THE BEDZED STORY

The UK’s first large-scale, mixed-use eco-village
BedZED: A successful sustainability pioneer

BedZED, in Sutton, south London, has gone down in history as the UK’s first large-scale, mixed-use sustainable community. It has been an inspiration for low-carbon, environmentally-friendly housing developments around the world.

Completed in 2002, it has been visited by tens of thousands of people and continues to attract thousands from across the globe. It remains, arguably, the most ambitious attempt at all round sustainability in a major new housing development.

Much of it has stood the test of time but some of its green technologies have proved challenging to adopt.

BedZED’s biggest and most important success, however, is that it remains an attractive and popular place to live, demonstrating that a large shift towards sustainable living need not entail sacrifice and discomfort. Children play happily and safely in its pedestrianised streets. Heating, power and electricity bills for its residents are much lower than ordinary housing. Sale prices for the few BedZED homes that do go on the market are above the local average.

In this booklet we explain how BedZED came to be built, the thinking behind its striking and award-winning design, what it is like to live here and how well it has performed.
Why we need sustainable communities...

We only have one planet Earth, but in Europe, North America and increasingly in other parts of the world we’re living as if we had several planets.

We’re consuming natural resources at a far faster level than they can be replenished, putting too much climate-changing pollution in the atmosphere and degrading the world’s remaining forests and wilderness. This has to change now, for future generations and to meet the needs of more than a billion people living in poverty and wanting a better life.

The best place to start is in our homes and communities, which do so much to shape our lifestyles and environmental impacts.

Sustainable communities save energy and water and reduce waste. They encourage low-impact travel and reduce the need for environmentally harmful travel. They help the people living in them to be resilient and resourceful. They are attractive, affordable and healthy places to live and raise a family.

At BedZED, we’ve started to show what a truly sustainable community looks like.

BedZED has won a number of prestigious awards including:

- Shortlisted for the Sterling Prize 2001
- London Lifestyle Award - Evening Standard New Homes Award 2001
- Special Awards: Sustainability - RIBA London Awards 2003
- Best Project & Sustainability Award - Housing Design Awards 2003
- Ashden Award 2003

“BedZED goes way beyond the standard environmental checklist by challenging both the way we live and work... Until now, pioneering communities have often been attained at the expense of architectural ambition but at BedZED the architects have been highly innovative.”

RIBA Journal Sustainability Award jury
BedZED basics

Major energy savings provided by high levels of insulation, airtightness and passive solar heating design. Electricity savings provided by solar photovoltaic arrays integrated into the buildings.

27% reduction in electricity consumption and 36% reduction in gas consumption between 2012 and 2015.

An on-site car club, ample secure cycle parking, excellent public transport links and 0.6 car parking spaces per home.

100 homes with approx. 220 residents.

Significant reductions are achieved with water-saving appliances.

High housing densities combined with abundant private and shared outdoor space and green roofs. The great majority of BedZED homes have their own gardens and there is a large community playing field and village square.

BedZED has won several awards for green architecture and design. It was shortlisted for the Stirling Prize, the UK’s premiere architecture award, in 2003.

Mixed sizes and mixed tenure – from 37 m² studio flats to a 131m² four bedroom town house.

BedZED provides homes for subsidised rent (25%), for subsidised and affordable home ownership (25%) and for sale on the open market (50%).

With workspace of about 1,000 m², BedZED is home to Orchard Hill College for young people with special educational needs, architecture firm ZEDfactory which designed BedZED and sustainability charity and social enterprise Bioregional.

Developed by Peabody Trust, a housing association, in partnership with Bioregional and ZEDfactory architects.

£15m (excluding land cost)
Origins and history

BedZED was conceived in 1997 when sustainability charity Bioregional and green architect Bill Dunster learnt that Sutton Borough Council was selling a plot of undeveloped open land, once used for spreading sewage sludge, for housing development near Beddington Farmlands.

At Bioregional, we wanted to build a new, green office in the area where our founders, Sue Riddlestone and Pooran Desai, had started out a few years earlier. Bill Dunster, collaborating with engineers Arup and Bioregional, was looking for an opportunity to create a zero fossil fuel eco-village. Peabody Trust, a long-established, London-based housing association, was recruited as the enlightened developer for this site. It was interested in how sustainable living could cut energy and water bills for its low-income tenants.

In 1998 the London Borough of Sutton, the site’s owner and the local planning authority, backed the idea of an exemplary, sustainable mixed-use development, more ambitious than anything previously attempted in the UK. The council agreed to sell its plot of land to Peabody at a price slightly lower than the full market value, having sought assurances that the government would have no objection. It justified this on the basis that building BedZED (Beddington Zero Carbon Energy Development) rather than a conventional housing estate would secure wider community benefits including reductions in climate-changing carbon dioxide emissions. Construction began in 2000.

Bioregional was founded in 1994 by Sue Riddlestone and Pooran Desai, two environmental entrepreneurs based in Sutton, South London who were keen to create practical green and sustainable initiatives.

From small beginnings we have grown into an organisation which has founded several green enterprises, influences the sustainability of many thousands of new homes and works with global businesses to make their operations and strategy more sustainable.

Bioregional champions a better, more sustainable way to live. We work with partners to create places which enable people to live, work and do business within the natural limits of the planet. This is called One Planet Living.
BedZED’s zero fossil fuel heat and power ambition

BedZED was designed to be free of fossil-fuel consumption once it was built, radically reducing its residents’ emissions of climate-changing carbon dioxide gas and giving them energy security. The plan was to achieve this by:

- using a wood-burning combined heat and power plant (CHP) to generate both electricity and heat for the site
- deploying 777 square metres of photovoltaic panels to generate electricity from sunlight
- having high levels of insulation, airtightness and thermal mass and making maximum use of the sun’s warmth for space heating.

Passive house approach

BedZED’s levels of insulation were much higher than those required by mandatory building standards at the time when it was built. The windows on the south-facing facades are double glazed while BedZED’s smaller windows facing north, east and west are triple glazed. The exterior walls have a 300 millimetre layer of rockwool insulation between an outer brick layer and an inner layer of concrete block. The same thickness of insulation was installed beneath the ground-level concrete floors and the roofing.

Concrete floor and ceiling slabs and the concrete blocks in the exterior walls, along with its structural steel frame, give BedZED most of its thermal mass. This helps to maintain temperatures at a comfortable level throughout the year.

BedZED also retains the warmth generated by people, appliances and electronics and the sun. Its eight main accommodation blocks are solar oriented, arranged in east-west rows with double glazing covering all of the vertical south-facing (and sun-facing) facades. The southern side of these blocks are occupied by terraced homes heated mainly by the sun.

Along most of these rows, the north facing side of the blocks consists of stepped terraces, descending at an angle which prevents any shading of the sun for the next row along. Even in winter, when the sun is low in the sky, it can shine onto all of the glazed facades of the adjacent row. These northern side terraces are covered by compact ‘sky gardens’ at first or second floor level, each of which belongs to a nearby home.
The original plan was for these northern sides to be occupied by two-storey workspaces and ‘live-work’ units with people working from home in them throughout the day.

The heat from the occupants’ equipment such as office computers would provide much of the space-heating required in BedZED’s work areas, which also have generous daylighting from overhead roof lights.

Most of BedZED’s homes, however, have conservatory-like ‘sunspaces’ behind big, south facing glazed facades; these are the key solar gain design feature. These sunspaces are found on all three storeys and are some four feet (1.2 m) deep. During sunny periods, and even under a light overcast of clouds, the air within them is warmed by the sun – the greenhouse effect. Once a comfortable temperature is reached in the sunspace, the double glazed doors and windows which separate it from the rest of the home can be opened to allow this warmed air to flow through the rooms.

Whenever the air temperature in the sunspace becomes uncomfortably cool (late or early in the day, at night, or when there is a heavy overcast) it can be closed off from the rest of the home by shutting these doors and windows.

During summer, when the air temperature inside the sunspaces can become uncomfortably hot, the exterior windows in the sunspaces can be opened to allow cooling. Even in midwinter, the sunspaces can provide daytime space heating when the sun is shining. In essence, the sunspaces offer a very simple way of using and controlling passive solar heating.
Those eye-catching wind cowls

BedZED was designed to have high levels of airtightness to reduce heat loss. So it needs a ventilation system to bring in fresh, exterior air into the homes and workspaces and expel stale air – without wasting heat in the process.

This requirement gave the development its most striking feature: BedZED’s brightly coloured rooftop wind cowls. Each of these cowls has a vane and can rotate, so that it always faces into the wind. At the front, a small opening collects fresh, exterior air which moves down into the building and emerges into the homes and workplaces through closeable vents. At the back of the cowl is a larger hole through which the stale, outgoing air (collected through vents in the homes’ ceilings) exits. As it leaves, this stale air warms the incoming cool air through a heat exchanger located in the base of the cowl.

BedZED’s homes and workplaces are well ventilated without the need for any electrically powered fans. In hot weather, windows can be opened to increase ventilation; many of the homes have windows opening on different sides, allowing for cross ventilation.

Hot water and additional space heating

While much of BedZED’s heat demand is met by the warmth from its occupants and by solar gain, its homes and workplaces still require some additional heat – mostly to provide household hot water. The homes and workplaces on the blocks’ northern sides, which lack their own sunspaces, need some space heating too.*

This additional heat is provided via BedZED’s own small-scale district heating system which circulates hot water around the eco-village through an underground network of insulated pipes. Every home has its own large hot water tank, placed in a vented cupboard, warmed by the heat network. The tank provides all of the household’s hot water, year round, plus background warmth in winter to supplement the lower levels of passive solar heating. The home and work spaces on the northern sides of the blocks have conventional radiators, also heated by this district heating system.

*During the construction of BedZED it became clear that the planned ‘live-work’ units would be difficult to market because of limited demand and because they would be treated as business space so far as local authority rating was concerned. So they were marketed as spacious homes with a mezzanine level.
When BedZED was first built, a woodchip-burning combined heat and power (CHP) plant was installed in a purpose-built ancillary building onsite. The woodchip was combusted in a gasifier, providing gas fuel for a piston engine which drove an electricity generator. Heat from the gasifier and engine warmed the water circulating through the district heating system.

This CHP plant was connected to the electricity grid. The plan was that when its electricity output fell below BedZED’s own demand, extra power could be imported from the grid.

The plant’s woodchip fuel came from the routine thinning and lopping of local street trees, turning a waste material into a useful resource. Wood is also a very low carbon energy source — provided growing trees replace the wood that is being burnt. They absorb carbon dioxide from the air as they grow, compensating for the carbon dioxide emitted when the wood is burnt.

Unfortunately, the CHP plant frequently had to be taken out of service for modification and maintenance. Interior condensation and build-up of tar was a real problem, partly attributable to the plant having to shut down every night and restart every morning instead of running continuously - a condition imposed by council planners concerned about noise.

In 2005 the CHP plant was removed and replaced by three conventional natural gas-fired boilers which supplied heat for the district heating scheme. From then on BedZED had to obtain the bulk of its electricity from the grid. This was a major setback.

So passive solar heating plus ultra-low carbon electricity and hot water from a wood-burning CHP plant were the key elements supporting BedZED’s zero fossil fuel ambition.

A new biomass boiler in 2017

In 2017 a new biomass boiler was installed burning wood pellets – a near zero-carbon fuel. Supported by the Government’s Renewable Heat Incentive, this 240 kilowatt boiler supplies all of the heat for BedZED’s district heating system. The grid electricity purchased for BedZED is on a green tariff, with all power consumption matched to generation by zero-carbon wind turbines and hydropower schemes and covered by Renewable Energy Guarantee of Origin certificates. So the eco-village is close to fulfilling its original zero fossil fuel ambition).
Sustainable travel and transport

BedZED was designed to encourage its residents to use greener forms of transport and to radically reduce greenhouse gas emissions from travel compared to conventional suburban housing development.

The original plan was to use the electricity generated by BedZED’s photovoltaic panels to recharge the batteries of electric cars parked on the site, some of them owned by a communal car club.

However, BedZED was completed almost a decade before plug-in electric cars reached the UK mass market. So, instead, the electricity generated on site goes to BedZED’s homes and workplaces, and on sunny days when supply exceeds demand any surplus power is exported into the local grid. This PV system is still generating around 30,000 kwh of zero-carbon electricity a year, a decade and a half after it was installed.

The eco-village has some 81 car parking spaces for residents, visitors and people who work there. That is far less than one space per home, a lower level than is usual for suburban housing developments. BedZED was home to London’s first car club to be sited on a new development, operated by City Car Club. It offers a low-emissions, highly fuel-efficient hybrid car parked on the site to any car club member. This gives residents a convenient alternative to owning their own vehicle – a car they can book online and use on a pay-as-you-go basis without all of the costs and time involved in owning and maintaining their own vehicle.

BedZED has just 0.6 car parking spaces per home

There are plenty of secure bicycle parking stands on the site and the larger BedZED homes have bike storage space inside. The location is well served by public transport with three bus routes passing close by. Hackbridge train station, just 600 metres away, has frequent services to Sutton and central London where many BedZED residents work. A stop on the tram system serving much of south London is a 15 minute walk away.
BedZED is in a region which, according to England’s Environment Agency, suffers from serious water stress. The eco-village was designed to safeguard water by consuming less than conventional new housing developments, by recycling waste water and by reducing the flow of water into the sewage system during heavy rainfall.

Its homes have aerated flow shower heads and taps to reduce flows and watersaving dual-flush toilets. The washing machines installed in its homes had high ratings for water efficiency. Household water meters are positioned at eye level in a kitchen cupboard, visible through a window in the cupboard door.

Urban sewers can become overloaded during rain storms, leading to flooding and raw sewage discharges into rivers and streams. Hence the need for sustainable urban drainage schemes, which retain and manage the rainfall falling on roofs, pavements and roads. BedZED’s ‘green roofs’, seeded with drought-resistant sedum plants, help to soak up and hold back the rain falling on the site. So, too, does its large green field, its porous walkways and the deep and broad tree-lined green ditch which separates and shields the front of the eco-village from the busy London Road.

When first built, BedZED had its own mini sewage treatment plant, housed next to its own power station. It used aquatic plants and associated microbes, floating in a sequence of large wooden tubs beneath a big glass roof, to clean raw sewage pumped through the treatment system. The cleaned water flowing out of this plant was used to flush toilets and water BedZED’s gardens. So, too, was rainwater collected from the roofs and stored in underground tanks.

This waste water treatment plant was closed in 2005, because of its high electricity consumption and because the process needed labour-intensive monitoring. The company which installed and operated it had also been dissolved, making it more difficult to operate the plant affordably and reliably. Today BedZED’s waste water is handled by the local sewage system.

The rainwater collection system is also no longer in use, because of concerns about the harvested water being contaminated with faecal coliform bacteria from the development’s ‘green roofs’, where sedum plants grow in a thin layer of growing medium which includes chicken manure.

BedZED’s average water consumption is 87 litres per person per day - 61% of the average for metered homes in Sutton (2007)
In order to reduce the environmental impacts and carbon footprint of BedZED’s construction, we prioritised the use of locally sourced or recycled or reclaimed building materials.

We estimate 52% of its construction materials by weight were sourced within 56 km of the site while 15% by weight (3,304 tonnes) were recycled or reclaimed. Some examples:

- The bricks came from a works at Cranleigh in Surrey, 35 km away.
- The extensive timber cladding consists of green oak harvested from woodlands in nearby Croydon and Kent.
- Just under 40 tonnes of structural steel was reclaimed from a refurbishment project at Brighton railway station to give BedZED much of its steel frame.
- The studwork for the interior plasterboard partitions used reclaimed timber, resulting in a 14% cost saving.
- Reclaimed timber was used to provide flooring in many locations where the floors are not concrete slab (eg mezzanine floors in offices). English ash was used for flooring in the sun spaces.
- 1,000 tonnes of ‘sand’ made from crushed recycled glass was used under the outdoor paving slabs (see image below).
- BedZED’s timber bollards were made from recycled railway sleepers.

It cost £15m to build BedZED. This figures include significant research and development spend due to BedZED being a prototype. There was a cost over-run during construction, some of which can be attributed to problems in managing the construction and design changes. But set against this is the low bills that its residents pay for water, power and heat (see pages 16 and 17).

The challenge is to build sustainable communities without large cost premiums compared to conventional, non-sustainable development. Subsequent green building projects, such as Crest Nicholson and Bioregional Quintain’s One Brighton apartment blocks in central Brighton, have shown this challenge can be met. See www.bioregional.com/one-brighton for more information.
Built-in community and a broad social mix

BedZED was designed to be an attractive place to live and work in order to encourage environmentally-friendly lifestyles. Low energy and water bills (see pages 16 and 17) and well-designed, comfortable homes with good daylighting are part of that. So, too, is promoting a strong sense of community among the people living and working there. As well as having the Pavilion, an indoor community space available to BedZED residents and the wider surrounding community, the eco-village has its own large communal green field for play and relaxation plus a small village square flanked by buildings.

Road vehicles can circulate and park around the periphery of BedZED but the mews streets running between the building blocks are traffic free, encouraging children to play there and adults to chat. This combination of high-density housing (relative to UK suburban norms) and BedZED’s rich mix of private outdoor space and shared, traffic-free outdoor space encourages neighbourliness. The great majority of BedZED homes have their own outdoor space in the form of balconies and small gardens at ground, first or second floor level. Several of the homes connect to their gardens by bridges spanning the mews streets – one of BedZED’s quirkiest and most charming features. With its mix of market housing, shared home ownership and subsidised renting and its wide variety of home sizes, the eco-village is home to a broad social mix. There are no differences in specification and appearance between the different types of tenure.

A survey carried out in 2007 found that the sense of community was what people most liked about living in BedZED. On average they knew 20 of their neighbours by name, while two thirds felt they knew more people living in the eco-village than they did when living in their previous neighbourhoods. In the surrounding neighbourhood of Hackbridge (excluding BedZED), residents knew an average of eight neighbours by name.

An entire generation has now almost grown up in BedZED, with children who moved in as babies and infants now well into adolescence. Many of the original residents from 2002 are still living in the eco-village. Its homes go up for sale relatively infrequently, but when they do they generally sell for higher prices than homes of the same size in the surrounding area. This suggests there is a small but significant BedZED price premium.
What is it like to live in BedZED?

HELEN

Helen has lived with her husband at BedZED for ten years. They have two small children. Their electricity consumption is less than half the average UK household’s.

“We love our home – it’s fantastically comfortable, and it’s so good to know that whenever you get in, whatever the weather, it’s always going to be warm and dry. The other thing we appreciate is the community aspect, with lots of people talking to their neighbours, knowing a bit about them and caring about them. There are often community events, and there’s an email list which lots of residents find really helpful for sharing things.

JACQUI

Jacqui has lived in a BedZED studio apartment for two years.

“I love it here. Everyone is very friendly, I feel very safe and people go out of their way to talk to you and keep an eye out for you. I love my little flat and I think it’s beautiful. My energy bills are about a fifth of what they were in my previous home.”

“We are definitely experiencing this as a place with a vision that works...”

Lukas and Elaine, BedZED residents
TOM AND JANETTE

Tom and Janette moved into BedZED when it was completed in 2002 and raised their family there.

“BedZED is different to anywhere else I have lived...to me it is very special and it’s a shame that many more people don’t have the opportunity to live in this sort of special place. Many former BedZEDders are still in touch with current residents due to the kind of people this place has brought together. Somehow the high density and closeness of residents has been reversed from a negative to a positive. It improves your quality of life to accept, consider and to an extent embrace (but not literally hug!) those around you, reflecting that we share a small planet.”

LUKAS AND ELAINE

Lukas and Elaine have lived at BedZED since 2012. Their annual energy bill is only a quarter of the average London household’s.

“In winter, our place stays cosy and warm. We rarely need any heating. What really surprised us, though, was how easy it was to get to know our neighbours. Many of them have become friends. It’s a bit like living in a village with a great mix of people. The amount of green space, nature and wildlife surrounding BedZED is also unusual and precious. We are definitely experiencing this as a place with a vision that works.”
BedZED’s performance - the facts and figures

BedZED’s residents enjoy significant savings in their energy and water bills, and the development as a whole offers big reductions in carbon dioxide emissions compared to conventional UK housing.

Between 2012 and 2015, BedZED’s annual gas consumption was 36% lower than a typical conventional development in Sutton, London of the same size and mix (100 homes plus office, college and community space).

Its annual electricity consumption during that period was 27% less. Consequently, we estimate that BedZED’s greenhouse gas emissions (tonnes of carbon dioxide equivalent) from heating and electricity use were 32% less than from an equivalent conventional development during that four-year period.

In 2015, researchers at the University of York estimated the total carbon footprint of BedZED’s residents using an online questionnaire and the REAP Petite methodology. This covers a much wider spectrum than greenhouse gas emissions from home heating and electricity consumption.

It also includes emissions from travel and from our consumption of food and other goods and services including public services. The footprint estimate for BedZED was 10.4 tonnes of CO₂ equivalent per resident, 23% less than the UK average.*

BedZED’s reduction in travel-related greenhouse gas emissions was much larger – 53% less CO₂ eq than the UK average (1.65 tonnes compared to 3.54 tonnes). An earlier 2007 survey found that 17% of BedZED residents travelled to work by car, much lower than the then Sutton average of 49%.

*This estimate should be treated with some caution because of the small sample size – 19 BedZED households.
Money savings for residents

In 2015 we looked in detail at the energy and water consumption, and the associated bills, of a typical two-person BedZED household. We found that the combined energy bills (for heating and electricity) were 68% less than for the average London home. This household’s water bills were 45% less than the London average. The combined saving amounted to £1,094 a year.

This household also has a City Car Club membership and uses the club’s vehicle parked at BedZED rather than owning its own car. With an annual car mileage of 2,960 miles (37% of the national average car mileage) this reduced the costs of having access to, and running, a car by 13% - or £297 a year.

Total energy, water and car bill savings for this typical household amount to £1,391 a year - nearly £4 a day.

Sources for national and London averages used in comparisons: Department of Energy and Climate Change, Ofwat, Thames Water, Department for Transport, AA.
Top: BedZED home
Bottom: Pooran Desai OBE, Co-Founder of Bioregional, gives visitors a guided tour of BedZED
What next?

For Bioregional, being a partner in the development of BedZED was transformational. We realised that building design could make a huge contribution to sustainability, but that far more needed to be done to encourage sustainable lifestyles. We went on to develop our One Planet Living framework, with ten guiding principles covering issues such as sustainable water, travel and transport, zero waste, zero-carbon energy and health and happiness.

We use these principles to provide a holistic framework to help organisations and project teams examine the sustainability challenges they face, develop appropriate solutions and communicate the actions being taken to key stakeholders, their supply chain, customers and local and national government.

Today there is a network of One Planet Communities extending to Europe, North America, Africa and Australia. Some have been built, some are under construction and some are still at the planning stage. Each has a One Planet Action Plan, endorsed by Bioregional, based on these ten principles which charts a course towards sustainability.

As for BedZED, there is a need for investment in refurbishment in order for the eco-village to fulfil its sustainability potential. Yet it continues to be a source of inspiration. Standing in stark contrast to the surrounding suburban housing, it draws hundreds of visitors each year, many of them from overseas, who come to see a unique and uplifting place.

The One Planet Living Principles

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<th>Category</th>
<th>Principle</th>
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<td>Health and happiness</td>
<td>Encouraging active, social, meaningful lives to promote good health and wellbeing</td>
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<tr>
<td>Equity and local economy</td>
<td>Creating safe, equitable places to live and work which support local prosperity and international fair trade</td>
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<tr>
<td>Culture and community</td>
<td>Nurturing local identity and heritage, empowering communities and promoting a culture of sustainable living</td>
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<td>Land and nature</td>
<td>Protecting and restoring land for the benefit of people and wildlife</td>
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<td>Sustainable Water</td>
<td>Using water efficiently, protecting local water resources and reducing flooding and drought</td>
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<td>Local and sustainable food</td>
<td>Promoting sustainable humane farming and healthy diets high in local, seasonal organic food and vegetable protein</td>
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<tr>
<td>Travel and transport</td>
<td>Reducing the need to travel, encouraging walking, cycling and low carbon transport</td>
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<td>Materials and products</td>
<td>Using materials from sustainable sources and promoting products which help people reduce consumption</td>
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<td>Zero waste</td>
<td>Reducing consumption, re-using and recycling to achieve zero waste and zero pollution</td>
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<td>Zero carbon energy</td>
<td>Making buildings and manufacturing energy efficient and supplying all energy with renewables</td>
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We offer a regular guided tour of BedZED on the last Thursday of each month at 11am, led by a member of staff from Bioregional. Bespoke tours can also be organised. For more information, visit www.bioregional.com/product/bedzed-tours

If you would like more information about BedZED, Bioregional or One Planet Living, please visit www.bioregional.com. Our Publications section has several reports on BedZED.