

# Passivhaus a route to carbon neutral – case study

**SCALA/SCHEME/CLAW**

Study Day 2009 Achieving a Low Carbon Environment - Fact From Fiction



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- Construction Procurement & Premises Manager

Powys County Council



# Dyfi Valley Path Finder



**Canolfan Hyddgen**  
**Passivhaus Case study**



# Main Points

- Project drivers
- Passivhaus Principles
- Application at DVPF
- Carbon Neutral proposal
- Cost
- Conclusion



# Project drivers

- WAG DCELLS (Education) & Powys County Council; joint funded
- objective
  - create a single building for key providers in education, training & access to services in the Dyfi Valley.
  - bring together various agencies, Powys Customer Services, Powys Training, Telecentre, school post 16 training under one roof
  - allow rationalisation of other properties
- Program: project initiated in August 2007  
WAG grant of £750k expended during financial year 2007/08
- building to achieve BREEAM Excellent



# Project drivers

- Powys County Council - Carbon Management Programme
- Targets Co2
  - reduction of 30% by 2012 and 50% by 2017
- Potential cumulative carbon saving of 39,000t and a financial saving of £7.8m over the next 5 years
- Beacon project
  - Demonstrate how the Council wants to meet its Carbon targets and show the community how to Low Carbon buildings

# Procurement

- PCC Project Manager
- John P. Williamson
  - JPW Sustainable Architectural Design  
Passivhaus Consultancy
- Design & Build – local contractor
- Target price NEC form
  - allow design to develop and meet program demands



# Breeam

- Passivhaus & Breeam Excellent Certification
  - First time in UK that both standards have been applied simultaneously
- Breeam Excellent Certification Score of 84.43% (2006 version offices)
- Short listed for BRE award this year
- Subject of another presentation



# Passivhaus Principles



**PASSIV  
HAUS  
INSTITUT**

- “Passivhaus concept” was **conceived 1980's** to develop low-energy buildings to meet the reduced energy standard for new buildings in Sweden and Denmark.
- was developed in May 1988 by Professor Bo and Wolfgang Feist during a research stay at the University of Lund/Sweden.
- validated at Darmstadt Germany, 'Economical Passive Houses Working Group' and the **Passivhaus Institute was founded in 1996**, by Dr. Wolfgang Feist, as an independent research institution.



# Passivhaus Principles



**PASSIV  
HAUS  
INSTITUT**

- 2007 - 8,000 Passivhaus buildings certified (from CH to S).
- BRE is registered with the PassivHaus Institut Darmstadt to issue PassivHaus Certificates.
- Certification to ensure that the proposed design performs as expected - in terms of the heating strategy, occupancy comfort and building maintenance.
- [www.passivhaus.org.uk](http://www.passivhaus.org.uk)
- <http://www.passiv.de/>



# Passivhaus Principles

## Five basic Principles

1. Super insulation, air tightness, minimal thermal bridging
2. Combine efficient heat recovery & supplementary air heating
3. Passive solar gain
4. Efficient electrical appliances
5. Energy demand met with renewable energy systems



# Passive House Qualities – five basics

thermal insulation:

$$U \leq 0,15 \text{ W/(m}^2\text{K)}$$

$$U_w \leq 0,8 \text{ W/(m}^2\text{K)}$$

without th. bridges

mech. ventilation system  
with heat recovery  $\eta \geq 75\%$

outside air

waste air

avoid thermal

bridge effects

$$\psi_s \leq 0,01 \text{ W/(mK)}$$

air tight envelope:

$$n_{50} \leq 0,6 \text{ h}$$

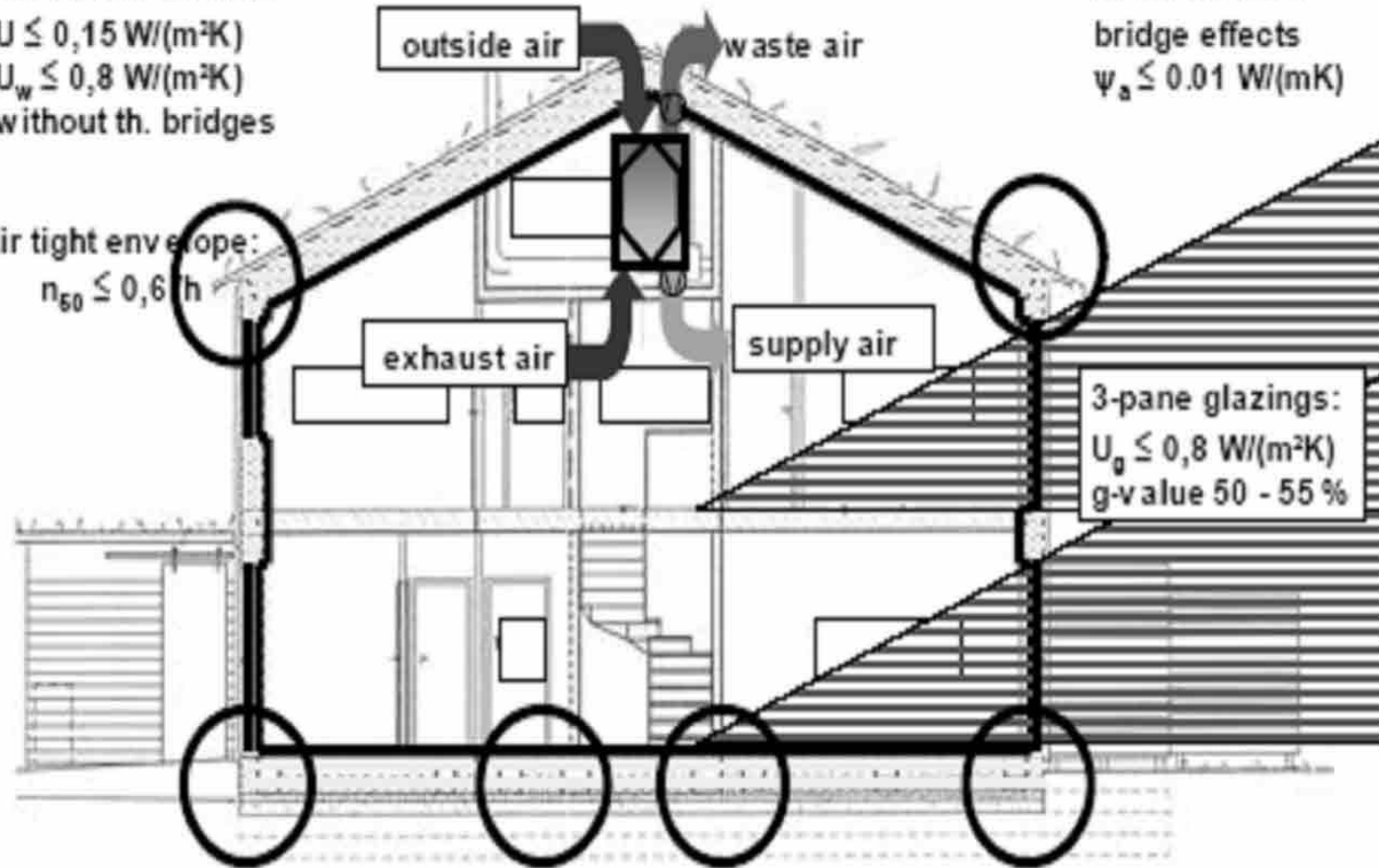
exhaust air

supply air

3-pane glazings:

$$U_g \leq 0,8 \text{ W/(m}^2\text{K)}$$

g-value 50 - 55 %



# Passivhaus Principles

- space heat requirement is reduced by means of passive measures
- there is no longer any need for a conventional heating system
- the air supply system distributes the remaining heat requirement



# Passivhaus Energy Targets

- **space heat requirement must not exceed 15 kWh/(m<sup>2</sup>/a).**
  - less than 20% of energy requirement mandated by the building regs
- **Total Primary Energy Use must not exceed 120 kWh/(m<sup>2</sup>/a).**
  - (Appliances, lighting, Ventilation, Pumps, DHW)
- **Average Heat Load 10W/m<sup>2</sup>**
  - New Build to UK Building Regs averages **100W/m<sup>2</sup>** (winter heat load)



# Passivhaus Principles

- space heat demand in cold season is the major energy consumer
- minimize heat loss
- Efficient electrical appliances
- **Low energy = low carbon**

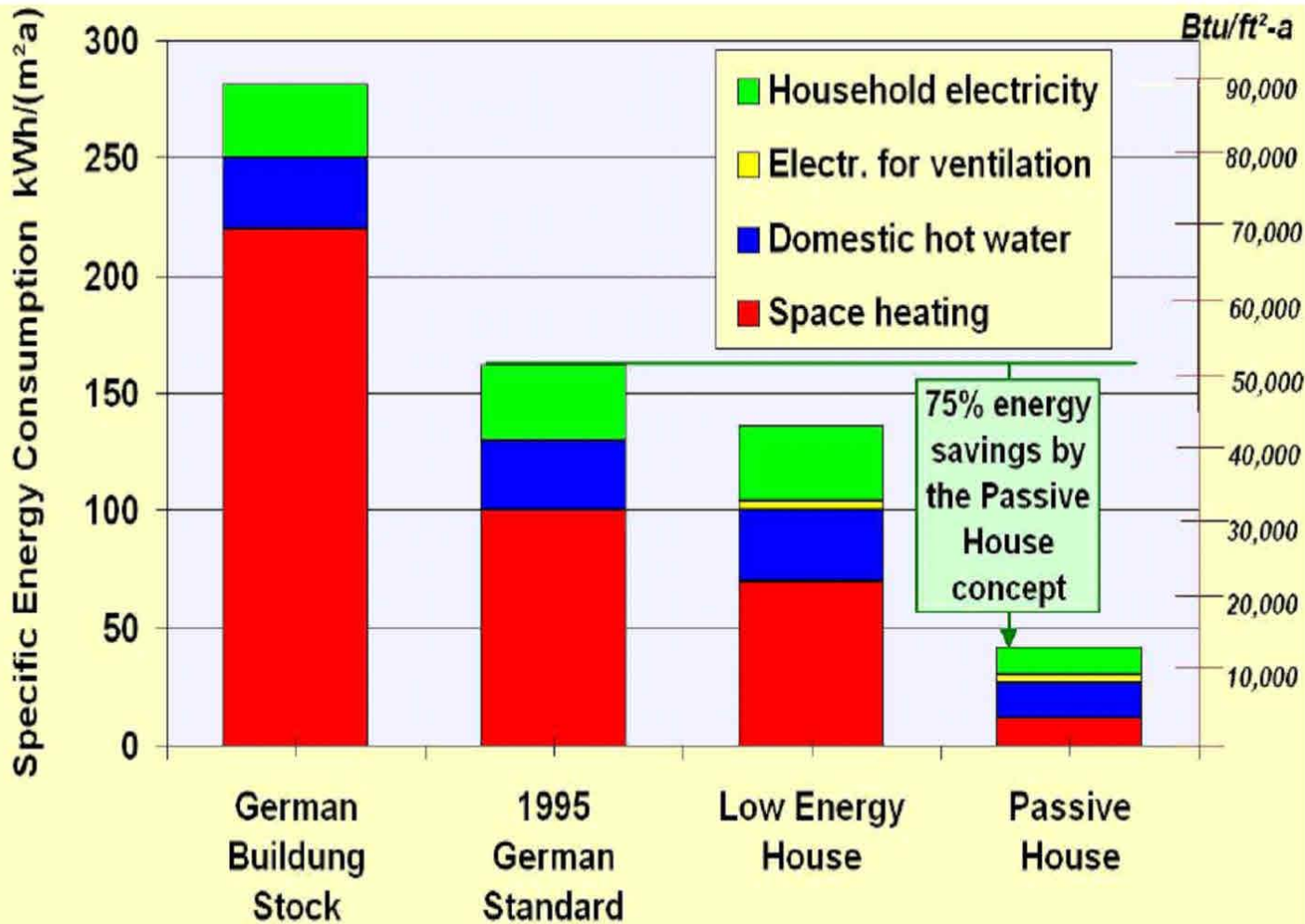
Passivhaus

less energy - more comfort

space heat  
requirement is  
reduced by up to  
**85%**



# Energy Savings comparison German Housing Stock



# Dyfi Valley Path Finder



**Canolfan Hyddgen**

**Passivhaus Principles in practice**



# Super Insulation / Air tightness



Exceptional thermal envelope preventing thermal bridging and air leakage  
200mm of warm cell in frame  
300mm slab insulation



# Super Insulation / Air tightness



Attention to detail by  
the contractor!



# Super Insulation / Air tightness

## DVPF Result

**n50 = 0.249** -1 @ 50Pa (Passivhaus requirement is 0.6)

**Q50 = 0.37** m<sup>3</sup> /(h.m<sup>2</sup> ) @ 50Pa (UK measurement)

## Air tightness Standards Comparison for UK

Bldg Regs - L2A UK Assumed air leakage provided TER is achieved using NCM (under 500m<sup>2</sup>) **q50=15** m<sup>3</sup> /(h.m<sup>2</sup> ) @ 50Pa

General non domestic & domestic **q50 = 10** m<sup>3</sup> /(h.m<sup>2</sup> ) @ 50Pa

Best practice for mechanically ventilated **q50 = 3** m<sup>3</sup> /(h.m<sup>2</sup> ) @ 50Pa

EST (energy saving trust) Advance Practice **q50 = 1** m<sup>3</sup> /(h.m<sup>2</sup> ) @ 50Pa



**Powys**

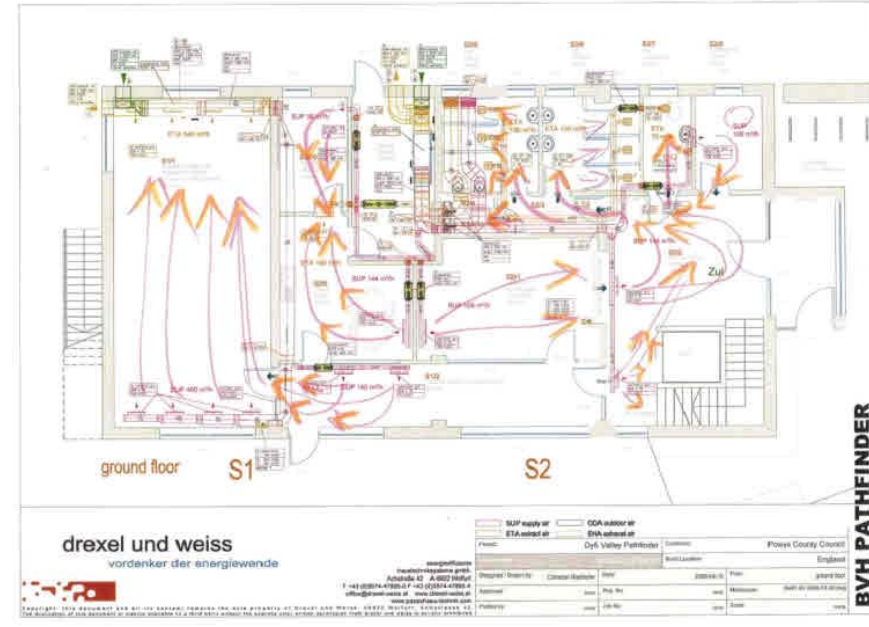
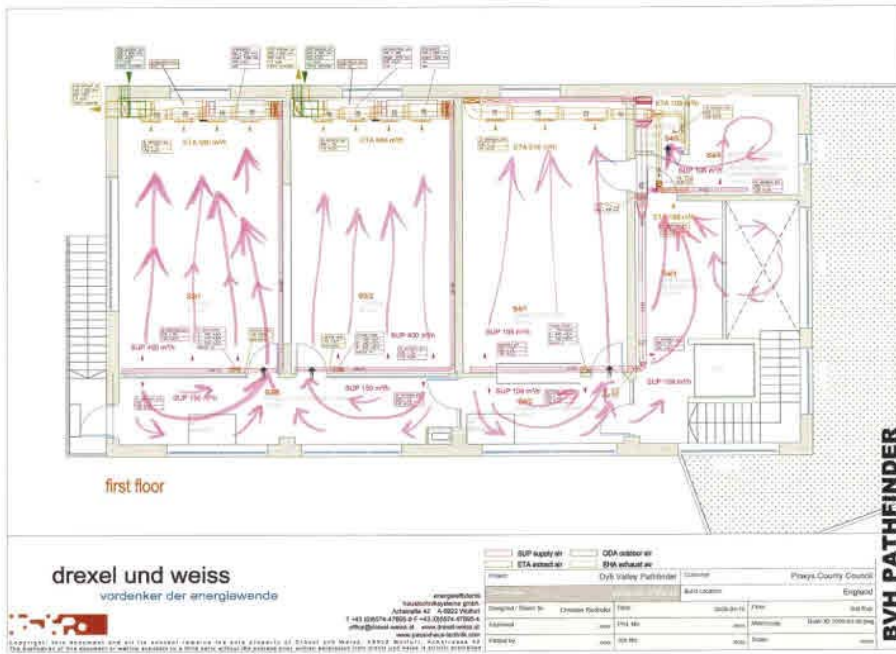
# Combining efficient heat recovery with supplementary heating



Optimized continuous supply of fresh air.  
Excellent indoor air quality. Supplementary heating when required. PLUS overnight free cooling!



# Combining efficient heat recovery with supplementary heating



Drexel und Weiss – air flow schematic



# Passive Solar Gain



North elevation small windows to reduce heat loss. Plant & IT server rooms & toilets on north elevation

Windows provide approx 1/3 of heat demand via solar gain. Triple low E glazing in super insulated frames produce a positive energy balance. Enhanced by un-shaded south orientation.



# Passive Solar Gain



Thermal mass in super insulated air tight frame  
Shading to internal windows

**Powys**

# Efficient electrical appliances



Control systems  
Central power down  
overnight – power,  
water heaters,  
ventilation



A challenge for end  
users & ICT depts!



# Energy demand with renewable energy systems



PV array 7kw  
Designed to meet  
minimum 15% of  
electric consumption



# Energy demand with renewable energy systems



Carbon Neutral  
Proposal

Working with JPW,  
Dulus & Cat  
Offsite wind generation  
Turbine 20-40kw



# Cost

- Pathfinder 410m<sup>2</sup>
- Basic building £1537/m<sup>2</sup>
- incl PV's & green roof £1721/m<sup>2</sup>
- incl PV's & green roof & canopy £1784/m<sup>2</sup>
  
- BRE & Faithful & Gould report, dated Sept 2008, stated benchmark
- Secondary school of 3116m<sup>2</sup> to meet Part L2 Building Regs cost £1711m<sup>2</sup>
- Addition to meet Breeam Excellent £1789 to £1858m<sup>2</sup>



# Programme

- August 2007; initial discussions with designer
- Handover October 2008
- Open to public early Jan 2009
- Official opening 26<sup>th</sup> March



# Design Considerations

- Elements must be combined & considered in detail to produce a **holistic outcome**
- Successful Passivhaus projects have adapted to **traditional** regional construction practices and **vernacular styles**
- Passivhaus Construction Method in Germany
  - 70% Masonry
  - 15% Concrete
  - 15% Timber
- Passivhaus house Construction Method in <sup>Austria</sup>
  - 80% Timber Frame
  - 20% Concrete & Masonry



# Design Considerations

- **Designers need to consider local Climatic conditions**
- PH solutions must be adapted for each territory and climate under consideration.
  - UK - warmer winters, less direct solar gain  
cloudier skies in winter
- PH solution can be soundly applied independent of the geographic and climatic circumstances with careful planning.



# Conclusion

- Excellence Wales Awards 2009
- OUR FUTURE- Responding to Climate Change
  - Sub Theme: *Reducing our Carbon Footprint*
- Awarded Commended Status
- Dyfi Valley Pathfinder Project
  - *example of Powys CC reducing it's Carbon Footprint*



# Conclusion

- **Accreditation by Passivhaus Institute**
- **Offices; first in UK**
- **Short listed for BRE award**
- First time In UK that both standards have been applied simultaneously



# Conclusion

- Powys has gained a significant asset
  - in terms of environmental credentials and a benchmark model for future building projects.
- scheme has brought together various agencies under one roof
- Project has demonstrated that Breeam Excellent can be achieved working with a limited budget and to compressed time scales.





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JPWC-ECO-JW13



ASSOCIATION FOR  
ENVIRONMENT-CONSCIOUS  
BUILDING



FSC  
FSC Supplier

SA-COC-0975 JPW

# Thanks

John P. Williamson

**jpw**

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jpw Construction Ltd



COLDER AT THE WEEKEND...

Shall we ask some friends round to keep the room temperature up?

# Conclusion

- Thank you
- Questions

