CASE STUDY

Low Energy Whole House Refurbishment

CHALLENGE

In early 2009 Knauf Insulation undertook a project to internally insulate an 1890's Victorian mid terrace property to current energy standards. The aim was to install systems that could be undertaken by any competent builder to achieve an effective and efficient low energy refurbishment at a modest marginal cost over a normal refurbishment. The attractive brick frontage made the property less suitable for external wall insulation (EWI) but ideal for Knauf Insulation's Internal Wall Insulation (IWI) system using their patented EcoStud as a replacement for the more traditional timber stud framing. To provide a side by side comparison, a Knauf Insulation insulated metal stud system was also installed in part of the property.

This private rental property had been damaged by a tenant and required renovation. Knauf Insulation assisted the landlord and his builder to enable a 'whole house - low energy', refurbishment to be undertaken with an emphasis on a low marginal cost.

Survey Summary		
	Observation	**Comment**
Walls - solid	No insulation	Very poor
Floor	No insulation	Poor
Loft	100mm	Inadequate
Boiler	New condensing	Very good
Heating controls	TRV's	Good
Windows	Double glazed	Adequate
Doors	UPVC	Adequate
Lighting	Incandescent	Very poor

Mid-terraced house, Doncaster
A low cost 'whole house' low energy refurbishment - 1890's Victorian mid terrace to current energy standards.

Using the standard trade skills held by a general builder this was a 'whole house low energy' refurbishment at a modest marginal cost compared with 'business as usual'.

An attractive brick frontage made this property ideal for Knauf Insulation's innovative glasswool internal insulation systems coupled with suspended wooden floor / loft insulation and low energy lights.

The reduction in floor area was less than 2% and an estimated £2,800 was added to the renovation costs (excluding one off training and instrumentation).

Even though the property already had 'better than average' energy efficiency, the low energy upgrade delivered:

- Reduced CO_2 emissions by 1.80T per year
- Reduction of 52% in CO_2 emissions, excluding appliances
- SAP rating increased from 63D to 82B
- Energy savings of approx £400pa
- Increased resilience to fuel price rises
- Improved comfort

Better still, it is readily replicable across millions of similar homes across the UK.

Fig 1

Fig 2

Fig 3

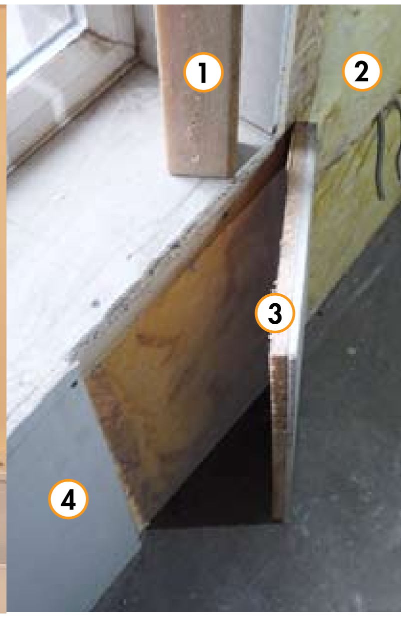


Fig 4

Photographs of refurbishment sequence and system components.

INTERNAL WALL INSULATION

Figure 1 shows Stage 1 with all fixtures removed and the plaster removed back to the original 225mm thick brickwork, although in most cases the EcoStuds would be affixed through the existing plasterwork.
Figure 2 shows Stage 2 with the new EcoStud mechanically fixed to the brick wall and 75mm of EcoBatt friction fitted between to ensure a complete coverage of insulation across the whole wall.

Figures 3 and 6 show Stage 3 with the 12.5mm vapour check plasterboard fixed to the EcoStud framework in the bathroom and the living room. The overall reduction in floor area was less than 2 per cent.

THE SYSTEM (fig 4)

1) **EcoStud** which has an overall size of 50mm wide x 75mm deep x 2400mm long to replace a typical size of timber stud. This comprises Polyfoam extruded polystyrene laminated to Oriented Strand Board (OSB). EcoStuds were mechanically fixed to the wall with the OSB facing into the room using 130mm screws and plugs, a minimum 40mm fixing penetration into the wall is required.

2) **75mm thick EcoBatt** water repellent glass mineral wool slab with a thermal conductivity of 0.032 W/mK friction fitted between the EcoStuds to ensure intimate contact between the inside of the wall and the back of the plasterboard thereby preventing unwanted air movement and draughts through the system.

3) **27mm Polyfoam Linerboard**, a laminate of 17.5mm Polyfoam extruded polystyrene and 9.5mm Knauf plasterboard fitted around all window and door reveals to limit cold bridging and surface condensation. 27mm Polyfoam Linerboard was also installed at all party wall junctions to a minimum width of 400mm and the full height of the rooms in order to prevent heat loss and the potential for condensation and mould growth in internal corners.

4) **12.5mm vapour check plasterboard** attached to the OSB of the EcoStuds using 25mm drywall screws with all edges sealed with Knauf Multi Purpose Sealant to prevent air movement behind the wall lining reducing the thermal performance of the installed system. Knauf Insulation also used the alternative Knauf metal framing system at the front of the property to assess suitability and timing of the two installations.

Both the Knauf Insulation IWI system and metal system resulted in an improvement of the U-value from approximately 2.00 W/m^2K to 0.35 W/m^2K, an improvement in thermal performance of almost 80 per cent.

At Doncaster there was little time difference between the installations of both systems, but the Knauf Insulation IWI System proved a more cost effective way to achieve the same level of thermal performance. In total the builder installed 73m^2 of internal wall insulation into the property.

Fig 6

Figure 5 shows the existing 100mm thickness of insulation between the ceiling joists, topped up with a second layer of 200mm Loft Roll.

INTERMEDIATE FLOOR

Insulation was also fitted between the timber floor joists and the external wall to ensure continuity of insulation between the two levels. This eliminates any major thermal bridge through the insulated internal dry lining system.

SUSPENDED TIMBER GROUND FLOOR

The front of the property had a ¾ height cellar above which was the timber floor of the living room. Knauf Insulation took the opportunity of insulating this area from below with 150mm of glass mineral wool friction

Illustration, not actual loft

Fig 5

fitted between the timber floor joists. As the cellar was prone to seasonal flooding, with a high moisture content in the cellar atmosphere, it was decided to use EcoBatt water repellent slab in 2 layers of 75mm to fully fill the 150mm deep floor joists and ensure the insulation was in close intimate contact with the underside of the timber floor boards to eliminate air movement. Figure 7 below shows part of the cellar ceiling.

A new tightly fitting UPVC door was fitted at the top of the cellar stairs to prevent cold air from entering the kitchen area, and as the internal wall to the dining room abutted the cellar atmosphere, it was also insulated with the Knauf Insulation IWI System. At the same time the underside of the staircase to the first floor was battened out and insulated.

SYSTEM MONITORING

In conjunction with University College London, Knauf Insulation have also installed monitoring equipment to enable measuring of the conditions at the interface of the insulation and internal face of the solid wall. Permanent in-situ sensors have been installed in each room to measure relative humidity and temperature and this data is collected in a logger located in the cellar. University College London will work with Knauf Insulation over coming years to measure and interpret the results generated. Sensors were also positioned within the suspended timber ground floor zone and on the cellar wall.

HoBo type sensors were used in each room to measure the internal conditions as well as installing an external HoBo sensor to monitor weather conditions. Figure 8 below shows the set up of the data logger.

The new tenant has agreed to maintain a daily activity log of the use of washing machines etc to inform the project team when high levels of moisture vapour are being generated.

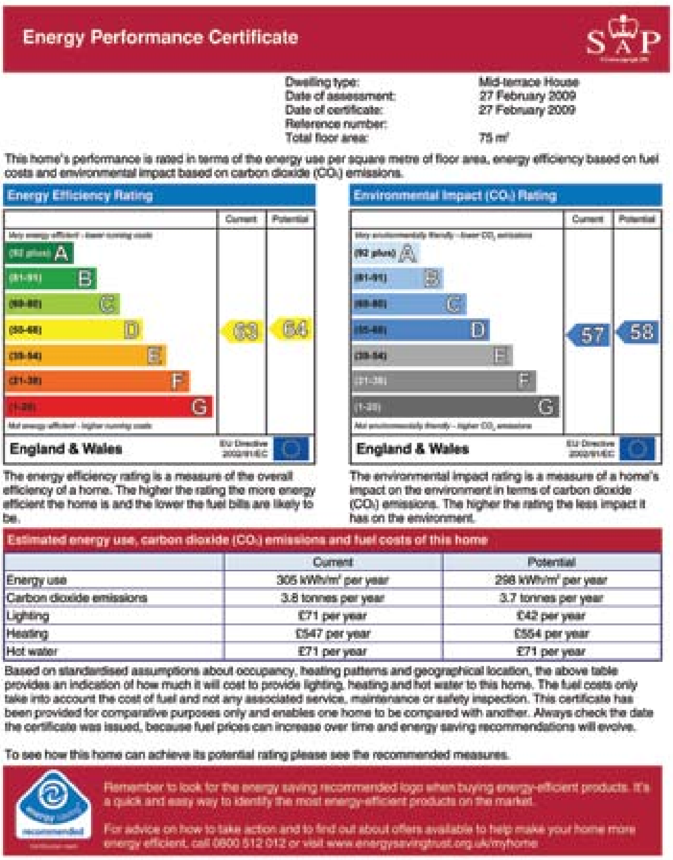
Fig 7

Fig 8

ENERGY PERFORMANCE IMPROVEMENT

The Energy Performance of the property prior to the low energy refurbishment (which had a condensing boiler with radiators in each room, UPVC windows and doors and 100mm of glass mineral wool loft insulation) was SAP 63D with a CO_2 emission rate of 3.80 tonnes per annum, excluding appliances. The property after the low energy refurbishment achieved a SAP 82B with a CO_2 emission rate of 1.80 tonnes per annum, a 52 per cent reduction in CO_2 emissions. The calculated energy savings are approximately £300 per annum, however, based on current fuel costs a figure of £400 would be more appropriate, with greatly improved comfort conditions.

Element	U-values (W/m²K)	
	Before Treatment	After Treatment
Walls	2.00	0.35
Roof	0.43	0.13
Floor	0.71	0.21



Energy Performance Certificate

Dwelling type: Mid-terrace House
Date of assessment: 27 February 2009
Date of certificate: 27 February 2009
Reference number:
Total floor area: 75 m²

This home's performance is rated in terms of the energy use per square metre of floor area, energy efficiency based on fuel costs and environmental impact based on carbon dioxide (CO_2) emissions.

Energy Efficiency Rating — Current: 63, Potential: 64 — England & Wales, EU Directive 2002/91/EC

Environmental Impact (CO_2) Rating — Current: 57, Potential: 58 — England & Wales, EU Directive 2002/91/EC

The energy efficiency rating is a measure of the overall efficiency of a home. The higher the rating the more energy efficient the home is and the lower the fuel bills are likely to be.

The environmental impact rating is a measure of a home's impact on the environment in terms of carbon dioxide (CO_2) emissions. The higher the rating the less impact it has on the environment.

Estimated energy use, carbon dioxide (CO_2) emissions and fuel costs of this home

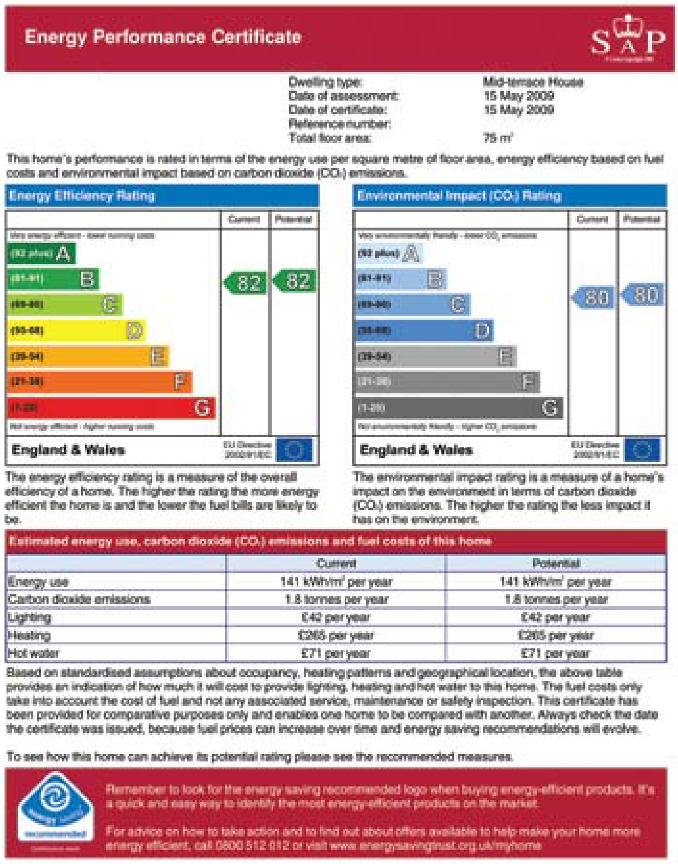
	Current	Potential
Energy use	305 kWh/m² per year	298 kWh/m² per year
Carbon dioxide emissions	3.8 tonnes per year	3.7 tonnes per year
Lighting	£71 per year	£42 per year
Heating	£547 per year	£554 per year
Hot water	£71 per year	£71 per year

Based on standardised assumptions about occupancy, heating patterns and geographical location, the above table provides an indication of how much it will cost to provide lighting, heating and hot water to this home. The fuel costs only take into account the cost of fuel and not any associated service, maintenance or safety inspection. This certificate has been provided for comparative purposes only and enables one home to be compared with another. Always check the date the certificate was issued, because fuel prices can increase over time and energy saving recommendations will evolve.

To see how this home can achieve its potential rating please see the recommended measures.

Remember to look for the energy saving recommended logo when buying energy-efficient products. It's a quick and easy way to identify the most energy-efficient products on the market.

For advice on how to take action and to find out about offers available to help make your home more energy efficient, call 0800 512 012 or visit www.energysavingtrust.org.uk/myhome



Energy Performance Certificate

Dwelling type: Mid-terrace House
Date of assessment: 15 May 2009
Date of certificate: 15 May 2009
Reference number:
Total floor area: 75 m²

This home's performance is rated in terms of the energy use per square metre of floor area, energy efficiency based on fuel costs and environmental impact based on carbon dioxide (CO_2) emissions.

Energy Efficiency Rating — Current: 82, Potential: 82 — England & Wales, EU Directive 2002/91/EC

Environmental Impact (CO_2) Rating — Current: 80, Potential: 80 — England & Wales, EU Directive 2002/91/EC

The energy efficiency rating is a measure of the overall efficiency of a home. The higher the rating the more energy efficient the home is and the lower the fuel bills are likely to be.

The environmental impact rating is a measure of a home's impact on the environment in terms of carbon dioxide (CO_2) emissions. The higher the rating the less impact it has on the environment.

Estimated energy use, carbon dioxide (CO_2) emissions and fuel costs of this home

	Current	Potential
Energy use	141 kWh/m² per year	141 kWh/m² per year
Carbon dioxide emissions	1.8 tonnes per year	1.8 tonnes per year
Lighting	£42 per year	£42 per year
Heating	£265 per year	£265 per year
Hot water	£71 per year	£71 per year

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COST BREAKDOWN

The Knauf Insulation IWI System is a highly cost-effective system for upgrading existing properties to current Building Regulation thermal standards and beyond. The marginal cost of installing the Knauf Insulation IWI System, over and above the work that was required to bring the property up to a decent standard, was approximately £2800. The reduction in energy bills results in the marginal installation costs being re-couped after approximately 7 years based on current energy prices.

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