

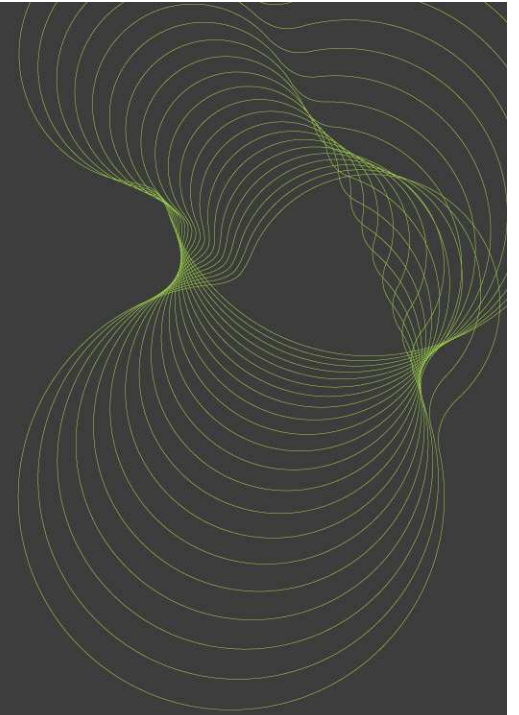
The logo for BRE, consisting of the lowercase letters 'bre' in a light green, sans-serif font.

bre

Zero Carbon Housing

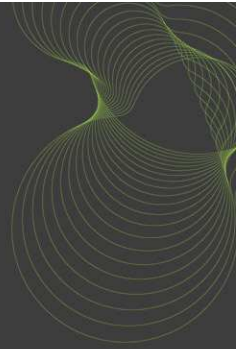
Richard Hartless

Housing Group, BRE



Scope of talk

- Background and legislative drivers
- Pathway to zero carbon
- Code for Sustainable Homes
- What is 'zero carbon'?
- How to achieve zero carbon
- What do zero carbon homes look like?
- Developments in the rest of Europe



Legislative drivers (Europe and UK)

EPBD

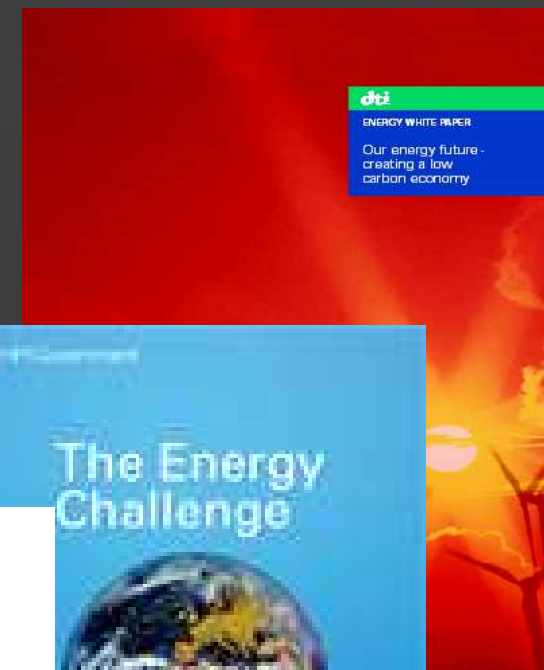
- EP calculation methodology
- Minimum EP requirements
- EP certificates
- Member States' EP regulations to be reviewed every 5 years

Housing Green Paper

- Proposes 2m new homes by 2016 and 3m by 2020 to meet predicted housing needs

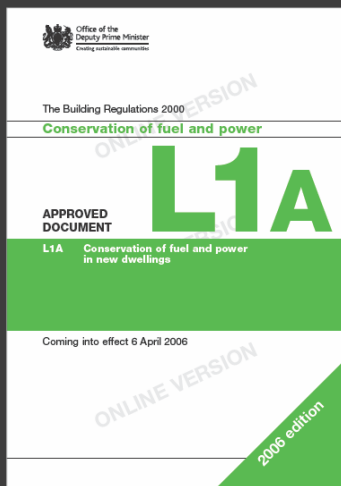
Energy White Paper

- 60% cut in CO₂ emissions by 2050. But will it be 80%?!

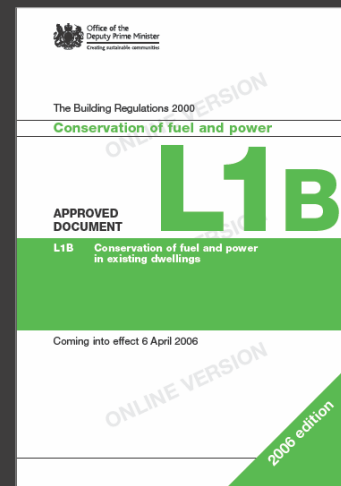


Pathway to zero carbon - Building Regulations

- Building Regulations apply in England & Wales and exist principally to ensure the health and safety of people in and around buildings. They also provide for energy conservation
- They are broken down into fourteen parts from Part A through to Part P
- We are concerned with Part L – Dwelling



Part L1A
Conservation of
fuel and power
(New dwellings)
(2006 edition)



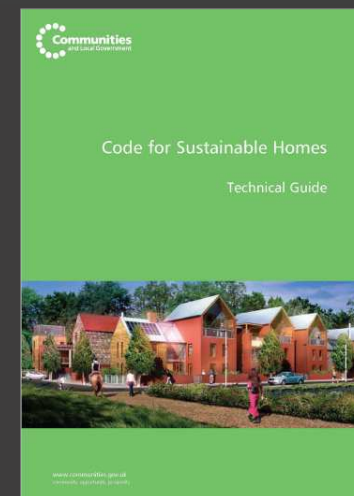
Part L1B
Conservation of
fuel and power
(Existing dwellings)
(2006 edition)



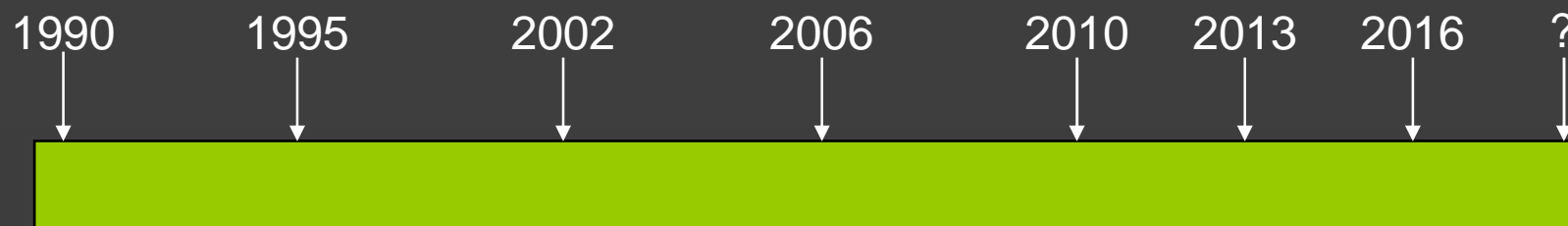
Code for Sustainable Homes



- On 13 December 2006, the Code for Sustainable Homes - a new national standard for sustainable design and construction of new homes was launched
- The Code for Sustainable Homes is a set of sustainable design principles covering performance in nine key areas:
 - *Energy and CO₂ emissions; water; materials; surface water run-off; waste; pollution; health & well-being; management; ecology*
- The Code uses a 1 to 6 star rating system to communicate the overall sustainability performance of a new home
- The Code sets minimum standards for energy and water use at each level and, within England, replaces the EcoHomes scheme
- From 1st May 2008 new dwellings to be assessed against the Code, but currently no requirement to achieve a particular Code level
- New housing funded through English Partnerships or the Housing Corporation has to achieve Code Level 3 as a minimum



Context and timeline



1990

20% improvement over 1985 regs

Standard Assessment Procedure is accepted as an alternative way of demonstrating compliance

EcoHomes first introduced

1995

25% improvement over 1990 regs

Elemental, calculation and energy use methods

Elemental trade offs allowed

2002

20% improvement over 1995 regs

Elemental, Target U-value and Carbon Index methods

SAP required to be produced

2006

20% improvement over 2002 regs

Approved document split L1A and L1B

TER/DER assessment

Increased low-energy lighting and quality of workmanship and airtightness req.

Energy Performance Certificates

2010

25% improvement over 2006 regs

CSH level 3

2013

44% improvement over 2006 regs

CSH level 4

2016

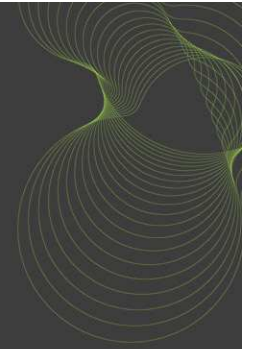
Circa 149% improvement
CSH level 6

?

What does an energy efficient house look like?



- Could this be an energy efficient house?

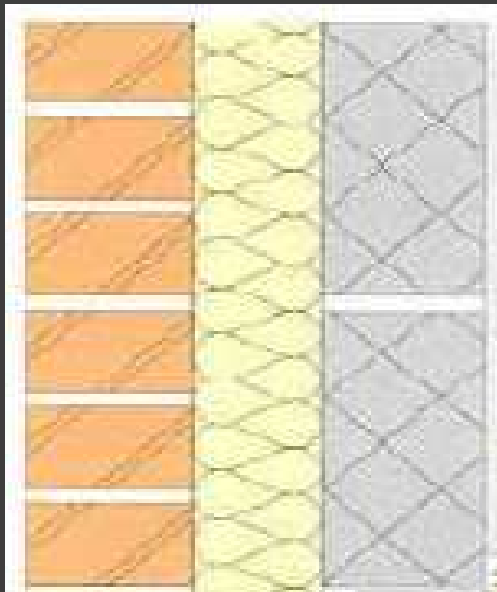


Part L1A (2006) Semi-Detached House

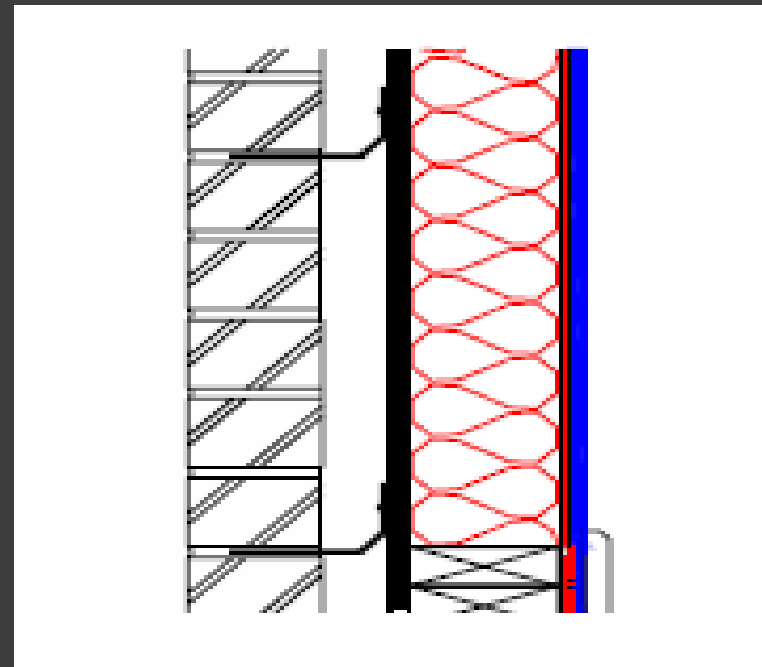
- Wall U-value 0.33 W/m²K
- Roof U-value 0.17 W/m²K
- Floor U-value 0.25 W/m²K
- Glazing U-value 1.8 W/m²K
- Doors U-value 1.8 W/m²K
- Boiler Efficiency 90%
- Airtightness 7 m³/m²hr @ 50Pa
- Thermal Bridging $y = 0.08$

Current wall constructions

100mm Full fill Cavity



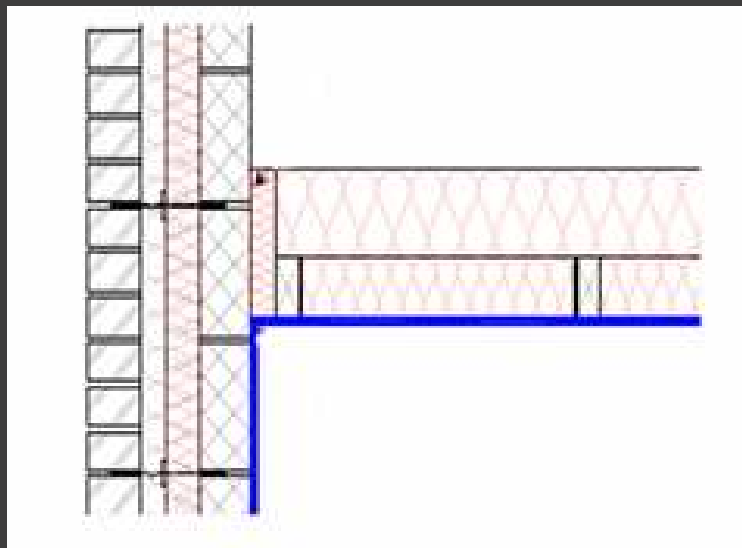
Timber Frame with Internal Lining



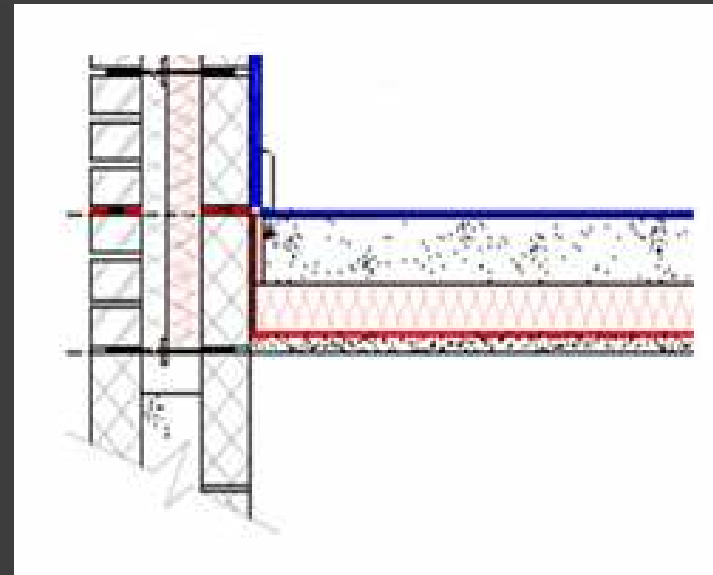
Current constructions

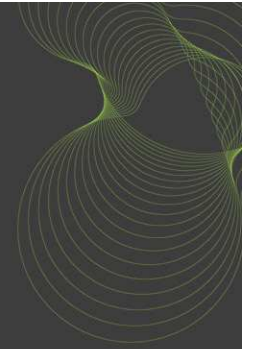


Pitched Roof, Ceiling Insulation



Solid Ground Floor





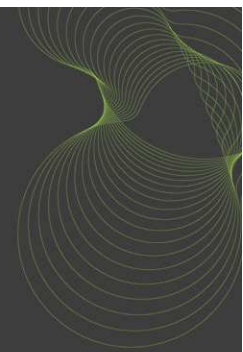
Improvements in insulation for 2010

- Walls - from 0.33 to 0.21 W/m²K
- Roof - from 0.17 to 0.13 W/m²K
- Floor - from 0.25 to 0.20 W/m²K
- Windows - from 1.8 to 1.5 W/m²K
- Doors - from 1.8 to 0.5 W/m²K
- Bridging - from 0.08 to 0.04

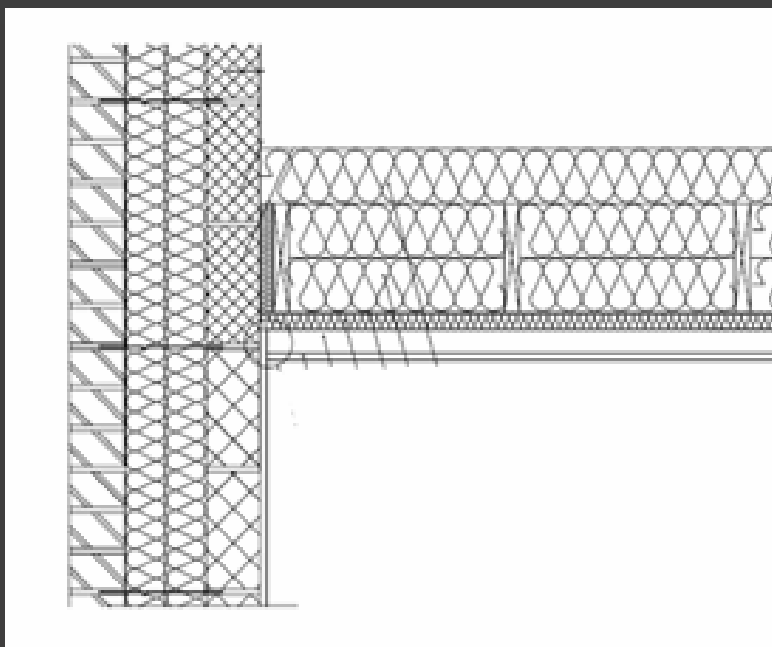
Constructions achieving U-values

Element	Part L1A [2006]	Improved [2010]
Pitched roof (ceiling level)	0.17 W/m ² K (250mm min wool)	0.13 W/m ² K (350mm min wool)
Floors	0.25 W/m ² K 50-100mm (EPS)	0.20 W/m ² K 50-100mm (PU)
Windows and Doors	1.8 W/m ² K	W - 1.5 W/m ² K (BFRC.org) D – 0.5 W/m ² K (Composite)

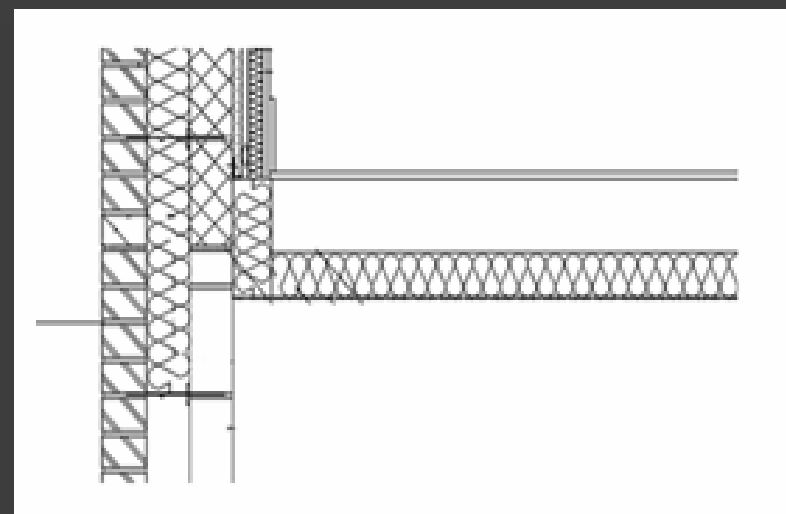
Enhanced Construction Details



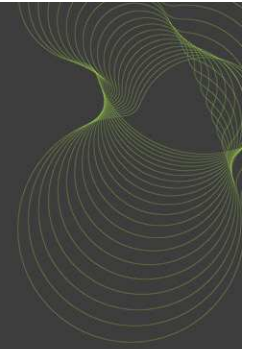
Pitched Roof, Ceiling Insulation



Solid Ground Floor



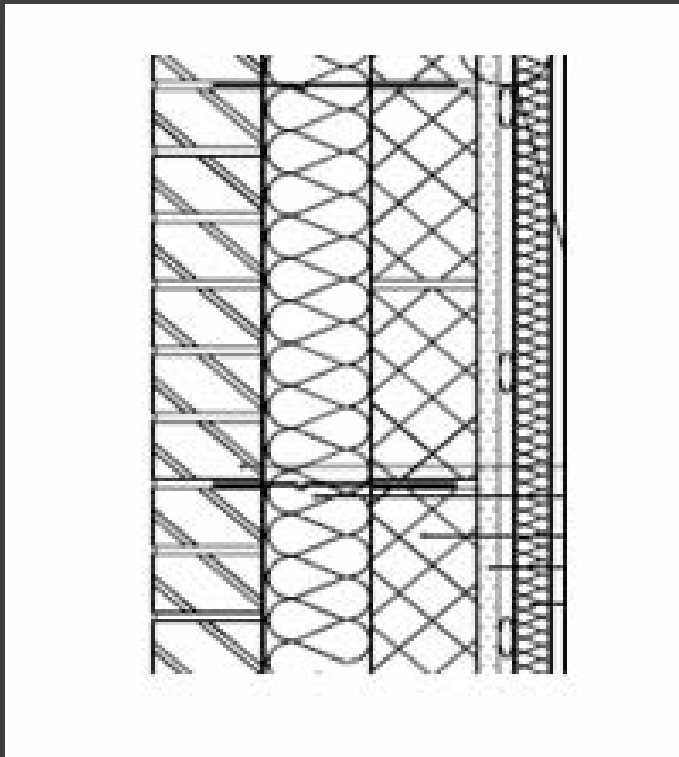
Walls achieving U-values



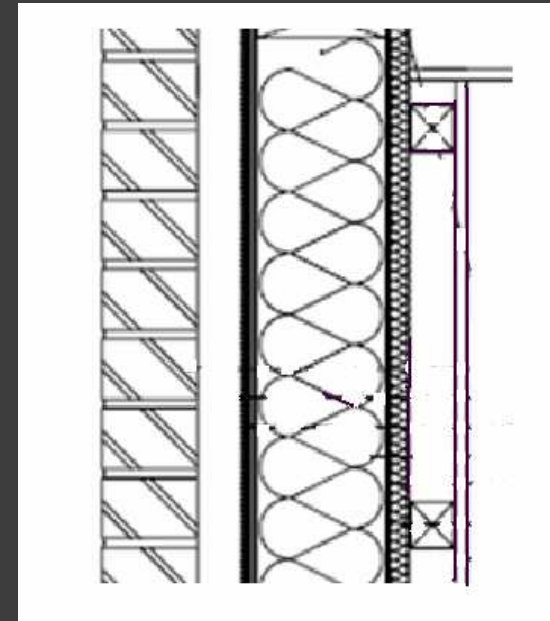
Wall type	0.33 W/m ² K [2006]	0.21 W/m ² K [2010]
Full fill	100mm ($\lambda = 0.037$)	150 mm ($\lambda = 0.037$)
Partial fill	Light 50mm ($\lambda = 0.023$) + 50mm clear	Light 100mm ($\lambda = 0.023$) + 50mm clear
Timber frame	100 stud fully filled ($\lambda = 0.037$) plus 10mm internal lining ($\lambda=0.023$)	140 stud fully filled ($\lambda = 0.037$) plus 25mm internal lining ($\lambda=0.023$)

Enhanced Construction Details

Cavity Wall with Thermal Lining



Timber Frame with Internal Lining

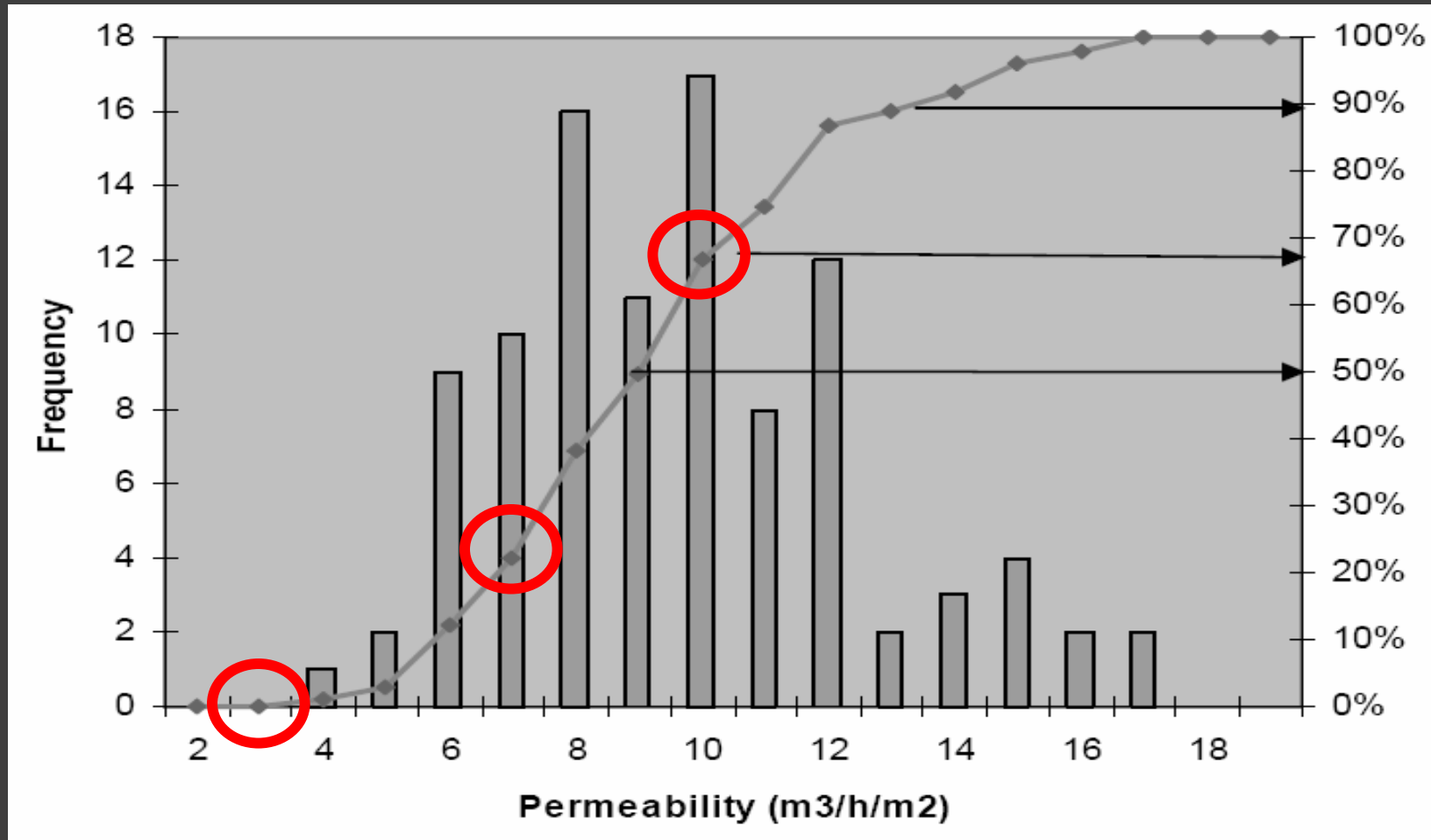
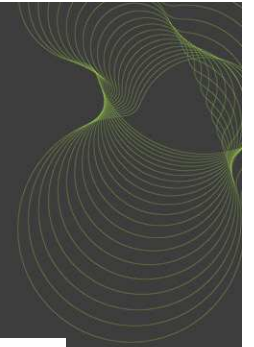


Airtightness: What level should you achieve?

- Part L1A default – 10 m³/m²hr @ 50Pa
- Enhanced Construction Details – 3
- Holland – 6
- Sweden – 3 (in 1981!)
- Germany 1.8 – 3.8
- Super E (Canada) – 2.0
- Passivhaus – 1.0

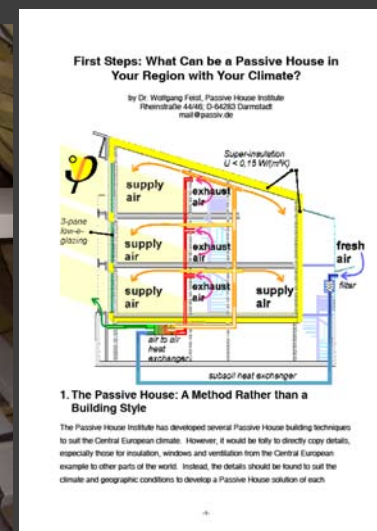


Airtightness: How do UK homes perform?

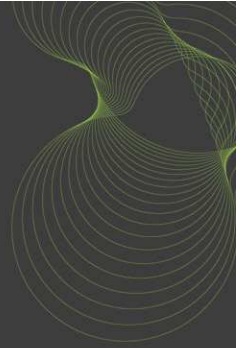


Going forward to 2013 – Passivhaus?

- European voluntary standard, approx. CSH Level 4 - 5
- Typical U-values: 0.15 (opaque), 0.8 (windows)
- Airtight: 1.0 m³/m²hr @ 50Pa
- Efficient MVHR (80%)
- Minimal thermal bridging
- Attention to solar layout
- Peak heating load 10 W/m² then ventilation system can be used for space heating
- 15kWh/m²yr space heating demand
- 120kWh/m²yr total primary energy use
- Passivhaus Institut: <http://www.passiv.de/>
- www.Passivhaus.org.uk managed by BRE

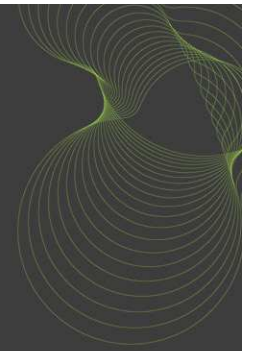


Transferring Passivhaus beyond Central Europe?



- Yes, but tailored to suit local climate and building traditions – the laws of Physics still hold!
- Indoor climate and summer comfort in low energy buildings are handled by same official procedures
- Insulation is recommended in all climates
- Shading is essential in all climates with high levels of solar radiation to prevent overheating
- Heat recovery is needed in cold and hot climates – air ducts can be used to transport heat during heating season and cool air during hot periods (use high efficiency ECMs)
- Use ground as heat or cold buffer to reduce heat and cooling loads

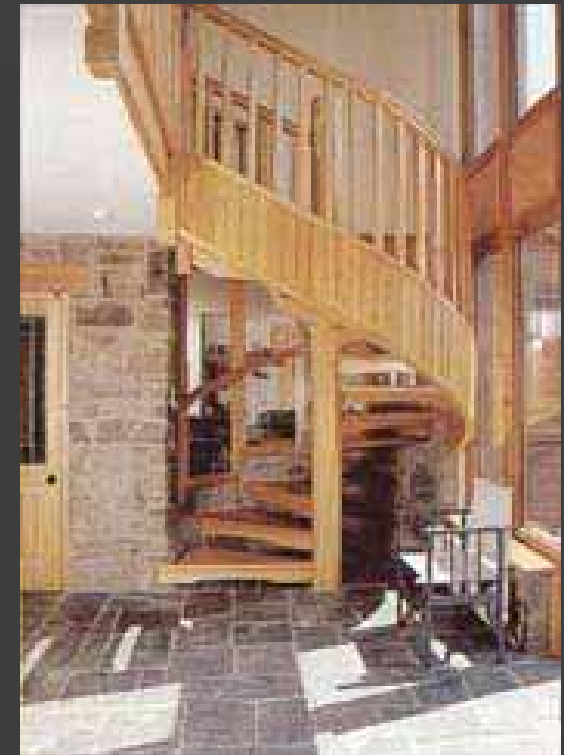
Limiting the effects of solar gains in summer



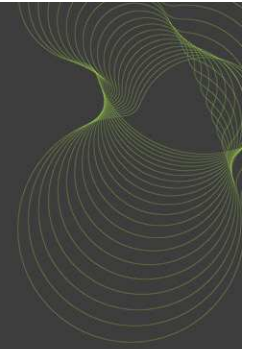
External roller blinds



Rising overhang and horizontal louvres



Stone wall and slate floor providing mass in timber frame house



The future: 'zero carbon' homes

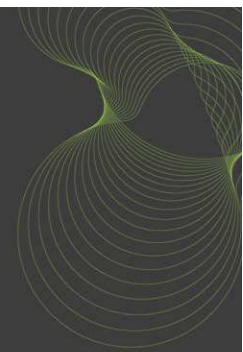
It gets *much* harder! Every available point matters.

Two critical decisions...

1. Precisely *which* carbon emissions are to be zero?
2. Exactly what do we *mean* by 'zero'?

Q1. Precisely *which* carbon emissions must be zero?

- Space heating, water heating and lighting: Level 5
- Everything, including cooking and domestic appliances too: Level 6



Q2. Exactly what do we mean by 'zero'?

- *Zero carbon*: “no carbon-emitting fuels are burnt on site, and we do not import any electricity from the grid”
- *Net zero carbon*: “we do burn carbon-emitting fuels on site but we export, to the grid, locally-generated renewable electricity to make up for it”
- *Carbon neutral*: “we import, via the grid, remotely-generated ‘additional’ renewable electricity”
- ***There are others!***
- Big debate in UK concerning zero carbon definition and Stamp Duty Land Tax relief scheme for zero carbon homes up to 2012 (private wire)

Low and zero carbon technologies

- Solar hot water, heat pumps, PVs etc.
- Regional Planning Policy
- Additional Code credits



Lighting and appliances

- Increase in existing number of low-energy fittings provided
- Inefficient lighting to be phased out in UK:
 - 100W cease selling from Jan 2009?
 - 60W from Jan 2010?
 - All incandescent lamps 2011?
- Appliances – legislation not required as market driven
- Required to achieve true zero carbon and CSH credits



BRE INNOVATION PARK – DEMONSTRATIONS



bre



Hanson



Code level 4

All opaque U-values
<0.18

Triple glazed windows

Ground source heat
pump with SHW

Natural ventilation

Airtightness $5 \text{ m}^3/(\text{hr} \cdot \text{m}^2)$
@ 50 Pa

Wonderwall system

Concentrates on use of
thermal mass and
providing comfortable
summer temperatures

OSBORNE



EcoHomes Excellent (Code level 3/4)

All opaque U-values
<0.15 SIP + pre-fab
bathroom pods

Triple glazed windows

A-rated gas boiler with
SHW

100% low-energy lighting
and appliances

MVHR

Airtightness <3 m³/(hr.m²)
@ 50 Pa

Lifetime homes



Code level 4

All opaque U-values
<0.18 timber frame
panels

Single storey flat on
bottom with two storey
house on top

Pre-fab bathroom and
kitchen (all services in
one central unit)

Triple glazed windows

Viessmann compact
service unit with SHW
– incorporates MVHR

Airtightness, design
target $1 \text{ m}^3/(\text{hr.m}^2) @$
50 Pa



Code level 5

All opaque U-values
<0.15 timber frame

Pre-fab bathroom pods

Triple glazed windows

A-rated gas boiler with
SHW

3 Micro wind turbines

PV 2.6 kWp roof + 0.8
kWp wall mounted

Mixture of MVHR
supplemented by MEV

Airtightness, design
target $1 \text{ m}^3/(\text{hr.m}^2)$ @
50 Pa



Code level 6

All opaque U-values
<0.11 SIPS panel

Bedrooms on ground
floor

Triple glazed windows

Biomass boiler with
SHW

PV 4.7 kWp

MVHR, with solar
chimney for summer
and shading to west
façade

Airtightness, design
target $1 \text{ m}^3/(\text{hr} \cdot \text{m}^2)$ @
50 Pa



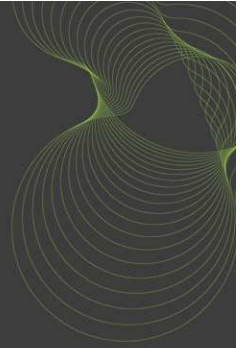
Winning Design: **GREEN HOUSE**
Architect: **Gaunt Francis Architects**



Green House

- Barratt is building the prototype on the BRE Innovation Park
- Design upgraded to meet Code Level 6
- Construction being carefully monitored. Code Level 6 certification of construction the target
- Construction completion - April 2008
- VIP launch today!

Green House: Unique credentials



First of a new viable breed of modern fully sustainable housing:

- To meet Level 6 Code for Sustainable Homes design
- To be built by a volume house-builder
- With the potential for large scale production
- To a design which has been selected by the public
- To achieve Stamp Duty Relief

BRE INNOVATION PARK – DEMONSTRATIONS



bre



Achieving Level 6 - Energy

- Maximized building fabric to meet HLP
- Provision of LZC technologies
- Renewable technologies to offset electricity use
- Private wire for offsite generation



Green House – Key features 1

Automatic
shutters

Airtightness
 $1.0 \text{ m}^3/\text{hr}/\text{m}^2$
@ 50Pa

$0.70 \text{ W}/\text{m}^2\text{K}$
windows

Rainwater
recycling

Green House – Key features 2

Internal flexibility

MVHR

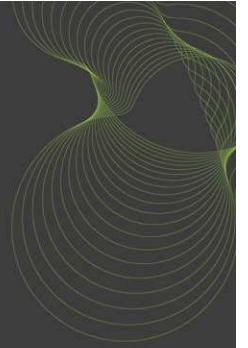
Computerised BMS

Energy efficient appliances



Green House:

Further features contributing to level 6 design



- 34 m² PV – utilises all of South-facing roof pitch
- Sedum Roof – utilises all of North-facing roof pitch
- Walls, ground floor and roof U-values below 0.15
- Thermal mass in core of building moderates high summer temperatures
- Provision for home office
- Air to air heat pump and solar thermal options available when CHP not available

Very low energy housing in Europe?

Recent survey of all Member States by SBI for EuroACE



Key findings:

- Austria, Czech Republic, Denmark, Finland, France, Germany and UK have official definitions
- Calculations consistent with EPBD and CEN standards but still national deviations
- Such buildings are promoted through loans and low interest rates, or lower (CO₂) taxes
- Ultimately, MSs need to introduce national/regional definitions in their building regulations and develop strategy towards achieving them
- Support from European Commission to develop EU strategy and follow ambition in EU Action Plan – linked to recasting of EPBD (end of 2008?)
- Full report can be obtained at:

<http://www.euroace.org/verylowenergybuildings/index.htm>

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