All the paints are vapour permeable to allow the walls to breathe. Keim Ecosil ME was used, which reduces noxious gases and odours by turning them into natural substances. It also increases light reflectivity

MAKING AN OLD HOME GREENER

Period properties are often criticised for being draughty and expensive to run, but this listed house has been transformed into a comfortable, cost-effective, much more eco-friendly place to live. Roger Hunt explains how this was achieved without compromising its character

Photographs Jody Stewart

Future-proofing a Grade II-listed four-storey house, built around 1840 and in a Conservation Area, may sound contradictory and difficult, but this was the ambition of two eminent scientists, who were relocating from Scotland to south-west London. Their aim was to make a home where they could retire, safe in the knowledge that they would enjoy low-energy living and comfort, while benefiting from the character and light-filled spaces that the old house offered.

Working with Harry Paticas of Arboreal Architecture, the couple soon realised that the semi-detached house would need a 'deep retrofit' if it was going to meet their expectations. The challenge was to achieve this while respecting the building's original features and historic fabric, some of which was in a very poor and delicate condition.

From the start, there were issues to consider that are common in many old houses, such as draughty single-glazed sash windows; other problems were less obvious. 'When we first saw the house it appeared to be in relatively good condition but, just scratching a little below the surface, the first thing we discovered was that the floorboards abutting the side wall were rotten and some of the walls were absolutely soaking wet,' says Harry.

The reasons for this soon became clear. An external brickwork plinth, finished in hard cement render, and a coat of modern waterproof plaster on the walls of the semi basement were trapping moisture. Meanwhile, a rainwater downpipe had clearly been leaking against the back wall for many years while the modern fibre-cement roof was in a poor state with rotten timbers. All of these issues had to be fixed in order to stabilise the house, so the inappropriate layers of plaster and render were removed, the external walls repointed with lime mortar and the leaky downpipe repaired. The roof was relaid in Spanish slates.

Retrofitting the old house to make it energy efficient was more complicated. 'The project was very much a collaboration with the owners who made it clear that this is their last home,' explains Harry. 'As they get older they may become less mobile and will be feeling temperature asymmetries and draughts more. That's where a deep retrofit comes into its own and we decided to aim for the AECB Silver Standard for performance.'

UNDERSTANDING THE HOUSE

Before work started it was crucial to understand the building's existing performance and condition. Using specialist testing equipment, the thermal conductivity of the solid brick walls was evaluated. This meant that the performance of the insulation could be tailored to the needs of the building. Tests were also undertaken to measure the building's airtightness and, through thermographic surveys, to see where the draughts and cold spots were.

AIRTIGHT BUT BREATHABLE

Understanding the difference between airtightness and breathability is vital when taking on a project like this: airtightness is about stopping draughts through joints and gaps, while breathability is to do with the speed at which water vapour passes through a building element.

Breathable products such as lime plaster were used throughout while, to achieve airtightness, it was important to make sure there was no air leakage between different components. Special airtight tapes were used at junctions and a 'parge' coat of lime plaster was applied to the walls before the insulation material was installed to seal any gaps in the brickwork; a further skim coat of plaster was then applied over this.

WARMER WALLS

When it came to insulating the walls, the local authority conservation officer was concerned about the potential loss of original plaster so, initially, there was some reluctance to grant listed building consent. Once it was established that nearly every ➤

THE SILVER STANDARD

This house achieved the AECB (Association for Environment Conscious Building) Silver Standard, which is aimed at those wishing to create high-performance buildings using widely available technology at little or no extra cost. Through appropriate design, the AECB estimates that overall CO_2 emissions will be reduced by 70 per cent compared to the UK average for the building type.

wall had already been disturbed, or replastered in a modern, pink gypsum plaster, consent was given.

Insulating the walls involved a tailored approach with each wall individually evaluated. This resulted in ten types of insulation materials being used (see box, right) in order to achieve the thermal performance required without compromising the historic fabric or its ability to breathe.

The thickness of the internal insulation was, in places, governed by the depth of the original cornice, as it was important not to lose this detail. As a result, some walls were clad with 10mm of aerogel blanket and others, where there was no historic detailing, with 100mm of wood fibre. Where appropriate, modern plasters, and lime plasters that were beyond repair, were hacked off to provide further depth for new lime plaster and insulation and to ensure the wall's breathability.

SECONDARY GLAZING

The original sash windows are single glazed and had to be retained due to their historic importance but, on their own, could never provide the thermal performance required, so the decision was taken to install double-glazed secondary glazing. A further benefit of this was the reduction in road noise.

A hinged tilt and turn aluminium system from Granada Secondary Glazing was chosen that opens inwards to provide natural ventilation. This enabled a single pane of glass to be used so the sashes are obscured as little as possible. 'What's nice is that we managed to match the sightlines of the secondary glazing to the window precisely,' explains Harry.

VENTILATION SOLUTIONS

Increasing the airtightness of the house meant that sufficient controlled ventilation had to be introduced. Installing a centrally based ducted ventilation system within the fabric of the old house would have been very invasive so separate mechanical extractor fans were installed through existing vents in each of the three bathrooms and the kitchen. These run continuously at a low extraction rate and have a boost function that the owners can activate when necessary.

HEATING THE HOUSE

The high levels of insulation and airtightness achieved within the house meant that relatively small radiators could be installed inconspicuously behind doors. Stelrad Radical radiators were chosen as they increase radiant heat by up to 50 per cent.

To minimise damage, a thermographic survey was done with the old heating system turned on. This enabled the position of both hot water and heating pipes to be marked and meant that the new system could be planned so the pipes were installed in the existing notches in the joists.

The owners were keen to have a degree of heating security should gas or electricity fail, so a 4kW Morso wood-burning stove was installed in the living room fireplace on a new hearth of Welsh slate in front of the original cast-iron fire surround.

INSULATION SHORTLIST

WOOD FIBREBOARD: Internal walls
AEROGEL BLANKET: Internal walls
PHENOLIC BOARDS: Lower-ground floor where, because of tanking, the walls were not breathable
EXTRUDED POLYSTYRENE: External walls below ground
FOAMED GLASS GRANULATE: Externally around the base of the wall to allow drainage
HIGH DENSITY FOAMED GLASS BLOCKS: Door and window sills
CALCIUM SILICATE BOARD: Between floor joists to wick away any moisture.
BLOWN CELLULOSE: Loft floor and shutter boxes
PERLITE BEADS: Poured between the side of the staircase and external wall
VACUUM INSULATED PANELS: Ground floor below screed

SOLAR PANELS

About half of the hot water used in the house is heated by solar thermal panels hidden from the street on one of the inner pitches of the roof.

These feed a thermal store (hot water cylinder) on the first floor landing with the hot water supply supplemented by a gas boiler. Much has changed in the energy market since the project was first designed and Harry admits that, while they were the right solution at the time, he would probably now specify solar photovoltaic (PV) panels instead. These generate electricity so excess energy could either be sold to the grid or stored in the thermal store using an immersion heater.

SUBTLE LIGHTING

Aware that, with advancing years, higher light levels are needed, the owners were keen that great care should be taken with the lighting. An understated but very effective scheme was devised for the house using low-energy LED wall mounted uplights by Delta Light, with just a few downlights.

AESTHETIC TOUCHES

Despite the huge amount of work done to the house, most of it is unseen. The biggest visible change is the transformation of the dark and cramped lower ground floor into a bright kitchen. This was achieved by excavating the back garden to create an airy sunken courtyard accessed through a glass door that allows in light. ➤

Above: The kitchen is where the biggest change can be seen. The garden was excavated and a patio door added. Due to the high levels of airtightness, this space is fitted with a mechanical extractor fan that runs continuously

Far left: A breathable membrane was used in the roof space. A rooflight allows maintenance access to the valley gutter and thermal solar panels

Left: Aluminium secondary glazing has improved the thermal performance of the original windows

Below left: Newly lime-plastered walls give a crisp backdrop for the couple's artworks. A subtle lighting scheme was designed that uses low-energy LED wall-mounted uplights from Delta Lights

Below: To give the living room a focal point, and to make it extra cosy on cold winter evenings, a small 4kW Morso stove was installed in front of the original cast-iron fire surround. The owners opted for a large Welsh slate hearth

The couple have created a beautiful sunken courtyard, which is accessed from the kitchen

Above: A weather station added by Historic England to monitor external conditions is linked to internal sensors so the performance of the house can be tracked
Left: Solar thermal panels, hidden on one of the inner pitches in the roof, supply around half of the hot water used in the house

The colour scheme is simple. Paints have been chosen with care and are all vapour permeable to allow the walls to breathe. Keim Mineral Paints were used on the rendered and plastered surfaces, with Keim Ecosil ME employed internally. This uses photo-catalytic pigments to reduce noxious gases and odours by turning them into natural substances, and also reflects high levels of light.

MONITORING SUCCESS

Since Arboreal Architecture completed the retrofit it has won a prestigious building performance award, and the house became the first listed building in England to meet the AECB Silver Standard, with the actual space heating demand cut by more than 75 per cent. Air leakage has been reduced from 9.6 air changes per hour to 1.8 per hour and, since the house has been occupied, its internal temperature has remained at an average of 20˚C with relative humidity between 50–60 per cent.

This is not the end of the story, as Harry sees ongoing monitoring of moisture and temperature as an important aspect of any retrofit project. Buried in the walls and other locations are 22 remote wireless sensors which, with a battery life of 15 years, continue to feedback information.

The cost of the energy efficiency aspects of the work was around 20 per cent of the total project. 'It's not a huge part of the budget given the performance and the comfort that can now be enjoyed,' Harry says. 'The really key point is that the retrofit has achieved virtually everything that was hoped for, and the owners now love the house.'