Beginner's Guide to Retrofit

Host:
Tom Bragg

Presenters:
Nicola Terry
Margaret Reynolds

Derived from a Carbon Co-op presentation:
To Come:

Poll 1: about you
‘Retrofit in Context’- Nicola
Q&A
Poll 2: your motivations
‘Getting Started’ - Margaret
Q&A
Finish 9pm
Poll 1:

- About you
- What age of retrofit home?
Retrofit in context

- Climate change
  - Decarbonising heating
- Comfort
- General upgrade

Domestic heating and cooking accounts for 60% of natural gas consumption in the UK (excluding powerstations) - or 35% of all gas use.
Open Eco Homes videos: openecohomes.org/video

Peter & Meg’s low-budget retrofit of two 1897 semis
Retrofit is possible...

- Insulation
  - Walls (inside or out)
  - Floors
  - Loft/attic
- Air tightness and ventilation
- Windows and doors
- Heating systems
  - Boiler upgrade or heat pump
  - Radiators/underfloor heating
- Solar panels/battery

Whole house approach takes into account shape and materials for best results without undesirable side effects.

Plan stages to fit your needs and opportunities and avoid wasted effort.
Internal wall insulation

- Messy and disruptive
- Fiddly
  - Windows and doors
  - Radiators and electrical sockets
    - DIY possible
- Combine with redecoration work
Insulation: how thick does it need to be?

Different materials have different properties: thermal resistance, vapour permeability, effect of liquid water.

Diminishing returns - but hard to add more later.

What is your ambition?
External Wall Insulation:
Fiddly downpipes and penetrations, extending roof overhangs
But you do not have to vacate rooms to do it
EWI results
You can do this even in a terrace, if you can get planning permission.
Can mix internal and external.
Decarbonising your heating:
Air source heat pump
Hot water cylinder
Ventilation
Draughts bad, ventilation good - control!
Avoid condensation and indoor air pollutants!
Choices:
- Wall units/Whole house
- Demand controlled/All the time
- Mechanical/passive
- With/without heat recovery
- Filters
Add PV to make a net zero home

Adding Solar Panels, lots of insulation home and an efficient heat pump can achieve net zero over the year. Net zero day by day is much harder.

Modelled electricity use and PV generation by day over a year for a well insulated house with a 4.2 kWp array and heating from a heat pump with nominal SPF 4.0.

Over the year: 3800 kWh generated; 2290 kWh for lighting and appliances, 760 kWh for hot water heating and 1440 kWh space heating. Net use 590 kWh/year. The heat pump uses 2,200 kWh. An equivalent gas boiler would use 6,400 kWh gas.
The Results

Typical living room temperature

Feb-14 Before Retrofit
Feb-15 Post Retrofit
What is most important for me?

<table>
<thead>
<tr>
<th></th>
<th>Bills</th>
<th>Carbon</th>
<th>Comfort</th>
<th>Air quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulation</td>
<td>X</td>
<td>x</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Windows</td>
<td></td>
<td>x</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Heat pump</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boiler</td>
<td>X</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air tightness</td>
<td>X</td>
<td>x</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Ventilation</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Solar panels</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Q&A

Poll 2: What are your priorities?  
Top three motivations
Establishing a **Baseline and Rates:**
- Energy use,
- Floor area
- Costs.

1. How much **ENERGY** do you use now?

• To compare we use a rate:

**kWh** per **Square Meter of Floor area** per **Year**
1. How much **ENERGY** do you use now?

---

### Your Energy Usage

**1. How much ENERGY do you use now?**

**Your estimated meter readings.**

| Gas | 8168 |

---

**What you paid – thank you**

**Total payments £32.67**

**Your gas use in detail**

**Meter number: 0270360**

<table>
<thead>
<tr>
<th>Date Range</th>
<th>Reading</th>
<th>Usage (kWh)</th>
<th>Cost (p)</th>
<th>Standing charge</th>
<th>Total charge (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Sep 2019 - 30 Sep 19</td>
<td>8150</td>
<td>17</td>
<td>3.682</td>
<td>20.80</td>
<td><strong>£24.48</strong></td>
</tr>
<tr>
<td>1 Oct 2019 - 1 Oct 19</td>
<td>8168</td>
<td>1</td>
<td>3.445</td>
<td>1.09</td>
<td><strong>£1.09</strong></td>
</tr>
<tr>
<td><strong>Total gas used</strong></td>
<td><strong>£29.46</strong></td>
<td><strong>£1.47</strong></td>
<td><strong>£30.93</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>VAT at 5.00 %</strong></td>
<td><strong>£1.47</strong></td>
<td><strong>£30.93</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**How we calculate your gas cost?**

Gas is a natural product. One unit does not always produce exactly the same amount of energy. In order to price energy from gas consistently, we convert your units used into kilowatt hours of energy, using the following formula:

- a. imperial units used
- b. x metric conversion
- c. x calorific value
- d. x volume correction
- e. x kWh conversion
- f. = kWh

**How does this compare with last year?**

- **910.82 kWh**
- **567.23 kWh**
Log utility bills on a spreadsheet - kWh

| 59 Oxford Road - Gas and Electricity usage |

<table>
<thead>
<tr>
<th>Area:</th>
<th>Sq Ft</th>
<th>Sq m</th>
<th>Total Sq m</th>
<th>Sq Ft</th>
<th>Sq m</th>
</tr>
</thead>
<tbody>
<tr>
<td>1927 original house</td>
<td>930</td>
<td>86.36</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1988 extensions</td>
<td>341</td>
<td>31.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>118.09</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1988 garage</td>
<td>470</td>
<td>43.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Renovations (Bathrm Showrm Hall)</td>
<td>108</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2004 kitchen extension</td>
<td>4.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2004 loft</td>
<td>48.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Renovations (Utility, Showrm, Kitchen)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>171.39</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Gas usage kWh |

<table>
<thead>
<tr>
<th>date</th>
<th>annual kWh</th>
<th>annual £</th>
<th>EPC</th>
<th>kWh/m2/yr</th>
<th>Gas kWh/day £/day</th>
<th>Electricity usage kWh</th>
<th>Solar photovoltaic generation</th>
<th>usage kWh</th>
<th>Cost</th>
<th>Total incl PV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct-07</td>
<td>16582</td>
<td>£ 532.00</td>
<td>96.75</td>
<td>45.43</td>
<td>£ 1.46</td>
<td>3754</td>
<td>£ 652.00</td>
<td>20846</td>
<td>£ 1,148.00</td>
<td></td>
</tr>
<tr>
<td>Oct-08</td>
<td>18957</td>
<td>£ 772.00</td>
<td>110.61</td>
<td>51.94</td>
<td>£ 2.11</td>
<td>3754</td>
<td>£ 652.00</td>
<td>19272</td>
<td>£ 1,161.76</td>
<td></td>
</tr>
<tr>
<td>Oct-09</td>
<td>17092</td>
<td>£ 496.00</td>
<td>121.63</td>
<td>46.83</td>
<td>£ 1.36</td>
<td>3754</td>
<td>£ 652.00</td>
<td>#REF!</td>
<td>£ 1,142.00</td>
<td></td>
</tr>
<tr>
<td>Nov-10</td>
<td>15687</td>
<td>£ 594.76</td>
<td>112.45</td>
<td>42.98</td>
<td>£ 1.63</td>
<td>3585</td>
<td>£ 567.00</td>
<td>20667</td>
<td>£ 1,228.94</td>
<td></td>
</tr>
<tr>
<td>Oct-11</td>
<td>15934</td>
<td>£ 537.00</td>
<td>114.76</td>
<td>43.66</td>
<td>£ 1.47</td>
<td>3734</td>
<td>£ 605.00</td>
<td>19272</td>
<td>£ 1,161.76</td>
<td></td>
</tr>
<tr>
<td>Oct-12</td>
<td>12795</td>
<td>£ 743.96</td>
<td>97.86</td>
<td>34.96</td>
<td>£ 2.03</td>
<td>3978</td>
<td>£ 660.00</td>
<td>2577</td>
<td>£ 1,194.84</td>
<td></td>
</tr>
<tr>
<td>Nov-13</td>
<td>17996</td>
<td>£ 941.54</td>
<td>126.21</td>
<td>49.30</td>
<td>£ 2.58</td>
<td>4150</td>
<td>£ 657.00</td>
<td>2550</td>
<td>£ 1,228.94</td>
<td></td>
</tr>
<tr>
<td>Nov-14</td>
<td>12216</td>
<td>£ 668.10</td>
<td>93.16</td>
<td>33.47</td>
<td>£ 1.83</td>
<td>3751</td>
<td>£ 569.00</td>
<td>2771</td>
<td>£ 1,368.97</td>
<td></td>
</tr>
<tr>
<td>Nov-15</td>
<td>17789</td>
<td>£ 878.63</td>
<td>122.55</td>
<td>48.74</td>
<td>£ 2.41</td>
<td>3214</td>
<td>£ 573.80</td>
<td>2712</td>
<td>£ 1,365.25</td>
<td></td>
</tr>
<tr>
<td>Nov-16</td>
<td>17874</td>
<td>£ 778.09</td>
<td>114.62</td>
<td>48.97</td>
<td>£ 2.13</td>
<td>1905</td>
<td>£ 297.95</td>
<td>2631</td>
<td>£ 1,399.04</td>
<td></td>
</tr>
<tr>
<td>Nov-17</td>
<td>17040</td>
<td>£ 748.22</td>
<td>100.28</td>
<td>46.68</td>
<td>£ 2.04</td>
<td>1690</td>
<td>£ 373.54</td>
<td>2498</td>
<td>£ 1,245.79</td>
<td></td>
</tr>
<tr>
<td>Nov-18</td>
<td>19022</td>
<td>£ 865.95</td>
<td>123.21</td>
<td>52.11</td>
<td>£ 2.37</td>
<td>2095</td>
<td>£ 382.31</td>
<td>2677</td>
<td>£ 1,445.00</td>
<td></td>
</tr>
<tr>
<td>Nov-19</td>
<td>18144</td>
<td>£ 753.97</td>
<td>118.74</td>
<td>49.71</td>
<td>£ 2.07</td>
<td>2206</td>
<td>£ 558.40</td>
<td>2704</td>
<td>£ 1,506.00</td>
<td></td>
</tr>
</tbody>
</table>

20
Area: Establishing a Baseline and Rates

2. What are the rooms and sizes in your house = SQ METER AREA?

**Energy Performance Certificate**

59, Oxford Road, CAMBRIDGE, CB4 3PH

Dwelling type: Detached house
Date of assessment: 30 April 2014
Date of certificate: 03 May 2014

**Total floor area:** 179 m²

**Use this document:**
- Compare current ratings of properties to see which properties are more energy efficient
- Find out how you can save energy and money by installing improvement measures

**Estimated energy costs of dwelling for 3 years:** £4,692

**Over 3 years you could save:** £1,380

**Estimated energy costs of this home**

<table>
<thead>
<tr>
<th></th>
<th>Current costs</th>
<th>Potential costs</th>
<th>Potential future savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lighting</td>
<td>£432 over 3 years</td>
<td>£267 over 3 years</td>
<td>You could save £1,380 over 3 years</td>
</tr>
<tr>
<td>Heating</td>
<td>£3,864 over 3 years</td>
<td>£2,793 over 3 years</td>
<td></td>
</tr>
<tr>
<td>Hot Water</td>
<td>£306 over 3 years</td>
<td>£252 over 3 years</td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>£4,692</strong></td>
<td><strong>£3,312</strong></td>
<td></td>
</tr>
</tbody>
</table>

These figures show how much the average household would spend in this property for heating, lighting and hot water. This excludes energy use for running appliances like TVs, computers and cookers, and any electricity generated by microgeneration.

**Energy Efficiency Rating**

- Very energy efficient - lower running costs
- (0-10) A
- (11-49) B
- (50-80) C
- (81-120) D
- (121-180) E
- (181-250) F
- (251-350) G

<table>
<thead>
<tr>
<th></th>
<th>Current</th>
<th>Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Graph showing 70]</td>
<td>81</td>
<td></td>
</tr>
</tbody>
</table>

The graph shows the current energy efficiency of your home.

The higher the rating the lower your fuel bills are likely to be.

The potential rating shows the effect of undertaking the recommendations on page 3.

The average energy efficiency rating for a dwelling in England and Wales is band D (rating 60).

**Top actions you can take to save money and make your home more efficient**

<table>
<thead>
<tr>
<th>Recommended measures</th>
<th>Indicative cost</th>
<th>Typical savings over 3 years</th>
<th>Available with Green Deal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal or external wall insulation</td>
<td>£4,000 - £14,000</td>
<td>£880</td>
<td></td>
</tr>
<tr>
<td>Floor insulation</td>
<td>£800 - £1,200</td>
<td>£250</td>
<td></td>
</tr>
<tr>
<td>Low energy lighting for all fixed outlets</td>
<td>£110</td>
<td>£142</td>
<td></td>
</tr>
</tbody>
</table>

See page 3 for a full list of recommendations for this property.

To find out more about the recommended measures and other actions you could take today to save money, visit www.direct.gov.uk/savingenergy or call 0300 123 4234 (standard national rate). The Green Deal may allow you to make your home warmer and cheaper to run at no up-front cost.
Your Energy Usage: Air tightness Test

Air Leakage Test Report

In compliance with European Norm EN 13829 – European Union

Cambridge Architectural Research

Building Address: 58 Oxford Road
Cambridge, CB2 3HE

Performed by: Prof David Kreissl

Performed for: MPI Group

Test date: 2015-06-18

Associated Test file: EN13829-41 2015-10-10 1311

Test Result: Permeability @ 50Pa = 12.2 m³/h/m²

Living Room: The floor in the entranceway lost air through the oaks, this could be sealed with silicone caulks. The flap for the interbox also does not seal very effectively.

Front Bedroom: Air enters through a crack around the outside edge of the window, goes into the sash boxes and then comes into the room around the pulley.
Costs: Establishing a Budget

What is a reasonable **BUDGET** for your proposed work?

1. Do you have a **budget figure** in mind?
   - is your budget fixed?
   - do you need a financial return? Eg room in house for lodger
   - where’s the money coming from?

2. How many **m2 of your house** do you want to retrofit? budget £/m2 for these?
   Any extensions? Could the work be phased?
   Here are some examples of **phasing**:
   - wet rooms first, bathroom and kitchen, and then living/bedrooms
   - inside then outside (EWI)
   - extension or loft conversion first, then the remainder of the house.

3. How are you going to **procure** the work?
   - how will you cope with disruption?
   - one big job or parcels of work? (scope/risk)
   - DIY or get the builders/ professionals in?

4. Can you get **specific quotes** for some of the works, eg supply and install
   - Air Source Heat Pump
   - Solar PV (photovoltaic) panels
   - new windows
   - External Wall Insulation
Deciding on Retrofit Measures

1. **INSULATION** of fabric – inside or out?
   - Roof/loft
   - Walls
   - Windows and doors
   - Floor

2. **AIR-TIGHTNESS** of envelope (walls floor roof)? (+ VENTILATION ↓)

3. **SERVICES**
   - HEATING
   - VENTILATION
   - HEAT SOURCES

4. **RENEWABLES** - eg Solar Photovoltaic

5. **EFFICIENT LIGHTING & APPLIANCES**

Government is establishing standards for retrofit, PAS 2035, including a new role:

RETROFIT COORDINATOR
Retrofit Coordinator - useful checklist

Intended Outcomes?

Examples:
- lower energy use, cost - tackling fuel poverty, OR emissions
- improving internal comfort, indoor air quality, OR reducing overheating
- remedial: elimination of condensation, damp and mould OR repair of gutters, flashings OR air leakage
- energy efficiency measures integrated with other works, eg extension, loft conversion, OR general upgrading of property

PAS 2035, 6. Requirements for retrofit coordination and risk management, p.13-15
How are you going to procure the work? balancing time, cost, quality

What can go wrong?
Beware: Quality!
How are you going to procure the work? - Trades?

Whole house plan?

Retrofit Coordinator?

DIY, mainstream or specialist contractors?

RetrofitWorks specialist network?
Contractors

- Qualities of a good builder?
- Which builders do you usually use?
- Would you recommend them?
Good Questions to ask householders or to explore in OEH Archive:

What was their brief?
- retrofit priorities?
- combined projects/ added value?
- retrofit values and philosophy?

What was their budget?
- was it fixed?
- was payback important?
- did they have grants?

How did they procure the work?
- where did they get advice?
- how did they manage time/cost/quality?
- one big job or parcels of work?
- DIY or builders/ professionals?
- how did they cope with disruption?

What do they wish they had done differently?
Resources:

openecohomes.org/eco-homes-archive

Cambridge Carbon Footprint Organization Home Energy Resources

cse.org.uk/advice/advice-and-support

Centre for Sustainable Energy

transitioncambridge.org/faqs

Energy Advice greenbuildingstore.co.uk/services/training-cpds/free-cpds Webinar
Donations welcome: cambridgecarbonfootprint.org/donate

Please write feedback in Chat one thing each:

● that’s been good
● that needs improving
● a suggestion

If you’d like a discussion session another time on tonight’s topics, please write ‘discuss’ in Chat.

Thank you,
Nicola Terry, Margaret Reynolds, Tom Bragg