BARNHAUS

Buildable **A**ffordable **R**enewable **N**o carbon

Imagine a house that is designed to be built by its occupants – without complicated machinery, or specialist trades. Imagine a house that is cost effective to build AND cheap to run, without sacrificing on quality of design or environmental credentials. You are imagining the BARNHAUS.

The BARNHAUS builds on the simplicity and economy of agricultural structures, and adds the sophistication of cutting edge residential design with the stringency of Passivhaus energy standards. The end result is a home that is simple to build, easy to maintain, and consumes a minimum of energy.

STREET VIEW - North elevation shows planting, shuttered windows and PV canopy

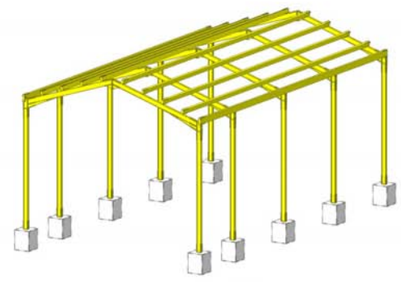
CONSTRUCTION

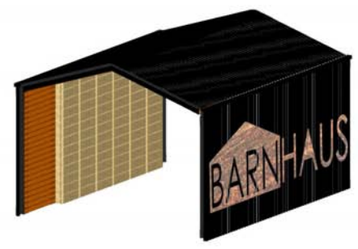
Structure is provided by a steel portal frame. The same frames are used for agricultural and storage units worldwide, providing an abundance of space at a minimum of cost. The frame is longer than the house at both ends, to provide outdoor places as well as generous internal space, and to ensure that the house is easy to extend in the future.

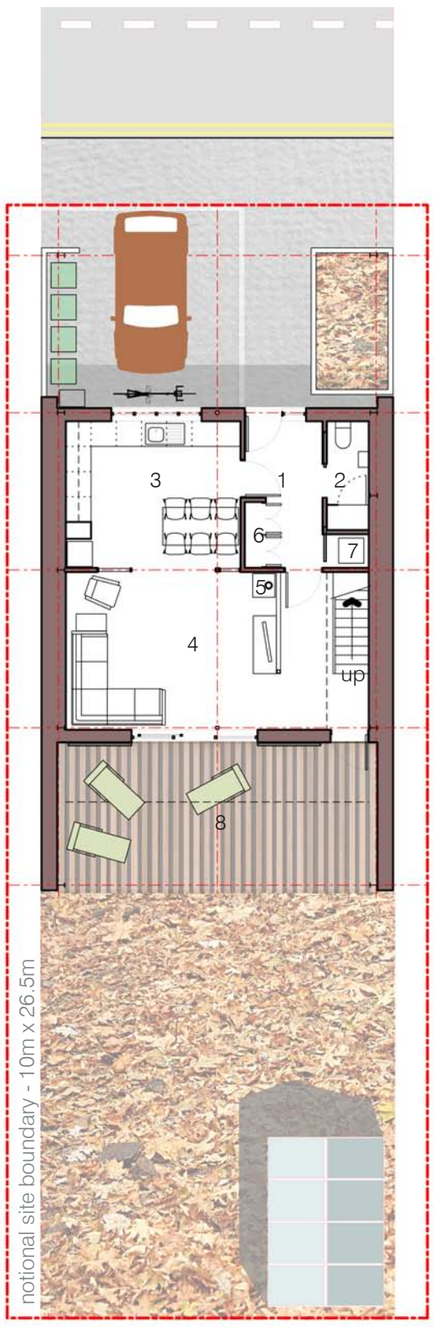
The frame sits lightly on the ground, minimising site works and foundations. A lightweight steel and timber first floor is inserted, providing floor area for two generous bedrooms over an open plan ground floor living area. Internal partitions are all lightweight to minimise wet trades, and lined in plywood to create a beautifully warm interior that is easy to service and adapt, and to avoid the need for plastering.

The frame is wrapped in a thick layer of insulation which, in turn, is clad in a rainscreen. This rainscreen cladding could be brick, slate or timber… The example shown uses corrugated fibre cement cladding which is lightweight, cheap and sustainably sourced. There are no windows, doors or other penetrations in the external wrap, to simplify construction and so that houses can be arranged in rows, or on tight sites.

All windows are north or south facing. On the north side, openings are small and the extended frame provides support for direct solar and PV panels, a car port, waste and recycling storage. On the south side, openings are much larger and the frame provides a generous overhang, creating a sheltered terrace and covered balcony that will not overheat and could be transformed in one simple move into a beautiful sun space.



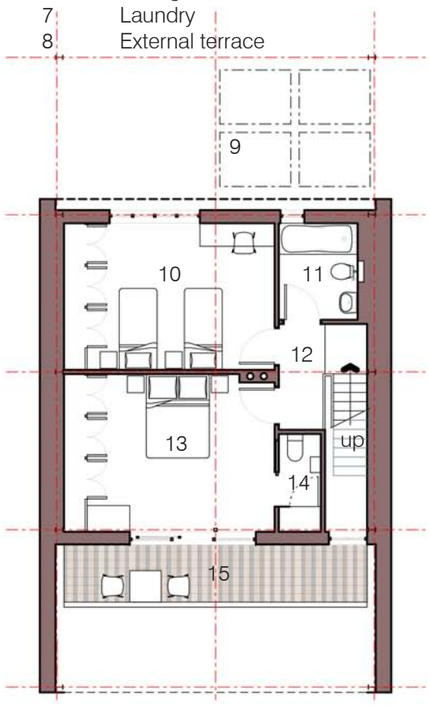




GROUND FLOOR PLAN

Ground floor key:

1 Entrance lobby
2 Ground floor WC
3 Kitchen / dining
4 Living room
5 Wood burner
6 Storage
7 Laundry
8 External terrace



First floor key:

9 Photovoltaic canopy (over)
10 Bedroom
11 Bathroom
12 Hallway
13 Bedroom
14 Ensuite
15 Balcony

FIRST FLOOR PLAN

ENVIRONMENT AND ENERGY

Passivhaus design principles require a highly efficient external envelope, in terms of both thermal performance and air tightness. For this approach to be successful, the building form must be simple, and details must be buildable.

To achieve Passivhaus accreditation, the building envelope must be insulated to a minimum of 0.15 W/m2K. Engineered timber joists create a deep external wall, which can be filled with straw bales – cheap, widely available and an excellent source of insulation (450mm deep straw bales laid parallel and sealed on both sides have a U-value of 0.165 W/m2K). However, small dwellings must go further than this to compensate for a high proportion of external envelope / perimeter. The walls and floor can be supplemented with an additional layer of generic rigid board insulant to achieve 0.07 and 0.09 W/m2K respectively.

Due to the high levels of insulation within the envelope, a single point heat source – a conventional wood burning stove - provides plenty of heat for the entire house. The design of the building maximises natural resources and ensures a controllable environment that will not overheat. Roof mounted solar thermal panels preheat hot water, which is topped up by a back boiler on the wood burning stove and stored in a solar hot water cylinder to provide thermal storage. Excess heat is distributed through heated copper pipe rails in the bathrooms, airing cupboard and coat store.

The basic BARNHAUS model exceeds the Buiding Regulations 2016. With the addition of deeper insulation, an MVHR system and careful attention to detail, the house can be constructed to meet Passivhaus standards. See Cost Report p.4 ‘options’ for details.

GARDEN VIEW - master bedroom and living room open up towards the garden to the south

INTERIOR VIEW - open plan living room, dining area and kitchen

DESIGN / FLEXIBILITY

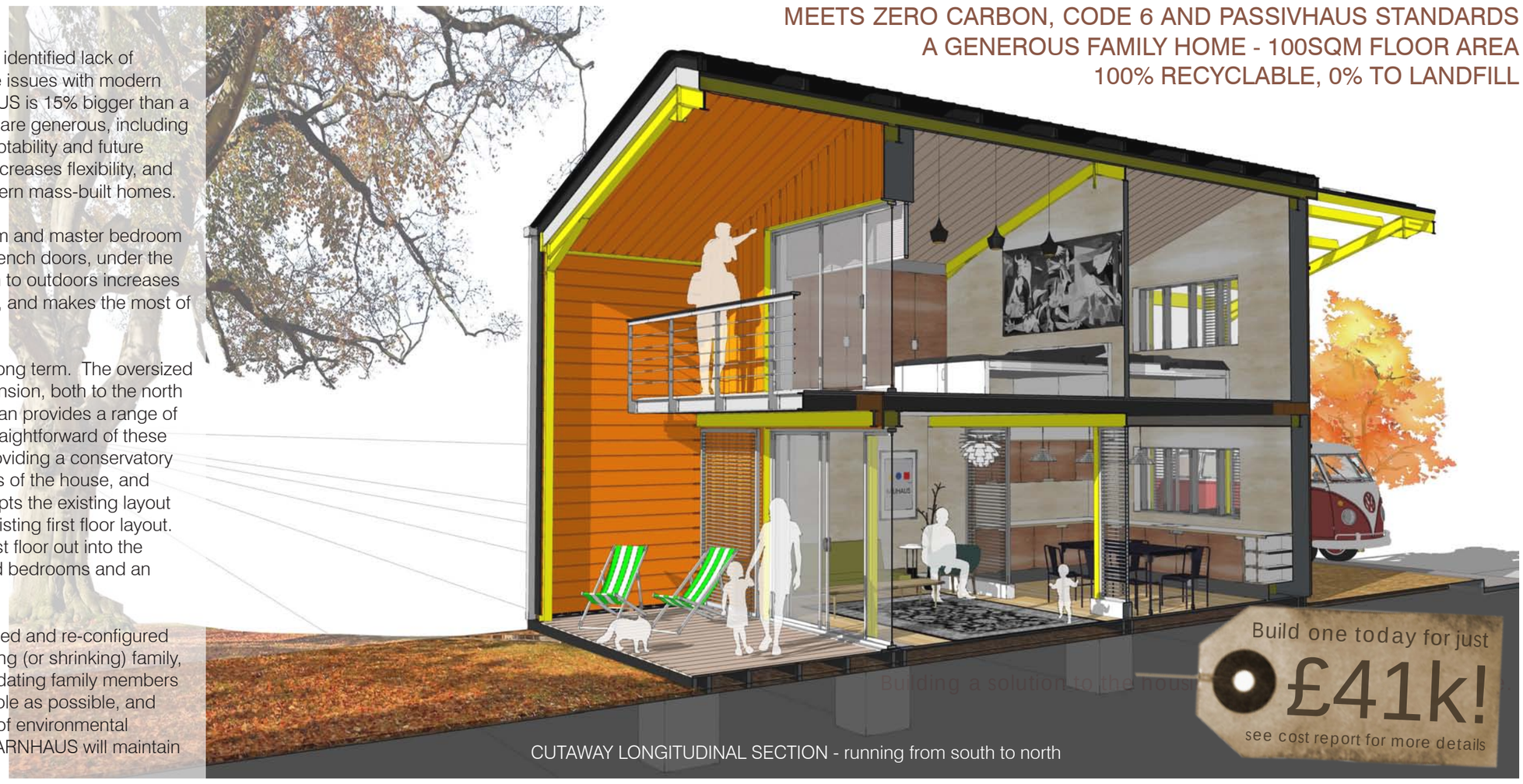
In 2012 the ‘Way We Live Now’ RIBA Mori poll identified lack of flexibility and shortage of space as being core issues with modern UK house building. At 100sqm, the BARNHAUS is 15% bigger than a conventional two bedroom home. All spaces are generous, including two full size bedrooms, providing greater adaptability and future flexibility. An open plan ground floor further increases flexibility, and provides a spatial richness missing from modern mass-built homes.

On the south side of the house, the living room and master bedroom both extend into outside spaces via sliding French doors, under the shelter of the oversailing roof. This connection to outdoors increases the sense of wellbeing provided by the house, and makes the most of both natural light and solar gains.

The house is also designed to be adaptable long term. The oversized steel frame means that there is room for expansion, both to the north and south of the house. The attached cost plan provides a range of options for extending the home. The most straightforward of these options encloses the south-facing terrace, providing a conservatory space in addition to the core component parts of the house, and acting as a solar buffer. A second option adapts the existing layout to provide a small third bedroom within the existing first floor layout. A third, more extensive, option extends the first floor out into the conservatory space, to provide three full-sized bedrooms and an extended living space.

These options cater for the house to be adapted and re-configured in a variety of different ways including a growing (or shrinking) family, space for working from home, and accommodating family members with disabilities. By making the home as flexible as possible, and by building to the highest standards in terms of environmental performance and energy consumption, the BARNHAUS will maintain its relevance, now and in the future.

MEETS ZERO CARBON, CODE 6 AND PASSIVHAUS STANDARDS
A GENEROUS FAMILY HOME - 100SQM FLOOR AREA
100% RECYCLABLE, 0% TO LANDFILL



CUTAWAY LONGITUDINAL SECTION - running from south to north

Works Package	Construction Element	Materials	Labour	Total
Works Package 1	Set up, Clearance, Demolitions….	£ 550.00	£ -	£ 550.00
Works Package 2	Foundations *(up to DPC)*	£ 280.00	£ -	£ 280.00
Works Package 3	Ground Floor Slab or Suspended Floor	£ 1,536.50	£ -	£ 1,536.50
Works Package 4	Drainage & Service Trenchwork	£ 600.00	£ -	£ 600.00
Works Package 5	Specialist Building System *(eg timber frame, SIPs, etc if applicable)*	£ 2,750.00	£ -	£ 2,750.00
Works Package 6	External & Internal Walls	£ 7,492.50	£ -	£ 7,492.50
Works Package 7	Intermediate Floor Zone (if applicable)	£ 330.00	£ -	£ 330.00
Works Package 8	Fireplace & Chimney (if applicable)	n/a	n/a	£ -
Works Package 9	Roof Structure, Insulation & Covering	£ 3,628.55	£ -	£ 3,628.55
Works Package 10	Joinery *(Windows, doors, stairs, skirtings…)*	£ 8,035.50	£ 500.00	£ 8,535.50
Works Package 11	Specialist Products *(eg; Eco products…)*	n/a	n/a	£ -
Works Package 12	Electrical Installation	£ 900.00	£ 1,600.00	£ 2,500.00
Works Package 13	Plumbing Installation	£ 3,815.00	£ -	£ 3,815.00
Works Package 14	Heating Installation	£ 970.00	£ -	£ 970.00
Works Package 15	Plastering *(or dry-lining)*	n/a	n/a	£ -
Works Package 16	Kitchen and Utility Units *(+ appliances)*	£ 730.00	£ -	£ 730.00
Works Package 17	Decorations & Wall Ceramics	£ 1,240.00	£ -	£ 1,240.00
Works Package 18	Floor Finishes	£ 2,485.00	£ -	£ 2,485.00
Sundries	at 5% of above work packages	£ 3,272.56	£ 210.00	£ 3,482.56
	TOTAL	**£ 38,615.61**	**£ 2,310.00**	**£ 40,925.61**

reference	notes	rate	units	quantity	materials	labour	total
WP1 Setup/clearance/dem	Steel frame delivery with HIAB, 1 day	1	£/day	550	£ 550.00	£ -	£ 550.00
WP1 total					**£ 550.00**	**£ -**	**£ 550.00**
WP1 notes:	Steel frame errectable with HIAB (following delivery) or telescopic digger arm. No other major plant required.						
WP2 Foundations	600x600 pad foundations (full depth)	100	£/cu.m	2.8	£ 280.00	£ -	£ 280.00
WP2 total					**£ 280.00**	**£ -**	**£ 280.00**
WP2 notes:	Minimal foundations required include 10no. Pads for stanchions plus a further 4no. Pads for intermediate posts.						
WP3 Ground floor	50x175 timber floor joists	4	£/m	92.5	£ 370.00	£ -	£ 370.00
	150mm rigid insulated board	17	£/sqm	55	£ 935.00	£ -	£ 935.00
	DPM	0.5	£/sqm	55	£ 27.50	£ -	£ 27.50
	chipboard sheathing	4	£/sqm	51	£ 204.00	£ -	£ 204.00
WP3 total					**£ 1,536.50**	**£ -**	**£ 1,536.50**
WP3 notes:	Suspended ground floor maximises thermal separation and minimises ground works.						
WP4 Drainage and service tr.	soakaway, gravel based				£ 100.00	£ -	£ 100.00
	allowancefor drainage connection				£ 500.00	£ -	£ 500.00
WP4 total					**£ 600.00**	**£ -**	**£ 600.00**
WP4 notes:	Services are distributed within the floor construction, and in the internal lining of external walls.						
WP5 Structure	60x30x14ft portal frame to BS5502 class 2, all steelwork primed and gloss finish, inlcluding:				£ -	£ -	£ -
	178x102x19kg u.b. stanchions			10	£ -	£ -	£ -
	178x102x19kg u.b. rafters			10	£ -	£ -	£ -
	60.3x3 CHS tubular wind braces			8	£ -	£ -	£ -
	175x75mm treated timber purlins			32	£ -	£ -	£ -
WP5 total	Package price (includes associated bolts, nuts, and 1 bay galvanised)				**£ 2,750.00**	**£ -**	**£ 2,750.00**
WP5 notes:	Agricultural steel frame packages are highly economic frames. With stanchions at closer centres, they are suitable for resi. loadings.						
WP6A External walls	engineered timber rails, 250mm	4	£/m	40	£ 160.00	£ -	£ 160.00
	timber cladding rails, 150mm	2.7	£/m	75	£ 202.50	£ -	£ 202.50
	ply sheathing	17	£/sqm	115	£ 1,955.00	£ -	£ 1,955.00
	compacted straw bale insulation	2	£/bale	230	£ 460.00	£ -	£ 460.00
	vapour barrier	0.5	£/sqm	115	£ 57.50	£ -	£ 57.50
	150mm rigid insulated board	17	£/sqm	55	£ 935.00	£ -	£ 935.00
	Cedral fibre cement board (unfinished)	16	£/sqm	55	£ 880.00	£ -	£ 880.00
	G6 corrugated fibre cement sheet, black	14	£/sqm	96	£ 1,344.00	£ -	£ 1,344.00
WP6B Internal walls	75mm studwork	1.5	£/m	77	£ 115.50	£ -	£ 115.50
	additional linings	17	£/sqm	75	£ 1,275.00	£ -	£ 1,275.00
	Joinery (skiritng architraves etc)	1.8	£/m	60	£ 108.00	£ -	£ 108.00
WP6 total					**£ 7,492.50**	**£ -**	**£ 7,492.50**
WP6 notes:	External walls are highly insulated with straw bales (cheap and locally sourced) and clad externally with low cost fibre cement rainscreen (2 types).						
	Internal partitions are timber stud - lightweight and easily adapted. Internal and external walls are lined with plywood to remove the need for plaster.						

reference	notes	rate	units	quantity	materials	labour	total
WP7 Intermediate floor	178x102x19kg u.b. joists	17	£/item	3	£ 51.00	£ -	£ 51.00
	102x102x19kg RHS for posts / strength.	15	£/item	9	£ 135.00	£ -	£ 135.00
	structural chipboard flooring	3	£/sq.metre	48	£ 144.00	£ -	£ 144.00
WP7 total					**£ 330.00**	**£ -**	**£ 330.00**
WP7 notes:	An intermediate floor is added to the portal frames by splitting the span of intermediate floor beams with an additional steel post.						
WP9 Roof	150mm timber roofing batten	0.6	£/m	198	£ 118.80	£ -	£ 118.80
	150mm celotex	17	£/sqm	70	£ 1,190.00	£ -	£ 1,190.00
	G6 corrugated fibre cement sheet, black	14	£/sqm	80	£ 1,120.00	£ -	£ 1,120.00
	Over-ridge G6 corrugated f.c. sheet	16.5	£/m	11.5	£ 189.75	£ -	£ 189.75
	breather membrane	0.5	£/sqm	82	£ 41.00	£ -	£ 41.00
	200x150mm box gutter, mill finish+clips	35	£/m	21	£ 735.00	£ -	£ 735.00
	75mm dia circular downpipes, mill finish	13	£/m	18	£ 234.00	£ -	£ 234.00
WP9 total					**£ 3,628.55**	**£ -**	**£ 3,628.55**
WP9 notes:	Roof is a simple low angle pitched roof, with no openings to give rise to maintenance issues, clad in same rainscreen as external flanks.						
WP10 Joinery	Balustrading / guarding	200	£/sqm	7.5	£ 1,500.00	£ 500.00	£ 2,000.00
	external doors - front	170	£/item	2	£ 340.00	£ -	£ 340.00
	external doors - sliding	1800	£/item	2	£ 3,600.00	£ -	£ 3,600.00
	windows	190	£/sq.metre	8.5	£ 1,615.00	£ -	£ 1,615.00
	internal doors	75	£/item	5	£ 375.00	£ -	£ 375.00
	internal doors, sliding	180	£/item	3	£ 540.00	£ -	£ 540.00
	staircase (25mm ply)	13	£/sqm	3.5	£ 45.50	£ -	£ 45.50
	staircase string	2.5	£/m	8	£ 20.00	£ -	£ 20.00
WP10 total					**£ 8,035.50**	**£ 500.00**	**£ 8,535.50**
WP10 notes:	A small number of large openings provide natural light and ventilation. No penetrations to flank walls mean the house can be terraced.						
WP12 Electrical installation	lighting (circuit, 14 spot, 8 pendant)		by other		£ 450.00	£ 600.00	£ 1,050.00
	small power, supply and sundries		by other		£ 450.00	£ 1,000.00	£ 1,450.00
WP12 total					**£ 900.00**	**£ 1,600.00**	**£ 2,500.00**
W12 notes:	to be carried out by approved electrical contractor. CAT 5e wiring to futureproof the home for smart technology throughout.						
WP13 Plumbing installation	shower (valve, shower kit, tray, enclos.)	280	£/pack	2	£ 560.00	£ -	£ 560.00
	wc (btw, cistern + seat)	135	£/pack	3	£ 405.00	£ -	£ 405.00
	basin + taps	130	£/item	3	£ 390.00	£ -	£ 390.00
	kitchen sink + taps	110	£/item	1	£ 110.00	£ -	£ 110.00
	150ltr solar hot water cylinder	550	£/kit	1	£ 550.00	£ -	£ 550.00
	associated pipework, valves				£ 200.00	£ -	£ 200.00
	Direct solar hot water panels				£ 1,900.00	£ -	£ 1,900.00
	saving £300, Renewable Heat Incentive				-£ 300.00	£ -	-£ 300.00
WP13 total					**£ 3,815.00**	**£ -**	**£ 3,815.00**

reference	notes	rate	units	quantity	materials	labour	total
WP14 Heating	la nordica woodburning boiler stove			1	£ 550.00	£ -	£ 550.00
	flue + extract kit			kit	£ 270.00	£ -	£ 270.00
	associated pipework, valves			kit	£ 150.00	£ -	£ 150.00
WP14 total					**£ 970.00**	**£ -**	**£ 970.00**
WP14 notes:	Centrally placed multi-fuel stove heats open-plan ground floor, and highly insulated envelope retains heat throughout dwelling.						
WP16 Kitchen & utility	off the shelf 600mm base units	45	£/unit	10	£ 450.00	£ -	£ 450.00
	off the shelf 600mm wall units	30	£/unit	4	£ 120.00	£ -	£ 120.00
	18mm cut ply fronts	25	£/sq.metre	4	£ 100.00	£ -	£ 100.00
	handles, hinges, accessories				£ 60.00	£ -	£ 60.00
WP16 total					**£ 730.00**	**£ -**	**£ 730.00**
WP16 notes:	High quality kitchen achieved using off-the-shelf units with cut ply fronts for a simple, clean finish.						
WP17 decoration/ceramics	ple	60	£/sq.metre	11.5	£ 690.00	£ -	£ 690.00
	paint generally (dec not rqd to internal walls)	le glaze			£ 300.00	£ -	£ 300.00
	intumescent treatment, ground floor steetlwork				£ 50.00	£ -	£ 50.00
	exterior stain to Cedral weatherboard				£ 200.00	£ -	£ 200.00
WP17 total					**£ 1,240.00**	**£ -**	**£ 1,240.00**
WP17 notes:	Ceramics are avoided in a framed building. Water resistant boards provide wet enclosures, with sealed marine ply to other areas.						
WP18 floor finishes	Sealed cork flooring	26	£/sqm	77	£ 2,002.00	£ -	£ 2,002.00
	non slip vinyl	23	£/sqm	21	£ 483.00	£ -	£ 483.00
WP18 total					**£ 2,485.00**	**£ -**	**£ 2,485.00**
WP18 notes:							
Sundries	as a % of all above work packages	5	percent		£ 3,272.56	£ 210.00	£ 3,482.56
TOTAL COST					**£ 38,615.61**	**£ 2,310.00**	**£ 40,925.61**

EXCLUSIONS:

VAT
Land
Services connections
Labour
Consultant fees
external soft landscape

OPTIONS:

A	**Additional floor/roof insulation to meet Passivhaus std for ext envelope**	**£**	**2,610.00**
B	**Triple glaze windows / external doors to meet Passivhaus accreditation**	**£**	**1,550.00**
C	**MVHR and associated ducting for full Passivhaus compliance**	**£**	**5,500.00**
D	**'Greenhouse' curtain walling to create sunspace / thermal buffer**	**£**	**7,200.00**
E	**Renewables - PV - sized to meet zero carbon**	**£**	**7,500.00**
F	**Alternative bedroom 3 (10sqm box room)**	**£**	**1,050.00**
G	**Alternative bedroom 3 (20sqm full room)***	**£**	**2,500.00**

* requires Option C - greenhouse

Notes on options:

A, B, C - upgrade is required, including MVHR, to achieve Passivhaus certification.

D - The southernmost structural bay is left open, providing solar shade. By enclosing this bay in a wall of glass, a conservatory space is formed.

E - Direct solar hot water is provided within the base price, as it compliments the heating system, pre-heating hot water. PV is an additional cost.

F - A third bedroom can be provided within the existing plan. Requires 18sqm more partition, 24lin.m 75mm stud, additional door, additional window

G - A full third bedroom can be provided within the additional bay once the 'greenhouse' is enclosed. Requires additional floor, wall + window constr.