OFF-GRID MICRO DWELLING

General information

The off-grid micro dwelling presented in this case study is to form part of a community of huts or bothies at Cash Strip Wood in Falkland Estate. The full project proposes the construction of 15 off-grid micro dwellings and the creation of an attractive, well designed and accessible development[1].

The building analysed hereafter is the pilot and was constructed by Quercus in 2018, in order to provide a prototype for people interested in constructing their own.

The project is related to the 'Thousand Huts Campaign'[2], which aims to revitalise the culture of hutting in Scotland in response to growing demand and a supportive policy pursued by the Scottish Government. According to the Scottish Planning Policy (SPP), the definition of a hut is as follows:

'A simple building used intermittently as recreational accommodation (ie. not a principal residence); having an internal floor area of no more than 30m^2; constructed from low impact materials; generally not connected to mains water, electricity or sewerage; and built in such a way that it is removable with little or no trace at the end of its life. Huts may be built singly or in groups.'

LOCATION	Cash Strip Wood, Falkland Estate, Scotland
YEAR	2018
PARTNERS	Centre for Stewardship, Studio Baird, Urban Animation, Quercus, Edinburgh Napier University (ENU)

Off-grid micro dwelling (image by Ninian Stuart)

Project description

The combined footprint of the proposed 15 huts would be approximately 250m^2, clustered in four informal groups throughout the wood strip.

The huts would be of three different sizes, with a defined number of huts for each size:

- 4 small huts of 9.36 m^2 internal area
- 5 medium huts of 16.32 m^2 internal area
- 6 large huts of 22.26 m^2 internal area

Momentarily set on an existing precast concrete paving slab located at the borders of the wood, the pilot has a floor area of 19.3 m^2 with a further 1.9 m^2 for the toilet, 3.4 m^2 in the sleeping loft and 14m^2 of deck area.

When situated in the wood the micro dwelling will be placed on to a ground beam structure situated on top of larch poles sunk into the ground or rock foundations that can be easily removed should the building be disassembled.

The main structure is formed from a larch timber frame system sourced entirely from the Estate and is insulated with natural materials.

The Cash Strip Woodland is a place of retreat and the

[1] *Design Statement: 'Change of Use from Woodland to Hutting (15 Huts) at Cash Strip Wood' by Falkland, Fife*
[2] *http://www.thousandhuts.org/*

building will be used intermittently throughout the year for recreational purposes.

As prescribed by the Scottish Planning Policy, the pilot off-grid micro dwelling is constructed with low impact materials and is completely off-grid, with no connection to mains water, electricity or sewerage. Water will be accessed via a communal standpipe, optional PV cells can be used to generate low voltage electricity and sewage will be dealt with using a composting toilet within the hut.

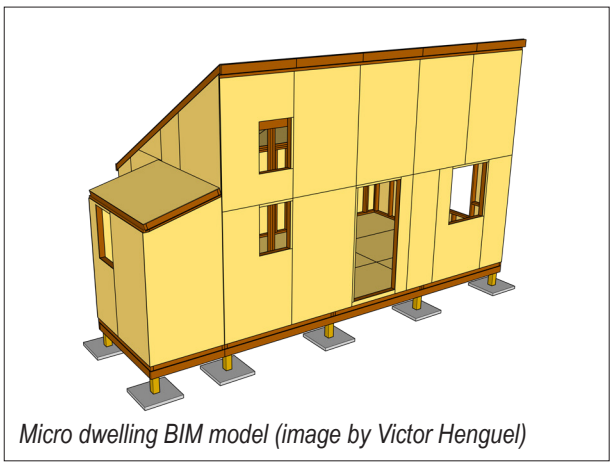
Organic waste will be composted on site, while recyclable and non-recyclable waste will be removed and disposed of through the owner's own domestic waste collection service.

Timber system

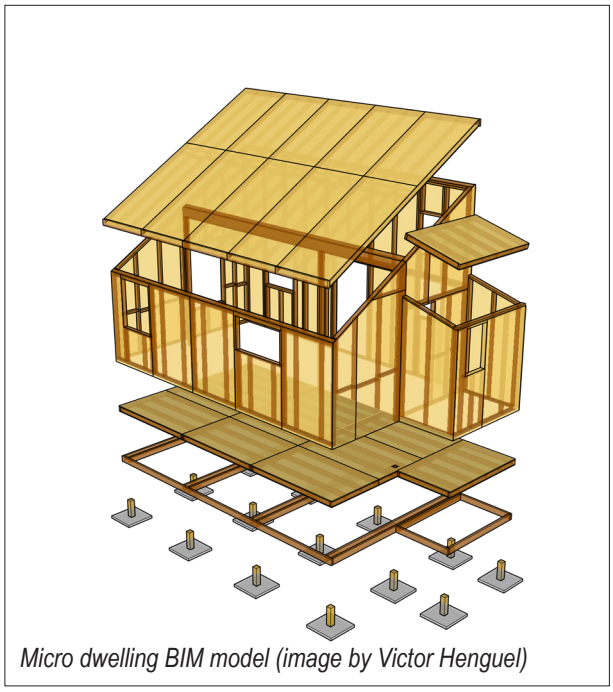
The larch material from the estate that was used to form the hut was processed using machinery and facilities already present locally. A "pop-up" micro-factory was implemented to manufacture the panels near to site for ease of erection.

The wall panels are formed of 9 mm OSB3 to inner face and 15mm Panelvent to outer face with an internal layer of sheep's wool insulation. The roof panels have the same layout, with the addition of a 9mm plywood ceiling finish. For weather protection a breather membrane is applied to the external sheathing which is then clad with larch vertical batten on board; the roof is covered with corrugated black "onduline" sheeting (a lightweight bituminous roofing system).

The structure was originally designed using C16 as a reference grade for the structural properties of the larch. C16 is the grade classification assigned to the majority of structural timber available in the UK. ENU has however presented a bespoke class C16+ on the basis that it best fits UK-grown timber properties.



Micro dwelling BIM model (image by Victor Henguel)



Micro dwelling BIM model (image by Victor Henguel)

Design for Assembly

The pilot project has demonstrated that for efficiency prospective "hutters" could be provided with a pre-manufactured kit comprising all the elements necessary for the panels and give them the necessary training to assemble them.

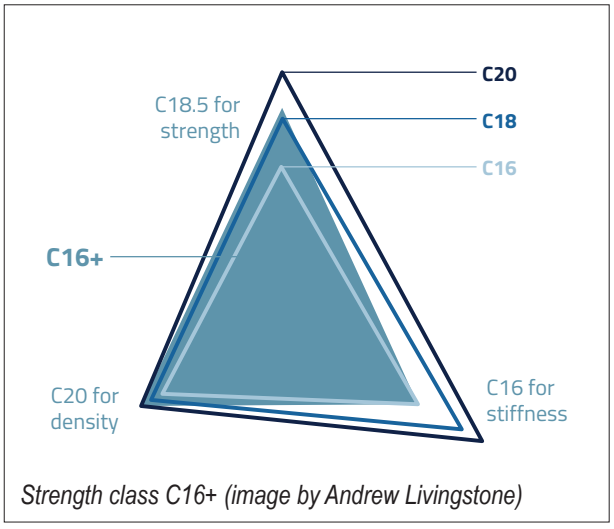
The panels themselves could additionally be pre-formed in a manner that they weigh less than 50kg allowing manual handling in-situ by two people for ease of erection. Follow on tasks would include applying the insulation and external and internal linings. However, this would be relatively straightforward with clear method statements allowing un-skilled operatives to erect their own hut safely without the need for a power supply.

Research focus

Material categorisation and system optimisation

ENU researchers undertook a comparative study between the originally designed configuration using standard grade C16 for the structural timber and an optimised configuration using bespoke strength class C16+. This parametric analysis provides an insight into the potential savings and benefits of using homegrown timber belonging to this bespoke class.

Timber grading is determined by three key properties of the material, namely bending strength, stiffness and density. According to the values that these properties have, the timber section is assigned to a class the limits of which have been defined by regulation and reflect the properties of the majority of species normally used for construction.



Strength class C16+ (image by Andrew Livingstone)

For many of UK-grown timber species, the values of the three key properties are not evenly distributed and don't fall all in the same grading band; in particular, it is the stiffness that usually limits the timber to class C16, while the bending strength and the density are actually higher than the grading limits (see figure 'Strength class C16+').

The bespoke class C16+ was introduced to best fit UK-grown timber properties and take into consideration its enhanced characteristics[3].

For the purposes of the research conducted on the pilot off-grid micro dwelling, a digital Building Information Model was created and the structure was re-calculated using C16+ grade characteristics. This analysis optimised further the design specification in order to improve the utilisation of resource demonstrating material savings.

The structural utilisation on average is a 10% uplift, as a result of the enhanced C16+ material characteristics.

	Optimised design using C16 customised section sizes	Optimised design using home grown C16+ customised section sizes	
	utilisation	utilisation	uplift
roof rafter	1.0	0.863	13.7 %
roof beam	1.0	0.910	9.0 %
floor joist	1.0	0.964	3.6 %
ground beam	1.0	0.865	13.5 %

Key findings

- Pre-manufacturing of components for small scale projects simplifies the on-site assembly process for un-skilled operatives
- Specifying C16+ as a timber grade for homegrown resource improves material utilisation
- The creation of a 3D digital models facilitates a design for manufacture and assembly approach.

[3] *Ridley-Ellis, D., Derivation of GoldenEye-702 grading machine settings for British Spruce. 2014, Report for CEN TC124/WG2/ TG1: Edinburgh Napier University.*