The old and the new
The clay-tiled roof, recycled bricks and lime render give the front elevation a house a 'traditional' appearance while the large expanses of glass, and the double-height conservatory make the rear appear quite contemporary. The extensive glazing makes the most of solar gain with the added bonus of maximising the wonderful views.

The day that made a lasting impression on Mike

"I would never have guessed as I set off for work one morning in the mid 1990s that my assignment that day would have such personal significance. Life as a travelling cameraman for ITV news was never predictable. I had been asked to shoot a story about 'some new kind of house' in Southwell, Nottinghamshire. It was built by architects Brenda and Robert Vale, who had set out to construct a home which would tread as lightly on the earth as possible. The core construction used a lot of bricks and concrete to provide high thermal mass. This was surrounded by an unprecedented amount of insulation for that period, with attention paid to airtightness too. With a relatively limited choice of materials available, many had to be imported from Europe and Scandinavia, including triple-glazed windows and low conductivity wall ties. Robert Vale showed us around the house – I particularly remember the large basement, with its Clivus Multrum composting toilet chamber, which created clean garden fertiliser from human waste, without using any water for flushing. There were also 20 'Rotoplas' tanks – giant 1500 litre plastic orange juice bottles – which were used to store rainwater, which after filtration by a slow sand filter supplied all of the domestic water. Together with the composting toilet system and a grey-water soakaway, this meant the house operated largely autonomously, with just a mains electricity connection, assisted by the first grid-connected photovoltaic array in Britain. The story never got a run on the news but my visit and meeting Robert Vale left a lasting impression. "

THE Autonomous HOUSE II

Mike Coe and Lizzie Stoodley have built an energy efficient home in Worcestershire, based on Brenda and Robert Vale's iconic Autonomous House.

WORDS: **DAVID OLIVIER** PICTURES: **STEVE TAYLOR**

Green living
Mike Coe and Lizzie Stoodley (above) have endeavoured to build a house with a green footprint. "If I hadn't been building a house as environmentally benign and cutting-edge as this one, I wouldn't have bothered," says Mike.

"In 2008, I was telephoned by Neill Lewis, a chartered architect from Malvern and AECB Board Member, asking if I could provide design advice on an exceptionally energy-efficient new house in south Worcestershire. The clients were Mike Coe, a former ITV news cameraman, and his partner Lizzie Stoodley, a freelance subeditor.

In the 1990s, Mike had visited Brenda and Robert Vale's iconic Southwell Autonomous House, having been asked to cover a story about a novel house for next day's news. Although the film was not used, the visit left a lasting impression (See panel opposite). In 2006, an opportunity arose to take early redundancy and the idea occurred to Mike and Lizzie that they could create a version of the Autonomous House and contribute to "doing their bit".

The couple had a long-standing desire to leave London, a decision which culminated in a plot search over almost the entire Midlands and the purchase of a site on the edge of Cropthorne, a small village in the Vale of Evesham. They found that the site had an eventful planning history. A cottage on it had been demolished after a major fire. A property developer then bought the land and tried to build an estate of new houses. Thwarted by planning refusals – most of the land was outside the village envelope – and unable to make a profit, the developer gave up and sold it on as a self build plot.

In a sense, the brief was straightforward - to learn from and improve on the Southwell Autonomous House, taking advantage of 15 years of progress and commercial leading-edge technology. All of the materials were to be assessed for environmental impact and sourced locally where possible.

The internal floor area was to be around 144 m² - "sufficient but not lavish" in Mike's words. There are four bedrooms on the ground floor and an open-plan living area above, with an adjoining kitchen, home office and toilet. The upside-down layout, copied from Southwell, helps the living areas stay warm during winter, thanks to zero overshading of the south-facing windows, while the bedrooms keep cooler in summer. Also copied from Southwell is the unheated basement, containing the composting toilet chamber, rainwater storage and other mechanical plant.

To meet the aim of near-zero backup heat, I suggested significant modifications to the original plans, including elongating the house more from east-west and turning it to face due south. In order to utilise more passive solar energy in this way, the house would no longer be parallel to the local road. But there are historical precedents for this, as I have found with my own house.

Spanish inspiration

All the floors have been laid with warm terracotta tiles to make the most efficient use of the heat stored in the concrete mass. Mike and LIzzie tried to source the tiles locally, but couldn't find anything suitable, so they imported them from Spain. The tiles are fired in kilns at a much lower temperature than anything available in the UK. The decorative tiles for the staircase were sourced from the Craven Dunnill Jackfield Tile Museum in Ironbridge, Shropshire.

With the team having all agreed a design, Neill submitted a planning application and Mike and Lizzie waited for what to them seemed like an eternity. Finally, the Wychavon Council planning officer informed them that he had approved the design under his delegated powers. Relief all round!

With the lack of local building contractors with experience on such houses, I suggested getting in touch with Mike Neate of Eco-DC. He had been working as project manager on the refurbishment of Grove Cottage in Hereford to near-Passivhaus standards and he had the advantages of an original training in architecture and a wide experience in low-energy building. His travelling lifestyle meant that he could work anywhere. He duly moved a caravan onto the site in May 2009 and the groundworks got underway in June, using a local specialist, LeBrun Construction.

LeBrun's work was so good that they were subsequently employed to build the structural core of the house, including the dense blockwork walls and the poured concrete ground and first floors, which make a major contribution to the total thermal mass and incorporate recycled aggregate. Several tonnes of electric storage heater bricks, with almost twice the heat capacity of a concrete block of the same volume, were salvaged locally and used to build a few internal walls.

As the blockwork neared completion, Mike Neate brought in a small team of his own men to fix the external insulation and build the timber roof. Lime plaster was applied to the dense blockwork to form the wall finish and air barrier on the external walls. The result of careful design and construction is that the finished house is 20 times more draughtproof than a normal new UK home. Without this feature, no home can expect to come close to zero backup heat.

The Green Building Store quoted for triple-glazed low-e argon-filled warm-edge windows in insulated wood frames, made by Optiwin, Austriay. All three panes of glass in the south-facing windows were changed slightly from the normal specification, to improve passive solar gains. This request seemed to be unfamiliar to the German supplier, although I had been through the same process with the supplier of the Canadian windows used on my house and they seemed to be familiar with it.

The thermal performance of the proposed house was modelled using Germany's Passive House Planning Package (PHPP), and a cross-section through the house "as built" is shown below. The desire to maximise energy performance, while making the elevations acceptable to the planners, plus changes during design and construction, led to a wide array of files circulating – the dreaded 'analysis paralysis'.

In an average winter, the finished house should need about 6kWh/m² per year of backup heat, if it is kept at 20ÐC. This is 98-99 per cent less heat than an old, uninsulated house would need to maintain the same temperature. A good example is the Victorian house in Evesham that Mike and Lizzie lived in during the build; in winter 2010-11, its gas central heating system could not even keep it warm. But Mike and Lizzie find internal

Composting toilet

The composting toilet system was one of the first considerations for the layout of the house as the toilets must be sited directly above the basement composting chamber. The hand-thrown pedestals were made by Tony Hall in his Welsh workshop and based on giant rhubarb forcers.

The kitchen

Although not strictly an 'eco' specialist, Mike and Lizzie were impressed by the Village Kitchen Company's enthusiasm and willingness to provide what they we wanted. Smile Plastics (now Remarkable Smile) supplied the kitchen worktops which are made of plastic panels recycled from vending machine cups . "After living with the panels we can report that they're great, and a splendid way to re-use an otherwise waste material," says LIzzie.

temperatures of below 20C in mid-winter perfectly comfortable in a draught-free Passivhaus, so they regard a 98-99 per cent reduction in energy consumption as an underestimate.

The original plan was to fit a small wood-burning stove for backup heating during the coldest parts of the winter, as did the Vales in the Southwell House. My list of environmental concerns over stoves; their invisible PM-2.5 air pollution and the effect of their visible soot on climate change, plus suggestions of alternative backup fuels, caused Mike to have second thoughts, and the woodstove and chimney were removed from the design during construction. But not, unfortunately, before Mike had bought a stove. This is now cluttering up the garage!

The electrical services include a 12 volt system which partly replaces the usual mains circuitry. Power is wasted in conversion from 240 volt mains to the extra low direct current (DC) voltages needed by LEDs and indeed most electronic devices. Supplying them from a 12 volt system can reduce overall losses.

The electricity is stored in a pair of ex-BT backup batteries, each with its own high efficiency switched-mode charger.

We came across a staggering example of the scale of power waste in new UK homes. Mike's measurements showed that his smoke alarms – Building Control require four in a new dwelling this size – consume 8W each if they are run off the mains. This is due to their inefficient AC-to-DC power supplies.

To avoid wasting 32 watts of power, 24/7, the individual alarms are supplied with DC from the batteries, which are in turn fed by the PV panels in daylight hours. This arrangement was approved by the Part P Electrical Inspector. The total power consumption of four smoke alarms is thereby cut from 32 watts to 2 milliwatts; – a factor of 16,000!

Mike's background in electronic engineering came in handy here, though, and the average self build couple might have difficulty with this approach. Overall, the buck stops with the government. With some changes in legislation and regulation, there should be ways to avoid virtually all this power waste without needing a mixed AC/DC wiring system.

Upside down

The layout of the accommodation is 'upside down', like The Autonomous House, with the main living area upstairs and the bedrooms downstairs. This has been done for practical energy saving reasons, rather than any aesthetic considerations.

Reaping the rewards

Air is extracted from the compost chamber by connecting it to the mechanical ventilation and heat recovery (MVHR) system, not by using a separate fan. So no additional electricity is consumed and any heat generated in the composting process contributes to warming the house.

The cost of going green – "we'll save £3,000 a year"

"In building a house like this, the strategy was very much to invest at the beginning, but reap the rewards in the longer term. Of course it won't just be us who reap the rewards – as long as they understand the house all future occupants will benefit from what it has to offer, and so will the environment. The two major cost inflators were the Passivhaus features and the autonomous systems. This includes building a whole-house basement (approx £45,000 extra) in order to house everything.

Despite this, total build costs (although still incomplete data) came to around £360,000, not allowing anything for my own significant input. The site cost was £295,000. A local surveyor valued an equivalent 'standard' house in this location at £650,000. But, he went on to say, they (as estate agents) are now beginning to encounter buyers who are very keen to reduce their environmental footprint and with it their running costs, and they are prepared to pay extra to do so. With this in mind he suggested a genuine value for this house 20 per cent higher. So a value of £780,000.

It's important to look at the longer term costs though. I've long believed what you pay for a home includes running costs during the time you live in it, not just the purchasing price. During the build, Lizzie and I lived in a typical Victorian semi-detached house in nearby Evesham. It had a condensing gas boiler, some double-glazing and some loft insulation. Total annual cost for water, sewage, gas and electricity was £2200.

In the new house we have no water or sewage bills. There's no gas in the village, and (still incomplete data) I expect the electricity bill to be between £200 and £300 per year. The photovoltaic array is expected to bring in £800 to £1000 annually from the Feed-In Tariff, plus when the Renewable Heat Incentive is finally introduced, there will be an additional allowance for the carbon offset of our solar hot water system.

So a reasonable estimate is a saving in running costs of £3000 per year at today's fuel prices. As these inevitably increase, our savings will increase in line with them. A total saving of £40,000 to £50,000 in a decade is, I believe not unrealistic. If we stay here (survive!) even longer, a saving of £100,000 in the second decade seems entirely achievable, and all the time with a tiny environmental footprint.

All of a sudden this initially more costly house

Home truths

Why did you chose to go down the difficult route of creating an autonomous house?

If I hadn't been building a house as environmentally benign and cutting-edge as this one, I wouldn't have bothered. **Lizzie:** Once Mike had put the idea to me and I'd had time to think it over, it seemed such an exciting challenge. Far more interesting than simply moving to another part of the country and buying a conventional house. Also, we were considering building – and improving on - something for which there is already a successful working model (the Vales' house). The idea of autonomy is very appealing, from the perspective of making fewer demands on the environment, future-proofing to some extent, and cost saving.

Did you have any previous building experience?

I had a great deal of experience working on houses, having restored my house in London to a kind of 'Edwardian splendour', although with relatively few environmental concessions. But I'm very practical, and usually designing and building something or other. But as time passed I became ever more motivated to attempt some kind of environmental project, based on what I was observing and books and articles I had been reading. Having seen the Vales' Southwell house previously, so much of their design seemed to make sense that it was the obvious thing to use that as a model for our own house.

Where did you go for advice and information?

The Vales' New Autonomous House book, CAT and The Whole House Book, the AECB, Neill Lewis, David Olivier, and as we progressed, a whole host of other people and publications, both printed and online.

How difficult is it to embark on this kind of self build?

It's very difficult really. Although the knowledge base is increasing, there are only a few experts at this level of energy efficiency in the UK. When you move into autonomy and the related specialist systems it becomes even harder, which is why I undertook so much research and hands-on installation work myself. The general building trade is stuck firmly in the past and the big developers exist purely to make a profit. They only innovate when forced to by legislation and even then they don't like it.

Were the architects, planners and your builders receptive to your ideas?

Our architect and builders were chosen because they were receptive and had experience and knowledge of this kind of building. The planners had little or no knowledge/experience of dealing with such a build. We thought we might have problems getting permission and were fully prepared to have to go to appeal. However, they approved our plans first time round and even allowed us to place the house at an unusual angle to the road (facing due south) and so stray over the village boundary because of the high level of sustainability of the build. So to be fair, in this particular case, planning were very good.

How much of the work did you tackle yourself?

Assisted by Lizzie, I did all the plumbing, electrics and design and custom-building of the 12 volt electrical systems, installation of the MVHR, design and installation of the rainwater harvesting system, sundry labouring and carpentry tasks throughout the build, overseeing the project and accounts, and the internal decorations.

Describe your day-to-day activities during the build?

I was on site almost every day (usually afternoons) including most weekends. I spent the mornings dealing with ordering materials and other correspondence. At weekends or in the evening I dealt with accounts and paying contractors. BUT the guideline was that in order to stay sane, every day should finish with a nice meal and a glass or two of wine, and generally we achieved this.

How did you rate the team on your project?

Neill Lewis, David Olivier and Mike Neate had specialist skills that were essential to the success of this project. The building team was hardworking, adaptable, uncomplaining and a pleasure to work with. LeBrun Construction, the local groundworks company, were excellent too – professional, hardworking and happy to learn and adapt to the challenges of this build. When attempting something as unusual as this you soon learn to judge who is 'right'. You can sense the curiosity and resulting enthusiasm, or total lack of it.

What was the highlight of the build?

Breaking ground on the first day (at last)...Climbing the concrete staircase to the first floor for the first time...The arrival and installation of the windows (it had been so cold and draughty)...When the scaffolding was taken down on the first floor and we saw what a lovely big open-plan room it was... Moving in – even though the house was barely functioning at first.

And the low point?

There were no terrible lows, although we had an ongoing series of minor problems which were resolved as we went along. Many of these were due to the non-standard nature of the building. But when our beautiful, fantastically well insulated Passivhaus front door finally arrived after a long wait, we discovered that a series of misunderstandings – nobody's fault really – had led to the hinges being on the wrong side. Because of the way the hallway is laid out, we just couldn't use the door, and reluctantly had to order another. The first one is still cluttering up the garage – I'm hoping we might be able to sell it one day – there's nothing wrong with it and it's far too good to throw away!

What has given you the greatest sense of satisfaction?

We pretty-much achieved what we set out to do, having never done anything like this before, and with very few major problems.

Any disappointing aspects with the completed build?

Not really, apart from the extra front door in the garage, and that so far we've not managed to stop the conservatory leaking in heavy rain.

What do you like most about your new home?

Everything! It's exactly what we hoped it would be and more. We're constantly surprised and delighted by the play of light and shadows around the house, but especially in the main living room upstairs. The round window and the stained-glass panels enhance that at different times of the day/year. Plus we're better off financially. It's a lovely, comfortable house to live in. Being a Passivhaus, the lack of draughts and cold spots in winter mean it's genuinely comfortable at lower temperatures.

Living green

Have the energy-saving measures lived up to expectations?
Yes – better than our expectations. The house is warm and comfortable, and when we turn the tap on there's instant hot water heated by the sun for free. We don't have to think about these things, as they just work, but we don't have to pay for them either.

How has your new home changed or improved your lifestyle?
We're more in touch with the environment. We use electrical appliances (like the washing machine) on sunny days, so it's powered by the PV array, and we don't need to import electricity. The sun brings us warmth in the winter, topping up the thermal mass of the building, and provides hot water all year round. We appreciate it when it rains, because it tops up our water supply tanks. We're directly responsible for making sure we don't run out of water if there's a drought, by adjusting our consumption accordingly. If we do, it's our fault alone, but nobody else suffers. In this house you learn to observe and appreciate nature and understand how to make the most of the natural resources. In houses with 'centralised' servicing, people lose touch with all of this. They want lots of sunny weather, but still feel hard done by when there is a hosepipe ban.

In August 2011, Mike and Lizzie moved in, with just enough systems in place to make the house habitable. Since then, finishing the project has depended on their own efforts. Mike has installed all of the plumbing, the electrical wiring and the MVHR system, plus some carpentry and labouring.

In winter 2011-12, the internal temperature fell very slowly to 15.5°C, necessitating occasional use of a one-bar electric fire in the evenings. But significant lengths of MVHR ductwork in the basement were not yet insulated. After completing this work, the system was able to reclaim more heat and the house became noticeably warmer. Mike and Lizzie have few worries about the winters ahead, despite the lack of any kind of active heating system.

The 10m² roof-mounted solar hot water system has been very successful. After a week with no sun, the water in the 500 litre insulated storage tank is still hot enough for showers. It needed more insulation than the manufacturer supplied though – a common issue with DHW tanks.

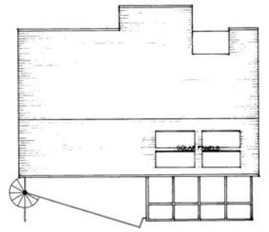
A 2.3 kW(e) ground-mounted PV array was installed in December 2011. In a normal year, it should produce more electricity than the house consumes, given that it is full of energy-efficient A, A+ and A++ rated appliances. Mike and Lizzie do large loads of washing on sunny days to avoid drawing power from the mains. Using a simple plug-in timer, the 12 volt batteries are charged only during the day, when the PV array is generating power, and are not charged from the national grid.

Nine months after moving in, Mike and Lizzie report that the house is a joy to live in. The thermal comfort, the abundant natural light and the smell-free water-saving composting toilet all contribute to this. The interior is all but complete. Mike has recently completed construction of the rainwater collection system in the basement, with its 10 storage tanks, slow sand filter and electric pumps and controls. In combination with the composting toilet, and the greywater soakaway, the house now operates almost autonomously, with only a mains electricity connection, aided by its grid-connected PV array.

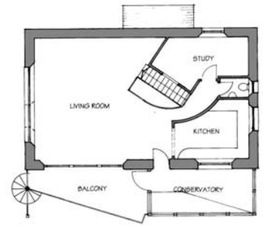
The author

David Olivier is Principal of Energy Advisory Associates. The consultancy provides independent advice to clients on energy efficiency in buildings, www.energyadvisoryassociates.co.uk

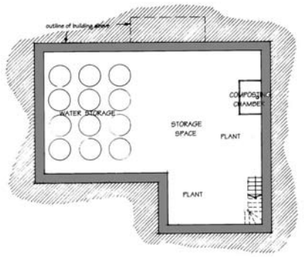
The floorplan



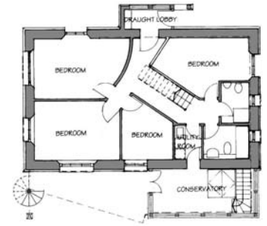
ROOF



FIRST FLOOR



BASEMENT



GROUND FLOOR

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PROJECT

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Structural engineer Stuart Derbyshire: 01905 641244
Quantity surveyor Steve Bowen: 01686 625455, www.bowenconsultants.co.uk
Independent building control services ACT Building Control: www.actsurveyors.com
Groundworks LeBrun Construction: www.lebrun-construction.co.uk

FIXTURES & FITTINGS

MVHR system and Optiwin windows Green Building Store: 01484 461705, www.greenbuildingstore.co.uk
Chamber for composting toilet system Kingsley Plastics: www.kingsleyplastics.co.uk
Solar photovoltaic system Greenearth Energy: www.greenearthenergy.co.uk
Solar hot water system Llani Solar Ltd: www.llanisolar.co.uk
Fitted kitchen The Village Kitchen Company: www.vkcdoors.co.uk
Recycled plastic kitchen worktops Remarkable Smile: www.remarkablesmile.co.uk
Ecological paints and materials The Greenshop: www.greenshop.co.uk
Lighting system Lightmaster Direct: www.lightmaster-direct.co.uk
Terracotta floor tiles Tiles of Stow: 01608 658993 www.tilesofstow.co.uk
Electrical system inspection, testing and certification for Building Regulations AJM Electrical: ajmelectrical@dsl.pipex.com
Landscaping and garden clearance and preparation Peter and Matt Wallin: 01386 860334
Antibacterial heat-transfer pipework system used in the MVHR ground tube. Rehau Ltd: www.rehau.co.uk
Masonry support and restraint fixings Ancon Building Products: www.ancon.co.uk
Hand-thrown kiln-glazed straight-through pedestals for composting toilet Castle Hill Pottery: www.castlehillpottery.co.uk
Bespoke stained glass panels using recycled wine bottle glass Jackie Harris Glass Design: 01684 566693, www.jackieharrisglass.co.uk
The Sustainable Building Association AECB: www.aecb.net
Lizzie and Mike's blog www.cropthornehouse.co.uk