

© Zero Bills Home Limited

# The Zero Bills Home

An Innovation Affordable Zero Carbon Housing System

\*Photograph credit: Duan Fu

# BRE Demo House



An integrated energy roof which produces more net energy yearly.



The Zero Bills Home at the BRE is only connected to the grid for **20%** of the year and still generates some surplus renewable electricity to run electric vehicles.

A demonstrative Zero Bills House is being erected at the BRE (Building Research Establishment — the highest authority in the UK construction Industry) Innovation Park in Watford. The BRE house will act as a prototype and sales house for the London Rd application employing the same energy, sustainability and construction strategies and utilising similar materials and M&E systems. Lessons learnt from the BRE house will be incorporated into the detailed design of this application moving forward, should it be approved.

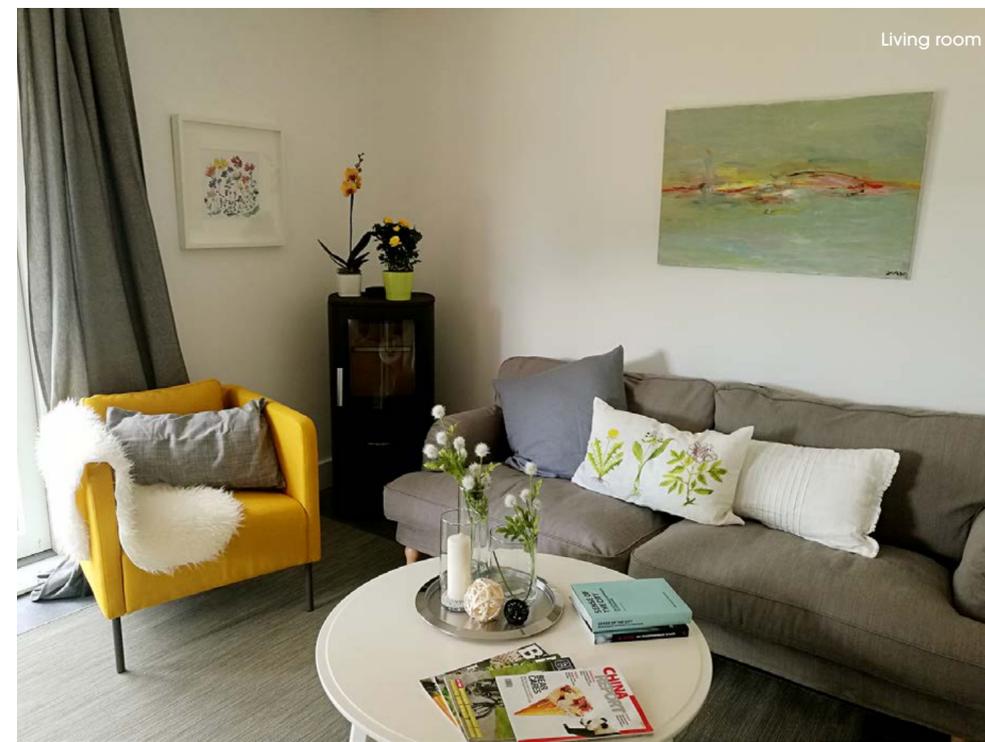
The demo is a three storey — 4 bedroom detached house, with adjacent garage. The house demonstrates the range of technologies and the materials, components and techniques that will be used in the construction of the Newport development. The house will be systematically monitored by the BRE and the electricity output and other performance factors continually recorded. The house will be inhabited during extended periods under the control of the BRE to gain experience of the living environment, allowing the BRE to report any improvements that become apparent and will be accessible to visitors and potential buyers of the Newport development.

Zero Bills Homes will be among the first to be assessed for the Home Quality Mark standard, which has been designed by the BRE to replace the Code for Sustainable Homes.

The house has been designed specifically for the UK market, as an alternative to the ultra low energy Passiv Haus Germany standard. Whilst the thermal specification remains broadly comparable to Passivhaus, the Zero Bills Home system also includes embedded microgeneration in the form of the solar roof — ensuring the homes are not just low energy, but zero carbon and zero bills. Zero Bills Home Company will set up and train a national network of approved installers to ensure quality and reliability levels to support the Zero Bills Home™ brand.



Kitchen



Living room



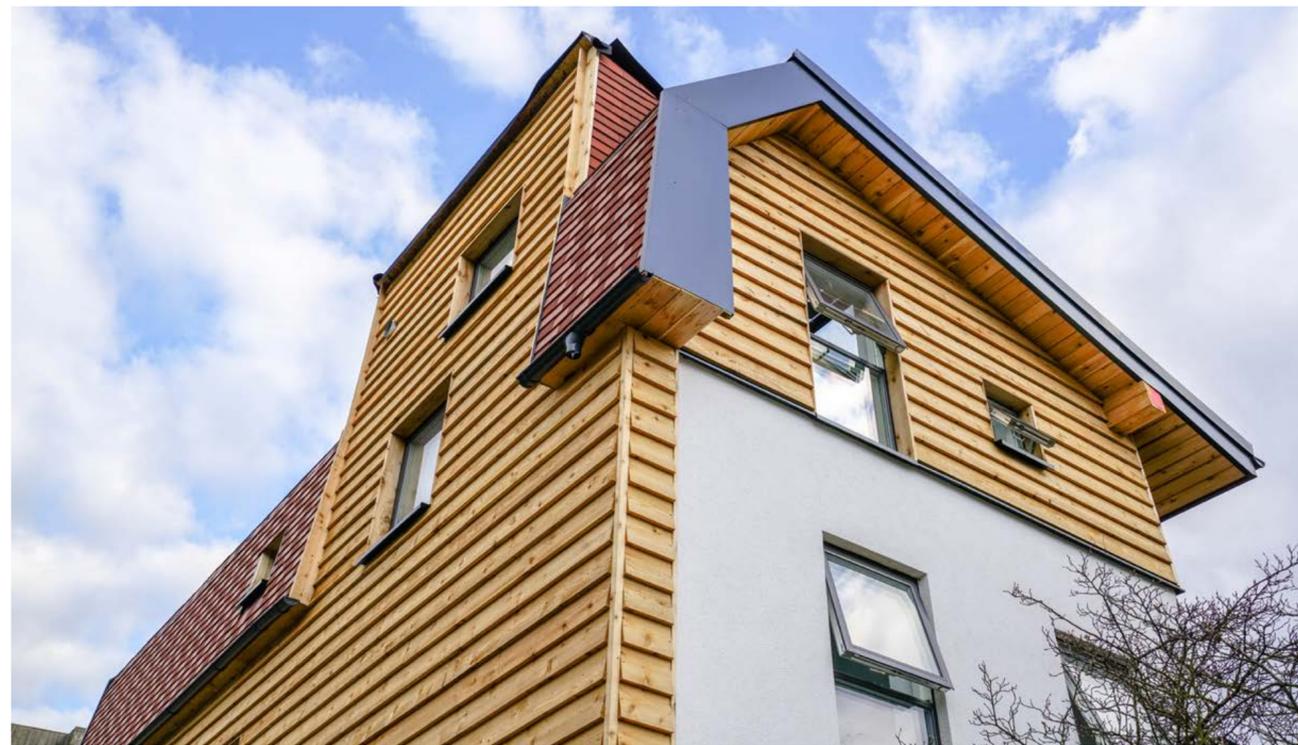
Inside the solar loft

## Zero Bills House Building Environment

70% of the new homes built in the UK are built to a density of 50 homes/ha or less. Large numbers of new homes are required quickly to create affordable homes throughout the country. It is important that these new homes do not increase our overloaded national energy and water infrastructure, and reduce these new communities exposure to annually increasing energy prices. Zero Bills Home Company have designed a simple urban system that enables a combination of East-West orientation and North-South orientated detached, semi-detached and terraced homes to deliver an economic housing solution on both large and small sites. This range of house types has been audited by the BRE to meet Code 6 En1 without requiring off site renewable energy investment — meeting the highest standard within the Code for Sustainable Homes.

This standard has been avoided by the UK volume house builders, who prefer to lobby the government to reduce environmental performance standards.

This has created an unique opportunity where it is often possible to obtain detailed planning approvals on greenfield and green belt sites because of the low environmental impact of these homes, and the fact that we do not set a planning precedent for relaxing construction restrictions in the countryside. Local authorities also welcome our development solution as a good way of meeting their environmental performance policy targets and creating local jobs. We have demonstrated this with a number of recently approved schemes in the UK — including a major application within view of Canary Wharf within the green belt.



If you can build an 'Ikea sofa' —you can now build your own energy positive home. It is now possible for relatively unskilled, but motivated people with simple power tools who are prepared to follow clear instructions can now build some of the most sophisticated homes in Europe. It takes a team of four semi skilled people about two to three weeks to complete a shell and core Zero Bills Home, providing that all the components are on site and ready to install. This makes off-site prefabrication of large finished components obsolete. The construction system also reduces considerably waste on site, with every component supplied being used in the final construction. This idea reduces or eliminates factory overheads, and all our supply chain components are made by experienced fabricators to our exact specifications and requirements.

Whereas a typical timber frame takes at least three months to order from an off site factory, it is now possible to order all the ingredients for a ZED home from stock. This reduces construction lead in times and reduces loan costs. It also minimises potential programme slippage. The majority of the labour can be sourced locally, and the Zero Bills Home Company can offer training schemes to upskill local teams as well as inspect construction quality and certify that completed projects meet our onerous quality standards.

Each structural and cladding connection is prefabricated and each timber component arrives pre-cut and numbered—enabling fast on site assembly. The services are prefabricated in Europe with a super —efficient heat pump integrated with the heat recovery ventilation, associated ductwork and the hot water cylinder. This leaves the kitchen and bathroom fit out to house-buyers, timetable and budget.

Wherever possible—each larger ZEDfactory project over around 50 to 70 units has a steel framed barn type assembly building where all numbered components are stored under cover ready to fix into place on site. Assembly teams can sign out components as required to complete each plot build. Smaller projects can have all components delivered in lockable reusable shipping container. Each part is numbered and packed in the correct sequence ready to apply on site. This strategy minimises the transportation carbon footprint of delivering construction components to site, and enables the Zero Bills Home Company to service smaller projects with an equally effective service. These smaller containers will be packed from our main distribution barns at Bickleigh Down in Plymouth (a potential Zero Bills show village) and possibly later next year from Newport in Essex (a site currently in planning).



BRE Domo Hosue — floor plans



Ground Floor Plan



Ground Floor Plan - Life Time Home / Granny Flat in the Garage



First Floor Plan



Second Floor Plan

The Zero Bills Home

Exceptional Performance & Enhanced quality of life

Exceeding Building Standards

ZBHC houses are designed to be modern and contemporary, built from traditional materials in a sustainable construction system. The system combines an energy efficient modular frame structure with an integrated solar PV panel roof. The electricity generated from the PV roof panels earns revenues from the Feed in Tariff scheme which, when combined with the free use of the electricity stored in the batteries, leads to incomes and savings exceeding the residual cost of electricity - a Zero energy bills home. This will protect households against ever rising energy bills and help to reduce fuel poverty.

Design Flexibility

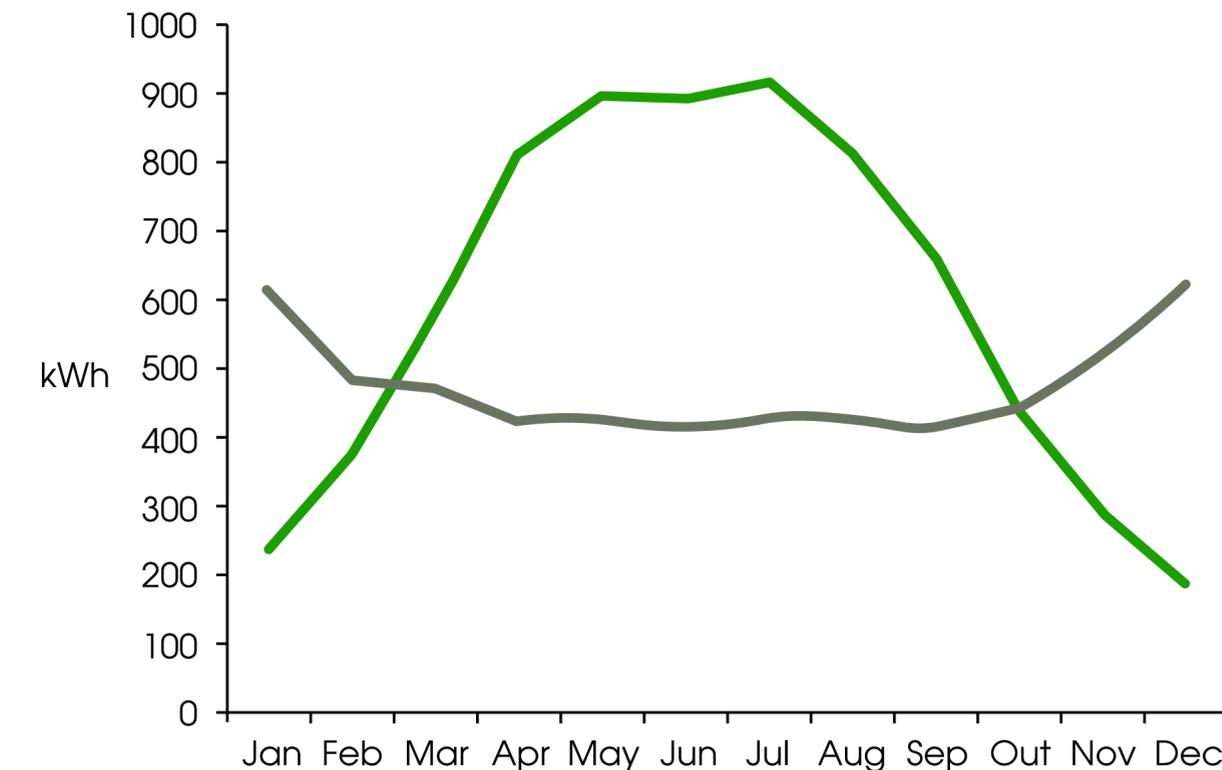
The system uses simple and adaptable plans which create convenient internal layouts for any plot orientation. The open structural system increases flexibility for self-build and site specific variations. We have developed this further to create a range of standard house types for detached, semi and terraced typologies. 'Design code' planning kits allow new communities on larger sites to design themselves whilst recognising the importance of the placemaking agenda.

Exceptional low Carbon Credentials

We have maximised the use of UK sourced materials to minimise the carbon footprint. The Timber studs, OSB and Steel are all UK sourced. We maximise the use of natural building materials and eliminate urethane foams, materials with high off gassing and materials with short life cycles. This makes the building one of the lowest embodied carbon buildings possible. Combined with our BIPV solar roof, battery storage and zero fossil fuel energy systems, the home starts paying back its embodied carbon by generating more electricity than it needs over a typical year.

Excellent Value

The system build costs for a completed building or for simply the shell and core compare favourably with current costs of meeting building regulations. The Shell and core which comprises of the structural weatherproof envelope, windows and doors, renewables package, heating and ventilation system, can be delivered at a fixed price. The package represents approximately 75% of the build costs and enables the owner occupier to reduce labour rates and overheads for finishing elements. These value adding features enables the zero bills home company to offer a cost effective and sustainable alternative to traditional builder offerings.

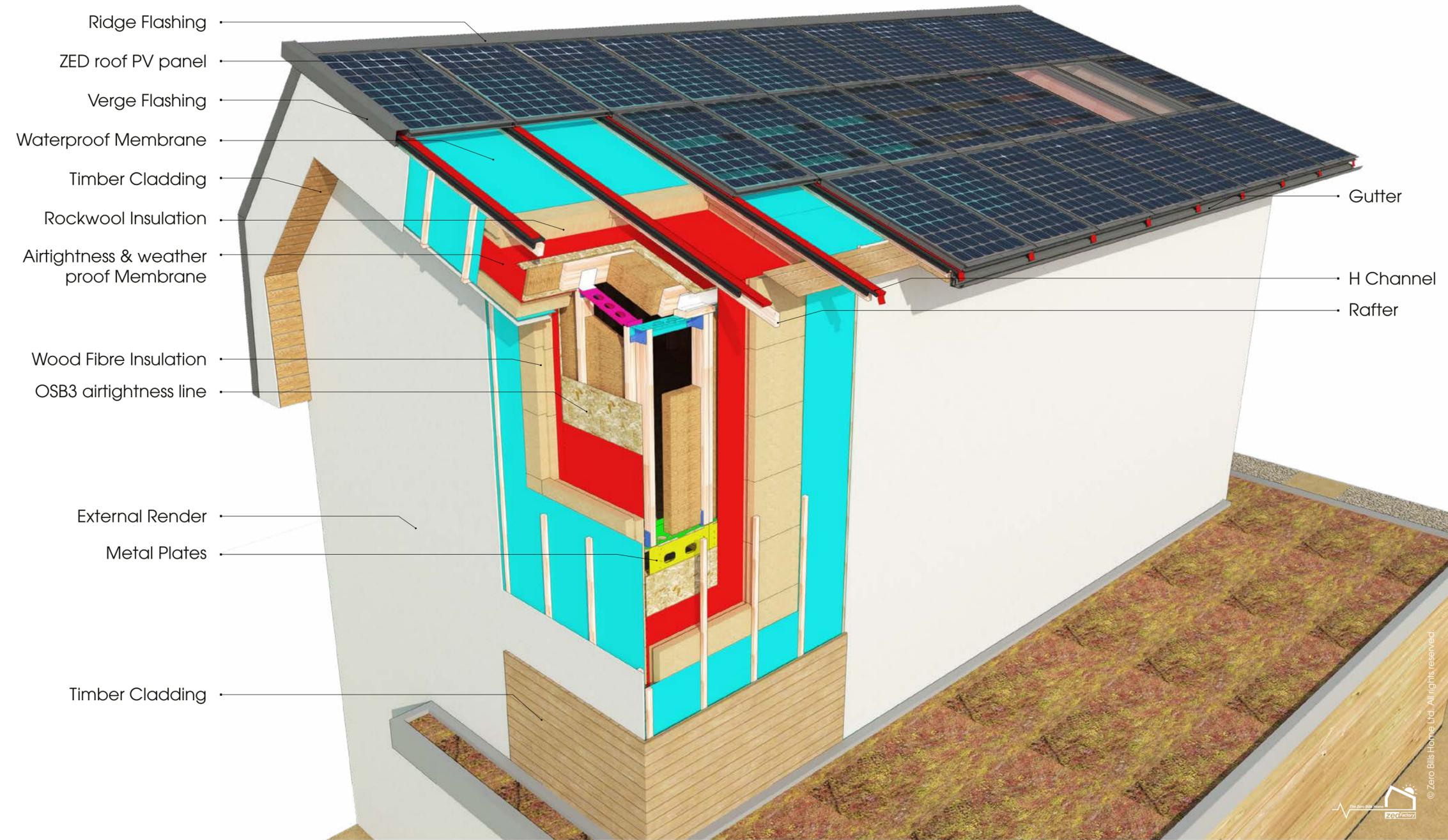


— Total PV production — Total energy use

Energy Production vs Energy Demand

## The Zero Bills Home Housing System

- Highest score achieved in new BRE home quality mark replacing Code for Sustainable Homes
- Exceeds new building regulations standards comfortably
- Represents 10 year innovation and supply chain development programme
- De-skilled construction process accessible to both small and larger builders
- No need for investment in off site factory so easy to scale up production to produce thousands of homes/year
- On site assembly with local labour and jobs is lower cost with shorter lead in times than conventional timber frame
- All bulk structural materials and components sourced and fabricated in the UK
- Excellent durability with healthy vapour permeable 'breathing' natural materials used with no urethane foams or unstable products.
- Full LABC warranty and fully mortgageable construction system protects homeowners
- Simple plans with convenient internal layouts easily adapted to plot orientation.
- Range of standard housetypes for detached, semi and terraced typologies available for both north/south and east/west orientations complete with design coded planning kit allows new communities to design themselves on larger sites whilst recognising the importance of the placemaking agenda.
- Planning kit already tested with detailed approvals on around 300 homes on 5 sites
- Open structural system allows design flexibility for custom build and site specific variation for smaller sites and self builds
- Instruction technical manual and training available with full house kits available at fixed costs from national chain of builders merchants.
- Easy to tune to local planning context with wide range of local materials to match streetscape
- Adds little or no additional load on overstressed national infrastructure such as water and electricity with no gas connection needed. Massive national infrastructure investment savings potential if new homes programme adopted zero bills thinking.
- Low carbon footprint of initial construction paid off within 25 to 30 years by CO<sub>2</sub> offsets from solar electric roof — achieving no net contribution to accelerating climate change
- BIPV solar roof generates more electricity than all electric home needs over typical year
- No net annual energy bills with enough surplus renewable electricity to run a commuter's electric vehicle
- Higher resale values than the legal minimum standard construction promoted by volume house-builders
- Build costs at scale circa £1350-00/m<sup>2</sup> including foundations and slab compares favourably with current costs of meeting building regulations with conventional construction.



## Energy Performance Strategy Summary

The building typology will be designed and constructed to meet or exceed the energy standard, Ene 1 of the Code for Sustainable Homes, Code level 6.

The buildings aim to achieve the energy performance criteria through high fabric efficiency and offsetting the regulated carbon emissions with photovoltaic glass roof panels that form the waterproof finish on the south facing roof of each property.

The energy strategy uses a combination of solar photovoltaic panels, heating using an MVHR based air source heat pump and heat exchanger, super insulation, Airtightness better than 1.5 ACH, Thermal mass.

No off-site or carbon offsetting solutions is used to create the zero carbon home.

The PV provides enough electricity to power the small air source heat pump integrated into each home's hot water cylinder.

High efficiency LED lighting, induction hobs and water saving appliances minimise both thermal and electric demand, maximising the energy efficiency of the homes.

Dwellings are capable of being upgraded to meet the BRE's HQM standard which replaces Code 6 of the Code for Sustainable Homes.

The solar PV roof will be Micro-generation Certification Scheme (MCS) accredited, fitted by MCS approved personnel and be designed and constructed to a standard to ensure that the local power company accept these for connection to the grid and export tariff.

Life of the inverter: to be guaranteed for 5 years (extendable to 10, 15, or 20 years). A battery integrated inverter is available as an option

The specification of the solar PV panels are designed for the location

Solar lofts to be designed to prevent condensation and provide a secondary waterproof line with an expected lifetime in excess of 25 years.

Space heating is provided via ducted warm air heating.

Dwellings are designed to be capable of taking wood burning stove.

## Fabric Thermal Performance

### U-values:

0.13 W/m<sup>2</sup>K for walls

0.1 W/m<sup>2</sup>K for floor and roof

0.9 W/m<sup>2</sup>K for windows and external doors.

1.5 ACH designed air tightness at 50 Pascal's frame pressure.

The contractor is to demonstrate a successful pressure test post completion.

## Fabric

The design of the external wall insulation system complies with the relevant ETAG or BBA certificate for installation without a cavity. The composite wall build up is breathable. The design prevents internal humidity build up and interstitial condensation without the use of plastic membranes or easily damaged VCL's. This is confirmed by relevant calculations.

The exterior and interior finishes are sufficiently robust to avoid chipping of the internal/external fabric. The external fabric has been third party tested to verify performance against water ingress and taped and sealed joints to OSB, linings and window reveals will be installed in accordance to the relevant manufactures guidelines.

Impact resistance and robustness of external finishes have been third party verified. External finishes are verified to be sufficiently robust to resist chipping/minor vandalism.

A plinth of brick slip or other client approved material to be provided below render/external cladding will ensure the thermal performance of the building is not compromised whilst meeting minimal heights for building materials above ground level.

## Thermal Bridging

The design detailing will ensure that the insulation forms a continuous unbroken layer between insulation around the roof, walls and floor of the fabric.

Designs will incorporate a thermal break in between walls and slab with uninterrupted insulation layer to reduce thermal bridges.

## Water Saving

- Low flow taps will be specified (Hansgrohe)
- Lower flow showers will be installed
- The design will accommodate an option for rainwater harvesting

## Ventilation

- Ventilation is to be achieved with Mechanical Ventilation with Heat Recovery (MVHR) ensuring that adequate levels of ventilation can still be achieved with all the doors and windows closed. A highly efficient MVHR system that's also contributes to space heating and hot water demand is used
- The units will have sufficient acoustic attenuation within the intake and distribution ductwork to provide good levels of sound insulation.
- Ventilation distribution pipe work is smooth bore flexible duct. All duct work and pipe runs facilitate ease of access for maintenance. Ventilation to solar lofts is provided by openable windows / Velux roof lights

## Acoustics

The homes will meet:

- 30 dBAeq for bedrooms
- Internal sound insulation will be designed so that
  - (i) Airborne sound insulation values are at least 3dB higher than Building Regulations.
  - (ii) Impact sound insulation values are at least 3dB lower than Building Regulations.

## Power and Lighting

Lighting will be provided by LED lights throughout the property. Switches and power points will be installed in accordance with Building Regulations.

Day lighting

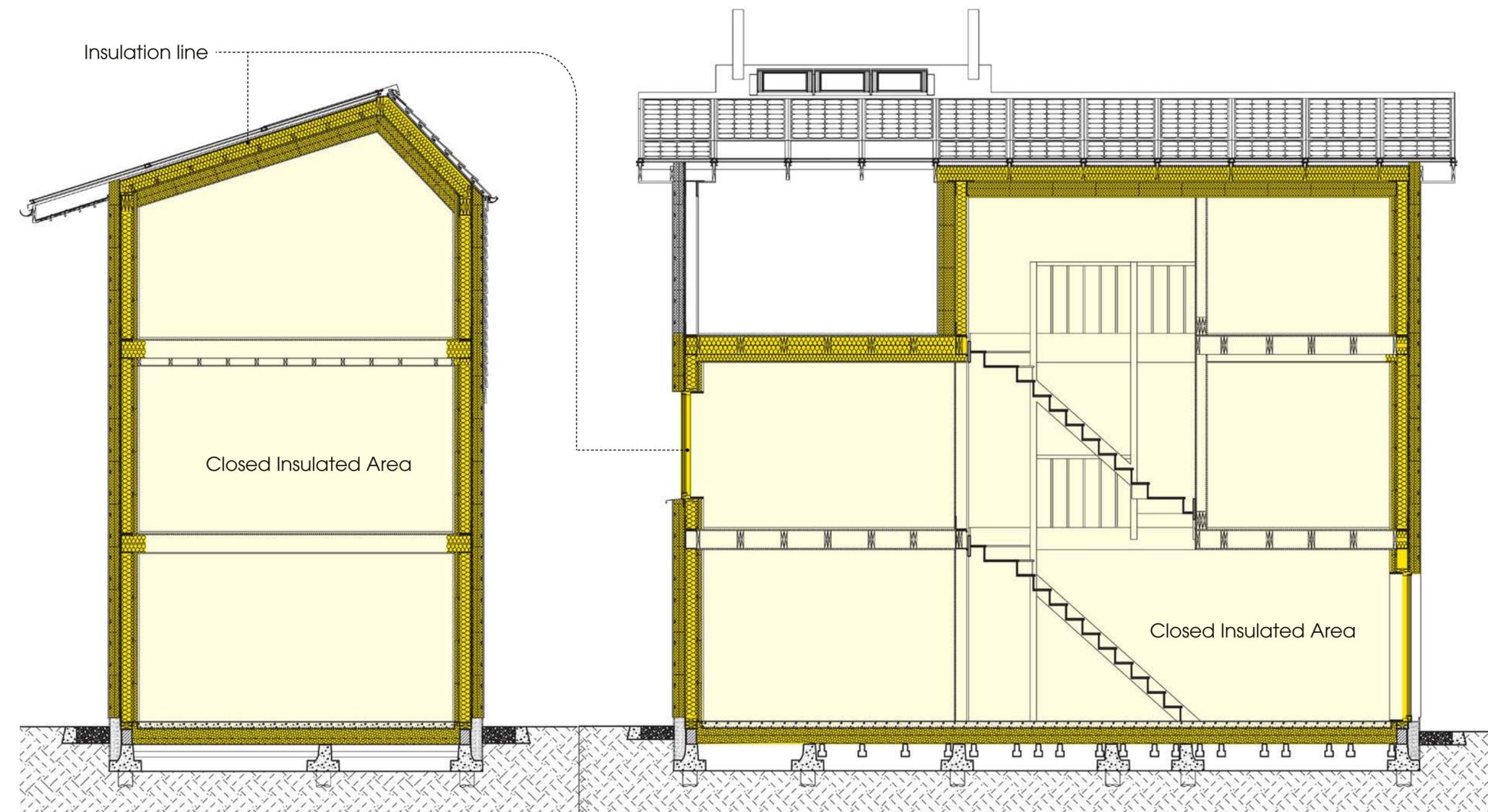
Kitchens must achieve a minimum Average Daylight Factor of at least 2%.

All living rooms, dining rooms and studies (including any room designated as a home office under Ene 9 - Home Office) must achieve a minimum Average Daylight Factor of at least 1.5%

## Mechanical and Electrical

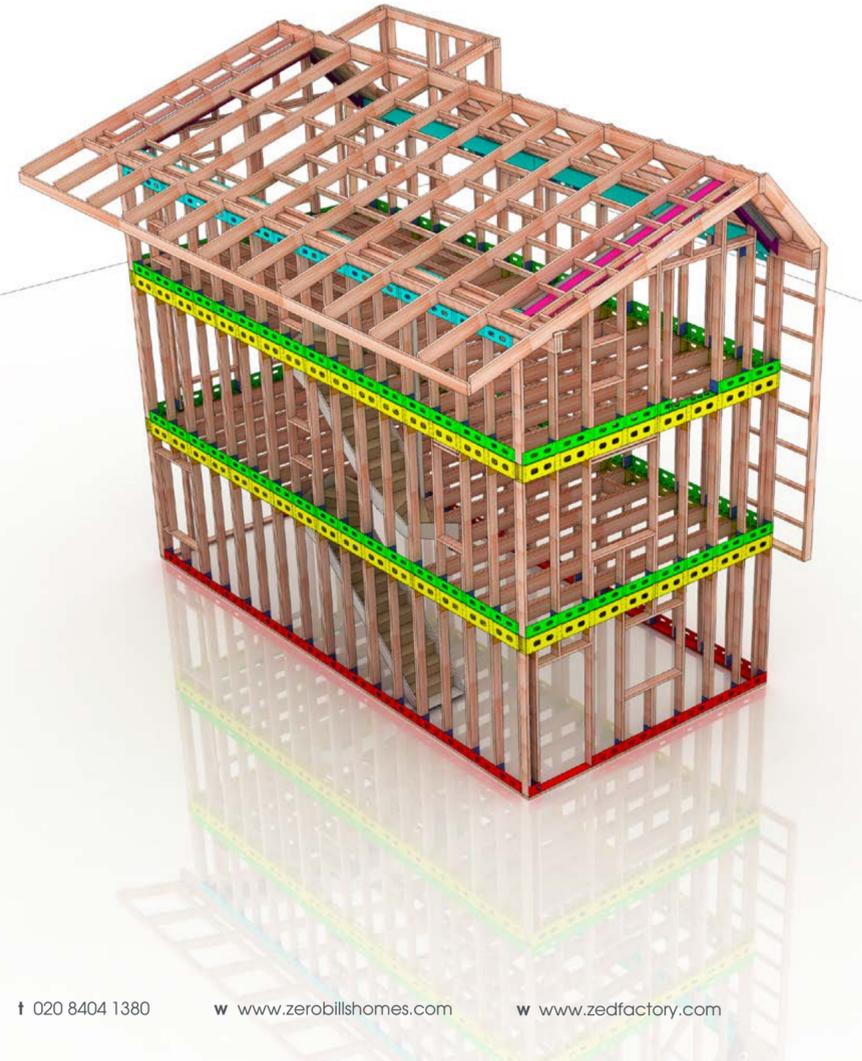
- 7.75 - 8.25 kWp Roof integrated PV array. Size is adjustable for daylight requirements into solar loft (See Specification Sheet)
- Heating and Ventilation — MVHR based heat pump
- Solar Assisted heat Pump Auxiliary heat pump
- Renewables 7.75 kWp of Solar PV (See Specification Sheet)
- Lighting LED/ CF

## Thermal Envelope Strategy on Construction Drawings



### Hybrid Shell — Design Flexibility

The build system has been simplified to benefit both small and large builders. It brings the benefits of off-site construction on site without the additional overheads or lead in times of factory production. The system promotes the use of local labour trained using the technical manual and the ZBHC house kit ordering process, creating a fully scalable system from single homes to thousands of homes annually through a chain of national builders merchants.



Superinsulated Concrete Foundation



Factory laser cut steel structural ring beam



Factory cut steel easily combined with timber studs sourced through local builders merchants



Self-adhesive airtightness and weather proof membrane bonded to OSB board and then fixed to timber studs



OSB fixed to floor joists



Breathable external insulation skin removes thermal bridges

- ▶ The BRE house has achieved an airtightness of 1.3 ach @50 pascals test pressure on first test without walls plastered. Building Regulations requires 10 ach @50 pa.
- ▶▶ The Zero Bills Home 7.5 KWh battery inverter
- ▼ ZED Roof power station 7.5 kW peak





### Hastings Zero Bills Home Development

#### Project Information

Client: Neil Brown  
Project Date: 2016

Site Location: Castle Hill Road Hastings, UK  
Project Status: Construction Finished

### Five custom build homes for self-build community group beside Hastings Castle

This development of five zero carbon homes is located on one of the best plots in Hastings - just a stones throw from Hastings castle, with panoramic views to both the East, the West and the Castle. Perched high up between Hastings Old Town and the Town Centre, it sits in a residential setting within the Old Town Conservation Area.

The ambition of the client is to create a high quality and highly efficient terrace of homes for the 21st century, and to demonstrate that zero carbon dwellings can be commercially viable. ZEDfactory have worked up a design which both delivers in design quality and environmental performance, providing an opportunity to transform this derelict site into a historically important project for the city to coincide with the 950th anniversary celebrations of 1066.



# The Zero Bills Home **Eco-village**

Overall masterplan & site design





## Newport Eco-village

New Code 5 development in Newport Essex

### Project Information

Client: Empeendimentas Project Date: June 2012  
 Site Location: Newport, UK Project Status: Under construction

The site is located on the south western edge of Newport village, comprising 4.6 hectares of arable sown land, managed by a local farmer under a yearly renewable lease. The scheme includes 95 residential units and allows for extra retailing and a local market to be allocated.

The layout is enriched by a variety of green areas ranging from private gardens to semiprivate courtyard areas to communal village greens. In addition to the substantial soft landscape to site boundaries and within the site, the scheme includes dedicated children's play spaces on the southern boundary, within a substantially planted woodland environment. The landscape proposal will include provision for a pond within the village green with substantial tree and shrub planting to the pond perimeter.

The proposal includes for the provision 0.36 hectares of land for Newport Primary School as part of the Education Contribution. Within which it is proposed to include an additional 24 car parking spaces together with the option to provide vehicular access from the residential development through to the bridal path and Frambury Lane, which currently provide access to the school and village recreational facilities.

In addition to the parking facilities the additional the School Board intend to create an ecological park with substantial tree planting forming a buffer zone between the school and the new development and through which the extended pedestrian pathway will provide safe access for local schoolchildren walking to school from Newport.



The Trustees have planning permission for a comprehensive mixed residential zero carbon sustainable development appropriate to Newport village.



### Layout

The homes are all located around 2 central open spaces, with back gardens generally backing on to the perimeter of the site. This provides each home with a garden that is secure and private, in line with Secure by Design recommendations. It also ensures nearly all kitchens and bedrooms have views over the public open spaces and play areas, which improves natural surveillance and enhances a sense of community.

The layout of the homes has also been carefully considered to minimise any over-shading of adjacent electricity generating solar roofing panels, or overlooking of adjacent properties gardens or windows.

Distances between bedroom windows has always been kept down to a minimum of 25m, and usually 35m. Gardens are always at least 15m long, as recommended in the Essex design guide.

Surface water drainage considerations have also played a key role in the development of the site plan, with under-road attenuation tanks designed to follow the contours of the site to optimise a challenging drainage strategy. This has also resulted in the strategic location of attenuation ponds in the open spaces, which double up as wildlife ponds - both increasing biodiversity and providing an additional educational facility for the school children.



Newport recreation grounds

London Road



### Masterplan

The development will consist of 57 market properties, 37 affordable homes and a community or commercial building together with two village greens, a public area for allotments and the area between the Rec and the school intended to be leased in perpetuity to the school for a peppercorn annual rental subject to its continuing user being for educational purposes.

### Housetype

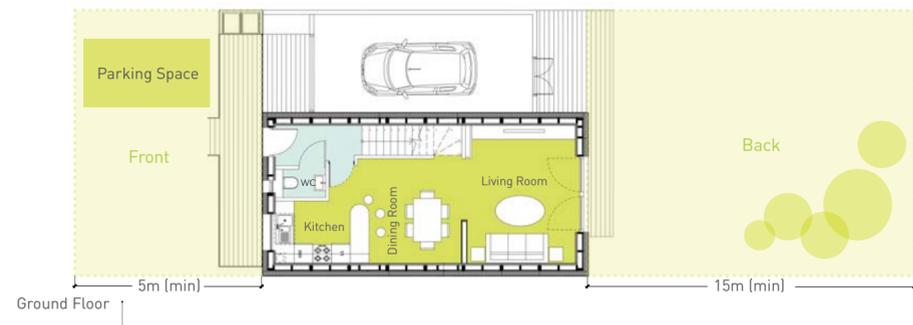
#### East west Three Story

House Information  
Orientation: East/West  
GIA: 116m<sup>2</sup>  
Bedrooms: 4

Areas  
Ground floor area: 42.5m<sup>2</sup>  
First floor area: 42.5m<sup>2</sup>  
Second floor area: 31m<sup>2</sup>



• Demonstration House at BRE Innovation Park

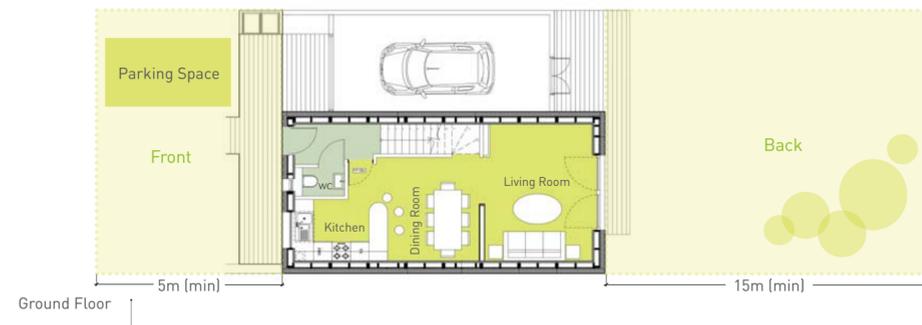


#### South facing three story



House Information  
Orientation: North/South  
GIA: 111.5 m<sup>2</sup>  
Bedrooms: 3

Areas  
Ground floor area: 42.5 m<sup>2</sup>  
First floor area: 42.5 m<sup>2</sup>  
Second floor area: 26.5 m<sup>2</sup>

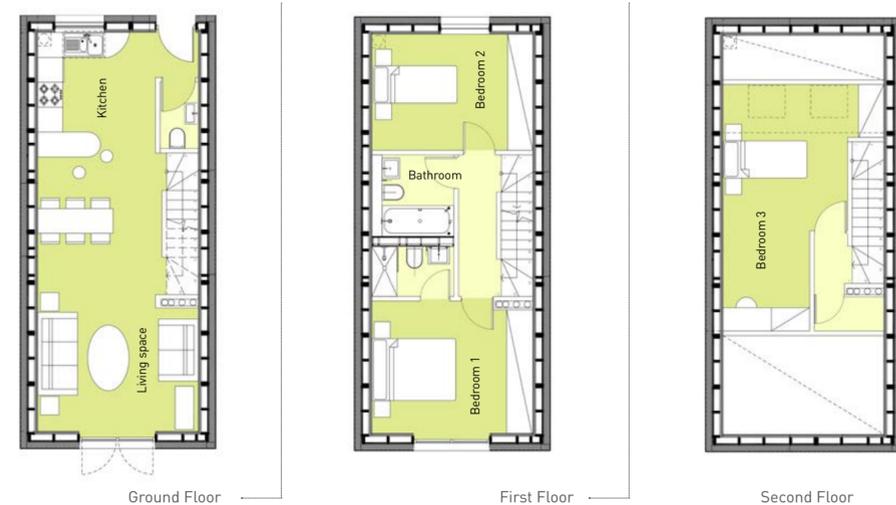


#### South facing two story



House Information  
Orientation: North/South  
GIA: 96.3 m<sup>2</sup>  
Bedrooms: 3

Areas  
Ground floor area: 36.8 m<sup>2</sup>  
First floor area: 36.8 m<sup>2</sup>  
Second floor area: 22.7 m<sup>2</sup>



#### South facing terraced house



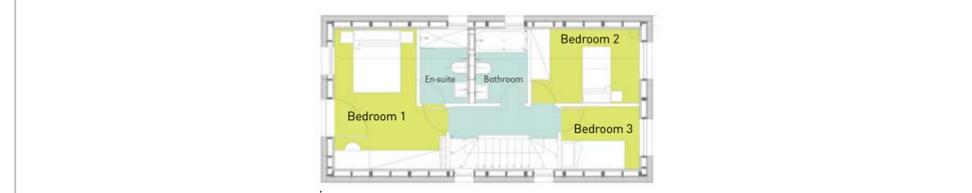
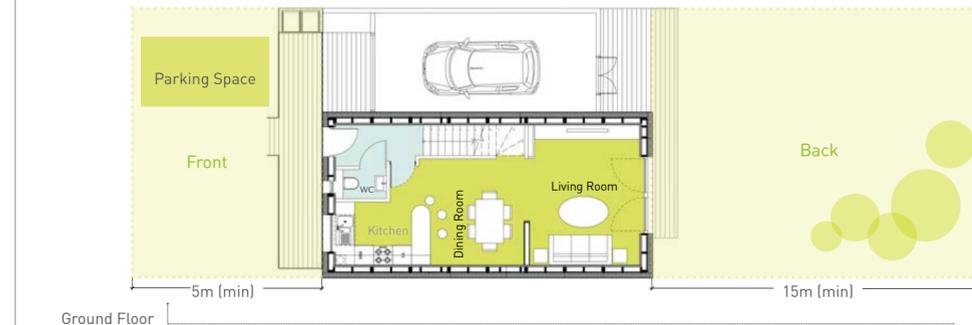
#### East west two story



House information  
Orientation: East/West  
GIA: 85 m<sup>2</sup>  
Bedrooms: 3

Areas  
Ground Floor Area: 42.5 m<sup>2</sup>  
First Floor Area: 42.5 m<sup>2</sup>

#### East west terraced house





## Ecogrove Eco-village

A flagship Code 6 development

### Project Information

Client: Ecogrove Homes Ltd.  
Site Location: London borough of Barking and Dagenham, UK

Project Date: 2009–now  
Project Status: Under construction

## The EcoGrove

EcoGrove is a new flagship urban eco-village currently under construction. It has been designed to enhance each residents' quality of life, whilst making a step-change reduction in their personal carbon emissions. This regenerates an area which has suffered unplanned development and contributed to significant degradation of the local Green Belt. The development of 89 five bedroom homes integrates an urban farm run by a local charity, and shows how Code 6 of the Government's Code for Sustainable Homes can be delivered economically and provide homes that are easy to sell with the potential for net zero annual energy bills.

As well as being super-energy efficient and durably built to last over 100 years, the homes are well-specified and modern, and are designed to be healthy, easy to run, light and well-ventilated. No toxic 'Grenfell materials' have been specified, and the homes should be overall climate neutral from cradle to grave. Micro-generation technologies, including solar panels to generate electricity, will be fitted to individual homes.





#### BIPV Roof & solar loft sunspace

New homes with an overall annual carbon footprint of zero. Enough renewable energy has been integrated into the project to meet its overall annual energy demand with potentially surplus to power an electric car. All homes will have on plot electric vehicle charging points. The solar loft provides covered amenity space all year round, and gives kids play space in adverse weather, or provides a calm indoor garden.



#### Electric Vehicle Charging

Electric powered personal mobility powered by renewable energy. Although cars will be present in the development, their annual electric demands can be met by this means.



#### Heat recovery ventilation with ASHP

Mechanical ventilation with heat recovery provides a continuous supply of fresh, filtered air – plus, the air source heat pump then recovers heat from the extracted air, so you don't waste energy.



#### Near Zero winter heating specification

Carefully draught-proofed super insulated homes are air-tight to 1.3 air changes / hour @50 pascals test pressure. The roof and wall insulation are made from natural materials and are vapour permeable to avoid creating sweaty internal air. High quality aluminium-clad timber windows and doors are specified as standard.



#### Proven design as tested at the BRE Innovation Park Watford

The construction process and building performance has been tested since 2016 at the BRE, with full building insurance warranties and high street mortgages available for the system.



### Construction detail





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