avoid! - Continuous Insulation!

UNAVOIDABLE? MITIGATE....
If Thermal Bridge is Unavoidable without unrealistic expense on disruption....

1. Work out the 'correction factor' (Ψ-value) to correct the U-value calculation & heat loss using THERM or similar

2.Thermal bridges lead to cold spots - 12.6°C is the threshold for moisture to condense (leads to mould & human health issues) So alarm bells if surface temperatures below 14°C. Simple Calculation.

3. Enter into PHPP to ensure additional heat-loss taken into heat demand calculation



Passivhaus Enerphit standard state that surface temperatures should be around **17°C** for retrofit

Triple-Glazed Windows

ANNE THORNE ARCHITECTS LLP

Minimise Heat Loss

Triple-glazing: Window U-Value = Max. 0.8 W/(m²K)

Maximise Comfort

Triple-Glazed Windows mean the internal pane of glass is never below 17 degrees!

Achieving Airtightness

What is an Airtight Barrier?

Walls & Roof: Air-tight Membrane

Fully Plastered Wall

Damp Proof Membrane

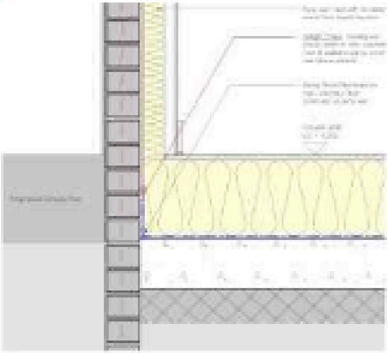
Carefully Detailed Airtight Junctions

Tapes, windows, service penetrations

Careful Site Installation

Attention to Detail

Methodical Sequencing



Heat Recovery Ventilation

Fresh, Warm, Low Energy Air

Air supply will never be lower than 16.5°C due to high efficiency of heat exchanger, and frost protection to unit.

Ventilates the Whole House

Supply Fresh Air to Living Room and Bedrooms
Extract Stale Moist Air from Kitchen & Bathroom

Finding Space for the Unit & Ducts!

Careful planning in existing house for ducts

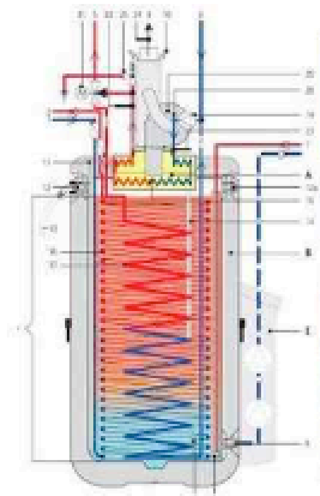
Solar Thermal Hot Water

Combined Gas & Solar Unit
Works to prioritise use of Solar Panels

One Integrated System
Simple Controls

65% reduction in energy for Hot Water
Calculated Using PHPP

Back Up Heating
Supplies Small Radiators as Back-Up



Modelled Reductions

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	Existing House (50sqm)	Retrofit House (64sqm)	
Heat Demand*	670 kWh/m^2yr	22 kWh/m^2yr	**97% Reduction**
Hot Water Demand	27 kWh/m^2yr	9 kWh/m^2yr	**65% Reduction**
Electricity Demand	38 kWh/m^2yr	17 kWh/m^2yr	**55% Reduction**
Air Tightness (Air Changes per Hour)	10.9h-1	3.5 h-1***	**78% Reduction**
TOTAL Primary Energy	788 kWh/m^2yr	85 kWh/m^2yr	**89% Reduction**
CO2 Emissions	164 CO2/m^2yr	16 CO2/m^2yr	**90% Reduction**
SAP Rating	47**	90	
Energy Bills	**£1170 a year**	**£121 a year**	**90% Reduction**

Route to Passivhaus

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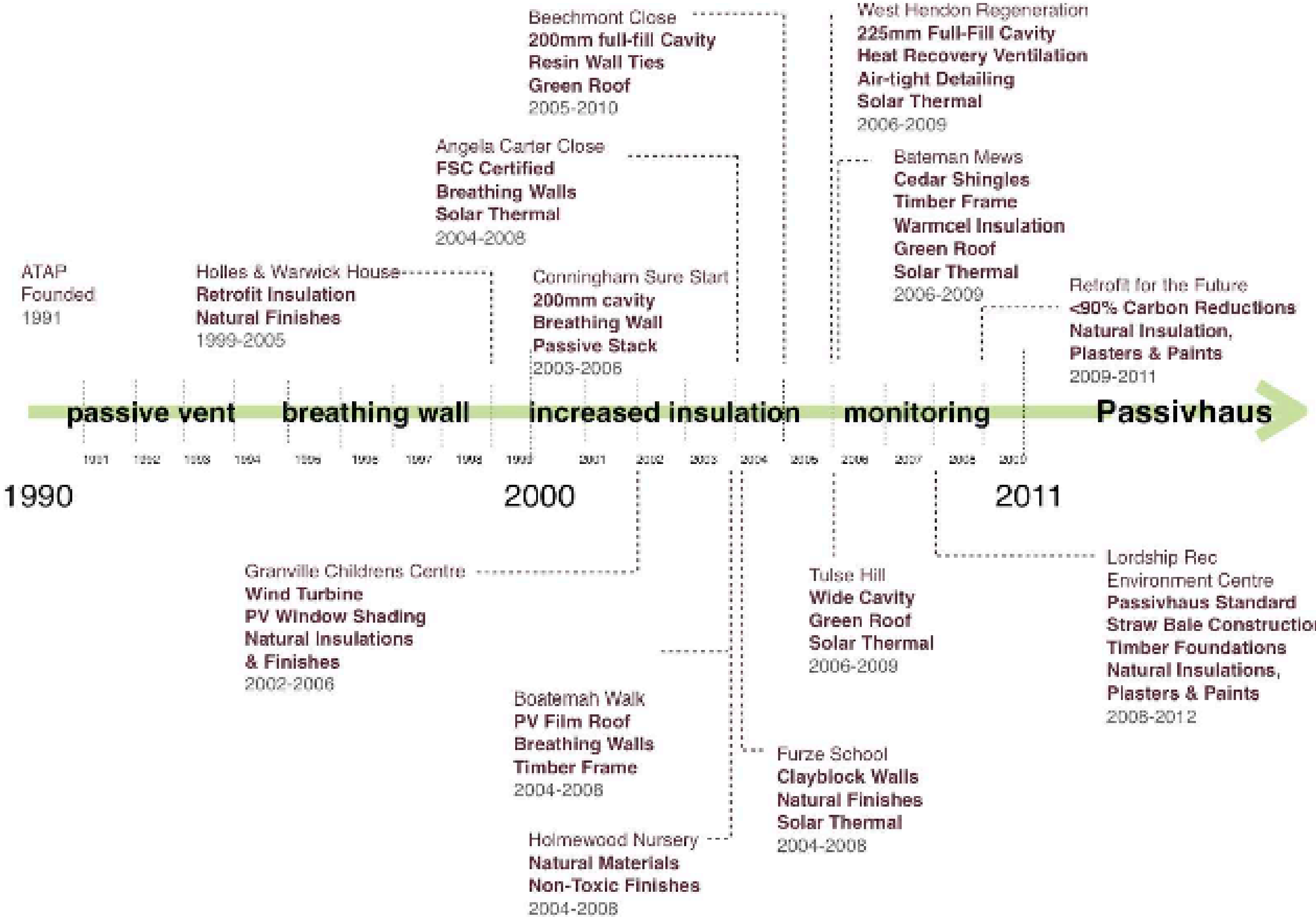

Thank you!

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