4 In A Block Apartment

Final Design Submission

ARCH 1280: Retrofit Technology Project

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Project 4

Performance Specification

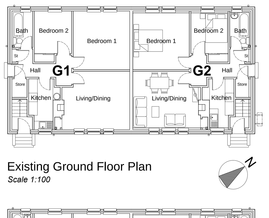
The aim of this project is to comprehensively assess the energy performance of a typical domestic dwelling and to apply optimal energy solutions to achieve a near zero energy building (nZEB). The proposed design criteria are set out as follow:

- Reduce the primary energy demand for each apartment to less than 45kWh/m²y
- Each apartment to achieve a BER of A2 using DEAP methodology.
- 60 year minimum design lifetime with an expectation of up to 100 years of use from date of retrofitting.
- Hygrothermal analysis for all building fabric elements using BuildDesk U software.
- Surface temperature/condensation risk (RSs) calculation for internal surfaces of the thermal envelope in accordance with Irish Building Regulations.
- Design stage sustainability assessment made using BREEAM metric.

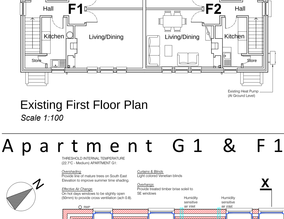
Subject Building Description

The subject building is 'four-in-a-block' typical Scottish apartment dwelling, of which there are 265 thousand in the country and 3 million of a similar design in England. This type of dwelling, where there are two flats on the ground floor and two on the first floor is one of the worst performing apartment building types both thermally and acoustically in the UK. The subject building has already been refurbished by the BRE on their site in Ravenscraig but for purposes of this project we have taken the baseline for apartment G1 and F1 in their original construction. The baseline for apartments G2 and F2 is the existing BRE retrofit.

Existing Building Plan and Baseline Specification



Existing Ground Floor Plan
Scale 1:100



Existing First Floor Plan
Scale 1:100

Apartment G1 and F1 Baseline Specification

Building Element - Fabric		Description	U-Value
Ground Floor	G1	22mm T&G Chipboard, 225x18mm Timber Joists @ 400cts. 150mm Vented Air Space, 50mm Oversite Concrete Screed	0.57
Cavity Wall		102.5mm Outer Brick, 80mm Air Cavity (Partially Ventilated), 102.5mm Inner Brick, 13mm Plaster	1.72
Ceiling/Roof	F1	Timber Truss Roof, 150x38mm Ceiling Joists @ 400cts, 100mm Mineral Wool Quilt Insulation Between Joists, 9mm Plasterboard	0.37
Windows		Wooden Framed Single Glazed. 50% Draught Stripping.	4.8
Doors		Solid Timber with Glass Panels. 50% Draught Stripping.	3
Building Element - Systems			
Ventilation		Natural Ventilation - Room Vents (3 per apartment). Chimney blocked up.	
Space & Hot Water Heating Services		Mains Gas. Radiators. Fan Assisted Combi Boiler - ~74% Efficient. Time & Temperature Control & Room Thermostat.	
Secondary Space Heating		Gas Radiant Heater - Kitchen - 90% Efficient	
Lighting		There are no Low Energy Light Fittings	

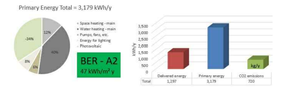
Apartment G2 and F2 Baseline Specification

Building Element - Fabric		Description	U-Value
Ground Floor	G2	22mm T&G Chipboard, 225x18mm Treated SW Timber Joists @ 400cts. 200mm Insulation Between Floor Joists, 150mm Vented Air Space, 50mm Oversite Concrete Screed	0.15
Cavity Wall	G2	19mm Silicone Render, 102.5mm Outer Brick, 80mm Graphite Bead Cavity Insulation, 102.5mm Inner Brick, 13mm Parge Coat Plaster, 100mm WoodFibre Insulation, 13mm Lime Plaster	0.19
	F2	19mm Silicone Render, 102.5mm Outer Brick, 80mm Graphite Bead Cavity Insulation, 102.5mm Inner Brick, 13mm Parge Coat Plaster, 16mm Dot & Dab Adhesive, 72.5mm Kingspan K17/18 Insulation	0.19
Ceiling/Roof	F2	100mm Mineral Fibre Insulation Between Ceiling joists, 270mm Mineral Fibre Insulation Over Ceiling joists	0.13
Windows	G2	Timber Double Glazed (Heritage)	1.9
	F2	Triple Glazed Low E	0.7
Doors	G2	Timber Double Glazed (Heritage)	3
	F2	Triple Glazed Low E	0.7
Building Element - Systems			
Ventilation	G2	Intermittent Room Only Heat Recovery	
	F2	MVHR System	
Space & Hot Water Heating Services	G2	Electric Combi Heat Store / Underfloor Heating	
	F2	Air Source Heat Pump with Radiators	
Lighting		Low Energy Light Fittings Throughout	
Renewable Technology	F2	2kW Solar PV Array	

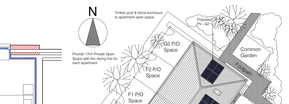
Baseline BER and Energy Analysis

Existing Apartment G1

Existing Apartment F1



Existing BRE Retrofit Apartment G2



Existing BRE Retrofit Apartment F2

Measures to Achieve nZEB Apartment G1 and F1

1. Upgrade Thermal Envelope

- Insulate Suspended Timber Ground Floor - U-Value of 0.15 W/m2K
- Insulate Cavity Walls - U-Value of 0.13 W/m2K
- Insulate Ceiling - U-Value of 0.08 W/m2K
- Windows/Doors - Triple Glazed, Argon filled, (low-E) - U-Value of 0.7 W/m2K

G1 Primary Energy ↓53% F1 Primary Energy ↓56%

2. Improve Structural Air Tightness & Ventilation

Air Tightness: To achieve 1m3/h. m2 @ 50pa. New air tight layer to form a continuous internal barrier to air infiltration. All junctions & penetrations of the air tight layer to be taped and sealed with approved air tightness tape. Any fixings through the air tight layer should be self sealing.

Floor: Air tight layer formed with 22mm OSB3 floorboards over existing joists.

Walls & Ceiling: Air tight layer formed by new 5mm wet plaster finish internally. Prepare existing plaster/ plasterboard surface by taping all gaps, openings and junctions.

Efficient Ventilation System: Demand Control Mechanical Extract Ventilation with Aereco V2A fan. Humidity sensitive air inlets wall mounted in habitable rooms. Humidity sensitive extract units to Bathroom and Kitchen.

BXC
Demand controlled extract unit for MEV
The BXC incorporates all the functions one could request from an air extract unit. With various activation modes such as humidity...

V2A
Acoustic whole house / individual apartment fan - rooms
With its silent operation an compact construction, the can be discretely fitted into dwelling...

EHT
Trickle humidity sensitive air inlet
Installed on a wall or on a rolling shutter casing, the EHT humidity sensitive air inlet is an ideal alternative for air admission throug...

G1 Primary Energy ↓60% F1 Primary Energy ↓65%

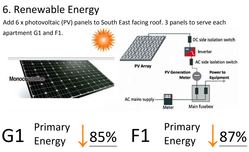
3. Reduce Thermal Bridges

Simplify building and improve detailing at key junctions to meet Acceptable Construction Detail standards and achieve the performance standards set out in the Technical Guidance Document (TGD) Part L of the Building Regulations 2008 – Conservation of Fuel and Energy – Dwellings. Thermal bridge or 'Y' factor of 0.08 (DEAP input).

G1 Primary Energy ↓63% F1 Primary Energy ↓67%

4. Efficient Space and Water Heating System

- New air to water heat pump for space heating and DHW. (358% efficiency)
- New factory insulated hot water cylinder
- Low temperature radiators.
- Insulate primary pipework.
- Install separate and independent time + temperature zone control.



G1 Primary Energy ↓75% F1 Primary Energy ↓78%

5. Energy Efficient Lighting

Low energy light fittings throughout.

G1 Primary Energy ↓78% F1 Primary Energy ↓81%

6. Renewable Energy

Add 6 x photovoltaic (PV) panels to South East facing roof. 3 panels to serve each apartment G1 and F1.

G1 Primary Energy ↓85% F1 Primary Energy ↓87%

Apartment G2

1. Certified Values for DEAP

Obtain and input the certified values for the existing Heat Recovery units and the existing windows and doors.

Primary Energy ↓12%

2. Thermal Bridge 'Y' Factor

Change the DEAP 'Y' factor from the default of 0.15 to 0.08.

Primary Energy ↓19%

3. Efficient Space and Water Heating System

- Remove the existing inefficient electric combi heat store
- New air to water heat pump for space heating and DHW. (358% efficiency)
- New factory insulated hot water cylinder
- Low temperature radiators.
- Insulate primary pipework.
- Install separate and independent time + temperature zone control.

Primary Energy ↓65%

4. Renewable Energy

Add 4 x photovoltaic (PV) panels to North East facing roof.

Primary Energy ↓78%

Apartment F2

1. Thermal Bridge 'Y' Factor

Calculated 'Y' of 0.058 achieved through a combination of ACD's and Therm models of selected junctions.

Primary Energy ↓15%

2. Certified Values for DEAP

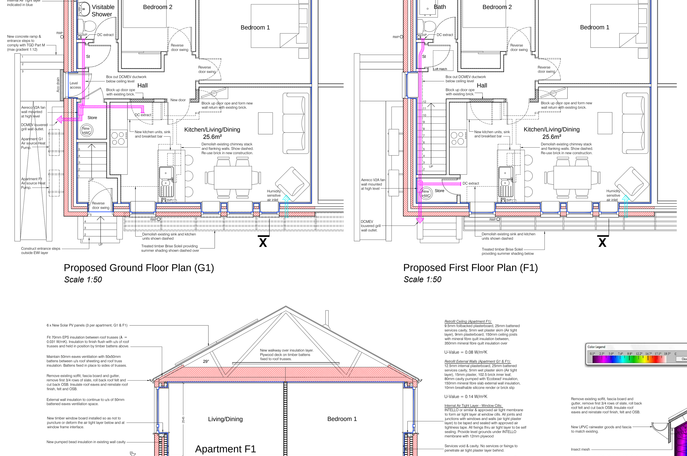
Obtain and input the certified values for the existing PV electrical contribution.

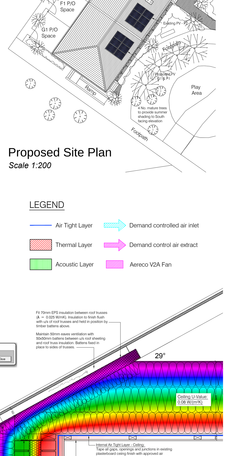
Primary Energy ↓32%

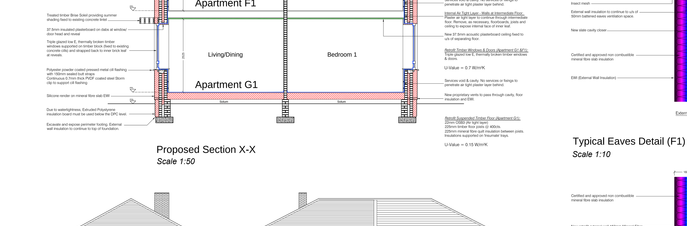
Retrofit Energy Performance & Emissions Summary

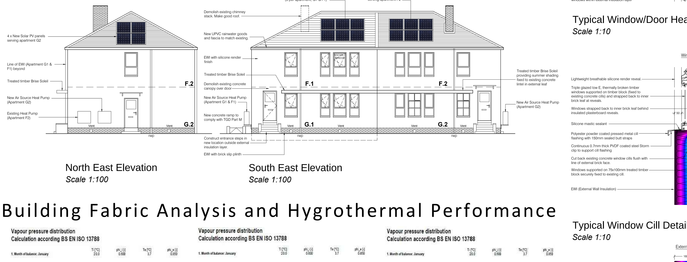
Apartment	Fl. Area	Delivered Energy kWh/y	Delivered Energy per m²	Primary Energy kWh/y	Primary Energy per m²	CO_2 Emissions kg/y	CO_2 Emissions per m²	EPC	CPC	BER
G1	62m²	1,147	18	2,831	45	657	10.26	0.257	0.275	A2
G2	61m²	1,053	17	2,580	43	584	9.66	0.249	0.271	A2
F1	67m²	1,192	18	2,920	43	661	9.81	0.249	0.270	A2
F2	68m²	889	13	2,177	32	493	7.31	0.192	0.205	A2
Area Weighted Average	65m²	1,070	16	2,622	41	594	9.25	0.237	0.257	A2
Difference From Existing	-	-89.70%		-81.30%		-78.70%		-81%	-79%	

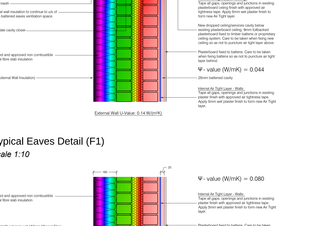
Apartment G1 & F1 Proposed Deep Retrofit Design Scheme

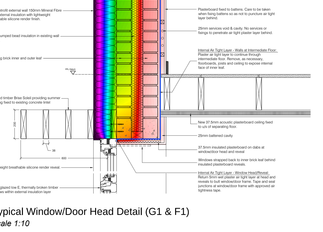


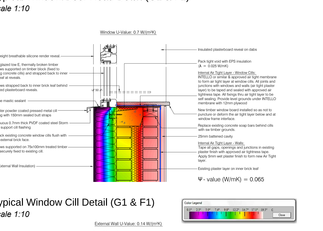


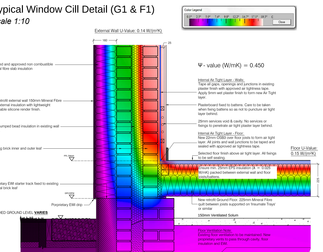




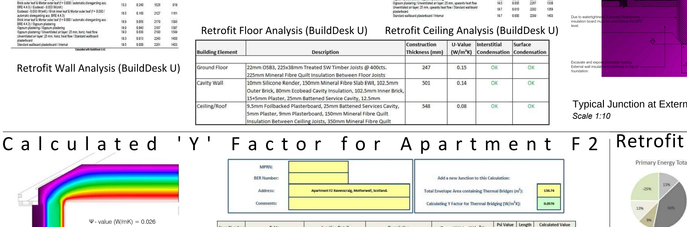








Building Fabric Analysis and Hygrothermal Performance

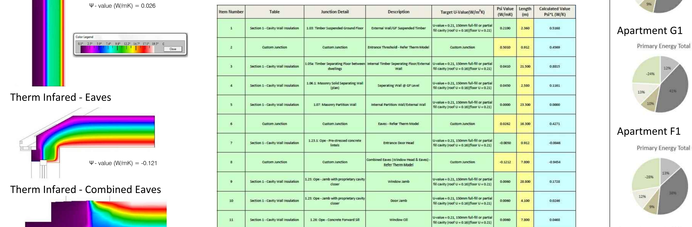


Retrofit Wall Analysis (BuildDesk U)

Retrofit Floor Analysis (BuildDesk U)

Retrofit Ceiling Analysis (BuildDesk U)

Calculated 'Y' Factor for Apartment F2

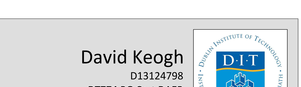


Item Number	Take	Junction Detail	Description	Target U-Value(W/m²K)	Psi Value (W/mK)	Length (m)	Calculated Value Psi*L (W/K)
1	Section 1- Clarity Wall Insulation	E.03 Timber Suspended Ground Floor	External Wall/SW Suspended Timber	U-value = 0.21, 150mm full fill or partial fill cavity (real U = 0.18)(Real U= 0.21)	0.1196	2.760	0.3301
2	Custom Junction	Custom Junction	Entrance Threshold - Refer Therm Model	Custom Junction	0.3650	0.452	0.4569
3	Section 1- Clarity Wall Insulation	E.05a Timber Separating Floor between dwellings	Internal Timber Separating Floor/External Wall	U-value = 0.21, 150mm full fill or partial fill cavity (real U = 0.18)(Real U= 0.21)	0.0410	21.596	0.8919
4	Section 1- Clarity Wall Insulation	E.08 c Masonry Solid Separating Wall (plan)	Separating Wall @ GF Level	U-value = 0.21, 150mm full fill or partial fill cavity (real U = 0.18)(Real U= 0.21)	0.0450	2.590	0.1161
5	Section 1- Clarity Wall Insulation	E.07 Masonry Partition Wall	Internal Partition Wall/External Wall	U-value = 0.21, 150mm full fill or partial fill cavity (real U = 0.18)(Real U= 0.21)	0.0000	23.700	0.0000
6	Custom Junction	Custom Junction	Eaves - Refer Therm Model	Custom Junction	0.0242	18.288	0.4371
7	Section 1- Clarity Wall Insulation	E.23 E Ope - Pre-Stressed concrete lintels	Entrance Door Head	U-value = 0.21, 150mm full fill or partial fill cavity (real U = 0.18)(Real U= 0.21)	0.0856	0.912	-0.0044
8	Custom Junction	Custom Junction	Combined Eaves (Window Head & Eaves) - Refer Therm Model	Custom Junction	0.3152	7.695	-0.0454
9	Section 1- Clarity Wall Insulation	E.25 Ope - Jamb with proprietary cavity closer	Window Jamb	U-value = 0.21, 150mm full fill or partial fill cavity (real U = 0.18)(Real U= 0.21)	0.0560	24.336	0.1710
10	Section 1- Clarity Wall Insulation	E.25 Ope - Jamb with proprietary cavity closer	Door Jamb	U-value = 0.21, 150mm full fill or partial fill cavity (real U = 0.18)(Real U= 0.21)	0.0980	4.190	0.0230
11	Section 1- Clarity Wall Insulation	E.26 Ope - Concrete Forward Sill	Window Cill	U-value = 0.21, 150mm full fill or partial fill cavity (real U = 0.18)(Real U= 0.21)	0.0980	7.890	0.0466
12	Section 1- Clarity Wall Insulation	E.27 C Corner	External Corner	U-value = 0.21, 150mm full fill or partial fill cavity (real U = 0.18)(Real U= 0.21)	0.0440	7.992	0.1445
13	Section 1- Clarity Wall Insulation	E.06.2 Masonry Separating (cold) Roof Junction	Separating Wall/Ceiling	U-value = 0.21, 150mm full fill or partial fill cavity (real U = 0.18)(Real U= 0.21)	0.4000	0.900	0.3600
14	Section 1- Clarity Wall Insulation	E.09 S Solid Masonry Separating Wall through ground floor	Separating Wall/SW Junction - Heat Loss Shared with G1 Apartment	U-value = 0.21, 150mm full fill or partial fill cavity (real U = 0.18)(Real U= 0.21)	0.2530	1.950	0.9317
15	Custom Junction	Custom Junction	Ceiling/Chimney (Sic Plan)	Custom Junction	0.0439	34.486	1.0712
16	Custom Junction	Custom Junction	Ceiling/Chimney (Ctr. Plan)	Custom Junction	0.4100	1.040	0.4264

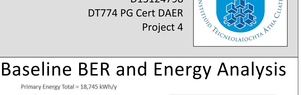
Retrofit BER and Energy Analysis

Apartment G1

Apartment F1



Apartment G2



Apartment F2

BREEAM Assessment

An Outstanding score of (>85%) was achieved for the proposed Retrofit scheme when assessed with BREEAM (British Research Establishment Environment Assessment Method) Domestic Refurbishment. The specific areas assessed in BREEAM DR and their weightings are: Management (12%), Energy (43%), Water (11%), Materials (8%), Pollution (6%), Waste (3%) and Health & Wellbeing (17%).

BREEAM Rating:
Achieving a score of 90.01% OUTSTANDING

PASS GOOD VERY GOOD EXCELLENT OUTSTANDING