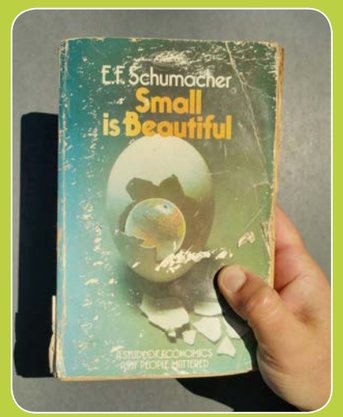
ZED POD

Parking New Homes

Solution to the affordable homes crisis

HOW to use Existing Parking to Create Accommodation Generate Electricity & De-carbonise Urban Mobility?



No land already identified for housing is used up, and the homes are full zero carbon spec and make very little demand on existing power infrastructure. The plan is to turn any existing car park or hard standing with good public transport or a good location into key worker first homes. There are 1.2 million public parking spaces in the UK – allowing the ZEDpod concept to make a very significant contribution to help solving the UK housing shortage without local authorities having to find land or funding. We anticipate between 1 and 5% of these existing parking spaces having potential for ZEDpods creating between 10,000 and 50,000 homes nationally / year – with up to 200,000 homes deliverable over a 5 to 10 year period. On most city centre public car park sites provided by local authorities our architectural team have achieved 1 ZEDpod home for every 5 public parking spaces.

ZEDpods provide first homes for young people and key workers - that can be erected in a few days above existing parking lots close to amenities and jobs. The idea enables responsible local car park owners to provide affordable homes for key workers without using land already allocated for affordable homes.

The pods can either be purchased from the ZEDpod co or leased. The longer the lease over parking spaces - the lower the rental cost. Private car park owners can purchase the same offer and rent the pods out at market rent – creating a valuable extra income stream.

The ZEDpods company could supply thousands of starter homes to keyworkers and young people on existing car parks beside public transport nodes without requiring any scarce local authority funds.

The plan is to use retail park, station parking, town centre car parks, garage blocks, hospital and school car parks and even park and rides to provide affordable homes connected to existing public transport. Supermarkets or retail stores could house local critical key workers to keep public services running smoothly in areas with high property prices.
Each ZEDpod dweller either pays high market rates to park their own vehicle on any non allocated public parking spaces below their homes, or must use electric bikes, pedal bikes or public transport. A large ZEDpod pop up village typically only loses 2 parking spaces for every 24 homes created sitting over 48 existing spaces.

If local authorities made the air rights above their own council owned car parks – each home can be installed and maintained by the ZEDpod company at zero cost to the local authority. Pods can be relocated easily if car park owners wish – providing a new site is found and movement costs are met.

A young couple sharing a ZEDpod and enjoy privacy, their own balcony and front door, a micro kitchen and dining table, their own bathroom, a TV sofa, and a stair leading to a mezzanine floor with home office desk and double bed and wardrobe. It is possible to live in a ZEDpod with potentially zero net annual energy bills.

The ZEDpods are net zero carbon, and use integrated roof mounted solar panels to charge a LIPO4 battery store that often means they only need to connect to the grid for 30 % of the year – mostly in midwinter when offshore wind powered electricity is often available.

The pods are constructed off site in the UK, and can be erected in a matter of days with a forklift. They have a patented raft foundation that exerts no more pressure on existing tarmac than a conventional vehicle. They are more cost effective than purchasing land and building conventional construction with conventional foundations. The Pods are built to higher standards than conventional homes with superinsulation, vapour permeable draught proofed construction, heat recovery ventilation, aluminium clad triple glazing, hot dip galvanised structural frame with timber infill panels and external insulation.
The external envelope is designed to be around 20 years to first maintenance, and is constructed from fireproof, durable and robust materials.

The ZEDpod is a unique kit of parts concept that does not rely on one centralised factory. Pop up assembly sheds can be set up locally to meet housing demand and create local employment. We can fund and build as many as the UK population asks for with parallel production facilities throughout the UK.


ZED Pod at BRE Innovation Park, 2016

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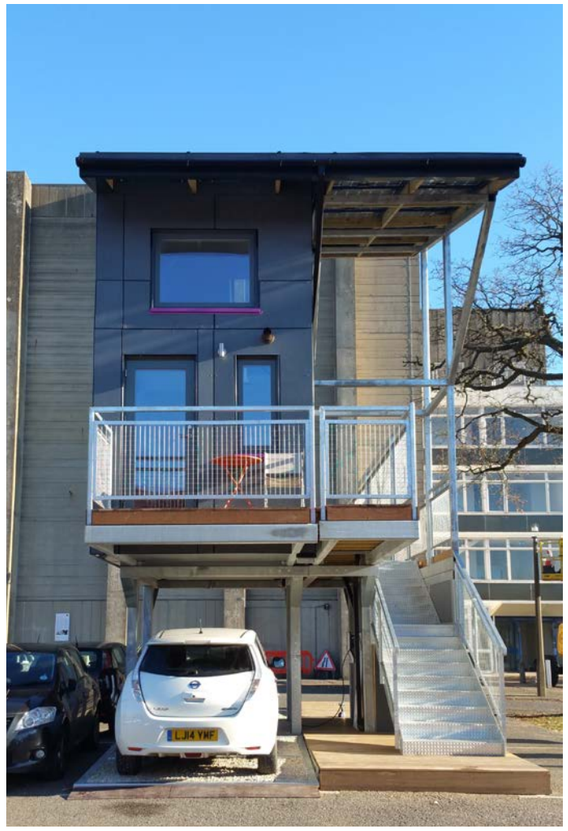
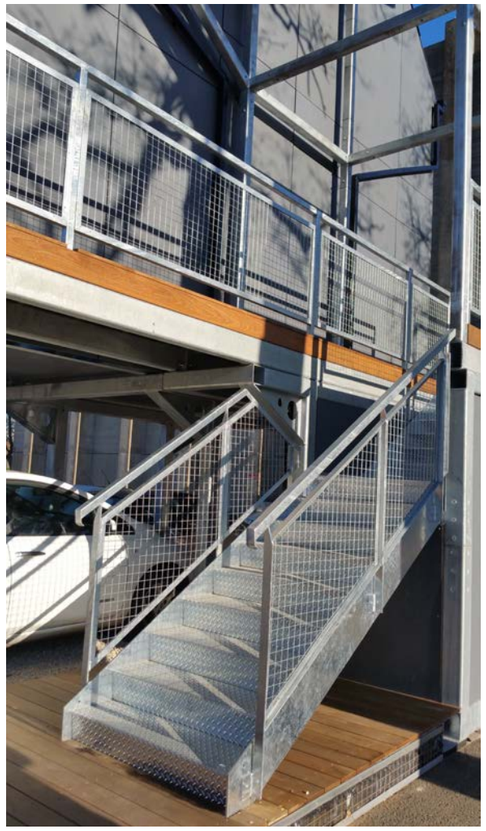
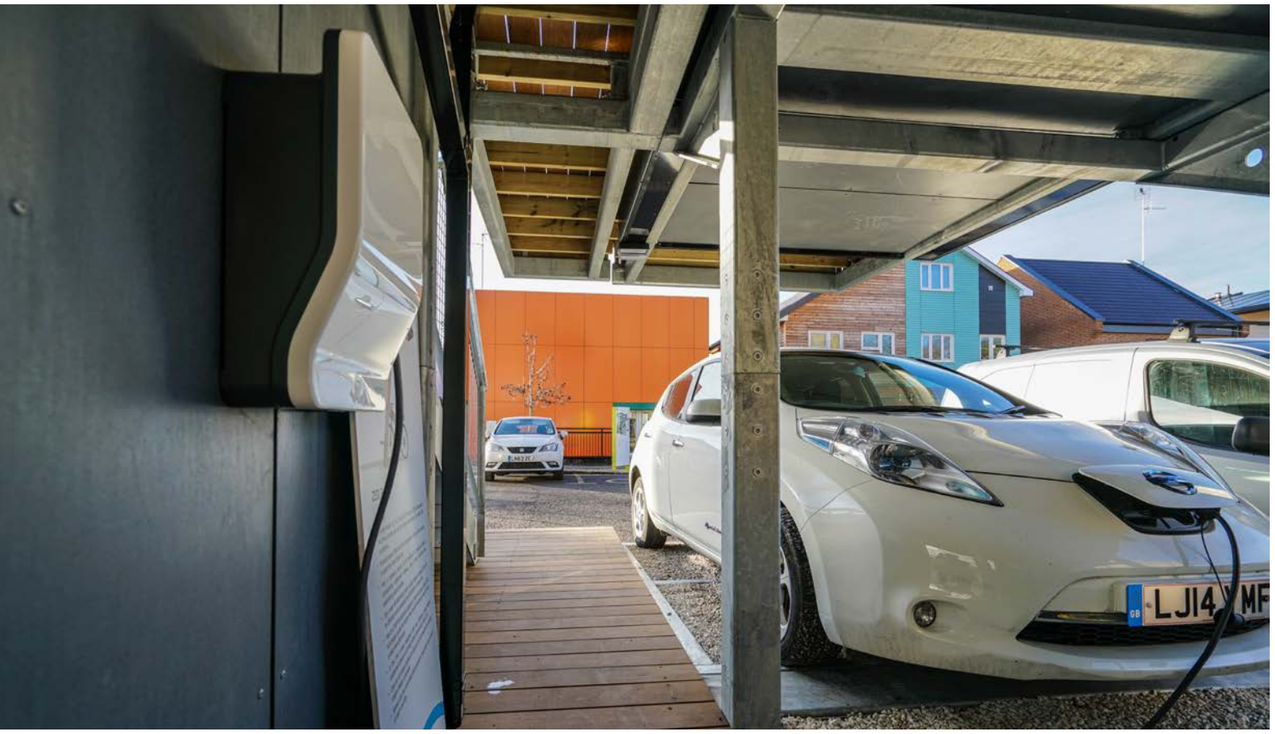




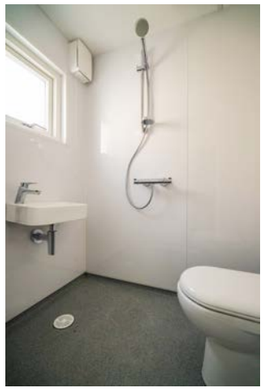


▲ Open plan kitchen and living space

▶ Study space & bedroom

⏭ Double height space

▼ Bathroom



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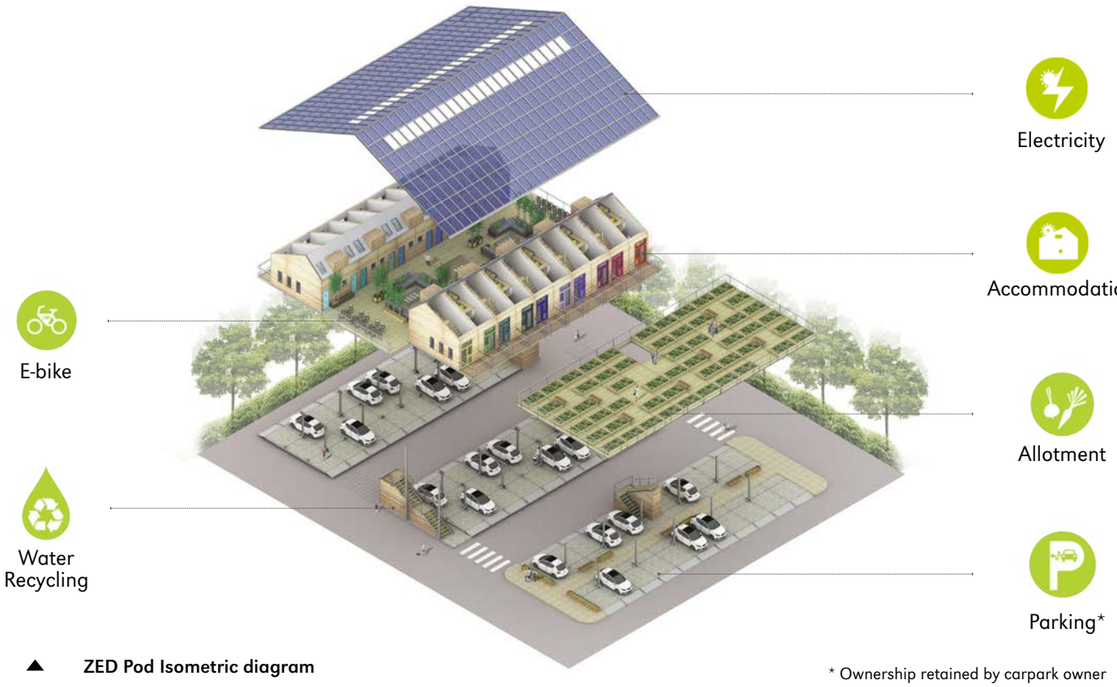


▲ **ZED Pod Isometric diagram**

* Ownership retained by carpark owner

Specification & Features

Specification: No toxic materials, no Urea based insulation systems, low VOC paints and adhesives, vapour permeable, breathing wall construction, galvanised steel internal frames with treated timber softwood studs counter battoned to minimise thermal bridging.

External Envelope

• 0.16 U-value Roof: 140mm Knauf Ecose recycled Mineral wool with zero formaldehyde binder in between rafters @ 600mm centres with a further 100mm Ecose above inside counter batons or 100 mm woodfibre board
• 0.2 U value Walls: 2 No 100mm Knauf Ecose Mineral wool in between in between studs @ 600cc counterbatoned to avoid thermal bridging or 100 mm woodfibre board
• 0.13 U-value Floor: 150mm Knauf Ecose Mineral wool in between joists @ 600mm centres, 100mm Knauf Ecose Mineral wool in between cross battens @ 600mm centres or 100 mm woodfibre board
• Airtightness: 1.3 ACH @ 50 Pa
• Heat recovery through wall ventilation fan providing fresh air with over 80 % efficient heat recovery from extracted stale air, allow ventilation without opening windows
• Triple glazed low 'E' Rationel windows and doors 0.89 U value with low maintenance aluminium cills and flashings and good acoustic performance
• OSB floor with acoustic underfelt and wood flooring panels
• Integrated kitchen with induction hob, microwave and fridge and LED lighting throughout
• Integrated wet room with water saving taps and spray showers plus wash hand basin
• 25 year guarantee EPDM roof
• BIPV HiminZED monocrystalline solar electric roof – BRE MCS approved for feed in tarif
• 25 year life thermally treated weatherboarded cladding and balcony decking with option for pre painted cement board lapboarding or through colour cement board panels as options
• Party walls exactly as per timber frame robust details with no structural connection between homes and non combustible rockwool insulated acoustic and vibration isolation cavity. Fire proof cement board soffit finish above parking bays

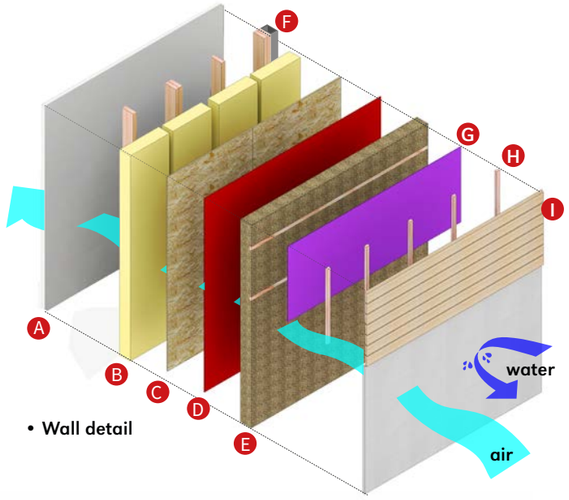
M&E

• Space heating Peak Load: 1.6kW (excluding internal gains) supplied by evaporator plate heat pump and integrated Cylinder supplies heat to an 2.0kW peak @ 50'c low flow temp Eco-rad
• PV: 9 Panel 2.25kW system producing 2100 kW/per Annum average installation
• Battery Storage: approx 3kWh of communal lithium iron phosphate battery storage capacity/Pod
• LED lights throughout

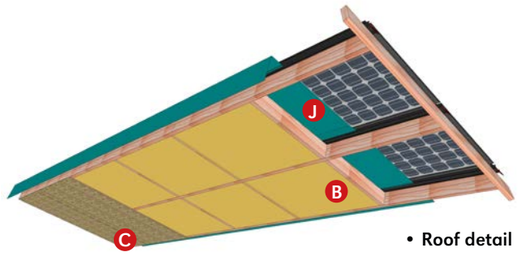
The support structure is heavy duty welded steel with rubber buffers to absorb vehicle impact.

How does it work?

By superinsulating the Pod and providing heat recovery ventilation and high standards of draught proofing, only very small amounts of space heating are required to be comfortable. The biggest heat demand becomes domestic hot water, and this is met by a tiny 400watt electric evaporator plate heat pump. This heat pump works like a fridge in reverse, and circulates its refrigerant through an absorber plate fitted to the upper roof. No fan noise is heard. One unit of solar electricity will normally produce around 3 units of heat, enabling each home to be substantially powered by solar electricity generated by the photovoltaic roof panels. The solar electricity produced during the day is stored in a large 60kwh lithium ion phosphate battery store with integrated inverter, which can power the homes at night. On the rare occasions when solar radiation is low in mid-winter, the battery store automatically trickle charges itself during the day from the street light circuit. This avoids spending scarce funds on digging up the car park to install new electricity supplies. There should be enough renewable electricity to charge a number of electric vehicles during the day. The interlocking array of solar panels provides the roof surface, and covers the access decks. It would cost more to remove them and service the development using conventional grid services. The increased demand on the local electricity grid will be barely noticeable, allowing substantial numbers of new homes to be built without requiring investment in new power stations, new cables, and new water treatment plants. This saving in centralised infrastructure provision can both make sites without good mains services viable, and save investments by the local government and local utilities. An off grid drainage strategy can also be deployed where necessary, and the only conventional services required are a fresh water supply and a street lighting circuit to tap into. Totally off grid solutions can easily be achieved at modest extra cost.

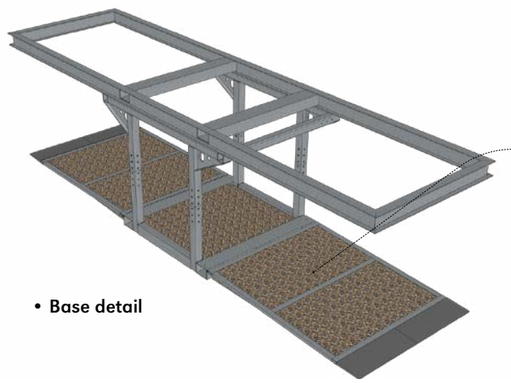


• **Wall detail**

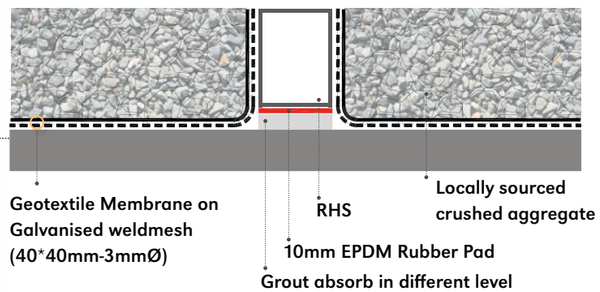


• **Roof detail**

A	Cement board	F	Cladding batten
B	Mineral wool insulation	G	Breather membrane
C	OSB board	H	Cladding rails
D	Airtightness membrane	I	Cladding panel
E	Wood fibre insulation	J	Waterproof membrane



• **Base detail**



Environmental performance of Pods

Window positions encourage stack ventilation and cross ventilation in summer. If an entrance floor window and the uppermost bedroom Velux is open - both cross ventilation and stack ventilation are easily achieved with warm air vented at the highest point in the room.

Heat recovery ventilation draws fresh air in at high level away from fumes and provides ventilation and fresh air without having to open windows. Large solar canopies shade windows to prevent overheating in summer and the need to open windows to stay cool inside. Vapour permeable insulation materials and minimal thermal bridging means no need to open windows to combat condensation.

The duration of engine run time in most car parks is a fraction of almost any reasonably busy road and air quality in a car park is often significantly better than many existing residential streets. The ZEDpod Co will submit air quality reports with each planning application. The height of the pods above the parking bays and large 6m gaps over the access roadways means good dispersion and cross ventilation of any fumes generated by cars is far better than normal residential garages with flats above.

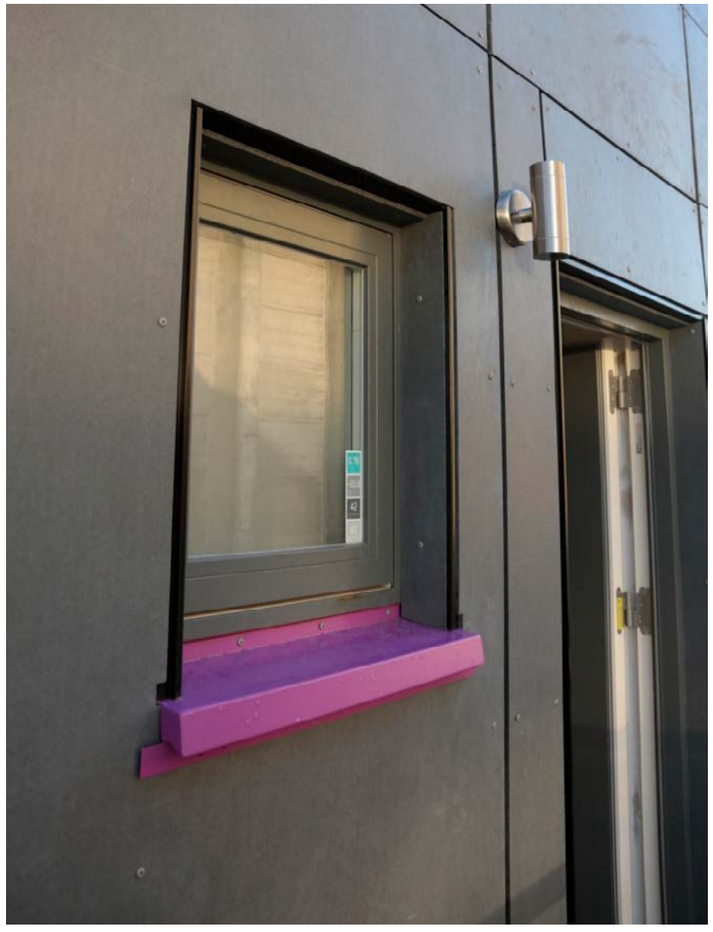
The tested airtight construction resists the passage of fumes from cars inside the pod homes. The ZEDpods come with optional EV charging facilities making the dedicated spaces under the pods easy to promote the use of clean zero emission electric vehicles in urban areas. These could also be part of a car pool for both residents and the public.

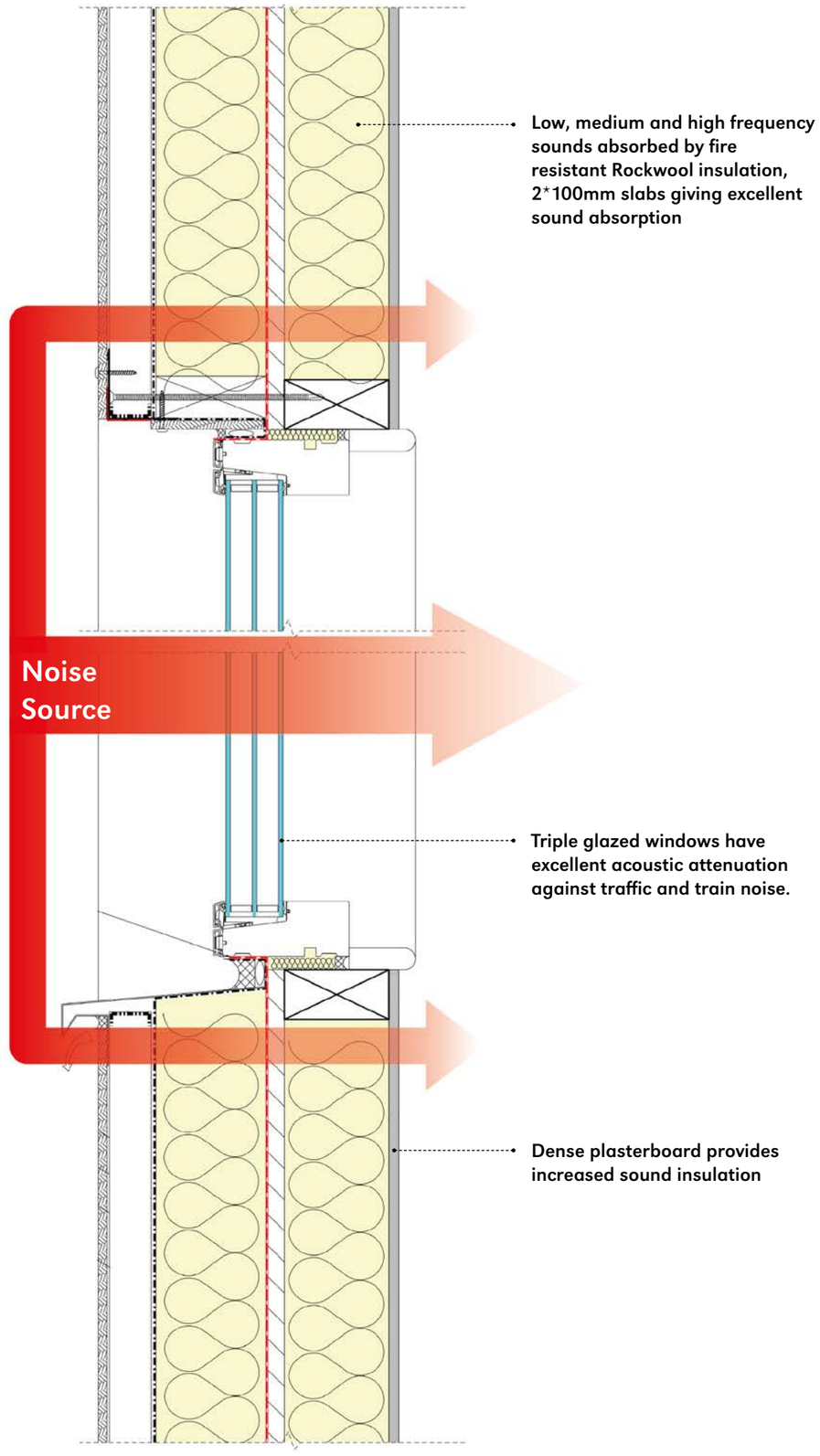
Acoustic planning

Each pod sits on rubber pads isolating vibration transmitted from the steel frame lifting the homes above the parking bays. Each steel raft sits on reclaimed rubber pads that both absorb surface undulations in the car park and help isolate the entire pod structure from any ground based vibration from trains or HGVs.

Triple glazed windows have excellent acoustic attenuation against traffic and train noise. The airtight construction and fire resistant rockwool insulation mean very little sound passes through building fabric. Each Pod has its own independent structure with no structural bridging elements ensuring same robust detail party wall acoustic performance as conventional timber frame construction.

Additional rubber pads at bumper height around column bases absorb gentle car impact, although our patented column positions are designed to make it far easier to park and open car doors than conventional under-croft car parks with columns next to the carriageway.





Planning

It is possible to double stack homes to increase the density; however piled foundations will be needed, and this will damage the existing car park surface.

The ZED Pod has a dual aspect. One elevation has the balcony and large glazed openings which allow for views. The other elevation is the access side, which has only opaque openings, minimizing overlooking and privacy issues. The access corridor can even be further enclosed in translucent glazing in sensitive sites.

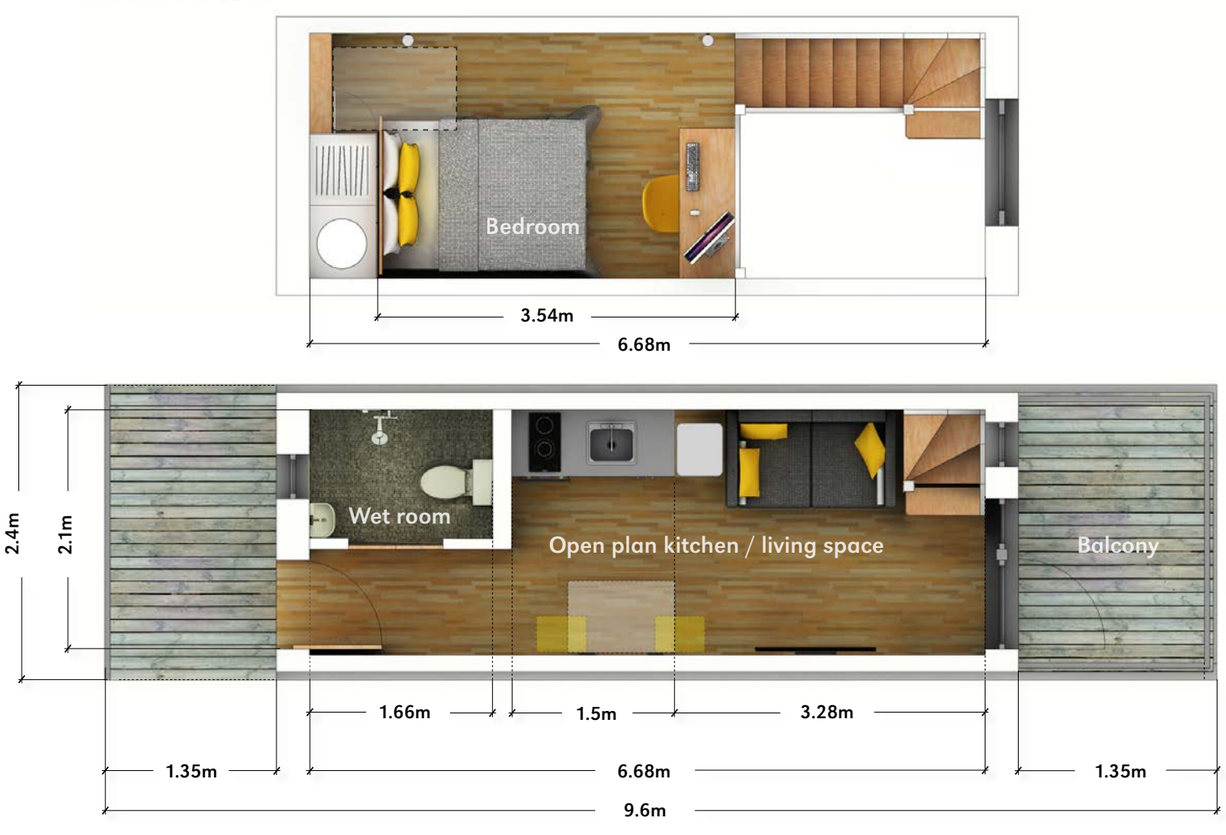
We can also integrate large communal rooms, shops and shared facilities into the terraces to create mixed use urban regeneration.

On most car parks, the stationary parked vehicles emit much lower levels of air pollution and noise than almost any inner city road in constant use – it is therefore possible to prove that a higher quality of life will be enjoyed by residents than that experienced by social housing fronting almost any reasonably busy road. Raised urban orchards and shared public realm are also available at an additional cost where site values can justify the increased rental premium.

Single pod section

Single pod plan

Total floor area: 22.4m²



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Single or double Pods or cohousing?

The Pods have been designed to sit over existing areas of tarmacked parking bays. By necessity they must respect the bay size of a typical parking space. This is either 2.4m wide and 4.8m long, or more recently 2.5m x 5m long. The support columns for the Pod housing sit between parking bay delineations, and are positioned to allow the car front doors to open without obstruction. Rubber D profiles stop careless drivers impacting on the support columns. By taking two back to back bays, a planning grid of 2.5m x 10m is achieved, which is enough space to fit a 22.4m² Pod with a generous private balcony on its living room side, and a generous communal access deck to its front door. The Pods do not touch each other, and a small fire proofed cavity between them prevents sound and impact transmission between party walls. Placing up to 12 Pods in a line with a shared staircase at each end provides good fire safety, and allows the bin stores, batteries and water treatment tanks to be integrated with the staircases.

The Pods are prefabricated off site in one of our factories, or assembled locally in a warehouse under cover using local labour. They are delivered to site in floor height sections, and must be easily transportable by road, so the width is restricted to around 2.5m. Two prefabricated sections make one completed home, and these are forklifted into place onto a welded steel support base unit. This frame (patent pending) is prefabricated off site and sits on pads that result in no greater loadings to the existing car park surface than a car or light commercial vehicle. No damage is done to the existing car park surface, and a new ramped porous wearing surface from local stone aggregate will often provide a more attractive surface to the existing car park than the old tarmac. Installation is staggered so that on site assembly would only close small sections of a typical car park for a day, and could even be achieved overnight if minimising disruption to a car park operation was considered important. The only equipment needed on most sites is a heavy duty forklift.

The size of each Pod is 22.4m² gross internal floor area. This does not include double height spaces or external private balcony. This makes a comfortable microhome for a young couple that does not feel claustrophobic because there is daylight from large triple glazed windows, and a double height void and stair leading to a mezzanine bedroom floor. A roof light window gives direct light and ventilation to the bedroom. A generous wrap around desk makes a good home office space looking down to the living room, designed for students and teachers to facilitate homeworking. Each Pod can have 7.5m² of shared communal space below the raised roof solar canopy that can be enclosed if necessary to create a co-housing type shared living room space at modest expenditure. This is achieved by adding a vertical glazed screen at either end, enclosing the space between Pods.

If the additional glazed screen is installed, the usable internal floor area allocated to each Pod can rise to around 30m².

Another plan variant is double Pods with two large bedrooms, larger living room and kitchen, bathroom and front door for 60m² (including a share of the communal space). This should meet national affordable homes space standard recommendations if this is insisted on by the planners.

Double pod plan

Total floor area (approx.): 50-52m²

Ground floor

First floor
Floor area (approx.): 27.5-28.5m²

Second floor
Floor area (approx.): 22.5-23.5m²

ZED Pod Catalogue

A a single Pod terrace

North-south option

E double Stacked Pod

Enhances quality of public realm. Pop up orchards over parking can reclaim large barren tarmacked spaces.

F 90 Degree Pod terrace

Supermarket carpark layout

B double Pod terraces

Creating a communal space

C student Pod

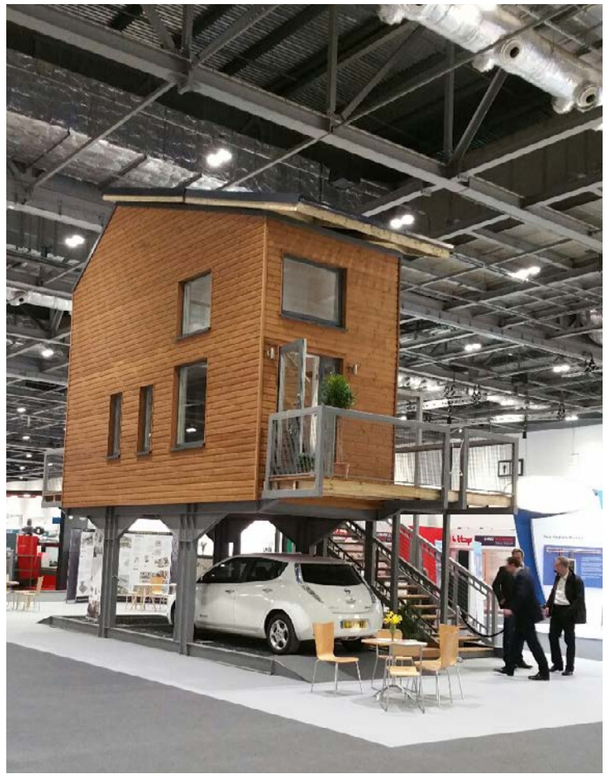
Communal space (within thermal envelope)

Communal space under solar canopy

Meeting National Legislation

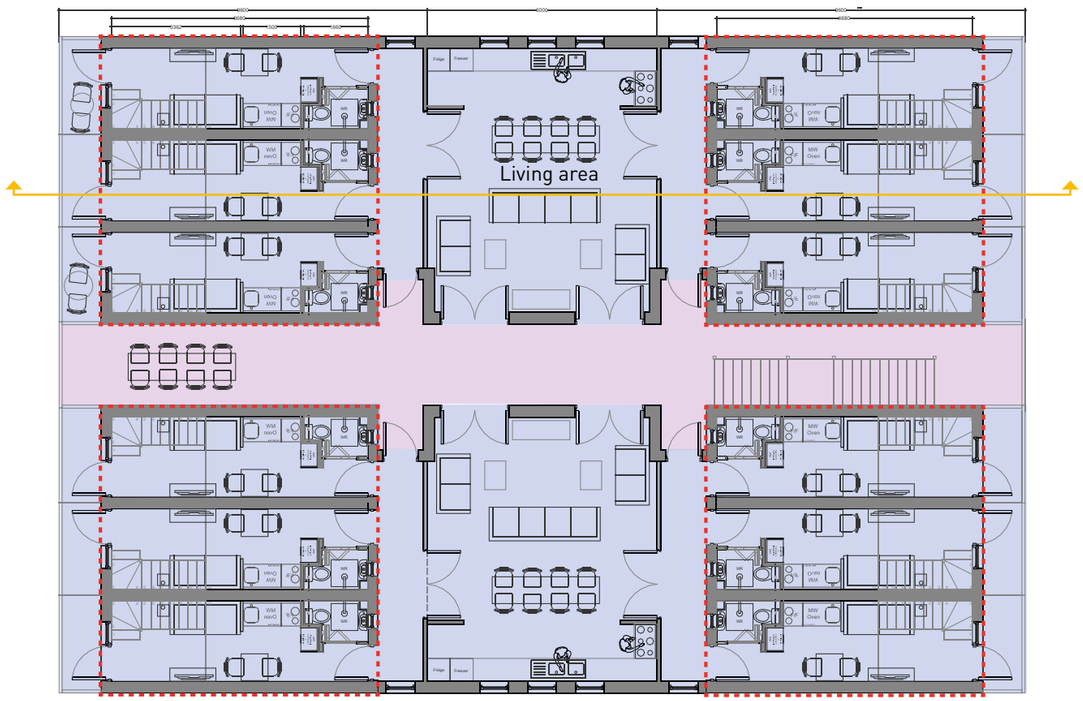
The National Housing Standards guidance requires minimum space standards for affordable homes that are part of section 106 agreements with local authorities, or requiring social housing grant from the Housing Corporation. The Pods do not request any funding from the housing Corporation, and do not need to be considered affordable homes. They should be designated affordable rent or market rent and are designed not as long stay accommodation but as the transition between student homes and conventional dwellings.

Several registered social landlords are happy to consider the Pods as providing a helpful and affordable intermediate solution to starter homes for sale or rent, and the planning application process is being initiated currently in Bath. The National Housing Standards are not mandatory, and are used as recommendations for conventional developments by many planning authorities without being legally enforceable. If a local authority insists on meeting these higher space standards, these can be met by two Pods sharing one front door and enclosing the communal access space between two terraces below the solar roof. This could create a two bedroom unit of compliant floor area



▲ ZED Pod at Eco Build 2016

First floor – ZEDpods lower floor



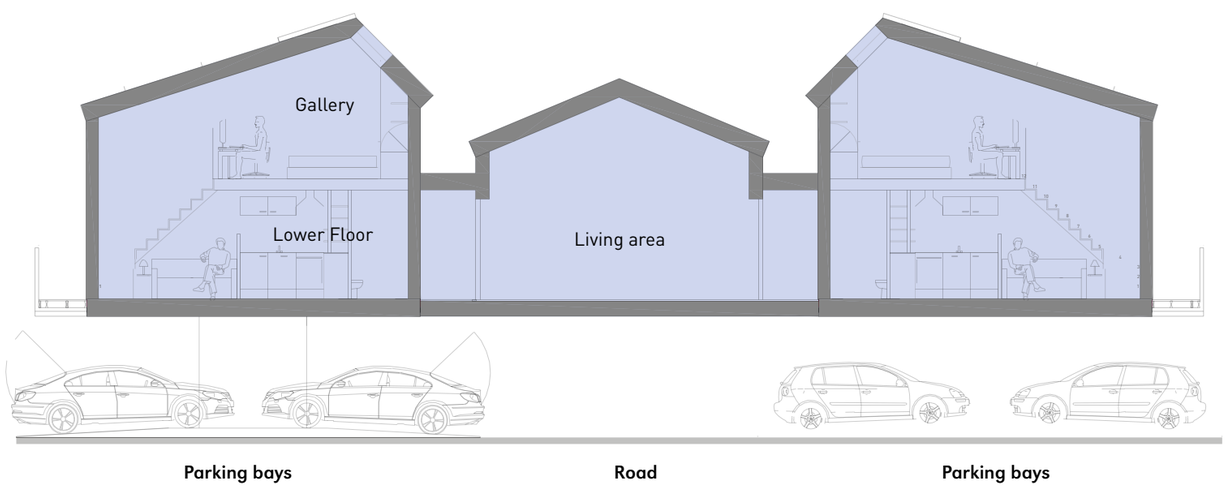
Providing future flexibility for landowners

All landowners want to maximise the value of their land. The trouble is that many vacant sites or car parks are seen as possible long term development opportunities – so they are left empty as land speculation. The hope is always that rising local land values will reach the point where the local planning rules are relaxed, and valuable development is permitted by the local authority and the local community. Whilst this speculation goes on, the site is left empty or used as temporary car parking often reducing local property values and contributing to planning blight. There are many examples where sites can remain empty for twenty years or more. This process of urban regeneration needs to be recognised, and understood by local communities. The ideal situation could be for a site to support a temporary use for a minimum of 5 years, corresponding to a temporary planning approval. Providing the community can be rehoused on another comparable car park, and the rental income from the Pods continues to flow to the investors that funded their creation, it should be possible to unlock many underused urban sites. This idea works providing another site is always made available. Most local authorities or large landowners owning a large number of car parks should be in a position to make this commitment.

The advantage of our ZEDPods is that they are designed to be forklifted into place with very little site works needed so that, although they are durable and long life buildings, they can also be moved and relocated with near zero waste. The concept of placing re-locateable homes above existing parking that need little infrastructure has taken us years to develop and is now ready for roll out at a large scale. It does not stop anyone else building conventional sized homes on conventional sites with conventional solutions that deliver the minimum legal environmental performance standards. On this basis we can be considered as an immediately implementable solution to solving the affordable homes crisis in many cities in the South?

Minimum gross internal floor areas (minimum space standard)				
N° of Bedrooms	N° of Bedspaces	1 storey dwelling	2 storey dwelling	3 storey dwelling
1b	1p	39m² (37)	/	/
	2p	50m²	58m²	/
2b	3p	61m²	70m²	/
	4p	70m²	79m²	/
3b	4p	74m²	84m²	90m²
	5p	86m²	93m²	99m²
	6p	95m²	102m²	108m²
4b	5p	90m²	97m²	103m²
	6p	99m²	106m²	112m²
	7p	108m²	115m²	121m²
	8p	117m²	124m²	130m²
5b	6p	103m²	110m²	116m²
	7p	112m²	119m²	125m²
	8p	121m²	128m²	134m²
6b	7p	116m²	123m²	129m²
	8p	125m²	132m²	138m²

Indicative section



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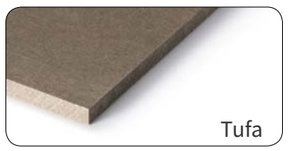
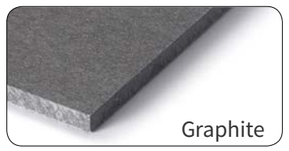
External Cladding Options

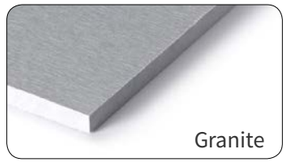
Treated wood shiplap board

Locally sourced timber weather boarding

Cembonit







Cembonit thro' colour

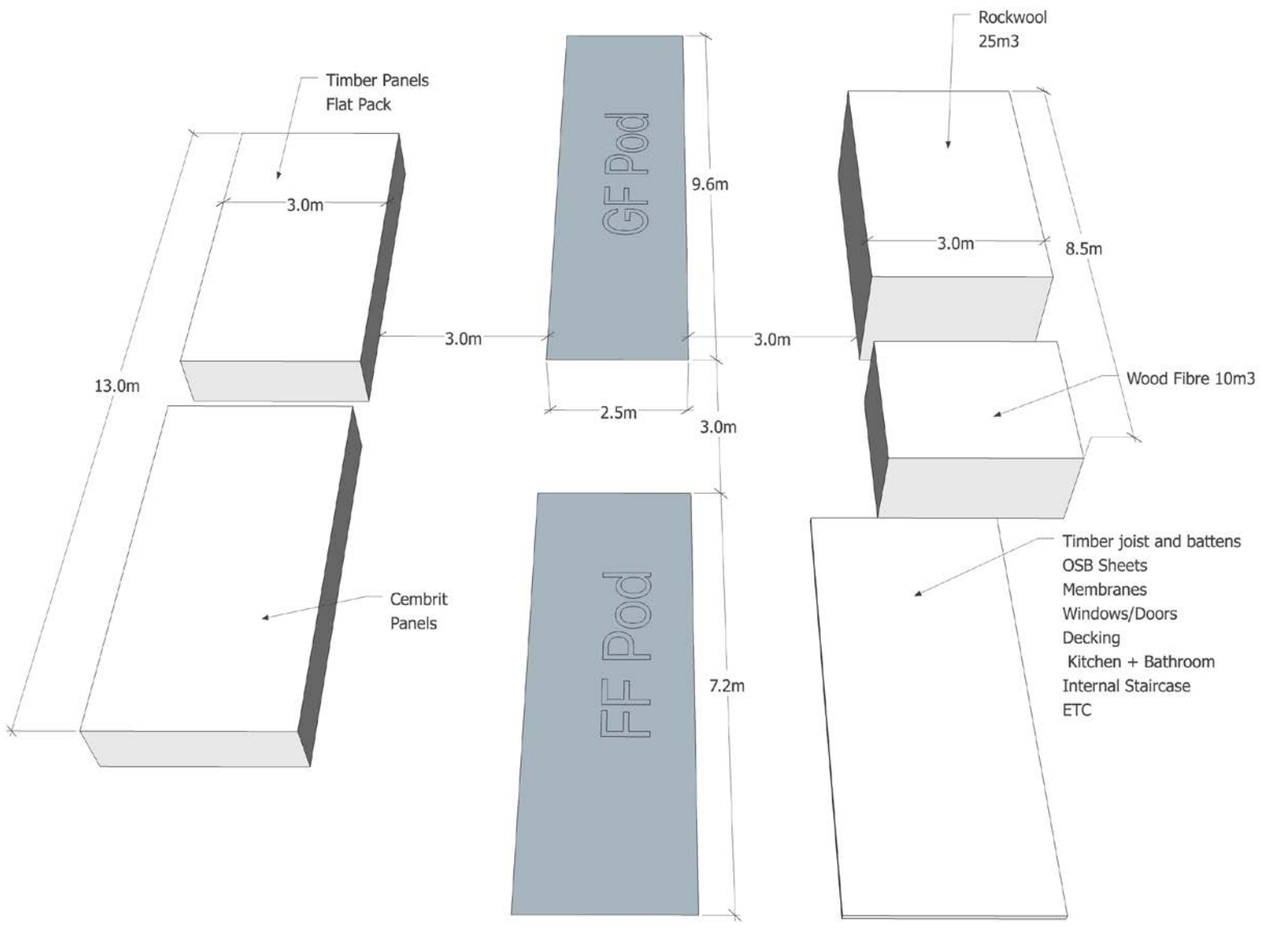
Eternit Vertigo slate rainscreen cladding

▲▲ Double Pod at Shanghai Design Week 2016

▲ Interior view showing living space and double height space

ZED Pod pop-up factory concept

• All other volumetric building providers have one centralised factory with huge investment and huge overheads and are limited by capacity.
• They also tend to ask for substantial deposits before starting fabrication.
• ZED Pods have a completely different business model. We manufacture a prefabricated kit of parts that is delivered to a local pop up factory to meet local demand.
• All ZED Pods components are prefabricated and tendered and manufactured by reputable companies with good Q A systems.
• The list of components, specifications and suppliers is defined and numbering / documentation is finalised.
• Local labour is trained to assemble the components by the ZED Pod team led by Leigh Jarvis.
• Some tools and equipment need to be rented and some purchased.
• We are working on specially fitted out shipping containers so that we can set up a mobile assembly line without excessive investment.
• Our first assembly unit has been in Cardiff, and we can set up as many others local to demand required.
• This allows the parallel operation of assembly lines and stops any one pop up factory being overloaded.
Any size contract can now be met by a larger number of parallel pop up production units and our training programme
• The finished ZED Pods are delivered to the car park of your choice and erected ready for occupation within days



▲ **Assembly space layout (Factory area: 240m² = One ZED Pod per week)**

ZED Pod at BRE Innovation Park








The 21 Steps

The following data speeds up a viability analysis for potential sites:

1. digital site plan in CADfile format (dgn or dxf not pdf please) with matching google earth screenshot and site boundary within owners possession clearly marked in red.
2. A car park with one or more double banked perpendicular entry parking spaces in linear runs of 6 to 15 spaces long
3. mains foul drainage position marked on plan with invert level.
4. Car park vehicle circulation marked on plan.
5. Positions of any major trees and buildings with canopy / building heights to calculate overshading
6. All surrounding residential principal habitable rooms marked on plan to assess planning privacy distances required.
7. Fresh water main supply location on plan.
8. Streetlight positions on plan
9. Mains electric availability on plan
10. Areas of green landscape and tree / planting positions shown on plan
11. Any Pedestrian desire lines or footpaths through car park on plan
12. Full photograhic elevations of car park perimeter to record outlook – can be phone images
13. Location of nearest bus / train / bike hire / tram public transport connections plus frequency of service
14. Rental value of typical local one bed studio flat.
15. Average daily vehicle moverments and parked duration.
16. Any existing acoustic or air pollution surveys
17. Location of supermarket loading bay plus no of vehicle movements plus hours of operation.
18. Location of any noisy air conditioning plant or chillers on the supermarket
19. existing electric vehicle charging point locations on plan
20. Position of any fuel stores or toxic or inflammable or smelly compounds.
21. Any former planning history or refusals for car park development.

• The digital ZEDpod layout CAD files can be sent providing a signed NDA has been received by our financial director: david@zerobillshome.com

ZED Pod at typical park & ride site

Site layout example (further information required)

It is now perfectly possible to place these lightweight homes on top of car park additional levels allowing any car park owner to increase capacity and deliver significant numbers of affordable homes without losing land already allocated to housing. Double decking allows park and ride sites to both increase parking capacity and create affordable homes. There is less noise and air pollution experienced living over a car park than in most city centre streets due to most vehicles being parked and relatively low numbers of vehicle movements.

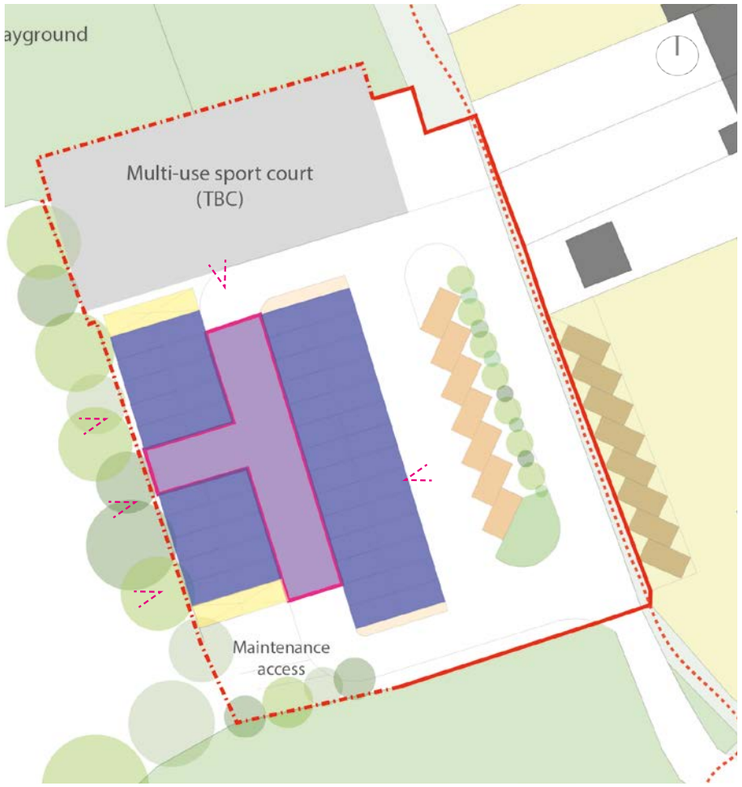
- 140 ZED Pods (including one co-working space)
- 34 car parking spaces lost (different layouts may involve additional car parking space loss).
- Potential for over 500m² of communal space
- Potential for over 1500m² of amenity space

- Pods
- Bus Stop
- Amenity Space
- Communal Space
- Co-working Space
- Horizontal Circulation (Escape route)
- Vertical Circulation (One per block for bin store access)
- Ground Floor Plant (Location and numbers to be defined)

Before

After

ZED Pods replacing existing lock up garages providing parking spaces below



25 Pods

Vertical Access

Covered communal space

Views


Existing garages


South view


East view


North view

ZED Pod over existing car parks, whilst retaining parking spaces below

Proposed site layout

91No Car parking spaces

- Existing buildings
- ZPODs Terraced (**12**No.)
- ZPODs 90° (**22**No.)
- Communal Space
- Raised Circulation
- Vertical Circulation
- Pedestrian circulation
- Stair (**6**No.)
- ZPODs gable end (**26**No.)

- ZPODs & ZPOD 90° are positioned in a sensitive manner reconstructing the urban fabric.
- Vertical circulation is restricted to 3 points Once above ground level pedestrians can circulate throughout the raised pop-up village
- The ZPODs have a covered communal space, which encourages interaction between occupants.
- Grove road elevation recessed to prevent overlooking issues and reduce daylighting implications.
- **21** Party walls
- **5** Bridges B1 B2 B3 B4 B5

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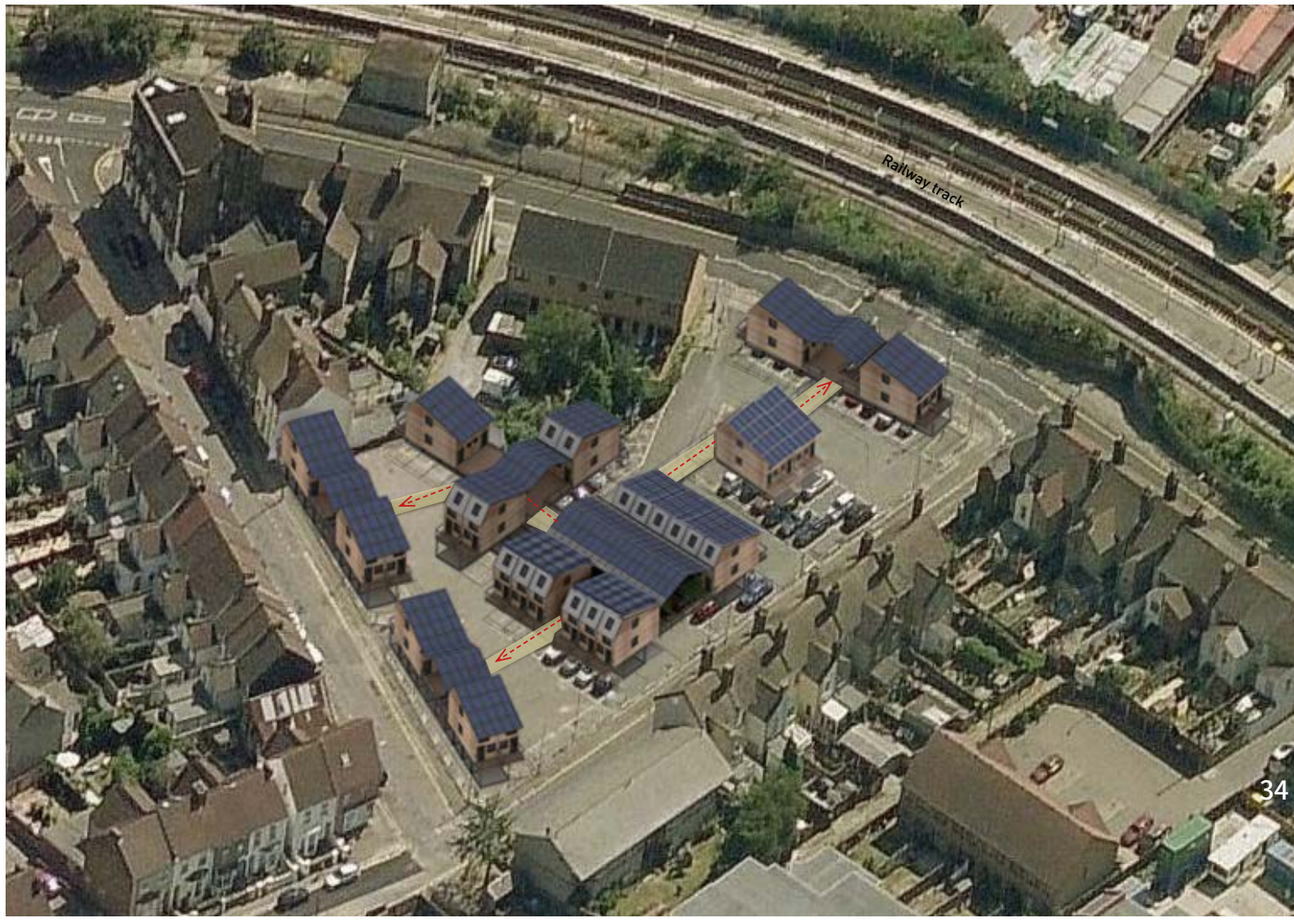


ZED workspace - Climate Neutral Office

The ZEDworkspace designed around the idea of providing a climate neutral and comfortable work space above existing parking areas with integrated zero carbon transportation.

One of the key differences between the ZEDworkspace and the generic office is its capability to facilitate and promote electric vehicle (EV) charging. This is partially fuelled by photovoltaic panels and lithium iron phosphate batteries installed under the access staircases. The office has a capacity for 26 EV's in total with an office seating capacity of 17 on the first floor and 37 on the second floor.

The ZEDworkspace aims to explore new operation modes for PV electricity generation rather than the more traditional electric exportation to the grid. With the ever less attractive feed-in tariffs and emphasis on self-consumption, the office can consume as much solar energy as possible before selling to the grid. With the help of demand side management of electricity, the ZEDoffice hopes to balance storage with generation and load, minimizing the need for investment in centralized grid power generation.

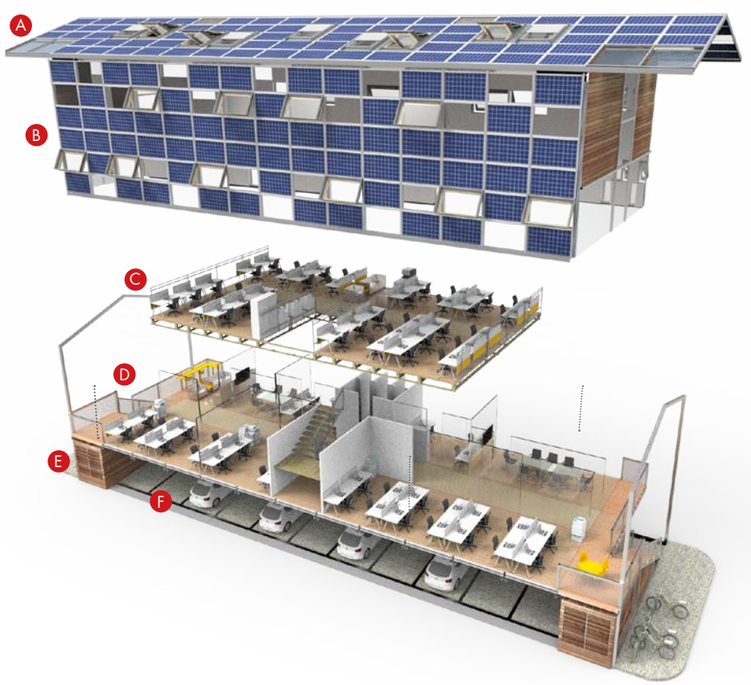
▶ **External view of the ZED workspace**

ZED workspace Specification

- Triple glazed Rationel aluclad low maintenance windows and doors, good acoustic performance
- Walls, roof and floor – U value 0.15 w / m^2 / deg C
- Airtightness 1.5 air changes / hour @ 50 pascals test pressure
- 1 hr fire barrier to parking below
- Two access stairs offering potential for subdivision
- Shared restrooms, meeting rooms and reception areas
- Double height exhibition / gallery space
- Solar assisted air source heat pump with high COP
- No gas connection required
- 120 kWh lithium battery store
- Low temp reversible underfloor heating / cooling
- 254 No 250 watt/ peak monocrystalline BIPV PV panels
- 50 to 60 kW peak of BIPV total
- Grid connected approx 20% of year with off grid capability
- Integrated rainwater storage tanks
- No gas or fossil fuels required
- Only fresh water and pumped drainage connection needed
- Optional disabled lift
- Optional solar powered electric bike pool
- Optional solar powered car pool
- Full finance available providing local authority sign up for 25 year lease with full system maintenance

Life expectancy 50 years – 25 years till first refurbishment
Estimated budget circa 800k
Timescale from place of order 16 weeks

Parking area: 308m^2 Total floor area: 413m^2
Parking space: 22 total, 4 car parking spaces lost



- **A Energy roof**
- **B Energy facade**
- **C Second floor area: 158m^2 Office sitting: 37**
- **D First floor area: 255m^2 Office sitting: 17**
  A board room
  A coffee bar
  A meeting room
  Three toilets
- **E Water storage tanks and battery banks**

- **F Ground floor (Car park)**

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Zero carbon office & charging station

(PV + battery solution with solar Heat pumps for space heating/cooling and hot water)

To work out the generation capacity on the office building using all façades for PV. To establish optimum battery size to maximise off grid time and charge EVs. Calculate when the building can supply charge to EV's or if more panels are need elsewhere i.e. as a carport with dedicated battery storage separate from main building. Look to break the metrics into useable data for energy (kWh) and maybe travel miles for EV.

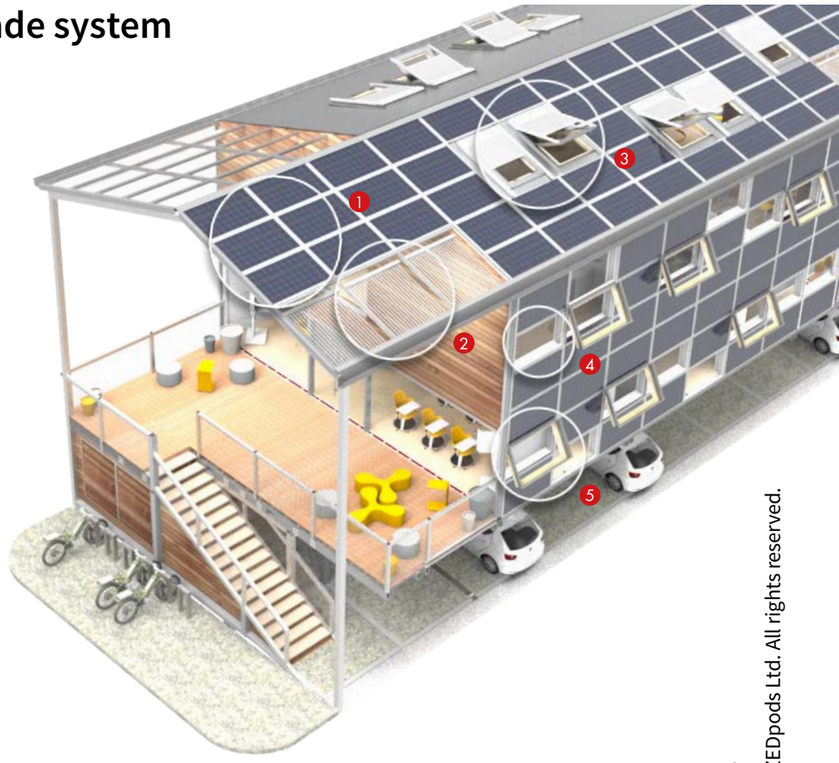
- Take the commercial office building and design, calculate the outputs from the solar panels on each façade / roof (use PVGIS online tool in Bristol location)
- Research charge rates /loads/amps/ battery capacity for electric cars and mileage per kWh (Google search with manufacturers and general available papers)
- Research LiFePo 4 batteries and charging from solar (Google search with manufacturers and general available papers)
- Estimate battery storage capacity required for the building and for charging EV

Notes
- Establish self-consumption at 50% of PV energy produced
- Each PV panel is 275w use sketch-up model to count PV's
- Battery units are available in 1.5kWh storage modules or pre-packaged at 24kWh and 60 kWh
- Use 50 kWh per m^2 for electrical energy use for the office building
- Use 36 kWh for heating cooling/ hot water (this is thermal. Divide by 3.5 to account for heat pump efficiency when calculating electrical load)

Output
- PV count and annual / monthly outputs
- Estimation of zero energy calculation for building i.e. does it produce more energy than it needs annually
- Battery size to accommodate the PV energy and assist in load matching and summer will over produce and winter under produce
- Can the building charge EV's from the energy generated as well as meeting annual building loads? If so how many and how many miles can be travelled from the energy generated
- How much energy is consumed on site assuming EV's are plugged in to charge from 25% to fully charged

ZED BIPV Roof & façade system

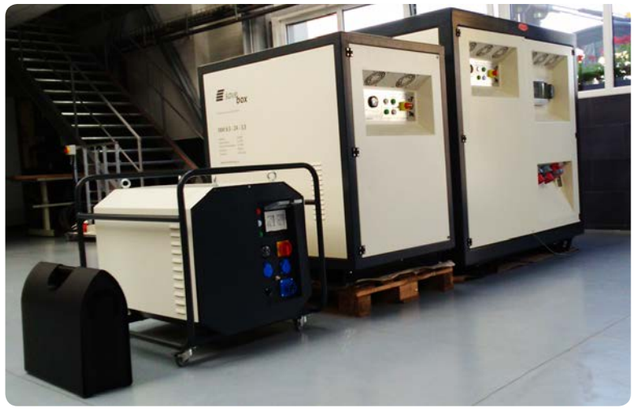
The intelligent BIPV enclosure providing vision, daylight, ventilation, hot water, cooling, heating, and electricity.



- **1 Insulated BIPV Panel**
- **2 Evacuated tube solar thermal collector filled with refrigerant for solar cool solar assisted heat pump system**
- **3 Matching rooflight - tripled glazed to provide ventilation to heated thermal envelope**
- **4 Clear panel**
- **5 Triple glazed low- e window**

Solar charged intelligent grid connected battery concept

A continuous output power	20.4kVA
Surge rating (overload 1 min)	40 kVA
Accumulator	LA 3016, LuFePO4
Stored energy	60 kWh
Charge time 100% (AC input)	5 hours
Battery lifetime	>4000 cycles
Size	1600 x 1600 x 1260 mm
Weight	1600 kg



Electric vehicle charging infrastructure

How DC fast charging works

Charging points proposed for the filling station will use DC power both rectified from the grid and drawn from the lithium iron phosphate battery bank. This will provide a charge rate of up to 50 kWs. Although EVs do have an on-board rectifying circuit to change AC power from the grid to DC power for storage, cost of upgrading the circuit and thermal issues related to rectifying high amounts of electricity limits the charge rate. Using stationary DC charging points means the limit to the amount of power that can be delivered is much higher than usual, consequentially reducing charge time. Like mobile phone companies, EV use a selection of different sockets to deliver charge, therefore the station shall accommodate the two main charging points to ensure most EVs are able to charge, these include:

- CHAdeMO for Japanese EVs
- Combined charging system (CCS) for European EVs

▼ **Shared outside veranda decks with coffee table for outdoor working**

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