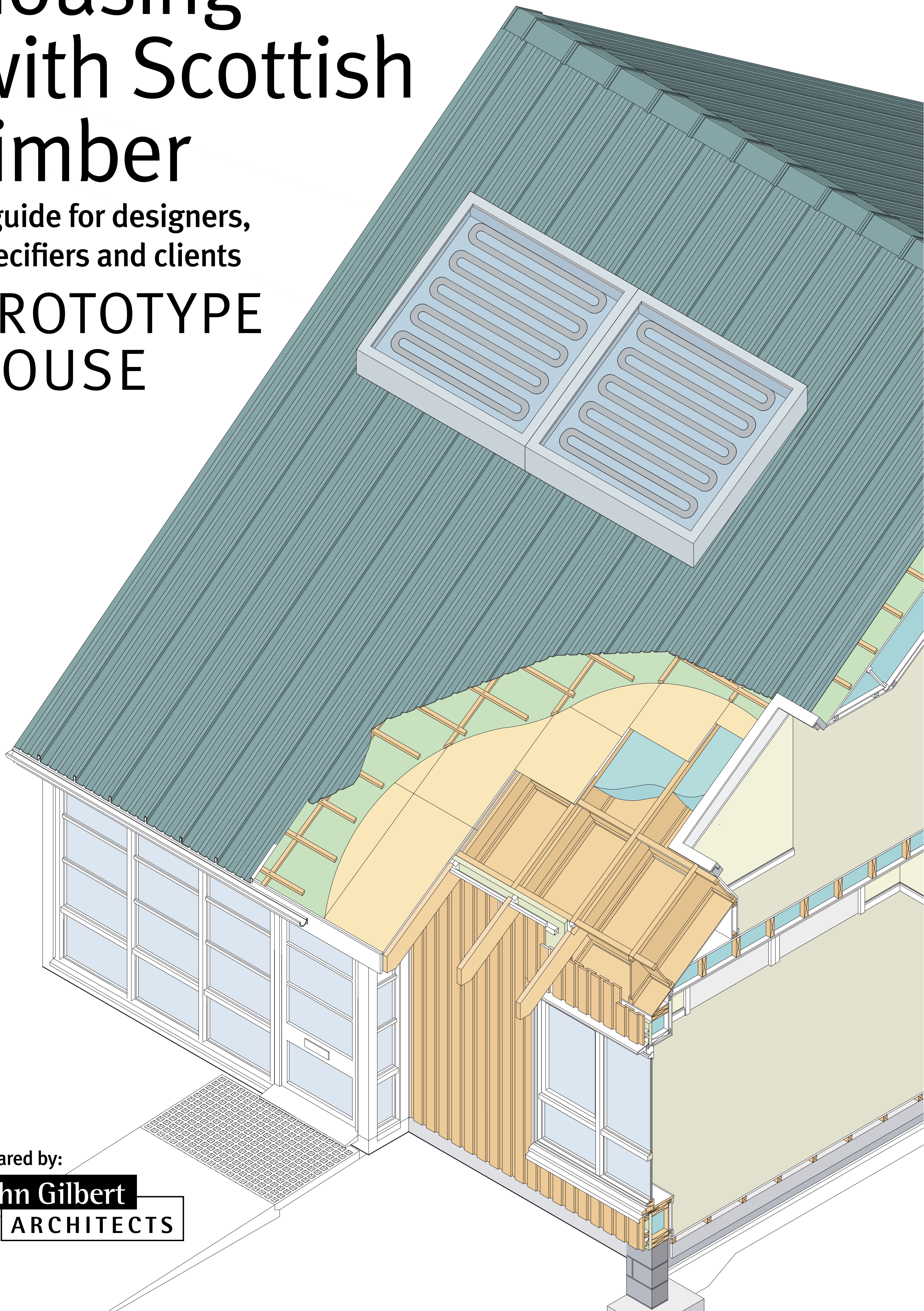
2009 Edition

Designing housing with Scottish timber

A guide for designers, specifiers and clients

PROTOTYPE HOUSE

Forestry Commission Scotland



Prepared by:
John Gilbert ARCHITECTS

Introduction

The provision of locally sourced and produced construction materials is a key part of the sustainable design agenda. Rural Scotland is on the periphery of most transport networks and has vast timber resources. The potential to reduce transportation and increase local employment is huge. This report examines current sustainable housing and uses the lessons learnt to develop a new prototype, maximising the use of Scottish timber in rural, affordable, low energy housing provision. In addition, it examines the practical implementation issues, such as costs and procurement, which need to be addressed.

This report was commissioned to John Gilbert Architects in 2004 by the Forestry Commission Scotland and Perthshire Housing Association, with support from Scottish Forest Industries Cluster, with the aim to reach a wider audience including those involved in providing social and private housing for rural locations.

A low carbon prototype using Scottish timber
Section One outlines the development of a prototype, initial costs and the issues that would be important in construction. Drawings and supplementary information are within the appendices at the back.

Case studies
Section Two analyses four case studies of complete social housing projects in terms of their construction, timber usage and environmental credentials. It also considers the main reasons why Scottish timber is not commonly used at present in timber frame buildings.

Acknowledgements
John Gilbert Architects acknowledges the assistance and guidance given by a number of individuals, particularly Ivor Davis and Geoff Pitts together with information and assistance from J. Jones. Their input is much appreciated although the final report is the responsibility of the authors. Information contained in this report does not infer compliance with the building standards, where a building warrant is required. Appropriate advice can be obtained from the relevant local authority building control office.

2009 Edition
Since this report was first published in 2004, there have been a number of changes to building legislation and standards that require substantial revisions to bring the report up to date. In addition to the 2007 building standards changes, there are proposals made in the Sullivan Report for future changes to the energy section of the building standards. In addition, the introduction of SPP6 to the planning framework which now requires at least 15% reduction in CO^2 for larger developments. This updated report responds to, and reflects on, these changes and proposals.

Prepared by John Gilbert Architects 2009

First edition published September 2005
and funded by:
Forestry Commission Scotland
Perthshire Housing Association
Communities Scotland
Scottish Enterprise
Scottish Forest Industries Cluster

Second edition 2009 update funded by:
Forestry Commission Scotland

Forestry Commission Scotland

Prototype House
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1. Prototype House Development

1.1 **Introduction and Brief**

1.2 Perthshire Housing Association commissioned John Gilbert Architects to create a prototype house design. The brief was to investigate the best approach for affordable rural housing that would only require backup heating and would maximise the use of Scottish timber and timber products.

2. The Association was keen to see what the additional costs might be for more energy-efficient forms of construction as well as various heating and ventilation options that would make the building less dependant on fossil fuels. The nature of the project demanded a design that could be used on a variety of sites and locations throughout rural Scotland. It was agreed to develop a 'prototype house' designed in the form of a semi-detached house on the assumption that a typical development would consist of about six houses. It is appreciated at the outset that a site-less design needs to be robust enough to accommodate changes in site levels, orientation, surroundings and ground conditions.

2.1 We developed four prototype designs, one of which we we selected one for further development.

2.2 Types 1 & 2 have designed-in adaptability that would allow the initial construction to include ground floor rooms only with a stair and upper rooms and services being constructed at a later date, if and when required. This adaptability would give the building increased potential lifespan and avoid the need for young families to relocate as their housing requirements changed over time.

2.3 The prototypes show a progression of the design and are not necessarily comparable. Types 1 & 2 are two options for the same requirements – both have two bedrooms on the ground floor. The Association wanted to have a prototype that would present a narrower overall width in plan. As a result, prototypes 3 and 4 were developed, both of which have only one bedroom downstairs. Although the design could be adaptable to have the third bedroom and additional bathroom upstairs added at a later stage, it would be more economical to build all the rooms at the same time.

2.4 In parallel with the development of the building design, a range of specification options were to be developed. These narrowed down the vast array of specification options to five sets. This we have called our Green to Greener specification, starting off with a base model typical of that provided under the building regulations and ending up with a very low emissions option. Each option illustrates building fabric specification, heating and hot water systems and potential energy generation measures. These options are used to calculate annual energy usage and an indicative cost for the prototype.

2.5 In addition, there is a commentary on the main elements of the design with reasoning behind the choices made and a full cost analysis.

2.6 It should be noted that this report is written in the Scottish context, with all references to standards and regulations being the appropriate Scottish documents. In particular, space standards refer to those accepted as benchmarks by the Scottish Government.

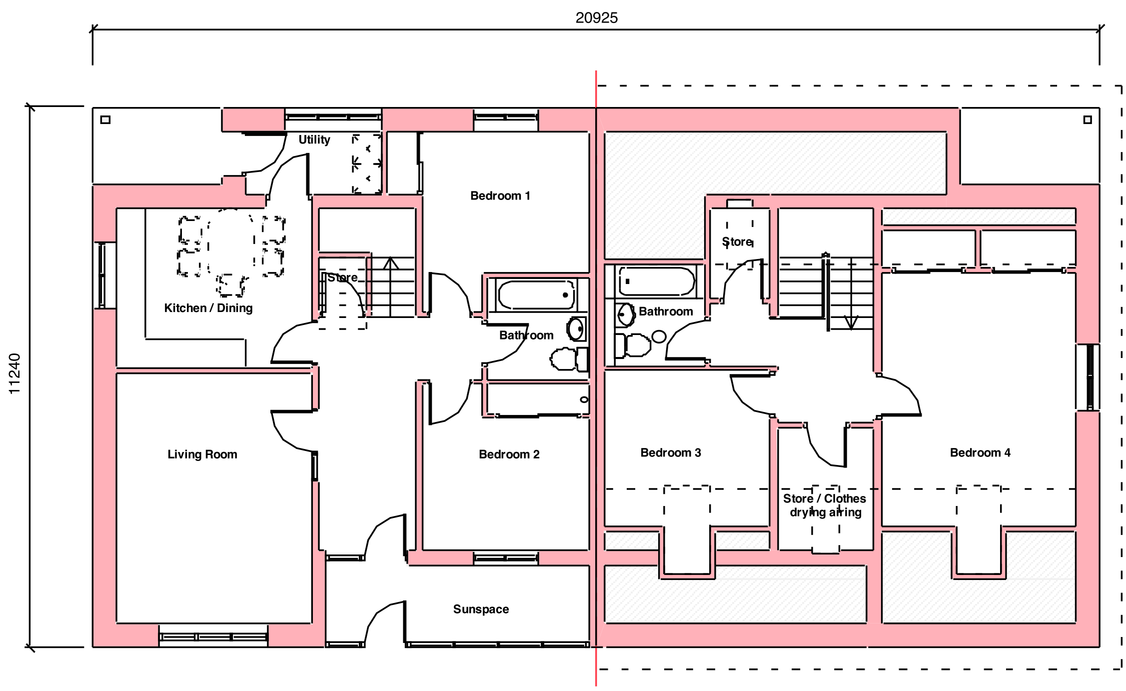
3. Prototype Development

3.1 Approach

3.1.1 Four house prototypes were developed for initial discussion with the client group. The types developed from two different approaches. One approach was to create a two-bedroom semi-detached bungalow.

3.2 Prototype 1

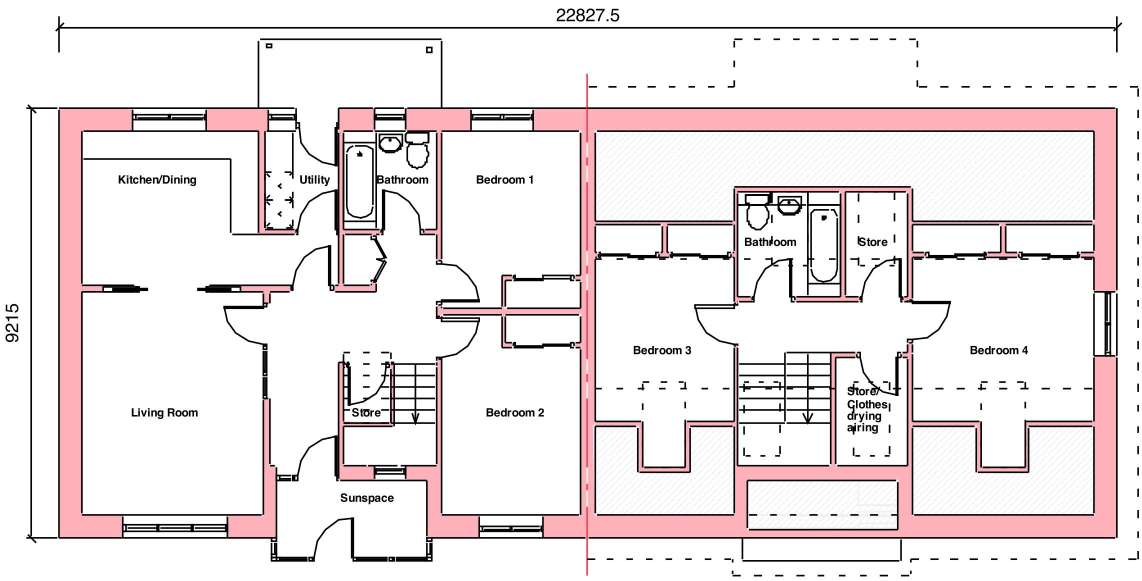
3.2.1 This is a simple rectangular plan providing separate kitchen and living facilities and two double bedrooms on the ground floor. There is an integrated sunspace which provides a buffer space at the front entrance and a rear utility room, also providing an unheated buffer space. The bathroom is internal although this could be altered to a gable location if the plan was flipped. If the upstairs rooms were not built initially, the space where the stairs are located could be used as the clothes drying room. Upstairs there are two additional bedrooms plus an additional bathroom and drying room. This plan provides a four-bedroom eight-person house.



PROTOTYPE 1 - GROUND & UPPER FLOOR PLANS

3.3 **Prototype 2**

3.3.1 This plan takes a similar approach to Prototype 1 but has a wider footprint (though a smaller overall area). It also has a buffer space front and back with connected kitchen/dining and living spaces. The bathroom faces the rear. If the upper rooms were to be built later, the space for the stairs would become a drying room. Upstairs there are two further bedrooms and a bathroom.

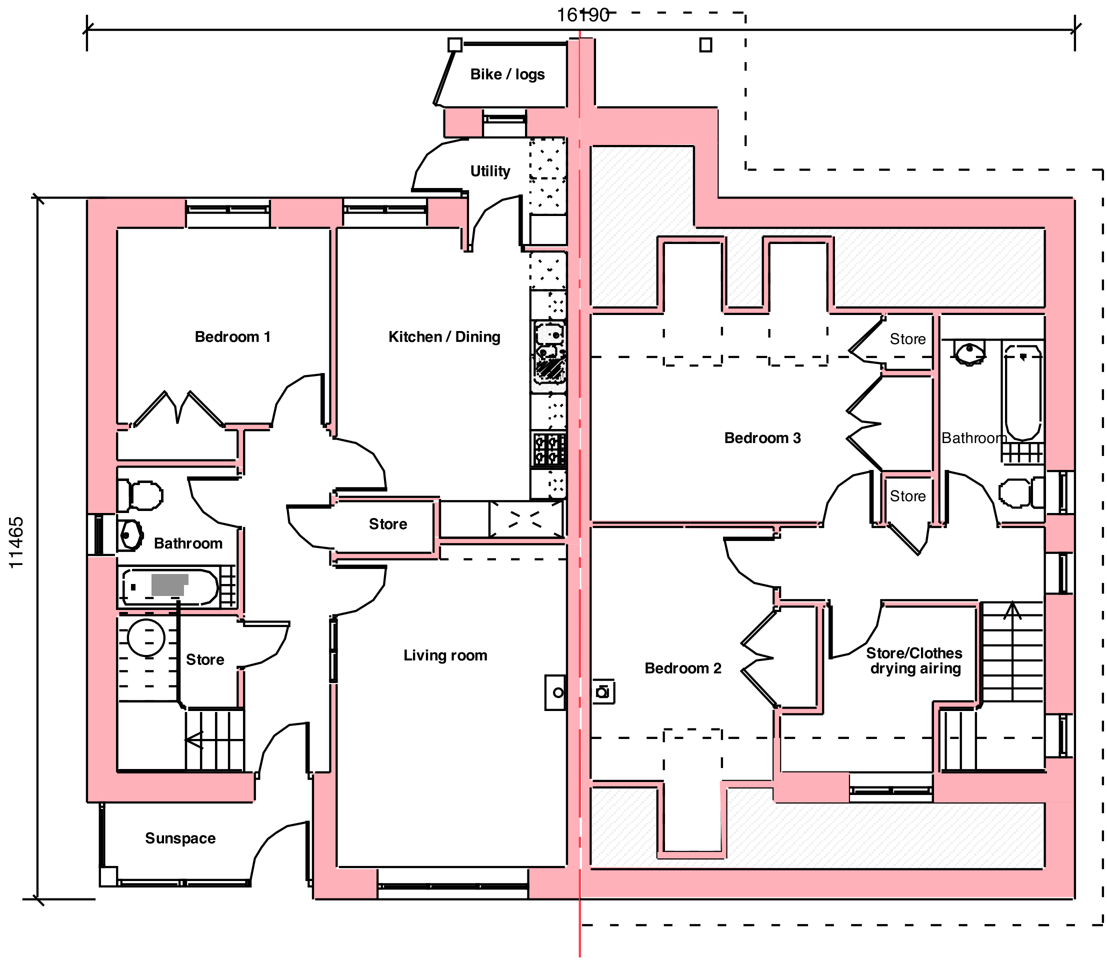


PROTOTYPE 2 - GROUND & UPPER FLOOR PLANS

3.4 **Prototype 3**

3.4.1 This plan provides one bedroom at ground level and an upper floor bedroom. The bathroom on the ground floor is on the gable with the front and back doors each having a buffer space (sunspace and utility space respectively). Upstairs there are two bedrooms, a bathroom and a drying room. A space for bike storage and logs is also provided.

3.4.2 To achieve the two bedrooms required, the stairs and one upper bedroom have to be constructed, although the bathroom and third bedroom could possibly be added at a later date.

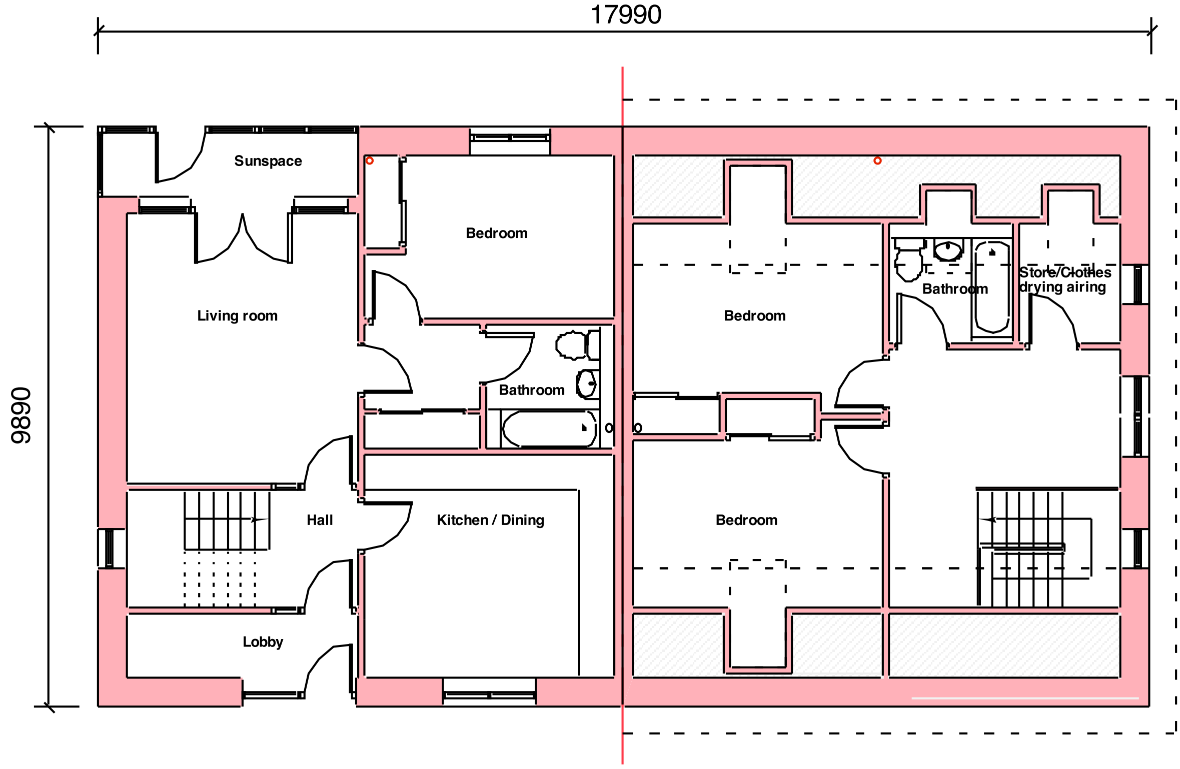


PROTOTYPE 3 - GROUND & UPPER FLOOR PLANS

3.5 Prototype 4

3.5.1 This plan provides similar accommodation to Prototype 3 but re-orientates the living room and kitchen to take into account a different orientation. The rear, south-facing living room opens out into a sunspace and a buffer space is provided at the north-facing front entrance. The ground floor bedroom and bathroom are accessed via a small lobby via the living area. The upstairs bedroom is accessed from an open hallway space. An upstairs bathroom and drying room are also included.

3.5.2 Due to the kitchen being located at the front in this option, a utility space is included instead of a draught lobby.



PROTOTYPE 4 - GROUND & UPPER FLOOR PLANS

3.6 **Preferred Option**

3.6.1 The diagram below shows the constructional elements of the prototype. Full details of the proposed plan, elevations and details are contained in Appendix 2. It should be noted that the prototype would always need adjustment to fit the specific site context, the slope of the land, orientation and open or forested location together with any requirements of the local planning department etc.

3.6.2 The preferred option developed Prototype 3, adjusting the floor area to meet the Scottish Housing Handbook, Bulletin 1 Metric Space Standards and incorporation of a sunspace. There is one ground floor double bedroom, a fully wheelchair-accessible bathroom, a kitchen and dining space and an 18.4m^2 living room. There are two double bedrooms upstairs, a bathroom and large store for drying clothes and airing.

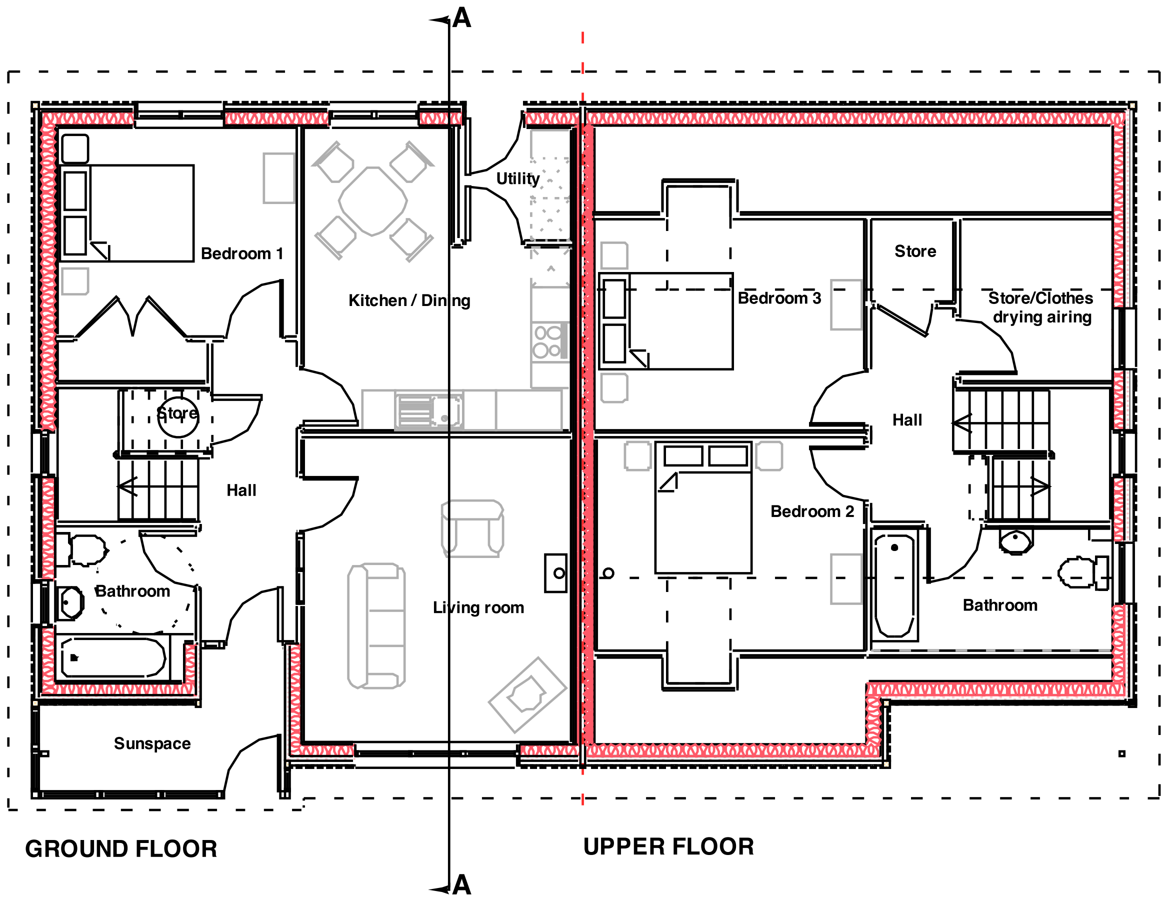
This gives the following floor areas:

Size	Scottish Housing Handbook, Metric Space Standards	Prototype Size
6 Person	107 m^2	106.9 m^2

3.6.3 Phasing adaptability has not been incorporated into this design to the same extent, however, it would be possible to initially build only one bedroom and a store upstairs, reducing the floor area to 87.9m^2 for a four-person house, measured against a space standard of 84m^2.

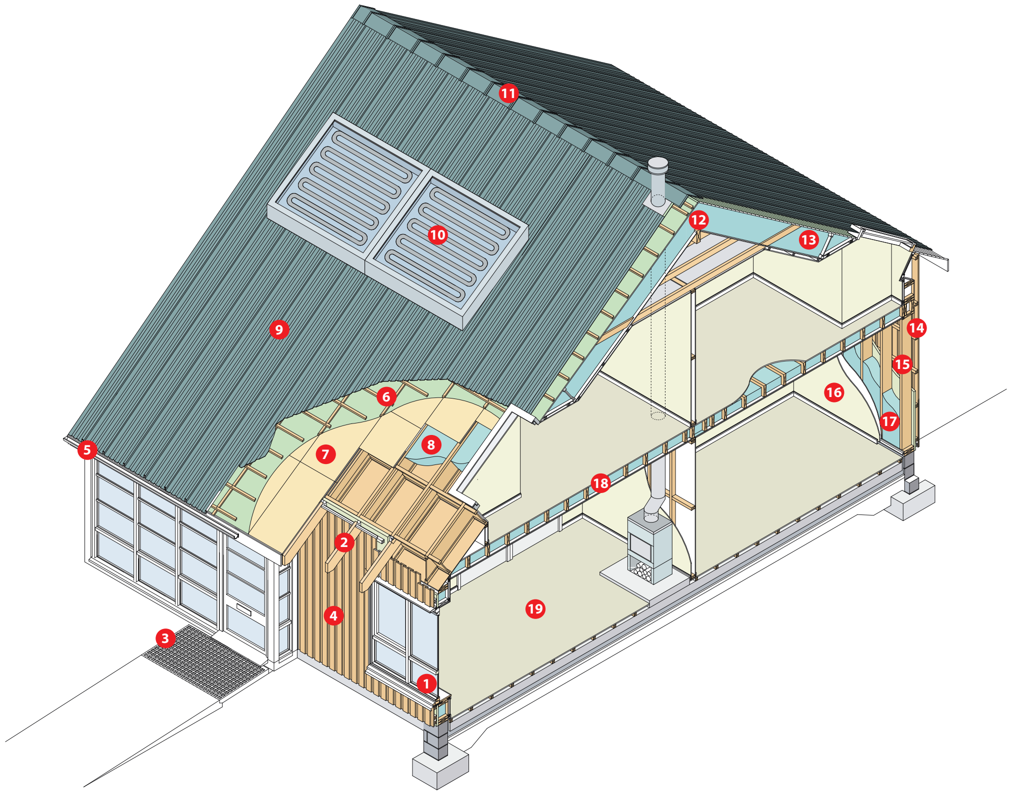
Full plans and elevations are in Appendix 2.

3.7 Each of the other prototypes have their merits, depending on the particular site constraints.



PREFERRED OPTION - GROUND & UPPER FLOOR PLANS

3.8 **Cut-away Diagram of Prototype House**
(Based on Enhanced (High Thermal Mass) Specification)



1. 4:16:6, I Plus, Low E, Argon filled, timber framed windows
2. Rafter extensions to provide roof overhang and protect cladding
3. Perforated deck to allow moisture dispersal and provide wheelchair access
4. Heartwood larch cladding with ventilated space behind
5. Galvanised metal gutter
6. Timber battens and counter battens to allow ventilation of underside of roof finish
7. Wood fibre board sarking
8. Vapour permeable underlay
9. Roof finish to suit local style and planning policies
10. Solar water panel on south slope (optional)
11. Ridge capping
12. Engineered timber ridge beam
13. Timber web beam 300mm deep filled with cellulose insulation
14. Wall make up of 195mm x 44mm C16 homegrown timber studs
15. Orientated strand board (OSB) or similar sheathing with service zone
16. Plasterboard
17. Cellulose fill insulation
18. Timber joists or web beams depending on span
19. PFA levelling screed on concrete slab on 100mm EPS insulation

4. Growing Greener Specification

4.1 Issues

4.1.1 One of the original aims of the study was to try and achieve affordable rural housing so well insulated that minimal heating is required. Ideally, central heating could then be omitted - resulting in savings (and need for gas supplies unlikely).

4.1.1 A wood-fired stove could then provide back-up heating in cold snaps. However, location of any site would need to take into account proximity to a supply of wood, as this is not always easily available.

4.1.2 To achieve a house that would require no heating but simply rely on body heat, an overall U-value in the region of 0.1 Wm^2K would be required. This target is presently too high for affordable housing and it was also felt that some form of heating would still be a requirement in any socially rented house to cater for varying requirements of comfort.

4.1.3 Timber destined for structural use is strength graded at the sawmill. This strength grade is then used in the design of the timber frame. Throughout this report we are principally concerned with two strength grades:

- C24 – strength grade widely used in timber frames. Imported timber reaches this grade and very little Scottish timber reaches this grade.
- C16 – lower strength grade than C24 but entirely possible to create timber frames. The majority of structural Scottish timber achieves C16.

4.1.4 In order to assess the viability of different levels of insulation, we have provided costs and U-values for a range of constructions. Clearly there are a tremendous number of variables in wall construction types, so we have tried to focus in on constructions that were a) hygroscopic, breathing wall construction which did not require an additional plastic vapour barrier and b) constructions that would favour use of solid C16 timbers, rather than I-beams, enabling use of timber from homegrown sources. There is a source of I-beams manufactured in Scotland from Scottish-produced orientated strand board (OSB).

4.1.5 If homegrown timber is to be encouraged, then kit suppliers who source their timber within Scotland should be allowed to tender for the kit manufacture.

4.1.6 The U-values, CO^2 emissions, SAP and energy use are calculated using Elmhurst SAP 2005 software and based on the standard calculations given in Section 6 of the domestic section of the Scottish building regulations. The Scottish building regulations state that where available, it is acceptable to use certified manufacturers' thermal resistance and U-values. We have done this with a number of products throughout this study, giving a more accurate assessment of the U-value and energy use.

4.1.7 Timber frame constructions need to be designed to prevent interstitial condensation taking place within the frame, otherwise rot outbreaks could occur. Vapour control is required in all constructions with the general requirement that vapour resistance inside is five times that of the outside face. This can be provided by a polythene vapour check (and other membranes), however vapour checks can be damaged in the course of a building's history. As a result, we have opted to design walls that do allow vapour transmission, but still maintain some form of internal vapour control layer on the internal face. This can usually be achieved with a board material.

4.1.8 Air tightness or the lack of air tightness is a key source of energy loss in well-insulated buildings. The revised Scottish technical standards now have a clause addressing this. As air tightness testing is still uncommon in Scotland, the factor is assumed as being one of two default values. If the building is constructed in accordance with SBSA 'Accredited Construction Details' this is set at 10 $m^3/hr/m^2$ at 50 pascals. Otherwise, the default value is 15 $m^3/hr/m^2$ at 50 pascals. If anything other than these two values is claimed for the building, this value would have to be proved by site testing. Air tightness is primarily achieved by good detailing at the design stage to minimise routes for draughts and on site by good supervision, ensuring air pathways are sealed. For the purposes of the green to greener specification in this report, air tightness increases with the required performance of the building, hence the models with claimed air tightness greater than 10 $m^3/hr/m^2$ would require to be site tested.

4.1.9 Three tables summarising five different specifications are given in Section 4.8. For each specification we have taken the prototype and calculated the various U-values, SAP ratings, dwelling emission rate (DER) against target emission rate (TER), energy requirements, $C0^2$ emissions and running costs per annum. Different EcoHomes levels would apply but these are indicative as they require site-specific information.

4.2 The Sullivan Report

4.2.1 “A Low Carbon Building Standards Strategy for Scotland” (The Sullivan Report) was commissioned by the Scottish Government’s Scottish Building Standards and published in 2007. It outlines the Scottish Governments approach to meeting recommendations in the Stern Report and National Government commitments to carbon reduction.

4.2.2 In terms of new domestic buildings, the main recommendations are related to increasing the requirements of the energy section:

- 2010 – low carbon standard 30% better than 2007 regulations
- 2013 – very low carbon standard of 60% better than 2007 regulations
- 2016 – net zero carbon in use
- 2030 – total life zero carbon domestic standards.

The Sullivan Report is available online at: http://www.sbsa.gov.uk/sullivanreport.htm

4.2.3 We have redesigned the Green to Greener specification for this 2009 update to the 2005 report to the outline steps required to meet the The Sullivan Report in 2007, recommendations for rural housing.

4.3 Scottish Planning Policy 6 – Renewable Energy

4.3.1 In March 2007, the Scottish Government introduced SPP6 Planning Policy on renewable energy. This required all local authorities to incorporate policies into their local plans that reduce carbon emissions from new development by 15% over the 2007 building standards. In March 2008, PAN 84 was produced to demonstrate how the targets of SPP6 can be met. SPP6 only applies to developments of $500m^2$ or more. It is unlikely that SPP6 in its present form will apply to many rural developments.

4.3.2 As part of the Green to Greener specification in Section 3.10, we have outlined (but not costed) the requirements for the basic building regulations standard spec and enhanced kit spec to meet SPP6.

4.3.3 It is anticipated that as the building regulations change in response to the Sullivan Report, SPP6 requirements would be changed or phased out, therefore it is not possible at this stage to predict what those changes could be.

4.4 Basic Building Regulation Standard.

4.4.1 This assumes a typical timber kit construction using 89 x 44mm studs and glass wool insulation to achieve a wall U-value of 0.25 W/m^2K. Wall and roof construction, windows and doors are all designed to meet the present Scottish building regulation standards. By assuming the building will be built in accordance with the accredited construction details, the dwelling will have an air tightness measurement of 10 $m^3/hr/m^2$ at 50 pascals. Even at this basic standard, the heating costs per annum are relatively modest, however the $C0^2$ emissions are twice as high as the enhanced kit.

4.5 **Enhanced Kit Construction (2010 Standard)**

4.5.1 This specification achieves a 30% carbon saving (comparing TER and DER methodology) over the 2007 building standards, therefore we believe that this specification complies with the aspirations of the Sullivan Report for new domestic buildings in 2010.

4.5.2 Enhanced 145 x 47mm C16 studs are used in the wall framing with cellulose insulation used throughout walls and roof. The rafters are fully filled providing 250mm of insulation, the breathing construction removes the need for ventilation which would be required below sarking. Floor insulation is enhanced (see table 4.8) and windows are low-E glazed, argon-filled in attic windows. Passive stack ventilation is provided.

4.6 **Enhanced (High Thermal Mass)**

4.6.1 This is similar to the enhanced kit construction but incorporates an insulated slab ground floor to provide additional thermal mass. Lightweight structures are able to make best use of passive solar and incidental energy if it can be stored in the fabric over periods where there is no heat gain. It would be ideally suited to an underfloor heating system. The wall construction still uses the 145 x 47mm studs, but sheep's wool insulation is used instead of cellulose to facilitate the construction process. The external fibreboard sarking also reduces cold bridging of the solid stud timbers.

4.6.2 In this case, whilst there is still passive stack ventilation, there is also the inclusion of solar roof ventilation providing a positive input of pre-heated air to the hallway space. Solar roof ventilation is only possible where the roof is not overshadowed. Heat gain from the sun's rays on the tiles heats up the air in the space under the tiles and this is then pumped into the house. Incoming air is therefore pre-heated by up to 10^0C. All glazing is enhanced with argon with a wider space between panes and the door U-value is also increased

4.7 **Timber High Insulation (2013 Standard)**

4.7.1 This specification achieves a carbon saving of more than 60% (comparing TER and DER methodology) over the 2007 building standards, therefore we believe that this specification complies with the aspirations of the Sullivan Report for new domestic buildings in 2013.

4.7.2 This option aims to provide a high level of insulation using 195 x 38mm C16 studs. Wool insulation is used again and the external sarking is increased to a 60mm fibreboard, leading to reduced air leakage of 5 $m^3/hr/m^2$ at 50 pascals and a reduction in cold bridging. The wall U-value here is at $0.14W/m^2K$. Roof construction remains at 300mm using I-joists, but the ground floor is made using timber with a solum space. This floor would be well insulated but ramping would be required front and back to raise to the finished level of the timber floor. The option has been included to maximise the use of C16 timber although site and ground conditions may suggest a solid floor construction which may also facilitate a barrier-free design. The sunspace (an optional extra) would be lined with a wood fibreboard and clay plaster to provide a form of thermal mass.

4.8 **Low Emissions (Aiming for 2016 Standard)**

4.8.1 This 'best' proposal would produce 0.42 tonnes of $C0^2$ per annum, but this is still a fraction of the 2.94 tonnes per annum that the basic building regulation standard achieves. This construction adopts 300 deep timber I-joists filled with cellulose for the wall construction. This achieves a U-value of $0.12W/m^2K$. The floor reverts to a concrete screed but the insulation levels are increased. Particular care is taken in achieving the best practice air tightness rate of 3 $m^3/hr/m^2$ at 50 pascals. As before, a mechanical heat recovery system is used but in this case we have also incorporated the sunwarm air solar collector that provides heat to the hot water system as well as pre-heating the air supply.

4.8.2 With the addition of a modest amount of photovoltaic (PV), it is possible to turn this low emissions model into a model that would pass the potential 2016 building regulations energy section that requires zero emissions in use.

4.9 Green to Greener Calculations

4.9.1 The following table summarises the above construction options. The calculations are based on the U-value and SAP calculation methods in the Scottish building regulations. Using this data and taking an average site, with average occupancy, a total energy requirement per annum for space and water heating is calculated along with a CO^2 output and indicative cost for space and water heating. The methods in the Scottish building regulations make no allowance for specific site conditions.

4.9.2 The SAP and U-value calculations have all been carried out by John Gilbert Architects using Elmhurst Energy SAP2005 software.

4.9.3 Where applicable, specific products have been researched, named and their specific thermal resistance used to assist accurate calculations. Window and door U-values have been verified by confirming that two companies can supply a window or door to at least the specified U-value.

4.9.4 Air tightness in timber-framed buildings has been discussed with the Building Research Establishment (BRE) and Elmhurst Energy software. We have also reviewed publications by the Air Tightness Testing Methods Association. This has led us to the range of air tightness values from 10 $m^3/hr/m^2$ at 50 pascals (SBSA accredited default value) and 3 $m^3/hr/m^2$ at 50 pascals which is considered to be best practice by all parties consulted.

4.9.5 The costs illustrated are abstracted by standardised occupancy and the generic nature of the calculation software. As such, they are useful for comparison with each other but should be used with caution for comparison with other, external figures.

4.9.6 The timber sizes are all available as a standard product, readily sourced from UK timber mills. These sizes have been corroborated with Scottish sawmills. Note that the basic building regulations specification assumes the current standard frame size of 89x38mm for comparison. This timber is usually imported.

4.10 **Green to Greener Specification**

Jan 2009 Rev. C

SAP 2005	**58 D**	**70 C**	**71 C**	**73 C**	**84 B**
Environmental	**72 C**	**80 C**	**84 B**	**93 A**	**100 A**
DER	31.58	22.9	19.03	8.83	6.7
TER	32.5	32.5	35.36	35.36	35.36
% Reduction CO^2	**3%**	**30%**	**46%**	**75%**	**81%**
	Basic Building Regs	**Enhanced**	**Enhanced (High Thermal Mass)**	**Timber High Insulation**	**Low Emissions**
Wall construction	89 x 44 Timber kit	145 x 44 Timber Kit	145 x 44 Timber Kit	194 x 44 stud	300 web stud
Wall Insulation	Sheathing ply 90mm glass-fibre service zone 25mm Crown Polyfoam Linerboard	Panelvent 145mm cellulose (Warmcell) OSB internal Service zone Plasterboard	35mm Isolair wood-fibre board 145mm sheep's wool Paneline Service zone Plasterboard	60mm Pavatherm wood-fibre board 194mm sheep's wool Paneline Service zone Plasterboard	Panelvent 300mm cellulose (Warmcell) OSB internal Service zone Plasterboard
Wall Uvalue	0.25	0.24	0.2	0.14	0.12
Roof construction	Internal plasterboard 200mm rafters with Rockfall Underlay between 70mm Rockfall Overlay sarking board	Internal plasterboard 250mm rafters with cellulose (Warmcell) insulation between 33mm wood fibre Isolair board	Internal plasterboard, 300mm timber composite beams with cellulose (Warmcell) insulation between 33mm wood fibre Isolair board	Internal plasterboard, 300mm timber composite beams with cellulose (Warmcell) insulation between 33mm wood fibre Isolair board	Internal plasterboard, 300mm timber composite beams with cellulose (Warmcell) insulation between 52mm wood fibre Isolair board
Roof U-value	0.16	0.14	0.12	0.12	0.11
Floor construction	Solid Floor - OSB flooring on Battens on Screed on 70mm Dow Floormate 200x on concrete slab	Solid Floor - OSB flooring on Battens on Screed on 100mm extruded polystyrene 200x on concrete slab	Solid Floor -PFA levelling Screed on Concrete slab on 100mm extruded polystyrene 200x on concrete slab	Suspended Floor - OSB flooring on 250x45mm joists with 200mm sheep's wool between	Solid Floor - PFA leveling Screed on Concrete slab on 100mm extruded polystyrene 200x on Concrete slab
Floor U-value	0.21	0.17	0.18	0.16	0.11
Windows	Timber double glazed 4:12:4	Timber double glazed 4:12:4	Timber double glazed 4:15:4 low E (As Nordan)	Timber double glazed 4:15:4 low E (As Nordan)	Timber triple glazed nordan n-tec Low E glass internal, argon filled
Window U-value	1.8	1.8	1.6	1.6	0.7
Roof Window			Timber double glazed 4:16:4 low E with Argon (As Velux)	Timber double glazed 4:16:4 low E with Argon (As Velux)	Timber double glazed 4:15:4 low E with Argon (As Velux)
Roof Window U-value	1.8	1.8	1.2	1.2	1.2
External doors	Timber with draughtseal	Timber with draughtseal with buffer space and secondary door front and back	Insulated Timber with draughtseal with buffer space and secondary door front and back	Insulated Timber with draughtseal with buffer space and secondary door front and back	Insulated Timber with draughtseal with buffer space and secondary door front and back
Door U-value	1.8	1.8	1.5	1.5	1.5
Air Tightness	10 Air Changes per hour @ 50Pa	10 Air Changes per hour @ 50Pa	5 Air Changes per hour @ 50Pa	5 Air Changes per hour @ 50Pa	3 Air Changes per hour @ 50Pa
Passive solar	south facing	South facing, buffer space	South facing	South facing solar sunspace with solid timber and pavatherm and clay plaster for thermal capacity	South facing solar sunspace with clay brick for increased thermal capacity
Ventilation	Individual mechanical extract fans Ten air changes per hour	Passive stack ventilation system Ten air changes per hour	Passive stack ventilation system with solar roof ventilation Five air changes per hour	Passive stack ventilation system with solar roof ventilation Five air changes per hour	Mechanical ventilation system with heat recovery using solar panel e.g. Sunwarm system Three air changes per hour
Primary Heating system (assumes no gas and all individual systems)	Air-to-water heat pump with thermostat Electric radiators Electric immerser boost with off-peak load	Air-to-water heat pump with time and temperature zone control Closed wood log stove Electric immerser boost with off-peak load, green electricity tariff	Manual feed log stove (Clearview Pioneer 500) Electric storage radiators on Eco 2000 tarriff, green supplier Electric immerser boost with off-peak load, green	Log stove with direct feed to HWC and hallway radiator with TRV (Clearview Vision 500 with boiler)	Pellet stove providing back up, with direct feed to HWC and Hallway radiator with TRV (3G Energi Preziosa Ceramic)
Secondary heating System	Electric radiators	Closed wood log stove	Electric storage radiators on eco 2000 tarriff, green supplier	Electric storage radiators on Eco 2000 tarriff, green supplier	0.75 KW electric panel heaters
Hot water supply	Electric immerser boost with offpeak load	Electric immerser boost with offpeak load, green supplier	Electric immerser boost with offpeak load, green supplier	Solartwin panels linked to HWC, linked to wood stove	Sunwarm solar panels heating 200 litre tank (80mm insul) with off peak and boost electrical immerser
CO^2 (Tonnes per year)	2.94	2.10	1.72	0.75	0.42
Build Cost index	**100**	**104**	**106**	**122**	**132**
Additional Electrical Input method			600W Wind generator (assumes av. Wind speed = 12mph): 1,333kWh per year	Redland PV-80 Roof tile system, 15.3m2: 1,469kWh per year	6kW Communal Wind Generator (Assumes av. Wind speed of 12mph and 6 houses per development): 2000 kWh per year per house
Additional CO^2 saved			**0.61**	**0.67**	**0.92**
Revised CO^2 (Tonnes per year)			**1.11**	**0.08**	**-0.50**

5. Cost Report

5.1 Introduction

5.1.1 Gordon Hyslop of Towler and Hyslop, Chartered Quantity Surveyors has prepared the cost estimates contained in Appendix 1. Towler and Hyslop has considerable experience of houses similar to the proposed prototypes. In compiling the enclosed estimate, Towler & Hyslop has used current rates where applicable and consulted with the quantity surveyors who prepared costs for the Glenmore prototype. John Gilbert Architects provided rates for some of the more specialised items. The Notes and Assumptions should be read carefully before looking at our estimates in detail.

5.1.2 The costs are based on the range of specifications identified in the Green to Greener Specification. Refer to Section 3.

5.1.3 It was agreed that for the updated report we would cost a pair of houses on their own and would cost a group of three pairs together, to give an estimate of the potential savings in procuring larger volumes.

5.1.4 It was agreed that prototype 3 would be developed as the preferred option and was readjusted to bring the floor area in line with Scottish Government standards. The ground floor area was reduced to 68.0m^2. The upper floor fully built out totalled 38.9m^2 with 1.5m or more headroom, resulting in a total area of 106.9m^2. In this prototype there is an option to install an additional 5.4m^2 sunspace at the front of the house. This choice would depend on location, orientation and any overshadowing.

5.1.5 The costs for prototype 3 are:

Table 2: 2no houses on a single site

Preferred Prototype	Bed/Person	Total unit area	Cost per m^2	Cost per unit
Basic Building Regulations	3 Bed 6 Person	106.9m^2	£1274	£119489
Enhanced	3 Bed 6 Person	106.9m^2	£1332	£124628
Enhanced (High Thermal Mass)	3 Bed 6 Person	106.9m^2	£1369	£126306
Timber High Insulation	3 Bed 6 Person	106.9m^2	£1555	£146086
Zero Emissions	3 Bed 6 Person	106.9m^2	£1694	£158129

Table 4: 6no. Houses on a single site

Preferred Prototype	Bed/Person	Total unit area	Cost per m^2	Cost per unit
Basic Building Regulations	3 Bed 6 Person	106.9m^2	£1274	£119489
Enhanced	3 Bed 6 Person	106.9m^2	£1332	£124628
Enhanced (High Thermal Mass)	3 Bed 6 Person	106.9m^2	£1369	£126306
Timber High Insulation	3 Bed 6 Person	106.9m^2	£1555	£146086
Zero Emissions	3 Bed 6 Person	106.9m^2	£1694	£158129

A full breakdown of the costs is given in Appendix 1.

5.2 House Areas

5.2.1 The preferred prototype compares favourably with the Scottish Housing Handbook Bulletin 1 metric space standards. This is based on a six-person, two-storey house. These space standards are used by Scottish Government and local authorities for assessing schemes for Housing Association Grant funding together with allowances for Housing for Varying Needs Part 1. They are also the basis for the New Indicative Cost Limits (Ref CSGN 2003/10). Within these space standards, the house accommodates barrier-free design and also gives substantial storage space and living/working options.

5.2.2 The sunspace is treated as an option and is omitted from these calculations. If it is included, it takes the floor area very slightly over the Scottish Housing Handbook Bulletin 1 metric space standards.

5.3 Building Elements

5.3.1 The substructure, superstructure, internal finishes and services elements of Prototype 3 have all been costed. Towler & Hyslop has not estimated the external works or site development and servicing elements as these elements would be site-specific and no details were available. Therefore, direct comparison of the enclosed estimated costs and the new indicative costs cannot be made.

5.4 Contract Preliminaries

5.4.1 As we believe that an affordable housing provider would seek cost efficiency in providing a number of houses on one site, built in one contract. In Table 4, we have assumed that this contract on a single site would be for three pairs of semi-detached houses (this total of six dwellings) for the calculation of the contract preliminaries. We estimate that it would take 39 weeks to build six houses and we enclose a breakdown of estimate for the preliminaries. Our elemental estimates are for a block of two semi-detached houses, therefore we have proportioned the allowance for contract preliminaries accordingly. Increasing the number of units in a scheme would reduce the cost per unit. In Table 2, we have assumed that this contract on a single site would be for one pair of semi-detached houses (total of two dwellings) for the calculation of the contract preliminaries. We estimate that it would take 28 weeks to build two houses and we enclose a breakdown of estimate for the preliminaries.

5.5 Other Costs

5.5.1 The cost estimates are works-only costs and exclude VAT, professional fees and planning and building warrant charges. It also excludes site acquisition and site investigation costs etc.

5.6 Further Savings

5.6.1 Once a prototype is finalised and acceptable to all parties then further savings might be achieved through volume procurement or repetition.

6. Construction Issues

6.1 Wall Construction

6.1.1 The prototype designs assume an average wall thickness rather than a specific wall make up. Constructional choice will depend on the site, scale, timescales and contractor selected. Small developments are more likely to be ‘stick built’ on site rather than ‘kit built’, but kits have the advantage of early site erection and the ability to provide a weathertight enclosure at an early stage. At the time of writing, and to the best of the research team’s knowledge, ‘Alexanders Timber Design’ in Ayr were the only kit manufacturer working exclusively with Scottish timber.

6.1.2 In walls which utilise cellulose, the material is most likely to be ‘turbofilled’ on site. The internal sheathing can be a compressed fibreboard or orientated strand board (OSB). OSB has the advantage of being locally sourced and also provides racking strength. However, the installation of cellulose requires specialist installers and if the site is remote, work could be delayed.

6.1.3 The advantage of spray-applied cellulose is that the internal lining sheet can be plasterboard, whereas, when it is turbofilled, the enclosing sheet material will tend to bow, requiring the inclusion of a service zone to compensate for the irregularities. This is not a problem as OSB is often used for racking strength as well, although it can be designed-out by using other forms of bracing, either steel straps or timber bracing. A preformed insulation (known as a batt) like wool could be designed to omit an additional board layer.

6.1.4 Wool (and other hygroscopic materials such as cellulose and flax) is supplied in batts and therefore can be installed by the contractor. It is cheaper than cellulose and flax in batt form although it is quite difficult to cut.

6.1.5 Wool insulation has a low-embodied energy and can be recycled. It has been used for other social housing projects where the wall make up is suited for its use. Clearly, other products including glass fibre and vapour membranes could also be specified to provide similar U-values, but in this case, wool has been specified because it is hygroscopic, is supplied in batt form and has a lower embodied energy than glass wool.

6.1.6 A breathable wood fibreboard has been used as a sheathing. This has the benefit of insulating the wall studs, thus reducing cold bridging. It is specified as tongue and groove board to further increase air tightness.

6.1.7 It is assumed that all internal walls are dry-lined in plasterboard. However, additional thermal capacity, improved insulation and better internal air quality could be achieved by lining the walls with a fibreboard or clayboard and applying a clay plaster. Costs are likely to be outwith affordable practices but it would be useful to see how well such a system would work in any pilot development. It could also be used adjacent to any sunspaces in order to provide added thermal capacity.

7. It is assumed that the insulated walls would then be battened and clad with timber cladding. The choice of cladding will depend on the site location and availability of good quality heartwood larch. Whilst most heartwood larch can be classified as class 3-4 (moderately or slightly durable), variability occurs and quality can reduce to class 5 (not durable). Selection of the larch is therefore important as quality can vary. British larch should therefore be preservative treated when used as an external cladding unless grading and selection can guarantee a class 3 product. Juvenile heartwood occupying the first 15 rings should be discarded as should the non-durable sapwood. Good detailing and design also remain important factors in the use of any timber cladding.

8. Although Spruce is used as a cladding in Norway, it doesn’t work well in the damper Scottish climate. If used in Scotland, it will need to be preservative treated and painted, but it will not weather well.

8.1 Underbuilding

8.1.1 Where underbuilding or blockwork foundations are required, it is possible to specify concrete blocks which have a recycled content. Thermalite make lightweight concrete blocks which use pulverised fuel ash in manufacture and Masterblock make use of recycled aggregates. Some sites may also be close to a brickmaker where frostproof clay bricks may be selected.

8.2 Roof

8.2.1 As the roof is designed to be fully insulated, rather than have the insulation at the attic floor level, the first choice is to use a trussless roof construction using I-joists at least 300 deep and filling the void space with cellulose or wool. This is the option we have selected for the prototype house which gives a U-value of $0.12Wm^2degC$. If the web beam is deepened to 400mm, then the U-value can drop down to $0.1Wm^2K$. Other construction options are available including formation of an attic truss. Such trusses can facilitate speed of construction as they also incorporate flooring joists for the attic. However, they can be more problematic to insulate because of the trusswork.

8.2.2 The roof covering would normally use concrete tiles on a battened and counter-battened roof. Some planning departments may require a particular roof finish. An alternative option is to use corrugated lightweight roofing. Aluminium and metal roof finishes which can be profiled to appear tile-like or in simple corrugations. Stainless steel sheet roofing has the advantage that it can be taken from recycled steel. Aluminium, which is capable of being recycled, requires, like steel, a high amount of energy to produce it. Steel coated in plastic protective finishes is less attractive ecologically, although it can be recycled. The various coatings increase the cost of recycling.

8.3 Floor

8.3.1 The requirement for level floor access tends to result in a much greater use of concrete raft floors than suspended timber floors. This can be used to provide additional thermal mass to a lightweight structure. Insulation below the slab and at perimeters is essential and floor finishes are best formed to benefit the thermal mass. Tiled finishes on a levelling screed should be considered here.

8.3.2 Many housing associations prefer to finish a concrete base with a battened timber floor, carrying any services in the void space below and adding additional insulation at perimeters. This approach will reduce the effectiveness of the thermal mass of the concrete slab, but barrier-free access is maintained.

8.3.3 A suspended all-timber floor will allow the best underfloor insulation and will work well on a sloping site where underbuilding structure can be avoided. However, a raised timber floor needs ventilation under it and this can result in additional substructure and ramping costs.

8.3.4 The use of solid 32mm pine flooring, on a suspended timber floor, would provide some additional thermal mass to this lightweight construction and could act as a finished floor surface, provided the timber quality was good.

8.3.5 Most softwoods produced in Scotland tend to be too soft for use in flooring, so the majority of softwood flooring is imported. It is possible to obtain good quality homegrown pine, larch and douglas fir flooring from some suppliers, but it is not readily available. Scottish hardwood flooring is available but considered to be outwith the price bracket for social housing. More commonly, particleboard and OSB flooring is used, with tenants providing a carpet, vinyl or laminated floor finish.

8.4 Doors and Windows

8.4.1 Window sizing should be designed to suit the orientation of the house. We would expect that any site-specific design would address the site to achieve maximum passive solar gain. However, views and internal daylighting are also very important. The specification of glazing has improved considerably so that U-values of $1.1W/m^2K$ are readily achievable provided argon filling is specified (double glazing with 16mm argon filled cavity and a silver coating on inner pane). However, windows still present an area of heat loss so care must be taken in avoiding the excesses of glazing.

8.4.2 The U-value of doors and windows in the Green to Greener specification have been corroborated by requesting U-values from two separate manufacturers. All manufacturers who have provided information have confirmed that the U-values calculations conform to BS EN 10077 Part 1 & 2.

8.4.3 Doors are less well insulated - even those that are purpose designed systems only reach U-values of 1.5W/m^{2}K. Also, we are conscious that as people’s lifestyles vary, a single access door can be responsible for large heat losses. Therefore, the prototype always shows a two-door buffer space between inside and outside. Where possible, this unheated area provides useful space for coats, boots and prams or as a utility room.

8.5 Sunspaces

8.5.1 These are welcome additions to any house, but their inclusion will add to the total area and increase costs. There would be more advantage in building a sunspace to a three or four bedroom house than a two-bedroom starter home. The preferred prototype has a sunspace as an option in place of the buffer space.

8.5.2 It should be noted that the sunspace should be omitted in a forest context where there would be minimal heat gain.

8.6 Air Tightness and Ventilation

8.6.1 Good envelope design is an essential part of sustainable housing. Higher standards of insulation are achievable in new buildings, although air leakage can still present a problem if care is not taken in construction, detailing and specification.

8.6.2 The British units for air leakage are m^3/(h.m^2). Currently, there are no standards for maximum permissible air leakage in the Scottish building regulations. In the English regulations, buildings fail if a post completion pressure test achieves 10 m^3/(h.m^2) or greater.

8.6.3 We have discussed air tightness in the context of timber frame houses, with Mike Jaggs at BRE, Elmhurst Energy and reviewed publications by the Air Tightness Testing Association. Current experience shows that timber frames can achieve ratings between 18 m^3/(h.m^2) and, in exceptional cases, 1 m^3/(h.m^2). Normal practice is 9 m^3/(h.m^2) and good practice is generally 3 m^3/(h.m^2).

8.6.4 Infiltration can account for between 30 and 50 percent of heat loss (and gain) in buildings of poor performance. As well as door and window openings, there are numerous services that penetrate through the fabric, such as water pipes, electricity and telephone cables, flues, vents, waste pipes etc. Such items are often installed by sub-contractors who have no interest in energy conservation or even filling the hole that they create.

8.6.5 In a small semi-detached cottage, the areas that will require attention, in addition to sealing holes, will be sealing the base plate to the foundation, junctions between wall and window and door frames and panel junctions of any prefabricated kit. Corded wool or jute can be used as a filling material for small gaps.

8.6.6 The more airtight we make our buildings, the more we need to ensure that adequate ventilation is maintained to ensure removal of moisture and pollutants that are released from a range of materials in every house, as well as the activities of occupants. Poor air quality is produced by higher levels of formaldehyde concentrations and volatile organic compounds (VOCs) being released. Higher humidity levels and warm environments lead to an increase in dust mites. The resulting internal environment can exacerbate the onset of asthma and other respiratory infections. Mechanical heat recovery systems are therefore more important in airtight buildings. We have shown a number of different ventilation options which would be appropriate in the Green to Greener specification:

- natural passive stack ventilation: works through the stack effect and will draw stale air from the rooms to exhaust at roof level. They can be controlled by humidistat-controlled window vents
- as above but with the incoming air being fed into the common hallway, by taking fresh air, pre-warmed with the solar gain from under-the-roof finish
- a mechanical heat recovery ventilation system
- an integrated air solar/ heat recovery ventilation system supplying fresh air and a contribution to heating the hot water.

8.7 Insulation

8.7.1 This is the key to achieving low energy housing in Scotland. We have illustrated three different insulation materials in the Green to Greener specification, glass wool (λ 0.040), cellulose (λ 0.035), and sheep's wool (λ 0.039). These are used in a variety of thicknesses to achieve very high insulation values.

8.7.2 As previously noted, we have selected insulation materials with very low embodied energy that are hygroscopic in nature. This allows moisture vapour to migrate through the structure without condensing out, provided the internal wall face has five times the vapour resistance of the external face. We recognise that other forms of insulation exist, such as glass wool, mineral wool and reflective foil sandwich membranes, all of which can achieve very high levels of insulation with the advantage that wall thickness can be kept small. However, they need to be used in association with impermeable vapour membranes which we are trying to avoid because of the possibility of poor site control and damage to the membrane over the building's life.

8.7.3 The progressive increase in insulation levels is shown in the diagrams below:

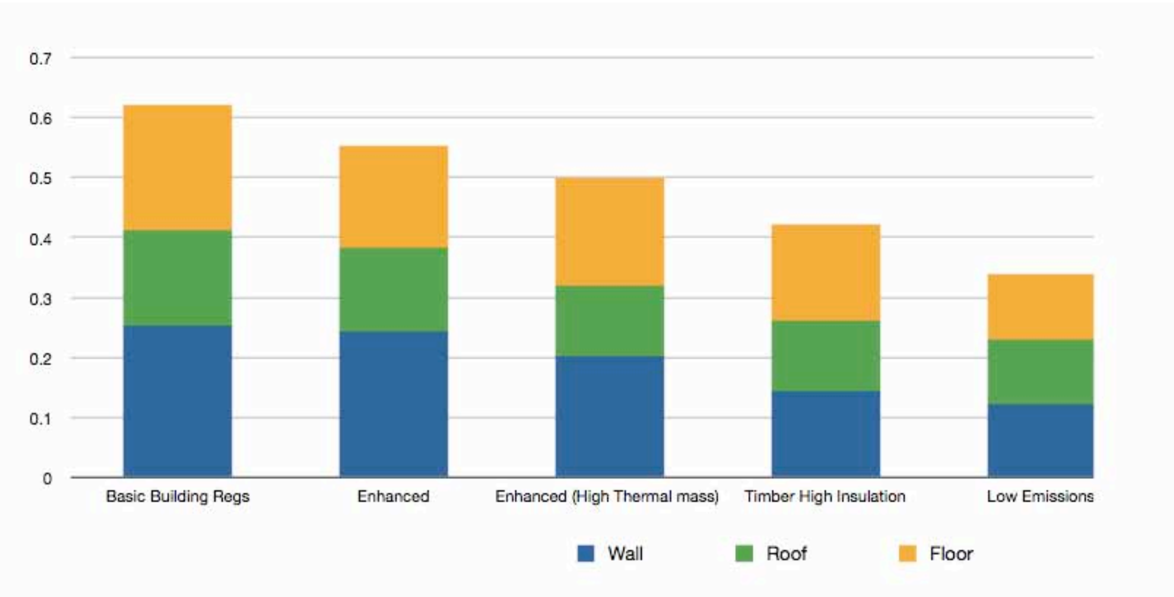


Fig 1: Summary of the changes in structural U-values with the different options

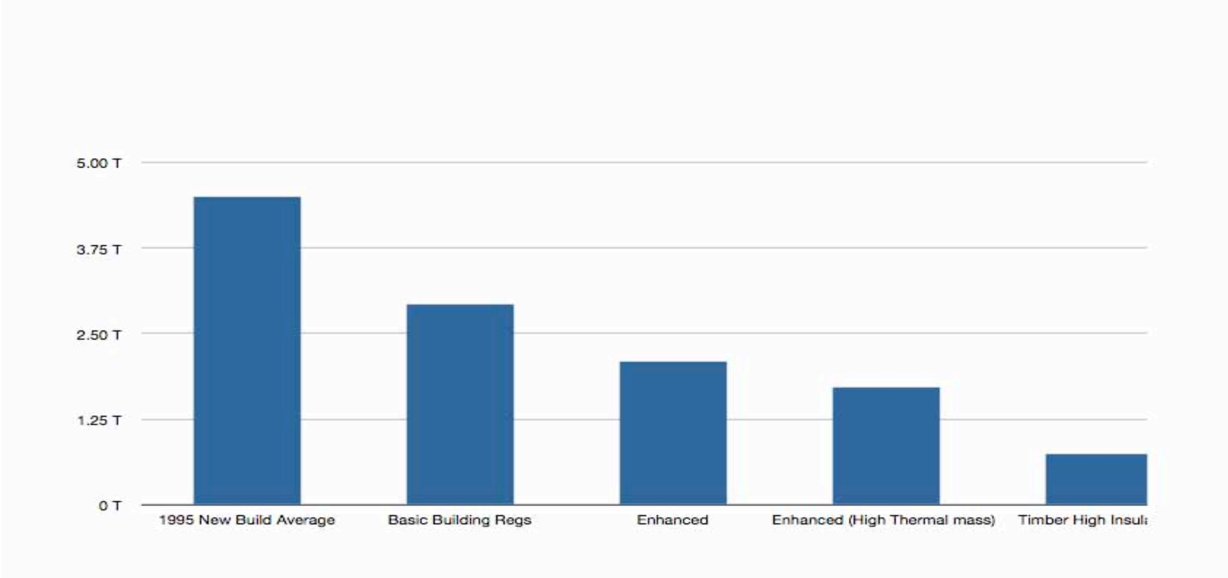


Fig 2: Chart showing the reduction of C0² emissions with improvements to specification levels.

The Housing Energy Best Practice Programme estimates that a four-person house built in 1995 will produce 4.2 tonnes of C0² per annum.

9. Heating

9.1 Introduction

9.1.1 Heating spaces and water accounts for the majority of the energy used in Scottish homes. We have assumed that the site is located away from the gas mains grid and have therefore examined a number of options based on electrical energy, renewable energy and wood fuels.

9.2 Wood fuel

9.2.1 Wood as a fuel in Scotland is generally available in three forms throughout the country, either as logs or as chips or imported pellets. The advantage of pellet fed stoves is that it requires significantly less attention than the equivalent log fuelled stoves and they are more efficient. Hoppers on the pellet stoves can provide heating for up to three days without the need for refilling. The disadvantage is that there is an additional cost for this automation.

9.2.2 At present, the supply of pellets in Scotland is limited although there is at least local producer who will supply pellets and a new plant is presently being built in Invergordon. The pellets that are currently sold may be imported and have different efficiencies and costs. It is possible to purchase small individual bags of pellets from some local stores, but this will be more expensive than bulk buying. For example, 900 kilograms (nearly a ton) of Austrian pellets in the form of 60x15kg bags take up a space of 1220 x 1520 on a pallet.

9.2.3 Whereas an average centrally-heated house could use between one and three metric tons of wood pellets per year, a highly-insulated house would require less.

9.2.4 Log stoves typically last a couple of hours before re-stoking is required. Most modern designs incorporate thermal mass to enable the stove to continue emitting heat after the fire has gone out. Compared to gas systems, standard log-fuelled models may have a low efficiency and seem to require more energy, but this is balanced out by the low cost and low CO^2 emissions of wood. Logs for burning need to be stored and dried for about two seasons before being used.

9.2.5 A simple log burning stove such as the Clearview pioneer 400 has a firebrick backing to store and release heat, the fire producing 5kW. If it is to be connected to a hot water system or any kind of simple heating system, the Vision 500 with boiler should be used. However, it should be recognised that if using the boiler option, the fire should be kept going to ensure the benefits of the system. This can be more problematic with log burners than with pellet stoves. Our view is that it is probably simpler to rely on the log stove for simple back up heating and nothing more, leaving the hot water and electrical loads to be supplied electrically or by solar water and photovoltaic (PV).

9.2.6 For comparison, we have included the pellet stove system in the zero emissions option. Whilst more expensive than the log stove initially, it provides space heating and hot water heating, but still has the problem of limited local pellet supply. This means that electrical panels are for use as a back-up system and CO^2 emissions and annual cost are a small percentage of the basic building regulations house.

9.3 Solar

9.3.1 Wherever possible, housing orientation and design should make best use of solar gain. This may range from having large south-facing windows and small north-facing windows to providing sunspaces and thermal mass in order to make best use of solar gain. Sunspaces can also be used as useful buffer spaces to reduce heat losses when entering the house and as a useful space for drying clothes.

9.3.2 There are two main options using solar energy to heat water or provide electricity through solar water heating panels for hot water and photovoltaic (PV) panels for electricity.

9.3.3 A $5m^2$ solar water panel on a south-facing roof, connected through to the hot water cylinder can considerably reduce the demand for water heating. Even in Scotland this can reduce the load on hot water systems considerably. Obviously the effect on the hot water heating system depends on what system is used. Whilst the energy is only available intermittently, with a well-insulated hot water tank, hot water can be stored for a number of hours until required. Fitting a solar hot water heating panel at construction stage is relatively cheap and provides reasonable heating energy reductions, whatever heating system is eventually chosen. We have assumed 5m^2 of solar hot water panels in the timber high insulation model and the zero emissions model. A number of different models are available but we have chosen the freeze tolerant 'solartwin' model because of its simplicity in not requiring drain back of water or anti-freeze. It also incorporates a PV panel which powers a pump which circulates the warmed water.

9.3.4 Photovoltaic (PV) roof panels are becoming more widespread. These convert solar energy directly into electrical energy. Many products are available to fit a variety of roof types, although care would be required to ensure the roof direction and pitch optimise a panel's performance. PV panels have a number of disadvantages - it is still comparatively expensive to fit a system large enough to make a significant impact on a dwellings energy use and the electricity they generate is intermittent, storage being a costly addition. A very large roof area of PV panels (eg the whole roof) could produce enough energy to lower electricity costs by 70%, but the initial capital costs would be high. It does have certain advantages - even in cloudy weather, some electricity can be generated and every square metre of PV panel can displace two tonnes of $C0^2$ over its lifetime.

9.3.5 If choosing a system, it will be necessary to decide if battery storage is to be incorporated. This will add to the cost and also takes up space. It can be simpler to make use of the electricity during daylight hours only and not rely on battery back-up. The system we have shown as optional such as the Redland 24 tile PV tile kit. This gives a coverage of 15.3m^2, a peak output of 2 kilowatts and costs around £18,000. It would be grid-connected and we estimate that it would contribute some 1,469 kWh per annum to the house. A smaller 10 tile kit would cost around £8,000 contributing about 600 kWh per annum.

9.3.6 Some simple measures to reduce the electrical load in the house should be considered although the selection of white goods is often left to the tenants.

9.4 Wind

9.4.1 Wind is available to some degree on all sites in Scotland, however the feasibility of a wind turbine is very site-specific, dependant of ground form, surrounding buildings and site exposure. In the analysis of prototype we have made a number of assumptions, basing our data on a site suitable for a variety of turbine sizes and average wind speed.

9.4.2 There are a variety of sizes of wind turbine, from individual domestic scale to large commercial generators. Recently, an economical domestic scale wind turbine has been developed. This system does not store energy or return it to the grid. Its sole purpose is to supply electricity to cover the base load i.e. the things that are always on. It is a relatively simple system to install and for a single building provides a reasonable output for a modest initial outlay.

9.4.3 There are significant advantages in a communal system serving a number of houses. Whilst initially more expensive, a single larger turbine would be more efficient than several smaller turbines. The need for storage is reduced as there would be a larger base load on the system and annual maintenance costs would be lower. It would be possible to size a system so that the output of a communal system matches the combined output of individual system.

9.4.4 In principle, a communal wind generator, serving six dwellings on an average site could provide 2,000 kWh per annum or approximately 50% of the energy requirements for the zero emissions house type or 20% of the energy requirements for the basic building regulations house type over the year. For this energy to be converted into heat and hot water, the house must operate on an all-electric system.

9.5 **Electric**

9.5.1 Standard electrical storage heaters are shown as a secondary heating system supplementing the wood boiler in four options. Their efficiency, low initial cost and ability to be free from a distribution system makes them a reasonable choice provided the house is well insulated. They should not be treated as the main heating system and tenants would need to understand that their use should be limited and follow the use of the wood fuel stove.

9.5.2 However storage radiators are dependant on off-peak electricity, so they are not very responsive to changing conditions. In the zero emissions house we have opted for simple electric panel heaters to provide back up heating in very cold snaps.

9.5.3 Communal Heating Options

9.5.4 There are a number of communal heating options, depending on the number of houses within a single development. However, there can be more management requirements for a communal system. A single wood chip boiler could supply the necessary energy though it would have a high cost initially without capital grant aid. Geothermal heating could also be organised communally, extracting low grade heat from a borehole or a ground loop (or a lake or river) and converting the energy with a heat pump using off-peak electricity, then storing the warm water in a thermal storage tank before circulating to the houses.

9.5.5 If gas was available, a simple gas-fired communal boiler could be used.

9.5.6 Each option would need to be assessed in relation to the number of units required for each site and site-specific constraints in terms of ground conditions, fuel available locally etc. Because there are so many site and development, specific matters in choosing a communal system, we have omitted this from all our calculations.

9.6 **Reducing Electrical Loads**

9.6.1 With significantly greater emphasis being placed on structural insulation standards, the heating demand will fall. However, there is an increasing demand for appliances, so the choice and use of electrical products should take into account their energy use.

9.6.2 The use of low energy lighting and fluorescent fittings will save energy, as will good daylighting standards.

9.6.3 Fridges can be low energy rated and should not be sited near heat producing appliances like cookers. Air should be allowed to circulate freely around the fridge.

9.6.4 Washing machines should use a hot water supply fed from the solar connected cylinder. They should also have a half load facility to reduce energy loads. Spin dryers are more efficient than tumble dryers and if possible, an internal drying area should be provided to reduce dependence and use of the spin dryer. Where possible, EU energy rated white goods should be used. The EcoHomes standard (ENE 4) requires A-rated appliances for all appliances except for dryers and washer dryers which can be B-rated and above.

10. Material Selection

10.1 Introduction

10.1.1 Within the tight cost constraints of affordable housing projects, there is limited scope in specifying materials which cost more than the cheapest product on the market. Life expectancy, recyclability and environmental side effects are not often taken into account when comparing costs.

10.1.2 The prototype house is aiming to use C16 timbers for wall construction which can be sourced from homegrown suppliers. Use of homegrown timber should be incorporated into the design and specification at the outset and reviewed continually throughout the construction process. The wall frames of timber kit housing can be designed to only require C16 grade timber. Kit manufacturers may choose to use imported C24 timbers because of their supply chain and manufacturing processes. Therefore, it is advantageous to try and select kit manufacturers who source their timber from homegrown forests at an early stage. Other timber products and insulation materials have been discussed elsewhere in this report, but a few alternatives to certain products should be incorporated in the prototype house.

Table 4: alternative materials

	Material	**Option with lower embodied energy or less toxic.**
FOUNDATIONS	Hardcore	Recycled hardcore Pulverised fuel ash, as an additive to concrete as it reduces the cement content.
STRUCTURE	Concrete blockwork	Durox lightweight blocks Recycled aggregate blocks
EXTERNAL SKIN	Brick	Recycled brick, specify local brick manufacturer if possible.
	Concrete block and roughcast	Calcium silicate board and render system
	Cement mortar	Lime mortar
TIMBER PRODUCTS	Softwood	From sustainable sources only conforming to FSC certified. Chain of custody paperwork should be provided. Specify C16 for structural use as it can be sourced in Scotland. Composite joists use smaller sections of timber.
	Hardwood	Should be FSC certified or locally sourced Otherwise avoid where possible.
	Imported plywood	Non-tropical with low formaldehyde glues e.g. using birch and spruce or pine veneers.
	Particle board etc	Ideally we should adopt materials with zero formaldehyde content, if particle board is used it can be provided formaldehyde free. OSB flooring grade is also an option.
	Timber preservatives	Avoid where possible through good detailing. However insurance companies may require preservative treated timbers to be used on external walls to satisfy their warranties.
ROOFWORK	Roof finishes	Concrete roof tiles – (not necessarily slates) may be sourced in Scotland. Clay tiles. Stainless steel, copper and aluminium profiled sheet materials which can be recycled.
LININGS, SUNDRY ETC	Roof insulation	Cellulose insulation (recycled paper) Wool
	Solvent woodstains	Water-based woodstains Wax finishes
	Solvent-based paints	Water-based paints
	Kitchen units	Low formaldehyde chipboard or solid wood
	Tungsten light bulbs	2D low energy bulbs
PLUMBING	Cisterns	Dual flush cisterns 4/6 litres
	Wash basins	Flow regulators, autosave off systems, aerating taps, showers with flow rate equal or less than 4.5 litres a minute
	PVC drains	HDPE pipe/ clay drains
	PVC gutters and downpipes	Galvanised steel or aluminium gutters and downpipes (Nordal or Lindab)
EXTERNAL LANDSCAPE	Peat mulch	Bark and straw mulch

	Material	**Option with lower embodied energy or less toxic.**
	Surface drainage	Sustainable urban drainage system (SUDS). Gravel instead of brick and block driveways. Grasscrete.
INSULATION	Polyurethane insulation and other oil based insulants, sometimes used in composite lining boards in timber frame kits.	Mineral fibre/rockwool Fibreglass batts made locally. Cellulose and wool insulation

11. Health

11.1.1 Whilst health and safety legislation covering the work place is among the reasons for minimising solvents in paints and varnishes, market place competition is also driving change. Natural paint manufacturers are making a significant contribution to the growth of the sustainable development agenda. When specifying for a healthy interior air quality, their expertise is indispensable. In Scotland, where health concerns such as asthma are especially prevalent, healthy interior air quality must be weighed against cost. In special needs houses provided for people with respiratory or allergy problems, natural paints and varnishes without Volatile Organic Compounds (VOCs) are essential regardless of cost.

11.1.2 Currently non-VOC paints can be up to as much as five times more expensive than conventional paints. In a specification for affordable housing this is an obvious dilemma.

11.1.3 It should however be noted that most of the large paint manufacturers are taking notice of the need to reduce VOCs. Water-based matt emulsions are available instead of solvent based emulsions and most major manufacturers make a low solvent (40% less solvent) gloss paint as an alternative to high VOC gloss paint.

11.2 Meeting EcoHomes Standards

11.2.1 EcoHomes is an environmental assessment method created by the Building Research Establishment (BRE) to provide a credible, transparent label for new and refurbished homes.

11.2.2 It is not limited to energy matters but considers the broad environmental concerns of climate change, use of resources and impacts on wildlife. It also considers the requirements for a healthy internal environment.

11.2.3 The issues assessed are grouped into seven categories:

- energy
- water
- pollution
- materials
- transport
- ecology and land use
- health and wellbeing.

11.2.4 An EcoHomes assessment is undertaken by licensed assessors for a fee and is carried out at the design stage in a similar way to a SAP rating. Every house type on a site is considered, but the award is given for the whole development. The environmental performance is expressed on a scale of pass to excellent and depicted by sunflowers, one for a “pass”, two for “good”, three for “very good” and four for “excellent”. The various criteria may be described as follows:

- **Pass:** most developments should achieve this with only minor changes to the specification and at minimal additional cost.
- **Good:** the developer has been able to demonstrate good practice in most areas.
- **Very Good:** developments which push forward the boundaries of environmental performance.
- **Excellent:** developments which demonstrate exemplary environmental performance across the full range of issues.

11.2.5 The only case study project which has undergone an EcoHomes assessment was at Leitch Street where a ‘very good’ rating was achieved.

11.2.6 In order to achieve an ‘excellent’ rating, care has to be taken to meet the full range of EcoHomes criteria. We have found that the following points could make a difference between achieving an ‘excellent’ rating and a ‘very good’ rating:

- cycle storage should be provided
- any timber should have a full chain of custody for certification. (this can be very difficult to achieve because of the use of packers and lippings, thresholds etc that are so commonly used)
- hard landscaped areas should use gravel (permeable blockwork appears not to be acceptable, although we would question the validity of this criteria)
- there should be water reducing features (much more of an issue in England than in Scotland)
- downpipes should have water butts, but it only counts as part of an integrated water attenuation design (sustainable urban drainage system (SUDS) design not included in EcoHomes)
- a planting regime which incorporates ecological enhancement. This means only specifying native species, difficult since many of our common plants may have been imported in the past.

There are limitations to EcoHomes:

- it is geared to pressures affecting housing developments and environment in the South of England. In this respect it does not account for rural housing where access to local transport networks is more difficult
- the building footprint favours higher densities – not an issue in rural areas.

12. Site-related matters

12.1.1 A fundamental element of building design, both aesthetically and functionally, is that buildings respond to their context. In this respect, a prototype always needs some level of adaptation to fit its context.

12.1.2 Individual site specific designs would need to be adopted for different orientations, open or forested locations, site and access conditions.

12.1.3 Site conditions and planning constraints may dictate that cladding materials and roof finishes are changed. In particular, if groups of houses are built adjacent to one another, gable ends will require to be clad in a fireproof material for example, surfaces need to provide class 0 surface spread of flame and the overall wall needs to provide 60 minutes fire resistance. Whilst brick and the ubiquitous block and render can be used, it is possible to clad the building in a lightweight calcium silicate board, also available in wood effect planks, or provide a render finish on a board or mesh backing.

12.1.4 Site orientation and aspect will influence which windows will receive most solar gain and whether the installation of a sunspace will provide added value as well as energy savings.

12.1.5 The slope of any site will have an influence on the type of foundations and underbuilding that may be required. On heavily sloping sites, the post and beam frame system reduces the need for underbuilding, however there may be other considerations such as level access to consider. In this respect it is not appropriate to say which floor build-up is best without knowing the constraints of a site.

12.1.6 Other points to be considered include:

- shelter from wind
- onsite sewage treatment
- surface drainage
- existing trees and biodiversity
- soil conditions
- access and parking requirements
- proximity to services.

12.1.7 In summary, the prototype will always need some level of adjustment for any site, to adequately respond to its context.

13. Practical Experience – Glenmore

13.1.1 Since the publication of the initial report in 2004, John Gilbert Architects has been commissioned by Albyn Housing Society to construct a pair of houses based on the Scottish timber prototype, on land in Glenmore near Aviemore – previously owned by the Forestry Commission. The houses will be for social rent and were funded by the Scottish Government. The Cairngorm National Park Authority was very supportive of the proposal and funding was also received from SUST at The Lighthouse.

13.1.2 The proposal was based on the preferred prototype and the enhanced high insulation model from the Green to Greener specification. Sunspaces and solar panels were omitted due to the overshadowing in the forest, areas were reduced to social housing minimums to minimise cost and design was adjusted to meet Albyn Housing Society's Design Guide.

13.1.3 In negotiating planning permission and consents, the following issues occurred:

1. a slate roof finish was required
2. solar panels were inappropriate for a forest context
3. log stoves alone are not acceptable in meeting Scottish housing quality standards, therefore we have specified log stoves in the living rooms with additional electrical heaters elsewhere in the dwellings. It is expected that tenants will make use of cheaper logs to provide the majority of their heating requirement rather than more expensive electrical heating.
4. The costs for the project came out substantially higher than the costs in this report due to:
    - site-related matters such as tree protection, demolition of an existing building, site access and drainage infrastructure
    - the planning authority asked for slate roof finish
    - there were few kit manufacturers prepared to supply a Scottish timber kit therefore the price of this element was higher than an imported kit
    - cost of site works and access to this remote site have been substantially higher than anticipated.

13.1.5 In preparing the specification for this project, we were aware of the EU procurement rules that govern public procurement. These stipulate that restrictions on products and tenders cannot be made on the basis of geography, therefore it is illegal to specify Scottish timber directly. In order to achieve the desired outcome we undertook the following:

- Products can be specified by name irrespective of their origin, therefore we researched all our products and mapped them to minimise non-UK products
- We used Scottish timber products such as Russwood timber who have trademarked a product called 'Scotlarch' which is a Scottish larch cladding profile. Stirling OSB and particle board is produced exclusively from offcuts from the Scottish timber industry in Scotland.
- We provided additional information on Scottish timber sourcing within the specification. It provided names of potential suppliers, timber associations and expanded on industry myths.
- We expressed the desire and intention of the client to use Scottish timber throughout the specification referring to a single Scottish timber clause (G20/01). This did not stipulate that timber should be Scottish, only that it was

the client's intention.

13.1.6 We used the following specification clause in the NBS specification:

02 TIMBER ORIGIN AND CERTIFICATION

It is the Clients intention in this project to use Scottish timber for structure, cladding and sundry timber items. There is additional information in Appendix 1 of this specification, on Scottish timber sourcing.

Scottish timber shall be taken to mean:

- Timber and products made largely from timber whereby that timber has been grown in Scotland, and
- where evidence in the form of an agreed certificate, may be found with all and every batch of timber or composite products arriving on site, and shall be available for inspection by the client or CA at any reasonable time

The following Certificates are acceptable:

- FSC (COC) - Forest Stewardship Council Chain of Custody
- CSA - Canadian Standards Association
- SFI - North American Sustainable Forest Initiative
- PEFC - Programme for the Endorsement of Forest Certification schemes

In the event of any Contractor Design Portion, the Designer is deemed to be knowledgeable about the design and specification implications of Scottish timber. Further sources of information may be found at: http://www.forestry.gov.uk/forestry/infd-6b2jfb

The contractor is deemed to be knowledgeable about the construction and sourcing implications of Scottish timber. Further sources of information may be found at: http://www.forestry.gov.uk/forestry/infd-6b2jfb

The use of Scottish timber in no way absolves the contractor or their designers from specifying and sourcing materials to all relevant and appropriate standards of material and workmanship, British Standards, European Norms, NHBC Guidelines, and any relevant Government or local authority conditions such as the most recent SBSA technical Standards.

Any conflict between the detailed specification and the use of Scottish timber or timber based products should be brought to the attention of the CA as soon as possible.

The contractor should note that the specified timber may not be available through their normal supply routes. It is sometimes possible to achieve the necessary certification through standard supply chain routes, but where this is not possible, suppliers may be contacted through the links below.

In some cases, Scottish timber or timber based products may take longer to supply than more established sources. The contractor shall be deemed responsible for establishing any programme implications this may have before site start.

Individual clauses have specific product sources, other sources of Scottish timber information and suppliers include:

UK Forest Products Association - http://www.ukfpa.co.uk/
Forestry Commission - http://www.forestry.gov.uk/forestry/infd-6b2jfb
Association of Scottish Hardwood Sawmills - http://www.ashs.co.uk/

13.1.7 The project began onsite in August 2008 and is scheduled to be completed in March 2009.

13.1.8 Practically, the onsite project has (to date) gone well. We assisted the contractor to find a kit manufacturer, Alexanders Timber Design, who use Scottish timber and with whom we worked on timber detailing. It is vital that the contractor chosen for the project is as committed to working with Scottish timber as the design team.

14. Prototype Summary

14.1.1 This report illustrates that it is entirely feasible to construct a warm, energy-efficient and low-carbon emitting affordable house. The prototype design meets Scottish Government space benchmarks and maximises the use of C16 timber to allow homegrown timber to be used. A range of options in the Green to Greener specification allows for varying levels of specification and cost.

14.1.2 The preferred option provides a flexible house that can initially be built with two bedrooms and then be extended to three. However, the installation of the stair at the first phase does have a cost penalty and the house sizes are largely dictated by the need to provide sufficient ground floor space for a three-bedroom house with six people.

Phase	Size	Scottish Housing Handbook, Metric Space Standards	Prototype Size
Phase 1 only	4 Person	84 m^2	87.9 m^2
Phase 1 + 2 Together	6 Person	107 m^2	106.9 m^2

14.1.3 The costs for phase 1 range from £83,390 for the basic building regulations type to £118,535 for the zero emissions type. If both phases are done at the outset, providing a three bedroom house, the costs range from £90,879 for the basic building regulations type to £127,605 for the zero emissions type. In both configurations, the basic building regulations standard house costs about 70% of the cost of the zero emissions house.

14.1.4 It would be more cost effective to build the three-bedroom house at the outset.

14.1.5 The report illustrates that it is possible to build this prototype using C16 homegrown timber within the structure.

14.1.6 The Green to Greener specification illustrates the range of options available for insulating, heating and servicing a dwelling in rural Scotland. It illustrates the concept that incremental increase in insulation thickness can be matched with varying types of heating system to provide warm, energy-efficient housing that emit low levels of carbon dioxide.

14.1.7 In addition to specifying highly-insulated components and efficient heating systems, the 2005 report outlines a number of other approaches to energy generation and a range of construction materials that have low toxicity in their use or production. We have examined how the prototypes could potentially measure up against the EcoHomes criteria, a national benchmark of environmental quality.

14.1.8 A pilot house which demonstrates the principles of this prototype would be of great benefit to those wishing to specify greater use of homegrown timber in social housing. Whilst we recognise that there are pilot demonstrations such as the Timberframe 2000 project which built a six-storey block of flats largely from C16 Scottish timber, we do not think that this makes the necessary link to providing simple rural housing, nor is it accessible for clients and organisations wishing to view the pilot and learn from it.

15. Appendices

1. Cost breakdown
2. Prototype plans and details
3. Contacts and Suppliers

PROPOSED SCHEME	**: NEW BUILD HOUSING - PROTOTYPE 3 - PHASE 2 - OPTION A - BASIC B-REG SPECIFICATION**					
ARCHITECT : JOHN GILBERT ARCHITECTS				**DATE :**	**REVISED 1ST DEC 2008**	
CLIENT :	**PERTHSHIRE HOUSING ASSOCIATION**			**142**	**M2 GRD**	
				78	**M2 1ST**	
PRELIMINARY ESTIMATE			**G.F.A.**	**220**	**M2 GROSS**	
			NR OF UNITS	**2**	**NR**	
ELEMENT		**WORKS COST**	**COST PER M2 GFA**	**WORKS INCL PRELIMS**	**TOTAL PER M2 GFA**	**COST PER UNIT**
1.0 SUBSTRUCTURE		£ 20,766.08	£ 146.24	£ 25,538.96	£ 179.85	£ 12,769.48
2.0 SUPERSTRUCTURE						
	2.1 EXTERNAL WALLS	£ 1,173.60	£ 5.33	£ 1,443.34	£ 6.56	£ 721.67
	VERTICAL WEATHERBOARDING	£ 3,726.00	£ 16.94	£ 4,582.38	£ 20.83	£ 2,291.19
	PAINTING WEATHERBOARDING	£ -	£ -	£ -	£ -	£ -
	2.2 INTERNAL WALLS	£ 213.75	£ 0.97	£ 262.88	£ 1.19	£ 131.44
	2.3 UPPER FLOORS	£ 1,872.00	£ 8.51	£ 2,302.26	£ 10.47	£ 1,151.13
	2.4 ROOF	£ 14,487.50	£ 65.85	£ 17,817.31	£ 80.98	£ 8,908.66
	2.5 STAIRS	£ 800.00	£ 3.64	£ 983.87	£ 4.48	£ 491.94
	2.6 SKIRTINGS	£ 1,073.60	£ 4.88	£ 1,320.36	£ 6.00	£ 660.18
	2.7 WINDOW AND EXT DOORS	£ 7,109.56	£ 32.32	£ 8,743.62	£ 39.75	£ 4,371.81
	2.8 INTERNAL DOORS	£ 6,614.10	£ 30.06	£ 8,134.28	£ 36.97	£ 4,067.14
	2.9 KITCHEN FITMENTS	£ 2,400.00	£ 10.91	£ 2,951.62	£ 13.42	£ 1,475.81
	2.10 FIXTURES AND FITTINGS	£ 926.40	£ 4.21	£ 1,139.32	£ 5.18	£ 569.66
	2.11 STRUCTURAL KIT	£ 18,452.90	£ 129.95	£ 22,694.11	£ 159.82	£ 11,347.06
	TOTAL	£ 58,849.41	£ 313.57	£ 72,375.35	£ 385.65	£ 36,187.69
3.0 INTERNAL FINISHES						
	3.1 WALL FINISHES	£ 8,170.80	£ 37.14	£ 10,048.78	£ 45.68	£ 5,024.39
	3.2 FLOOR FINISHES	£ 2,014.98	£ 14.19	£ 2,478.10	£ 17.45	£ 1,239.05
	3.3 CEILING FINISHES	£ 2,778.60	£ 12.63	£ 3,417.23	£ 15.53	£ 1,708.62
	3.4 PAINTING AND DECOR	£ 4,703.60	£ 21.38	£ 5,784.68	£ 26.29	£ 2,892.34
	TOTAL	£ 17,667.98	£ 85.34	£ 21,728.79	£ 104.95	£ 10,864.40
4.0 SERVICES						
	4.1 SANITARY APPLIANCES	£ 5,172.00	£ 23.51	£ 6,360.73	£ 28.91	£ 3,180.37
	4.2 SOIL AND WASTE INSTALL	£ 1,170.40	£ 5.32	£ 1,439.40	£ 6.54	£ 719.70
	4.3 WATER INSTALL	£ 2,347.40	£ 10.67	£ 2,886.93	£ 13.12	£ 1,443.47
	4.4 HEATING INSTALL	£ 9,391.80	£ 42.69	£ 11,550.41	£ 52.50	£ 5,775.21
	WOOD STOVE HEATER		£ -	£ -	£ -	£ -
	4.5 VENTILATION INSTALL	£ 1,196.60	£ 5.44	£ 1,471.63	£ 6.69	£ 735.82
	4.6 ELECTRICAL INSTALL	£ 12,188.00	£ 55.40	£ 14,989.29	£ 68.13	£ 7,494.65
	4.7 GAS INSTALL	£ -	£ -	£ -	£ -	£ -
	4.8 RAINWATER INSTALL	£ 2,273.00	£ 10.33	£ 2,795.43	£ 12.70	£ 1,397.72
	TOTAL	£ 33,739.20	£ 153.36	£ 41,493.82	£ 188.59	£ 20,746.94
SUB TOTAL		£ 131,022.67	£ 698.51	£ 161,136.92	£ 859.04	£ 80,568.51
UPDATE FROM MARCH 2004 TO DECEMBER 2008.	**ADD 22%**	£ 28,824.99	£ 153.67	£ 35,450.12	£ 188.99	£ 17,725.07
PRELIMINARY ESTIMATE		£ 159,847.66	£ 852.18	£ 196,587.04	£ 1,048.03	£ 98,293.58

PROPOSED SCHEME : NEW BUILD HOUSING - PROTOTYPE 3 - PHASE 2 - OPTION A - BASIC B-REG SPECIFICATION

ARCHITECT : JOHN GILBERT ARCHITECTS — DATE : REVISED 1ST DEC 2008

CLIENT : PERTHSHIRE HOUSING ASSOCIATION

	142	M2 GRD
	78	M2 1ST
G.F.A.	220	M2 GROSS
NR OF UNITS	2	NR

PRELIMINARY ESTIMATE

ELEMENT		WORKS COST	COST PER M2 GFA	WORKS INCL PRELIMS	TOTAL PER M2 GFA	COST PER UNIT
1.0 SUBSTRUCTURE		£ 20,766.08	£ 146.24	£ 31,046.12	£ 218.63	£ 15,523.06
2.0 SUPERSTRUCTURE						
	2.1 EXTERNAL WALLS	£ 1,173.60	£ 5.33	£ 1,754.58	£ 7.97	£ 877.29
	VERTICAL WEATHERBOARDING	£ 3,726.00	£ 16.94	£ 5,570.52	£ 25.33	£ 2,785.26
	PAINTING WEATHERBOARDING	£ -	£ -	£ -	£ -	£ -
	2.2 INTERNAL WALLS	£ 213.75	£ 0.97	£ 319.56	£ 1.45	£ 159.78
	2.3 UPPER FLOORS	£ 1,872.00	£ 8.51	£ 2,798.71	£ 12.72	£ 1,399.36
	2.4 ROOF	£ 14,487.50	£ 65.85	£ 21,659.39	£ 98.45	£ 10,829.70
	2.5 STAIRS	£ 800.00	£ 3.64	£ 1,196.03	£ 5.44	£ 598.02
	2.6 SKIRTINGS	£ 1,073.60	£ 4.88	£ 1,605.07	£ 7.30	£ 802.54
	2.7 WINDOW AND EXT DOORS	£ 7,109.56	£ 32.32	£ 10,629.08	£ 48.32	£ 5,314.54
	2.8 INTERNAL DOORS	£ 6,614.10	£ 30.06	£ 9,888.34	£ 44.94	£ 4,944.17
	2.9 KITCHEN FITMENTS	£ 2,400.00	£ 10.91	£ 3,588.10	£ 16.31	£ 1,794.05
	2.10 FIXTURES AND FITTINGS	£ 926.40	£ 4.21	£ 1,385.01	£ 6.29	£ 692.51
	2.11 STRUCTURAL KIT	£ 18,452.90	£ 129.95	£ 27,587.82	£ 194.28	£ 13,793.91
	TOTAL	£ 58,849.41	£ 313.57	£ 87,982.21	£ 468.80	£ 43,991.13
3.0 INTERNAL FINISHES						
	3.1 WALL FINISHES	£ 8,170.80	£ 37.14	£ 12,215.67	£ 55.53	£ 6,107.84
	3.2 FLOOR FINISHES	£ 2,014.98	£ 14.19	£ 3,012.48	£ 21.21	£ 1,506.24
	3.3 CEILING FINISHES	£ 2,778.60	£ 12.63	£ 4,154.12	£ 18.88	£ 2,077.06
	3.4 PAINTING AND DECOR	£ 4,703.60	£ 21.38	£ 7,032.07	£ 31.96	£ 3,516.04
	TOTAL	£ 17,667.98	£ 85.34	£ 26,414.34	£ 127.58	£ 13,207.18
4.0 SERVICES						
	4.1 SANITARY APPLIANCES	£ 5,172.00	£ 23.51	£ 7,732.35	£ 35.15	£ 3,866.18
	4.2 SOIL AND WASTE INSTALL	£ 1,170.40	£ 5.32	£ 1,749.79	£ 7.95	£ 874.90
	4.3 WATER INSTALL	£ 2,347.40	£ 10.67	£ 3,509.46	£ 15.95	£ 1,754.73
	4.4 HEATING INSTALL	£ 9,391.80	£ 42.69	£ 14,041.12	£ 63.82	£ 7,020.56
	WOOD STOVE HEATER		£ -	£ -	£ -	£ -
	4.5 VENTILATION INSTALL	£ 1,196.60	£ 5.44	£ 1,788.96	£ 8.13	£ 894.48
	4.6 ELECTRICAL INSTALL	£ 12,188.00	£ 55.40	£ 18,221.55	£ 82.83	£ 9,110.78
	4.7 GAS INSTALL	£ -	£ -	£ -	£ -	£ -
	4.8 RAINWATER INSTALL	£ 2,273.00	£ 10.33	£ 3,398.23	£ 15.44	£ 1,699.12
	TOTAL	£ 33,739.20	£ 153.36	£ 50,441.46	£ 229.27	£ 25,220.75
SUB TOTAL		£ 131,022.67	£ 698.51	£ 195,884.13	£ 1,044.28	£ 97,942.12
UPDATE FROM MARCH 2004 TO DECEMBER 2008.	ADD 22%	£ 28,824.99	£ 153.67	£ 43,094.51	£ 229.74	£ 21,547.27
PRELIMINARY ESTIMATE		£ 159,847.66	£ 852.18	£ 238,978.64	£ 1,274.02	£ 119,489.39

PROPOSED SCHEME	: NEW BUILD HOUSING - PROTOTYPE 3 - PHASE 1 - OPTION A - ENHANCED SPECIFICATION							
ARCHITECT : JOHN GILBERT ARCHITECTS						DATE :	REVISED 1ST DEC 2008	
CLIENT :	PERTHSHIRE HOUSING ASSOCIATION					142	M2 GRD	
						40	M2 1ST	
PRELIMINARY ESTIMATE					G.F.A.	182	M2 GROSS	
					NR OF UNITS	2	NR	
ELEMENT				WORKS COST	COST PER M2 GFA	WORKS INCL PRELIMS	TOTAL PER M2 GFA	COST PER UNIT
1.0 SUBSTRUCTURE				£ 22,981.28	£ 161.84	£ 28,442.32	£ 200.30	£ 14,221.16
2.0 SUPERSTRUCTURE								
	2.1 EXTERNAL WALLS			£ 1,173.60	£ 6.45	£ 1,452.48	£ 7.98	£ 726.24
	VERTICAL WEATHERBOARDING			£ 4,005.45	£ 22.01	£ 4,957.27	£ 27.24	£ 2,478.64
	PAINTING WEATHERBOARDING			£ -	£ -	£ -	£ -	£ -
	2.2 INTERNAL WALLS			£ 176.70	£ 0.97	£ 218.69	£ 1.20	£ 109.35
	2.3 UPPER FLOORS			£ 960.00	£ 5.27	£ 1,188.12	£ 6.52	£ 594.06
	2.4 ROOF			£ 14,067.19	£ 77.29	£ 17,409.98	£ 95.66	£ 8,704.99
	2.5 STAIRS			£ 800.00	£ 4.40	£ 990.10	£ 5.45	£ 495.05
	2.6 SKIRTINGS			£ 888.16	£ 4.88	£ 1,099.21	£ 6.04	£ 549.61
	2.7 WINDOW AND EXT DOORS			£ 6,602.75	£ 36.28	£ 8,171.76	£ 44.90	£ 4,085.88
	2.8 INTERNAL DOORS			£ 5,773.40	£ 31.72	£ 7,145.33	£ 39.26	£ 3,572.67
	2.9 KITCHEN FITMENTS			£ 2,400.00	£ 13.19	£ 2,970.31	£ 16.32	£ 1,485.16
	2.10 FIXTURES AND FITTINGS			£ 926.40	£ 5.09	£ 1,146.54	£ 6.30	£ 573.27
	2.11 STRUCTURAL KIT			£ 19,667.00	£ 138.50	£ 24,340.47	£ 171.41	£ 12,170.24
	TOTAL			£ 57,440.65	£ 346.05	£ 71,090.26	£ 428.28	£ 35,545.16
3.0 INTERNAL FINISHES								
	3.1 WALL FINISHES			£ 6,759.48	£ 37.14	£ 8,365.74	£ 45.97	£ 4,182.87
	3.2 FLOOR FINISHES			£ 2,014.98	£ 14.19	£ 2,493.80	£ 17.56	£ 1,246.90
	3.3 CEILING FINISHES			£ 2,298.66	£ 12.63	£ 2,844.89	£ 15.63	£ 1,422.45
	3.4 PAINTING AND DECOR			£ 3,891.16	£ 21.38	£ 4,815.82	£ 26.46	£ 2,407.91
	TOTAL			£ 14,964.28	£ 85.34	£ 18,520.25	£ 105.62	£ 9,260.13
4.0 SERVICES								
	4.1 SANITARY APPLIANCES			£ 2,180.00	£ 11.98	£ 2,698.03	£ 14.83	£ 1,349.02
	4.2 SOIL AND WASTE INSTALL			£ 968.24	£ 5.32	£ 1,198.32	£ 6.58	£ 599.16
	4.3 WATER INSTALL			£ 1,941.94	£ 10.67	£ 2,403.40	£ 13.21	£ 1,201.70
	4.4 HEATING INSTALL			£ 9,391.80	£ 51.60	£ 11,623.57	£ 63.86	£ 5,811.79
	WOOD STOVE HEATER			£ 3,228.00	£ 17.74	£ 3,995.07	£ 21.96	£ 1,997.54
	4.5 VENTILATION INSTALL			£ 1,236.60	£ 6.79	£ 1,530.45	£ 8.40	£ 765.23
	4.6 ELECTRICAL INSTALL			£ 10,082.80	£ 55.40	£ 12,478.78	£ 68.56	£ 6,239.39
	4.7 GAS INSTALL			£ -	£ -	£ -	£ -	£ -
	4.8 RAINWATER INSTALL			£ 2,313.26	£ 12.71	£ 2,862.96	£ 15.73	£ 1,431.48
	TOTAL			£ 31,342.64	£ 172.21	£ 38,790.58	£ 213.13	£ 19,395.31
SUB TOTAL				£ 126,728.85	£ 765.44	£ 156,843.41	£ 947.33	£ 78,421.76
UPDATE FROM MARCH 2004 TO DECEMBER 2008.		ADD	22%	£ 27,880.35	£ 168.40	£ 34,505.55	£ 208.41	£ 17,252.79

PROPOSED SCHEME : NEW BUILD HOUSING - PROTOTYPE 3 - PHASE 2 - OPTION A - ENHANCED SPECIFICATION

ARCHITECT : JOHN GILBERT ARCHITECTS — **DATE : REVISED 1ST DEC 2008**

CLIENT : PERTHSHIRE HOUSING ASSOCIATION

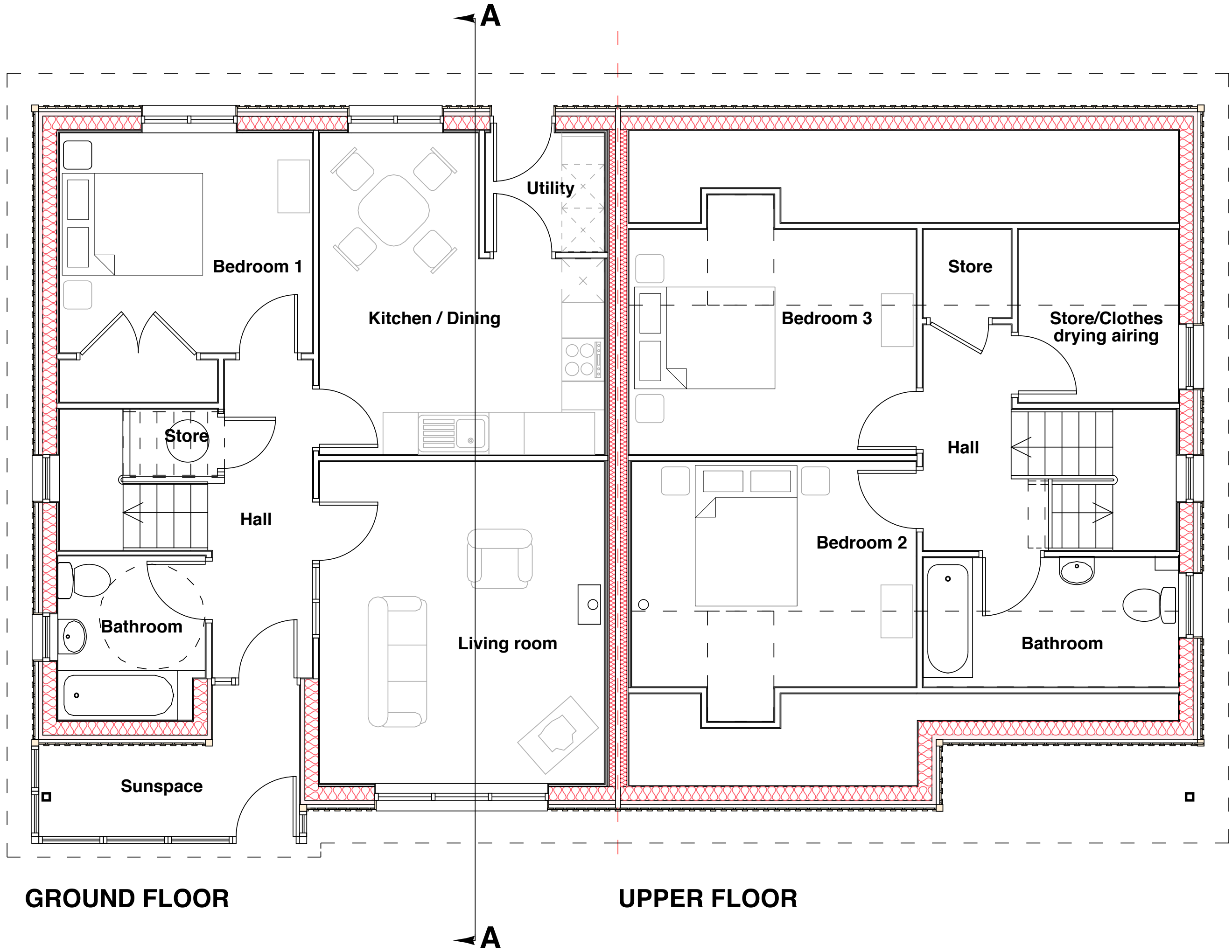
	142	M2 GRD
	78	M2 1ST
PRELIMINARY ESTIMATE — G.F.A.	220	M2 GROSS
NR OF UNITS	2	NR

ELEMENT		WORKS COST	COST PER M2 GFA	WORKS INCL PRELIMS	TOTAL PER M2 GFA	COST PER UNIT
1.0 SUBSTRUCTURE		£ 22,981.28	£ 161.84	£ 27,944.22	£ 196.79	£ 13,972.11
2.0 SUPERSTRUCTURE						
	2.1 EXTERNAL WALLS	£ 1,173.60	£ 5.33	£ 1,427.05	£ 6.48	£ 713.53
	VERTICAL WEATHERBOARDING	£ 4,005.45	£ 18.21	£ 4,870.45	£ 22.14	£ 2,435.23
	PAINTING WEATHERBOARDING	£ -	£ -	£ -	£ -	£ -
	2.2 INTERNAL WALLS	£ 213.75	£ 0.97	£ 259.91	£ 1.18	£ 129.96
	2.3 UPPER FLOORS	£ 1,872.00	£ 8.51	£ 2,276.27	£ 10.35	£ 1,138.14
	2.4 ROOF	£ 15,274.15	£ 69.43	£ 18,572.69	£ 84.42	£ 9,286.35
	2.5 STAIRS	£ 800.00	£ 3.64	£ 972.76	£ 4.43	£ 486.38
	2.6 SKIRTINGS	£ 1,073.60	£ 4.88	£ 1,305.45	£ 5.93	£ 652.73
	2.7 WINDOW AND EXT DOORS	£ 7,329.56	£ 33.32	£ 8,912.42	£ 40.52	£ 4,456.21
	2.8 INTERNAL DOORS	£ 6,614.10	£ 30.06	£ 8,042.45	£ 36.55	£ 4,021.23
	2.9 KITCHEN FITMENTS	£ 2,400.00	£ 10.91	£ 2,918.29	£ 13.27	£ 1,459.15
	2.10 FIXTURES AND FITTINGS	£ 926.40	£ 4.21	£ 1,126.46	£ 5.12	£ 563.23
	2.11 STRUCTURAL KIT	£ 19,667.00	£ 138.50	£ 23,914.20	£ 168.41	£ 11,957.10
	TOTAL	£ 61,349.61	£ 327.97	£ 74,598.40	£ 398.80	£ 37,299.24
3.0 INTERNAL FINISHES						
	3.1 WALL FINISHES	£ 8,170.80	£ 37.14	£ 9,935.33	£ 45.16	£ 4,967.67
	3.2 FLOOR FINISHES	£ 2,014.98	£ 14.19	£ 2,450.13	£ 17.25	£ 1,225.07
	3.3 CEILING FINISHES	£ 2,778.60	£ 12.63	£ 3,378.65	£ 15.36	£ 1,689.33
	3.4 PAINTING AND DECOR	£ 4,703.60	£ 21.38	£ 5,719.37	£ 26.00	£ 2,859.69
	TOTAL	£ 17,667.98	£ 85.34	£ 21,483.48	£ 103.77	£ 10,741.76
4.0 SERVICES						
	4.1 SANITARY APPLIANCES	£ 5,172.00	£ 23.51	£ 6,288.92	£ 28.59	£ 3,144.46
	4.2 SOIL AND WASTE INSTALL	£ 1,170.40	£ 5.32	£ 1,423.15	£ 6.47	£ 711.58
	4.3 WATER INSTALL	£ 2,347.40	£ 10.67	£ 2,854.33	£ 12.97	£ 1,427.17
	4.4 HEATING INSTALL	£ 9,391.80	£ 42.69	£ 11,420.01	£ 51.91	£ 5,710.01
	WOOD STOVE HEATER	£ 3,228.00	£ 14.67	£ 3,925.11	£ 17.84	£ 1,962.56
	4.5 VENTILATION INSTALL	£ 1,636.60	£ 7.44	£ 1,990.03	£ 9.05	£ 995.02
	4.6 ELECTRICAL INSTALL	£ 12,188.00	£ 55.40	£ 14,820.07	£ 67.36	£ 7,410.04
	4.7 GAS INSTALL	£ -	£ -	£ -	£ -	£ -
	4.8 RAINWATER INSTALL	£ 2,313.26	£ 10.51	£ 2,812.82	£ 12.78	£ 1,406.41
	TOTAL	£ 37,447.46	£ 170.21	£ 45,534.44	£ 206.97	£ 22,767.25
SUB TOTAL		£ 139,446.33	£ 745.36	£ 169,560.54	£ 906.33	£ 84,780.36
UPDATE FROM MARCH 2004 TO DECEMBER 2008.	ADD 22%	£ 30,678.19	£ 163.98	£ 37,303.32	£ 199.39	£ 18,651.68
PRELIMINARY ESTIMATE		£ 170,124.52	£ 909.34	£ 206,863.86	£ 1,105.72	£ 103,432.04

PROPOSED SCHEME	**: NEW BUILD HOUSING - PROTOTYPE 3 - PHASE 2 - OPTION A - ENHANCED SPECIFICATION**					
ARCHITECT : JOHN GILBERT ARCHITECTS				**DATE :**	**REVISED 1ST DEC 2008**	
CLIENT :	**PERTHSHIRE HOUSING ASSOCIATION**			142	M2 GRD	
				78	M2 1ST	
PRELIMINARY ESTIMATE			G.F.A.	220	M2 GROSS	
			NR OF UNITS	2	NR	

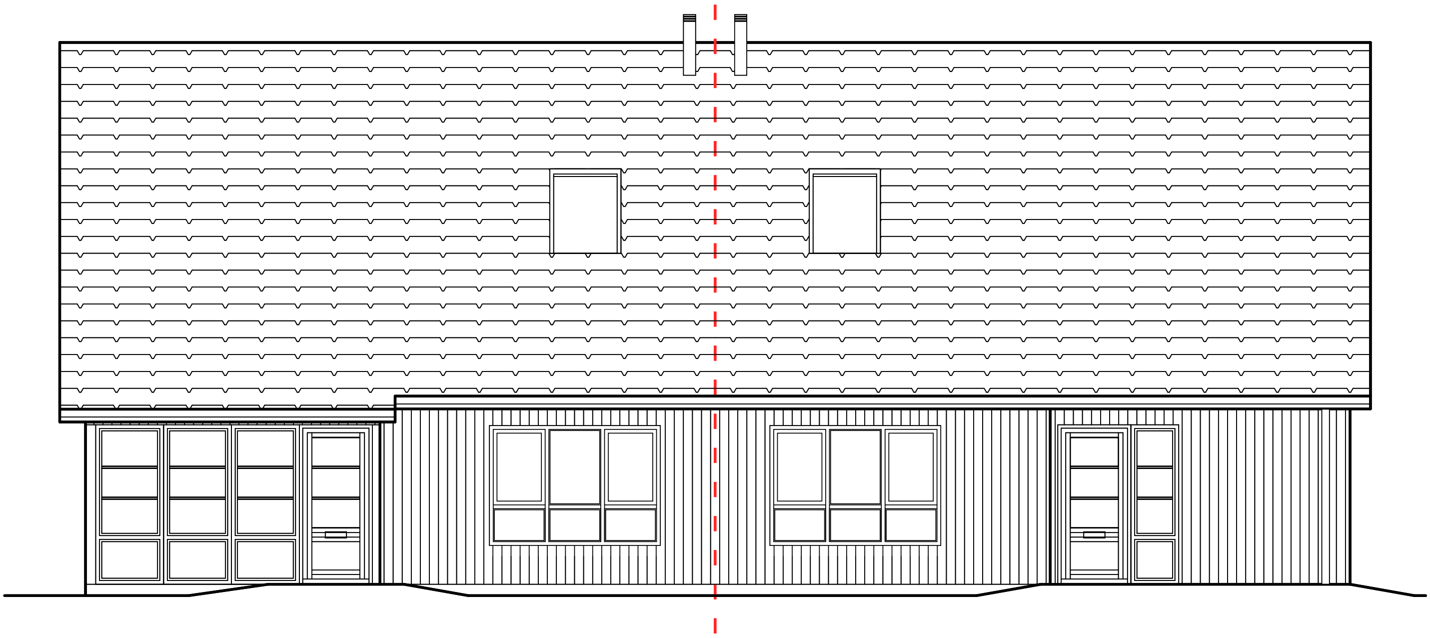
ELEMENT		WORKS COST	COST PER M2 GFA	WORKS INCL PRELIMS	TOTAL PER M2 GFA	COST PER UNIT
1.0 SUBSTRUCTURE		£ 22,981.28	£ 161.84	£ 33,670.69	£ 237.12	£ 16,835.35
2.0 SUPERSTRUCTURE						
	2.1 EXTERNAL WALLS	£ 1,173.60	£ 5.33	£ 1,719.48	£ 7.81	£ 859.74
	VERTICAL WEATHERBOARDING	£ 4,005.45	£ 18.21	£ 5,868.53	£ 26.68	£ 2,934.27
	PAINTING WEATHERBOARDING	£ -	£ -	£ -	£ -	£ -
	2.2 INTERNAL WALLS	£ 213.75	£ 0.97	£ 313.17	£ 1.42	£ 156.59
	2.3 UPPER FLOORS	£ 1,872.00	£ 8.51	£ 2,742.73	£ 12.47	£ 1,371.37
	2.4 ROOF	£ 15,274.15	£ 69.43	£ 22,378.70	£ 101.72	£ 11,189.35
	2.5 STAIRS	£ 800.00	£ 3.64	£ 1,172.11	£ 5.33	£ 586.06
	2.6 SKIRTINGS	£ 1,073.60	£ 4.88	£ 1,572.97	£ 7.15	£ 786.49
	2.7 WINDOW AND EXT DOORS	£ 7,329.56	£ 33.32	£ 10,738.80	£ 48.82	£ 5,369.40
	2.8 INTERNAL DOORS	£ 6,614.10	£ 30.06	£ 9,690.55	£ 44.04	£ 4,845.28
	2.9 KITCHEN FITMENTS	£ 2,400.00	£ 10.91	£ 3,516.33	£ 15.98	£ 1,758.17
	2.10 FIXTURES AND FITTINGS	£ 926.40	£ 4.21	£ 1,357.30	£ 6.17	£ 678.65
	2.11 STRUCTURAL KIT	£ 19,667.00	£ 138.50	£ 28,814.82	£ 202.92	£ 14,407.41
	TOTAL	£ 61,349.61	£ 327.97	£ 89,885.49	£ 480.51	£ 44,942.78
3.0 INTERNAL FINISHES						
	3.1 WALL FINISHES	£ 8,170.80	£ 37.14	£ 11,971.33	£ 54.42	£ 5,985.67
	3.2 FLOOR FINISHES	£ 2,014.98	£ 14.19	£ 2,952.22	£ 20.79	£ 1,476.11
	3.3 CEILING FINISHES	£ 2,778.60	£ 12.63	£ 4,071.03	£ 18.50	£ 2,035.52
	3.4 PAINTING AND DECOR	£ 4,703.60	£ 21.38	£ 6,891.41	£ 31.32	£ 3,445.71
	TOTAL	£ 17,667.98	£ 85.34	£ 25,885.99	£ 125.03	£ 12,943.01
4.0 SERVICES						
	4.1 SANITARY APPLIANCES	£ 5,172.00	£ 23.51	£ 7,577.68	£ 34.45	£ 3,788.84
	4.2 SOIL AND WASTE INSTALL	£ 1,170.40	£ 5.32	£ 1,714.79	£ 7.79	£ 857.40
	4.3 WATER INSTALL	£ 2,347.40	£ 10.67	£ 3,439.26	£ 15.63	£ 1,719.63
	4.4 HEATING INSTALL	£ 9,391.80	£ 42.69	£ 13,760.26	£ 62.55	£ 6,880.13
	WOOD STOVE HEATER	£ 3,228.00	£ 14.67	£ 4,729.46	£ 21.49	£ 2,364.73
	4.5 VENTILATION INSTALL	£ 1,636.60	£ 7.44	£ 2,397.84	£ 10.90	£ 1,198.92
	4.6 ELECTRICAL INSTALL	£ 12,188.00	£ 55.40	£ 17,857.07	£ 81.17	£ 8,928.54
	4.7 GAS INSTALL	£ -	£ -	£ -	£ -	£ -
	4.8 RAINWATER INSTALL	£ 2,313.26	£ 10.51	£ 3,389.24	£ 15.40	£ 1,694.62
	TOTAL	£ 37,447.46	£ 170.21	£ 54,865.60	£ 249.38	£ 27,432.81
SUB TOTAL		£ 139,446.33	£ 745.36	£ 204,307.77	£ 1,092.04	£ 102,153.95
UPDATE FROM MARCH 2004 TO DECEMBER 2008.	ADD 22%	£ 30,678.19	£ 163.98	£ 44,947.71	£ 240.25	£ 22,473.87
PRELIMINARY ESTIMATE		£ 170,124.52	£ 909.34	£ 249,255.48	£ 1,332.29	£ 124,627.82

PROPOSED SCHEME	: NEW BUILD HOUSING - PROTOTYPE 3 - PHASE 1 - OPTION A - ENHANCED (HIGH THERMAL MASS)													
ARCHITECT : JOHN GILBERT ARCHITECTS								DATE :		REVISED 1ST DEC 2008				
CLIENT :	PERTHSHIRE HOUSING ASSOCIATION								142	M2 GRD				
									40	M2 1ST				
PRELIMINARY ESTIMATE							G.F.A.		182	M2 GROSS				
							NR OF UNITS		2	NR				
ELEMENT				WORKS COST		COST PER M2 GFA		WORKS INCL PRELIMS		TOTAL PER M2 GFA		COST PER UNIT		
1.0 SUBSTRUCTURE				£	23,631.64	£	166.42	£	29,168.20	£	205.41	£	14,584.10	
2.0 SUPERSTRUCTURE														
	2.1 EXTERNAL WALLS			£	1,173.60	£	6.45	£	1,448.56	£	7.96	£	724.28	
	VERTICAL WEATHERBOARDING			£	4,034.48	£	22.17	£	4,979.70	£	27.36	£	2,489.85	
	PAINTING WEATHERBOARDING			£	-	£	-	£	-	£	-	£	-	
	2.2 INTERNAL WALLS			£	176.70	£	0.97	£	218.10	£	1.20	£	109.05	
	2.3 UPPER FLOORS			£	960.00	£	5.27	£	1,184.91	£	6.50	£	592.46	
	2.4 ROOF			£	13,703.19	£	75.29	£	16,913.66	£	92.93	£	8,456.83	
	2.5 STAIRS			£	800.00	£	4.40	£	987.43	£	5.43	£	493.72	
	2.6 SKIRTINGS			£	888.16	£	4.88	£	1,096.24	£	6.02	£	548.12	
	2.7 WINDOW AND EXT DOORS			£	6,602.75	£	36.28	£	8,149.68	£	44.78	£	4,074.84	
	2.8 INTERNAL DOORS			£	5,773.40	£	31.72	£	7,126.03	£	39.15	£	3,563.02	
	2.9 KITCHEN FITMENTS			£	2,400.00	£	13.19	£	2,962.29	£	16.28	£	1,481.15	
	2.10 FIXTURES AND FITTINGS			£	926.40	£	5.09	£	1,143.44	£	6.28	£	571.72	
	2.11 STRUCTURAL KIT			£	24,128.64	£	169.92	£	29,781.64	£	209.73	£	14,890.82	
	TOTAL			£	61,567.32	£	375.63	£	75,991.68	£	463.62	£	37,995.86	
3.0 INTERNAL FINISHES														
	3.1 WALL FINISHES			£	6,759.48	£	37.14	£	8,343.13	£	45.84	£	4,171.57	
	3.2 FLOOR FINISHES			£	2,014.98	£	14.19	£	2,487.06	£	17.51	£	1,243.53	
	3.3 CEILING FINISHES			£	2,298.66	£	12.63	£	2,837.20	£	15.59	£	1,418.60	
	3.4 PAINTING AND DECOR			£	3,891.16	£	21.38	£	4,802.80	£	26.39	£	2,401.40	
	TOTAL			£	14,964.28	£	85.34	£	18,470.19	£	105.33	£	9,235.10	
4.0 SERVICES														
	4.1 SANITARY APPLIANCES			£	2,180.00	£	11.98	£	2,690.74	£	14.79	£	1,345.37	
	4.2 SOIL AND WASTE INSTALL			£	968.24	£	5.32	£	1,195.09	£	6.57	£	597.55	
	4.3 WATER INSTALL			£	1,941.94	£	10.67	£	2,396.91	£	13.17	£	1,198.46	
	4.4 HEATING INSTALL			£	6,422.00	£	35.29	£	7,926.58	£	43.56	£	3,963.29	
	WOOD STOVE HEATER			£	3,228.00	£	17.74	£	3,984.28	£	21.90	£	1,992.14	
	4.5 VENTILATION INSTALL			£	1,236.60	£	6.79	£	1,526.32	£	8.38	£	763.16	
	4.6 ELECTRICAL INSTALL			£	10,082.80	£	55.40	£	12,445.06	£	68.38	£	6,222.53	
	4.7 GAS INSTALL			£	-	£	-	£	-	£	-	£	-	
	4.8 RAINWATER INSTALL			£	2,313.26	£	12.71	£	2,855.22	£	15.69	£	1,427.61	
	TOTAL			£	28,372.84	£	155.90	£	35,020.20	£	192.44	£	17,510.11	
SUB TOTAL				£	128,536.08	£	783.29	£	158,650.27	£	966.80	£	79,325.17	
UPDATE FROM MARCH 2004 TO														
DECEMBER 2008.		ADD	22%	£	28,277.94	£	172.32	£	34,903.06	£	212.70	£	17,451.54	
PRELIMINARY ESTIMATE				£	156,814.02	£	955.61	£	193,553.33	£	1,179.50	£	96,776.71	



GROUND FLOOR

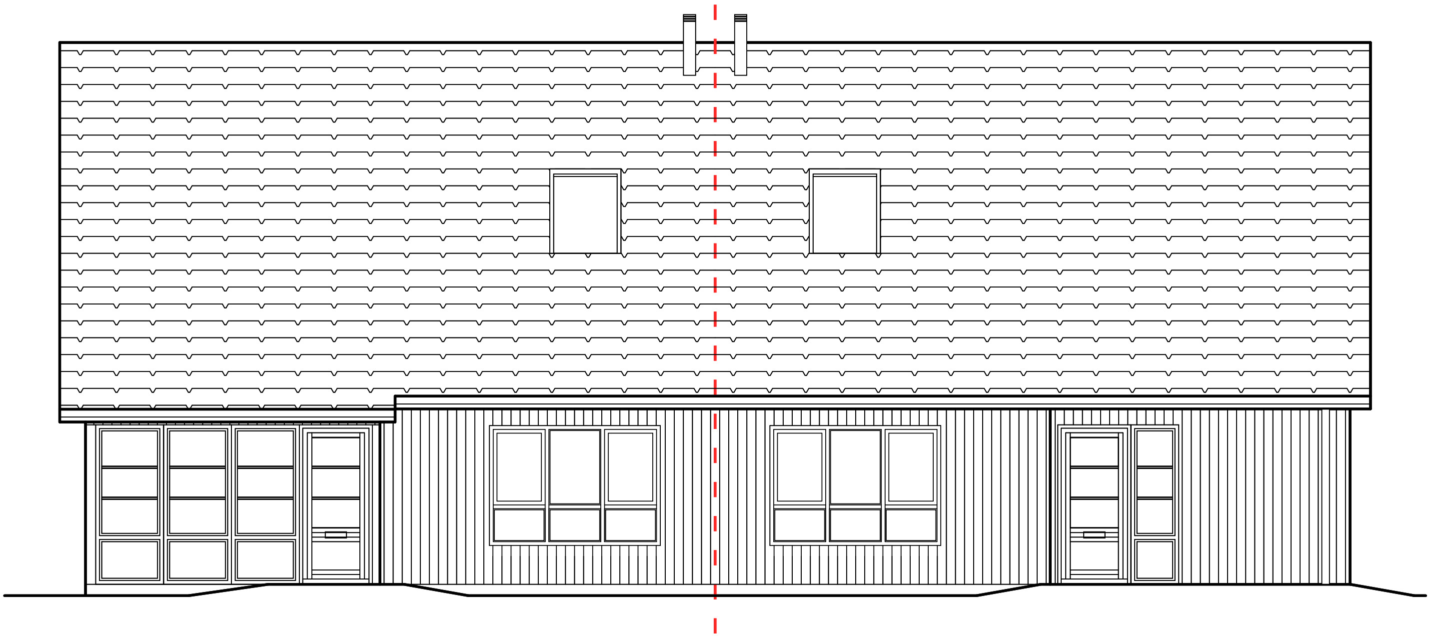
UPPER FLOOR



FRONT ELEVATION
with sunspace

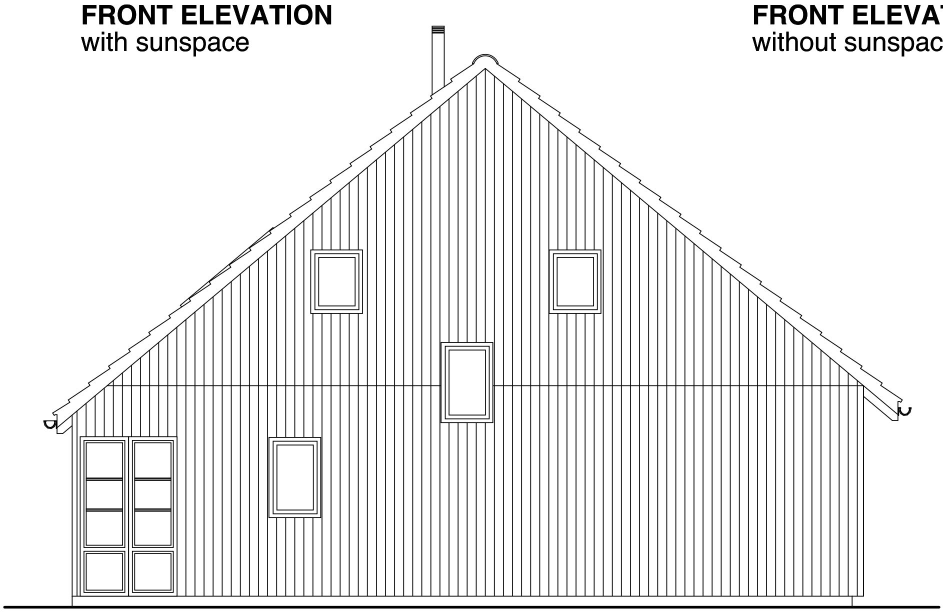
FRONT ELEVATION
without sunspace

John Gilbert ARCHITECTS 4C1 Templeton Business Centre Templeton Street, Glasgow G40 1DA Tel 0141-551 8383 Fax 0141-554 7884 e-mail: info@johngilbert.co.uk www.johngilbert.co.uk	Title: **Prototype 3 Two bedroom house PLANS AND FRONT ELEVATION Phase 2**	Project: **Perthshire HA**		
		Job No 02770	Scale 1:100	
	Rev / Alteration / Date	Date Dec 04	Drawn by NM	Size A4
		Drg No PT3.3		Rev

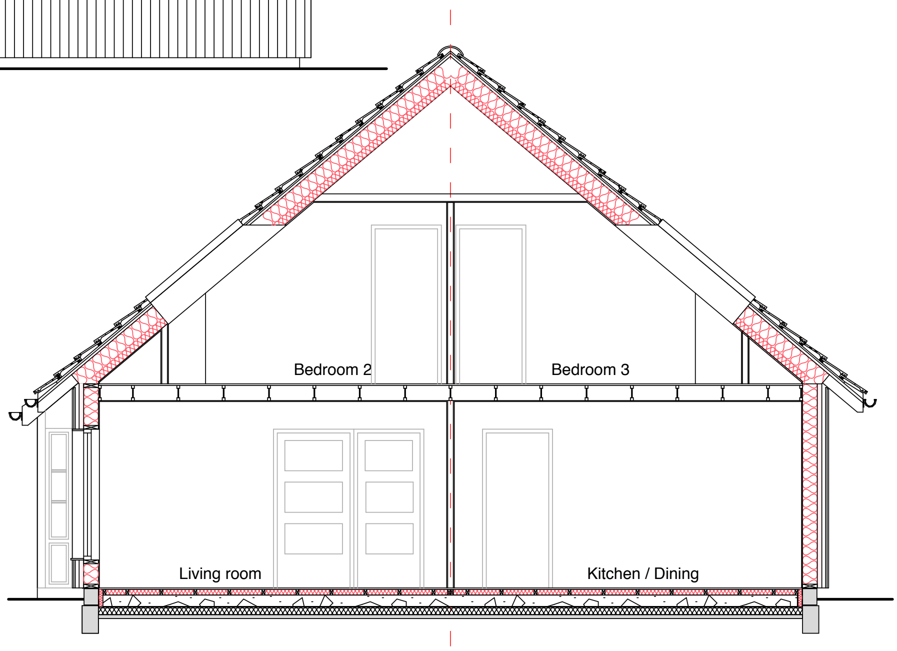


FRONT ELEVATION
with sunspace

FRONT ELEVATION
without sunspace



SIDE ELEVATION



SECTION

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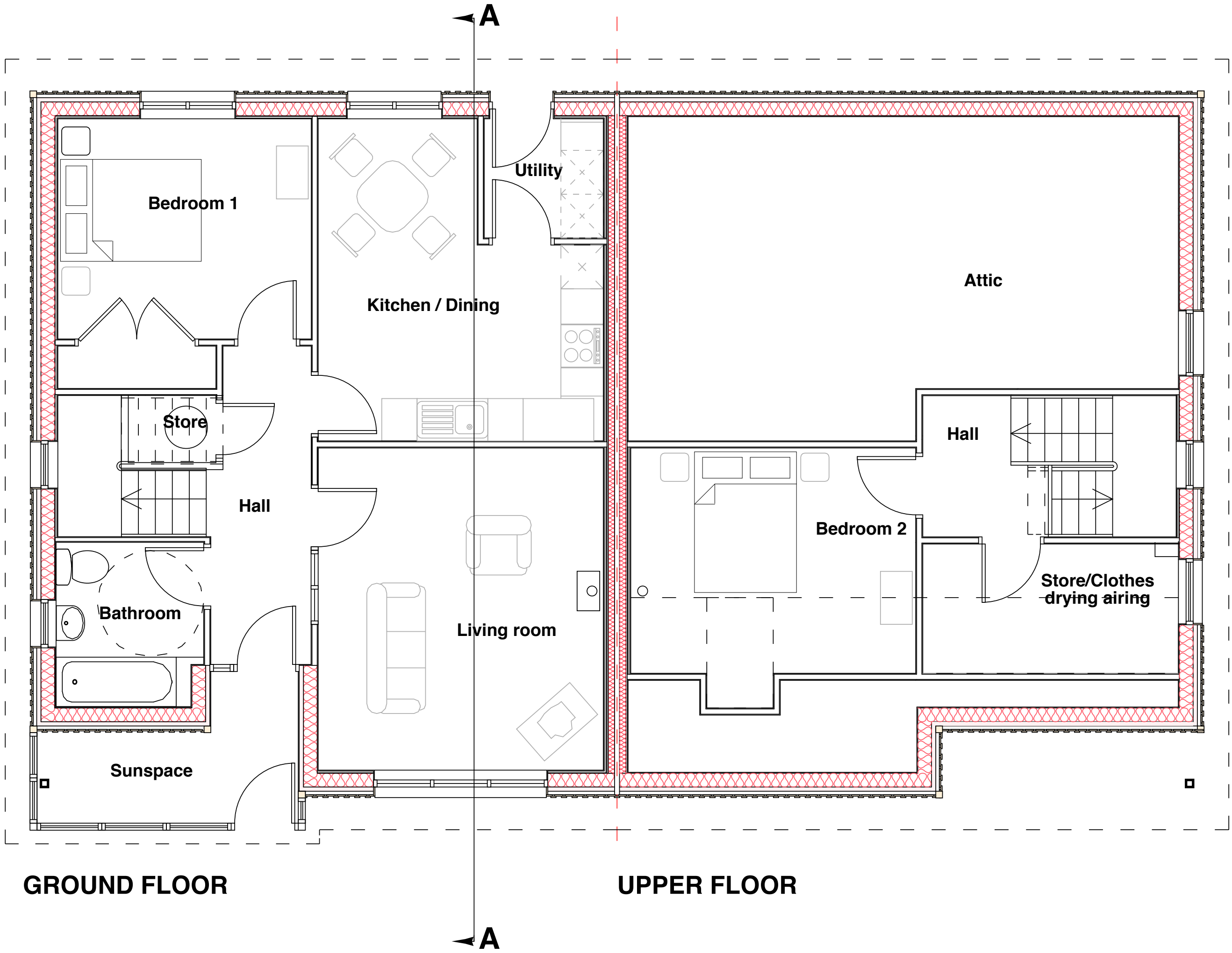
Title
Prototype 3
Two bedroom house
ELEVATIONS AND SECTION
Phase 2

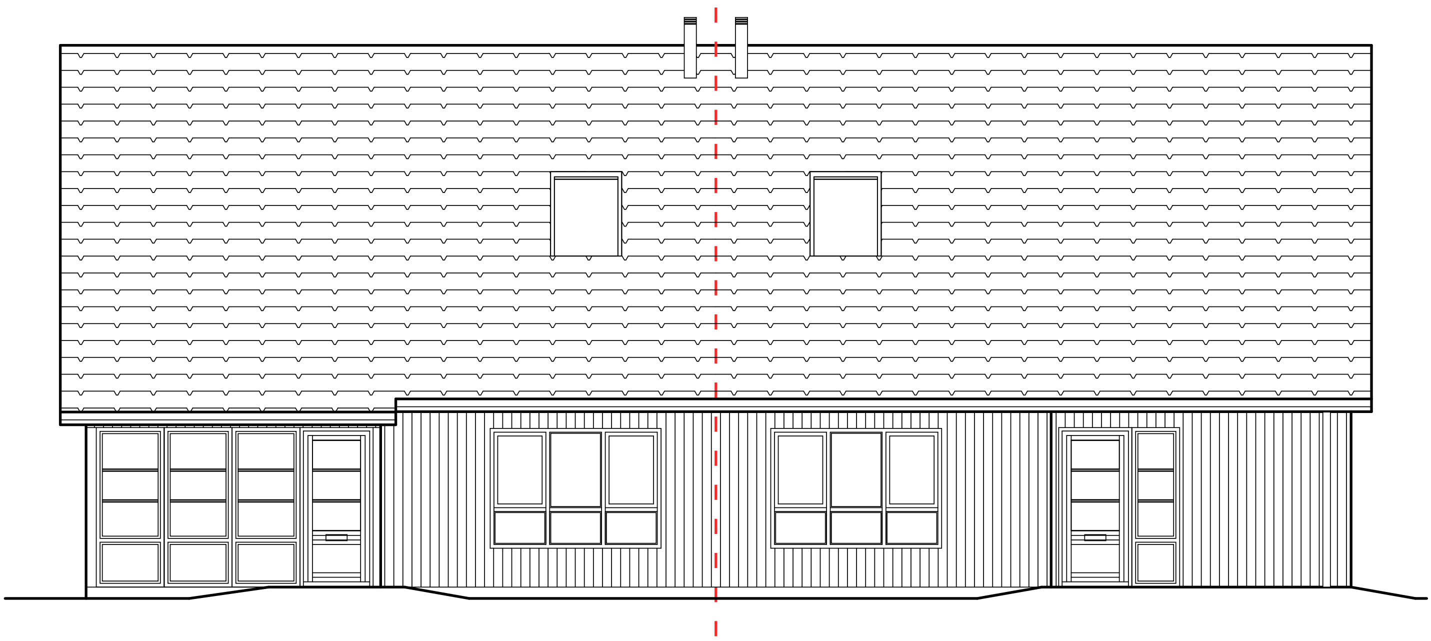
Rev	Alteration	Date

Project
Perthshire HA

Job No	Scale		Date	Drawn by	Size	Drg No	Rev
02770	1:100		Dec 04	NM	A4	PT3.4	



GROUND FLOOR **UPPER FLOOR**



FRONT ELEVATION
with sunspace

FRONT ELEVATION
without sunspace

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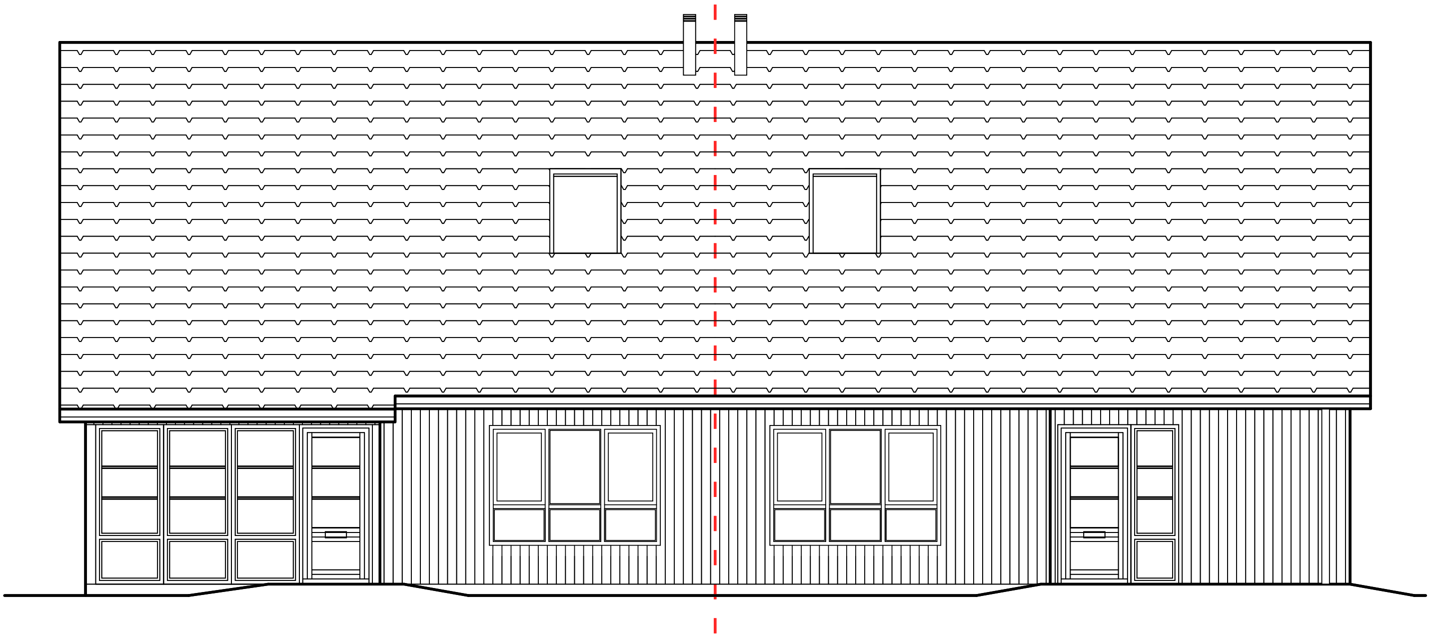
Title

Prototype 3
Two bedroom house
PLANS AND FRONT ELEVATION
Phase 1

Rev	Alteration	Date

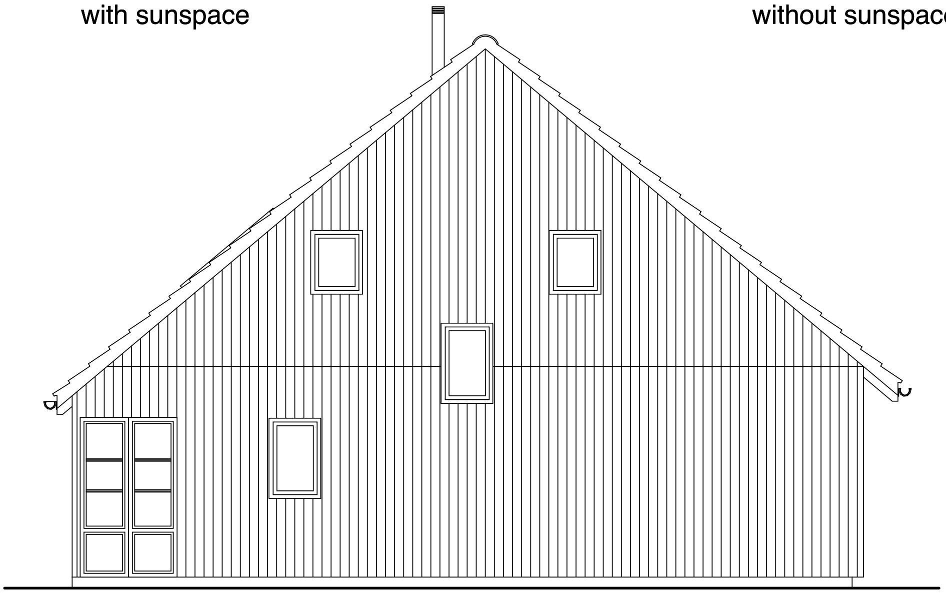
Project: **Perthshire HA**

Job No	Scale		
02770	1:100		
Date: Dec 04	Drawn by: NM	Size: A4	
Drg No: PT3.1		Rev:	

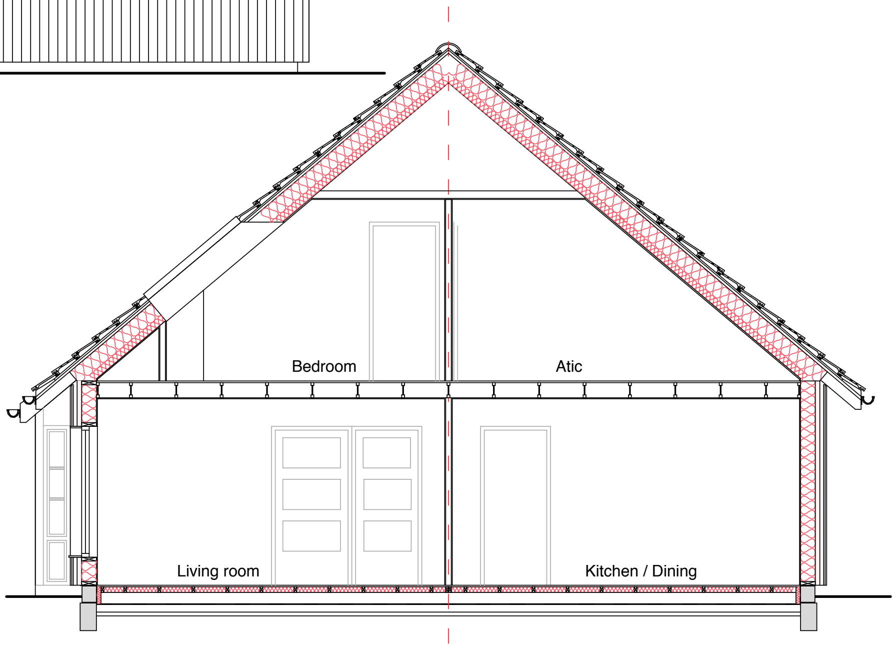


FRONT ELEVATION
with sunspace

FRONT ELEVATION
without sunspace



SIDE ELEVATION



SECTION

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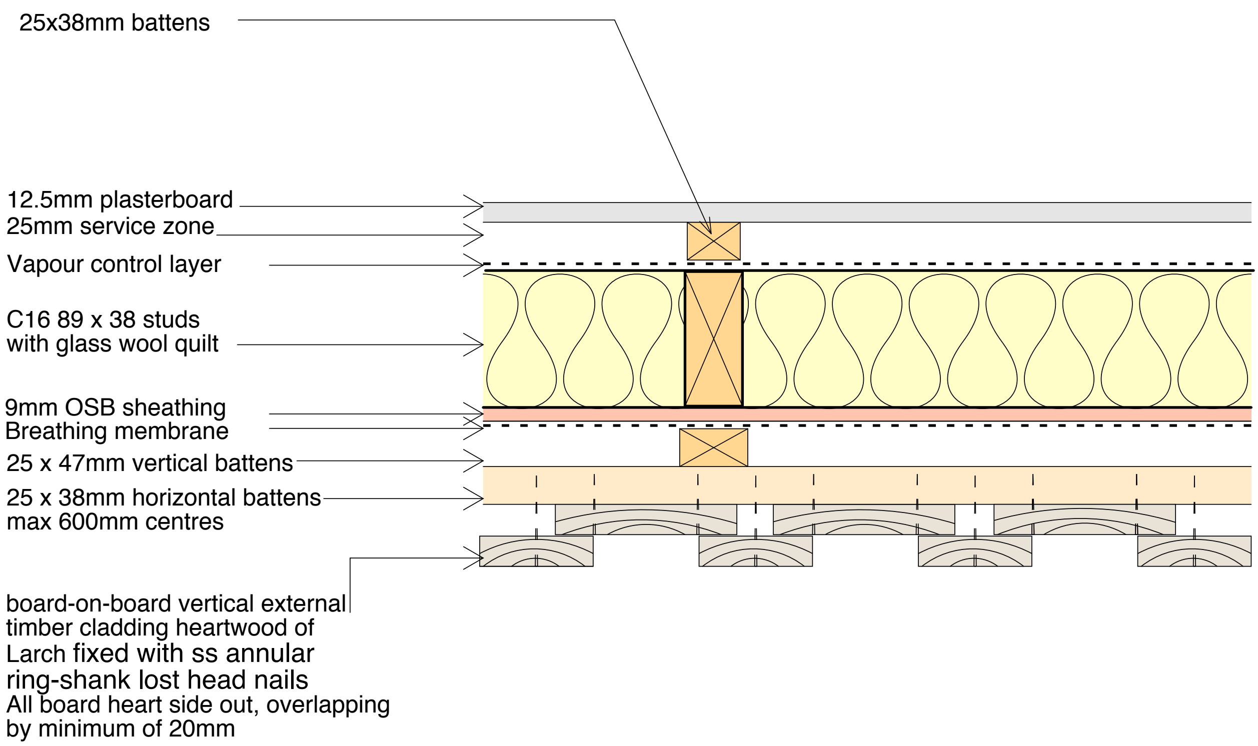
Title

Prototype 3
Two bedroom house
ELEVATIONS AND SECTION
Phase 1

Rev	Alteration	Date

Project
Perthshire HA

Job No 02770	Scale 1:100	
Date Dec 04	Drawn by NM	Size A4
Drg No PT3.2		Rev



Recent TRADA guidance shows the underboard with heartside in,
this appears to be based on Norwegian details published about 20 years ago.
The Norwegians have since changed their advice - their current details
specify that the most weather tight option is where both the inner and
outer board face heart side out on the wall.

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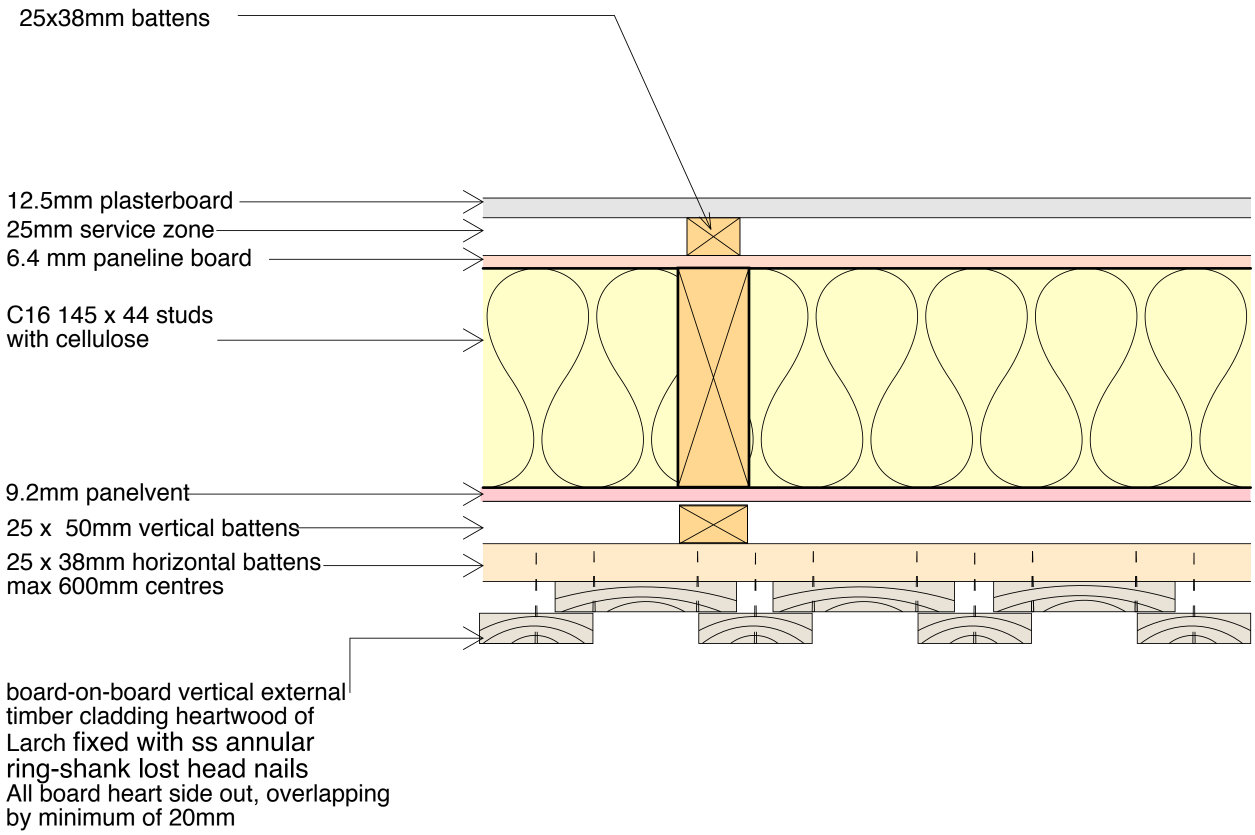
Title	BASIC BUILDING REGULATION EXTERNAL WALL DETAIL PLAN	Project	Perthshire HA	
		Job No 02770	Scale 1:5	
Rev	Alteration	Date	Date Mar 06	Drawn by JG	Size A4
			Drg No [21]10		Rev



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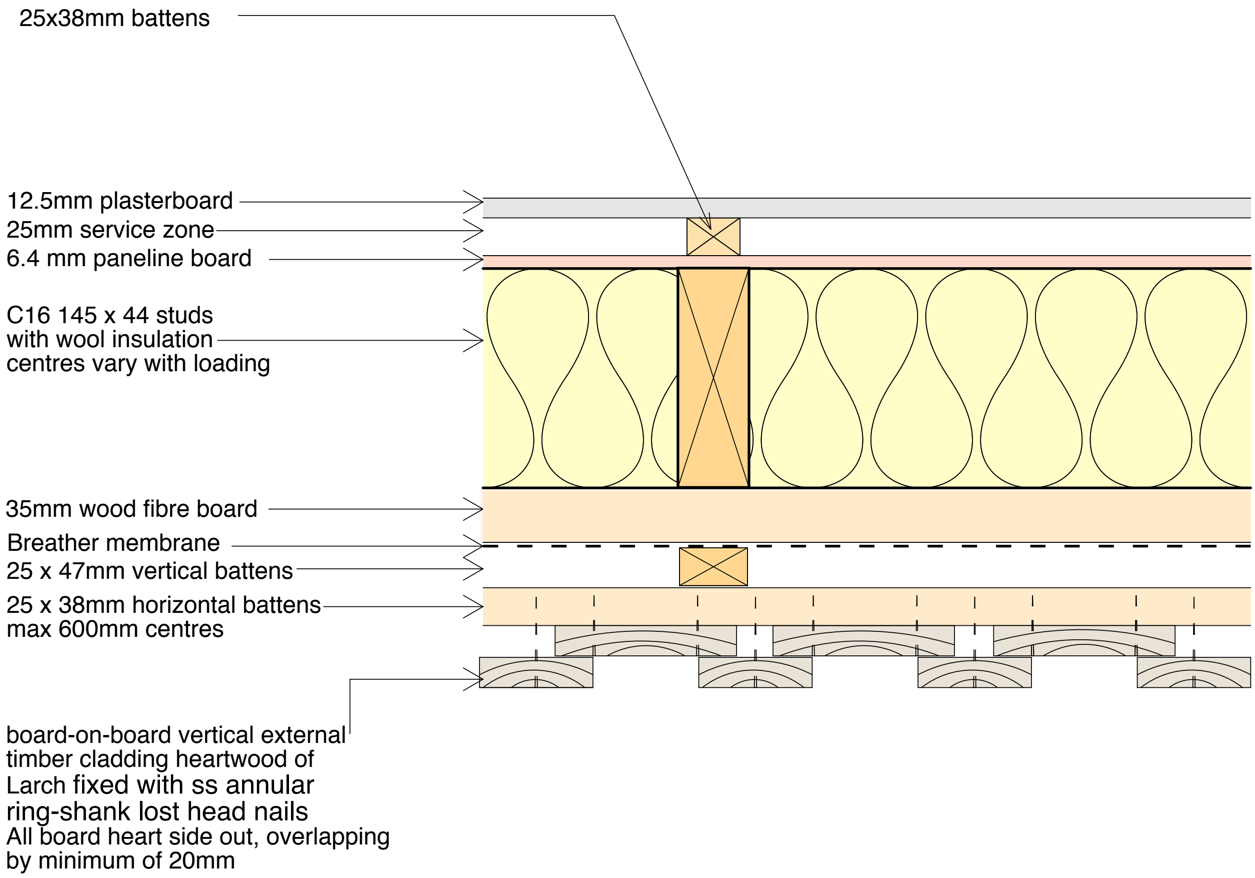
Title
ENHANCED
EXTERNAL WALL DETAIL PLAN

Rev	Alteration	Date

Project: Perthshire HA

Job No	Scale	
02770	1:5	
Date	Drawn by	Size
Mar 06	JG	A4
Drg No		Rev
[21]11		A



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Title

ENHANCED (HIGH THERMAL MASS)

EXTERNAL WALL DETAIL PLAN

Rev	Alteration	Date

Project: Perthshire HA

Job No: 02770

Scale: 1:5

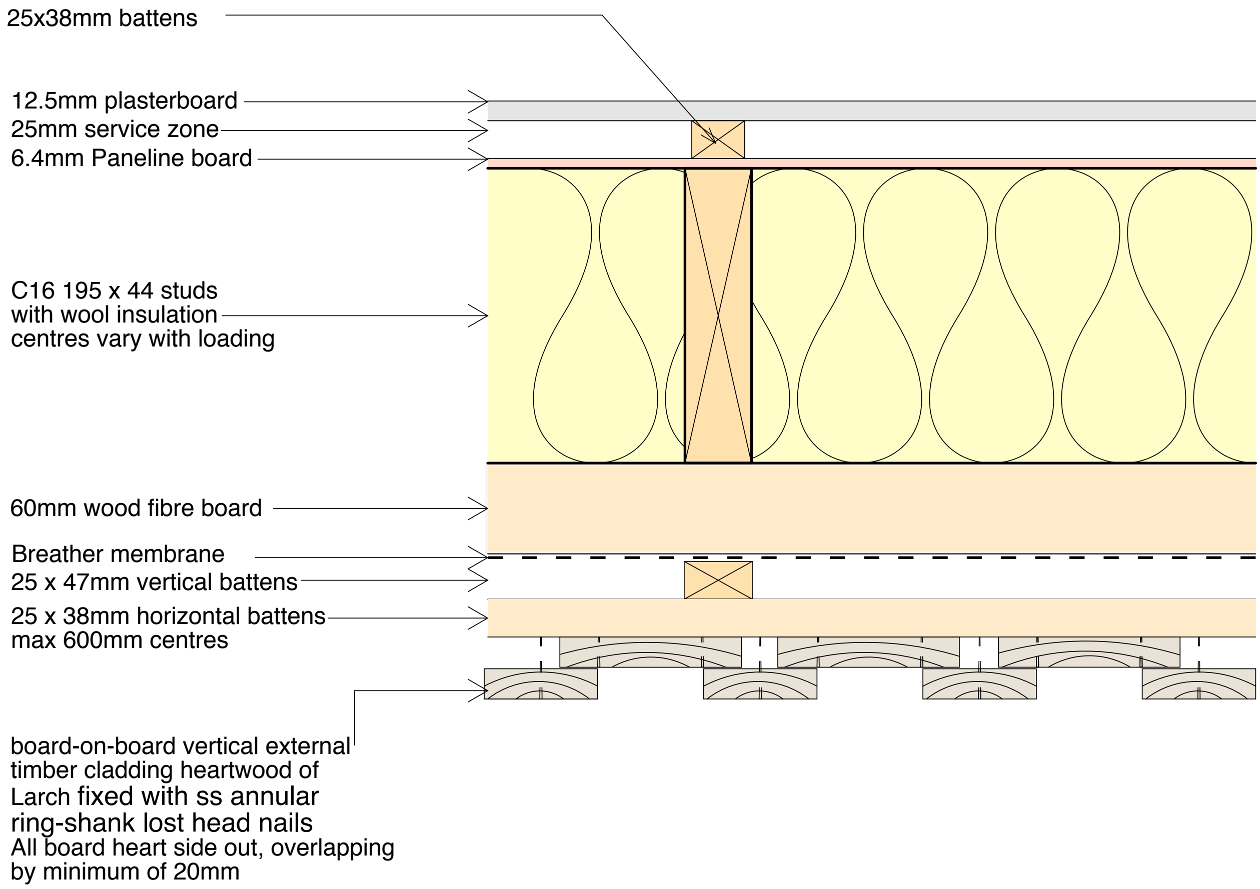
Date: Mar 06

Drawn by: JG

Size: A4

Drg No: [21]12

Rev:



The wood fibreboard idoes not contain any glue
or wood preservatives and is made to DIN 68755 Part 1.
The board is made in two bonded densities, one at 160Kg/m3
and the outer part at 250Kg/m3

***

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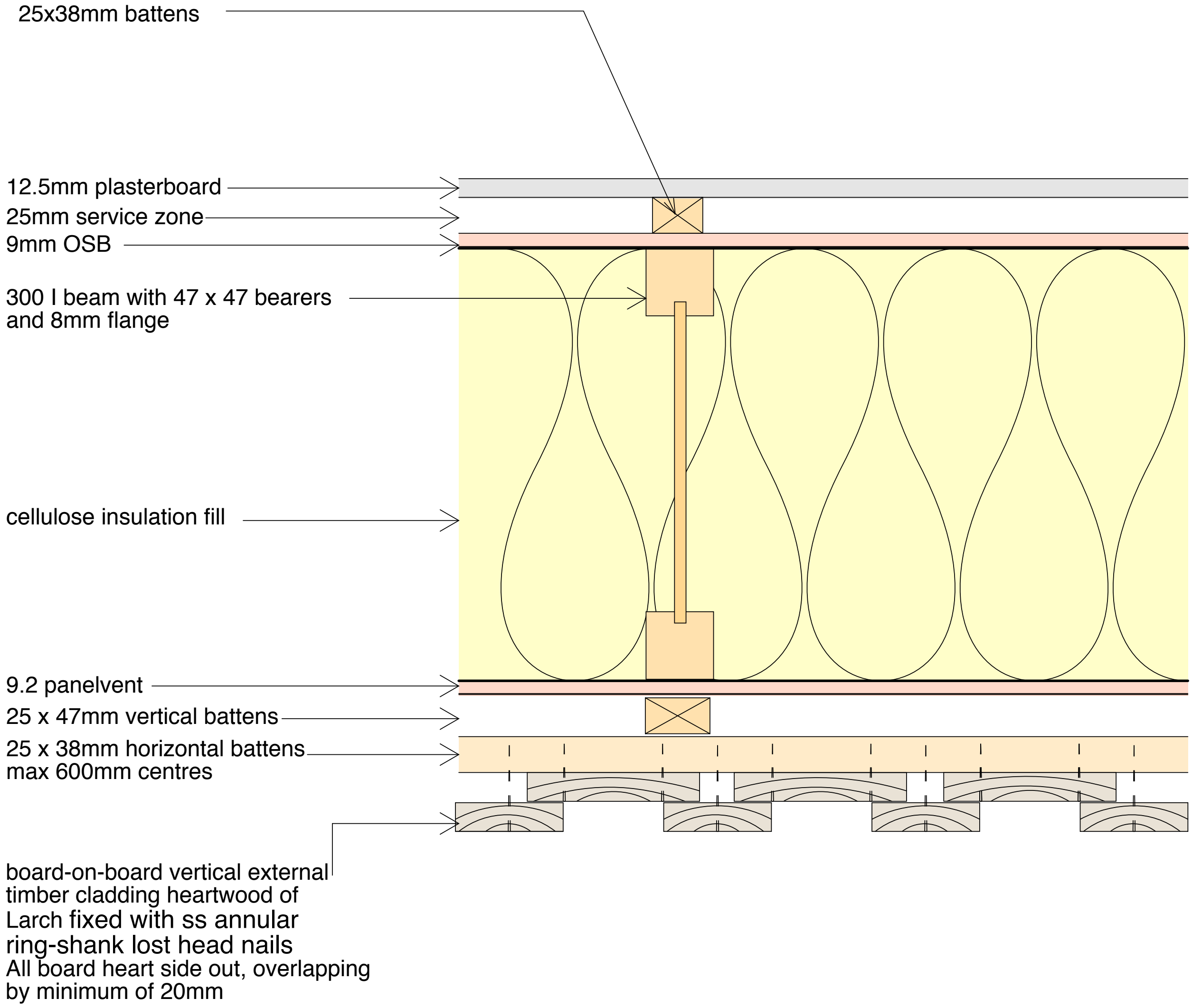
Title
TIMBER HIGH INSULATION
EXTERNAL WALL DETAIL PLAN

Rev	Alteration	Date

Project: Perthshire HA

Job No	Scale	
02770	1:5	
Date	Drawn by	Size
Mar 06	JG	A4
Drg No		Rev
[21]13		



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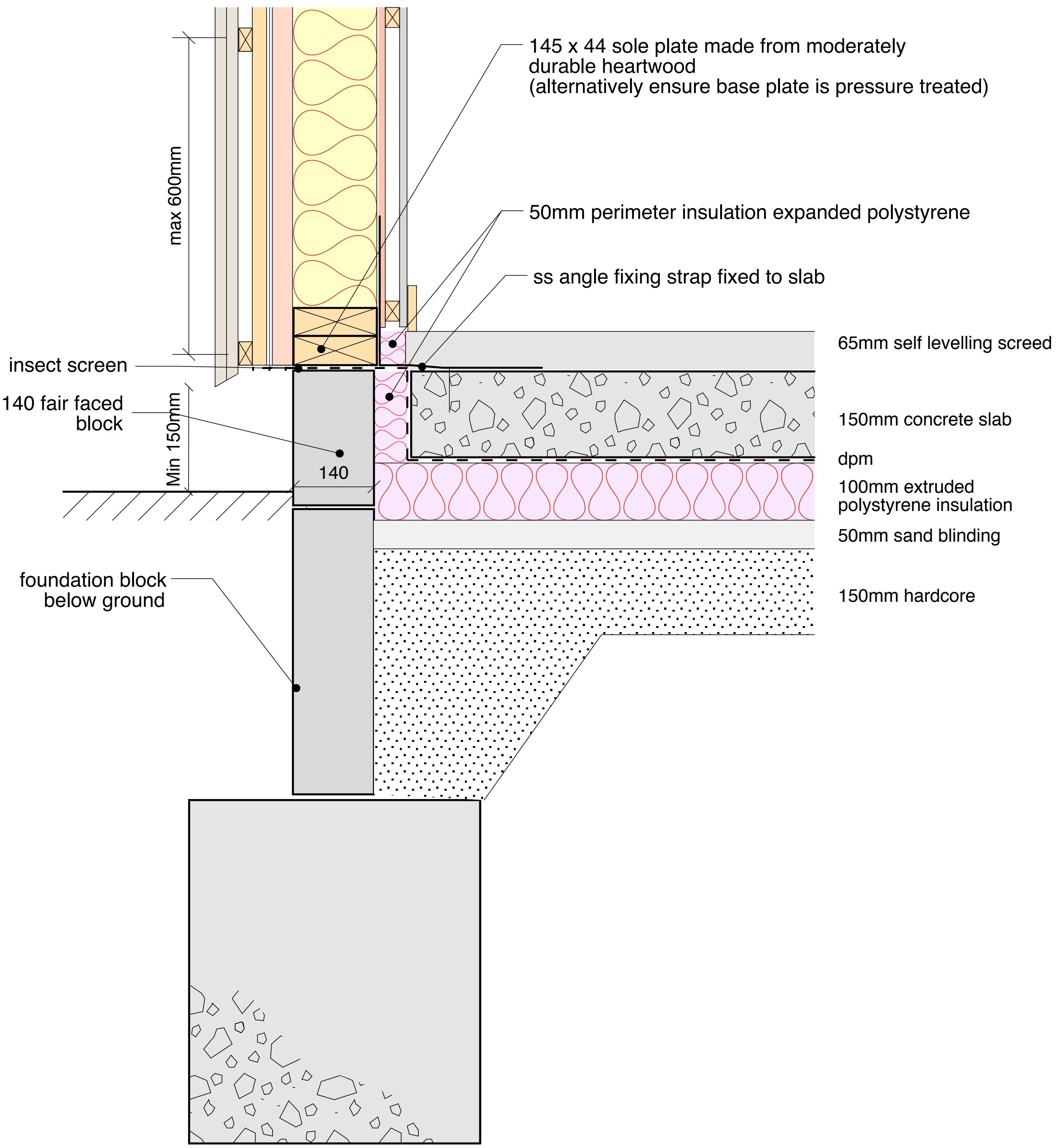
Title: ZERO EMISSIONS
EXTERNAL WALL DETAIL PLAN

Rev	Alteration	Date

Project: Perthshire HA

Job No	Scale	
02770	1:5	
Date	**Drawn by**	**Size**
Mar 06	JG	A4
Drg No		**Rev**
[21]14		



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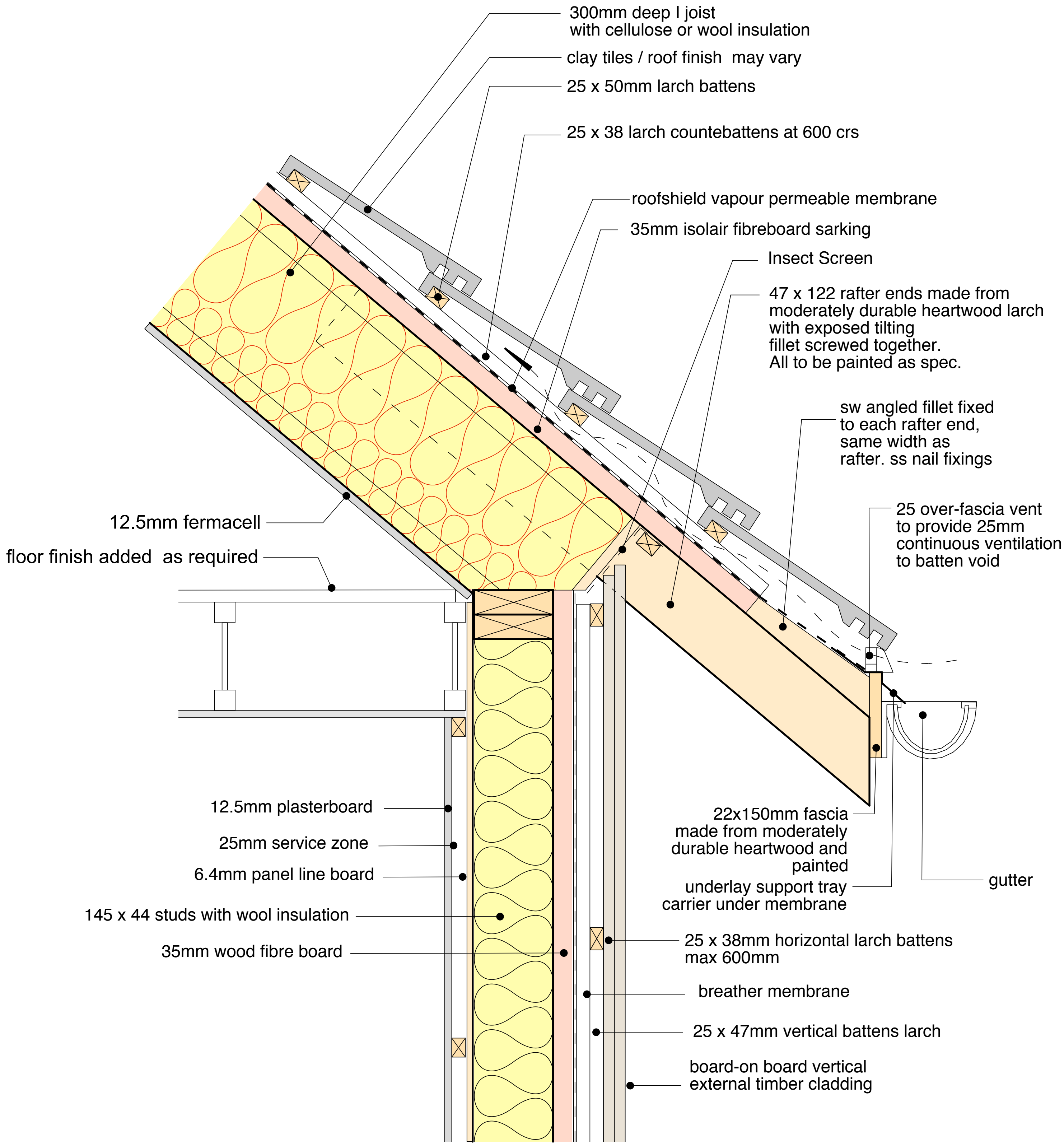
Title

GROUND SLAB WITH SOLID FLOOR ENHANCED HIGH THERMAL MASS

Project	Perthshire HA	
Job No 02770	Scale 1:10	
Date May 06	Drawn by NM	Size A4
Drg No [18]02		Rev

Rev	Alteration	Date



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Title

EAVES DETAIL
ENHANCED (HIGH THERMAL MASS)

Rev	Alteration	Date
A	Varies amendments.	080605

Project		
Perthshire HA		
Job No: 02770	Scale: 1:10	
Date: Dec 04	Drawn by: NM	Size: A4
Drg No: [37[01		Rev: A

Contacts and Suppliers

The authors in compiling this report have used the contacts below. This list is not intended to be exhaustive and no comment is made by inclusion or omission from this list.

Grant Making Organisations Contacts

Energy Saving Trust (EST)
112/2 Commercial Street
Leith
Edinburgh EH6 6NF

Telephone: 0131 555 7900

Makes grants for the installation of low energy features such as wood burning stoves and solar water heating panels.

Supplier Contacts

Timber Suppliers

For timber advice and suppliers of sustainable Scottish timber products see: www.forestry.gov.uk/ or www.ukfpa.co.uk/

Russwood Ltd,
Station Sawmill
Newtonmore PH20 1AR

01540 673 648

http://www.russwood.co.uk/

James Jones & Sons Ltd.
Greshop Industrial Estate
Forres
Moray IV36 2GW

01309 671111

www.jji-joists.co.uk

Wood fuel suppliers

Buccleuch BioEnergy
Computer House
Dalkeith Country Park
Dalkeith
Edinburgh EH22 2NA

0131 561 5000

www.buccleuch-bioenergy.com

Arbuthnott Wood Pellets Ltd
Arbuthnott, Laurencekirk
Kincardineshire
AB30 1PA

01561 320 417
info@hotstovies.com

The Scottish Stove Centre
63 Main Street
Croftamie
Glasgow G63 0EU

01360 661112

Clearview Stoves
More Works
Bishops Castle
Shropshire SY9 5HH

01588 650401

www.clearviewstoves.com

SunDOG Energy Ltd
Matterdale End
Penrith CA11 0LF

01786 482 282

www.sundog-energy.co.uk

Second Nature UK Ltd
Soulands Gate
Dacre
Penrith CA11 0JF

01768 486 285

www.secondnatureuk.com

Wind and Sun Ltd
Humber Marsh
Stoke Prior
Leominster
Herefordshire HR6 0NR

01568 760671

www.windandsun.co.uk

Nu-aire
Western Industrial Group
Caerphilly CF83 1NA

08705 121 400

www.nuaire.co.uk

Ecos Organic Paints
Unit 19, Heysham Business Park
Middleton Rd
Heysham
Lancs LA3 3PP

Tel 01524 852 371

www.ecospaint.co.uk

Nutshell Natural Paints
3 Leigham Units
Silverton Road
Matford Park
Exeter
Devon EH2 8HY

01392 823 760

www.nutshellpaint.co.uk

Green Building Store
Heath House Lane
Golcar
Huddersfield HD7 4JW

01484 461 705

info@greenbuildingstore.co.uk