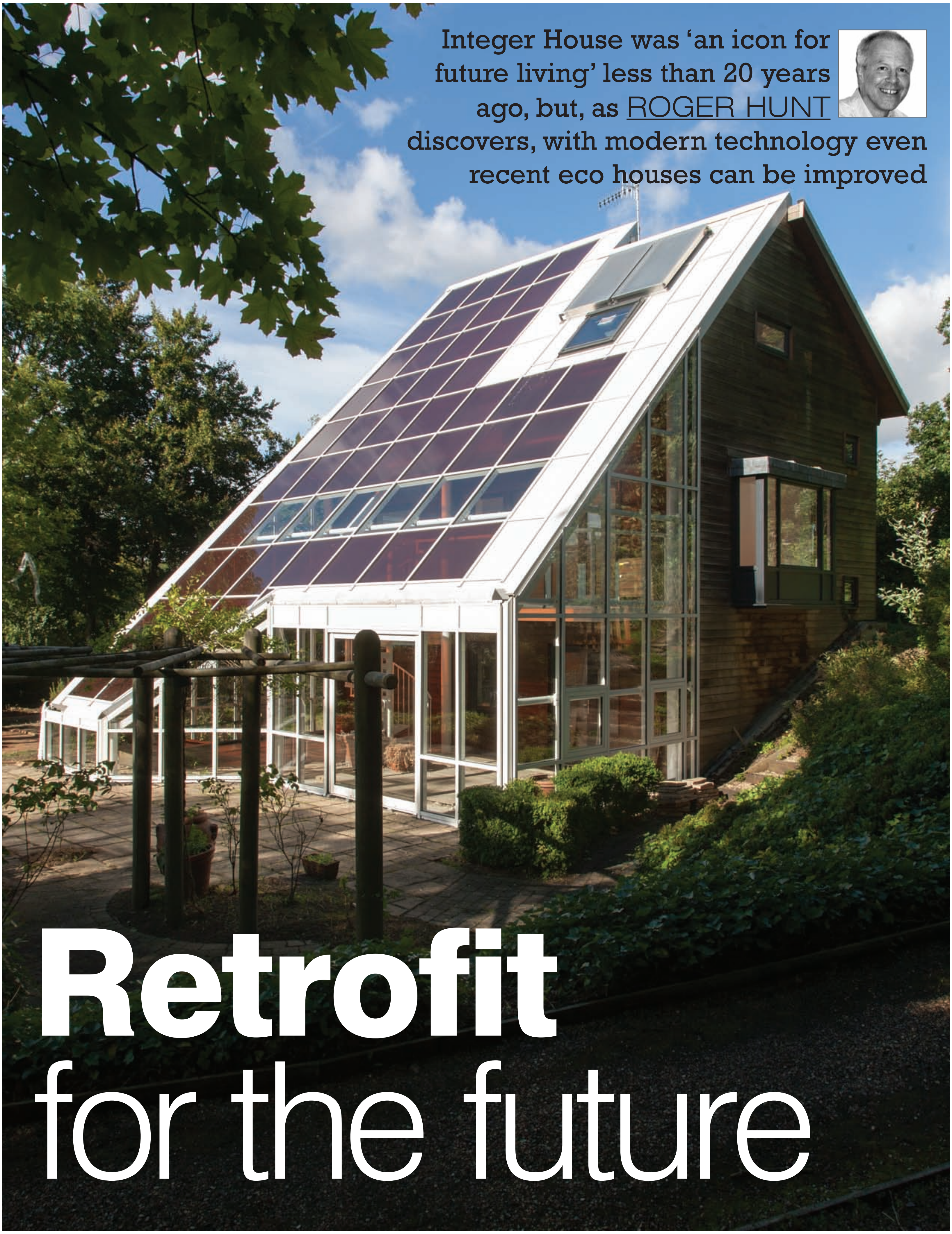
Retrofit for the future

Integer House was 'an icon for future living' less than 20 years ago, but, as ROGER HUNT discovers, with modern technology even recent eco houses can be improved



All photos in this feature : Peter White, BRE

Exterior of The Smart Home, formerly the Integer House, at the BRE

ABOVE Kitchen
BELOW Installing new windows
BELOW MIDDLE Spiral staircase in the conservatory
BELOW RIGHT Lounge area

Talk about retrofit and we tend to think of older houses, not a house built 16 years ago when it was branded by the BBC as "reinventing the home for the next millennium". But now Integer Millennium House, which was the focus of a six-part Tomorrow's World Dream House series fronted by Carol Vorderman, has undergone an exemplar retrofit.

Since 1998, Integer House has occupied a prominent position at the entrance to the BRE's campus at Watford, north of London. Architects, engineers, housebuilders and many others from across the world have come to see the house; this has resulted in a number of pilot schemes by housing associations in the UK and has inspired work in China. As one of the first true demonstration houses in Britain, it was also a catalyst for what has become the BRE Innovation Park. As John O'Brien, principal consultant BRE Innovation Park, says: "This building has always caused a lot of debate. It's not an Earthship approach to building homes, it's doable. It made people realise what can be done and we want to continue that."

With this in mind, the BRE, in a joint project with British Gas, has undertaken an extensive retrofit of Integer House, which has seen it rebranded The Smart Home. The project sets out to demonstrate that significant energy savings can be made through smart technology alongside fabric improvements and occupant empowerment. Re-equipped with a host of ultra energy-efficient features and functions, the house is now "super fit for the future".

The fact that such a relatively new house has undergone an extensive retrofit so soon should in no way signal that the original failed. Rather, it shows just how far our understanding of what constitutes an energy-efficient home has come and the extent to which building regulations have advanced. At the time, the building regulations required walls to have a U-value of 0.45W/m²K, Integer House achieved a U-value of 0.19W/m²K.

This is just one of the features that helped make Integer House, with its distinctive sloping conservatory, an icon of future living. It was jointly designed in October 1997 by four individuals – Tim Day and Damian Bree of Bree Day Architects, Nicholas Thompson of Cole Thompson Associates and Paul Hodgkins of Paul Hodgkins Associates – but its origins were earlier.

"We were looking to see how we could build houses in a smarter way in the next millennium; the name Integer was a play on the words intelligent and green," explains Damian Bree. "We started formulating ideas about different materials and the environmental and green aspects of those materials, how they could be assembled, how they'd perform and how a house could be built on- or offsite. It slowly snowballed and, out of the blue, we had a call from the Department of Trade and Industry (DTI) saying that they were planning a trade mission to Australia."

A scale model was duly dispatched to the DTI's UK Now exhibition in Melbourne in November 1997. That might have been the end of the project but for another call, this time from the BBC's Tomorrow's World team. "That's when the challenge started," recalls Bree. "We designed the house in about three months and, because most of it was going to be prefabricated, pretty much 99% of the design had to be finalised before going on-site. We then had 12 weeks to assemble the house at the BRE."

The BBC filmed the build from start to finish. The house was filled with cabling for prototype intelligent electronics; some were geared to energy efficiency but most were nice-to-haves, such as a centralised music system with a 100 CD changer and controls in every room, including the garden.

Energy came from a ground source heat pump, a solar thermal collector and two small and, at the time, expensive photovoltaic panels installed high on the conservatory roof that charged two 12V storage batteries. The house was topped by only the second green roof in the UK, from roofing specialists Bauder, which is still in excellent condition. Rainwater and greywater harvesting systems helped reduce the consumption of mains water.

The large conservatory was designed both as a year-round outdoor space and as a source of passive heating for the house; automatic blinds provided shading. Notably the house has an inverted layout. The bedrooms are on the lower ground floor, set into the surrounding land, while the living areas above offered a natural way of managing heat flow within the house through a passive ventilation system. This utilised louvered windows at low and high levels to aid air circulation. Indeed, the emphasis was not on airtightness, the importance of which was subsequently recognised in Part L of the Building Regulations in 2006.

Insulation was a key aspect of the house and the design team adopted an early cassette system, with the cellulose insulation blown into the OSB cassettes on-site. "We superinsulated the core of the building and were able to show that it was possible to build a modern house that exceeds building regulations for thermal performance without having massive walls," explains Bree.

All of these measures made a huge impact on thinking and learning about how homes should be built. Interestingly, in many ways, it did become the prototype millennium house, as we now take many of the features for granted.

Before the retrofit began, the house was temporarily occupied to gain real feedback. In addition, a full suite of testing was undertaken, explains John O'Brien. "We did a survey of what was here, we did infrared imaging and airtightness and indoor air quality testing." ▶

TOP LEFT KNX light switch and WiFi heating control
TOP RIGHT Downstairs bedroom
ABOVE MIDDLE Interior during retrofit. Note the vertical riser core and horizontal ducting behind the skirting
ABOVE British Gas security monitor

Some of the work that needed to be done was obvious. Based on quite early technology, the original ground source heat pump had failed. "We replaced that with an air source heat pump. The walls were great; we didn't need to do anything to them. We then looked at the services as a whole as well as the fabric, heating system and renewable technology," says O'Brien.

A new solar water heating system has been installed but the biggest change has been to the conservatory space. The roof has become a large integrated solar collector. A translucent 3.3kW PV array provides 70% shading over clear glass to reduce heat gains and should achieve 60% of the power needs of the house in ideal conditions.

A whole house living system controls the heating, lighting, ventilation, water, and security. The system employs occupational sensors that can be used for a range of purposes, including security or monitoring the movements of an elderly person in the home. Throughout, the latest low-energy LED lighting has been installed. Usefully, a vertical riser core, voids within the walls and horizontal ducting behind the skirting had been incorporated into the original design to enable future upgradability of the services, so installing new cabling, lighting and control systems was relatively easy.

"We've gone from 'runways' of halogen lights to very specific LED lighting linked to the smart technology," says O'Brien. "KNX (a network communications protocol for intelligent buildings) had been installed originally. This is a good example of a technology that was nascent and could be upgraded. Our requirements change, yet you have that standard KNX protocol that will still work across a suite of manufactures' products."

In the bedrooms, a 3mm-thick insulating plaster has been used to improve thermal performance in conjunction with paint that radiates heat back into the interior. The paint used on the internal walls contains light-reflective particles to reflect up to twice as much light back into the rooms, making them feel brighter and more spacious while reducing lighting needs.

Overheating was a problem in the upper floor. During the retrofit, phase change material (PCM) has been incorporated behind the plaster to introduce thermal mass into the structure and passively regulate the room temperature. 'Intelligent' triple-glazed rooflights have also been installed to facilitate the purge ventilation strategy needed for the PCM.

In 1998, Integer House was an early vision of the web-enabled home but it was cabled. Now WiFi is employed throughout, enabling 'intelligent' control of everything from energy to security along with supported living for the ageing demographic through 'tele-healthcare'.

So what has this retrofit achieved? According to the BRE, the house is now 50% more energy efficient, its carbon emissions have been halved and it achieves an A/B EPC rating rather than the D calculated just prior to the retrofit. All of this, along with its ability to demonstrate some cutting-edge technology, is pretty impressive, although nothing like as revolutionary as the original achievement of designing a mould-breaking, forward-looking house that remains iconic today. sh

CONTACTS

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BELOW WiFi radiator thermostat
BELOW MIDDLE WiFi controlled sockets
BOTTOM Stairwell