# Project Documentation
# Gebäude-Dokumentation

## 1 Abstract / Zusammenfassung

**‘Geanaisean’ Private Home, Strathpeffer, Scottish Highlands**

### 1.1 Data of building / Gebäudedaten

| | | | |
|---|---|---|---|
| Year of construction/ Baujahr | 2019 | **Space heating / Heizwärmebedarf** | **15 kWh/(m²a)** |
| U-value external wall/ U-Wert Außenwand | 0.102 W/(m²K) | | |
| U-value floor slab U-Wert Kellerdecke | 0.071 W/(m²K) | **Primary Energy Renewable (PER) / Erneuerbare Primärenergie (PER)** | 145 kWh/(m²a) |
| U-value roof/ U-Wert Dach | 0.101 W/(m²K) | **Generation of renewable energy / Erzeugung erneuerb. Energie** | 69 kWh/(m²a) |
| U-value window/ U-Wert Fenster | 0. 86 W/(m²K) | **Non-renewable Primary Energy (PE) / Nicht erneuerbare Primärenergie (PE)** | 62 kWh/(m²a) |
| Heat recovery/ Wärmerückgewinnung | 90.3 % | Pressure test $n_{50}$ / Drucktest $n_{50}$ | 0.34 h-1 |
| Special features/ Besonderheiten | Solar thermal hot water panels, PV panels, electric car charging point, rainwater harvesting system | | |

## 1.2 Brief Description

# Geanaisean Passive House, Strathpeffer, Highlands

'Geanaisean' is a certified Passivhaus situated in the village of Strathpeffer in the Scottish Highlands at an altitude of 105m above sea level.

The house is built in the garden ground of a former bungalow, which was derelict beyond repair. The site has good solar access to the south side, and is partially shaded by native woodland to the east and north-east.

The house was built using locally-grown untreated timber in an off-site panelised process which enabled the building to be erected within days on site using a crane. The off-site process allowed careful air-tightness detailing to happen in a dry, warm factory setting, leaving fewer junctions to be dealt with on site.

Insulation is by way of blown cellulose and woodfibre – demonstrating a fully vapour-open construction system, which is beneficial to the internal environmental quality for the occupant, as well as to the planet. Use if membranes was avoided as far as possible, with OSB board utilised as the air-tightness layer, taped at junctions.

The client was aware of the Passivhaus standard, and understood its benefits from the start. In addition, renewables were used to further reduce energy impact of the building and its reliance on the grid.

## 1.3 Responsible project participants / Verantwortliche Projektbeteiligte

| | |
|---|---|
| Architect/<br>Entwurfsverfasser | Catriona Kinghorn, for MAKAR Ltd<br>https://makar.co.uk/ |
| Implementation planning/<br>Ausführungsplanung | Catriona Kinghorn for MAKAR Lyd.<br>https://makar.co.uk/ |
| Building systems/<br>Haustechnik | Catriona Kinghorn, MAKAR Ltd.<br>https://makar.co.uk/ |
| Structural engineering/<br>Baustatik | SF Structures<br>https://www.sfstructures.com/ |
| Building physics/<br>Bauphysik | Catriona Kinghorn, MAKAR Ltd.<br>https://makar.co.uk/ |
| Passive House project planning/<br>Passivhaus-Projektierung | Catriona Kinghorn, MAKAR Ltd.<br>https://makar.co.uk/ |
| Construction management/<br>Bauleitung | MAKAR Ltd.<br>https://makar.co.uk/ |

| | | |
|---|---|---|
| Certifying body/<br>Zertifizierungsstelle | Passivhusbyrån Ingo Theoboldt<br>http://www.passivhusbyran.se/ | |
| Certification ID/<br>Zertifizierungs ID | Project-ID (www.passivehouse-database.org)<br>Projekt-ID (www.passivehouse-database .org) | 6865 |

| | |
|---|---|
| Author of project documentation /<br>Verfasser der Gebäude-Dokumentation | Catriona Kinghorn |
| Date, Signature/<br>Datum, Unterschrift | |

# 2 Photographs

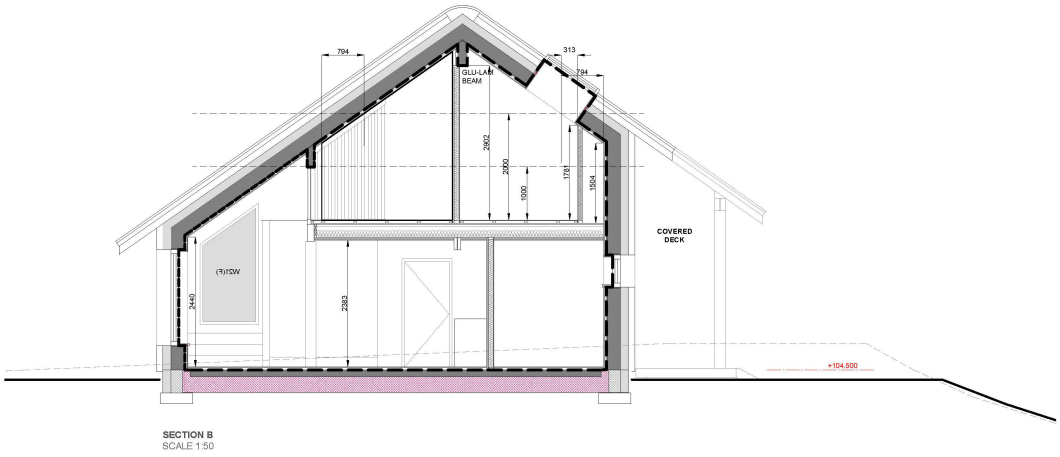
South Elevation

East and North Elevations

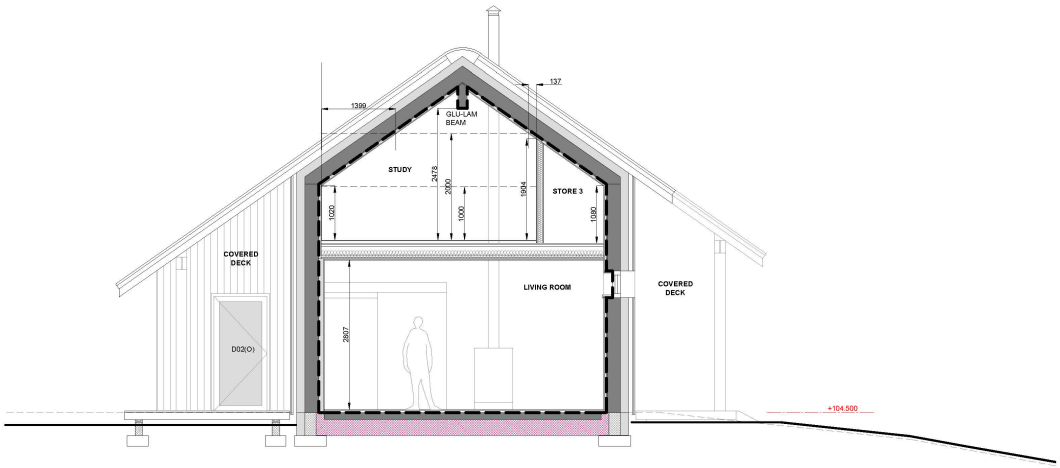
West Elevation

Typical internal view – from kitchen to living space on left and dining space on right

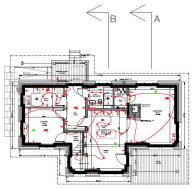
# 3 Section Drawing




SECTION B
SCALE 1:50




SECTION A
SCALE 1:50

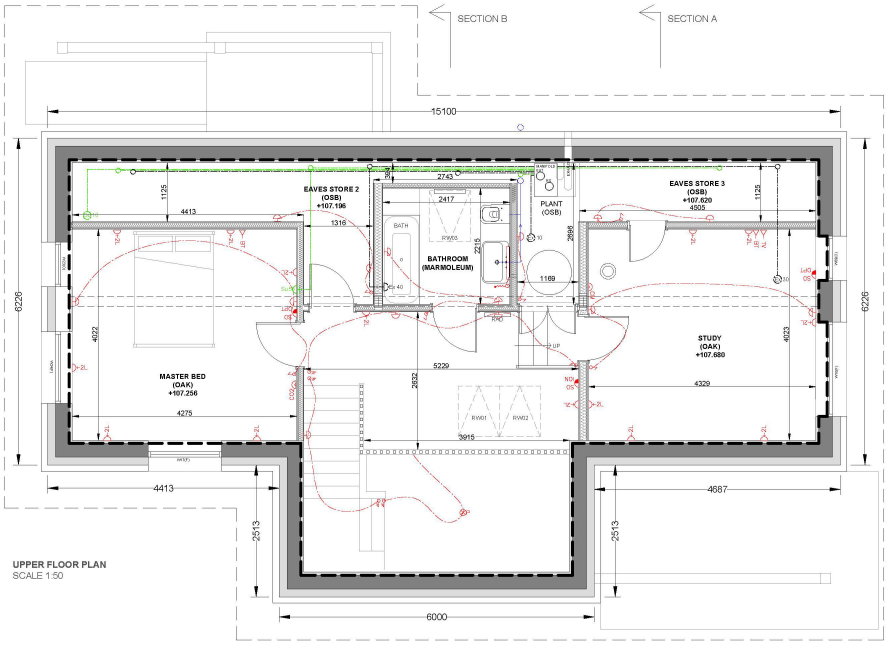


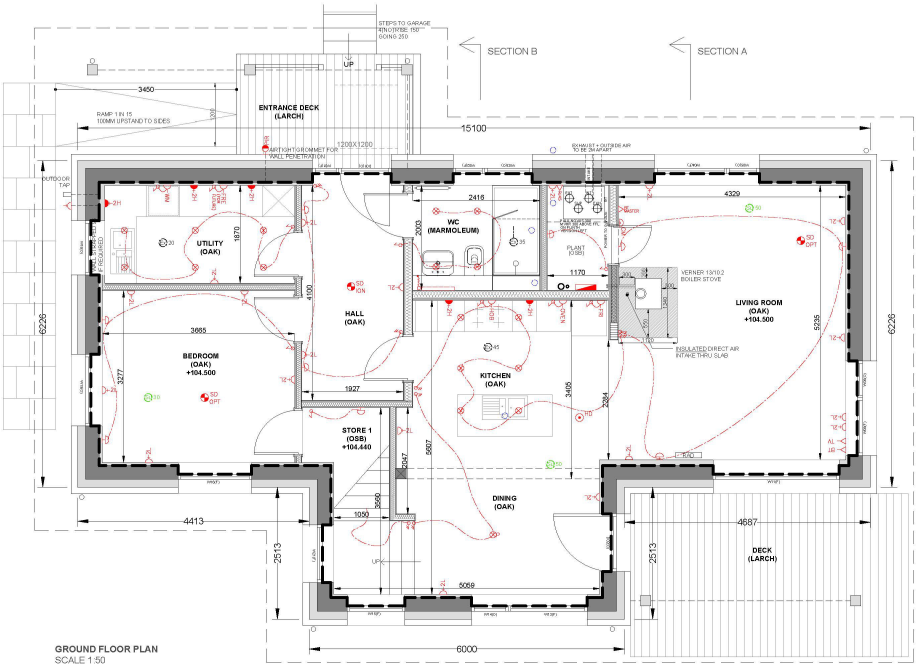

TFA = 135.84

MAKAR LTD
Incorporating Neil Sutherland Architects
Clachandreggy, Dores Road
Inverness, Scotland, IV2 6DJ
T: 01463 709 993
E: info@makar.co.uk
NOTES
DO NOT SCALE DRAWING
REVISIONS
PROJECT
NEW PASSIVE HOUSE DAWSON
CLACHANDREGGY, DORES ROAD
STRATHFARRER, IV14 8AZ
DRAWING
CROSS SECTIONS
PROJECT NO
1396-18
DRAWING NO
PH 2.4
DRAWING ISSUED FOR: PASSIVE HOUSE CERTIFICATION

Two Cross Sections (dimensioned)

# 4 Floor Plans



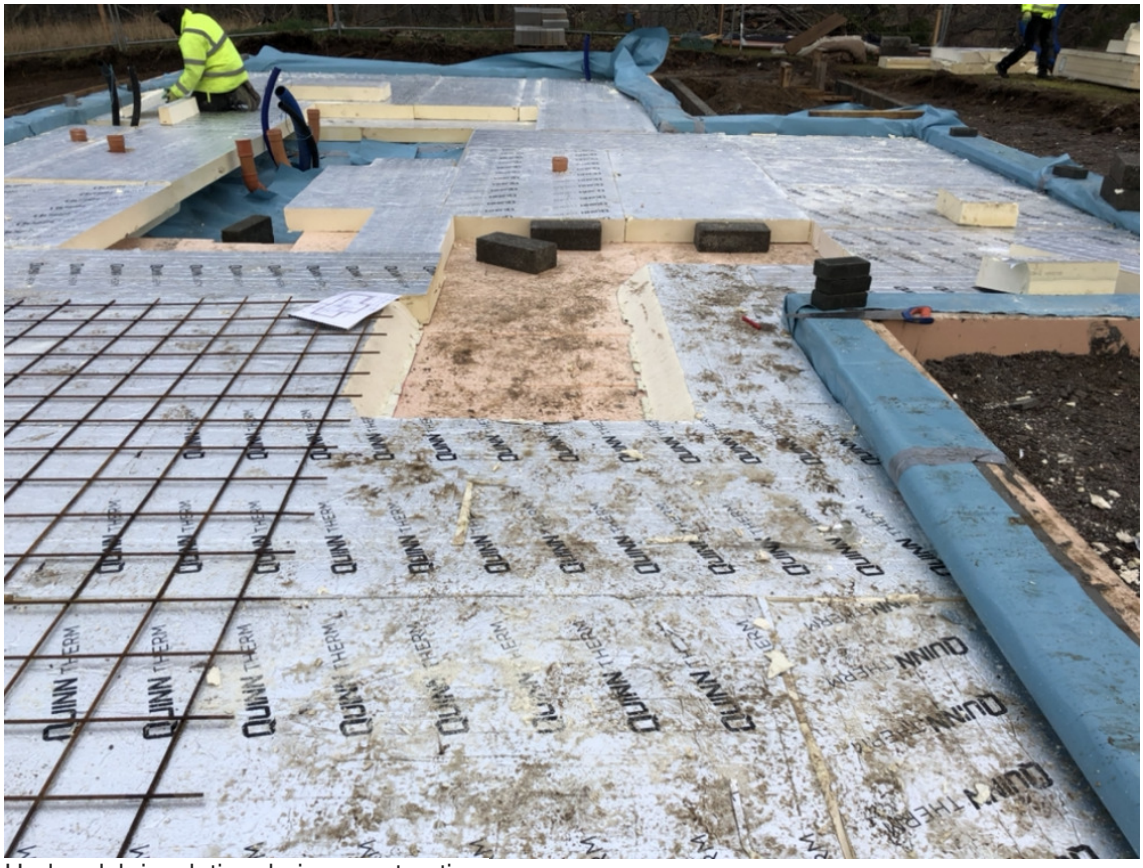


TFA = 135.84

Floor Plans (dimensioned)

# 5 5.1 Floor Slab

Hardwood floor finish on 45 mm battened service zone, on 125 mm reinforced concrete slab, on slip membrane, on 300 mm Quinn Therm ground floor insulation, on 1200 g DPM, on 150 mm sand blinded hardcore. Perimeter load bearing Thermalite Aircrete Trenchblock insulated externally with NBT plinth board. U-value: 0.071 W/m2k




Under-slab insulation during construction.

## 5.2 Exterior Walls

150x25 mm vertical board-on-board heartwood larch cladding on 38x50 mm horizontal battens, on 25x50 mm vertical battens, on prefabricated wall panel comprising: 180 mm Pavatex Isolair insulation board on C16 kiln-dried regularised untreated 245 mm studs with cellulose insulation, with 18 mm OSB 3 internal lining board as airtight layer taped at all junctions. Internally there is a 45 mm battened service zone insulated with Pavaflex wood fibre insulation, finished with 12.5 mm plasterboard, taped and filled. U-value: 0.091 W/m2k


Wall panel during factory construction with all cavities filled with Warmcel cellulose insulation (Panel uncovered for photograph, typically Warmcel pumped to a density of 65kg/m³ to meet requirements for off-site transportation).

## 5.3 Roof

Anthracite grey big six profile metal roofing on 50x50 mm battens, on 120x50 mm Douglas fir secondary rafters screwed to prefabricated roof panel comprising: Roofshield membrane on 180 mm Isolair wood fibre insulation, on 245 mm C16 kiln-dried regularised untreated rafters with cellulose insulation, lined internally with 18 mm OSB 3 airtight layer, all junctions taped. 45 mm internal service zone insulated with Pavaflex wood-fibre batts. 12.5 mm plasterboard internally, taped and filled. U-value: 0.090 W/m2k


Roof during construction

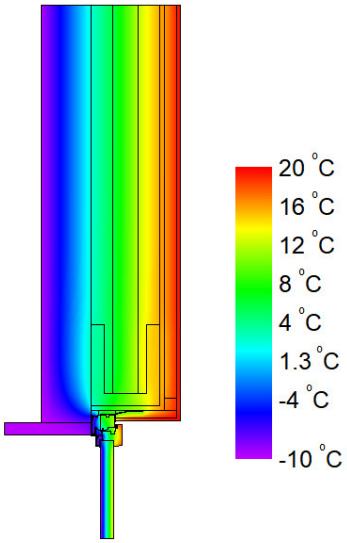
## 5.4 Windows and Doors

Internorm HF310 aluminium/timber composite triple glazed windows. Average installed U value average: 0.80 W/m2k

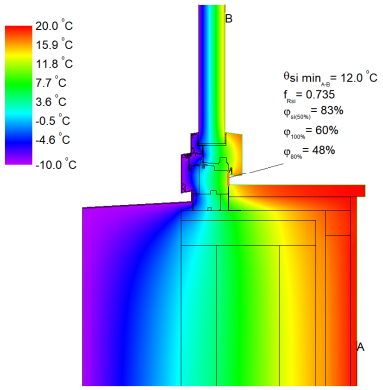
Windows and doors installed in panels in the off-site factory, with OSB panelled ingoes, taped at all junctions to create an airtight opening. Taped junction to all 4 sides of the window frame completes the air-tight installation. Externally the woodfibre board covers the front face of the frame, completing the thermal envelope. Detail section shown on following pages.

Frame
Uf: 0.86 W/m²K
Frame width: 0.780 m
Glazing edge thermal bridge: 0.036 W/mK
Installation Ψ 0.020 – 0.036 W/mK
Glazing
Type: Internorm 33U Iso SolarXPlus
g-Value: 0.59
Ug:  0.54 W/m²K

Internal view of Internorm door and sidelight.




Psi(top,A,rev.) = 0.020 W/(m·K)




18/09/2018
D:\Passivhusbyrån\Makar - Dawson House\TB\Window_cill_optionA_20180910_fRsi.flx

2

flixo pro 7.0.633.1

Windows top and cill therm model

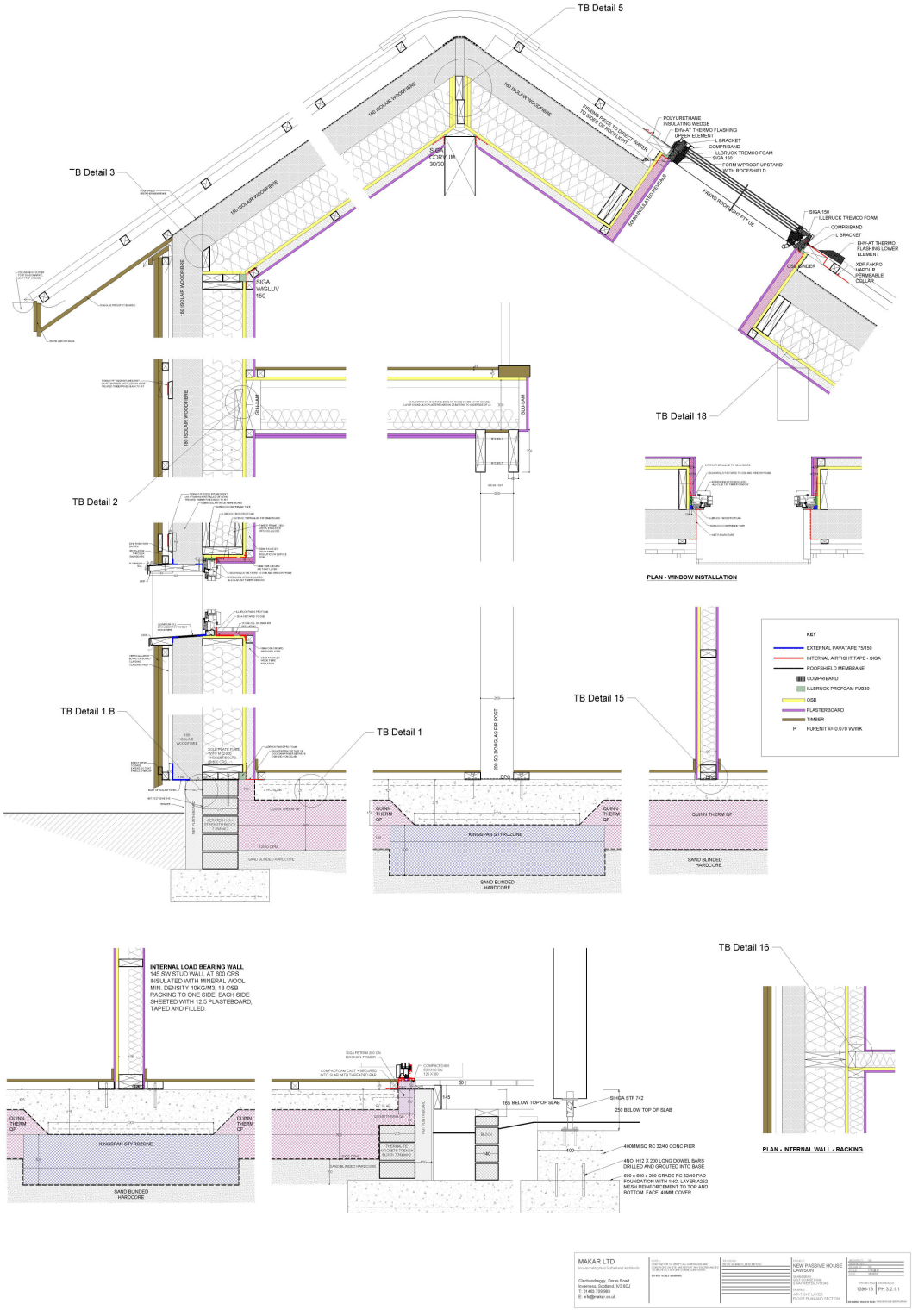
# Rooflights

Fakro FTT U8 Thermo triple glazed roof windows. Average installed U-value: 0.94 W/m2k

Rooflights installed in a similar way to the windows – with airtight taped installation internally and insulated Fakro flashing completing the external thermal envelope.

Frame
Uf: 1.08-1.10 W/m²K
Frame width: 0.092 – 0.112 m
Glazing edge thermal bridge: 0.034 – 0.037 W/mK
Installation Ψ 0.040-0.050 W/mK
Glazing
Type: Fakro Quadruple
g-Value: 0.55
Ug:  0.51 W/m²K

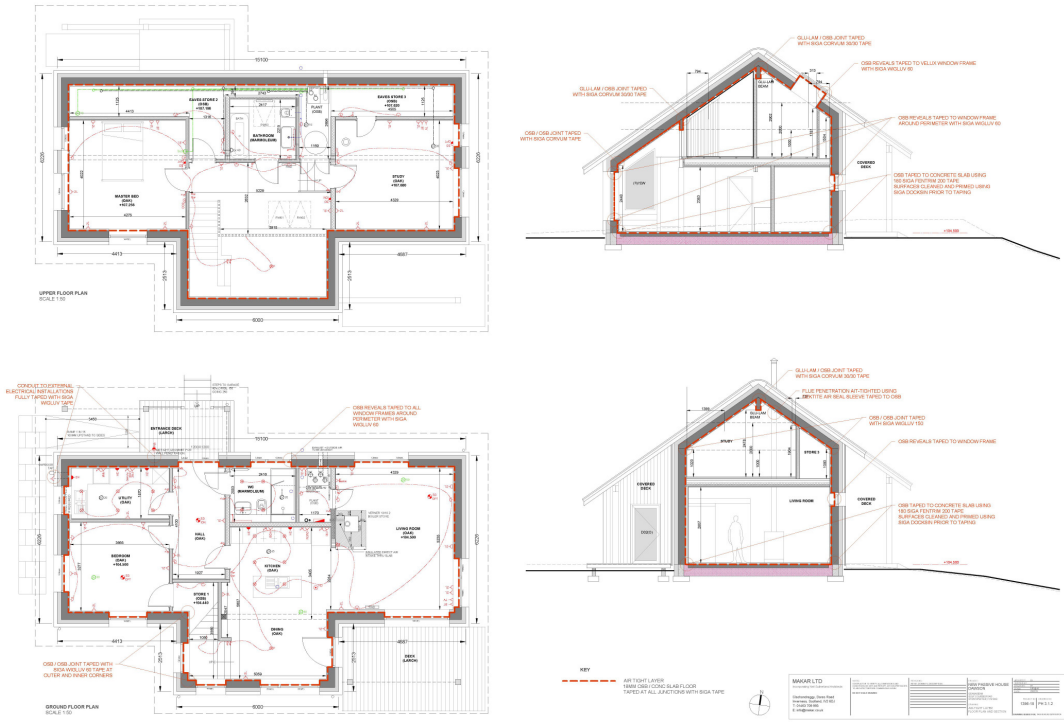
Internal view of Fakro rooflights



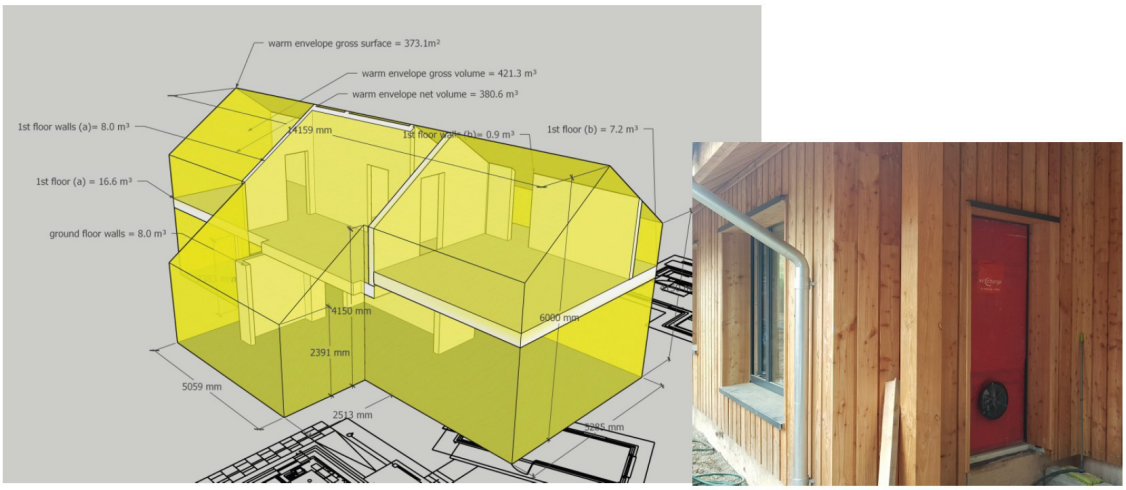

Details through typical cross section

# 6 Air-tight envelope

The air-tight envelope is formed on the inside face of the timber kit using 18mm OSB , taped at all junctions to the walls and roof. The concrete slab forms the floor air-tight layer. Specialist SIGA tape junctions the OSB walls to concrete floor slab.
All openings are taped including windows, doors, supply and exhaust vents, and any through-the-floor drains.
The house was air tested mid-build, once the OSB envelope was complete but prior to battening for services or installing dry lining board. Minor leaks found at this time were sealed in order to achieve <0.4ach. At completion the air-tightness test achieved 0.34ach. All air tests were carried out by Jamie Reid, director of Air Tight Build.
The section below shows the air-tight layer and key junctions.



Air-tightness envelope in plan and section



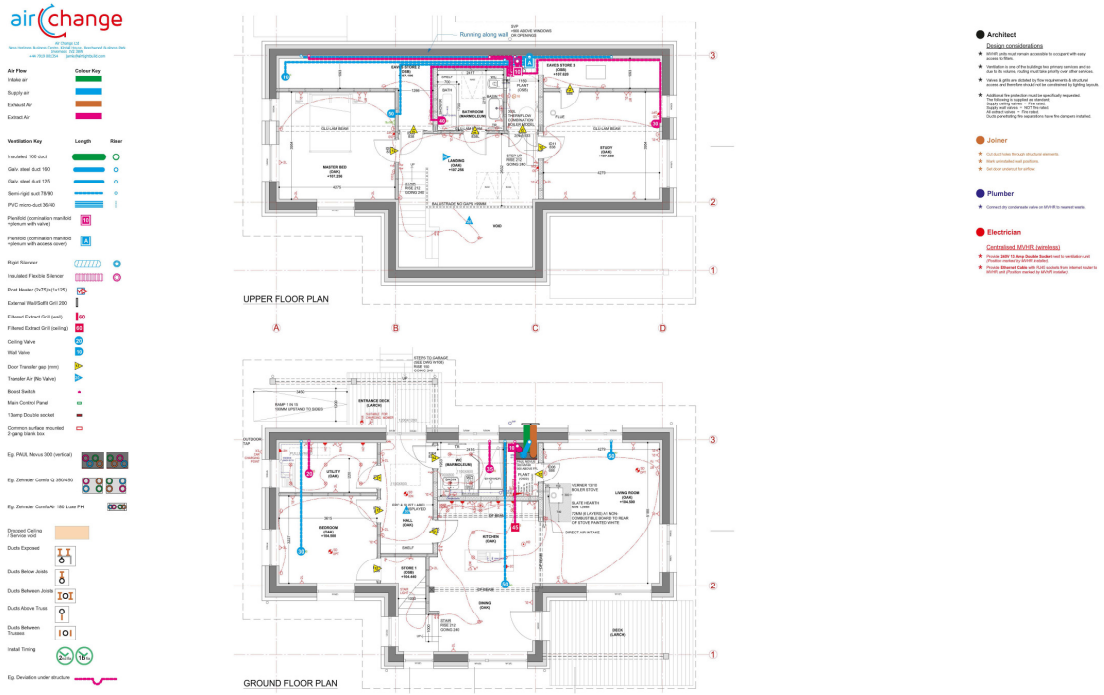

Extract from air-tightness test report

Taping to junctions of OSB and windows at first floor

# 7 7.1 Ventilation ductwork

The exhaust and intake through-the-wall vents are located on the north facing external wall. The eaves space on the north side is utilised to move the internal MVHR ductwork east and west, with the service zone in the roof, and the depth of the intermediate floor to move the ducts north and south – all inside of the air-tight and insulated envelope.

1080 MKR dawson D1




Extract from ventilation system design pack

# 7.2 Central Unit

The ventilation unit is a Paul Novus 300 with an effective heat recovery efficiency of 90.3%. Specific efficiency is 0.24 Wh/m³

Verner stove in living room, with Paul MVHR unit visible in plant cupboard in background.

# 8 Heat supply system

Space heating is provided by way of a wood burning stove, which feeds a back boiler and large thermal store. Solar thermal panels contribute to the thermal store, and PV panels automatically feed the electric immersion.
Two radiators are fed from this system, one on each floor.

Radiator in living space – which provide heat from the thermal store when the wood burner is not being used.

# 9 Main PHPP results

## Passive House Verification

| | | | |
|---|---|---|---|
| **Building:** | GEANAISEAN | | |
| Street: | GOLF COURSE ROAD | | |
| Postcode/City: | IV14 9AS | STRATHPEFFER | |
| Province/Country: | HIGHLAND | UK | |
| Building type: | NEW RESIDENTIAL HOUSE | | |
| Climate data set: | GB0018a-Aviemore | | |
| Climate zone: | 3: Cool-temperate | Altitude of location: | 105 m |
| **Home owner / Client:** | TIM DAWSON | | |
| Street: | GOLF COURSE ROAD | | |
| Postcode/City: | IV14 9AS | STRATHPEFFER | |
| Province/Country: | HIGHLAND | UK | |

| | | | |
|---|---|---|---|
| **Architecture:** | CATRIONA KINGHORN FOR MAKAR LTD | | |
| Street: | CLACHANDREGGY, DORES ROAD | | |
| Postcode/City: | IV2 6DJ | INVERNESS | |
| Province/Country: | HIGHLAND | UK | |
| **Energy consultancy:** | | | |
| Street: | | | |
| Postcode/City: | | | |
| Province/Country: | | | |

| | | | |
|---|---|---|---|
| **Mechanical system:** | AIR CHANGE LTD | | |
| Street: | NEW HORIZONS BUSINESS CENTRE, KINTAIL HOUSE | | |
| Postcode/City: | IV2 3BW | BEECHWOOD BUSINESS PARK | |
| Province/Country: | INVERNESS | UK | |
| **Certification:** | INGO THEOBOLDT | | |
| Street: | 10 GRANTON MILL PLACE | | |
| Postcode/City: | EH4 4UP | EDINBURGH | |
| Province/Country: | MID LOTHIAN | UK | |

| | | | | | |
|---|---|---|---|---|---|
| Year of construction: | 2019 | Interior temperature winter [°C]: | 20.0 | Interior temp. summer [°C]: | 25.0 |
| No. of dwelling units: | 1 | Internal heat gains (IHG) heating case [W/m²]: | 2.5 | IHG cooling case [W/m²]: | 2.9 |
| No. of occupants: | 2.8 | Specific capacity [Wh/K per m² TFA]: | 84 | Mechanical cooling: | |

**Specific building characteristics with reference to the treated floor area**

| | | | | Criteria | Alternative criteria | Fullfilled?[2] |
|---|---|---|---|---|---|---|
| | Treated floor area m² | 135.8 | | | | |
| **Space heating** | Heating demand kWh/(m²a) | 15 | ≤ | 15 | - | yes |
| | Heating load W/m² | 12 | ≤ | - | 10 | |
| **Space cooling** | Cooling & dehum. demand kWh/(m²a) | - | ≤ | - | - | - |
| | Cooling load W/m² | - | ≤ | - | - | |
| | Frequency of overheating (> 25 °C) % | 0 | ≤ | 10 | | yes |
| | Frequency excessively high humidity (> 12 g/kg) % | 0 | ≤ | 20 | | yes |
| **Airtightness** | Pressurization test result $n_{50}$ 1/h | 0.4 | ≤ | 0.6 | | yes |
| **Non-renewable Primary Energy (PE)** | PE demand kWh/(m²a) | 62 | ≤ | 120 | | yes |
| **Primary Energy Renewable (PER)** | PER demand kWh/(m²a) | 145 | ≤ | - | - | - |
| | Generation of renewable energy kWh/(m²a) | 69 | ≥ | - | - | |

[2] Empty field: Data missing; '-': No requirement

I confirm that the values given herein have been determined following the PHPP methodology and based on the characteristic values of the building. The PHPP calculations are attached to this verification.

**Passive House Classic?** yes

| Task: | First name: | Surname: | Signature: |
|---|---|---|---|
| 1-Designer | Catriona | Kinghorn | |

| Issued on: | City: |
|---|---|
| 26/11/19 | Inverness |

# 10 10.1 Construction costs

£365,000 ‘turn-key’ construction cost including design fees.

## 10.2 Building costs

The house is largely powered by PV, and heat is provided by burning wood logs sourced from the owner’s land, therefore building running costs are extremely low.

# 11 User assessment, actual consumption

Per (10.2) above, actual energy use is difficult to accurately report. For the publication linked below the owner estimated that his monthly bills are int eh region of £35/month in winter.

# 12 Existing studies, publications

Passivhaus Plus Magazine Article, Jan 2021
https://passivehouseplus.ie/magazine/new-build/highland-warrior-scottish-passive-house-built-with-innovative-local-timber-system