House Insulation

For Open Eco Homes – Cambridge Carbon Footprint
Solid Wall Insulation – follow-up to house tours
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An energy-saving economy

- UK energy security
- Cuts carbon emissions from building stock
- Cuts costs
- Lower energy bills
- Warmer, more comfortable homes; well being
- Attacks fuel poverty

http://www.innovationresearchfocus.org.uk/Issues/100/IRF100_BIS.html
Heat losses

www.selfsufficiency4u.com
Building Regs U-Values

Table 3  Upgrading retained thermal elements

<table>
<thead>
<tr>
<th>Element†</th>
<th>(a) Threshhold U-value W/m²K</th>
<th>(b) Improved U-value W/m²K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well – cavity insulation‡</td>
<td>0.70</td>
<td>0.35</td>
</tr>
<tr>
<td>Well – external or inner insulation°</td>
<td>0.70</td>
<td>0.38</td>
</tr>
<tr>
<td>Floor‡</td>
<td>0.70</td>
<td>0.25</td>
</tr>
<tr>
<td>Processed roof – Insulation at ceiling level</td>
<td>0.26</td>
<td><strong>0.16</strong></td>
</tr>
<tr>
<td>Processed roof – Insulation between rafters</td>
<td>0.26</td>
<td><strong>0.16</strong></td>
</tr>
</tbody>
</table>

1. “Roof” includes the roof sections of cavity and solid walls, including the facings thereof, of thermal elements.
2. The figures quoted in column (b) are to be multiplied by the following factors to allow for the reduction in the U-values due to the provision of insulation in the gap between the rafters and the roof:
3. A saved U-value may be appropriate where using such an insulation results in a reduction of more than 10% in the internal face area of the room bounded by the wall.
4. This is the outside face of an external wall, or the inside face of an internal wall, excluding the face of the cavity or solid wall, as appropriate.
5. A saved U-value may be appropriate where using such an insulation results in a reduction of more than 10% in the internal face area of the roof.
6. A saved U-value may be appropriate where using such an insulation results in a reduction of more than 10% in the internal face area of the room bounded by the wall.
7. A saved U-value may be appropriate if there are particular problems associated with the insulation capacity of the frame or the structural height.

www.thinkinsulation.co.uk
1.4 Insulation Note

The choice of suitable insulation that is dictated by factors such as price, thickness, personal choice, locations and build fabric - space, risk and price.

A balance needs to be struck between the final choice will all be decided at the specification stage. To make that a simple choice and to allow relatively easy comparison of materials we usually model one insulation type but have provided the table below for you to translate what this would mean if other insulation materials are chosen.

<table>
<thead>
<tr>
<th>Insulation Group</th>
<th>Products</th>
<th>K Value (W/mK) (lower means higher insulation)</th>
<th>Characteristics</th>
<th>Types</th>
<th>Installed Price guide</th>
<th>Thickness Index multiplier compared to group R</th>
<th>M</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Aerogel</td>
<td>0.013</td>
<td>vapour diffuse</td>
<td>Native, Chipboard or plasterboard backed</td>
<td>£££££££</td>
<td>0.65</td>
<td>0.34</td>
</tr>
<tr>
<td>R</td>
<td>Rigid foam board</td>
<td>0.020 - 0.22</td>
<td>hygroscopic</td>
<td>Native, Foil or Plasterboard backed</td>
<td>££££</td>
<td>1</td>
<td>0.53</td>
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<tr>
<td></td>
<td>- PIR</td>
<td></td>
<td>hygroscopic</td>
<td>affected by liquid water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Phenolic</td>
<td></td>
<td>hygroscopic</td>
<td>affected by liquid water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>Polystyrene (XPS)</td>
<td>0.035</td>
<td>vapour diffuse</td>
<td>Native Beads are loose fill but usually bonded on fitting</td>
<td>£££</td>
<td>1.75</td>
<td>0.92</td>
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<tr>
<td></td>
<td>(expanded)</td>
<td></td>
<td>hygroscopic</td>
<td>not affected by liquid water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- EPS</td>
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<td>hygroscopic</td>
<td>affected by liquid water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(expanded)</td>
<td></td>
<td>hygroscopic</td>
<td>closed cell</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- minerals</td>
<td>0.038</td>
<td>vapour diffuse</td>
<td>Quilt or batts Vermiculite is loose granules</td>
<td>£ - £££</td>
<td>1.9</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>- glass wool</td>
<td></td>
<td>hygroscopic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- rock wool</td>
<td></td>
<td>hygroscopic</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>- vermiculite</td>
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<td>hygroscopic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>Sheep wool</td>
<td>0.038</td>
<td>vapour diffuse</td>
<td>Quilt or batts Celotex is loose fill</td>
<td>££££ - £££££</td>
<td>1.95</td>
<td>1.03</td>
</tr>
<tr>
<td></td>
<td>Cellulose</td>
<td></td>
<td>hygroscopic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Recycled fabric</td>
<td></td>
<td>hygroscopic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Fibreboard</td>
<td>0.042 - 0.048</td>
<td>vapour diffuse</td>
<td>Native board or hardboard backed</td>
<td>£££££££££</td>
<td>2.15</td>
<td>1.13</td>
</tr>
<tr>
<td></td>
<td>- Wood fibre board</td>
<td></td>
<td>hygroscopic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Thickness Index Multiplier** - both because we are independent of product manufacturers and this is not a specification document we usually model insulation measures using R and M as they are commonly available. You can use the last two columns to give a rough thickness translation to other material groups to understand what thickness would be required to achieve the same savings.
Ventilation & condensation

Room-in-the-roof design, showing ventilation requirements

help.tradingdepot.co.uk
Spray foam insulation

http://www.londoninsulation.co.uk/case-studies
Passiv Haus insulation

N.B. Passiv Haus retrofit = EnerPHit
Wall construction

- Cavity wall after c 1940
- Solid wall fair-faced brick √
- Solid wall rendered exterior √
- Concrete panel (post-war)
- Timber frame
- Steel frame


http://www.which.co.uk/
Insulation types
For existing solid walls

• External

• Internal

• Materials:
  - Impermeable (standard petroleum-based)
  - Hygroscopic (water responsive)
External Wall Insulation

Open Eco Homes

house

Ascham Road

BEFORE

AFTER
External wall insulation – EWI - pros

- Less disruption to occupants, as work done outside

- Uses thermal mass of house walls to temper internal temperature – cool in summer, holds heat in winter

- Walls stay warm and dry

- Good if at home much of the time

- Less concern for off-gassing, flammability > 4 stories

- Less concern about moisture trapped in wall, especially if hygroscopic materials used, eg wood fibre insulation

- New windows can be fixed in new insulation zone at external edge of existing wall
EWI - cons

- Must get Planning permission if appearance changed
- Must extend roof eaves and verges, window cills and heads
- External pipes: must be moved; if they interrupt the uniformity of the SWI “coat” a “cold bridge” will be created.
- Existing climbing plants, shrubs
- Need different material below damp-proof course: XPS insulation or plinth
Other environmental features

- Flow restrictors on taps, and dual flush toilets,
- large water butt (500L) to collect rain water,
- low energy lighting with numerous LEDs fitted,
- small glazing areas to north facing elevations,
- thermal mass to substructure, floors and features,
- ballasted brown roofs,
- native flower pocket habitats to support bees, butterflies and wildlife.

Overall we achieved 59% performance improvement on then current building regulations for emissions.

Professional Contacts

Architect: Gavin Langford Architects  
www.gavinlangfordarchitects.com 01223 847200
Builder: Britannia Build  www.britanniabuild.com 01953 666680
Structural Engineer: Haskins Robinson Waters  
www.engineers-hrw.co.uk 020 74079575

Products

- Biodiversity: pocket habitats on flat roofs,  
  Grey 2 Green  www.grey2green.co.uk
- Wood stain: Osmo natural Oil
- Flat Roofs: Evalastic membrane
- Pitch Roof: CEL Ltd Rheinzink zinc
- Floors: Forbo Marmoleum acoustic; Reeve oiled oak  
  and Stonell basalt, honed and sealed
- Timber Cladding: Vincent Timber, sweet chestnut

Insulation

- Roof and Walls: Excel Warmcell, Excel PaneVent,  
  Natural Building Technologies Perivewl
- Timber framed cavities 200mm, flat roofs 280mm;
- Pitched Zinc Roof 260mm
- Floor Insulation Celotex

Windows and doors – triple glazed throughout

- External doors and windows: Green Build Store  
  Internal doors: Bridgeman Doors
- Pitched Roof Windows; Velux
- Flat Roof Lights; Glazing Vision

Heating system

- MVHR system: £6500
- Underfloor heating: thermostats in each room,  
  controlled centrally from service cupboard £8500
- Condensing boiler: £2000

Generators: Ivett & Reed HWAM Vivaldi 4.5Kw  
www.hwam.com £2500

- Passive solar gain: South facing windows and roof lights
- Photovoltaic panels
Internal Wall insulation

- Standard impermeable

During internal insulation:
- Foil-backed Celotex
- Between timber studs

During internal insulation:
- Plasterboarding
- Sills & skirting to do

See Open Eco Homes 2012 data sheet
Internal Wall insulation (fossil fuel standard) – pros

- Air is heated, not mass of walls
- May suit people who are out all day
- High performance U-Values to thickness
- Logical for terraced property: only front and back walls
- Planning is not usually an issue
Internal (standard) - cons

- Disruption: joinery trim, electrical. Electrical cables must not be buried in insulation or they overheat.

- Window reveal detailing to be redone.

- Loss of floor space, especially detached houses, where rooms may have two or three external walls.

- Vapour barrier behind wall finish – this is HIGH RISK – cannot monitor if punctured.

- External and internal moisture: wall stays cold; extreme weather can soak mortar.

- HIGH performance but HIGH risk.
Bathroom insulated on 2 walls: Pavadentario wood fibre 100mm Aerogel insulation 10mm

Open Eco Homes 2013
Internal Hygroscopic – when to consider?

- Buildings in region of heavy rainfall (cf Joseph Little, architect in Ireland)
- Exposed sites: horizontal rain gets in mortar joints
- Existing buildings with wall dampness problem: RESOLVE
- Historic buildings: unknown conditions & less insulation may be acceptable
- Wet rooms with poor ventilation, incremental renovations
- When DIY might be an advantage
Floor insulation

**Suspended floor**

- Floor insulation
- Insulate between last joist and wall.
- There is insulation in the drylining.

**Solid floor and wall**

- Insulation goes up to drylining

**Solid floor, cavity wall**

- Insulated cavity wall.
- Edge of ring beam is insulated and joins insulation underneath exposed concrete.

www.superhomes.org.uk
Floor insulation – Under-floor heating

www.myson.co.uk
Summary

- **Choice of insulation material**: balance between SPACE - RISK – PRICE

- **Position of insulation**:
  - Occupancy: work at home vs out all day
  - House type: terrace vs detached
  - Disruption: internal walls and floor

- **Whole House Strategy**

- **Cost**
  - DIY
  - Phased works
Next Steps

- **Information**
  - Open Eco Homes – tours & archives
  - Transition Energy Group website FAQs
  - Books /web/ Join AECB (Assoc Envirn Consc Bldg)
  - Work out your own gas & electricity use in kWh/ metre² from bills and measured plans

- **Assessment:**
  - EPC (Energy Performance Certificate)
  - Cosy Action Plan
  - Parity Projects HEMP / RetrofitWorks
  - Carbon Co-op – Manchester-based

- **Builder advice and quotes**
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- Hand-outs available

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New windows
At edge of
Solid Wall Insulation
opportunity, with the flat surface that has been included, for water pooling and potential penetration.

Cold bridge
Evaluation Warm Wales p. 26
Action on Energy show home takes shape in time for winter

Action on Energy, the council led scheme that provides funding to make houses more energy-efficient, now has its first show home on Coleridge Road, to help demonstrate the benefits of solid wall insulation.

The property, which is owned by Kim and Charlie Brown, a four-bedroom semi-detached home of solid wall construction (typical of 1940s houses), will have refurbishments that are already in place.

Having visited many open eco-homes around Cambridge over the last few years, Kim and Charlie had gathered invaluable information and inspiration on how to make their home warmer and more energy efficient.

Kim said: “The one thing we have always struggled with is heat loss through the external wall, so as soon as we heard about the solid wall insulation offer we absolutely jumped at the chance to apply.

“The thought of having a warmer home that was also healthier for the environment was at the top of our list. Obviously we were looking for lower utility bills too. We were confident to go ahead with this scheme as it was a joint council initiative.”

Technical survey

After a assessment and technical survey of the property, Kim and Charlie chose to have internal wall insulation fitted. They were told to colour match the new render with the existing render and brick detail around the downstairs so the new render blends in well with the decorations.

The house is not in a conservation area, and the new external finish is of a similar appearance to the original. This means the work was considered by the council as an improvement to the property and so did not require planning permission.

Some neighbours, who are existing homeowners, were a bit of a burger alarm and a twin so had to be moved before the high performance insulating layer could be installed to cover the entire solid wall area. This was followed by several layers of render and render to give a durable and attractive finish.

The house currently the attention when the ‘refurbishment support has inspired several neighbours to consider adding solid wall insulation to their own properties. Kim commented: “On the first day insulating went up and then the outside house was covered in polyurethane boards, I am amazed at how much can be done in a day!”

A warmer home

Having had their insulation installed, Kim and Charlie will now find their home to be warmer and more comfortable – as the heat produced in their home will now leak quickly to the outside. This drastically reduces the insulation, and in addition replacing the boiler has increased their house energy performance certificate rating, and will reduce their fuel bills.

The insulation job cost less than £2,000, which included removing and extending

Brick finish (Wetherby)

Coleridge Road show home
External wall insulation – future

- EWI is now being rolled out all over the UK

- BRE Wales (Colin King) is completing a study of EWI, including warnings about bad practice, and good details - due out “by June,” publicly available either from the BRE or through DECC

- Available through the Cambridgeshire Action on Energy Green Deal Solid Wall Insulation fund.

- Open Eco Homes, Cambridge Carbon Footprint have 42 Open Eco Homes information sheets available online, and more on show next September.

- Transition Cambridge Energy Group FAQs on webpage
**IWI – hygroscopic - pros**

- **NATURAL:** Woodfibre, cork, sheeps wool (moth treated) = hygroscopic (absorbs moisture in fibre itself, still holds insulating air between these fibres); plentiful supply
- Permeable clay plaster or lime plaster
- Tempers internal humidity: Absorbs moisture from warm room air at high humidity and returns it to room at low humidity
- Allows moisture penetrating from exterior (eg damp wall or heavy rain in mortar joints) to dry on inner wall face
- Can wick moisture to the surface with capillary action
- Can be carried out DIY and for incremental work
IWI - hygroscopic – cons

- Insulation level lower for natural materials: generally 100-150mm max thick
- Must use breathable paint now & future
- High cost – depends on market demand - growing
- Empirical tests still being done
- Mineral insulation cost extremely high
- Not yet included in Green Deal funding - TBC
insulating envelope (yellow)
Insulation: occupancy, density & leakage

- Occupants: When are you home?
- Density: Can you make use of heat absorption?
- Air leakage: Controlled ventilation and heat exchange, along with all sealing of drafts