The all weather homes

Martina Lees goes inside the pioneering £16m Salford lab that is assessing houses' energy efficiency and ability to withstand climate change

Richard Fitton and Will Swan
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I am standing in the future — it is inside a giant black cube of a building in Manchester. Here, at the world's first laboratory of its kind, scientists will test the homes of tomorrow in every weather the climate emergency is set to bring.

Energy House 2.0, a new £16 million laboratory at the University of Salford "can replicate the weather in 95 per cent of the populated globe", says Richard Fitton, professor of building physics. Outside it is 5C, an average British winter's day. But in the two chambers where Fitton's team will test houses, you can "just about" create four seasons in one day — from -20C to 40C heat waves with wind, rain, snow and solar radiation, Fitton explains, dressed in a thick orange parka fit for the freezing conditions he can simulate.

Each of the test chambers is large enough to fit two detached houses. In one, a team from Barratt, Britain's biggest housebuilder, is putting the finishing touches to eHome2, a zero-carbon family house built with materials from the French company Saint-Gobain. Next to it stands another concept house by Bellway.

The research conducted within these walls will inform not only what technology the big developers will roll out to build homes fit for the climate crisis, but also what we can do to retrofit our homes. Scientists will test how different types of insulation, heating and renewable energy fare in the extreme weather patterns expected in decades to come. Some technologies are new; some are already available to consumers. The findings will show what works and what is not worth spending your money on.

Today, the second chamber is a balmy 19.7C and rising, to test how a small cabin could be upgraded to house a homeless person in comfort. "A local charity donated a lot of these cabins, but they're terribly inefficient. We're trying to bring it up to a zero-carbon shelter," Fitton says. Next his team might test a 3D-printed disaster shelter or, possibly, army tanks in sub-zero temperatures.

Far above us, three mammoth ceiling ducts suck the rising air into handling machines, which push it back down via heaters or chillers (like your freezer's motor, but much bigger) to control the temperature. Essentially, we are in the middle of a giant

The Energy House 2.0

air-conditioning system with a £6 million price tag.

On standby are mobile rain rigs (water nozzles attached to scaffolding on wheels) and wind machines (four giant fans) of the type used on film sets. "When we first started designing them, we worked with a guy that does a lot with Netflix," Fitton says. A snow cannon, due to cover the test houses in snow for Thursday's launch, "is exactly the same as you would find on the ski slopes". All the kit can be moved around to test buildings of any shape. "Our job is to stress test these buildings. We can see what works today — and what's going to work in 2030, 2050, 2080, with the climatic shifts we will get."

Over the past 12 years, Fitton's team have experimented on a Victorian terrace that permanently stands in a similar but smaller University of Salford test chamber. "We sat in the shadows for years when no one was interested," he says. Now, thanks to soaring energy prices, "everyone wants to know". Most recently, their research formed the scientific basis of the government information campaign to lower your boiler's flow temperature to 60C.

In the giant chamber, eHome2 – based on Barratt's popular three-bedroom Moresby house type – will test both the fabric of the house and the technology in it. Over the next few years, people will live in the house while hundreds of sensors (but no cameras) measure minute changes in motion, temperature, light, humidity and energy use. "It will basically be like Big Brother – everything will be monitored," jokes Sam Lafferty of Barratt.

Innovative materials mean the 36cm (14in) thick walls are highly insulated without eating into internal floorspace. A thin layer of Weberwall brick-effect sheets was plastered on. They are less carbon-intensive to make and faster to fit than brick slips, which are cut from real bricks. A timber frame using I-shaped beams (scotframe.co.uk) has more room for factory-fitted, non-combustible mineral wool insulation. This cuts the wall's U-value – which measures how quickly heat passes through – to 0.13 W/m2K, close to the levels of highly energy efficient Passivhaus buildings.

The Nuspan insulated concrete floor, fitted in only four hours, was manufactured offsite in Lincolnshire. Windows are double-glazed, but the Eurocell frames can fit triple-glazed panes for future testing.

"If you put this really warm coat on the house, you don't need as much energy [for heating]," says Oliver Novakovic, technical and innovation director at Barratt. Inside, the housebuilder fitted dual heating systems to test whether direct electric heat, usually expensive to run, becomes viable when demand is low.

The electric system is Cürv infrared heating via flat white panels and mirror heaters, which feel like the sun warming your skin. Hot water for showers comes from a tank with a small integral air-source heat pump. (This combination suits smaller homes and flats that lack garden space for a bulky heat pump which is typically the size of an air-conditioning unit.)

Pitted against this is a water-based system: a Vaillant aroTherm heat pump outside takes heat from the air and amplifies it to heat water in a large cylinder inside the house. That supplies both the hot water and heating, via Thermaskirt skirting boards that emit ambient heat similar to underfloor heating, but are simpler and cheaper to install.

"The homes of the future are more airtight and more insulated, so you have to vent them," Novakovic says. Without ventilation, the house would trap moisture and become riddled with damp and mould. They will test two ventilation systems in eHome2. A centralised unit in the loft pumps moist air from the kitchen and bathrooms outside, while fresh air comes in through trickle vents around windows. The second system has a mechanical ventilation and heat recovery unit which does the same thing, but uses the heat from the stale outgoing air to warm the fresh incoming air.

On the roof is a 3.75kWp system of 30 small solar panels generating energy that is stored in a scalable 10kW Fox battery in the loft. It will supply enough power for all the heating, hot water and lighting – excluding cooking and appliances – making the house operationally zero carbon. At today's prices, your monthly energy bill at eHome2 would cost about £85, compared to £250 to £350 for a Victorian house, according to Barratt.

The housebuilder fitted 12,000 solar panels in 2021 but says the industry does not yet have a big enough supply chain to fit heat pumps and solar panels on more than 200,000 new homes a year – let alone 27 million existing homes. Hence the company focuses on getting the building fabric and ventilation right first, Lafferty says.

Hidden in a cupboard above the stairs is the brain of eHome2: a Loxone smart system monitors the simulated weather outside and adapts the house to it. It uses surplus solar energy to heat the hot water and charge the electric car for free; switches off lights and standby devices in empty rooms; and automatically controls blinds to let in (or block) solar heat for optimum comfort. You can control the system through smart switches in every room, an app or voice commands like Alexa, but can also leave it to run itself.

"I've built a lot of smart homes, but this one really is where we need to get to," says Novakovic, who previously oversaw BRE Innovation Park, which has some of the world's most sustainable homes. He says eHome2 is "one of the most significant projects that Barratt has ever undertaken".

Buildings account for a quarter of Britain's carbon footprint. From 2025, the Future Homes Standard will require all new-build homes (and extensions to existing homes) to be ready for net-zero carbon emissions. The country is legally bound to cut emissions to net zero by 2050, to help the world avoid catastrophic climate change.

"A lot of energy [research] is modelled, but there are errors in models. We're all about measurements," says Fitton, who worked as a surveyor before he became a professor at Salford. "These companies are going out there to build thousands of homes a year, and we'd have had a part in saying what is good, bad or indifferent [for climate change]. It's research with impact." ■