Salford, Greater Manchester

<table>
<tr><td>Project description</td><td>Whole house retrofit of mid-terrace house, built c.1900.</td></tr>
<tr><td>Treated Floor Area</td><td>70 m^2</td></tr>
<tr><td>Dates of work</td><td>2008 – 2010</td></tr>
<tr><td>Project team</td><td>Myself, along with various sub-contractors for different tasks</td></tr>
<tr><td>Introduction</td><td>House was damp and dark when I bought it, and parts of the house (e.g. the bathroom) were freezing in cold weather. I had to do a certain amount of things anyway since the house was in a fairly bad state (e.g. window frames were rotten), so I found that this was a good time to try to make it better while I was at it. I didn’t know much about energy efficiency or in what order to do things, so I spent some cash on a few books and read up about what I should do, after which I made a do-list and decided roughly in what order things should be done.</td></tr>
<tr><td>Space heating demand & carbon emissions – before and after according to PHPP</td><td>
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<tr><th></th><th>Before</th><th>After</th><th>% reduction</th></tr>
<tr><td>Space heating (kWh/m2/yr)</td><td>299.3</td><td>102.9</td><td>66%</td></tr>
<tr><td>Primary energy (kWh/m2/yr)</td><td>467.3</td><td>200.8</td><td>57%</td></tr>
<tr><td>CO2 (kg/m2/yr)</td><td>107.7</td><td>47.7</td><td>56%</td></tr>
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<tr><td>Fuel use before and after</td><td>No data before, as I had just moved in. Data after retrofit does not give accurate picture due to many periods when house has been unoccupied, especially during cold months.</td></tr>
<tr><td rowspan="3">What improvements done / strategies</td><td>Improvement</td><td>U-values / information</td></tr>
<tr><td colspan="2">Insulation</td></tr>
<tr><td>Bathroom ceiling</td><td>- Polyisocyanurate (Kingspan) 120mm thick friction-fitted in rafters, u-value 0.321 W/m^2K
  </td></tr>
<tr><td>Internal walls (external-facing – i.e. not party walls)</td><td>- Polyisocyanurate (Kingspan) 70mm thick friction-fitted in studwork, u-value 0.372 W/m^2K</td></tr>
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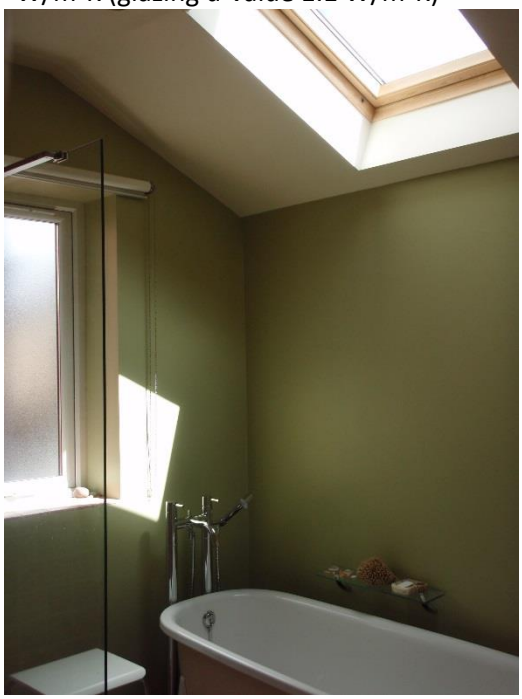
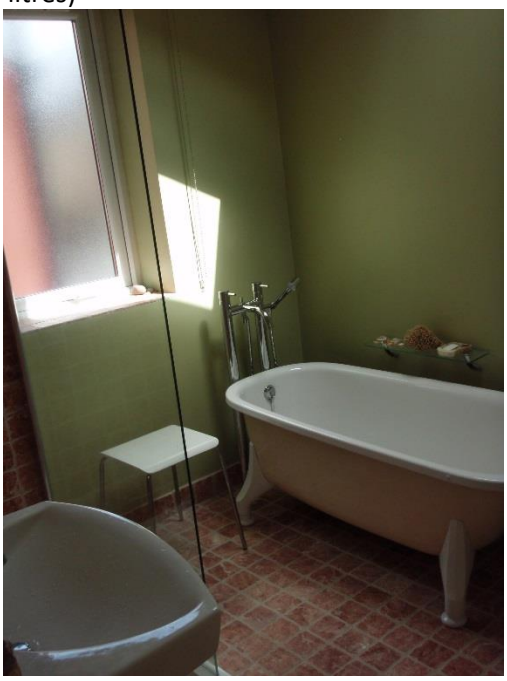
	Suspended timber floor	- Polyisocyanurate (Kingspan) 100mm thick friction-fitted between joists, u-value 0.321 W/m^{2}K 
	Loft	- Mineral wool 270mm thick, u-value 0.149 W/m^{2}K
	Bay window ceiling above French doors	- Polyisocyanurate (Kingspan) 100mm thick friction-fitted between rafters, u-value 0.332 W/m^{2}K

		
	Airtightness	
	Some vapour-impermeable sheeting, combined with use of expanding foam	- Vapour-impermeable polythene sheets used on insulated internal walls and bathroom ceiling, but these were not adequately taped or sealed to create a draught proof barrier - No membrane was used on ground floor – here I only relied on expanding foam - No membrane used on bedroom ceilings – here I used expanding foam to seal up between plasterboards and wire penetrations via the loft space 
	Ventilation	
	Mechanical Ventilation with Heat Recovery (MVHR) unit installed	- Xpelair Xcell-300 unit installed in loft, 91% heat recovery - Air is extracted from kitchen & bathroom and supplied to 2 bedrooms and lounge via 125mm round/rectangular ductwork and 180mm insulated ductwork in the loft space

		- 82 m^3/hour measured flow rate, which is the lowest flow rate possible before fans cut out – which means ventilation rate of 0.45 air changes per hour - Humidity in house varies within the 40-60% range, but occasionally dips below 40% in winter. 
	Doors & windows	
	New windows and doors	- Rehau PVC double-glazed windows and French doors, with 28mm gap argon-filled glazing, u-value of whole window 2.2 W/m^2K (glazing u-value 1.5 W/m^2K) - One Velux wood-framed window in bathroom, u-value of whole window 1.98 W/m^2K (glazing u-value 1.1 W/m^2K) 
	Damp	
	Ground floor & walls	- I had an injected damp course done on the whole ground floor

		- Kitchen floor had to be drilled up and re-laid (rising damp due to inadequate DPM) - Keim Lotexan capillary block added on external face of walls to reduce amount of moisture soaking into the brickwork 
	Crawl space	- Put 4.5 tonnes of MOT (gravel mix) onto the muddy crawl space floor to soak up moisture and deal with mud and unevenness - After that I laid a thick polythene sheeting on top of this to reduce evaporation (cleared up the condensation on windows overnight) 
	Heating system	
	Condensing boiler	- Replaced old boiler with Remeha Avanta Plus condensing boiler
	Radiators	- New radiators throughout, most with TRVs
	Wood-burning stove	- Løvenholm 5kW HETAS-approved smokeless zone stove put into larger chimney breast on ground floor - Appropriate chimney cowl added to stack

		
	Appliances & electrics	
	Appliances	- New energy-efficient washing machine, fridge, freezer
	Lighting	- Low energy CFLs and LEDs in most fittings
	Water	
	Sink, toilet & bath	- Ifö sink, toilet & bath which are designed to save water by design (e.g. toilet flush 2 or 4 litres) 
What would I have done differently?	- Better airtightness using vapour-open materials (e.g. membranes or lime plaster): this was my first renovation, and following advice from a book, my airtightness strategy consisted largely of using expanding foam, which I	

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<tr><td></td><td colspan="3">now know is not an effective strategy. The polythene sheets were also not vapour-permeable, and in any case were not correctly joined together or to walls/floors.
- Wood fibre as insulation for internal wall insulation (avoiding any kind of vapour closed insulation for solid walls), and having WUFI analysis done for the most at-risk wall where u-value would be planned to be under 0.4 W/m^2K
- Proper MVHR design prior to procuring unit, to ensure that a lower flow rate can be achieved that would result in 0.3 air changes per hour in winter (to avoid dry air), also to ensure no air flow noise at terminals
- Insulation for kitchen floor prior to concrete being laid
- Better suspended floor insulation stretegy – given what we now know about risk of moisture in joists, I would have taken the joists out and replaced with a recycled glass aggregate floor followed by a lime screed</td></tr>
<tr><td rowspan="4">Fan test results</td><td></td><td>Air changes per hour</td><td>m^3 / hour / m^2</td></tr>
<tr><td>Test 1: before</td><td>Not carried out</td><td>Not carried out</td></tr>
<tr><td>Test 2: after insulation</td><td>9.34</td><td>7.85</td></tr>
<tr><td>Test 3: after plastering</td><td>6.69</td><td>Not carried out</td></tr>
<tr><td>Cost</td><td colspan="3">£40,000, of which:
- 50% was related to energy efficiency work
- 50% was spent on things like new kitchen & bathroom, knocking walls through, carpets, paint, furniture, etc.</td></tr>
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