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How to retrofit a period property

The Duke of Westminster's update of a Victorian semi on his estate — the tenants love it — has lessons for the UK's six million historic homes. By Martina Lees

The spotlight fell on the Duke of Westminster's wedding last week, with Prince William among the guests at the Grosvenors' country seat, Eaton Hall in Cheshire. However, it is a less glamorous event on the same 11,000-acre estate that could make a far bigger difference to six million families with period homes.

In the village of Aldford, close enough to Eaton Hall to enjoy the live music as Hugh Grosvenor celebrated his union with Olivia Henson, a Victorian semi has just been retrofitted by the Grosvenor estate. With three bedrooms (the duke's manor has 150) and a handsome brick exterior, it is a typical pre-1900 home. In fact this house was chosen as a blueprint for retrofitting historic homes precisely because it is so typical.

Its performance is now anything but. Whole-life carbon emissions have been cut by 83 per cent, annual energy usage halved and emissions to heat the home lowered by 94 per cent, according to Grosvenor, the duke's property group. While tests confirm the semi is more airtight than a new-build, it has lost none of its Victorian charm.

"We absolutely love it," says Mike Devoy, 38, who rents the house with his partner, Holly Ashbrook, 36, and their children, Emelda, ten, and Milo, seven. The family moved in a few weeks ago, at a rent of £1,450 a month. "It's got all the charm of a period property, but it feels very much like a modern home. It's noticeably warmer and the air quality is fantastic," Devoy adds.

The 33-year-old Duke of Westminster was personally involved in the semi's retrofit, even signing off on window types. His experiment did not aim for the highest Passivhaus standards, but a more attainable ambition that could inform retrofit across Grosvenor's buildings, including 1,750 listed properties in prime central London and four rural estates. The group has pledged to cut emissions from running its buildings to net zero by 2030.

Its prototype has lessons for period homeowners across Britain. Such homes are hard to treat. Built to breathe, historic buildings cannot be sealed and insulated in the same way as modern equivalents. If you do that, condensation, damp and mould will ruin the building — and the health of residents. Yet Britain cannot hit net zero emissions by 2050 without retrofitting these homes.

"We've got about six million pre-1900 homes in the UK, and we need to make them warmer and more comfortable to live in and cheaper to heat. That's what this project is all about," says Diane Hubbard, the founder of Green Footsteps, which advised on the retrofit.

Despite the impressive results, the semi's energy performance certificate (EPC) rating has improved only from E to C. "This has underlined that the EPC process isn't fit for purpose for historic buildings," says Joby Howard, the director of building services at Grosvenor's rural estates.

EPCs rate the energy efficiency of a home on a scale of 0 to 100, banded from A (best) to G (worst). The current system used to calculate most EPC ratings, except those for new homes, does not count improved airtightness — even though such upgrades significantly reduce heat loss, Hubbard says.

It also punishes you for fitting a mechanical ventilation and heat recovery (MVHR) system, which pumps out stale air while extracting heat from it to warm incoming fresh air. MVHR, which is crucial in highly airtight homes, "typically reduces the EPC rating by ten or more points", Hubbard says, because the EPC calculations prioritise low energy costs, not low-carbon emissions, and assumes (usually wrongly) that an MVHR system will push up your electricity bill.

A new version of the EPC system, due this summer, will factor in airtightness. Howard is "pretty confident" that redoing the retrofit's rating under this regime will increase it from C to B.

This isn't a project done on a budget. The duke — Britain's richest man under 40 — gave Howard's team permission to "play" with the Victorian property. Sensors for temperature, humidity and air quality will monitor how the house performs over the next year. Here is what they have learnt.

A retrofit plan

Draw up a thorough retrofit plan, Howard says. "There is an

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overwhelming number of emerging products and technologies relating to energy efficiency and low-carbon retrofit. Homeowners need professional advice on which specifications are appropriate for their property."

To start with, Green Footsteps, which specialises in historic retrofit, did an airtightness test and a thermal imaging survey to pinpoint where the house leaked heat.

Tests showed the semi's original airtightness was "really good", Hubbard says. The original metal windows had stone surrounds with "very effective" secondary glazing, while the semi's solid-brick walls were 25 per cent more thermally efficient than the EPC system assumes for pre-1900 walls.

Embodied carbon

It usually takes far more energy to build a home than to run it. That is why Grosvenor calculated the whole-life embodied carbon of the retrofitted semi, including emissions that produce and transport building products, heat and cool the home and demolish it at the end of its life.

They used natural, local materials. They chose Gutex woodfibre board insulation instead of panels made from petrochemicals; lime plaster instead of gypsum plaster; and limecrete instead of concrete for the ground floor. The timber frame of a two-storey extension came from trees grown on the estate. Likewise, bricks and roof slate are reclaimed from estate property.

Decarbonised heating

A Bosch air source heat pump supplies heating and hot water without burning fossil fuels. A heat pump can produce three to five units of heat for every unit of electricity it uses. But the design and installation of a heat pump system is "critical" to its efficiency, Howard says. "Partnering with knowledgeable advisers and contractors is vital."

The team also fitted waste water heat recovery, which uses the warmth from waste shower water to preheat cold water for showers. An A+ wood-burner has a direct supply of external air, rather than using indoor air, and is fuelled with logs from the estate forest.

Although the semi has an electric car charger, it has no solar panels. "It is in a conservation area, so we were concerned about the aesthetic impact. We are looking at a central solar scheme," Howard says.

Airtightness

"Heat leaks out through air gaps. Even a 1mm gap around a window can lead to a significant heat loss," Howard says.

An unbroken layer of airtight chipboard (Finsa SuperPan Vapourstop) and airtightness membrane invisibly seals the house. It has increased the airtightness by a third from 6.3 to 4.2 air changes an hour. That makes it twice as airtight as a new home, Hubbard claims.

If you reduce airtightness below 5 air changes an hour, the home also needs an MVHR system to breathe. Without it, you will get condensation and mould, Howard warns. The benefits of MVHR systems increase if airtightness is below 3 air changes an hour, Hubbard adds.

The more intricate the shape of the building, the harder it is to avoid air gaps. The insulation layer must also be continuous with no gaps, to prevent thermal bridges that allow the cold to travel through the shell. This is simpler to do with external wall insulation. But because the semi is in a conservation area, external wall insulation covered in render was out of the question. Grosvenor had to insulate internally. Howard's team had to redo work where the complex roof of the Victorian semi joins its walls.

Many contractors do not yet have the skills to get it right, Howard adds. "Find trusted suppliers to advise on your retrofit project and be open to working with good contractors who are honest about their limitations and prepared to learn on the job."

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> It has the charm of a period home, but it feels modern. The air quality is fantastic

Above: Mike Devoy and his family rent the retrofitted home on the Grosvenor family's estate, right. Below: Hugh Grosvenor and Olivia Henson on their wedding day