It looks ordinary.

But it isn’t.

It’s what an extreme low carbon domestic refurbishment looks like. James Parker visits 89 Culford Road to find out whether today’s extreme is tomorrow’s normal
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Just how low can we go?

While we fret about making new homes zero-carbon, it’s easy to forget about the refurbishment market. James Parker visits 89 Culford Road in London to see what can be done to make existing dwellings extreme low carbon.

If you look through any estate agents window you can always find a house “in need of modernisation”. In most cases this means a new kitchen or bathroom suite, and maybe a lick of paint over horrible wallpaper from the 1970s.

Never does it say “opportunity to become zero-carbon.” At least, not yet. New houses may be being built to more stringent energy and environmental targets, but refurbishment is where the emphasis should truly lie.

The design, by architect Robert Prewett of Prewett Bizley Architects (a runner-up in Building magazine’s Sustainability Awards), involved major work to the fabric of the building, while retaining the front façade. While it was never intended to change the structural elevation facing the street, the same cannot be said of the rear of the house which has been completely rebuilt.

There were various motives for this, but notably it was driven by the need to increase and improve the existing accommodation space, which had significantly been reduced by the addition of high levels of thermal...
remarkable achievement. This creditable performance started with the architect lecturing the building team on the importance of airtight detailing. This led to more care being taken with wall, floor, window and roof junctions.

The initial target of 1.5 ach was always going to be a challenge, as the first test proved with a result of 5 ach. Taping and sealing brought this down to 3.5 ach, with a third and final push (before plastering) bringing it down to 1.1 ach. The final value will be a fraction of that.

However, an airtight house with negligible ventilation would soon become unliveable. Kitchen fumes (which may contain NOx if using gas hobs) and humid air from the bathroom would combine with volatile organic compounds released from materials in the house, and of course natural smells from the human (or animal) occupants to produce a very unpleasant environment.

The high level of airtightness therefore justified the use of a mechanical ventilation and heat recovery unit (mvhr). The product chosen was the Itho HRU Eco 4.

While the front elevation was kept original, an internal frame was constructed inside the front wall to support rebuilt floors and also to eliminate thermal bridges. The gap between the existing façade and the internal frame is filled with 140 mm of insulation, with a small ventilated space between the façade and the insulation. Extra insulation was also added to the floor (100 mm) and to the roof (180 mm).

Airtightness issues
Passive measures sorted, attention then turned to the building’s airtightness. Surprisingly, for such an old building, the team managed to get a very low air permeability rate of 1.1 air changes per hour (ach) prior to plastering - a
the heat to outside supply air, then
distribute it throughout the house via a
system of flexible ducts run down an
interstitial gap adjacent to the party wall.

As the mvhr manufacturer claims an
heat reclaim efficiency of up to 91 per
cent, the Cohens accepted the fan
power penalty as the mvhr should
considerably reduce the dwelling’s
heating requirements. (See tables 1-3 for
energy savings and paybacks.)

Energy savings
For Robert Cohen, the ventilation
strategy was the key feature of the
refurbishment in terms of reducing
energy demands. Looking at the figures
calculated for before and after the work
was carried out, it is clear where most
of the savings will come from.

A reduction of 210 kWh/m² per
annum or 92 per cent is outstanding,
and would not have been possible
without the mvhr/airtightness
combination. In fact, this saving is three
times the total predicted energy use of
the house.

The build team is so confident of the
thermal capability of 89 Culford Road,
that they have only installed underfloor
heating on the lower ground floor, with
two small towel rails in the bathroom to
make sure towels dry out.

Glazing
In addition to the walls, careful choices
had to be made with the windows. To
complement the rest of the house, they
had to have very good seals and very
low U-values. This was not easy to fit
into a façade in a strict conservation
zone. The solution was micro (or slim)
double-glazing. These have a small
argon-filled gap of only 4 mm. This
gave a glazing profile very close to the
original. Heat retention is improved
with a low-e coating that reflects heat
back into the room.

The front windows also kept the sash
opening, albeit reproduced with
improved seals (four draught seals per
sash) to help with the airtightness. This
gives the front of the house a virtually
original appearance. The rear of the
house, without the strict levels of
conservation to observe, is equipped
with a more traditional low energy
window: triple glazing with double edge
seals.

This all sounds quite ground-breaking
in the UK, but really it’s nothing new.
In general Robert Cohen’s approach
follows the guiding principles of
Passivhaus, developed in Germany by
the Passivhaus Institut in the 1990s.
Indeed, the architect Robert Prewett
used the Passivhaus Institute’s PHPP
software to predict the performance of
89 Culford Road as the building’s
design developed.

Due of the nature of Passivhaus, the
PHPP tool is much better at estimating
the effects of things like window design,
cold bridging and risk of summer
overheating than the UK’s SAP
calculation tool.
Renewables
No self-respecting low energy house would look complete without some kind of renewable energy technology. But having said that, with this development there was an agreement from the outset to avoid overt eco-bling. This was not only because of the conservation zone, but also because the team believed that they were neither appropriate nor cost-effective. That is not to say that there aren’t any.

The original plan was to have installed a heat pipe solar-thermal system. However, to be effective it would have been visible from the street – a consequence of the lack of space to hide it. But luckily for the Cohens the government announced feed-in tariffs that benefited micro-generation. They quickly jumped on this and with a few calculations found that installing solar photovoltaics could be the answer.

The feed-in tariff of 36p/kWh reduces the payback period of photovoltaics from 30 to 40 years down to just 10 to 15 years. The photovoltaics at 89 Culford Road, were installed at a cost of around £5000. They are calculated to provide 1.2 kWp and to meet around 30-40 per cent of the electrical load of the house.

Refurbishment versus new build
How does 89 Culford Road compare to a new house? The current benchmarking system for new homes is the Code for Sustainable Homes. However, it is important to note that this system can only assess new dwellings. At present the only (BRE-backed) assessment tool that can be used for refurbished homes is Ecohomes, although this hasn’t been updated since 2006. BRE is in the process of developing a domestic refurbishment assessment scheme, but this is not yet available.

Looking at the Code for Sustainable Homes and making small adjustments (not possible in a real assessment), the house would achieve a rating of Level 4. While a lot of the Code looks at the periphery of the construction process, the key elements of a rating are the energy and water categories. These have mandatory levels to reach to receive a rating at a particular level.

The 80 per cent reduction of energy use at 89 Culford Road has helped score highly here, but to reach the Level 5 rating a 100 per cent improvement would be needed, and even more for Level 6. The water issue would also pass the requirements of the higher levels of the Code because of the rainwater harvesting strategy.

The AECB Carbonlite silver and gold standards were also used, with the house...
FACTS AND FIGURES

Table 1: Emissions before and after the refurbishment.

<table>
<thead>
<tr>
<th>Energy end use</th>
<th>Prior to refurb</th>
<th>After refurb</th>
<th>Cut in</th>
<th>Percentage</th>
<th>Energy</th>
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</thead>
<tbody>
<tr>
<td>CO2 kg/y</td>
<td>CO2 kg/y</td>
<td>CO2 kg/y</td>
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<td>reduction</td>
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<tr>
<td>Space heating gas</td>
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<tr>
<td>Lighting electricity</td>
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<td>159</td>
<td>41</td>
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<tr>
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<tr>
<td>Total regulated (excluding PV)</td>
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Table 2: Annual energy costs before and after the refurbishment.

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<th>Energy end use</th>
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<th>After refurb</th>
<th>Reduction</th>
<th>Percentage</th>
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<td>£/y</td>
<td>£/y</td>
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<td>134</td>
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<td>Lighting electricity</td>
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<tr>
<td>Other electricity</td>
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<td>225</td>
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<td>Unregulated</td>
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<tr>
<td>Total regulated (excluding PV)</td>
<td>1147</td>
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<tr>
<td>Total excluding PV</td>
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<td>560</td>
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<td>Photovoltaics</td>
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<td></td>
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<tr>
<td>Total regulated (including PV)</td>
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<td>-133</td>
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<td>112</td>
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<tr>
<td>Total including PV</td>
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<td>92</td>
<td>1280</td>
<td>93</td>
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Table 3: Breakdown of annual energy consumption by end use.

<table>
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<tr>
<th>Energy end use</th>
<th>Prior to refurb kWh/y</th>
<th>After refurb kWh/y</th>
<th>Cut in kWh/y</th>
<th>Percentage</th>
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<tr>
<td>Lighting electricity</td>
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<td>Unregulated</td>
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<tr>
<td>Photovoltaics</td>
<td>-908</td>
<td>908</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

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