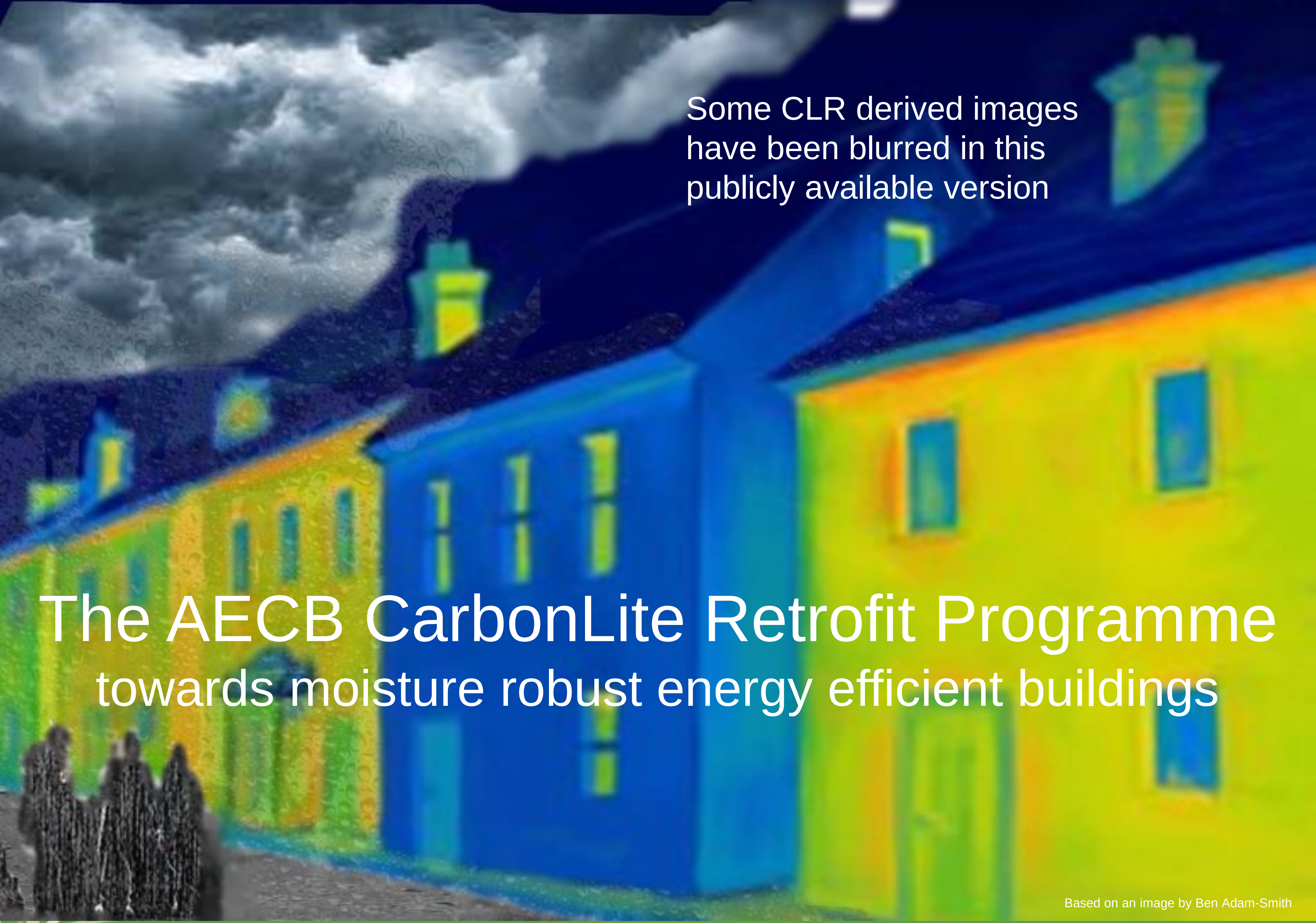


Some CLR derived images have been blurred in this publicly available version

The AECB CarbonLite Retrofit Programme

towards moisture robust energy efficient buildings

Based on an image by Ben Adam-Smith

AECB building knowledge

Andrew Simmonds

Andy is part time CEO of the AECB and Partner in Simmonds.Mills Architects

&

Dr Tina Holt

Tina has a PhD researching the impacts of climate change and a longstanding interest in exploring solutions to help address the energy problems we face

The world runs like clockwork

The climate is perfect

The physics simple & straightforward

The buildings are always shiny

In the real world maintaining and upgrading our buildings makes good sense :

Energy Security, Health, Social, Climate, Environmental, Economic

BUT we need to know how to do it *well* : effectively, safely, economically, holistically

CarbonLite Retrofit (CLR) Programme

So the AECB invested in extending the successful CarbonLite Programme into retrofit

Why do we need a CarbonLite Retrofit Programme?

Same reasons we needed the CL new build programme (now taken forward by the Passivhaus Trust and the UK PH community)

Put simply:

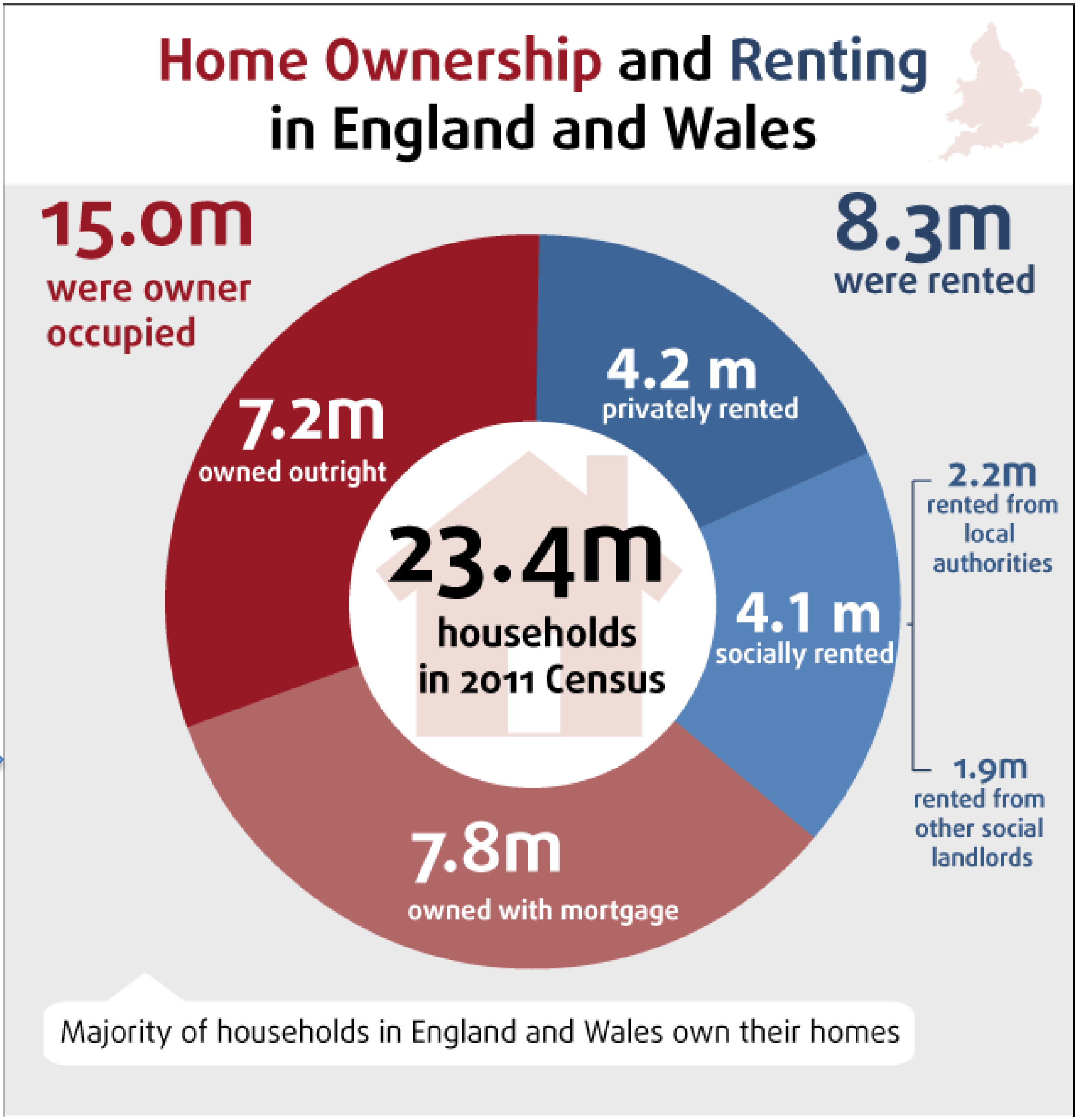
Because of (post) industrialised society's threat to the planet we no longer have the luxury of failing in what we set out to do – reliably and demonstrably reduce energy use and CO_2 emissions in the quickest, most sensible way we can manage.

The longer we wait, the less sensible or more risky the options available to us.
More speed, less haste – need to avoid industrialising mistakes

We need to apply best knowledge and adjust in line with measured results to achieve:

- Minimal performance gap
- Economic and robust retrofit solutions at scale – capturing as many co-benefits as possible.

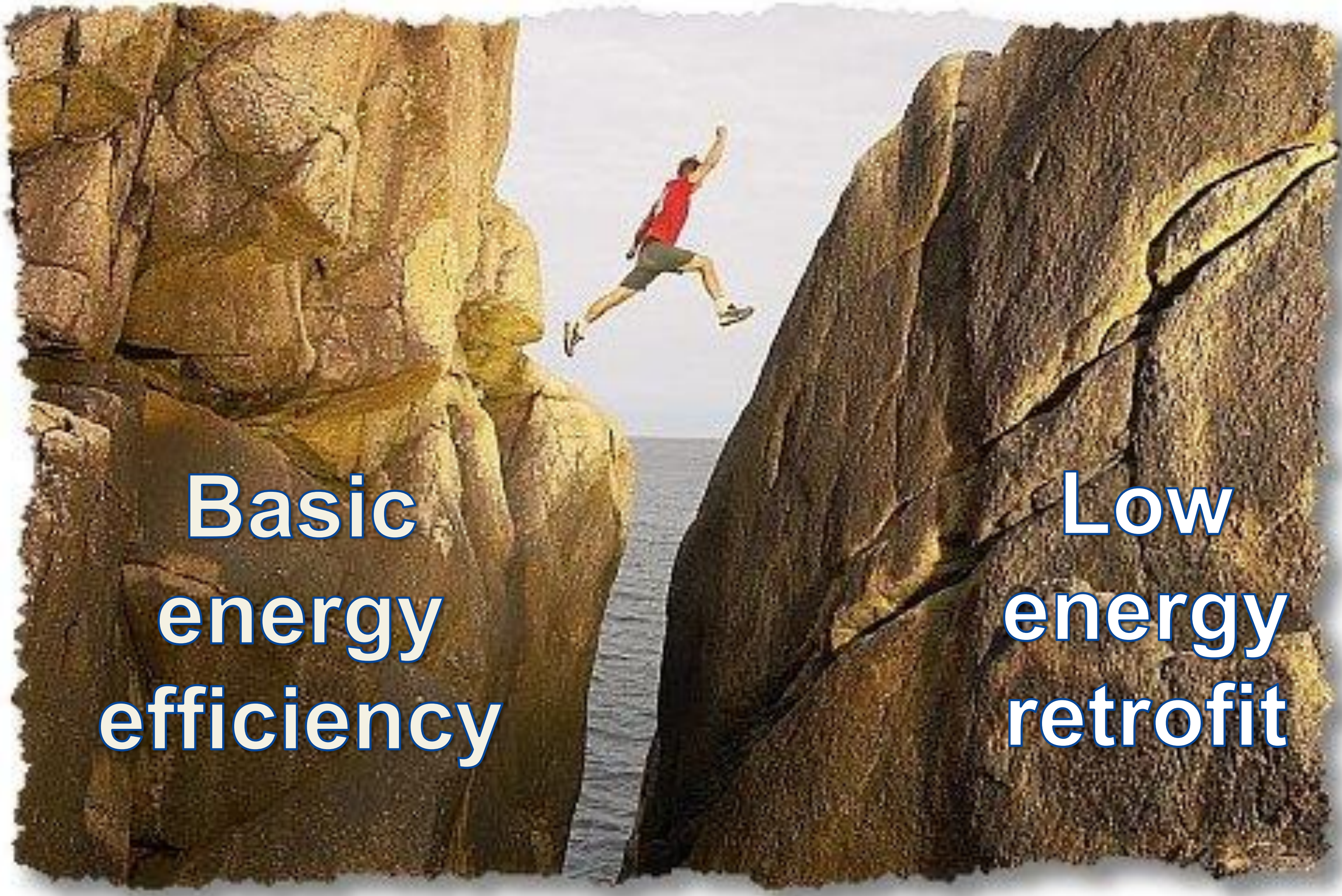
- Mainly domestic focus for now
- non-domestic section added in future funding dependent
- For all those interested to help decarbonise this lot over the next few decades



Why we need CarbonLite Retrofit

Dr. Tina Holt

A bit of a leap…



Something missing?

For me…

- ✓ Climate change
- ✓ Adaptation
- ✓ Mitigation
- ✓ Energy saving habits
- ✓ Common sense measures
- ✓ Energy politics

- ⌘ Building physics
- ⌘ Heat load
- ⌘ Moisture movement
- ⌘ Mould growth
- ⌘ Condensation risk
- ⌘ Robust assemblies
- ⌘ Whole life costings

Who is CLR for?

For everyone involved in retrofitting

- **Design & construction professionals**
- **Builders**
- **Trades**
- **Energy consultants**
- **Policy & decision makers**
- **Building owners**
- **Manufacturers**
- **Building owners**

–We want to build on our knowledge

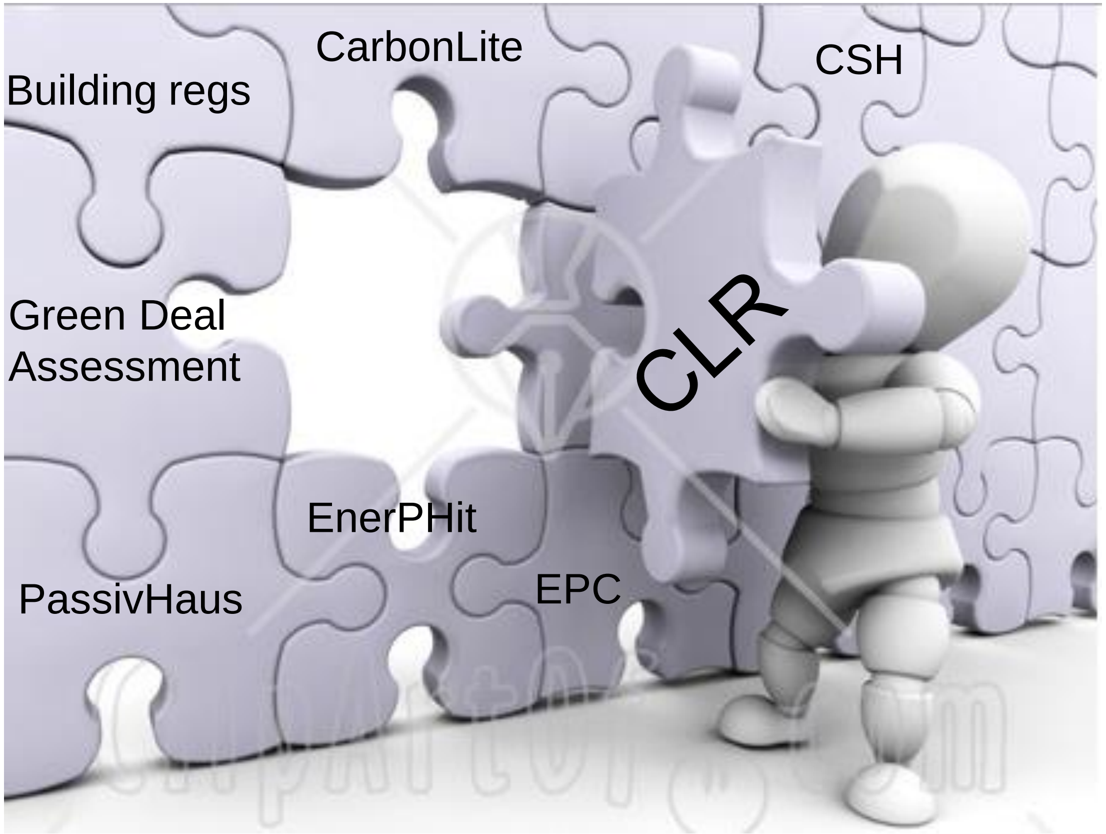
–We want standards and qualifications

Knowledge & Recognition

- **Building knowledge specific to retrofit**
- **Making the economic case for retrofit**

- **Certification for people**
- **Certification for buildings**
- **Visibility of widely relevant retrofit best practice**

The missing piece

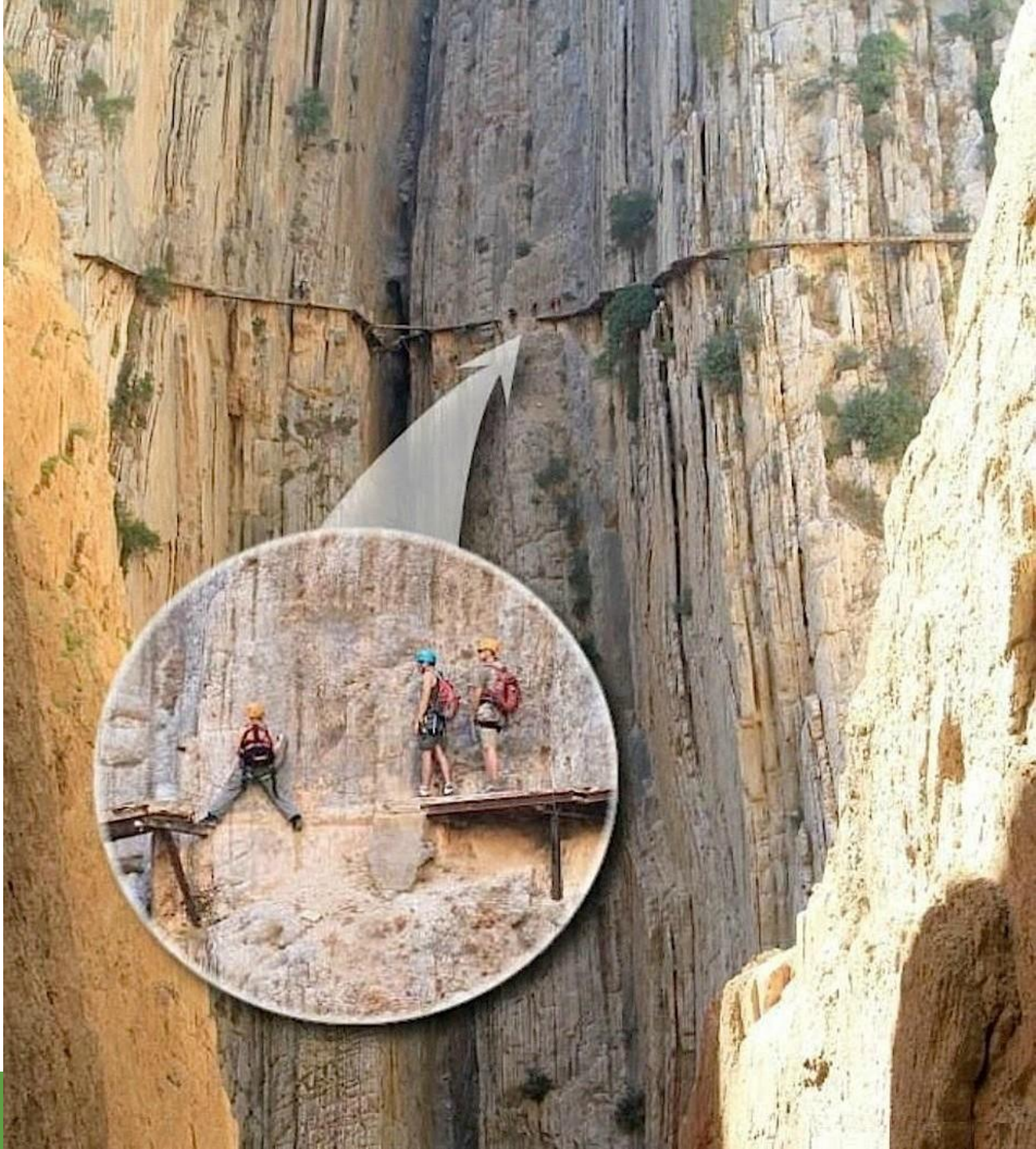


Bringing low energy retrofit to the mainstream in a formal way

Ever felt that low energy retrofit is a **delicate balancing act?**

We want to avoid the possible pitfalls…

We want to avoid situations that may be risky



AECB building knowledge

CLR gives users the concepts needed to find ways that will work.

And get everyone on a firmer footing

Along the way, it's good to have company

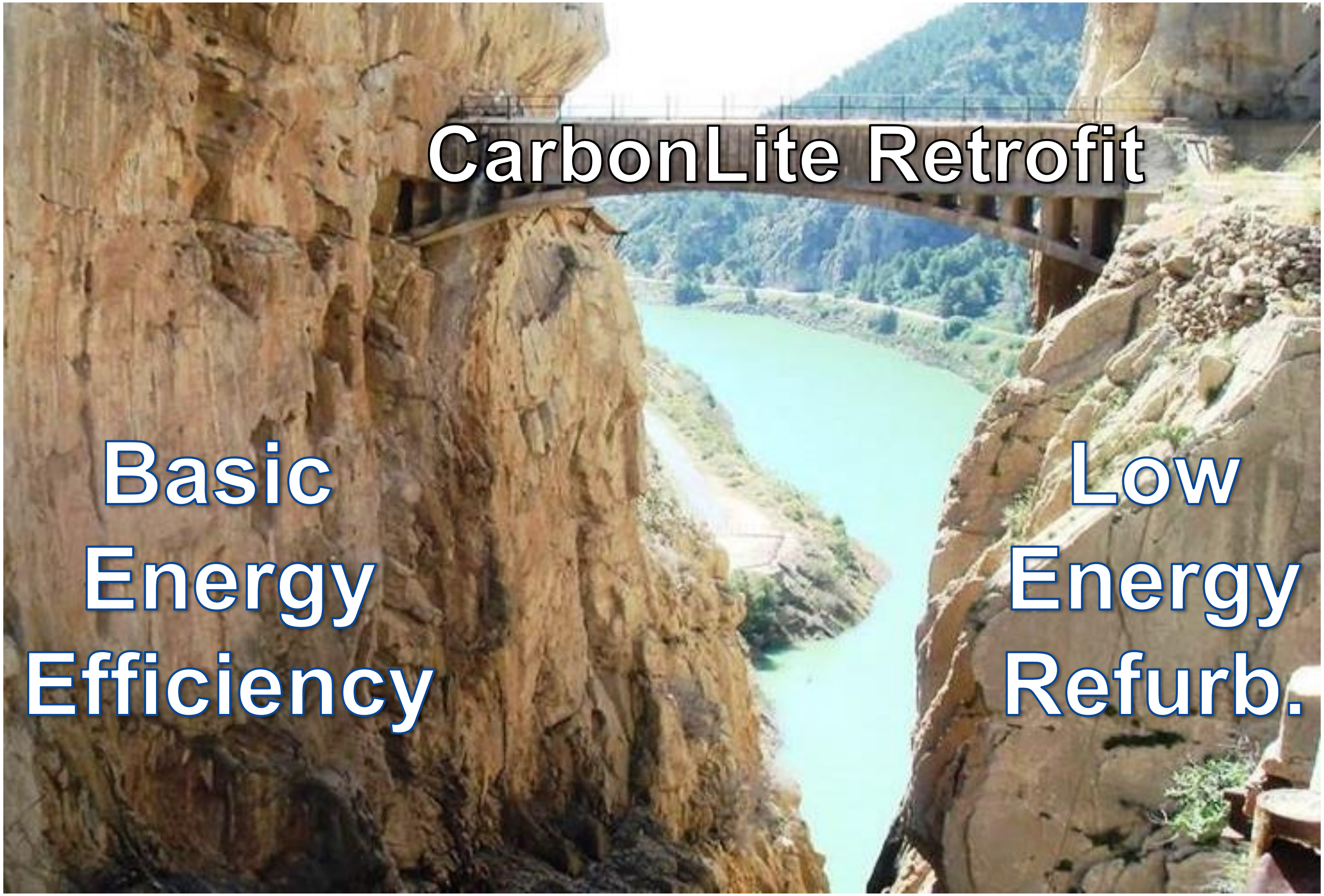
Especially in tricky areas…

And it's good to benefit

From the experience of others

A vast body of experience brought together in one course

- **Sharing the experience of those who have been doing this stuff for years**
- **Developing best practice**
- **Following ongoing research**
- **Raising standards in retrofit**


CarbonLite Retrofit
Basic Energy Efficiency
Low Energy Refurb.

From this…. to this

Top level potential retrofit outcomes
total failure – partial failure – partial success – total success

CLR aim

Adequate level of understanding in key areas + view of the big picture
Theory, Concepts, Methods, Calculations, Data, Tools, Magnitudes, Examples

- Use a constantly evolving attribute of the material to sequence it along a path.
- Order the concepts so that earlier concepts facilitate the understanding of later concepts.
- Provide a memorable introduction and conclusion.
- Use multiple representations and media to communicate.
- Allow for multiple levels of engagement and understanding.

Skills in identifying risks and delivering robust retrofit solutions
+
Increasing number of exemplar retrofits
+
Reduce environmental impact, increase expertise creating business for AECB members

Retrofit Monitoring questions, data, analysis, case studies

Share with & learn from others

Big picture

CarbonLite Retrofit

Big picture

The scientific evidence is clear. We must dramatically reduce greenhouse gas emissions if we are to avoid the worst effects of a warming world. Politically and economically, we must also prepare for a world in which fossil fuel supplies are likely to decline. In the absence of decisive action to address energy insecurity, this will inevitably lead to higher prices and rising fuel poverty.

Mitigate for <2C. Adapt for ~4C. Secure Affordable Heat & Power

The roots of climate change lie in the industrial revolution that began in Britain in the 18th century. We therefore have a particular responsibility to demonstrate ambition in defining and pursuing an affordable way to mitigate global climate change.

Moral case – but also beneficial for us in all sorts of ways

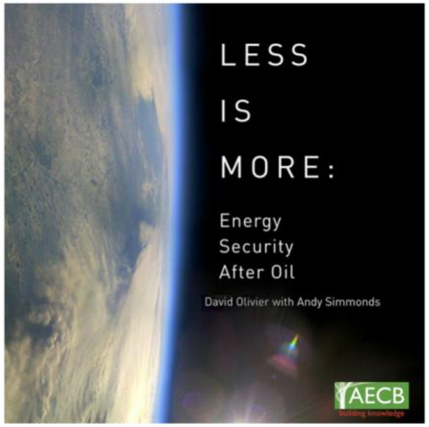
Maximum Ambition, Minimum Risk

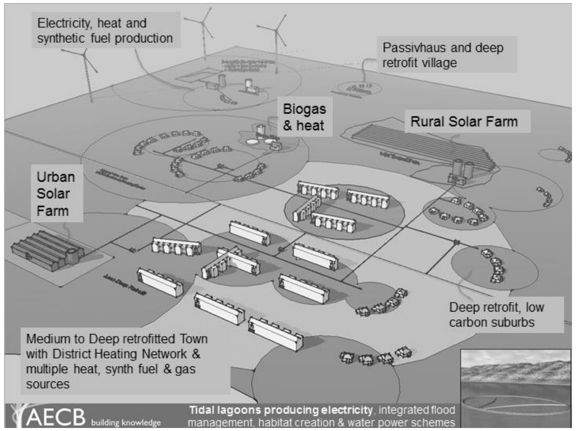
If we are to achieve a 100% cut in emissions by 2050, we cannot carry on tinkering at the edges. We have to embark upon a transformation of ways in which energy is produced, delivered and used. We have to rethink every part of the system. Yet this has to be done without damaging the economy through needlessly costly measures.

The AECB acknowledges that retrofit measures can have unintended consequences

CarbonLite Programme Now

Energy Efficiency ‘vs.’ Decarbonising UK Heat & Power





Energy Performance Standards

AECB Silver Standard

To achieve high performance buildings where other energy standards are not possible

Passivhaus

Europe’s best-known standard

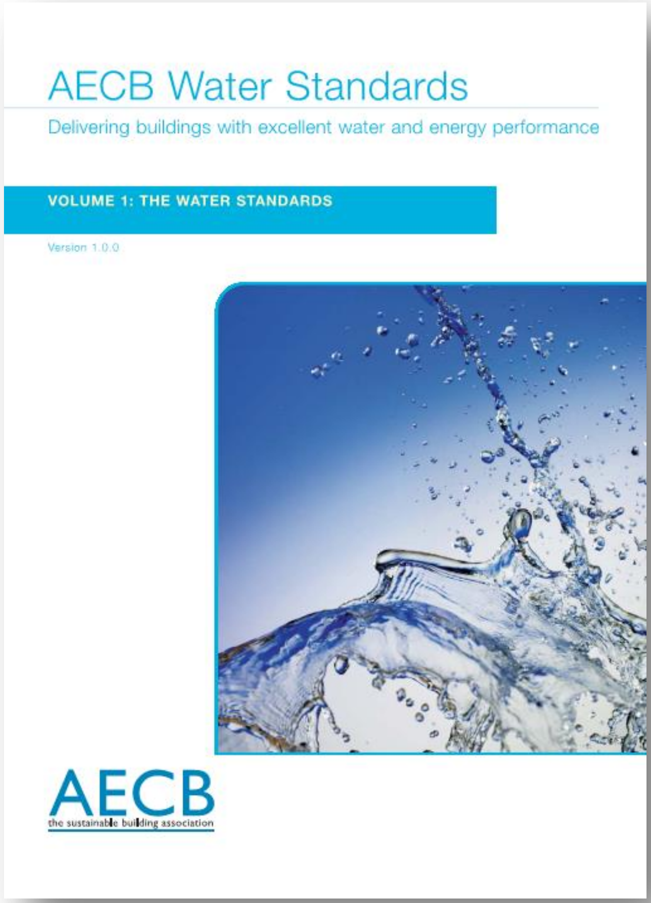
AECB building knowledge

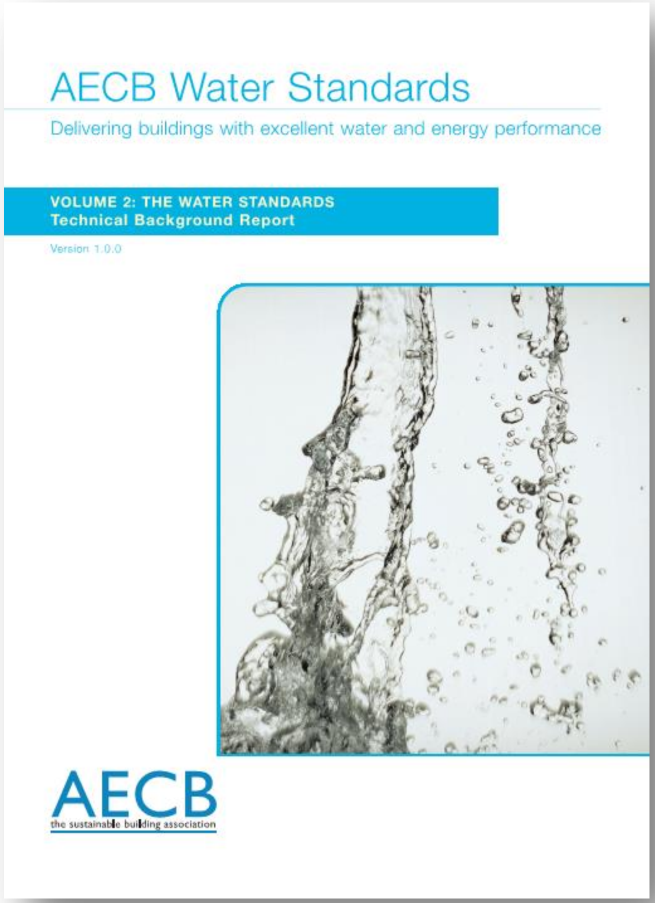
Passivhaus Trust

AECB Gold

For those looking to innovate

Energy Efficient Construction Guidance





http://www.aecb.net/wp-content/uploads/2013/02/1503_AECB_Water_Vol_1_V3.pdf

http://www.aecb.net/wp-content/uploads/2013/02/The_AECB_Water_Vol_2_V3.pdf

▼ LEB home ▼ LEB Project Library ▼ About the LEB ▼ LEB Reference Log-in Register

low energy building database

Search Go

Welcome to the Low Energy Building Database, a repository of low-energy building information created to help inform the planning and development of low energy new build and refurbishment

You can browse projects in our database, you can also create and edit projects if you have a log-in. New users can create an account.

Featured Projects

Clapham Retrofit

This 4-storey semi-detached Grade II listed Victorian townhouse has been eco-retrofitted to a high standard of airtightness and thermal performance. The 170-year old, solid brick building has been internally retrofitted with over 9 types of insulation material, each a bespoke solution to localised performance requirements respecting the historic significance of the existing fabric. The existing sash windows and doors have been upgraded through the installation of double-glazed secondary glazing. High performance insulation materials together with careful airtightness and thermal bridge detailing have resulted in a historic building that is both highly energy efficient and more comfortable to live in.

Semi-Detached, Solid Brick, Refurbishment

Project owner : Arboreal Architecture

AECB Silver Standard certified building

New Farmhouse

Passivhaus Trust Awards 2014 Finalist - Kirsty Maguire Architects worked in collaboration with Hope Homes and Morgan Associates to design and build this farmhouse to the Passivhaus standard. Construction started in August of 2012, and the building was completed and certifed as a Passivhaus 12 months later. The house has a timber frame with I-joists, glulam beams and zinc cladding for the roof, a small wood burning stove, with hot water provided by an air source heat pump.

Detached, Other, New build

Project owner : Kirsty Maguire Architect Ltd

Passivhaus certified building

About the LEB

During 2009-2010, the Technology Strategy Board implemented a £17m programme known as Retrofit for the Future (RfF), to kick-start the retrofitting of the UK's social housing stock. AECB – the sustainable building association was asked to develop appropriate energy performance targets for the competition and provide ongoing support and guidance. The AECB and the TSB have developed this database as an education and dissemination tool, incorporating both the RfF projects as well as new and refurbished domestic and non-domestic low energy buildings. Find out more about the LEB

Home energy use check

The AECB Home Energy Check helps you to see how your existing home energy use compares against retrofitted energy efficient properties entered in the AECB Low Energy Buildings database.You will only need basic information about the size of your home and the amount of fuel(s) your home uses over a twelve-month period. See how your property compares

Charts

Charts of Energy use and CO2 emissions and Airtightness compiled from

AECB building knowledge

200 Low energy projects inc. Retrofit for the Future Projects

Useful strategy

Clapham Retrofit

This 4-storey semi-detached Grade II listed Victorian townhous
170-year old, solid brick building has been internally retrofitted
requirements respecting the historic significance of the existin
double-glazed secondary glazing. High performance insulation
historic building that is both highly energy efficient and more c

Images | Graphs | Figures | Description | Strateg

Design strategies

Planned occupancy	Two people with occasional guests. Both oc
Space heating strategy	Low temperature hot water heating.Gas-fired
Water heating strategy	Unvented hot water cylinder with solar twin c
Fuel strategy	Mains gas. Mains electricity.
Renewable energy strategy	Solar hot water collectors. 3sqm facing due
Passive Solar strategy	n/a - retrofit of existing listed building.
Space cooling strategy	Natural cross-ventilation.
Daylighting strategy	n/a - retrofit of existing listed building.
Ventilation strategy	Whole house mechanical extract ventilation.
Airtightness strategy	Continuous air barrier formed by internal lime below. 2nd floor ceiling membrane sealed wi frames sealed with tapes. Grommets installe
Strategy for minimising thermal bridges	Continuous layer of internal insulation. Caref blanket, perlite, technopor, perinsul.
Modelling strategy	Whole house modelling in PHPP.
Insulation strategy	Application of Internal wall insulation includir insulation.Existing concrete slab retained bu lytag screed.2nd floor roof filled with cellulos
Other relevant retrofit strategies	Pre-design investigations undertaken to deve allow a fine grain of design.
Contextual information	The existing building is Grade II listed.

Useful detail

Clapham Retrofit

This 4-storey semi-detached Grade II listed Victorian townhouse has been eco-retr
170-year old, solid brick building has been internally retrofitted with over 9 types of
requirements respecting the historic significance of the existing fabric. The existing
double-glazed secondary glazing. High performance insulation materials together w
historic building that is both highly energy efficient and more comfortable to live in.

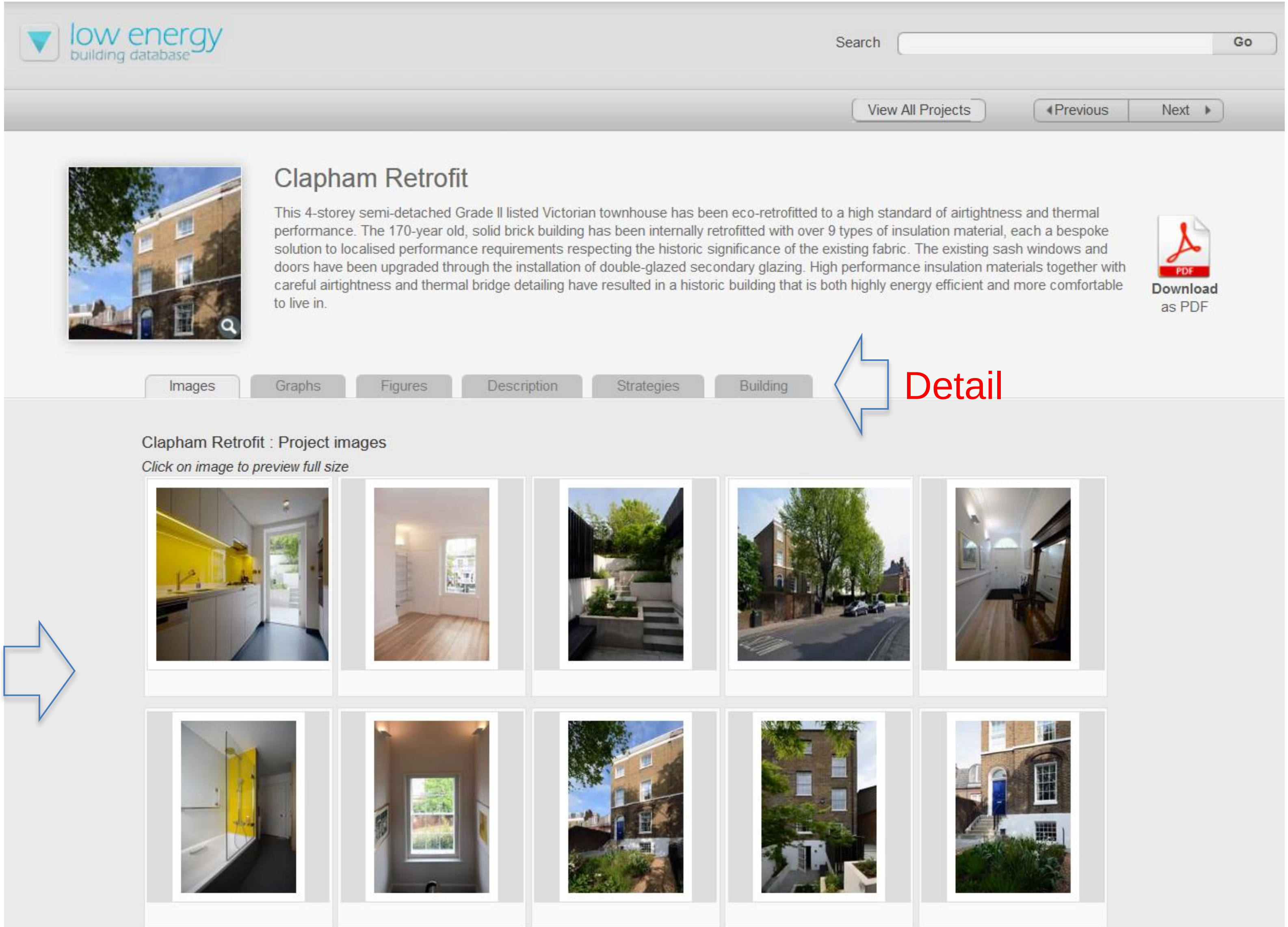
Images | Graphs | Figures | Description | Strategies | Building

Building services

Occupancy	Two people with frequent guests.
Space heating	Low temperature hot water heating.Gas-fired 12kW condensing b
Hot water	Unvented hot water cylinder with solar twin coil.
Ventilation	Whole house mechanical extract ventilation.
Controls	Digital controller with room temperature compensation, hot water Integral isolating and thermostatic radiators valves to all radiators
Cooking	Gas hob with electric oven.
Lighting	LED lighting throughout.
Appliances	All appliances A+ to A+++ rated.
Renewable energy generation system	Solar hot water collectors. 3sqm facing due south.
Strategy for minimising thermal bridges	Continuous layer of internal insulation. Careful detailing of a rang blanket, perlite, technopor, perinsul.

Building construction

Storeys	4
Volume	613 m^3
Thermal fabric area	376 m^2
Roof description	Insulated 2nd floor ceiling with cold (but windtight) roof above. TG
Roof U-value	0.15 $W/m^2 K$
Walls description	Internal wall insulation including: woodfibre, aerogel, IQtherm, PIF
Walls U-value	0.11 $W/m^2 K$
Party walls description	Solid brick. Party wall returns to external walls insulated (u-value
Party walls U-value	1.21 $W/m^2 K$



Detail

Gallery

Retrofit Knowledgebase

Categories

Construction Features (37)

- Below-ground Masonry, Crawlspaces and Basements (19)
- Chimneys (1)
- Damp proof courses and Waterproof Tanking (2)
- Ground floors (11)
- Insulation (20)
- Masonry walls (11)
- Roof structures (9)
- Timber (7)
- Wall assemblies (21)

Environmental Systems (11)

- Energy targets (3)
- MEV, MVHR, Passive Stack (2)
- Monitoring & Metering (7)

Risk Points (46)

- Air infiltration (4)
- Climate (8)
- Existing Conditions (12)
- Flooding (2)
- Fuel Poverty (1)
- Heat loss (11)
- Historic Status (7)
- Indoor air quality (9)
- Moisture in Materials (32)
- Occupants (3)
- Penetrating and Rising Damp (11)
- Performance Gap (3)
- Rot, Mould and Bugs (18)

Type of Information (45)

- Analysis tools and techniques (4)
- Background and concept (18)

Carbonlite Knowledgebase

Carbonlite Knowledgebase

Mold: Cause, Effect and Response

1 January 2002

This paper offers a review of a variety of scientific, technical and medical resources to answer questions and to educate readers about the complex and often controversial issues surrounding mold growth in buildings. This paper is intended for the construction industry, including manufacturers, contractors and building owners and managers. It is not intended to provide design guidance or to serve as a training manual for mold assessment and remediation. The goal is to provide readers with an understanding of the state of the science so they can be better equipped to prevent mold problems, handle mold complaints when they do occur, and practice good risk management.

Originating URL : http://c.ymcdn.com/sites/www.wallcoverings.org/resource/resmgr/product_performance/wa-_mold_information.pdf

Year of publication: 1 January 2002

Relevant region :

Categories: Background and concept, Key reference, Moisture in Materials, Rot, Mould and Bugs, Wall assemblies

Status : Publicly available

Publishing Organisation(s): Wallcoverings Association

Download

Document : Mold: Cause, Effect and Response (206 kB)

Show/hide review

Reviewed 1 April 2014

1 April 2014

Reviewer: **Dr Jane Nicklin**
Reviewer's organisation & position: **Biological Sciences, Birkbeck, University of London**
Reviewer's professional qualifications: **BSc PhD**
Reviewer's area of expertise and interest: **Mycology, effect of mould on heritage materials**

Strengths and weaknesses of the document

Well written very informative, a very good source of information within the document but also in the appendices and references. Balanced.

Potential benefit of applying the knowledge

An excellent source of information for practitioners and students

Relevance of knowledge to the UK

Good, other than section 5 which pertains to the US regs on liability, assignment and insurance.

Buildings at Risk in Wales

1 April 2009

Cadw has commissioned this report to identify trends and to inform future actions. It is hoped that local planning authorities will use it as a tool when considering their priorities and future strategies for listed buildings in their area.

Training Courses

Featured : CarbonLite Training

Training to achieve Certified Passivhaus Designer (CEPH)

Guiding you through becoming a certified Passivhaus designer and giving you the confidence to tackle UK Passivhaus projects

This course is aimed principally at building professionals in the UK: Architects, Builders, Building Engineers and others who want to learn how to deliver real low energy buildings. It introduces the principles behind the Passivhaus standard and methodologies and the use of the Passivhaus Planning Package (PHPP) for achieving low energy performance. To get the most out of taking the full course we recommend that you need to have a knowledge of UK construction systems, an ability to read building plans and an understanding of basic algebra.

DESIGNER

CERTIFIED PASSIVE HOUSE DESIGNER

What does the course involve?

The Passivhaus Designer qualification is an internationally accredited scheme linked back to the Passivhaus Institut in Germany. On successful completion of the exam delegates are listed on

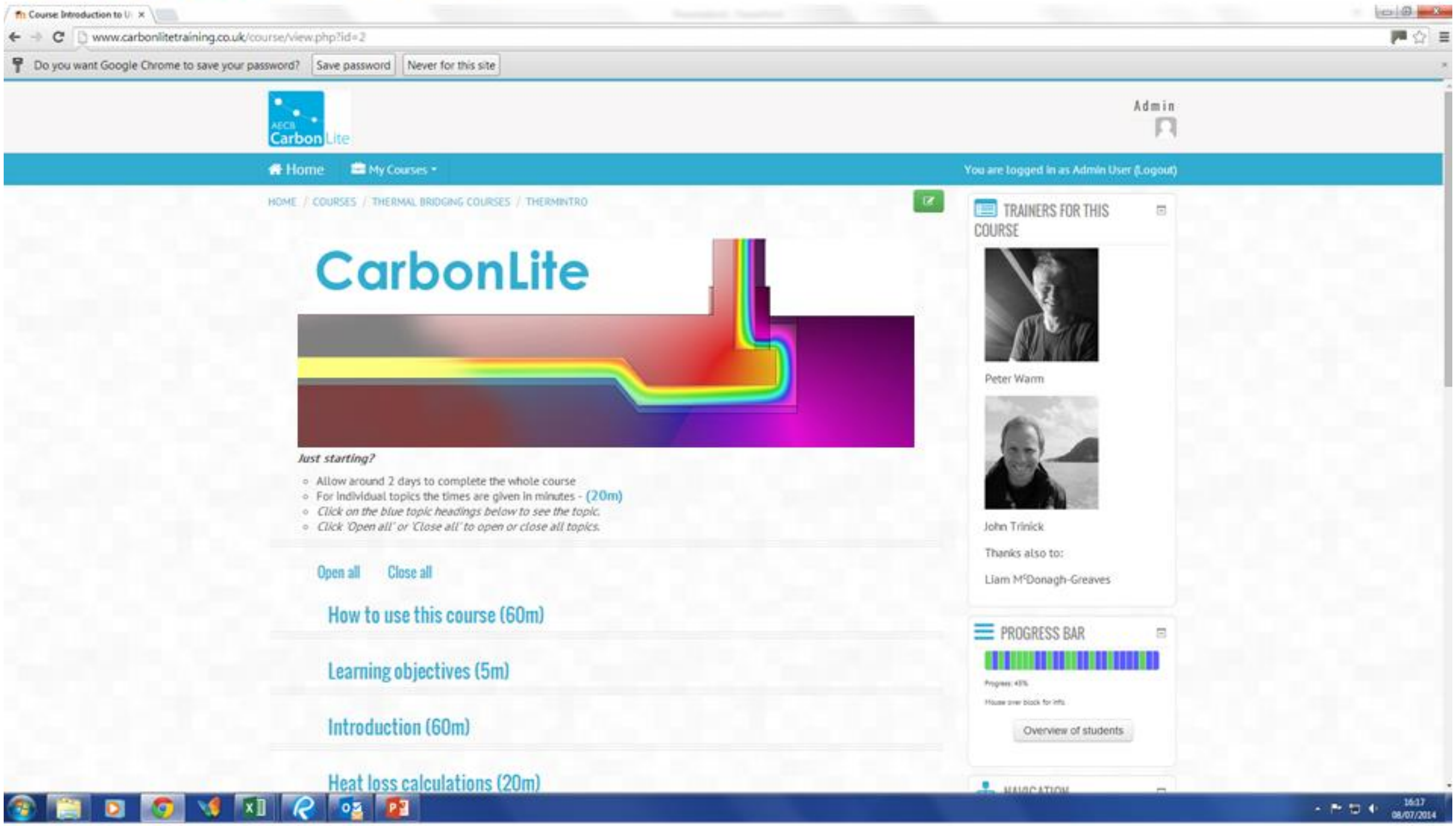
the Passivhaus Designer database where they will be awarded either Passivhaus Designer or Passivhaus Consultant status, depending on existing academic qualifications.

The CarbonLite Passivhaus Designer Programme is designed to prepare delegates not only for the exam but for future involvement in very low energy building projects.

AECB CarbonLite Online Training

Thermal Bridging Course

NEW



Learn in your own time. Learn at your own pace. Learn to improve your buildings.

Developed to prepare online system for CarbonLite Retrofit Course, this separate course is now available

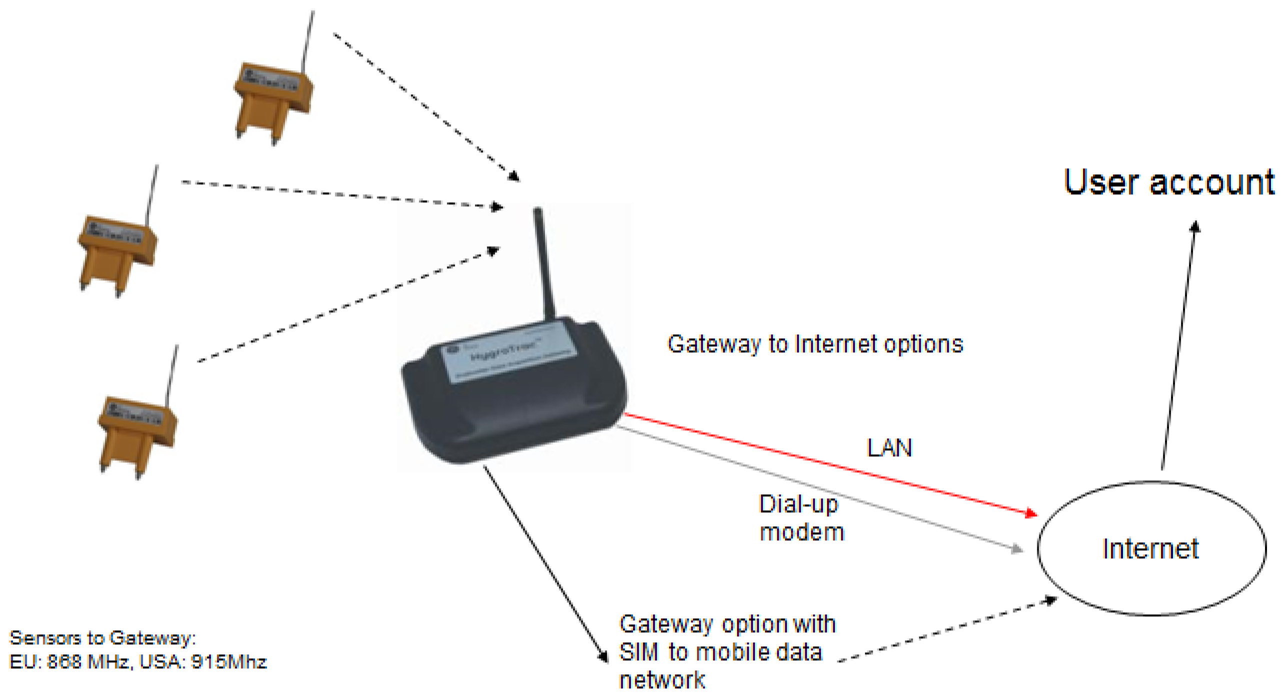
Environmental Condition **Monitoring**

Omnisense Remote Monitoring System

Omnisense remote monitoring combines wireless sensors with a reporting web site for 24/7 monitoring of humidity, temperature and wood moisture content in buildings. The remote monitoring system is quick and simple to install ("plug and play") and easy to use.

For more information about the system please download this case study (PDF) .

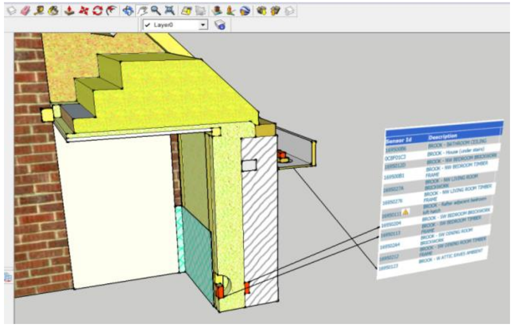
Connectivity

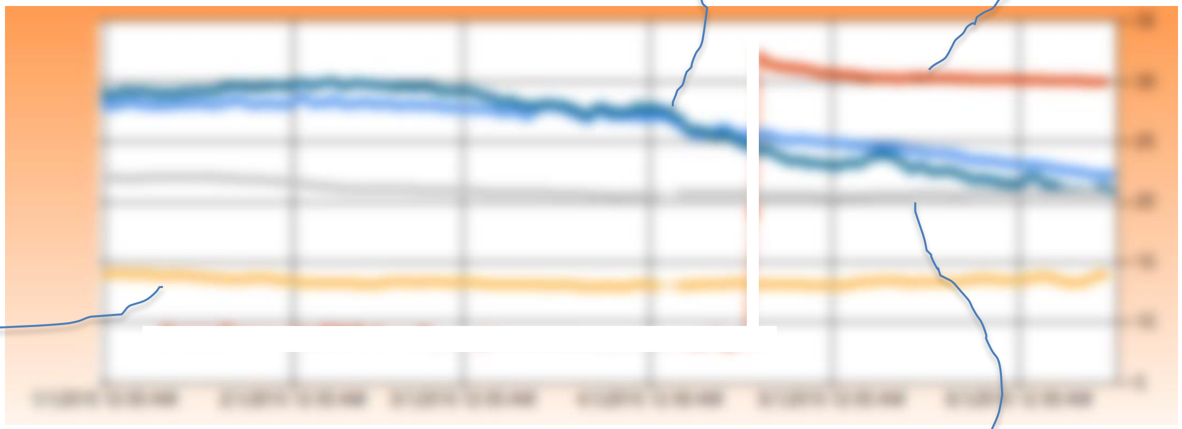


Environmental Condition Monitoring & **Data**

What 'questions' are being asked?

- Humidity in crawlspaces & basements
- Conditions behind and within insulation
- Effect of different vapour control membranes
- Temperatures across building assemblies
- Effectiveness of DPCs
- Effect of sun on IWI systems
- Effect of EWI on masonry
- Effect and condition of capillary active materials
- Do damp walls dry after retrofit and if so how fast and in what direction
- Is there a risk of rot or mould
- Do joist ends remain in good condition

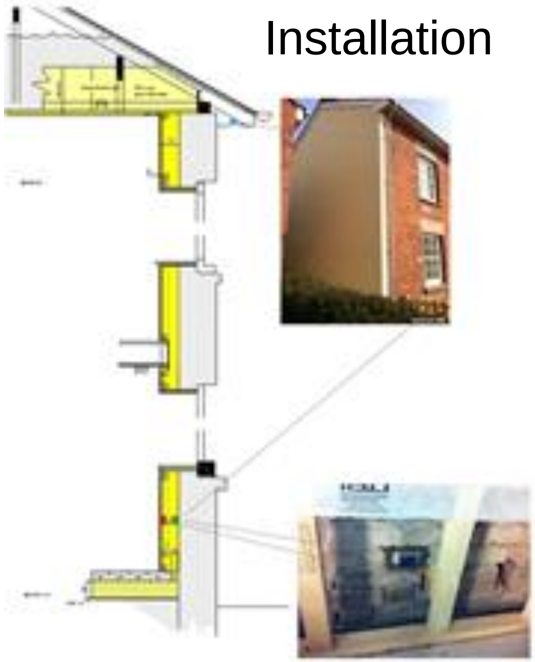




Moisture contents

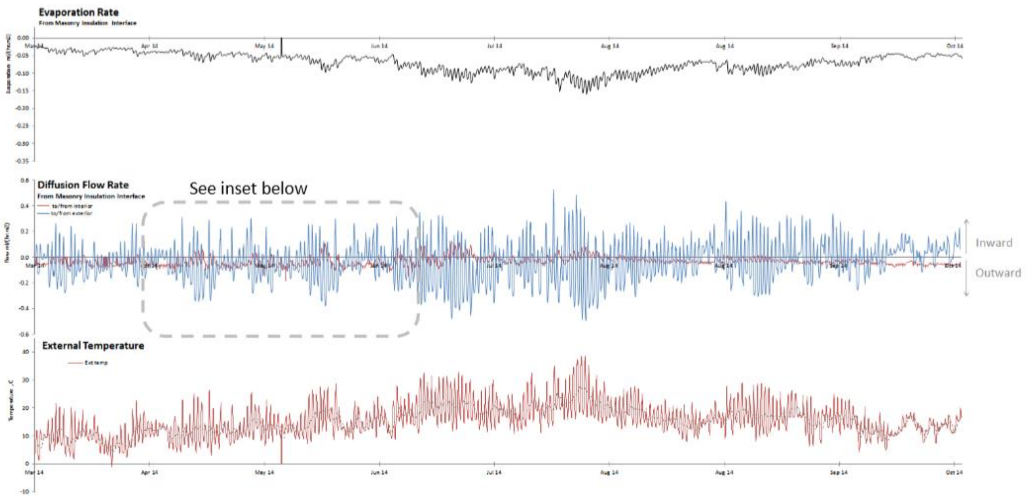
Environmental Condition Monitoring & Data **Analysis**

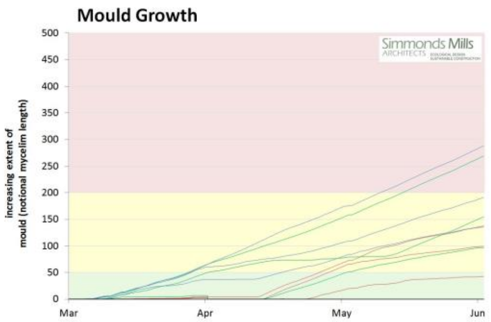
Installation



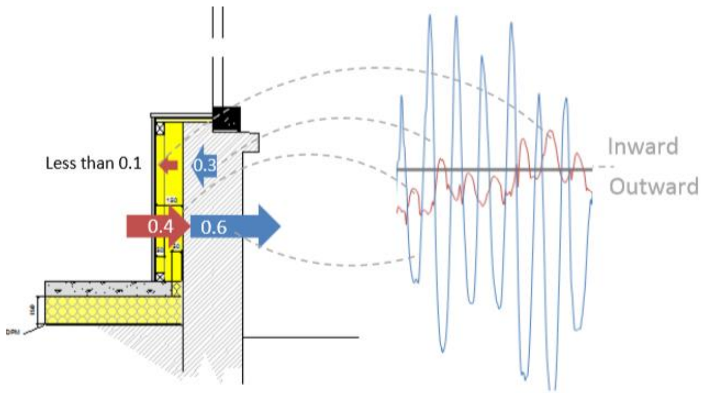
Evaporation, Condensation, Diffusion, Temperature

Analysis





Mould growth risk



Magnitude and direction of moisture flows

The CarbonLite Retrofit Programme:

1. An online searchable knowledge base
2. Online training, tutorial support & exam
3. Guidance on space heat demand reduction targets
4. A platform to share and learn from others via discussion, project monitoring, analysis and case studies
5. Project certification system
6. Access to discounted project finance from Ecology Building Society

CarbonLite, in association with the AECB, has offered training courses in low energy building, building physics and energy assessment since 2007.

For details of the classroom courses, including the full Passivhaus Designer course, please see the AECB CarbonLite website.

We have now launched our online course, "Introduction to Using THERM to Model Thermal Bridges" and we are soon to offer a retrofit course and much more.

For further information on any of the courses listed below, please email training@peterwarm.co.uk.

Course	Price	Length of Access	Purchasing Information
Setting up THERM for Use in Thermal Bridging Calculations (Follow link, then click on "login as a guest")	Free	Unlimited	It's free!
Introduction to Using THERM to Model Thermal Bridges (includes a nominal 2 hours of email support)	£200 + VAT	1 year	Buy Now
Retrofit Course - coming soon			

Course Syllabus: Introduction to Using THERM to Model Thermal Bridges

Click here to download the course syllabus as a PDF

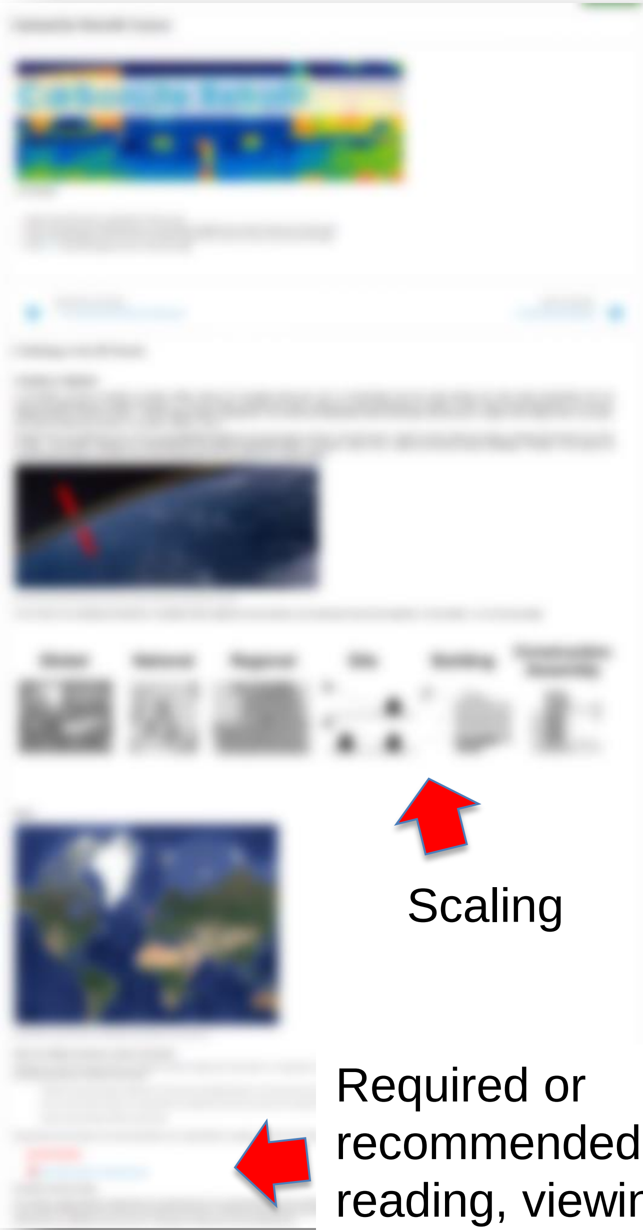
Promotional Video: Introduction to Using THERM to Model Thermal Bridges

- Your account details
    - blog, course notes, links to tutorial support dates
- See who your fellow students are

- Introduction
- How to use the course
- Learning Objectives

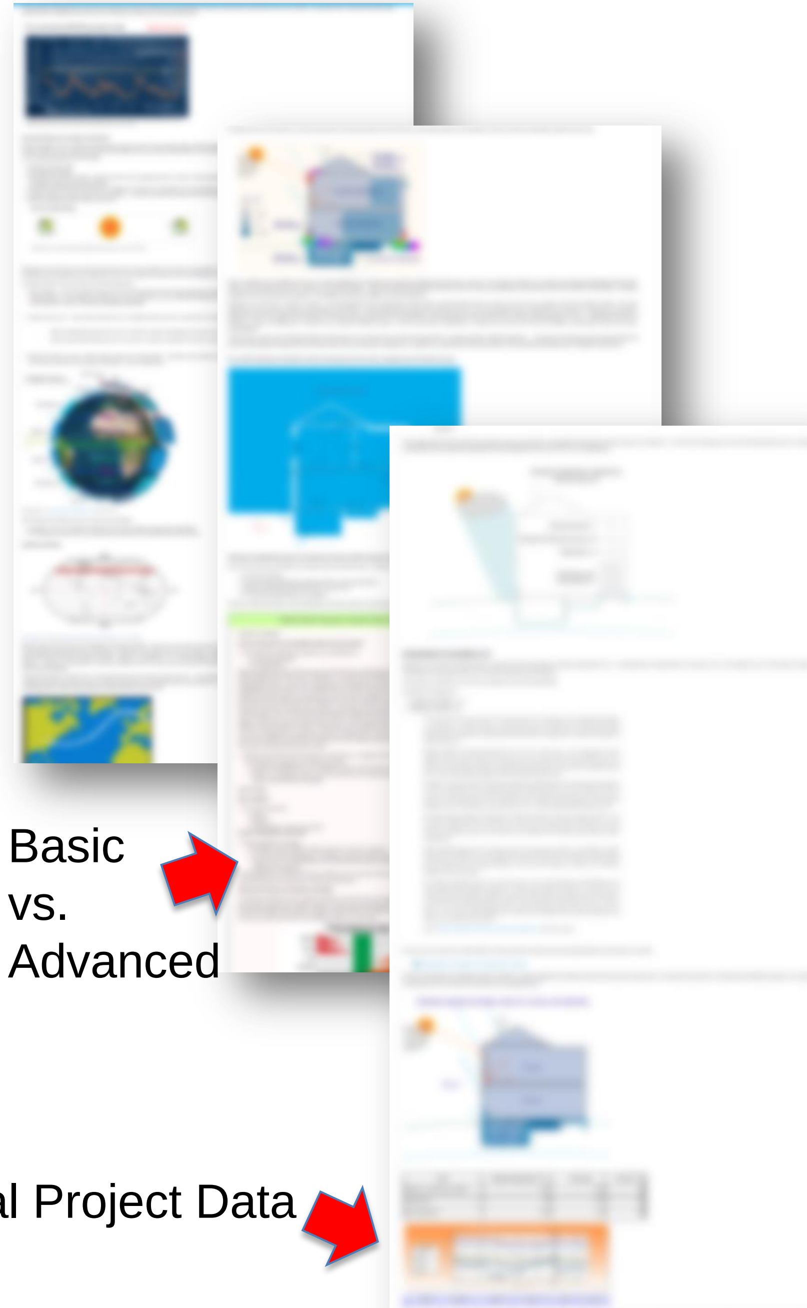
Quiz

1. The CarbonLite Retrofit (CLR) Programme
2. Buildings in the UK Climate
3. Understanding Buildings
4. Achieving Low Energy & High Comfort
5. Retrofit Building Science
6. Case Studies
7. Fuel, Heat, Power & Services
8. Financial, Climate, Comfort, House Type Factors
9. Financing
10. Resources (including technical reports, section appendices)



Scaling

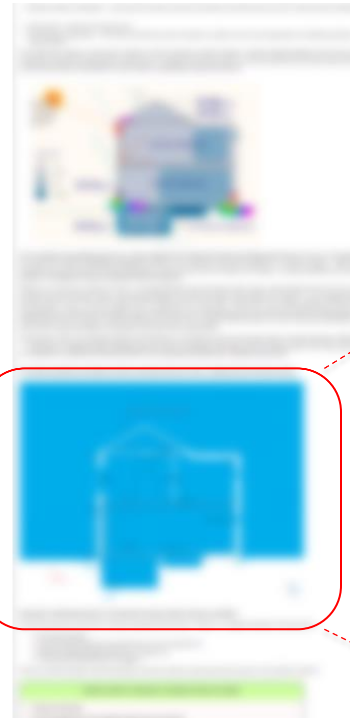
Required or recommended reading, viewing

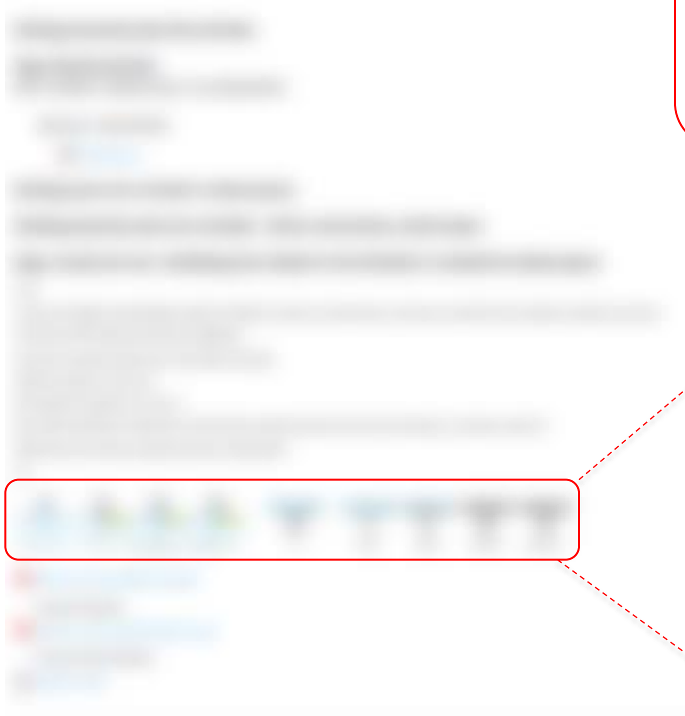


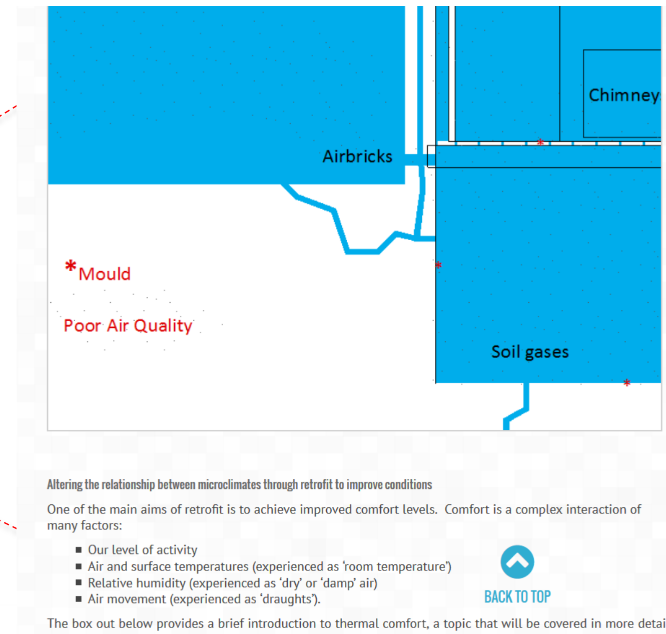
Basic vs. Advanced

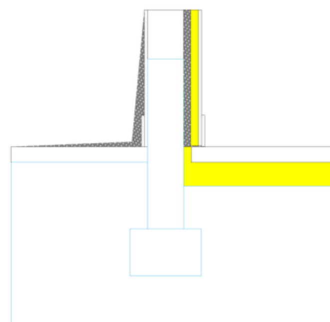
Real Project Data

Clear (zoomable) detailed diagrams

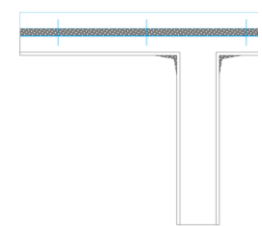








Party wall, section (solid floor), void behind insulation



Party wall (plɛ

Simple, story telling graphs

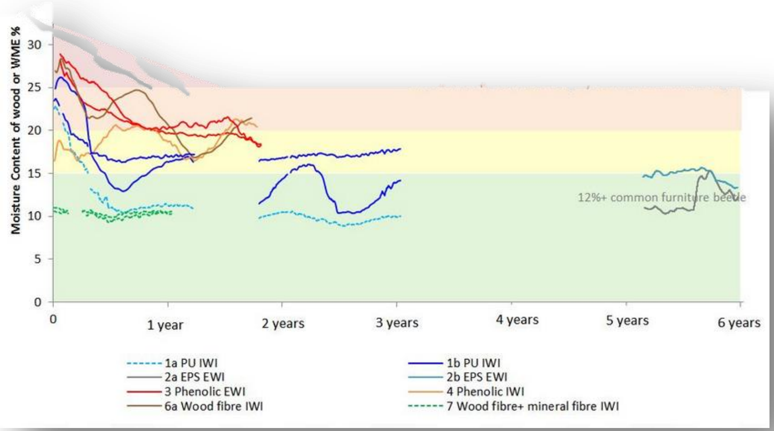
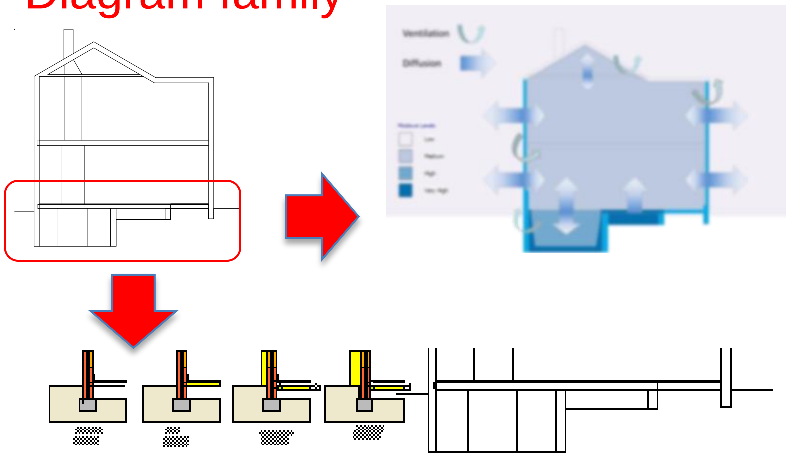
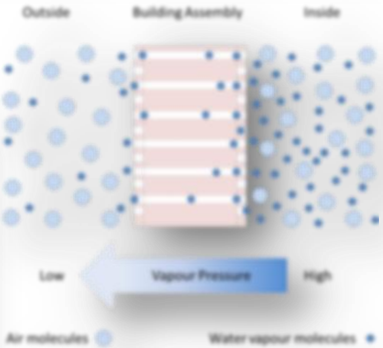
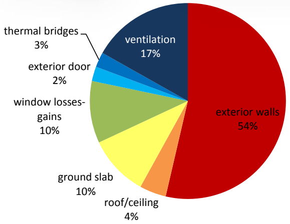


Diagram family

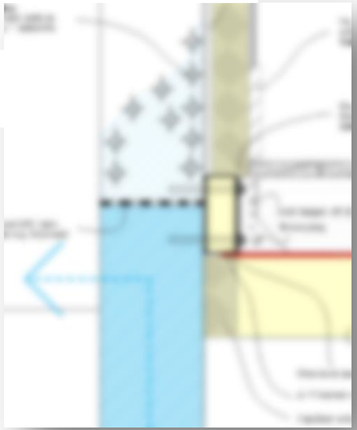


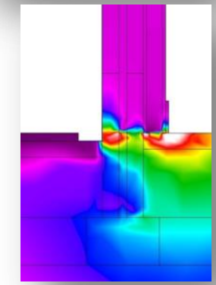
Making it real

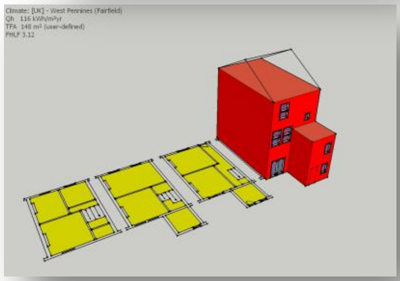




Bespoke diagrams







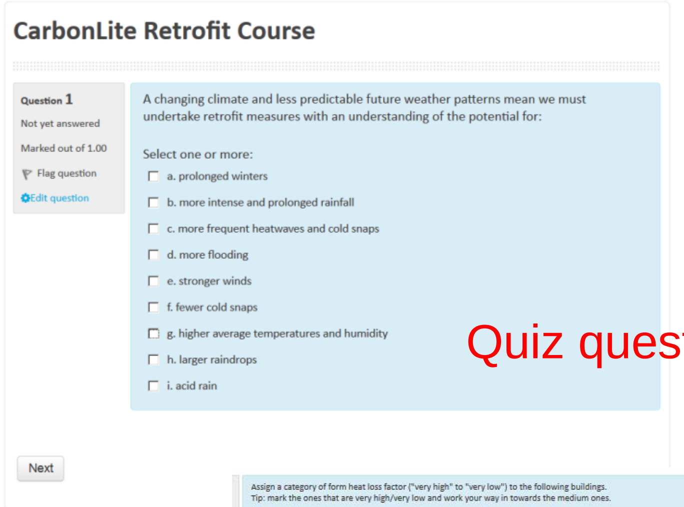
Bespoke modelling useful numbers

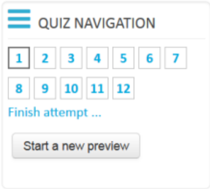
Exam ☹


Quiz based, in your own time, can re-take ☺



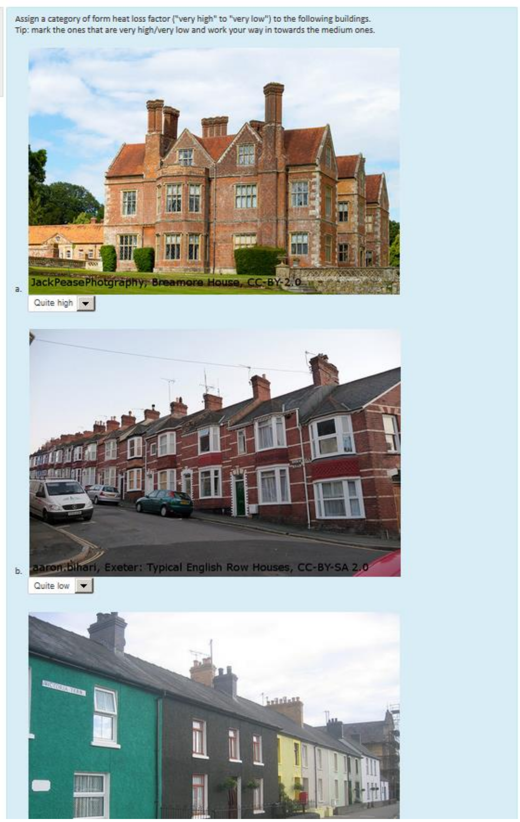

Keep track of progress



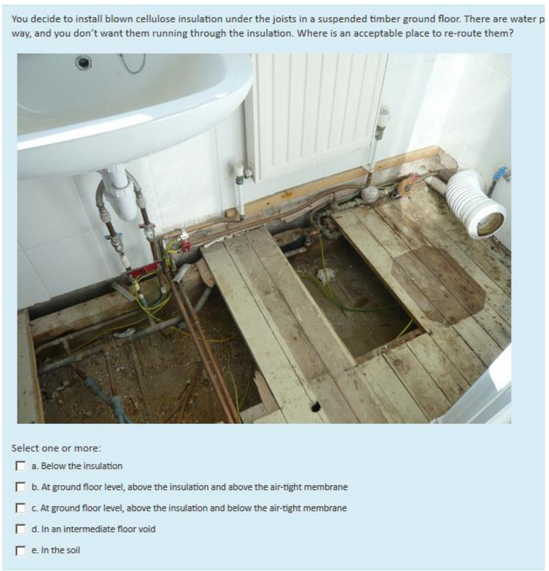


Quizes in Section

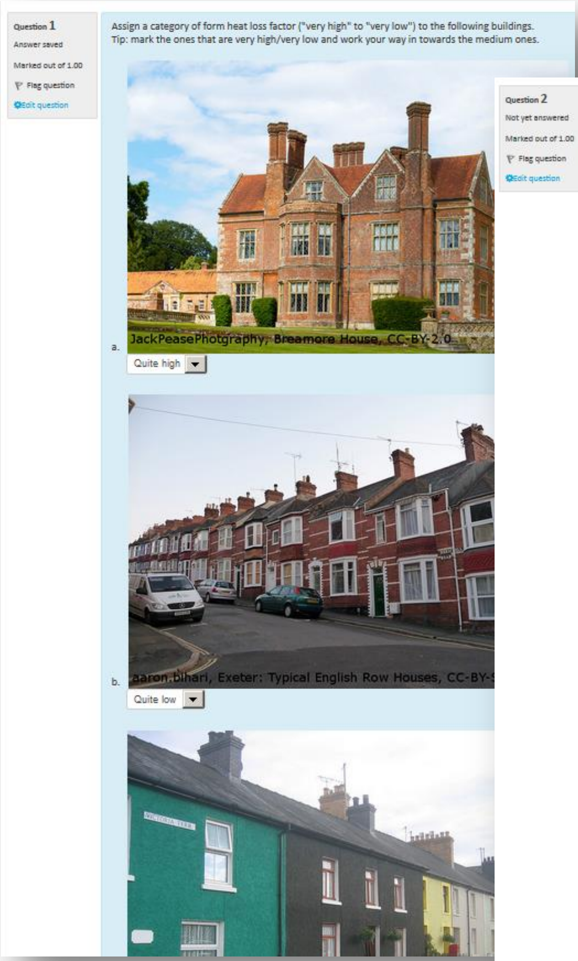
Quiz questions



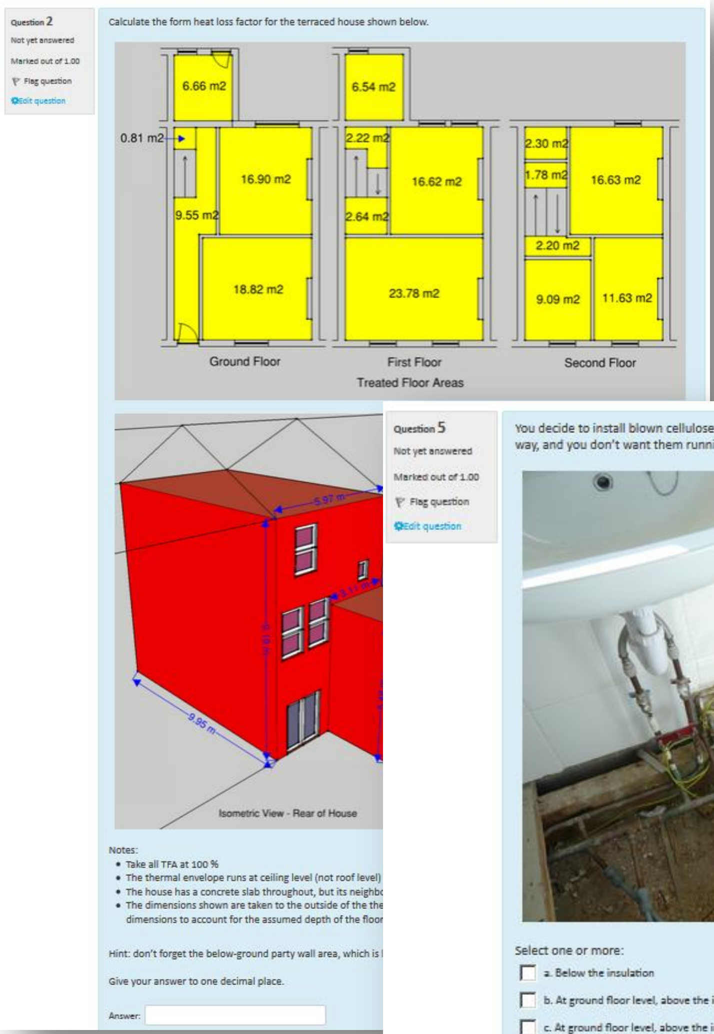
Keeping it real



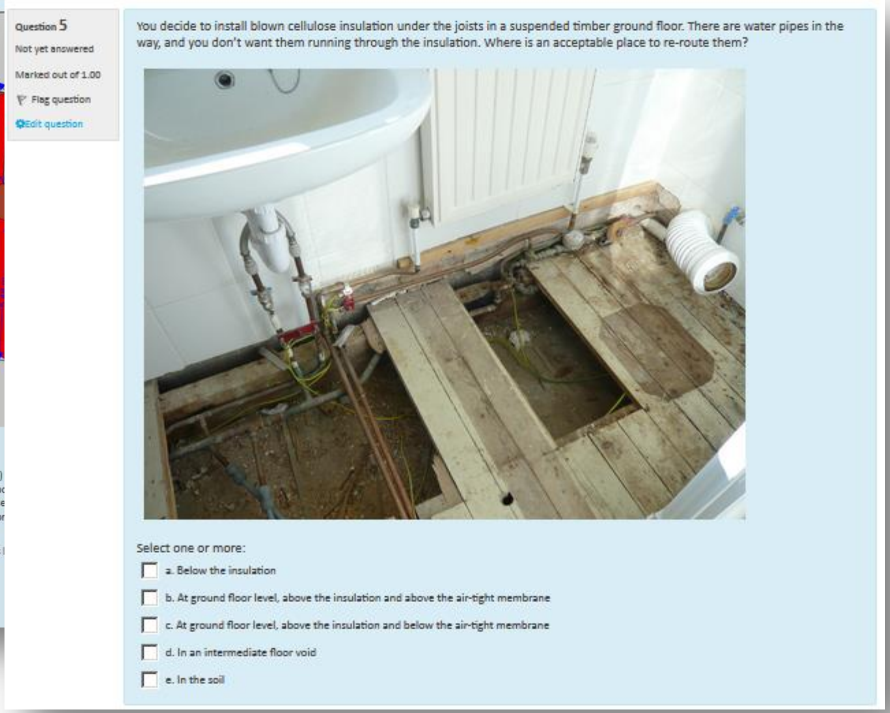
Knowledgeable estimate



Simple but careful calculation



Keeping it real

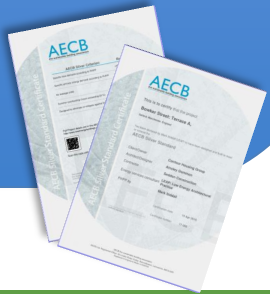


CLR online course

Course Trials July – October 2015
Open to all AECB Members – November 2015

- Allow 30 hours study
- £300/student
- Quiz based exam – Basic or Advanced ‘Pass’
- Online tutorial support for basic and advanced level passes *
- Pass registered to individual not company
- Basic pass allows use of CLR project certification system
- Annual renewal fee to benefit from new and updated material

- *being trialled



Certification

What is the CLR certification system?

It is similar to the ‘self policing’ AECB Silver Certification:

- The self certifier (who must have passed the CLR course) takes responsibility for certification
- The certifier signs a form of declaration for completion by the certifying consultant (AECB does not audit or take responsibility for the certification)
- Certification makes explicit the project’s claim to be a well conceived and implemented energy efficient retrofit and
- provides the consumer with a degree of protection under trading standards – without the AECB having to get involved in quality control and legal matters
- Responsibility for performance claims lie clearly with the person signing the certificate and a duty of care on the client to ensure that the consultant is competent and suitably insured

Create New Project

Your Saved Projects

Project Name (click to edit)	Last Edit	Publish Status	Download PDF	Energy charts	CLR Certificate		Silver Cert.	
daffodils	09 Mar 2015	draft	PDF	View Charts		View		Begin
King Canary Cottage	05 Sep 2014	draft	PDF	View Charts		edit certification		view cert
october mansions	03 Oct 2014	draft	PDF	View Charts		edit certification		Begin
projectName			PDF	View Charts		edit certification		Begin
test 1	10 Jul 2014	draft	PDF	View Charts		edit certification		edit
test 2	10 Jul 2014	draft	PDF	View Charts		edit certification		Begin

Projects marked 'Draft' are not viewable by the public. You can toggle the relevant Draft/Publish status by clicking it

All your saved LEBD projects

Certificates

Carbonlite Retrofit Certification

Manage CLR Certifications

Apply for, and manage, your Carbonlite Retrofit certificates

Carbonlite Retrofit Certification is a self-certification scheme open to building projects that ..... some criteria goes here.

Read more about Carbonlite Retrofit and Certification

Manage CLR Certifications

AECB Silver Standard Certification

Manage Silver Certifications

Apply for, and manage, your AECB silver certificates

AECB Silver Certification is a self-certification scheme open to building projects that meet the AECB Silver Standard design and performance criteria.

Read more about the AECB Silver Standard and Certification

Manage Silver Certifications

CLR & AECB building certification costs. POA for developments of multiple units (floor area based)

- AECB Members £60

- AECB Members £60
- Non-members £250

About the Certifiers

Certifier Name (Design)	Joe Blog
CLR course Pass Date (Design)	17 September 2015
CLR course Pass Certificate Reference ID (Design)	123
Certifier (design) Email Address	joe@blog.com
Is Certifier (design) a Member of AECB ?	Yes
Certifier (design) AECB Membership Number	20

Please describe any relevant professional qualifications including the following details;

1. *Type of course (eg full time, part-time, OU, specialist, post graduate, business/org courses)*
2. *Name of course*
3. *Body providing course*
4. *Qualification gained*

Certifier(design) other nationally recognised professional qualifications	

Certifier Name (builder)	Jo Blog
CLR Course Pass Date (builder)	21 August 2014
CLR Course Pass Certificate Reference ID (builder)	124
Certifier (builder) Email Address	Jo@blog.com
Is Certifier (builder) a Member of AECB ?	Yes
Certifier (builder) AECB Membership Number	5

Please describe any relevant professional qualifications including the following details;

1. *Type of course (eg full time, part-time, OU, specialist, post graduate, business/org courses)*
2. *Name of course*
3. *Body providing course*
4. *Qualification gained*

Certifier(builder) other nationally recognised professional qualifications	

This might be just one certifier:
e.g. the ‘master builder’

Your pending & fully certified retrofit projects

As Built Stage (certificate 1)

Design Stage (certificate 2)

Carbonlite Retrofit Certification

Project Name	Status	Action
daffodils	(4/5) **As Built** Stage Started	Continue
King Canary Cottage	(4/5) **As Built** Stage Started	Continue
october mansions	(2/5) **Design Stage** submission Not Complete	Continue
projectName	(2/5) **Design Stage** submission Not Complete	Continue
test 1	(2/5) **Design Stage** submission Not Complete	Continue
test 2	(2/5) **Design Stage** submission Not Complete	Continue

Carbonlite Retrofit- Guidance Notes
Support and further information

1 Enter Design Data | 2 Design stage declaration | 3 Enter As-built data | 4 Declare certification

Save

Carbonlite Retrofit Certification

Interim Certification : Design Stage Data

Design Data, *including:*

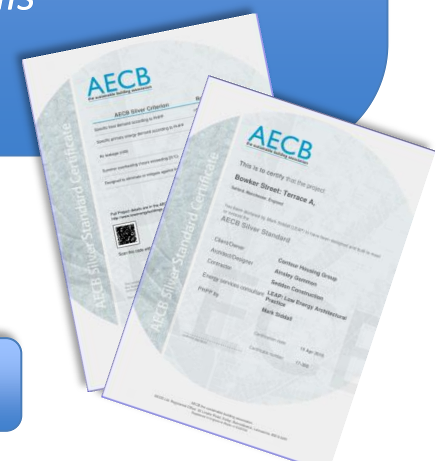
Location, Materials, Measurements
People, Finance & Grants
Energy targets, **Ventilation method** &
Airtightness target
Wall insulation approach, Form Factor,
Heat Demand
The Certifier(s)

Design Strategies, *including***:**

- ***Reducing rain wetting** loads*
- ***Reducing rising/penetrating damp** loads*
- ***drying pathways***
- ***Preventing decay or damage** to vulnerable materials*

Info. published

Certificate

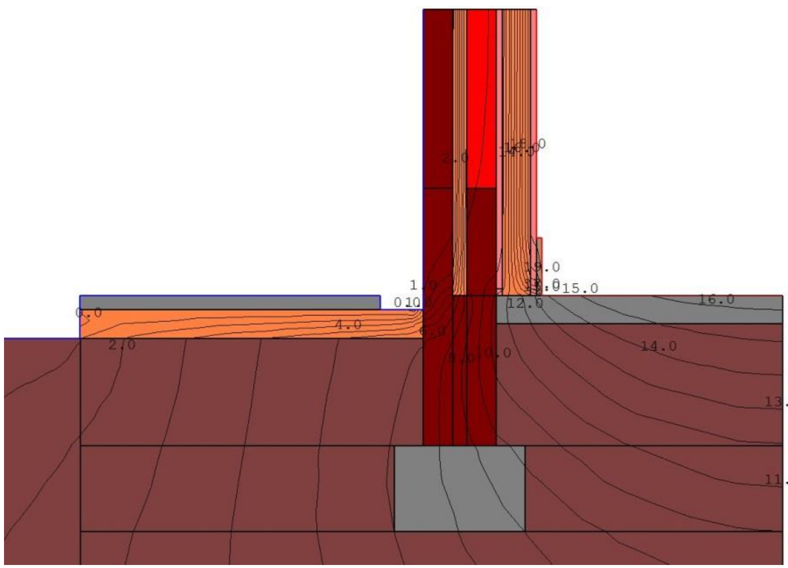


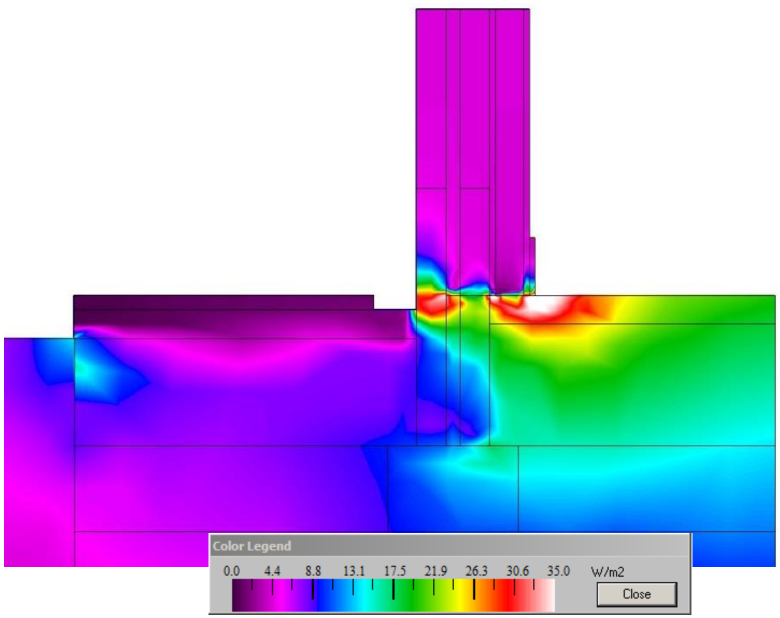
Design Stage Declaration i.e. a ‘Whole House Plan’

What are the space heat demand ‘energy targets’

Realistic Energy Calculations

- **Uses the Passivhaus Planning Package (PHPP)**
- **Average temperature before retrofit 17C, after 20C**
- **Thermal bridges identified & calculated**
- **Judgement calls made on construction methods, material condition etc.**



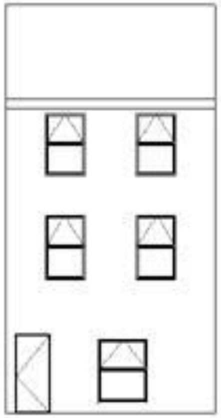


House Types (from BRE full list)

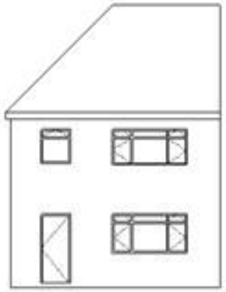
‘Typical’ dwelling, average space heat consumption

Bungalow

3 Storey Town House



Semi Detached



	Bungalow	Town House	Semi Detached
Treated Floor Area TFA, m^2	62.7	147.9	78.4
Form Factor (no measures)	4.0	1.7	2.8

From 12 house types defined by BRE

3 Dwelling Types
Construction Types
Form Factors
Building Condition

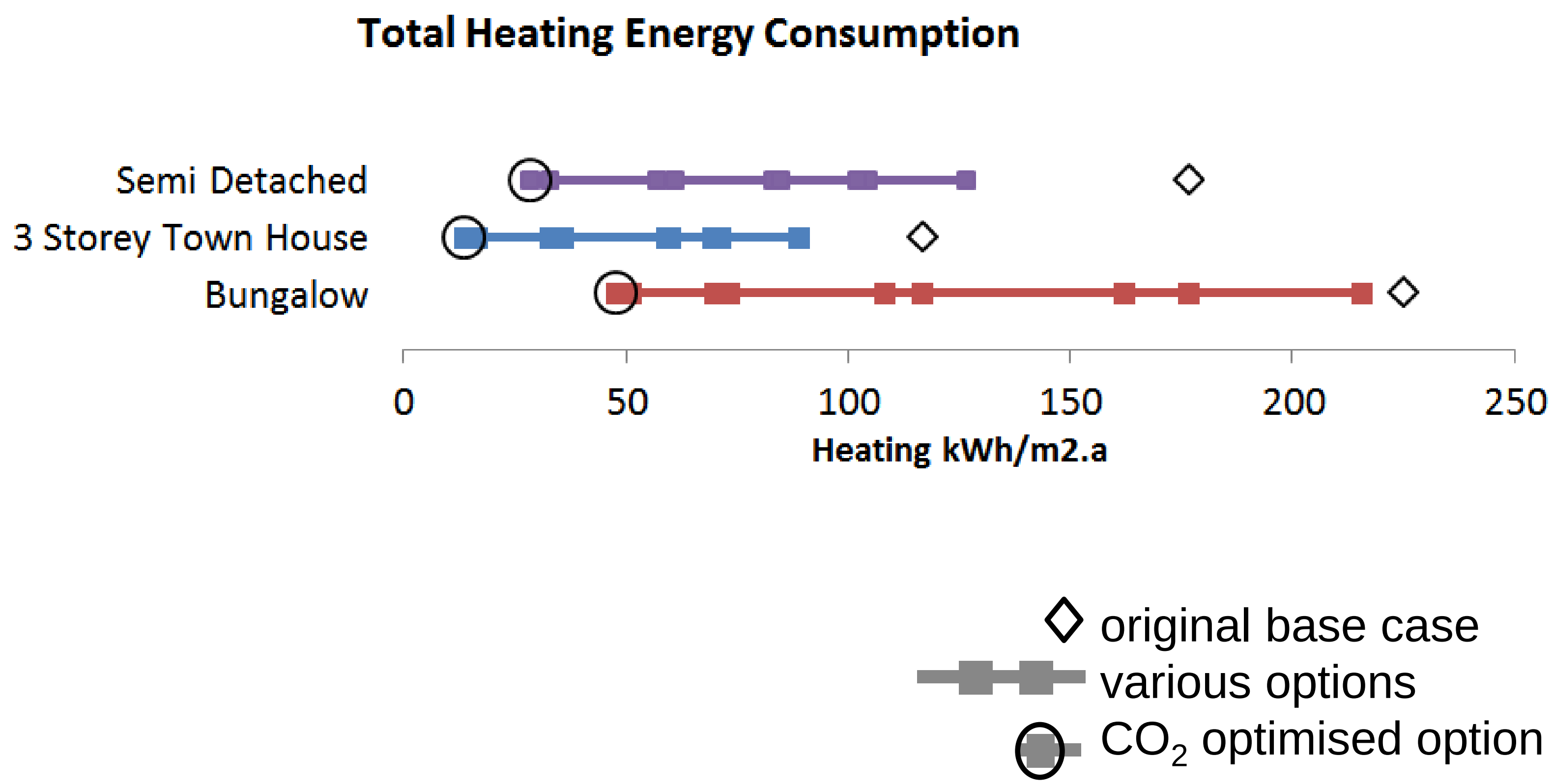
Chosen to usefully represent the UK dwelling stock

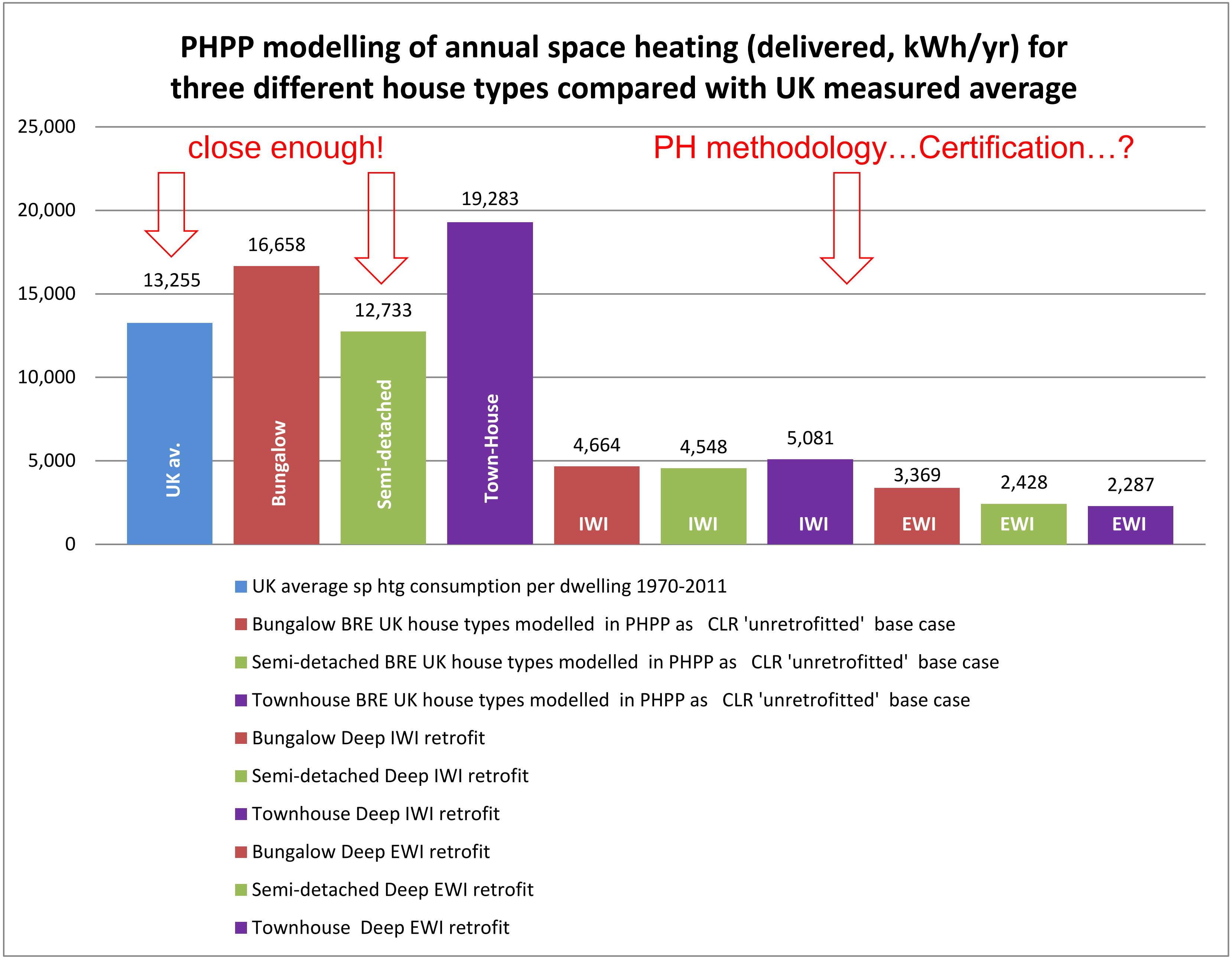
Typical measures modelled

<table>
<tr><th></th><th colspan="5">Walls</th><th></th><th></th><th></th><th></th><th></th><th></th></tr>
<tr><th>Scenario</th><th>IWI</th><th>Leaf</th><th>CWI</th><th>Ext. leaf</th><th>EWI</th><th>Loft ins. mm</th><th>Floor</th><th>Glazing</th><th>Ventilation</th><th>Air Tightness</th><th>Boiler</th></tr>
<tr><td>Existing (Base Case)</td><td></td><td></td><td></td><td></td><td></td><td>200</td><td rowspan="2">None</td><td rowspan="2">Double</td><td rowspan="2">Trickle vents + extract fans</td><td>8-10 ach</td><td rowspan="2">Existing efficiency</td></tr>
<tr><td>Light</td><td></td><td></td><td></td><td></td><td></td><td>250</td><td>5 ach</td></tr>
<tr><td>Medium IWI</td><td></td><td></td><td></td><td></td><td></td><td rowspan="2">300</td><td rowspan="2">Some insulation</td><td rowspan="2">Better Double</td><td rowspan="2">MEV</td><td rowspan="2">3 ach</td><td rowspan="4">New higher efficiency</td></tr>
<tr><td>Medium EWI</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Deep IWI</td><td></td><td></td><td></td><td></td><td></td><td rowspan="2">400</td><td rowspan="2">Well insulated</td><td rowspan="2">Triple</td><td rowspan="2">MVHR</td><td rowspan="2">1.0-3.0 ach</td></tr>
<tr><td>Deep EWI</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Existing: the bungalow has a solid floor, the rest suspended apart from the town house extension.

Effect of various ‘retrofit scenarios’ modelled – SSHD results reported




PHPP modelling of annual space heating (delivered, kWh/yr) for three different house types compared with UK measured average
close enough!
PH methodology…Certification…?
25,000
20,000
15,000
10,000
5,000
0
13,255
16,658
12,733
19,283
4,664
4,548
5,081
3,369
2,428
2,287
UK av.
Bungalow
Semi-detached
Town-House
IWI
IWI
IWI
EWI
EWI
EWI
UK average sp htg consumption per dwelling 1970-2011
Bungalow BRE UK house types modelled in PHPP as CLR 'unretrofitted' base case
Semi-detached BRE UK house types modelled in PHPP as CLR 'unretrofitted' base case
Townhouse BRE UK house types modelled in PHPP as CLR 'unretrofitted' base case
Bungalow Deep IWI retrofit
Semi-detached Deep IWI retrofit
Townhouse Deep IWI retrofit
Bungalow Deep EWI retrofit
Semi-detached Deep EWI retrofit
Townhouse Deep EWI retrofit

SSHD before at 17C

PHPP vs SAP

SSHD after at 20C

EWI/IWI

Dwelling	Retrofit	Description	Vent. Type	Air changes	PHPP: Average whole house temp. during heating Season	PHPP: Specific Space Heat Demand (SHD)	PHPP: Gas used for space heating	PHPP: Reduction in space heating energy	SAP under (negative) or over (positive) estimating SHD compared to PHPP	SAP 2012 v9.92: Average whole house temp. during Heating Season	SAP 2012 v9.92: Specific Space Heat Demand (SHD)	SAP 2012 v9.92: Gas used for space heating	SAP 2012 v9.92: Reduction in space heating energy	PHPP: CO2 emitted from space heating (based on using natural gas)	PHPP: Reduction in space heating related CO2 emissions	SAP 2012 v9.92: CO2 emitted from space heating (based on using natural gas)	SAP 2012 v9.92: Reduction in space heating related CO2 emissions
Bungalow (form factor 4.0)					degrees C	kWh/m2.a	kWh/yr	%		degrees C	kWh/m2.a	kWh/yr	%	Tonnes CO2/yr	%	Tonnes CO2/yr	%
	Original House	Repair & maintenance poor		8	17	230	14,524	0	-30%		161	12,917		3.7	0	2.79	
	Deep IWI retrofit	Cost prioritised retrofit	MEV	3	20	119	7,129	48%	-41%	18.83	71	5,064	56%	1.7	54%	1.094	61%
		CO2 prioritised retrofit	MVHF	1	20	75	4,505	67%	-41%	19.56	44	3,193	72%	1.1	70%	0.69	75%
	Deep EWI retrofi	Cost prioritised retrofit	MEV	3	20	108	6,820	53%	-37%	18.89	68	4,888	58%	1.6	57%	1.06	62%
		CO2 prioritised retrofit	MVHF	1	20	51	3,216	78%	-38%	19.89	32	2,266	80%	0.8	78%	0.489	82%
3 storey mid-terrace townhouse (form factor 1.8)					degrees C	kWh/m2.a	kWh/yr	%						Tonnes CO2/yr	%		
	Original House	Repair & maintenance poor		10	17	117	17,419	0	-4%		112	21,315		4.4	0	4.604	
	Deep IWI retrofit	Cost prioritised retrofit	MEV	3	20	72	9,991	38%	-4%	18.57	69	12,201	38%	2.3	48%	2.635	43%
		CO2 prioritised retrofit	MVHF	1	20	40	5,559	66%	5%	19.26	42	7,399	62%	1.3	70%	1.598	65%
	Deep EWI retrofi	Cost prioritised retrofit	MEV	3	20	58	8,552	50%	11%	18.71	64	11,284	43%	2	55%	2.437	47%
		CO2 prioritised retrofit	MVHF	1	20	18	2,707	85%	37%	19.78	25	4,325	78%	0.6	86%	0.934	80%
2 storey semi-detached (form factor 2.8)					degrees C	kWh/m2.a	kWh/yr	%						Tonnes CO2/yr	%		
	Original House	Repair & maintenance poor		8	17	179	13,736	0	-22%		140	13,890		3.5	0	3	
	Deep IWI retrofit	Cost prioritised retrofit	MEV	3	20	104	7,459	46%	-28%	18.40	74	6,852	51%	1.7	51%	1.481	51%
		CO2 prioritised retrofit	MVHF	1	20	62	4,416	68%	-27%	19.19	45	4,172	70%	1	71%	0.901	70%
	Deep EWI retrofi	Cost prioritised retrofit	MEV	3	20	79	6,082	56%	-16%	18.61	66	6,119	56%	1.4	60%	1.322	56%
		CO2 prioritised retrofit	MVHF	1	20	26	2,029	85%	-16%	19.86	22	2,019	85%	0.5	86%	0.436	85%

Benchmark by Dwelling Type, and Form Factor

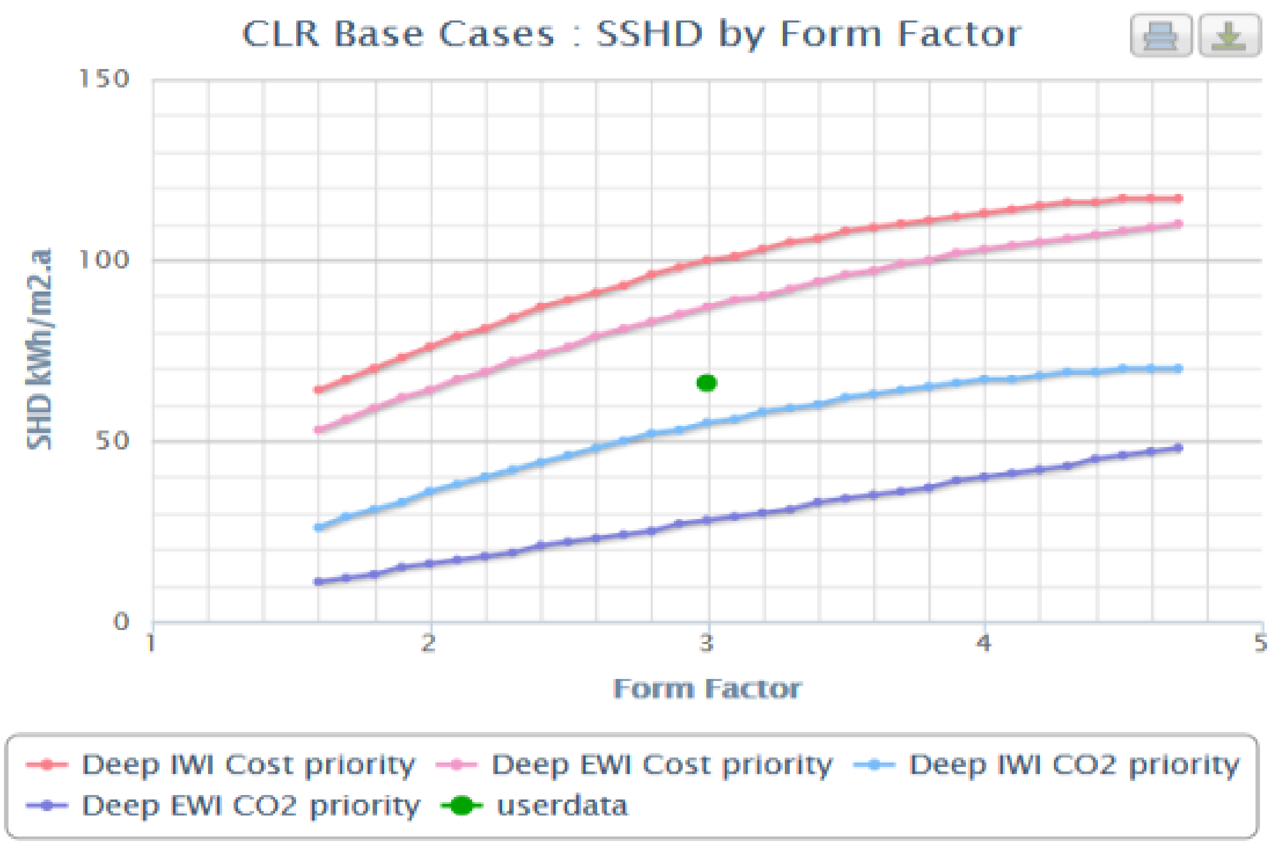
		Average **modelled** whole house temp. during heating season	50% minimum recommended SSHD reduction		CO2 prioritised SSHD reduction target	Reduction in space heating related CO2 emissions	
			SAP 2012 v9.92	PHPP	PHPP	PHPP	SAP 2012 v9.92
High		deg.C	kWh/m2.a			%	
Bungalow	Original House	17		230			
	IWI retrofit				75	70%	75%
		3C comfort take	81	115			
	EWI retrofit				51	78%	82%
Low Form Factor							
3 storey mid-terrace townhouse	Original House	17		117			
	IWI retrofit				40	70%	65%
		3C comfort take	56	59			
	EWI retrofit				18	86%	80%
Medium Form Factor							
2 storey semi-detached	Original House	17		179			
	IWI retrofit				62	71%	70%
		3C comfort take	70	90			
	EWI retrofit				26	86%	85%

Retrofit Standards

PH, AECB 'family' of Standards	Specific Space Heat Demand (kWh/m2.a)	
Northern Europe average for poorly insulated homes	120-150 (this figure is still being researched)	
Passivhaus Classic	15	
EnerPHit	25	
New categories for rebranded PH family of standards:[1]		
Passivhaus Plus	+ renewable energy equipment & strives to meet the definition of a "nearly zero energy building."	
Passivhaus Premium	Incorporates a renewable energy system that is large enough to aim for the goal of an "energy positive" building. To be based on the building's footprint rather than the total floor area	
Energy Conservation Building	'nearly Passivhaus buildings' - not quite achieving the standard	
	30	
AECB Silver	40	
CLR modelled house types	'Deep IWI'	'Deep EWI'
Bungalow (form factor 4.0)	See CLR chart	See CLR chart, Silver possible
Semi-detached (form factor 2.8)	See CLR chart	See CLR chart, EnerPHit possible
3 Storey Town House (form factor 1.7)	See CLR chart Silver possible	See CLR chart, Passivhaus possible

Form Factor and Heat Demand/Loss

target SSHD	66
Form Factor	3

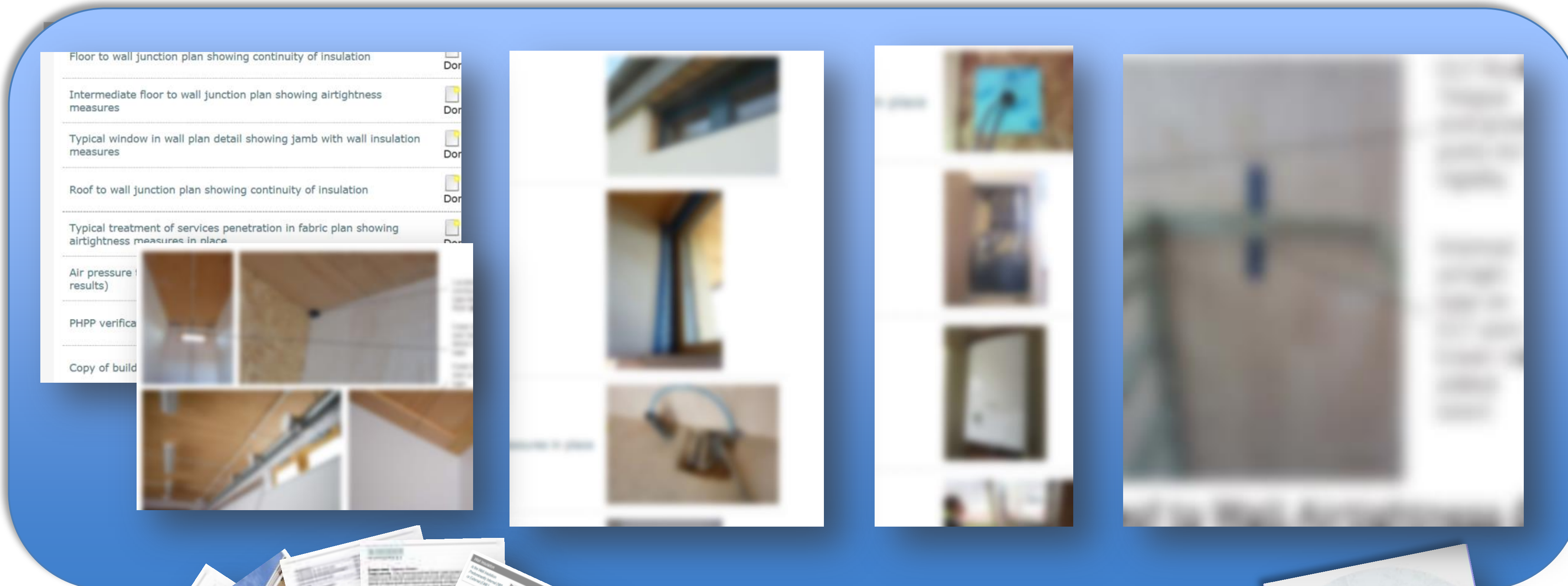


1 Enter Design Data | 2 Design stage declaration | 3 Enter As-built data | 4 Declare certification

Save

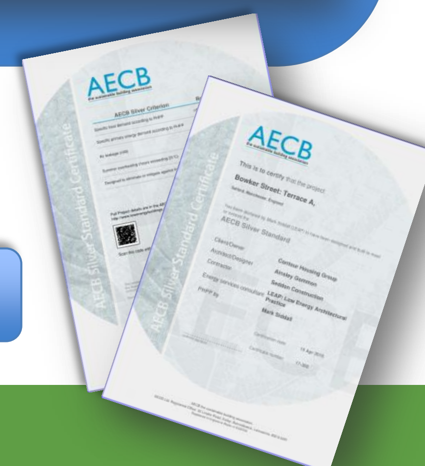
Carbonlite Retrofit Certification

Interim Certification : Design Stage Data



Private (certifier, client, owner)

As Built – Certified



Adapting Silver level evidence for retrofit - checklists
(we will review whether to tighten up Silver too!)

Carbonlite Retrofit Certification

As Built certification : Data entry

As Built Evidence type	Action / Status
Airtightness	Continue
Whole House Ventilation	*either* MHVR Continue *or* MEV Continue
Heat source & distribution : Boiler	Continue
Heat source & distribution : Heat Pump	Continue
Heat source & distribution : Hot Water System	Continue
Moisture Risks : Walls	Continue
Moisture Risks : Floor	
Moisture Risks : Roof	
Moisture Risks : Windows, doors, rooflights	
Moisture Risks : other	

Carbonlite Retrofit Certification

As-built Data: Whole House Ventilation (MHVR)

Please supply evidence for only one type of Whole House Ventilation ; either MHVR or MEV

Design and commision

Ventilation system designed by

Ventilation system commissioned by

Manuals

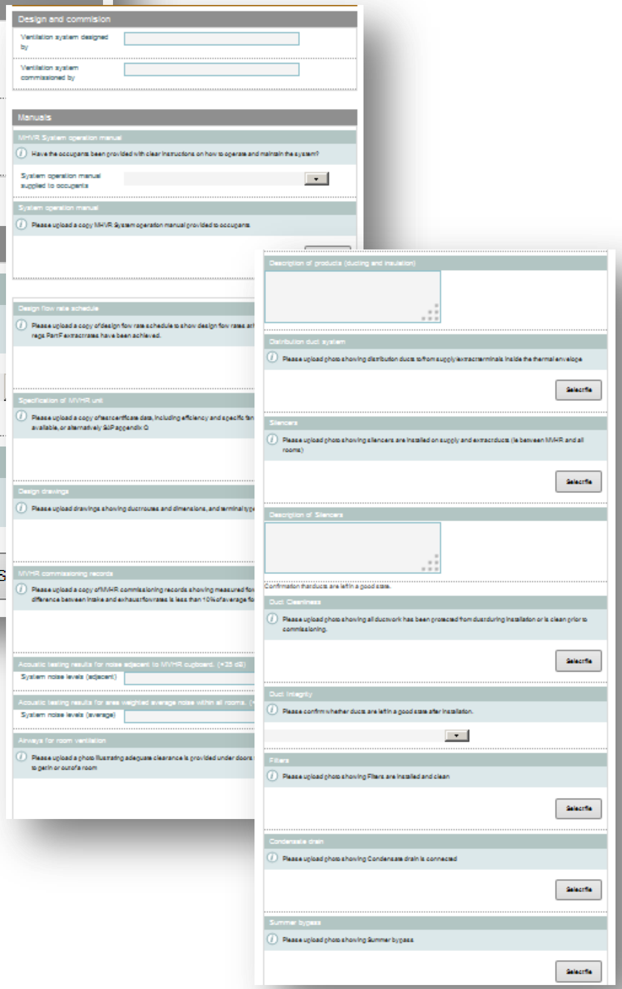
MHVR System operation manual

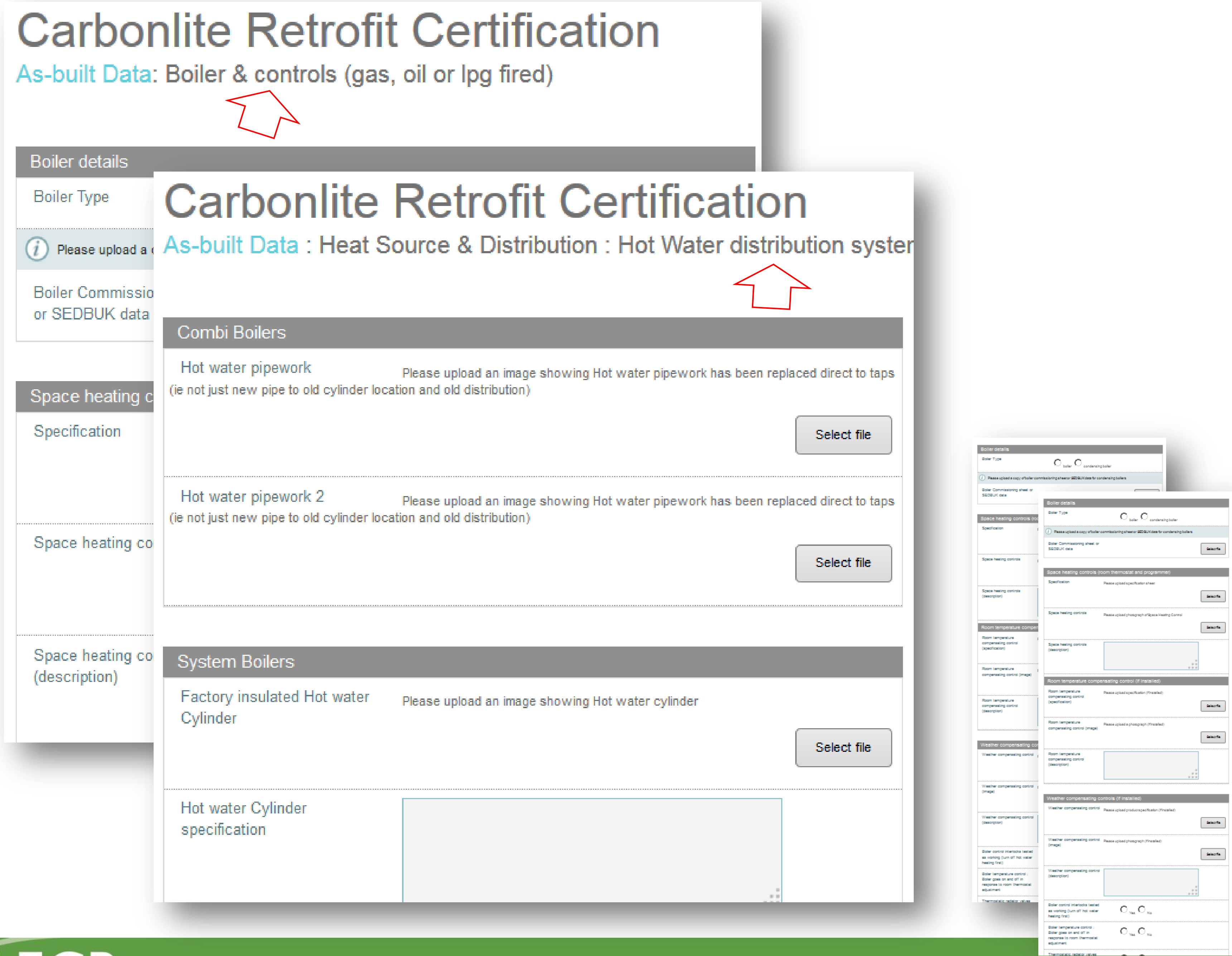
Have the occupants been provided with clear instructions on how to operate and maintain the system?

System operation manual supplied to occupants

System operation manual

Please upload a copy MHVR System operation manual provided to occupants





Carbonlite Retrofit Certification

As-built Data: Boiler & controls (gas, oil or lpg fired)

Boiler details

Boiler Type

Please upload a ...

Boiler Commissio... or SEDBUK data

Space heating c...

Specification

Space heating co...

Space heating co... (description)

Carbonlite Retrofit Certification

As-built Data : Heat Source & Distribution : Hot Water distribution syster

Combi Boilers

Hot water pipework — Please upload an image showing Hot water pipework has been replaced direct to taps (ie not just new pipe to old cylinder location and old distribution)

Select file

Hot water pipework 2 — Please upload an image showing Hot water pipework has been replaced direct to taps (ie not just new pipe to old cylinder location and old distribution)

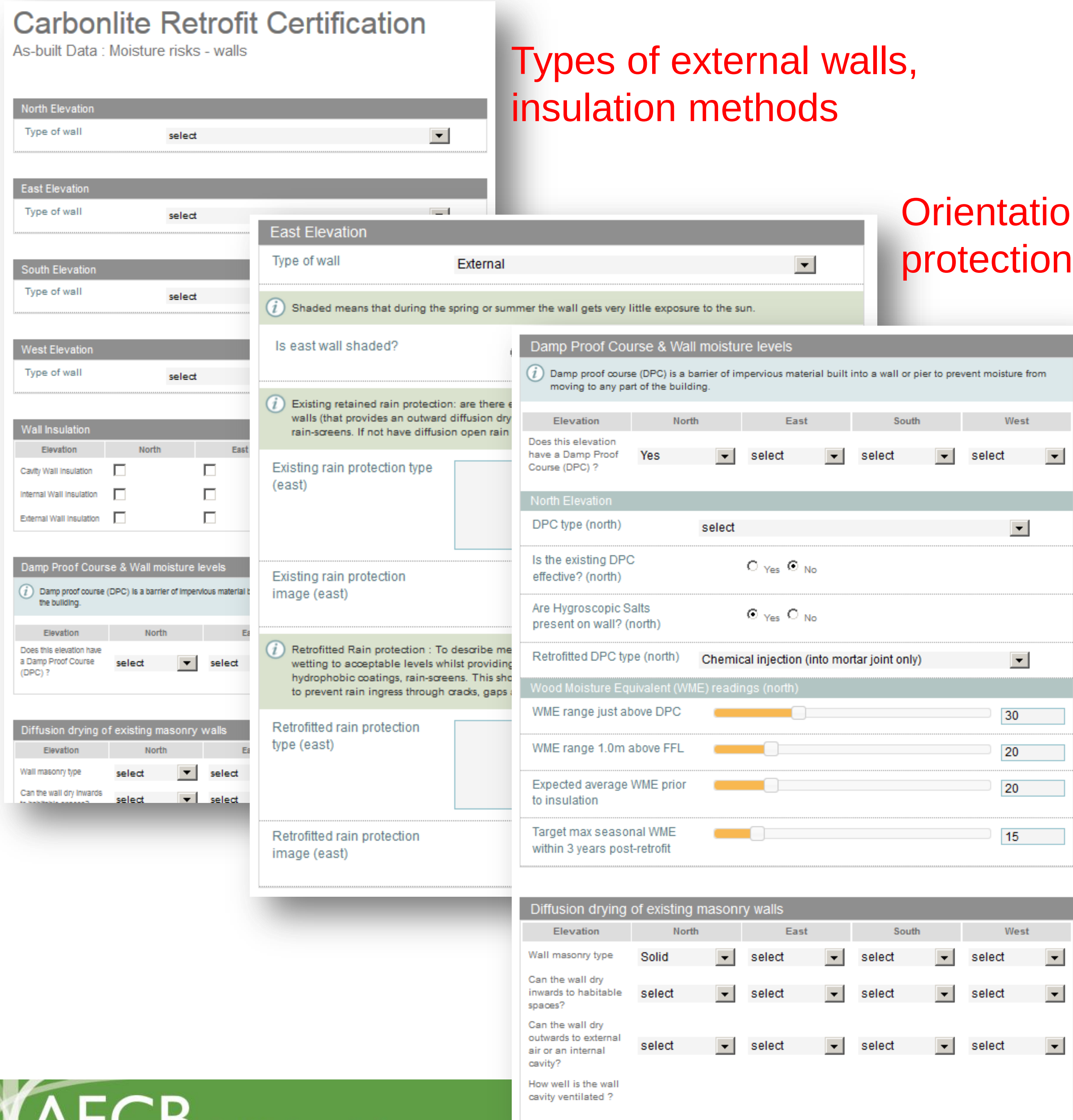
Select file

System Boilers

Factory insulated Hot water Cylinder — Please upload an image showing Hot water cylinder

Select file

Hot water Cylinder specification



Types of external walls, insulation methods

Orientation & rain protection of walls

Protection of wall bases

Moisture contents & targets

Drying mechanisms

Online training – what is covered?

1. The CarbonLite Retrofit Programme
2. Buildings in the UK Climate
3. Understanding Buildings
4. Achieving Low Energy & High Comfort
5. Retrofit Building Science
6. Case Studies
7. Fuel, Heat, Power & Services
8. Financial, Climate, Comfort, House Type, Factors
9. Financing
10: Resources & Appendices

1. The CarbonLite Retrofit Programme

- Introduction
- Climate Change & Energy Security Context
- Financial Context
- Energy Standards & Retrofit Energy Targets
- Electricity & Heating Efficiency, Biomass Fuel, Water Efficiency

2.Buildings in the UK climate

Climate & Weather
Global Climate
UK Climate
UK Regional Climate
City vs Rural Climate
Site Scale Microclimate
Building Scale Microclimates
Main Types of Building Scale Microclimates
Thinking About Temperature & Humidity

Moisture Sources
Moisture Transfer Mechanisms
Heat Sources & Transfer Mechanisms
Introduction to Humidity in Air

Bugs, Moulds & Rots
Moulds
Rots
Environmental Conditions, Critical Thresholds & Limiting Factors

Moisture Content
Temperature and Relative Humidity
Assessing Mould Risk
The Moisture Performance Gap

External Air Pollution
What Do We Mean By Air Quality?
Health
Indoor Air Quality (IAQ)
Measuring
Health before Retrofit

Microclimates in Habitable Space – Before Retrofit
Microclimates in Habitable Space – After Retrofit
IAQ and Health after Retrofit
Building Assembly Scale Microclimates – Before & After Retrofit
Ground Floor Level
Intermediate Floor Level
First Floor And Above
Roof Level
Walls
Other Building Elements

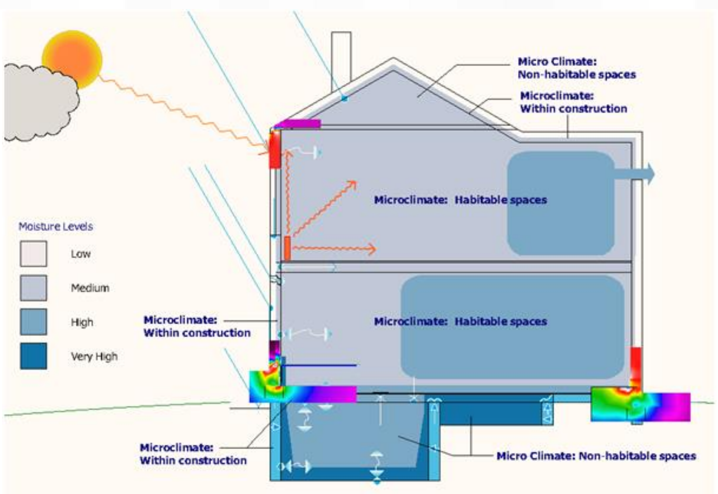
non-habitable microclimates and also within construction assemblies (roofs, walls and floors). The following questions are key to gaining a working knowledge that can be applied to any retrofit:

Understanding environmental conditions around and within buildings….

- Moisture sources – where is the moisture coming from?
- How much moisture is present in materials or on surfaces? How much can they hol[illegible] [illegible]s safe?)
- How much moisture is held in the air (Absolute Humidity or AH – expresse[illegible] [illegible])?
- How much moisture could the air hold (Relative Humidity or RH – [illegible])?
- Moisture transfer mechanisms – how does the moisture [illegible] place to another and how much is moved by each mechanism?

- Heat sources – what is the [illegible]
- Heat transfer mec[illegible] does the heat flow from one place to another, how do the temperatures of buildin[illegible] [illegible]ponents vary over time?

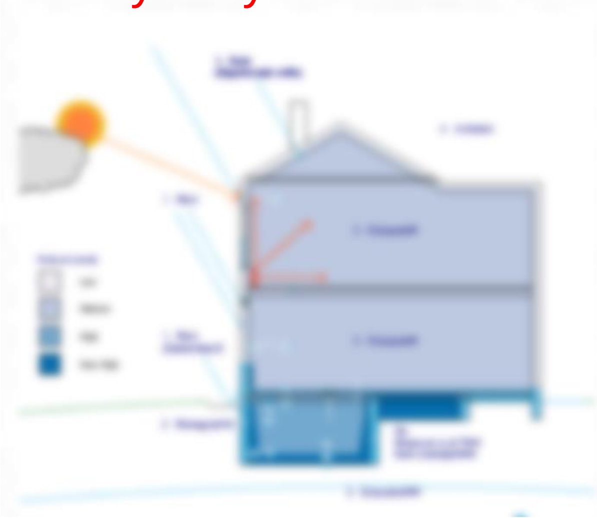
Th[illegible] [illegible] begins to bring these questions to life by showing a section through a notional existing dw[illegible] with the sources, levels and movement of moisture and heat shown at a basic level. Through the rest of this section, we will use elements of the section below and will remove or add relevant layers of information in order to assist in presenting concepts as they arise.



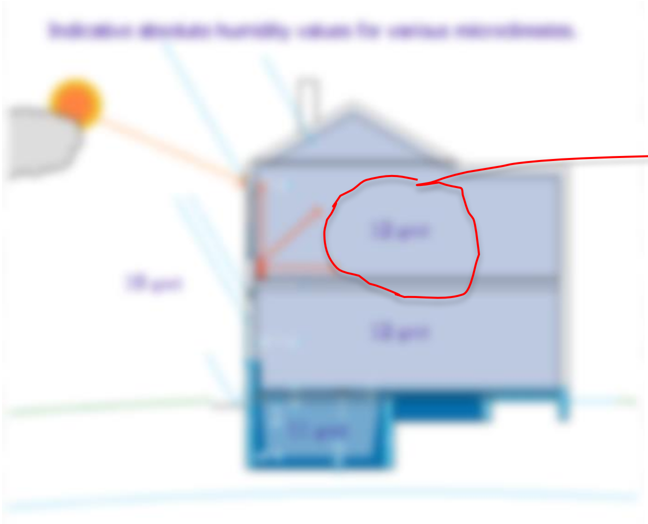
Air (heat & water vapour) & mould spore pathways - before & after retrofit

‘Before and after’ helps keep the focus on what it is exactly you are retrofitting & that building condition and repair and maintenance are important factors for successful retrofits

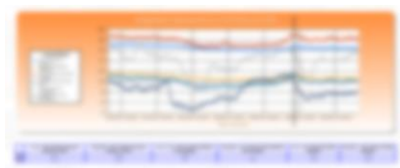
Identify risky microclimates



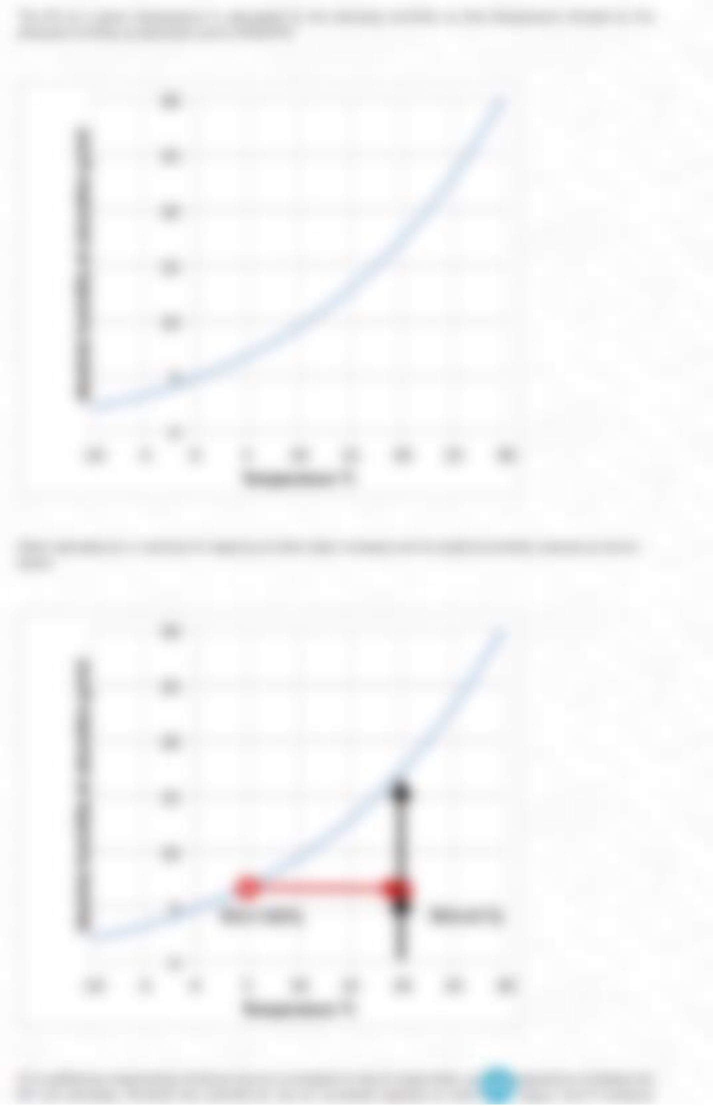
Moisture sources - magnitude



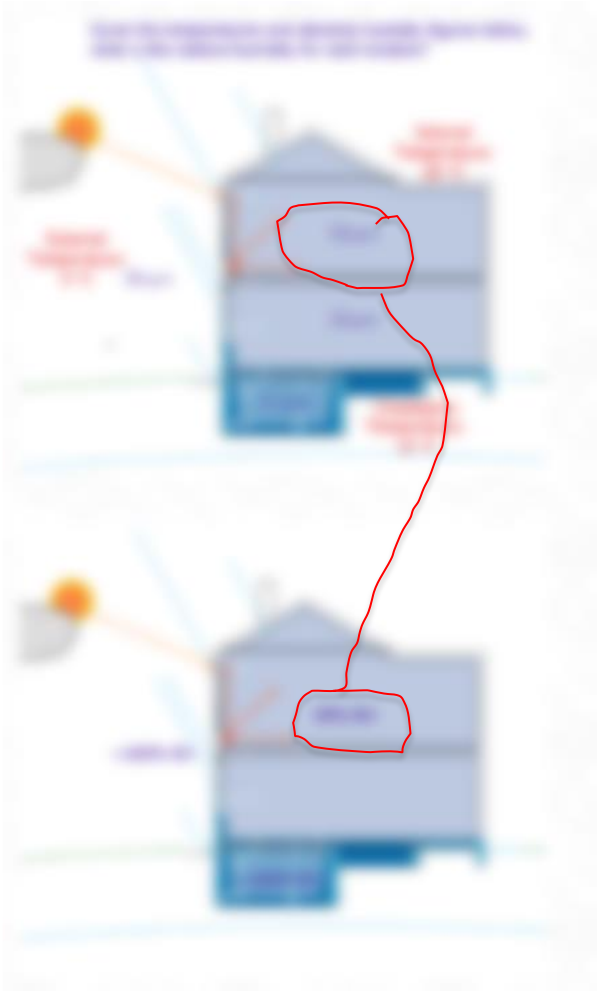
Examples based on monitored data – builds familiarity with environmental condition monitoring



A bit of science to ease you in….



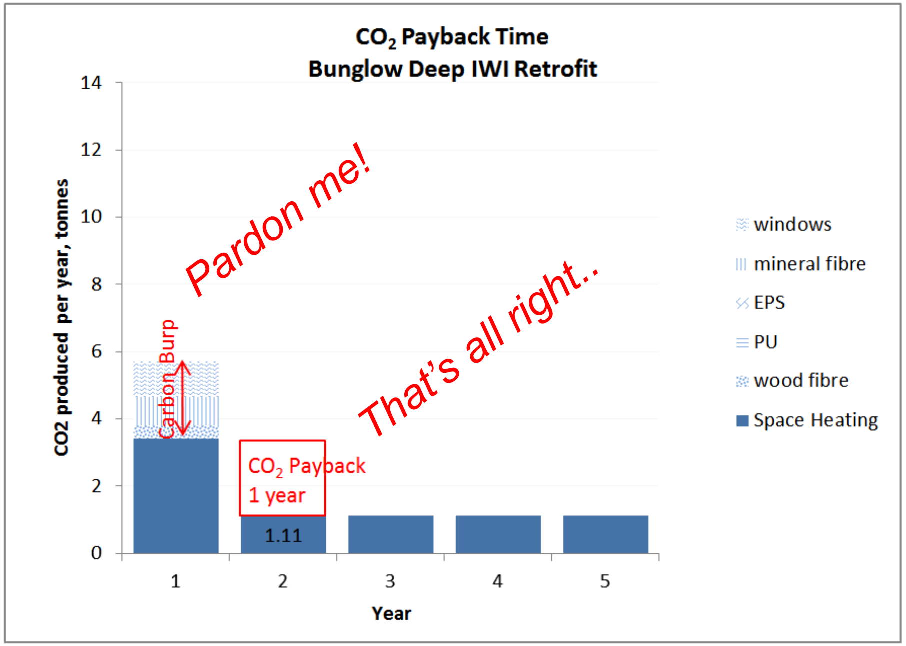
….simple exercises

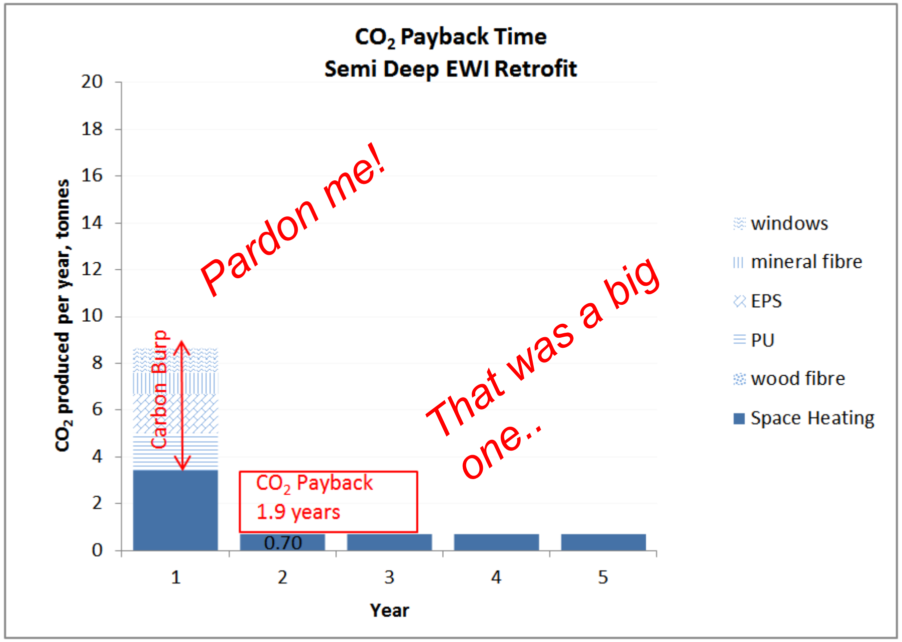


3. Understanding Buildings

Introduction
The Performance Gap
Where We Are
Energy Consumption & Space Heat Reduction Ambition
Comparison of Typical Domestic Energy Consumption
CLR Targets in Context
The Embodied Energy “Carbon Burp”
Building Types
Regional Types
Construction Types
The Building Retrofit
Survey and Investigation
Retrofit Strategy
Retrofit Works
Residual Risks

Carbon Burp





CO2 emissions for all insulations and windows (Bath Uni's ICE database values)

More work needed to identify all embodied emissions

4. Achieving Low Energy & High Comfort

Understanding Energy in Buildings
Power & Energy
Heat Load and Annual Energy Consumption
Useful, Delivered and Primary Energy
Energy Balance
Heat Transfer & Material Flow: Overview
Heat Transfer
Material Flow
Conventions for Floor and Heat Loss Areas
Floor Area
Heat Loss Area
Heat Loss Form Factor
Shape
Glazing
Thermal Performance
Thermal Comfort
Fabric Performance: General
Fabric Performance: Thermal Bridges
Airtightness
Ventilation
Heat and Power

Concepts & Principles

5. Retrofit building Science: introduction

Introduction
Moisture
Sources, Magnitude & Mechanisms
Capillary Action
Surface Diffusion
Hygroscopicity
Salts
Bulk Air Movement
Diffusion
Vapour Pressure and Diffusion Flow
Direction of Flow
Vapour Permeability
Vapour Resistivity
Material Permeability Categories
Evaporation
Condensation
Surface, Interstitial: Practical Examples
Bringing It All Together
The Role of Evaporation and Diffusion in the Drying Process
Condition of Materials
Moisture Content and Wood Moisture Equivalent
Relative Humidity & Equilibrium Moisture Content
Moisture Reservoirs and Buffers
Hygrothermal modelling, surveying, monitoring & analysis

Many permutations of insulated airtight construction junctions, across different:

- House Types
- Construction Methods
- Material Properties
- Budgets
- …

Aim of e.e. retrofit remains the same:

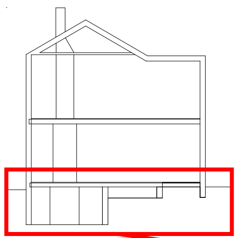
- Insulated
- Draughtproof (aka airtight)
- Robust Performance
- Longevity
- Healthy
- Sequestering
- Social, wellbeing aspects
- And so on

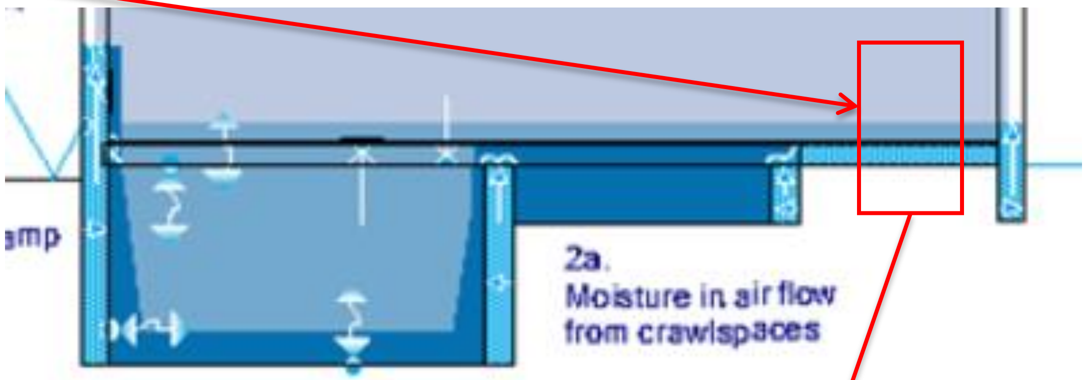
Understand microclimates S2
+
Understand the physics S5

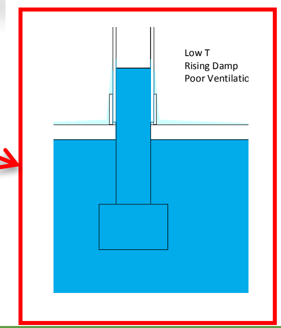
Apply this knowledge to better understand different complex retrofit design challenges

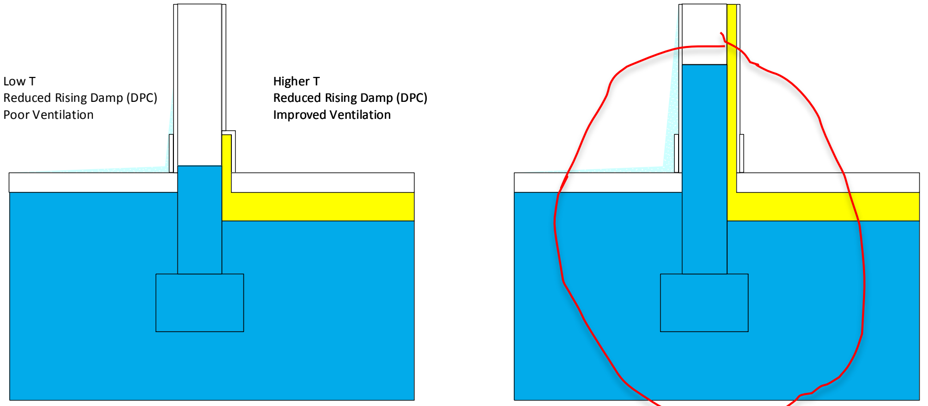
CLR helps you learn to identify, assess risks

- Avoid
- Reduce
- Manage



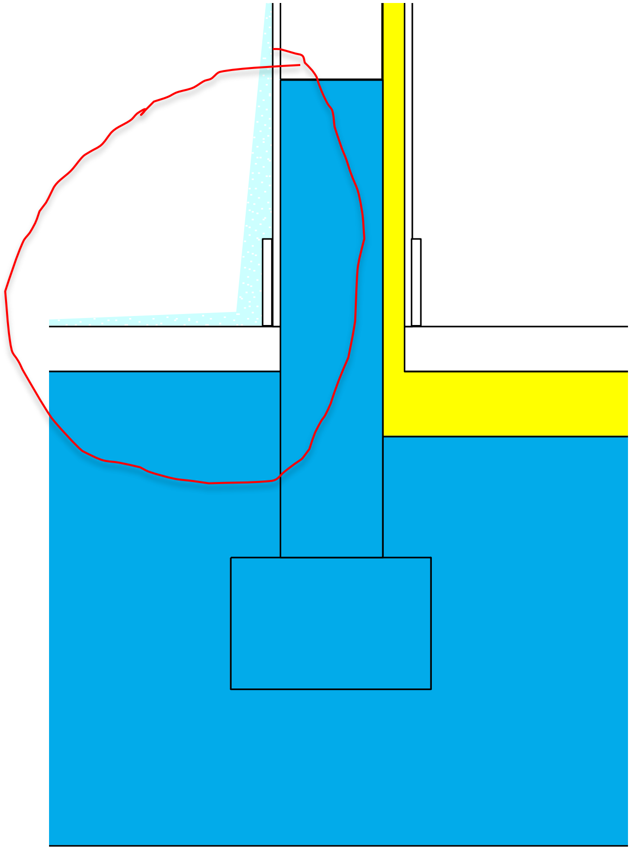






Party wall, section (solid floor)

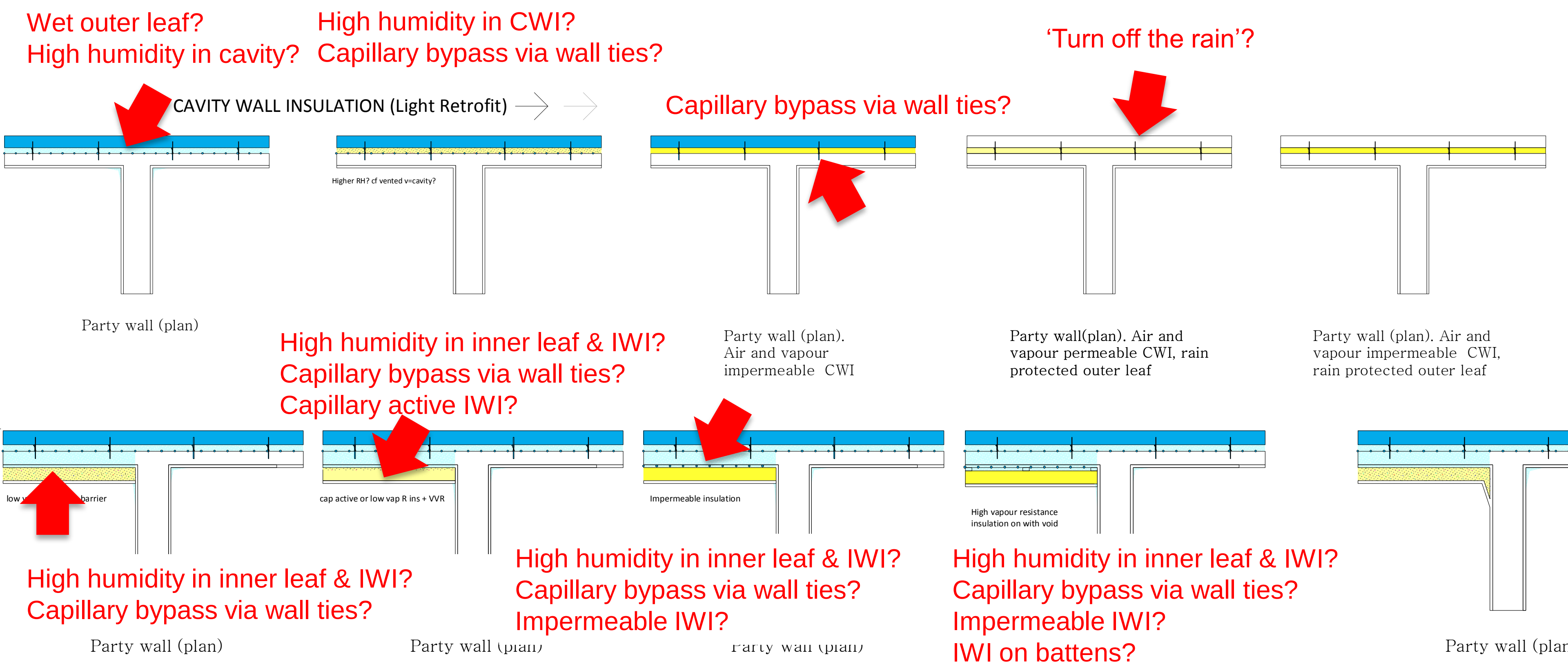
Party wall, section (solid floor), internal retrofit damp-proofing layer



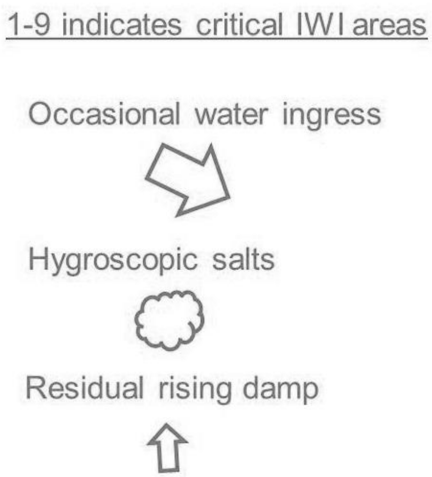
Understand the risk?

Explain it to others…

Now it's your call!



Even if we need to do more R&D, more monitoring…simply **asking the right questions** and thinking about building construction and associated microclimates takes us a long way towards more moisture robust retrofit…..



Complex situations can be simplified –
Section 5 should help you assess a range of complex challenges

1. resistance to wetting
2. resistance to wetting
3. airtightness
4. mould growth modification
5. resistance to wetting
6. condensation management
7. Insulation
8. Insulation
9. vapour control
10. insulation
11. insulation

6. Case Studies: introduction

Format

Buildings being monitored may offer several different areas of interest. For example in a single retrofit project IWI, EWI, ground and intermediate floors, floor voids or attics may be being studied. Each CLR case study looks at a specific area of interest in the context of the building as a whole. Generally data from a small number of selected sensors (typically three) is used in each case study, although other sensors' data may be referred to in order to aid analysis.

Each case study follows a simple format:

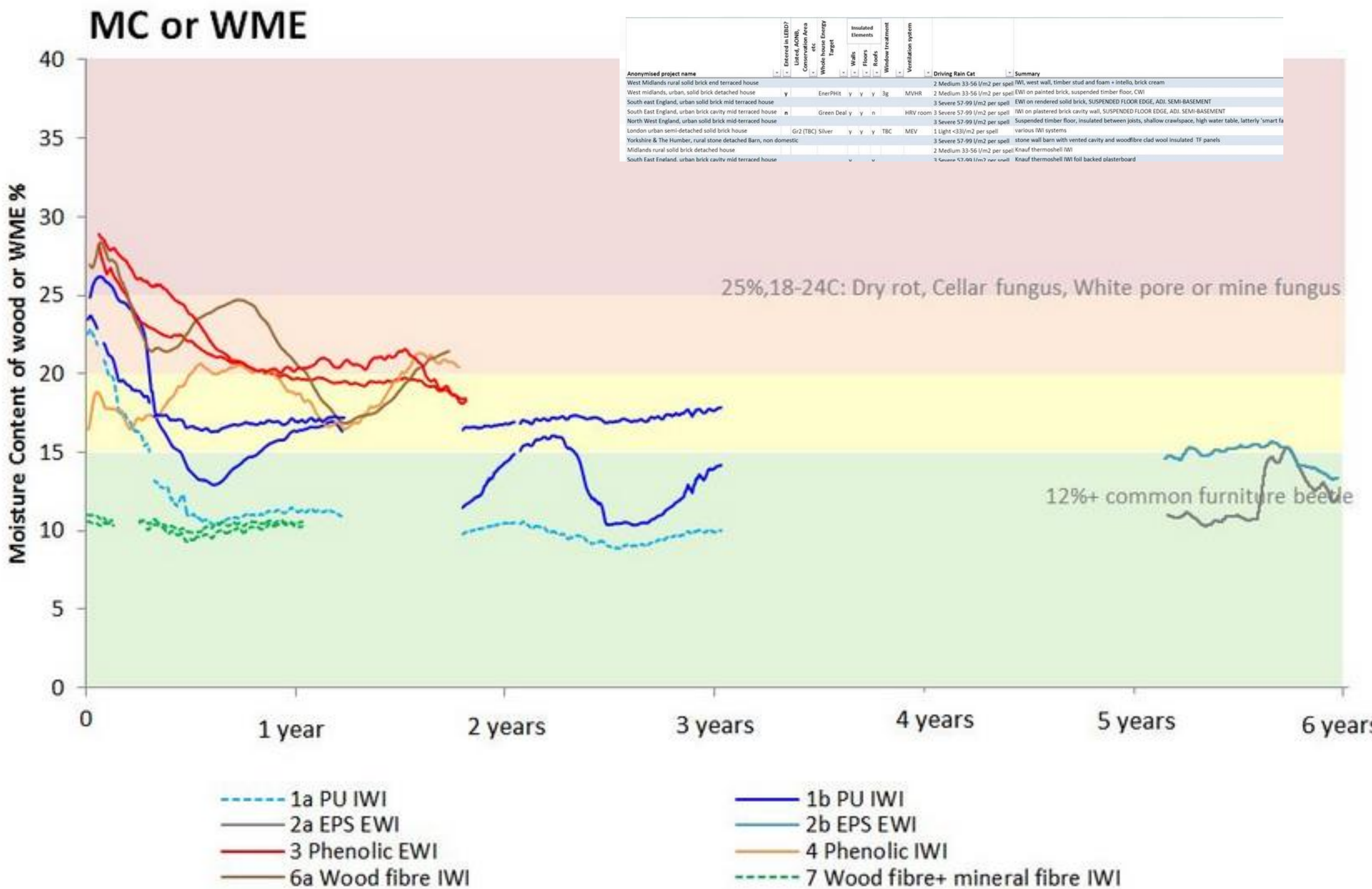
- Description of the construction assembly and retrofit measures being studied, U value and material properties
- Potential moisture influences on the assembly related to interior, ground and rain related moisture loads
- sensor positions, type and installation methods
- Location of the area of interest and nature of potential concerns
- Glaser method predictions
- WUFI analysis (if carried out)
- Monitoring results analysis:
  - Moisture Content
  - Temperature and Relative Humidity and mould risk
  - Evaporation rate, Condensation, water vapour diffusion flow rate, magnitude and direction
  - A summary of water vapour movement across the assembly during the monitored period showing direction and magnitude

Case studies conclude with a summary of the main findings.

Interim Conclusions

Case Study Library - as of March 2015

Anonymised project name	Entered in LEBD?	Listed, AONB, Conservation Area etc	Whole house Energy Target	Insulated Elements: Walls	Floors	Roofs	Window treatment	Ventilation system	Driving Rain Cat	Summary
West Midlands rural solid brick end terraced house									2 Medium 33-56 l/m2 per spell	IWI, west wall, timber stud and foam + intello, brick cream
West midlands, urban, solid brick detached house	y		EnerPHit	y	y	y	3g	MVHR	2 Medium 33-56 l/m2 per spell	EWI on painted brick, suspended timber floor, CWI
South east England, urban solid brick mid terraced house									3 Severe 57-99 l/m2 per spell	EWI on rendered solid brick, SUSPENDED FLOOR EDGE, ADJ. SEMI-BASEMENT
South East England, urban brick cavity mid terraced house	n		Green Deal	y	y	n		HRV room	3 Severe 57-99 l/m2 per spell	IWI on plastered brick cavity wall, SUSPENDED FLOOR EDGE, ADJ. SEMI-BASEMENT
North West England, urban solid brick mid-terraced house									3 Severe 57-99 l/m2 per spell	Suspended timber floor, insulated between joists, shallow crawlspace, high water table, latterly 'smart fa
London urban semi-detached solid brick house		Gr2 (TBC)	Silver	y	y	y	TBC	MEV	1 Light <33l/m2 per spell	various IWI systems
Yorkshire & The Humber, rural stone detached Barn, non domestic									3 Severe 57-99 l/m2 per spell	stone wall barn with vented cavity and woodfibre clad wool insulated TF panels
Midlands rural solid brick detached house									2 Medium 33-56 l/m2 per spell	Knauf thermoshell IWI
South East England, urban brick cavity mid terraced house				y		y			3 Severe 57-99 l/m2 per spell	Knauf thermoshell IWI foil backed plasterboard



Solid Wall, PU Foam IWI with brick cream, U value: 0.22

Interim Conclusions

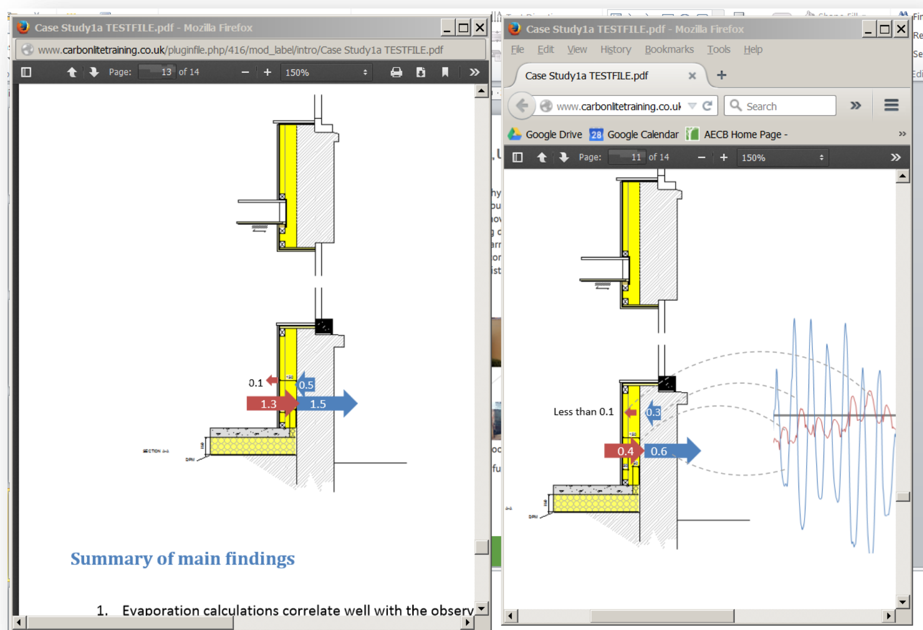
In this wall the brick cream creates a thin hydrophobic zone on the outside of the wall where no capillary action is possible but where water vapour can still freely pass through in either direction. Results show that the wall in this area dries out well after retrofit with warm spells helping drive the rate of drying. Significant inward vapour flows occur during these warm spells - however due to the vapour permeable insulation, membranes and decorative finishes the wall assembly avoids problematic build ups of humidity and moisture within and between its components.

Quick read summaries

make image zoomable

Open PDF to access full Case Study

Pop up windows allow in depth reading and comparison of full case studies:



Interim conclusions, for example:

EWI

we are seeing high mould risk which seems to be from existing & replenished moisture trapped in the wall – a **moisture reservoir**

- There seems to be very **slow drying**. Drying outwards would normally be the most effective path, but the vapour resistance of the material effectively blocks this route, it can only dry inwards
- The garden wall appears to be feeding moisture into the masonry of the main house, keeping it damp – **capillary bypass**

IWI

- The **drying** path seems to be almost all **inwards**.
- It is **not performing as well as it should**, the wall dries out a little in the summer, but then takes on moisture in the winter. This house has a cavity so no moisture should be getting through (as long as we are certain the cavity could not have been filled with a poor quality insulation!)

- This could be capillary bridging of the **cavity** by mortar snots and debris, Glaser indicates it could be **condensation**, particularly if the cavity is poorly ventilated.

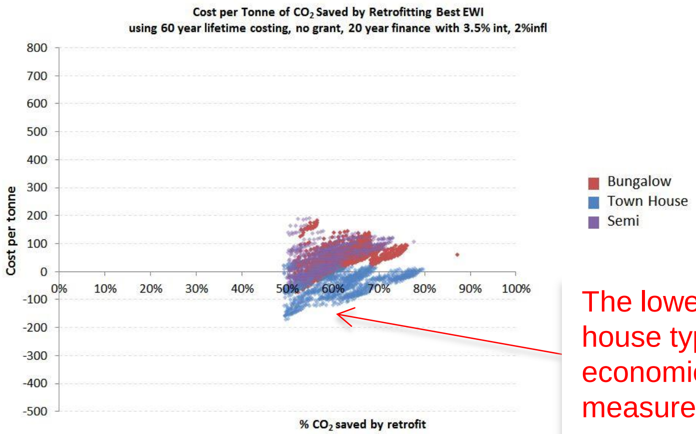
7. Fuel, Heat, Power & Services

Introduction
Which fuels
Appropriate scenarios for space & hot water heating systems
Overheating risks & space cooling strategy
Daylighting

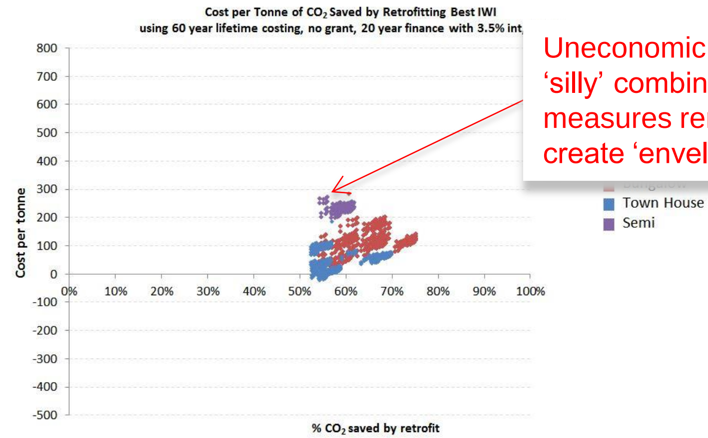
8. Financial, Climate, Comfort, House Type Factors

Introduction
Cost effective energy efficiency measures – the low hanging fruit
Whole house, lifetime costing evaluation methods
Components of the Modelling
Interpretation of Modelling Results
Measures covered
Scenarios & Sensitivity Analysis
Further Information (Assumptions on EE & Embodied Carbon)

Example: whole house combinations of e.e. measures for retrofit ‘ready’ and ‘unready’ properties reducing SSHD by at least 50%



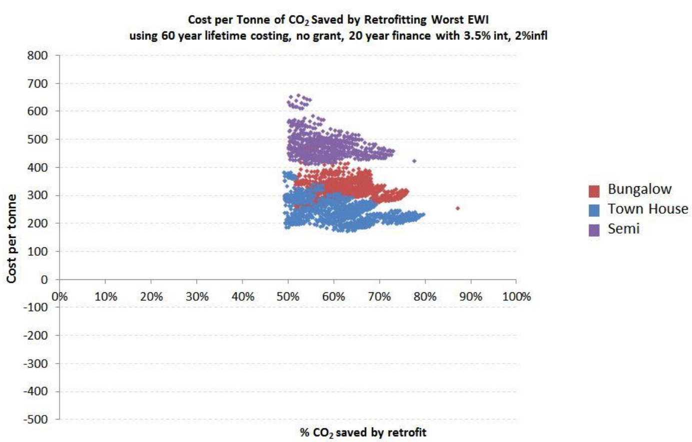
The lower band for each house type contains more economic combinations of measures

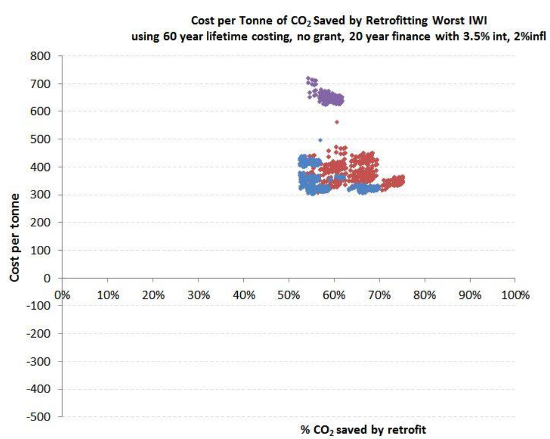


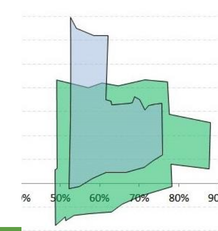
Uneconomic, even ‘silly’ combinations of measures removed to create ‘envelopes’

Above: EWI & IWI combination for ‘retrofit ready’ properties

Below: EWI & IWI combination for ‘unready’ properties

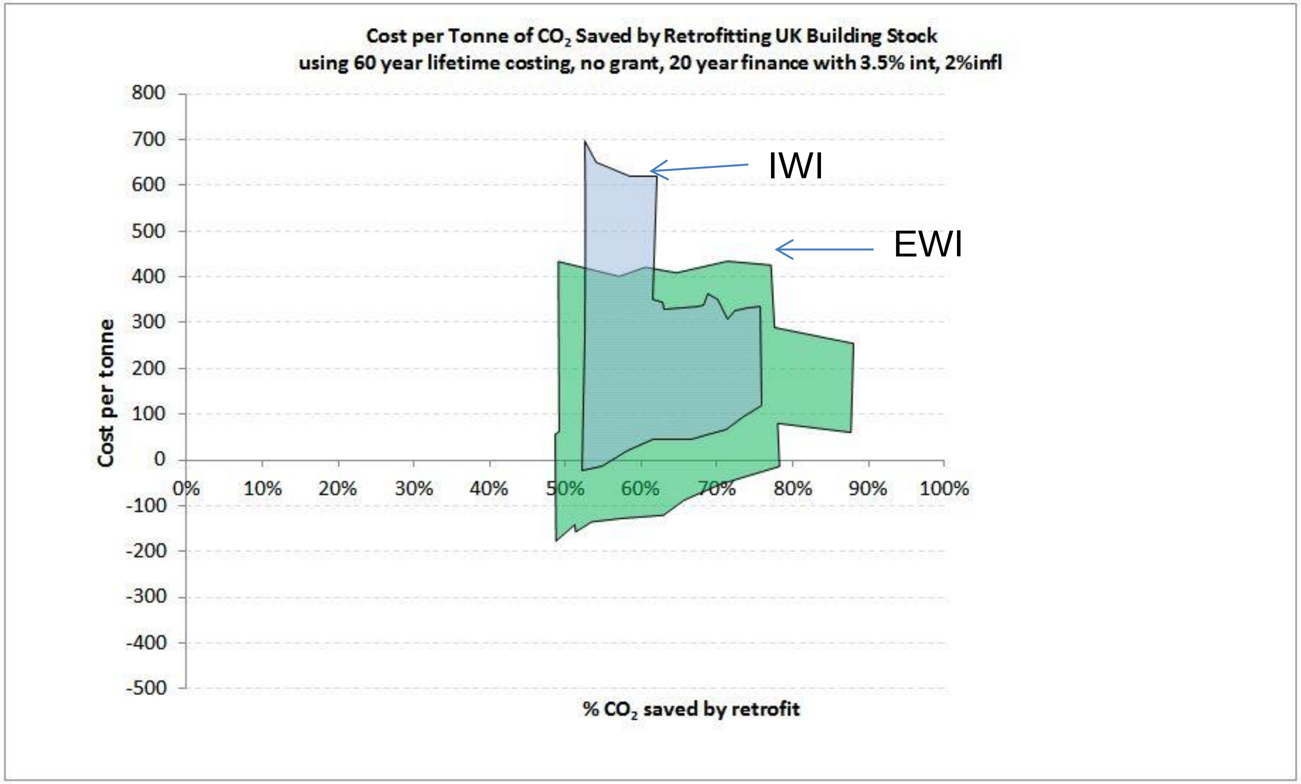






Many sensible whole house combinations of measures for buildings across the different types of dwelling in the UK housing stock can - in the CLR modelling - save carbon dioxide emissions at low to negative costs when modelled over 60 years!

With all the other free co-benefits from retrofit this should be irresistible to UK governments of all persuasions.



EWI = External Wall Insulation

IWI = Internal Wall Insulation

Carbon mitigation costs resulting from retrofitting a range of UK dwellings at different stages in their maintenance cycles (follows standard lifetime costing as set out in the Treasury Green Book)

“The climate is a common good, belonging to all and meant for all.”

Pope Francis, yesterday