Passivhaus Principles

by Jon Bootland,
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Passivhaus principles

Passivhaus Trust
The UK Passive House Organisation

1. What is Passivhaus

2. What it means for the building process

3. What it can achieve for carbon emissions and energy consumption (what are the benefits?)

4. Why bother

5. The Passivhaus Trust

Passivhaus

What is it?

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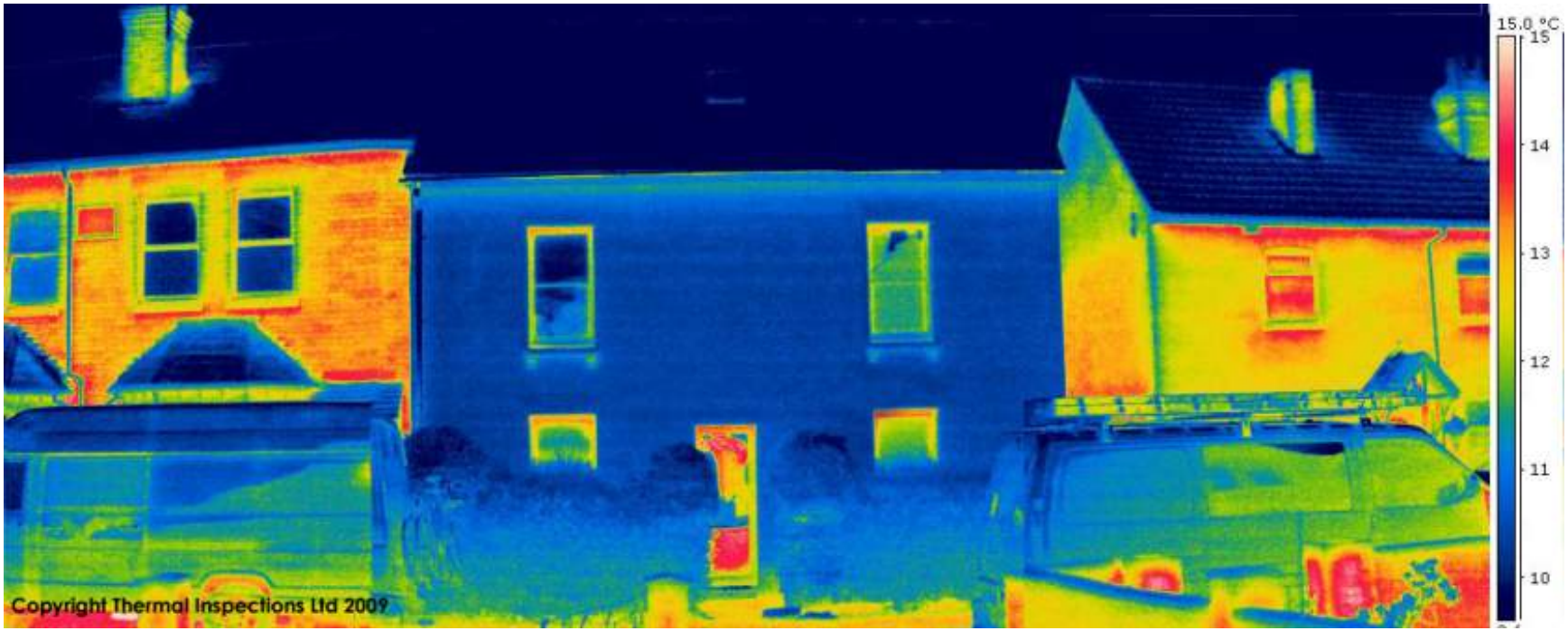
… Passivhaus is the leading international design standard for low energy, comfortable, high quality, affordable buildings.



Simmonds.Mills / Thermal Inspections Ltd.

Passivhaus

What is it?

… in simple terms

- Super- insulated
- Free of thermal bridges
- Very low air-leakage
- Mechanically ventilated (with heat recovery)
- Passive solar with solar shading

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Passivhaus

What is it?

… Houses, apartments …

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Hanssen-Höppener Passive House; photographs: Rongen Architekten

Nestwerk residential building; photograph: Reiter & Rentzsch Architects.

Passivhaus

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What is it?

… Schools, Kindergarten, Offices …

Riedberg Passive House School, Frankfurt (Architeckten 4a)

Canolfan Hyddgen in Machynlleth, Wales
JPW Construction

Lengdorf nursery school, Germany (AB Vallentin)

Passivhaus Origins

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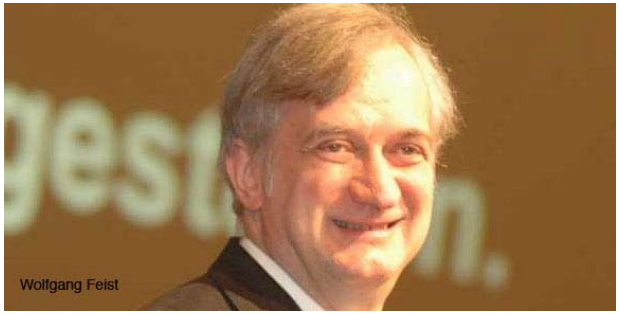

"I was working as a physicist. I read that the construction industry had experimented with adding insulation to new buildings and that energy consumption had failed to reduce.

This offended me – it was counter to the basic laws of physics. I knew that they must be doing something wrong. So I made it my mission to find out what, and to establish what was needed to do it right"

- Wolfgang Feist

Passivhaus

- When and where?

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Passivhaus

- When and where?

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Over 20,000 houses, schools, offices and other buildings have been designed, built and tested to this standard across Europe.

- 13,500 Passivhaus buildings in Germany - 10% certified to PHI criteria
- Range of building types
- Where?
  - different countries
  - Now including USA and Japan
  - Adaptation for different climatic conditions

Passivhaus

- When and where?

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1991 1996 2008 2011

Images: Passihaus Institut, JPW Construction, Green Building Company, Simmonds.Mills

Passivhaus in the UK

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Canolfan Hyddgen in Machynlleth, Wales

- 1st Certified Passivhaus in UK
- Offices and IT Suite
- Masonry & timber frame

JPW Construction

Passivhaus in the UK

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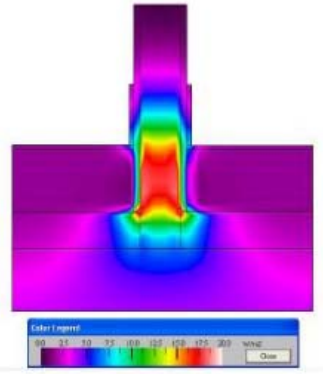
Retrofit for the Future

- Passivhaus principles applied to social housing
- Whole house strategy
- Use of Passivhaus components



Anne Thorne Architects

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What does it mean?

… Certification for buildings, products and designers

- Buildings
  - Through UK based certifiers

- Products / Components
  - Through Passive House Institute
  - Is a demonstration of performance but not required (except for MVHR systems)

- Designers / Consultants
  - Through CEPH courses by Strathclyde, BRE and others
  - List of CEPH designers / consultants on the PH Trust website

Passivhaus

- How is it achieved?

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The UK Passive House Organisation

Modelling with Passive House Planning Package (PHPP)

Specific Demands with Reference to the Treated Floor Area

Treated Floor Area: 87.0 m^2

	Applied:	Monthly Method	PH Certificate:	Fulfilled?
Specific Space Heat Demand:	15	kWh/(m^2a)	15 kWh/(m^2a)	Yes
Pressurization Test Result:	0.6	h^{-1}	0.6 h^{-1}	Yes
Specific Primary Energy Demand (DHW, Heating, Cooling, Auxiliary and Household Electricity):	100	kWh/(m^2a)	120 kWh/(m^2a)	Yes
Specific Primary Energy Demand (DHW, Heating and Auxiliary Electricity):	47	kWh/(m^2a)		
Specific Primary Energy Demand Energy Conservation by Solar Electricity:		kWh/(m^2a)		
Heating Load:	11	W/m^2		
Frequency of Overheating:	11	%	over 25 °C	
Specific Useful Cooling Energy Demand:		kWh/(m^2a)	15 kWh/(m^2a)	
Cooling Load:	11	W/m^2		

Passivhaus

- How is it achieved?

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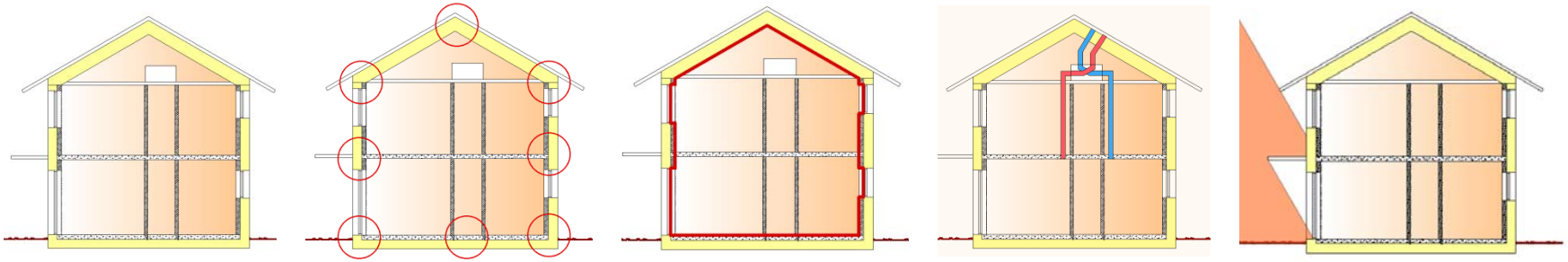

- High levels of insulation (Fabric U-value < 0.15 W/m^{2}K; Windows < 0.8 W/m^{2}K)
- Minimal thermal bridging
- Continuous air barrier to achieve < 0.6 ach @ 50 Pa
- Provide controlled ventilation and heat recovery during heating season with MVHR. Can use natural ventilation in summer.
- Maximise use of solar and internal heat gains & protect against overheating.

Passivhaus

What does it mean?

… Design certification criteria

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- Space heat demand of < 15 kWh/m^{2}.yr
  - How much energy is needed to heat the building

- Pressure test result< 0.6 ach @ 50 Pa
  - How much air leaks through the fabric of the building

- Primary energy < 120 kWh/m^{2}.yr
  - How much energy is needed to power all of the activities within the building (heating, hot water, lighting, cooking, appliances, active cooling)

- Frequency of overheating in summer < 10%
  How many times the temperature within the building exceeds 25°C

Passivhaus in the UK

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The EnerPHit Standard

- Effectively same criteria as Passivhaus standard with higher space heat demand of 25 kWh/m2/yr
- Very challenging to achieve
- A number of Retrofit for the Future projects are exploring how we might meet this standard

EnerPHit
Quality-Approved Energy Retrofit with Passive House Components
Passive House Institute

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Energy savings

… compared to UK standards

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- PHPP calculations are done on a different basis to SAP
- Passivhaus results in a fixed target for heating load (15kWh/m^2.a) or a total energy demand (120 kWh/m^2.a), not percentage reductions
- This doesn't correlate with UK targets, which cover "regulated energy"

  So……when modelled using SAP…….

- The Passivhaus standard is better than Code 4 energy standard (predicted 2013 Building Regulations Part L)
- And close to the Zero Carbon "Carbon Compliance" standard

  Or……..

- About 60% less energy than Part L 2010 compliant 3-bed terrace house

Passivhaus in the UK

Relationship of Passivhaus to UK policy

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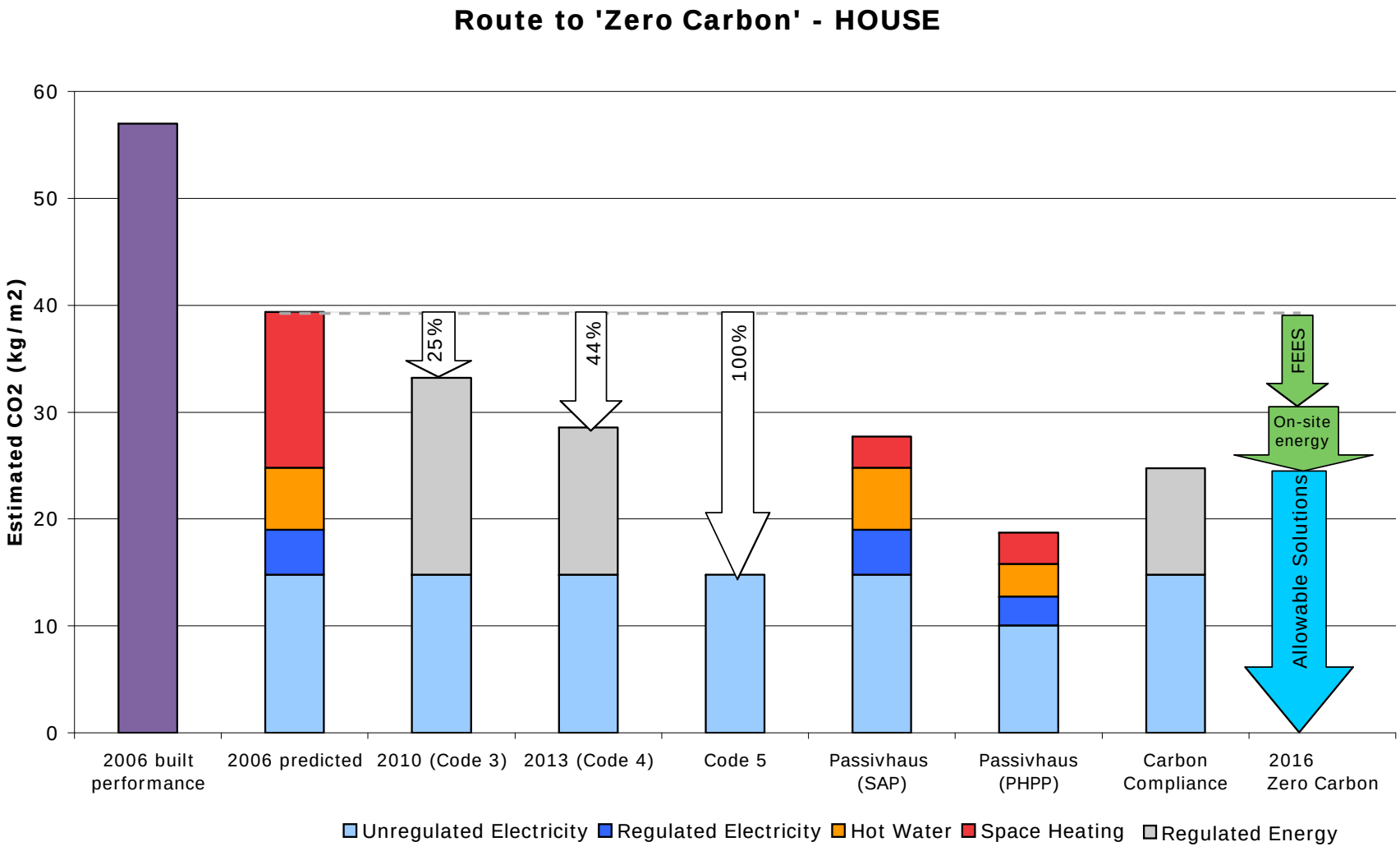

Passivhaus

Other benefits … Comfortable and healthy

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Comfortable
- in both winter and summer

"From the very first day we have felt comfortable in the house, as if wearing a good jacket which is the just the right size and comfortable."
Wilma Mohr, Passive House resident in Darmstadt since 1991

The Hanssen-Höppener Passive House (Rongen Architekten)

Thermal Comfort:
Air & Surface Temperatures

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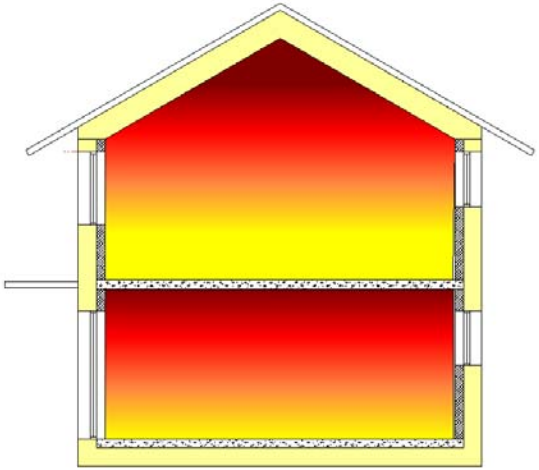
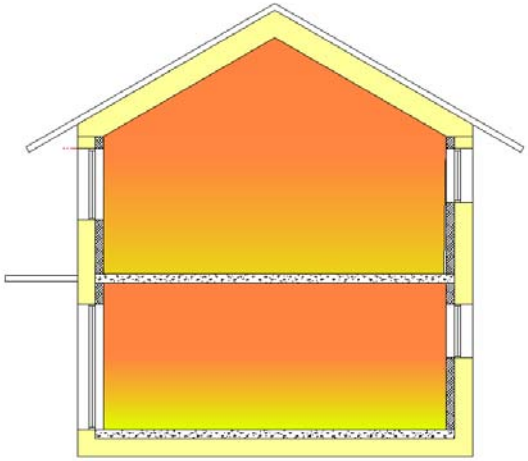
Typical Case



- Stratification
- Clear variation between surface and air temperatures

Passivhaus



- Even temperatures
- Surface temperatures similar to air temperature

Thermal Comfort: Movement of Air

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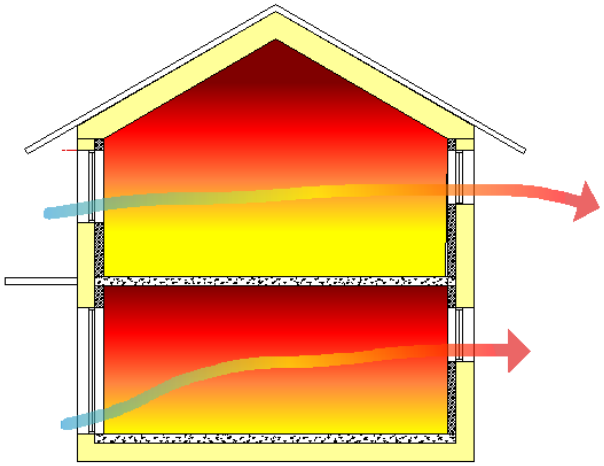
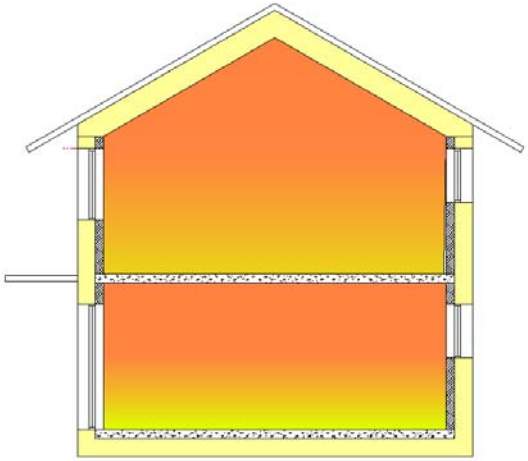
Typical Case



- Feels ‘draughty’
- Heat loss through infiltration can be over a 1/3rd of total
- Increased risk of interstitial condensation

Passivhaus



- No draughts
- Heat losses through leakage reduced to less than 1/10th of typical case
- Dry building fabric

Comfort & Health: Consistent Air Quality

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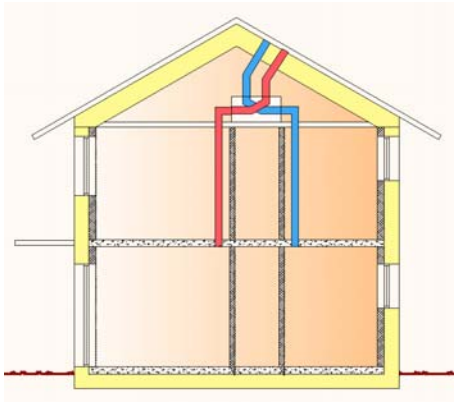

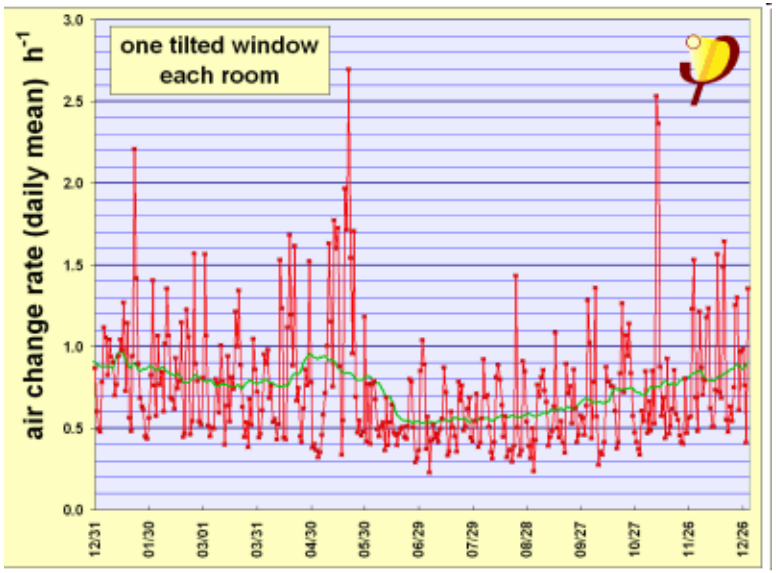

PHI image above from Passipedia
Filter images? / Window vs. MVHR? / Graph of MVHR vs. Nat vent?

Cost of Passivhaus

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Passivhaus in Germany costs around 3% to 8% extra

- Savings from the need for smaller heating and cooling systems
- Greater costs for thicker insulation, better windows and ventilation systems, certified components (especially outside Germany)
- Savings in running costs, especially with rising energy prices
- Financial support available for Passivhaus in some countries

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Passivhaus in the UK

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Denby Dale

- Detached dwelling
- Cavity wall construction
- Budget of £140k

Green Building Company Ltd. & Derrie O'Sullivan

Passivhaus in the UK

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Centre for Disability Studies

- Charity HQ & Offices
- Masonry & Glu-lam
- Articulated form

Simmonds.Mills

Passivhaus in the UK

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Hadlow Agricultural College

- Education building
- Pre-fabricated timber panel construction
- Masonry / slate internal walls and floors

Eurobuild

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Retrofit for the Future project in Balham, London

- Mid-terrace, solid wall
- Mix of internal (to front) & external insulation (to rear)
- Innovative ‘interface’ details

Prewett Bizley Architects

Passivhaus in the UK

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Retrofit of Mayville Community Centre, London

- Overcladding of existing building
- Redesign, new openings and windows
- Aim is to achieve Passivhaus certification

Bere:architects

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Structure

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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)

AECB
the sustainable building association

International
PASSIVE HOUSE
Association
iPHA

Aims & objectives

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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

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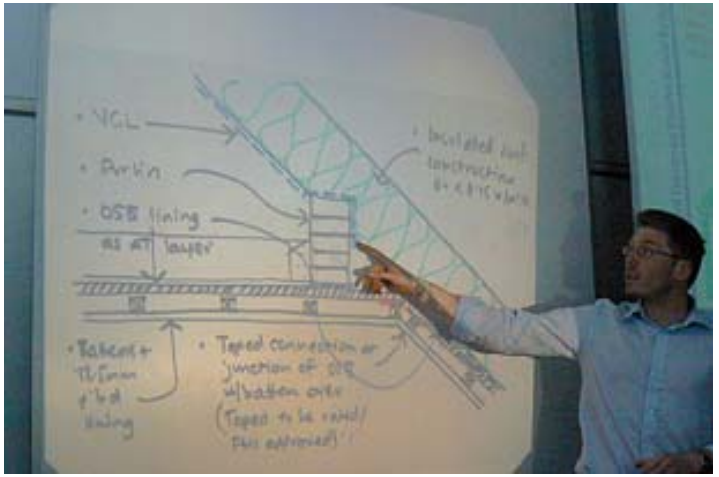
The Passivhaus Trust runs a core programme:

1: Research and guidance

- technical working groups

e.g. UK weather data



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

Founder members

Passivhaus Trust
The UK Passive House Organisation

Architype
Bere:architects
Bramall Construction
Brooks Devlin
EBS Elk Ltd
ECD Architects
Ecology Building Society
Hanse Haus
Hastoe Housing Association
Internorm Windows
ISG Pearce
Isover St Gobain
Kingspan
Knauf Insulation UK
Pilkington
Prewett Bizley Architects
Profine
Scottish Passive House Centre
Willmott Dixon Re-Thinking

ARCHITYPE
bere:architects
Bramall CONSTRUCTION
BrooksDevlin
EBS elk efficient building structures
ECD Architects ENERGY CONSCIOUS DESIGN
Ecology Building Society
HANSE HAUS
Hastoe Group
Internorm FENSTER • WINDOWS • FINESTRE • FENÊTRES
ISG Pearce
ISOVER SAINT-GOBAIN Your environment. It's the nature of our business.
Kingspan Insulation
KNAUF INSULATION it's time to save energy
PILKINGTON NSG Group Flat Glass Business
prewett bizley architects
profine INTERNATIONAL PROFILE GROUP KÖMMERLING KBE
SPHC Scottish Passive House Centre
WILLMOTT DIXON

Join the Trust

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