Works

Working outside the box

In tune with last month's Stern Review, a house squeezed between Victorian terraces in north London takes its own action to combat climate change, observes Graham Bizley

Just as we were all enjoying the remarkably mild autumn weather and mulling the apparent benefits of climate change, the aptly named Stern Review arrived last month – the latest salvo to try and shake us out of our complacency. But without an immediate cost saving, the UK construction industry has little incentive to use sustainable products, leaving committed individuals at a grass-roots level to push the boundaries.

Focus House in north London, just completed by Bere Architects, is an example of how modern materials can be integrated with simple building services to make an architecturally inventive home on a tight, infill site. Low embodied energy and low lifetime energy consumption mean the home has a very low carbon footprint.

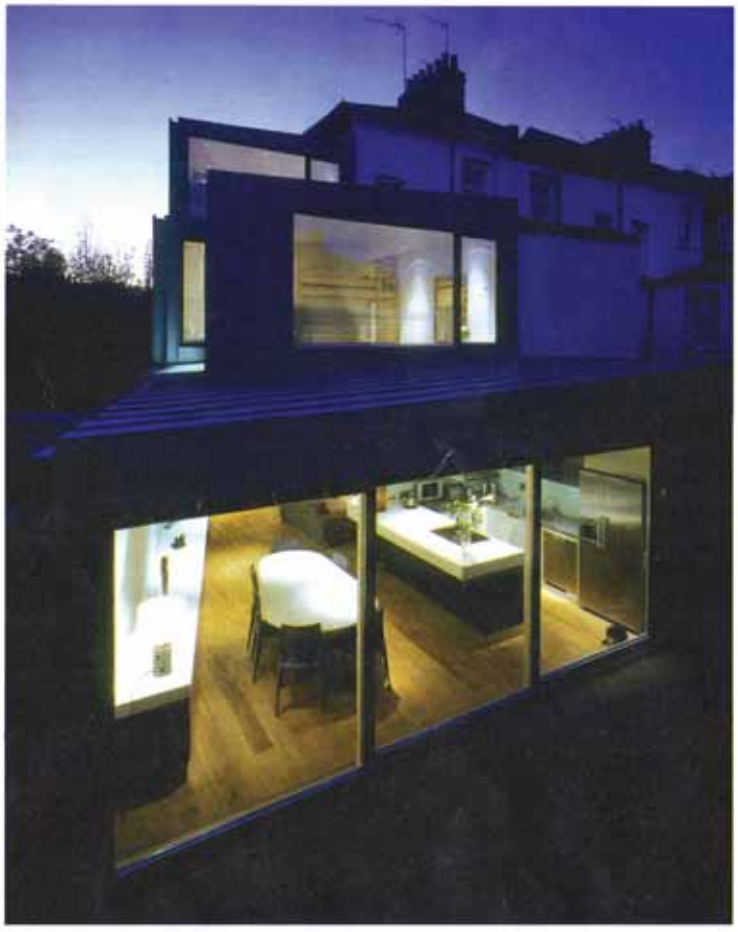
Through practical experimentation on a series of projects, Justin Bere's office is building up a strong practical knowledge of low-carbon buildings. His own house, nearing completion at Newington Green, sets out to define a language of architecture, "directly generated by the acceptance of the ecological imperatives of the 21st century".

The client for the Focus House found Bere through the RIBA Client Advisory Service and were delighted to find a like-minded collaborator. "The first one on the list was engaged and the second was Justin. I didn't call the rest," the client says.

Unhappy with the limitations of their large but high-maintenance Victorian terrace house, the family of five wanted to put its money into something smaller but better organised and more efficient. The site they found was adjacent to an end-of-terrace house which they bought, renovated and sold to help pay for building the new house.

Only 2.8m wide at the entrance, the house widens to 7m at the back where it opens on to a small garden. Every bit of airspace has been filled, the forms echoing the piecemeal additions at the rear of the neighbouring houses. Dark grey zinc cladding unites the volumes, linking the house with other more functional infill buildings like workshops and garages rather than the Victorian houses. Its narrow presence on the street modestly conceals the bulk behind, like an elephant looking through the gap in the houses.

Islington council planners were keen that the house address the street and not just look towards the garden. The front door and staircase are glazed so the occupants get constant glimpses of goings-on outside, helping police the street. There is no house directly opposite so from inside you get a vista right through the ground floor from the garden to the trees on the opposite side of the street. On the second floor landing a projecting office space forms a porch above the entrance, the only room with a direct view out, so when working from home the client can feel a part of the wider world.



Left: The Focus House, with its distinctive zinc cladding, has been inserted into the space next to an end of terrace house.
Above: The house widens from 2.8m at the front to 7m at the rear.

The house manages to be spatially inventive and simultaneously accommodate the complex technical requirements of the environmental control systems. The ground floor is planned to make subtly distinct areas for eating, cooking, working and sitting. The height of the kitchen element gives intimacy and enclosure when sitting down, but the space still feels open when you are moving around.

A short flight of stairs connects the office space and the parents' bedroom at the top of the house. Half a floor down from the office is a bathroom and this upper section of the house can be closed off from the children's bedrooms to give the parents some privacy. Carefully placed windows also increase the sense of detachment of the upper floor. Looking down from the parents' bedroom you get a distant view through the office to the pavement, while through a higher window you see the roofline of the houses opposite silhouetted against the sky.

Solid cross-laminated timber slabs form the walls, upper floors and roof slabs. Prefabricated in Austria and brought to London in kit form (see *In Detail*), the slabs are very fast to erect, able to span long distances and are made from a sustainable material. The timber shell is externally insulated so that its thermal mass is on the inside of the construction where it can moderate extremes of internal temperature and moisture. The walls are solid when you tap them and the house feels reassuringly sturdy.

Its narrow presence modestly conceals the bulk behind, like an elephant looking through the gap in the houses.

Timber was not the initial choice. The structure started off as in-situ concrete to achieve the cantilevers over the front entrance, but the cost was too high and the project had reached something of an impasse.

Material benefits

While the Focus House was built with a solid timber structure, two alternative structural materials were considered: ordinary portland cement; and 70% ground, granulated blast furnace slag (GGBS).

- By using reinforced Portland cement concrete, the concrete alone would have added a total of 32.42 tonnes of carbon dioxide into the atmosphere by the burning of fossil fuel.
- The GGBS option would have had less impact than portland cement but nevertheless added a total of 10.9 tonnes of CO_2 into the atmosphere by the burning of fossil fuel.
- A solid timber structure would effectively remove 42.4 tonnes of CO_2 from the atmosphere, though transporting it from Australia emitted 3 tonnes of CO_2 into the atmosphere. If the wood had been frown in a forest in England, transport emissions would have only been 0.3 tonnes.

Someone in Bere's office had heard about the properties of solid timber panels and they were able to form the first floor projection much more simply than would have been possible with steel or concrete. What's more, this turned out to be cheaper than building the structure in concrete. The entire timber shell was delivered on two lorries, erected in a week and cost about £50,000.

And timber is more sustainable. Building in concrete or steel adds carbon dioxide into the atmosphere through the burning of fossil fuel to produce the raw materials (see box above). Using wood stores carbon dioxide out of the atmosphere for the lifetime of the building or for as long as timber buildings are built on that site, even accounting for cutting and transportation costs, thereby mitigating the overall effects of the development.

Another factor is the Focus House's sustainability was its energy use. Space heating accounts for 60.5% of the UK's domestic energy consumption and water heating 25%.The design of the Focus House has been influenced by Passivhaus guidelines, a German standard where the building is well insulated and air-tight enough that the only heating required is a small electric heater within the ventilation system. Detailing of the house carefully omits most thermal bridges and potential ventilation heat losses, heat recovery ventilation is used ▶

Left: Looking out from the ground floor kitchen/ living space. The large window areas will ideally be protected by external louvres in the summer and by internal curtains in the winter.
Below left: Staircase.

throughout the house and solar thermal is used to contribute to heating the hot water.

The house is expected to generate 50-60% of its annual hot water requirements by means of the solar thermal installation (100% in summer, 5% in winter). The south elevation is not allowed windows as it overlooks

Total carbon storage benefits of the Focus House amount to a total CO2 extraction of 30 tonnes.

gardens so the Focus House has been unable to reap the full benefit of solar gain in winter, and on a tight site an increase in wall thickness can quickly reduce the internal area, so room for manoeuvre is limited.

High quality Scandinavian windows combined with an efficient heat recovery ventilation system will reduce ventilation heat losses to a minimum. However, the glazing would have needed to be triple glazed to meet PassivHaus standards. An average of over 200mm of Foamglass insulation on top of 200mm of solid wood will provide good winter insulation and Foamglass also provides particularly good summer protection from the heat of the sun due to its thermal capacity. The large window areas would ideally be protected by external louvers in the summer and by internal curtains in the winter. Manually adjustable external louvers would allow the sun's energy to be harvested on appropriate autumn, winter and spring days.

Taking all this into account, if the occupant was minded to be particularly economical, it should be possible to live comfortably in this house while consuming very small amounts of gas and electricity. If typical comfort levels are to be achieved, CO_2 emissions will remain relatively low compared to the average London end of terrace house, but depending on the habits of the occupants, heat and electricity appliances may be responsible for up to 2 tonnes of CO_2 emissions annually. In this event, after 15 years the carbon extracted out of the atmosphere in the choice of construction materials will have been balanced out by CO_2 emissions in space heating and topping up the solar heated water as necessary.

Fresh air is supplied to the whole house with a mechanical ventilation system using a 95% efficient heat exchanger to warm incoming air with waste heat from the bathroom extracts. More than half the annual water heating energy will come from a solar installation high up on the south elevation, supplemented by a gas fired boiler. Opening a cupboard on the ground floor reveals a mass of ducts taking air off to each room. A dedicated plant room the size of a cloakroom is needed to house all the kit.

Thousands of self-builders across the country are pursuing a similar agenda, but so often money is spent on gadgets and gimmicks instead of the building envelope. Here the clients have invested in a high-performance shell with low long-term emissions that is built to last.

Until recently governments have bowed to industry's threats of economic stagnation and baulked at imposing restrictions on indifferent voters. As more young people educated from an early age in the dangers of global warming reach voting age, pressure to act may have reached the critical level. Stern concludes, "Tackling climate change is the pro-growth strategy; ignoring it will ultimately undermine economic growth."

● *Graham Bizley is a director of Prewett Bizley Architects*

The domestic carbon footprint

Total carbon storage benefits of the Focus House as built amount to a total CO_2 extraction of 30 tonnes. This is calculated by total emissions of 3.11 tonnes for the concrete slab and foundations including piles (70% GGBS) and 5.24 tonnes for the zinc cladding, which has the lowest embodied carbon of any metal, set against CO_2 extraction of 39 tonnes for the wood structure.

As an end of terrace house Focus House required more insulation and cladding than a mid terrace would have needed, raising its CO_2 emissions.

Putting the house into context, a conventional 5.1m-wide, brick terraced house would create total CO_2 emissions of 5 tonnes, 35 tonnes more than the Focus House. This is calculated by total emissions of 2.53 tonnes for the concrete slab (70% GGBS) and 2.78 tonnes for the brick, comprising one party wall and two facades.

Housing accounts for around 30% of the UK's total CO_2 emissions, up from 26.4% in 1990. While insulation standards have improved domestic energy demand carries on rising.

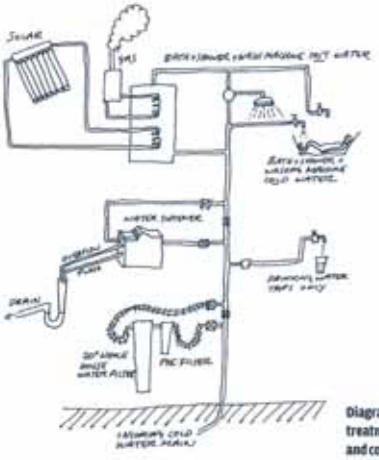


Diagram showing treatment of hot and cold water.

Architect
Bere Architects
Structural engineer
Techniker
Quantity Surveyor
Andrew Turner
Main Contractor
Vision Build
Structural wood panels
KLH UK
Zinc cladding
PMF Roofcraft
Heat Recovery Ventilation
Ubbink
Solar Thermal
Viessmann

In detail

Focus House north London
Architect: Bere Architects
Structural Engineer: Techniker
Solid timber shell: KLH UK

A new house on a north London infill site incorporates high quality materials and a carefully balanced services strategy to minimise its carbon footprint.

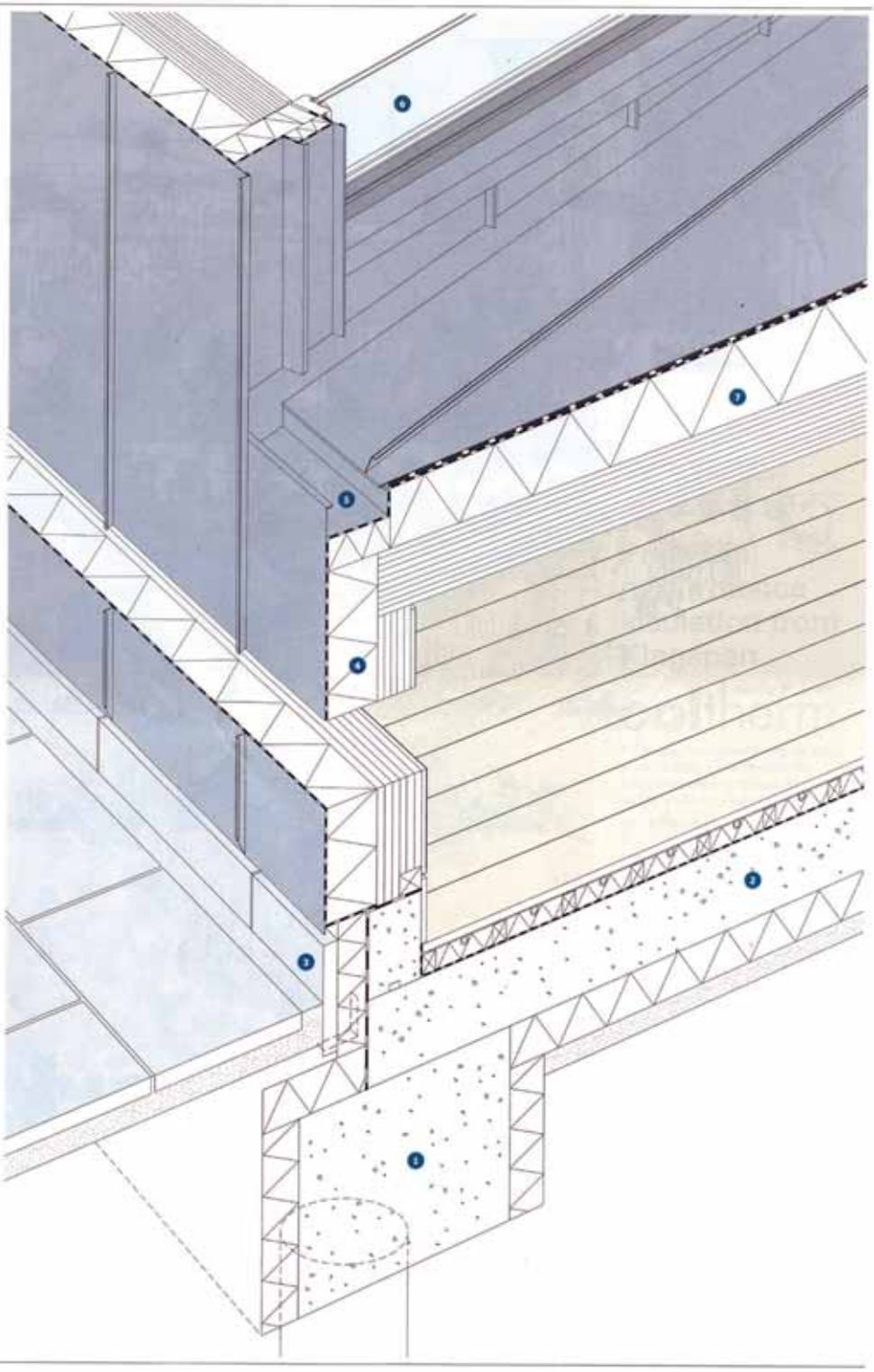
The shell is constructed from pre-fabricated, cross-laminated, solid timber panels manufactured in Austria. The panels are made precisely to size with service chases, window and door openings factory-cut. Its thermal mass helps control temperature variations inside and the timber acts as a carbon store, easily offsetting the carbon emission from transportation.

Zinc-titanium alloy sheet has been used to clad the roofs and walls, clipped to metal plates spiked directly into the cellular glass insulation, so there are no thermal bridges across the insulation layer. The insulation is cut to falls and is 500mm deep at its thick edge. The roofs fall to the south edge where the zinc is folded to form a continuous gutter which runs down the vertical faces in place of rainwater pipes.

There is no ventilation gap behind the zinc. This is possible because the insulation is completely waterproof and vapour impermeable. The outer face of the insulation was site painted with a bituminous coating to seal all the gaps. A loosely woven spun nylon matting beneath the zinc traps a layer of air and separates it just enough from the insulation to ensure that if a tiny amount of moisture does get in it will not corrode the metal.

Over the desk in the main living space is a rooflight. The triple-glazed sealed unit sits in a stainless steel angle frame invisible from inside so the rooflight just appears as a cut-out in the roof.

Detail drawing and text by Graham Bizley



Cut-away section through side wall, window and roof.

1. Foundations
600 x 450mm reinforced concrete ground beam with waterproof additive.
200mm thick reinforced concrete slab with waterproof additive spanning between ground beams.
100mm extruded polystyrene insulation below slab on 50mm sand blinding.

2. Ground floor
180 x 21mm European oak engineered timber floor boards with grey oiled finish.
Low temperature hot water underfloor heating pipes with metal radiation plates suspended between battens.
50 x 50mm treated softwood battens at 300mm centres.
50mm rigid insulation between battens.
Polythene vapour barrier.
200mm-thick reinforced concrete slab with waterproof additive spanning between ground beams.
100mm extruded polystyrene insulation below slab on 50mm sand blinding.

3. Slab edge
200 x 150mm concrete upstand around slab perimeter.
Bituminous liquid-applied waterproofing membrane to side and top of upstand.
100mm rigid polystyrene insulation.
40mm-thick precast concrete paving slabs fixed back to upstand on stainless steel brackets.

4. Typical wall
Zinc alloy sheet cladding with angled double standing seams folded over clips spiked into insulation.
Bituminous felt waterproof layer.
Liquid applied bituminous sealant to fill any gaps in insulation.
140mm Foamglass insulation bonded to solid timber panel with bituminous adhesive.
128mm (94mm on upper floor) solid cross-laminated timber wall panel notched over and fixed to softwood batten wall plate fixed to concrete upstand.
Plasterboard fixed to inside face of timber panel with skim coat and paint finish.

5. Gutter
180 x 80mm-deep pre-formed folded zinc alloy sheet gutter folded over clips spiked into insulation.
Bituminous felt waterproof membrane.
Foamglass insulation around gutter.

6. Typical window
Proprietary softwood framed double glazed high-performance window.
Softwood sub-frame fixed to structural timber panel.
Preformed zinc alloy cill slotted into route in bottom of window frame.

7. Roof
Zinc alloy sheet cladding folded over clips spiked into insulation.
10mm spun nylon open-weave matting to allow ventilation, expansion and acoustic isolation.
Bituminous felt waterproof layer.
Liquid applied bituminous sealant to fill any gaps in insulation.
Tapered Foamglass insulation varying from 500mm maximum to 140mm minimum thickness.
146mm solid cross-laminated timber panel structural deck sealed internally with coloured natural wax.