An Roinn Tithíochta,
Rialtais Áitiúil agus Oidhreachta
Department of Housing,
Local Government and Heritage

Improving Energy Efficiency in Traditional Buildings – new guidelines

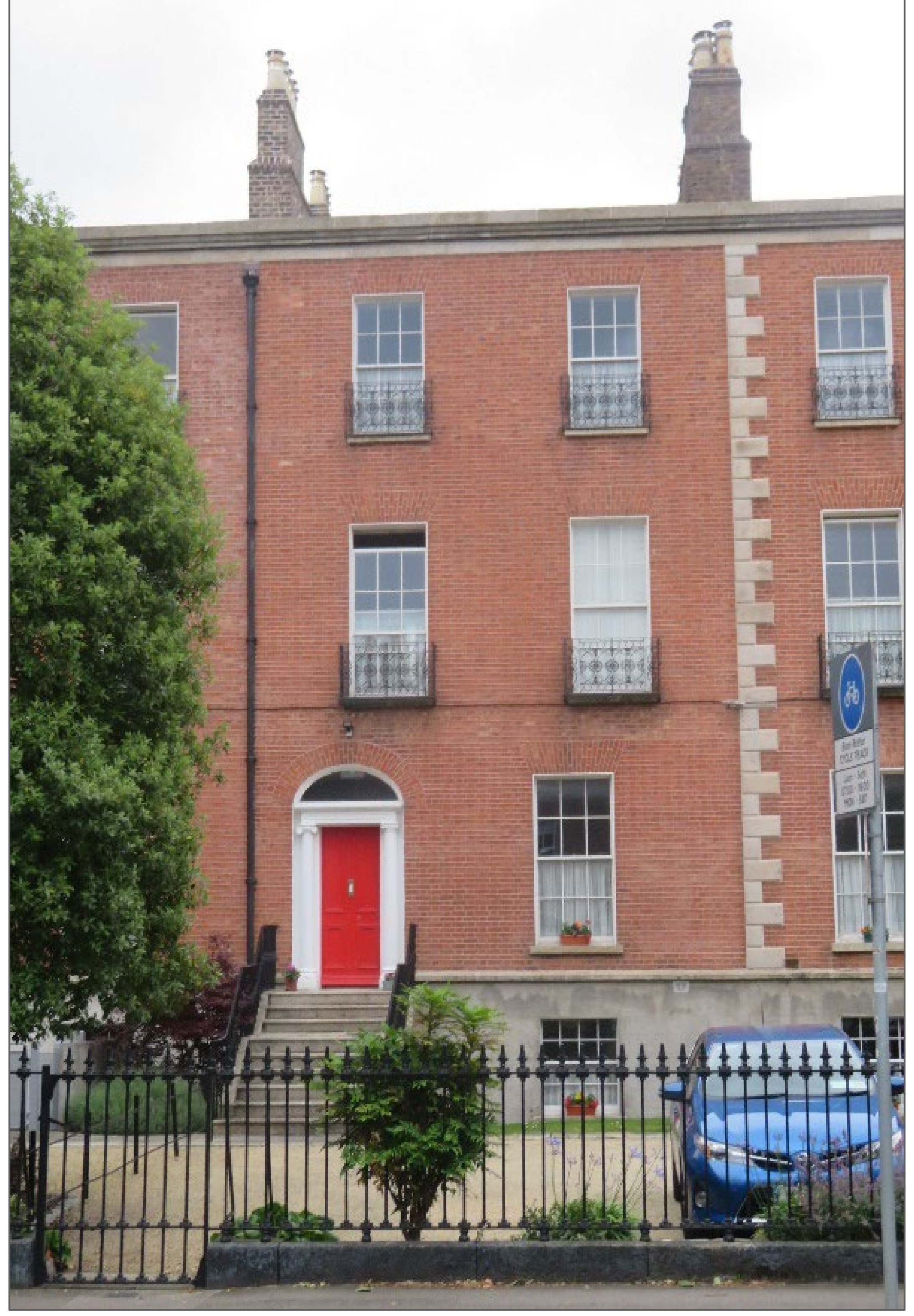
Jacqui Donnelly
Senior Architect, Built Heritage Policy

What is a 'traditional building'?

Traditional buildings are buildings with:

- Solid masonry walls (brick or stone, often with a render finish) – i.e. no cavity
- Single-glazed timber or metal windows
- Timber-framed roofs with slate or tiles, sometimes thatch or metal
- Traditional buildings are of flexible and 'breathable' construction
- Generally, they were built with no damp-proof course

This type of construction was used for the majority of buildings constructed in Ireland before 1940 and represent an estimated 15-18% of the building stock including a wide range of building types




Department of Social Protection
MacDONALD TRAVEL


LYNCH'S
COFFEE
SHOP
2 Impress
Ladies Fashions
Lynch's COFFEE SHOP

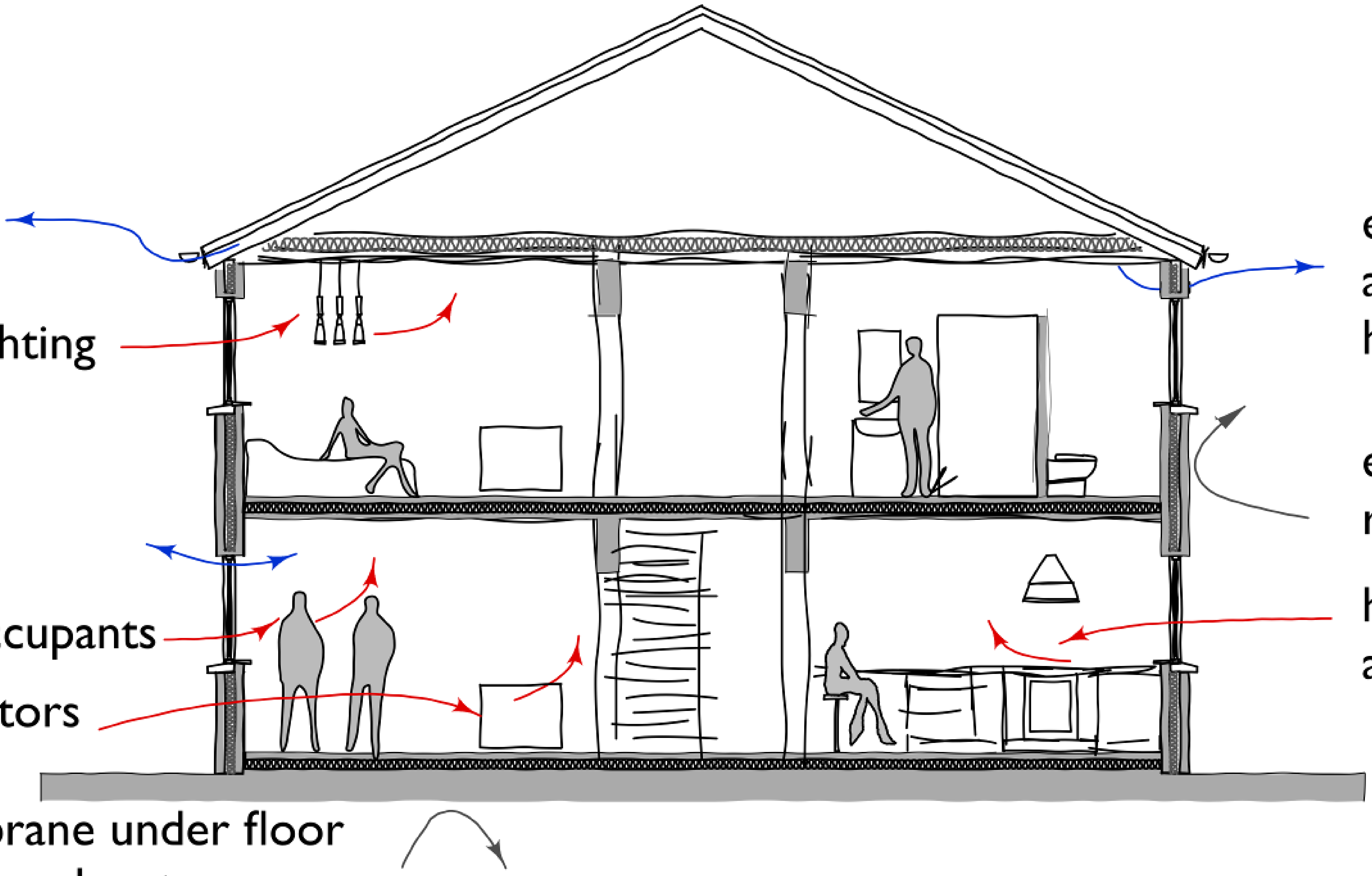
Traditional buildings

- Traditional building methods evolved over centuries, making best use of available materials and craft skills, to deal with local weather conditions
- Primary difference between traditional construction and modern construction is in how moisture is managed. Traditional building materials are usually soft, flexible and vapour-permeable. The building fabric needs to be ‘breathable’ in order to function properly, that is it needs to absorb and release moisture to the atmosphere depending on the environmental conditions
- Natural ventilation was originally provided through open fireplaces, gaps between slates and around windows and doors

Traditional buildings

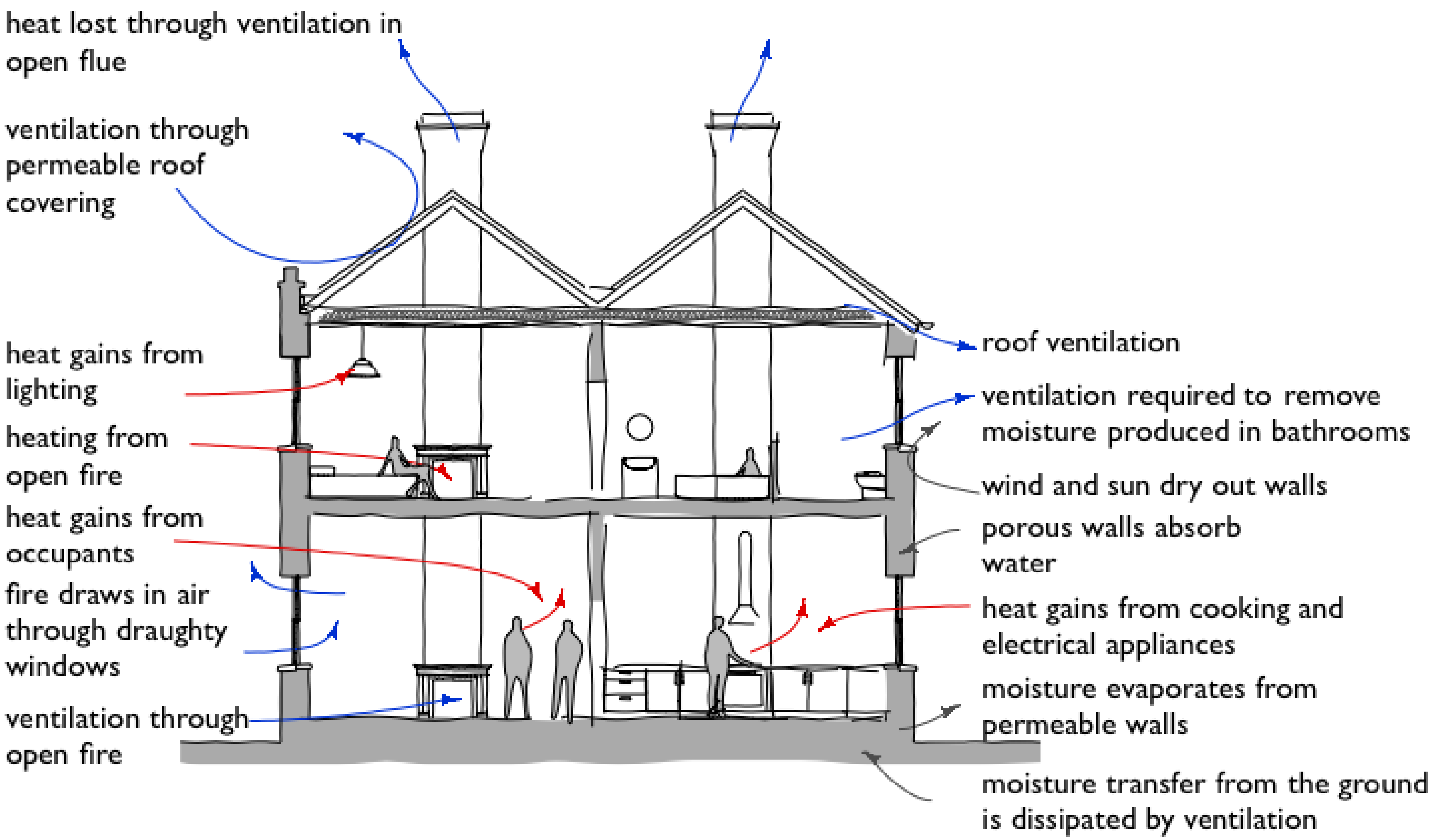
- Regardless of any statutory protection on the building, works to upgrade the energy efficiency of a traditional building will differ from those appropriate for modern construction
- Essential to understand how traditional buildings work before carrying out works to avoid causing irreversible damage
- In traditional buildings, elements are not isolated or separated by barriers or cavities so it is essential to consider the buildings as a whole
- There must be a balance between the requirements of energy conservation and of building conservation

How modern construction behaves



From ‘Energy Efficiency in Traditional Buildings’ (Government of Ireland, 2010)

How traditional construction behaves



From ‘Energy Efficiency in Traditional Buildings’ (Government of Ireland, 2010)

Professional skills & competence

- There are risks associated with altering a traditional building which has performed well sometimes over hundreds of years

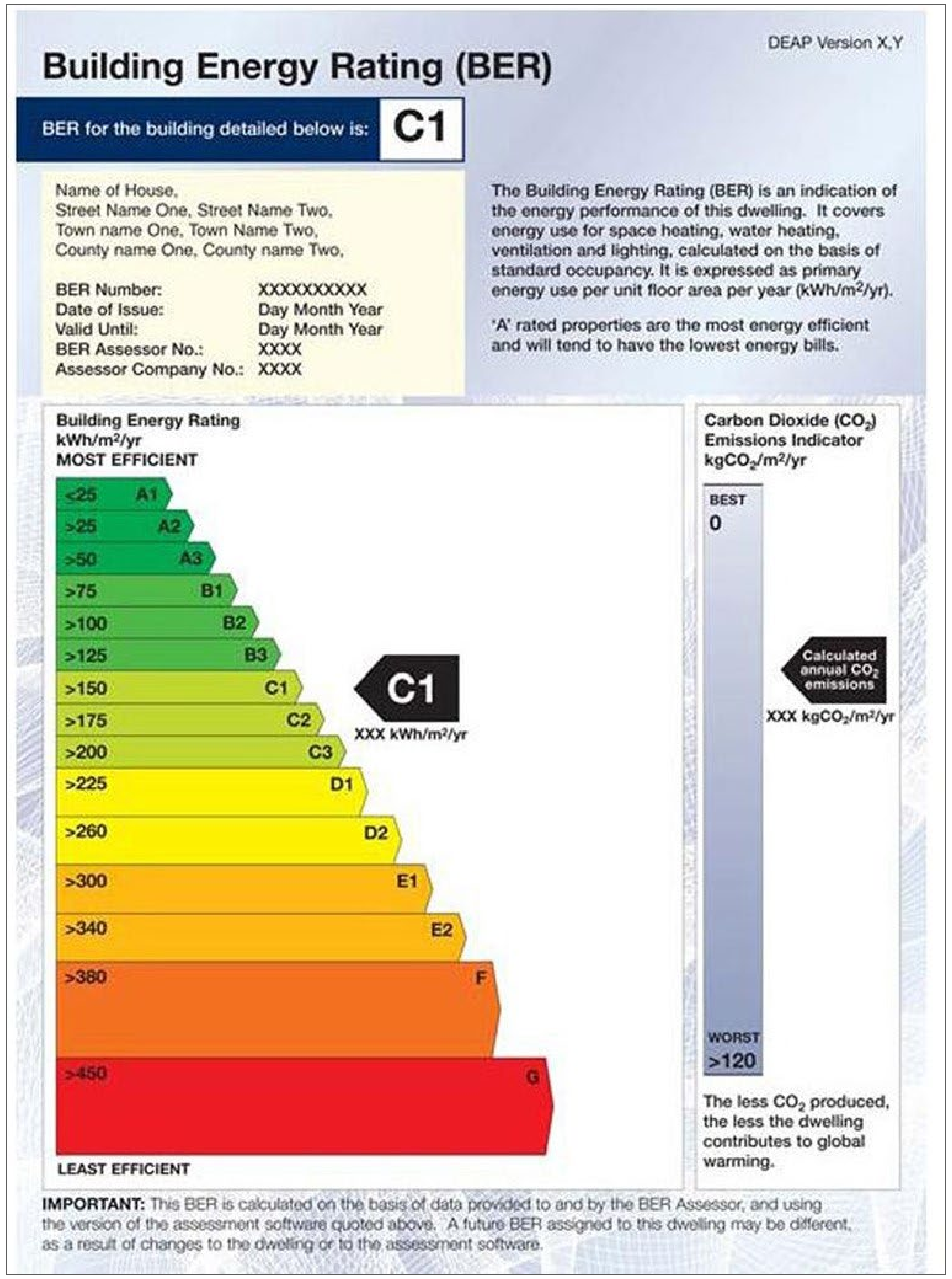
- Specification of retrofitting works for traditional buildings should generally only be undertaken by competent professionals with the necessary skills and experience

- Where a project is complex or the building is of architectural heritage significance, particular skill sets will be required of the specifier and the installer

- Certain low-risk interventions may be undertaken by skilled and experienced contractors where a traditional building is not protected

Statutory/regulatory requirements

- National Monuments Acts (national monuments, recorded monuments)
- Planning & Development Acts (protected structures, architectural conservation areas, other buildings)
- Building Control Acts and Regulations (buildings protected under the National Monuments Acts are exempt)
- Building Energy Rating (protected structures, buildings used as places of worship or for the religious activities of any religion and buildings protected under the National Monuments Acts are exempt)



Understanding the building

It is important to understand the building before considering any upgrading works, including:

- Approximate construction date of the building
- Architectural heritage significance
- Construction methods used
- Construction materials used
- Any later interventions or alterations and their appropriateness or otherwise
- The condition of the building

Assessing the building

- Before any retrofitting works begin, **it is important that the building is in good repair and dry**. A damp wall transmits heat at a higher rate than a dry one
- Identify the energy efficient design features in the building and use and improve these where possible (e.g. window shutters)
- Any inappropriate later changes should wherever possible be reversed - such as the removal of impermeable materials (e.g. cement, gypsum) where this can be done without damage
- Identify and remove or contain any toxic materials
- Assessing the building's energy usage prior to works can be useful

Ventilation

- Attention and care needs to be given to ventilation and indoor air quality (IAQ). Airtightness, ventilation, and IAQ are interdependent, and each building retrofit plan should address them as such
- Good ventilation is critical to the well-being of most traditional buildings
- Lack of ventilation will create or exacerbate damp problems such as condensation, on surfaces and within the fabric of the building
- High moisture levels make timber elements vulnerable to insect and/or fungal attack
- People too, require properly ventilated living spaces for their health and comfort

Sustainability & historic buildings

- ‘*The Greenest Building is the One Already Built*’ (Carl Elefante, 2007)
- The continued use and/or reuse of older buildings is an essential component of sustainable development and avoiding greenhouse-gas emissions
- Carbon reduction strategies for the built environment have often concentrated on operational emissions and fabric performance
- To meet climate goals, future focus must be on **carbon reduction** taking into account both operational and embodied carbon

Sustainability & historic buildings

- Life cycle analysis is important in assessing the sustainability of a new buildings and of maintaining, refurbishing and replacing existing buildings
- Embodied energy in an existing building is lost if a building is demolished
- Demolition waste has to be transported from the site and put into landfill
- The production and/or importation of building materials to construct new, replacement buildings require a significant amount of energy and create greenhouse-gas emissions

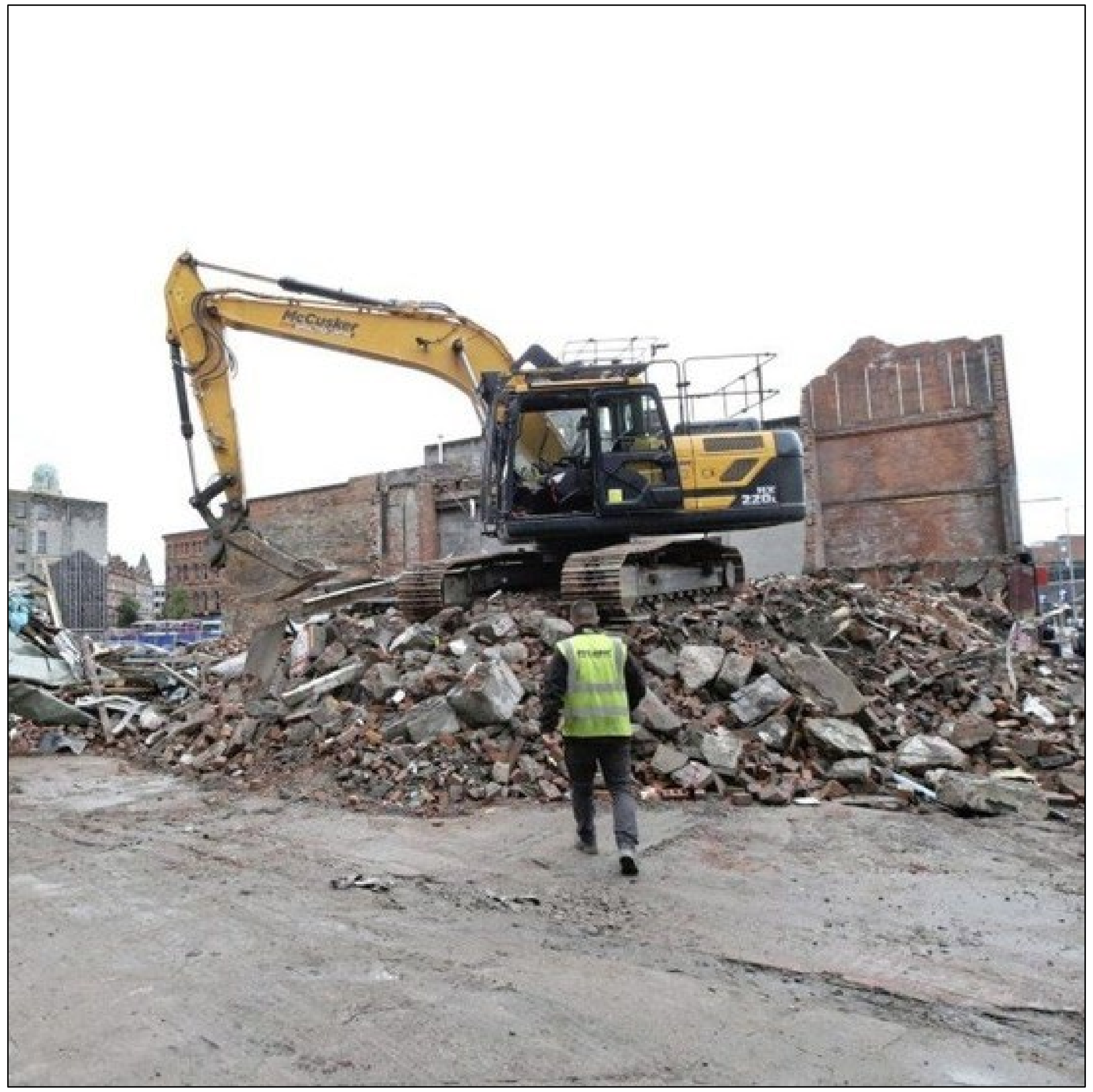


Image by Hugh Russell, The Irish News

Sustainability & historic buildings

- Older buildings were designed to maximise natural sources of heating, lighting and ventilation

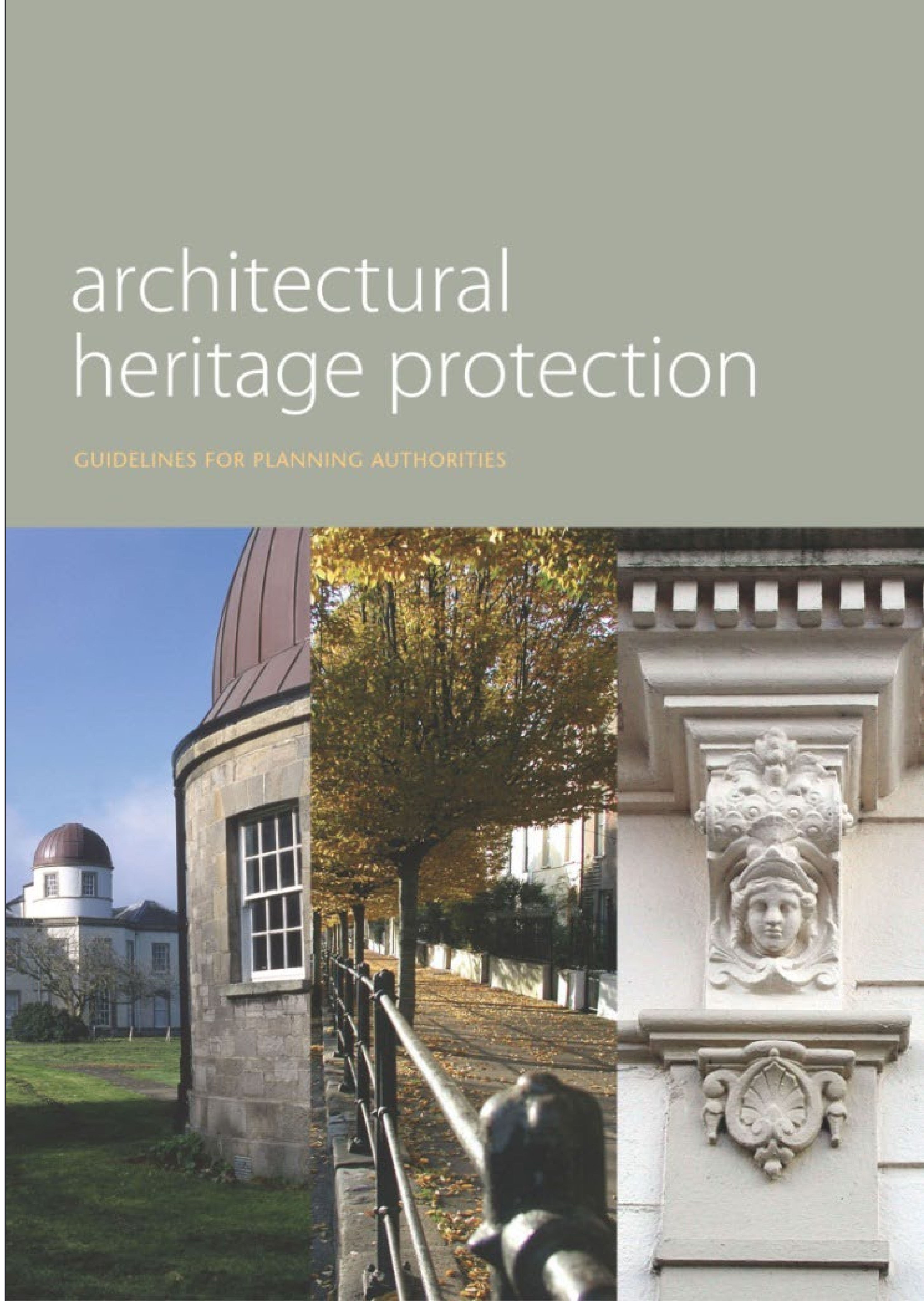
- The historic building stock is made of durable, long-lasting materials which reduce refurbishment cycles, therefore using less energy in the long term

- Generally the building elements are readily repairable – e.g. joinery, ironwork

Building conservation principles

- Keeping the building in use
- Researching and analysing
- Using expert conservation advice
- Protecting the special interest
- Promoting minimal intervention
- Repairing rather than replacing
- Using appropriate materials and methods
- Ensuring reversibility of alterations
- Avoiding incremental damage

'Architectural Heritage Protection: guidelines for planning authorities' downloadable from: www.buildingsofireland.ie/resources

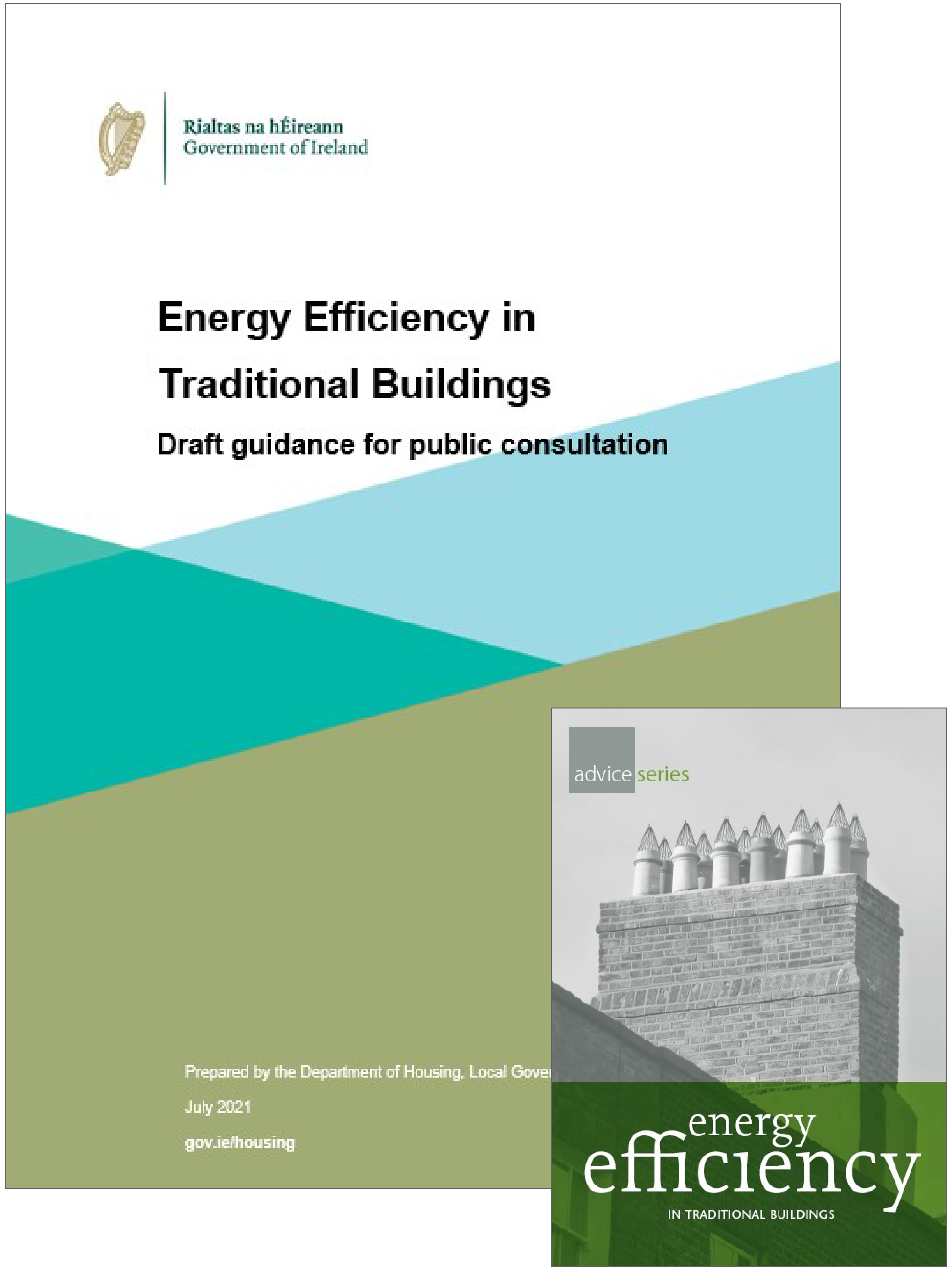


Retrofitting principles for traditional buildings

- Ensure the building is dry and in good repair prior to any upgrading work
- Use materials that are compatible with the traditional building fabric – vapour permeable and capillary active
- Provide adequate ventilation to ensure the health of the building and its occupants
- Minimise waste – upgrade existing elements rather than replacing them
- Balance the need to conserve energy with minimising impacts on the historic fabric. Don’t push the building beyond what is reasonable

Proposed guidelines

- Aim to provide clear and robust advice to specifiers and installers, while being accessible to a wide audience
- Guidance will be strategic more than prescriptive given the nature of the historic building stock
- Illustrate good practice and establish principles and processes to be followed
- Final publication will be this year and entitled *Improving Energy Efficiency in Traditional Buildings*



Proposed guidance - contents

- Chapter 1. Context
- Chapter 2. Understanding traditional buildings
- Chapter 3. Specifying retrofit measures
- Chapter 4. Heating systems and other services
- Chapter 5. Case studies

Chapter 1: Context

- An explanation of a ‘traditional building’ and the types of buildings considered within the guidance
- Statutory regulations that pertain to the alteration of traditional buildings
- Building Energy Rating (BER) system and its application to traditional buildings
- Professional skills and services that may be required on different retrofit projects types
- Information on the full environmental impact of construction, including embodied carbon emissions
- Information on step-by-step retrofits and Building Renovation Passports

Chapter 2: Understanding traditional buildings

- The physics of traditional buildings, how heat and moisture move through a building and how this can be dealt with, taking into consideration the importance of ventilation and indoor air quality
- Methods available for assessing a building to determine any thermal bridges, air leakage and existing damage
- The calculation method for U-values relevant to traditional buildings
- Potential health risks associated with the build-up of harmful substances/gases in a building and how to avoid them

Chapter 3: Specifying retrofit measures

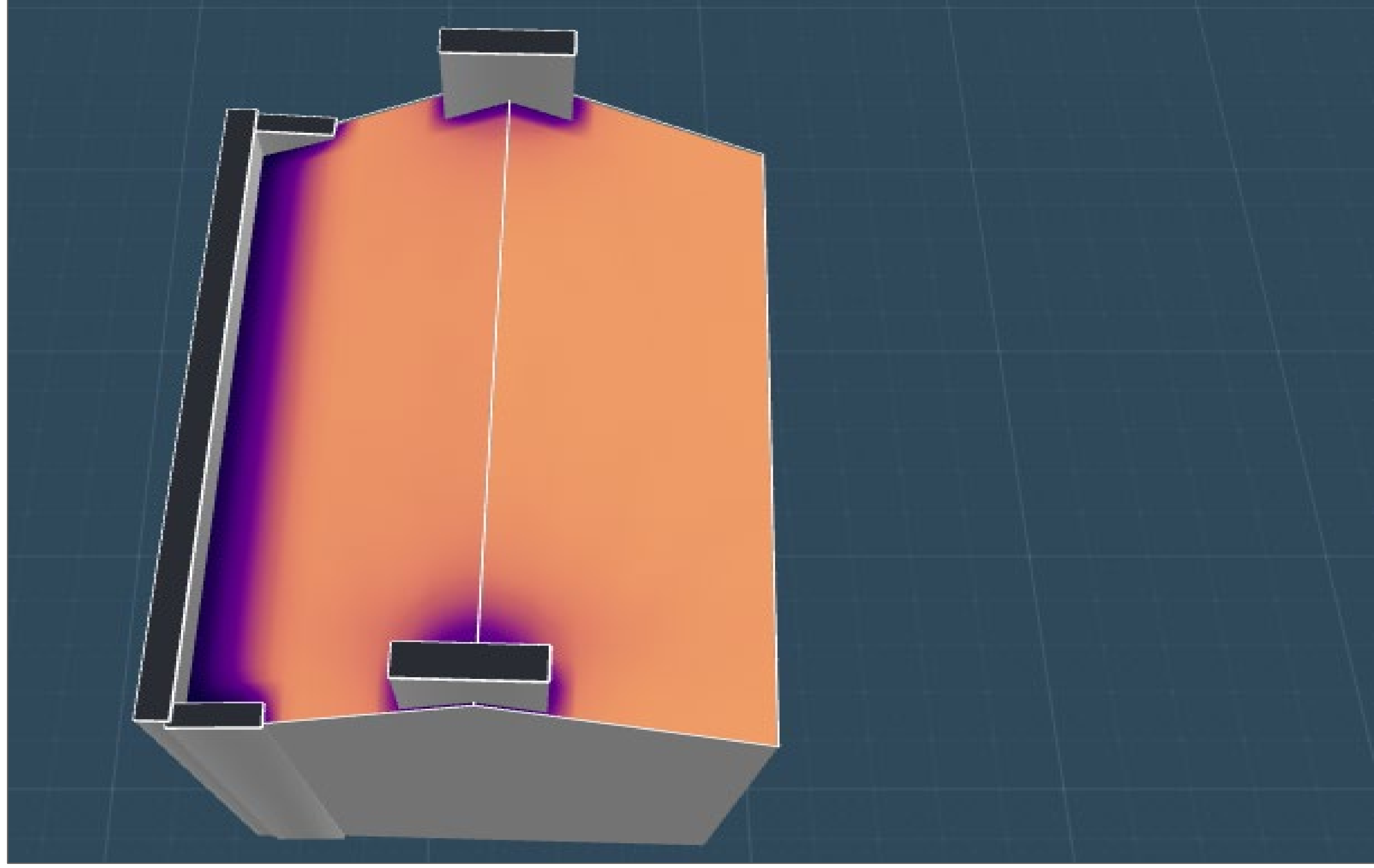
- Recommended steps to follow when developing a retrofit strategy and what should be completed prior to the start of retrofit works
- Recommended materials for retrofit works on traditional buildings
- Preparation and installation measures for the upgrade of roofs, floors, windows and doors, as well as solid walls
- Other non-fabric energy efficiency measures which are low cost and easy to implement

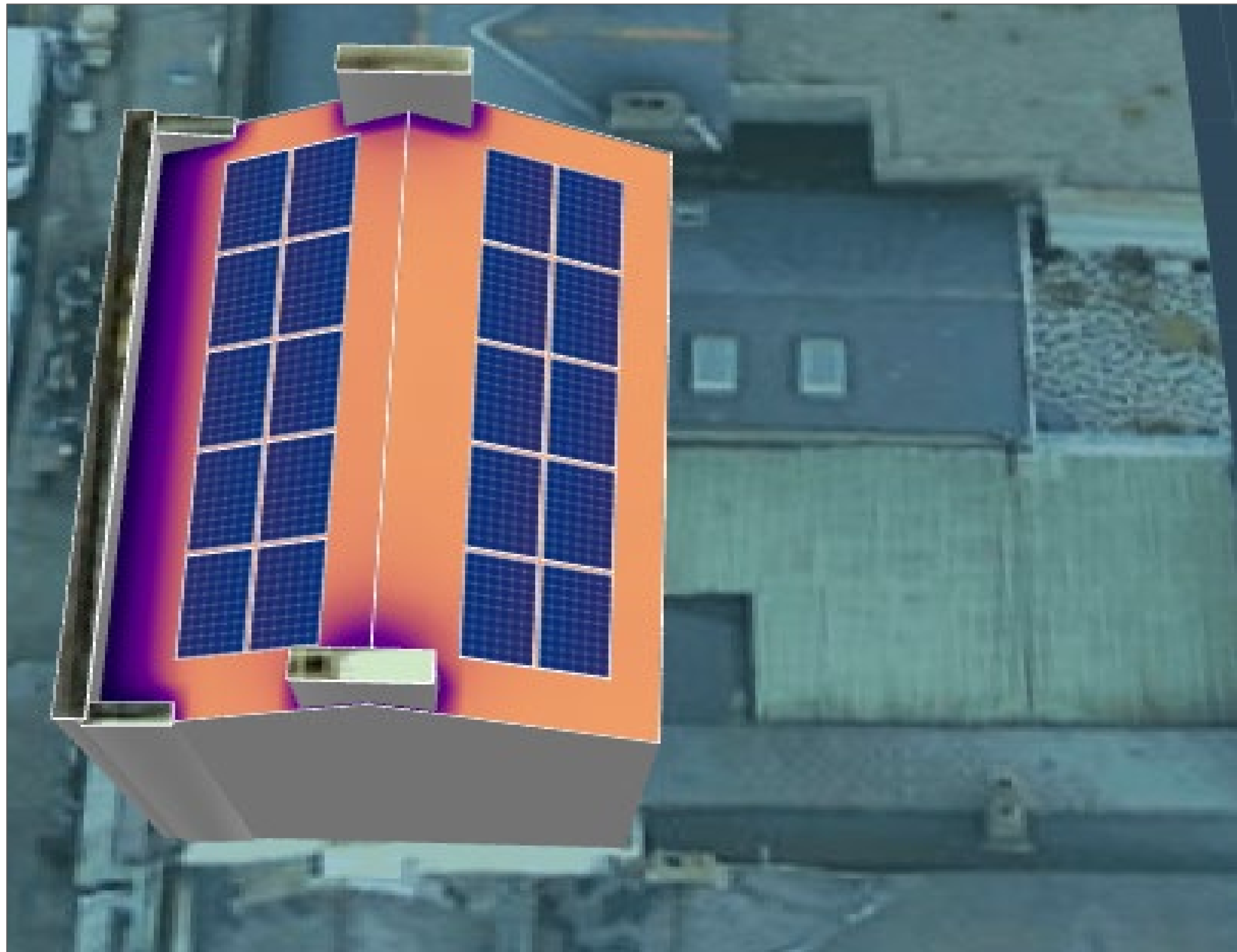
Chapter 4: Heating systems and other services

- Dealing with existing heating systems
- Choosing a heating system which is appropriate for different building types
- Supplementing energy usage with low-carbon and renewable sources of energy
- Accommodating changes to mechanical and electrical systems and location of plant
- Introducing management systems to assess the environmental and energy performance

Chapter 5: case studies

- Accommodation over the shop
- Office building
- Place of worship
- School
- Detached urban dwelling
- Terraced 18C house
- End-of-terrace late-19/early-20 century house





Chapter 5: case studies

- These are hypothetical retrofit projects
- Typologies chosen are intended to reflect some of the most common traditional building types
- Aim is to improve the energy rating to BER B2 or as far as technically, functionally and economically feasible. Calculated in accordance with the National Calculation Methodology (NEAP or DEAP as appropriate)
- Conservation principle of minimal intervention (or '*as much as necessary, as little as possible*', Burra Charter) to be followed particularly in the case of protected structures

Other related initiatives

- Study into **embodied carbon and life cycle assessment** for the retrofit of traditional buildings and develop a practical step-by-step guide to undertaking these assessments for the retrofit of case study building types

- Pilot a number of **exemplar projects** with OPW, local authorities and others to establish, demonstrate, monitor and publish best practice case studies of the appropriate and sensitive energy retrofitting of traditional buildings across the country in accordance with the forthcoming guidance

- SEAI has commissioned a research project (‘FabTrads’) to identify the **hygrothermal properties** for a range of Irish traditional construction materials/assemblies. The findings are intended to inform the National Calculation Methodology (BER ratings) and be of use in developing further retrofit guidance for traditional buildings

Future issues to be addressed:

- Training and upskilling of specifiers, installers (and owners/occupiers too)
- Developing grant schemes tailored to traditional building upgrades
- Identification and certification of suitable materials for use in upgrading traditional buildings
- Taking account of embodied carbon in existing buildings

Thank you

SEAI Energy Show - Exploring a Deep and Circular Retrofit Case Study

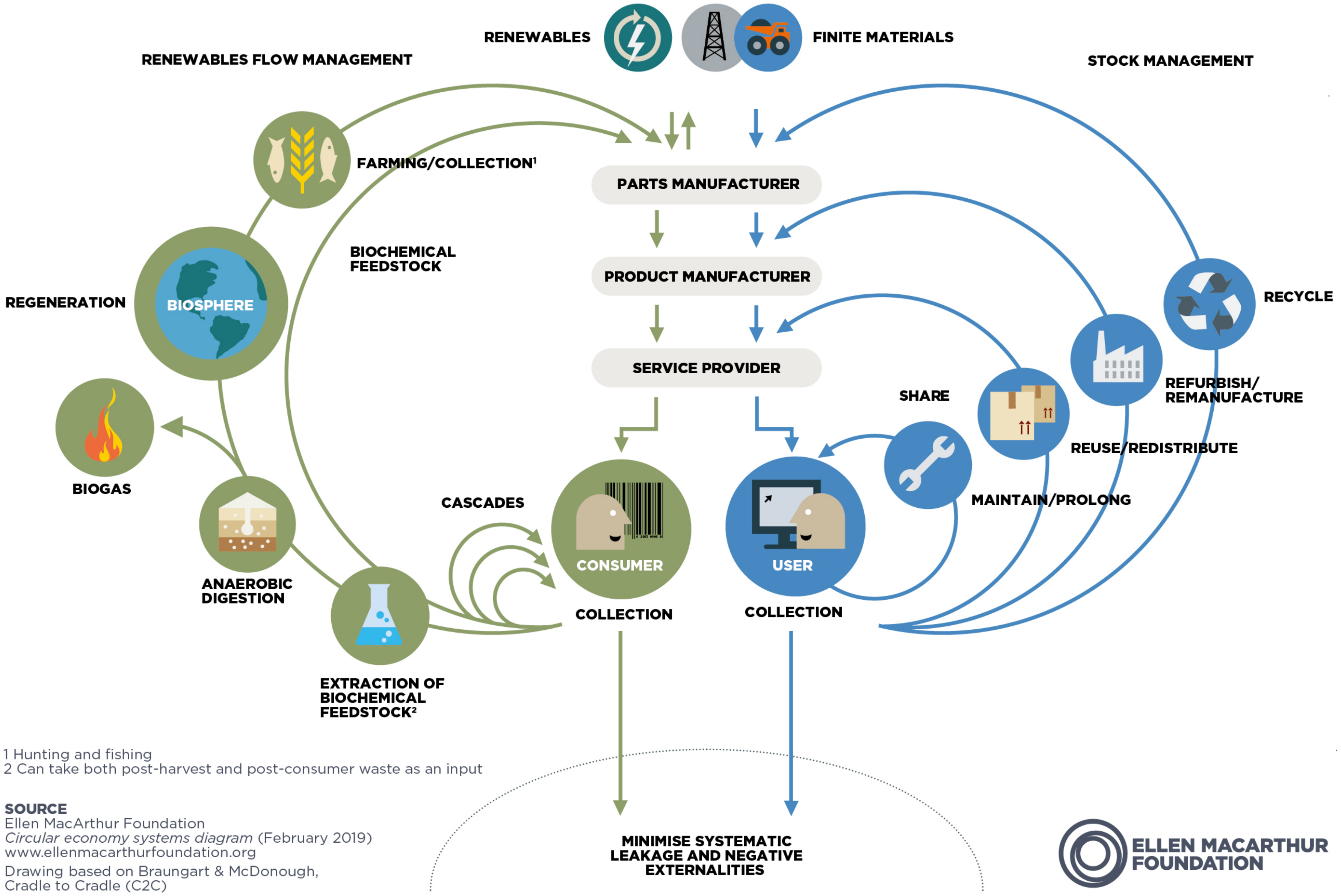
30th March

Joseph Little
Head of Construction & Building Performance
Technological University Dublin

Carbon - circularity

The *6 R's of sustainability* are a *waste hierarchy*, not just a catchy list

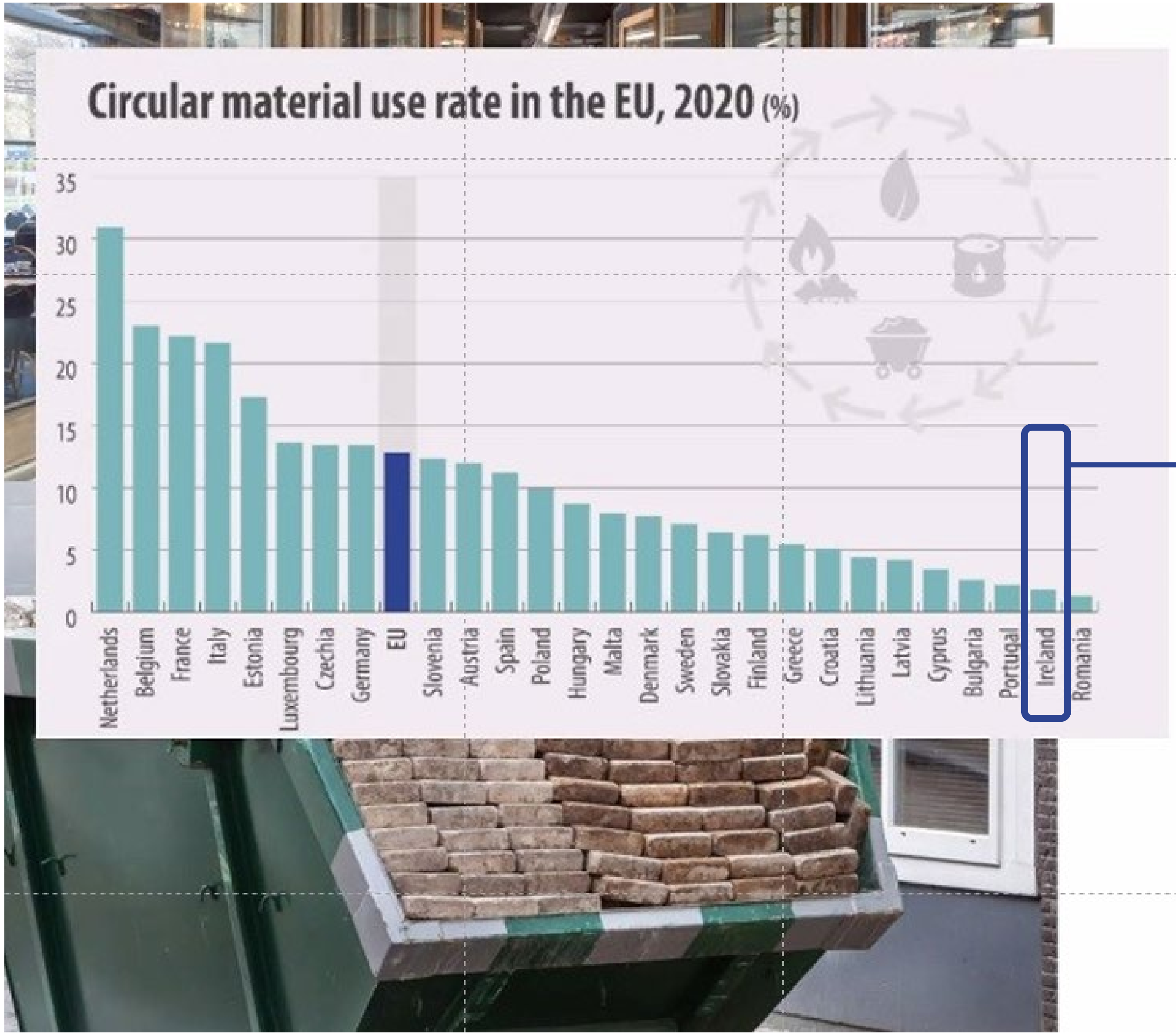
Carbon - circularity



1 Hunting and fishing
2 Can take both post-harvest and post-consumer waste as an input

SOURCE
Ellen MacArthur Foundation
Circular economy systems diagram (February 2019)
www.ellenmacarthurfoundation.org
Drawing based on Braungart & McDonough, Cradle to Cradle (C2C)

Carbon accounting – a strategic response



Ireland has the second lowest rate of circular material use

Carbon – circularity strategy

Build less buildings, retrofit first

- EC of retrofit is ~ 1/3 the EC of rebuilding
- Multiple other benefits

Use less building materials

- Refuse works
- Maintain & repair more
- Reduce materials used & structurally optimise

Use materials with lower embodied carbon

- Shift specifications to low carbon, renewable and reused
- Transition supply chain from over-reliance on imported products and carbon intense native manufacturing to local, low carbon construction product sector

Embrace circularity

- Specify re-use, re-manufacture
- Stimulate the market
- Design for disassembly

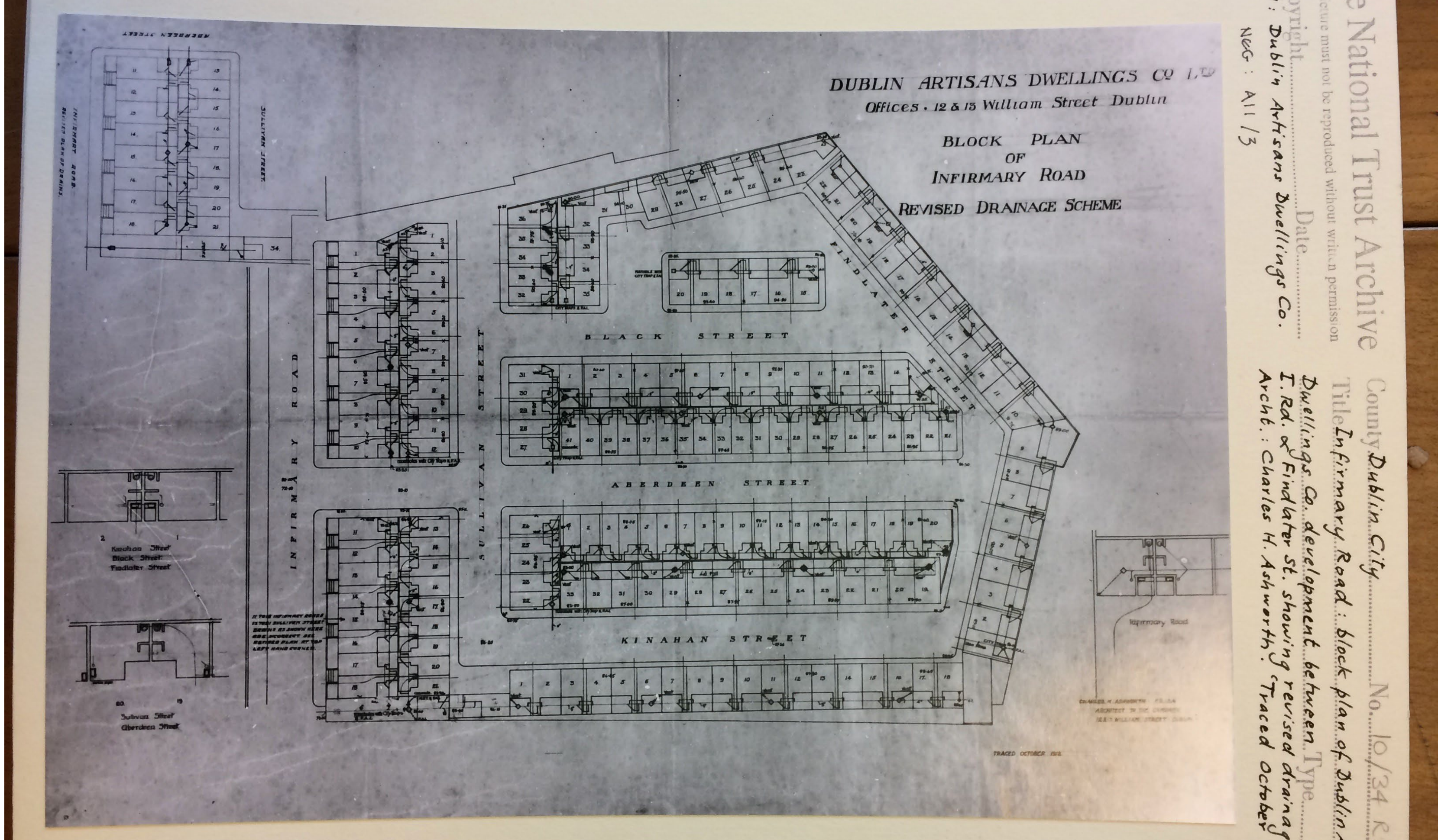
With input from Ramboll, EHA, IGBC
Net Zero Carbon Roadmap (2021) &
R. O'Hegarty & O. Kinnane, (2022)

DADCo development

According to Jacinta Prunty *'DADCo Housing estates were to be characterized by two house types – single-storey concrete cottages and two-storey red brick houses... long repetitive lines of parallel streets, conforming to bye-law widths, as laid out in the Public Health (Ireland) Act 1878'.*

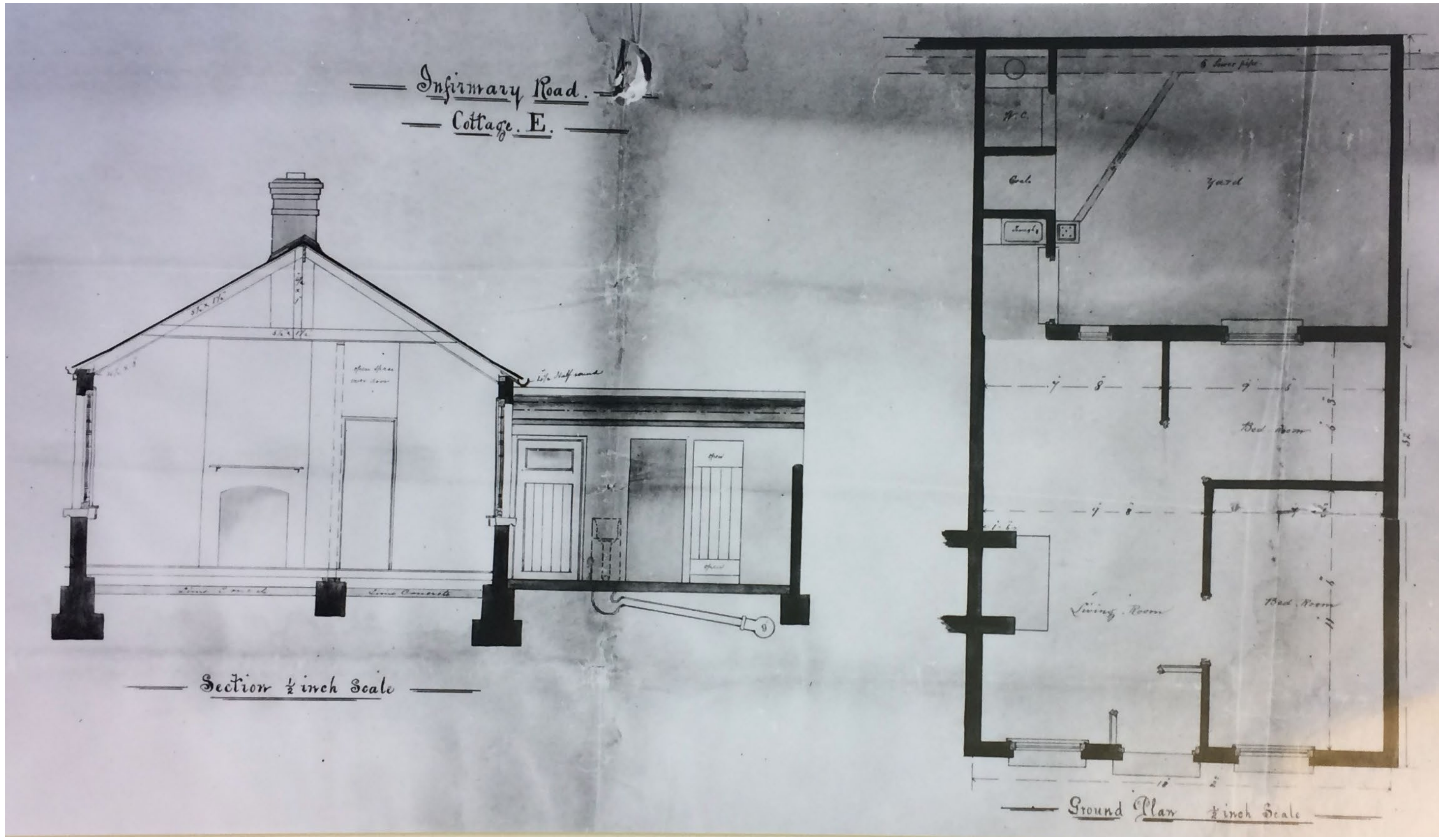
ref: Brady, J. & Simms, A. 2001.
Dublin Through Space and Time (c. 900-1900),
Four Courts Press, Dublin.

Developer: Dublin Artisan Dwellings Company (DADCo). 1885-86

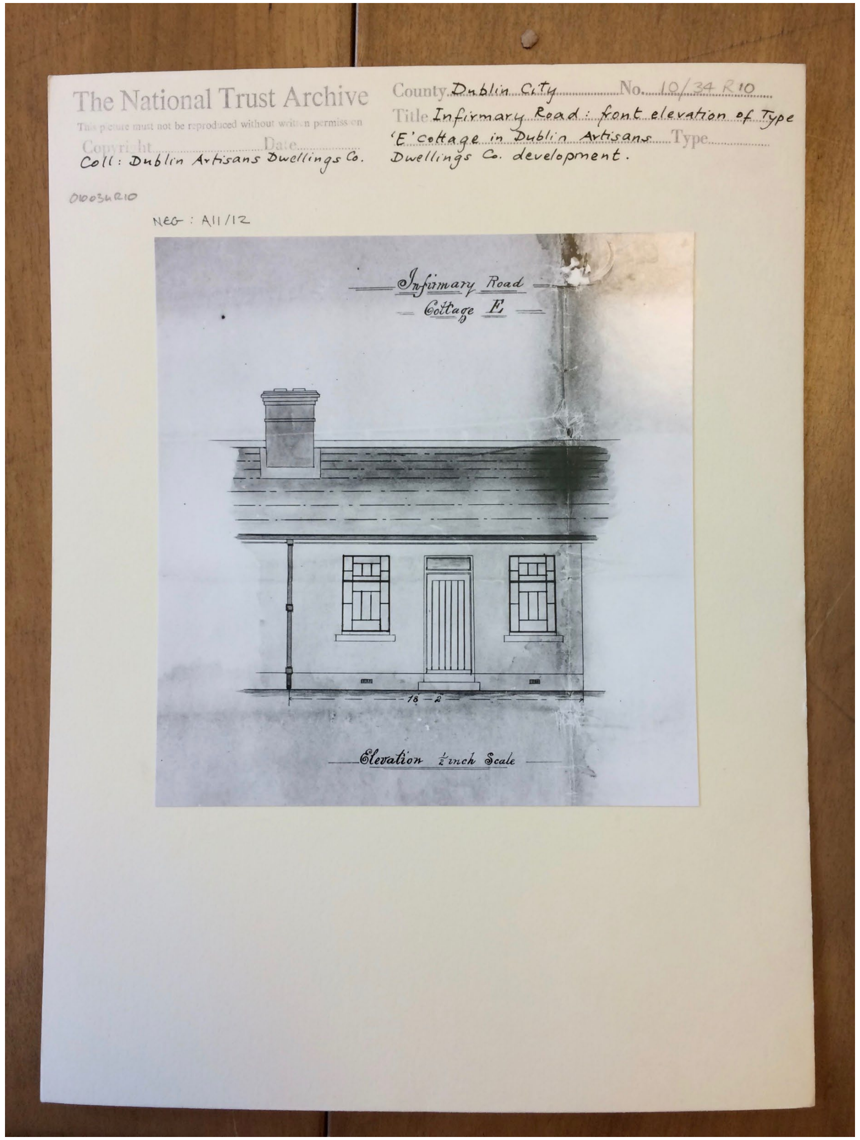


Architect: Charles H Ashworth. Builder: J. Beckett & Sons

DADCo development



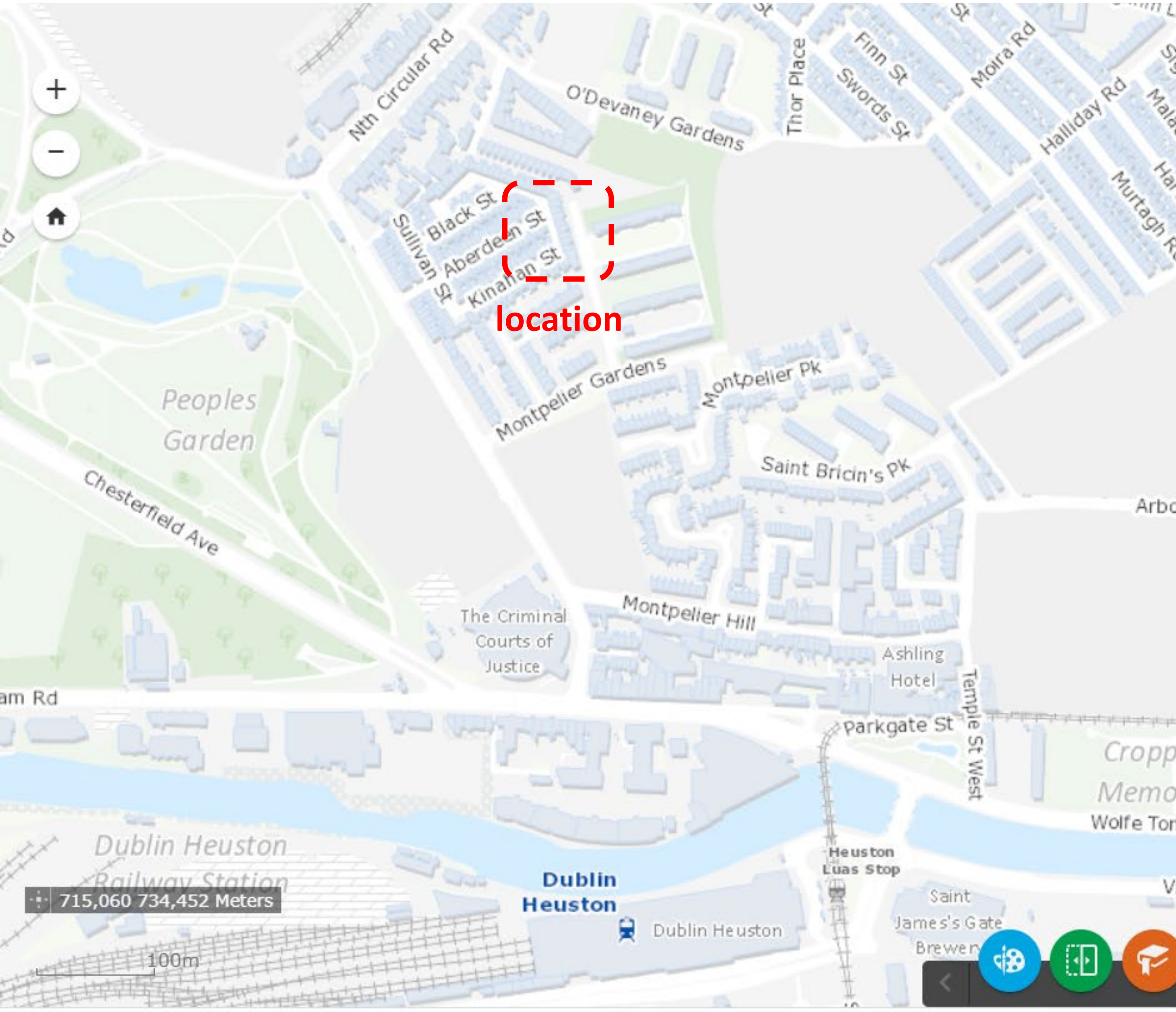
Single-storey, three-bay, mid-terrace cottage. Camber-arched door opening, render details at door, boot scraper, sash window frames, high ceiling. Much original detail (including chinoiserie-style pivot windows removed.



Found condition

Found condition

Inherent value: location



Settled community

Great location

13 minutes:	**cycle to the GPO**
10 minutes:	**cycle to family home**
11 minutes:	**cycle to Christ Church Cathedral or walk to Hueston Station**
9 minutes:	**cycle to the Papal Cross, Phoenix Park**

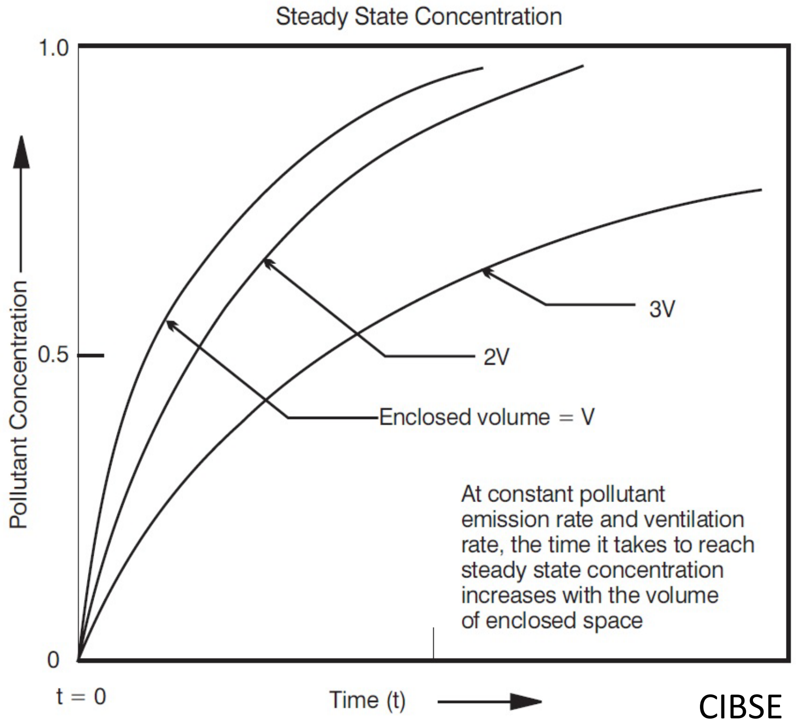
Inherent value: form and fabric

Existing building fabric

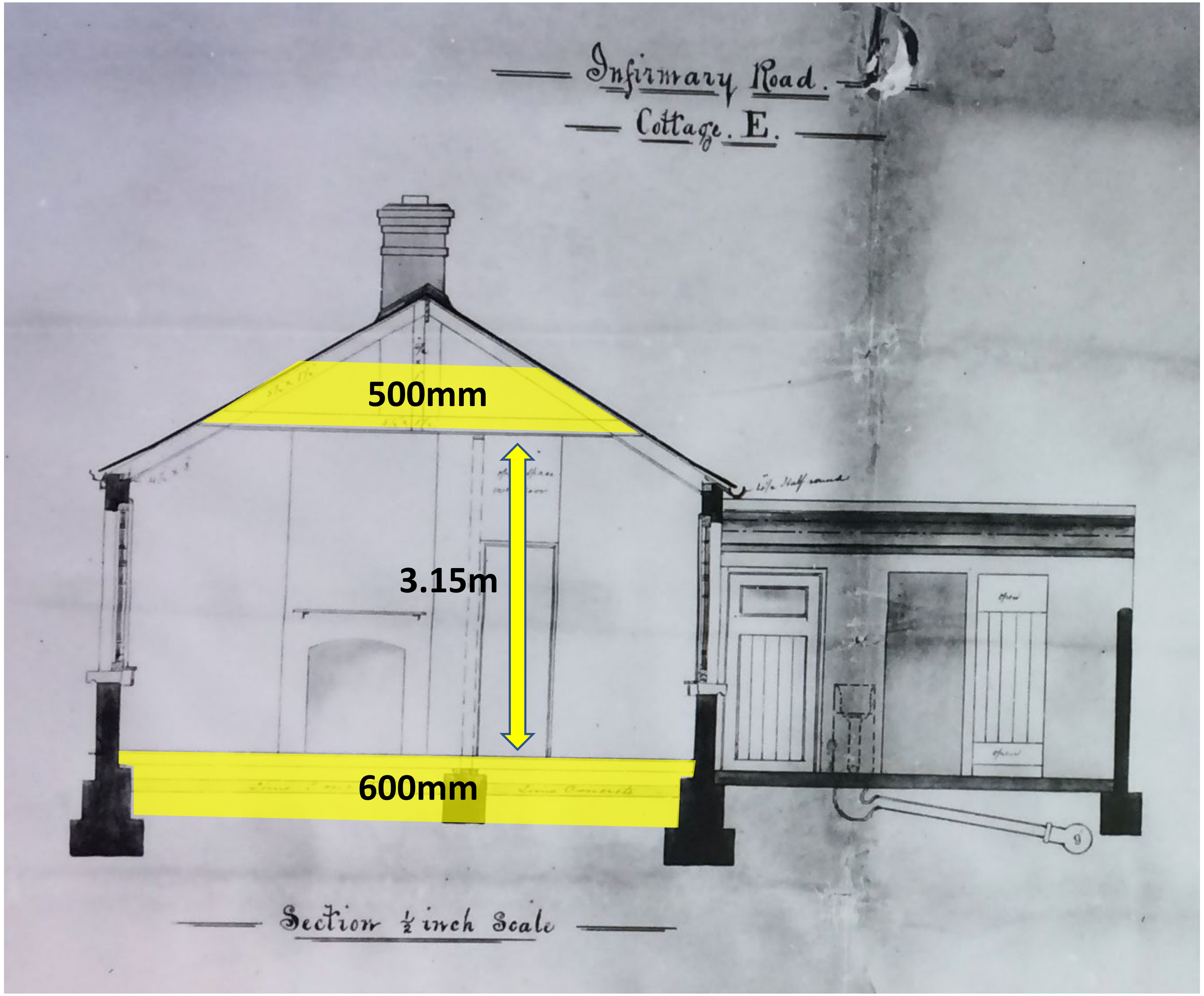
No heat loss to neighbours

Large internal volume supporting IEQ

Attic void & floor voids



CIBSE

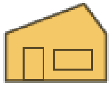
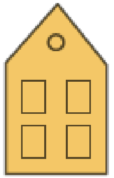
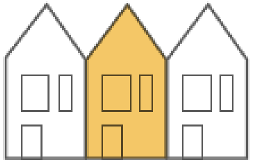
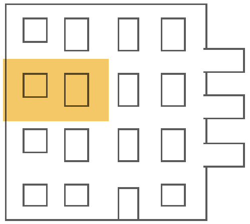


Heat loss form factor as a design aid

The Heat Loss Form Factor: the ratio of surface area that can lose heat (the thermal envelope) to the floor area that gets heated

120sqm / 38sqm = 3.15

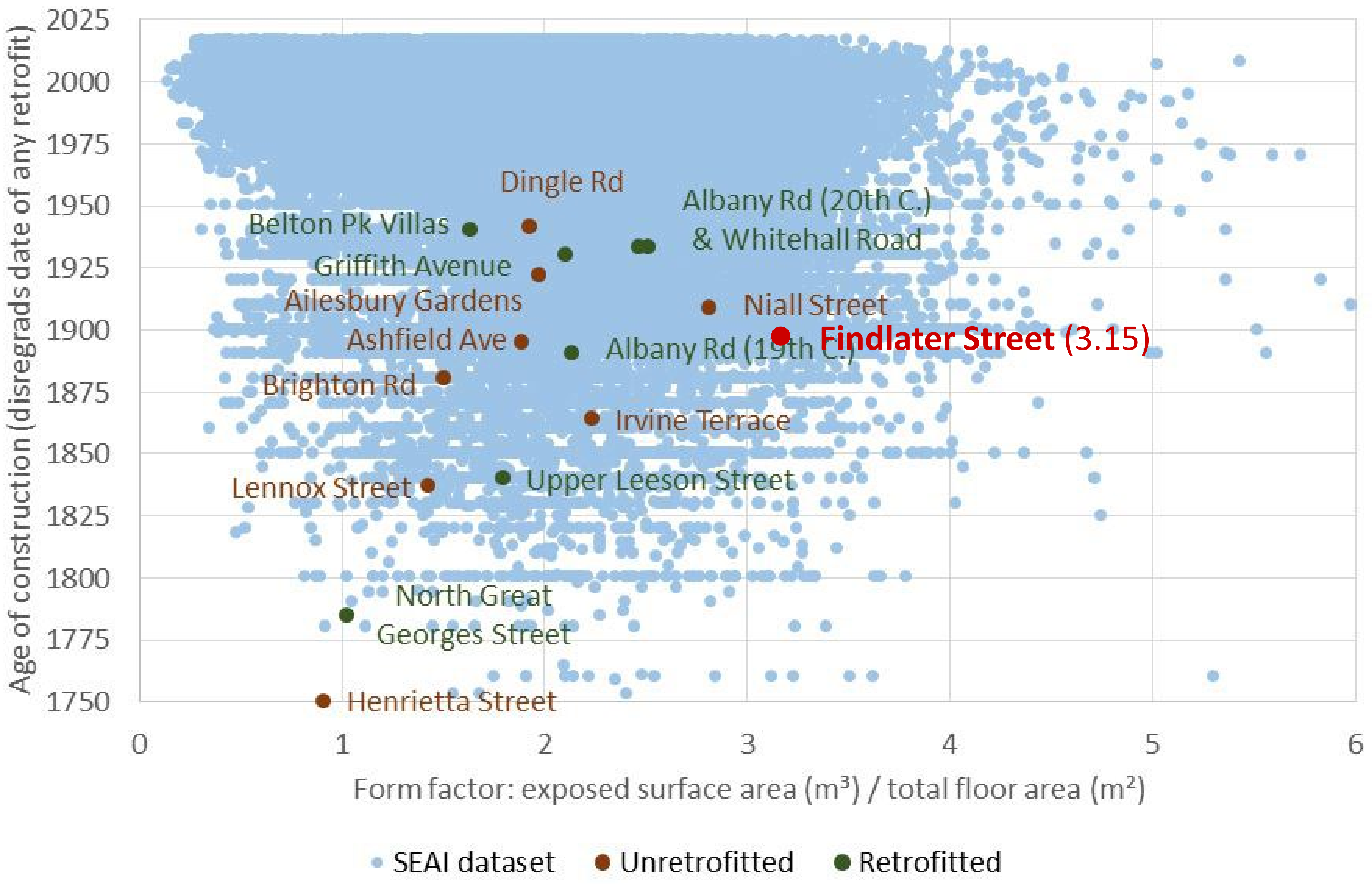
With HLFF of 31.5 mid-terrace cottage has form factor of detached bungalow!

Type		Form factor	Efficiency
	Bungalow house	3.0	Least efficient
	Detached house	2.5	
	Semi-detached house	2.1	
	Mid-terrace house	1.7	
	End mid-floor apartment	0.8	Most efficient

Heat loss form factor as a design aid

Even historically the HLFF is an outlier.

A lot of thermal envelope meets a lot of cost.



Heat loss form factor as a design aid

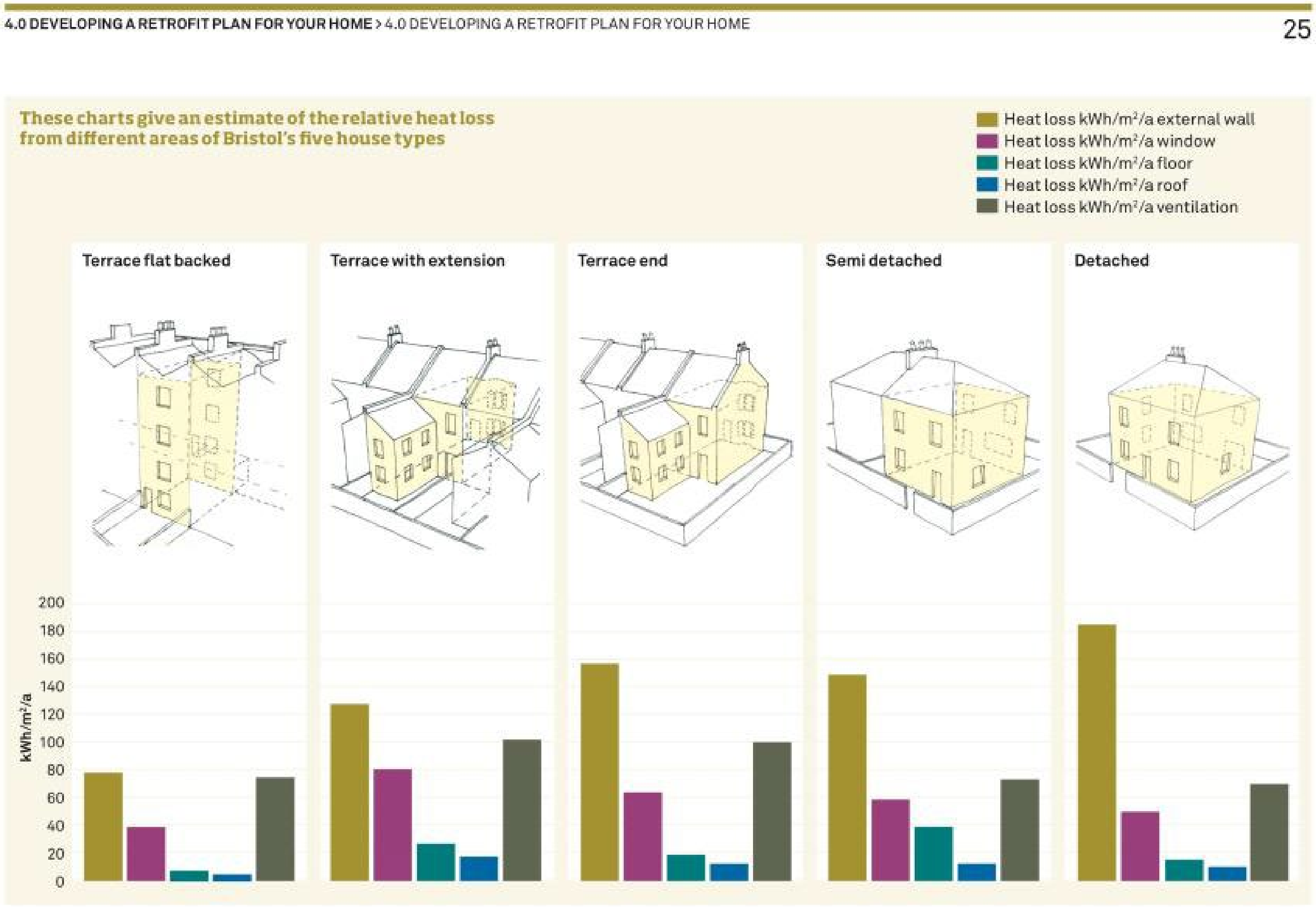
Heat loss form factor (HLFF) is large for area contained:

- Floor area: 38 sqm
- Thermal envelope: 120 sqm
- Resulting HLFF: 120 / 38 = 3.15

Heat loss area:

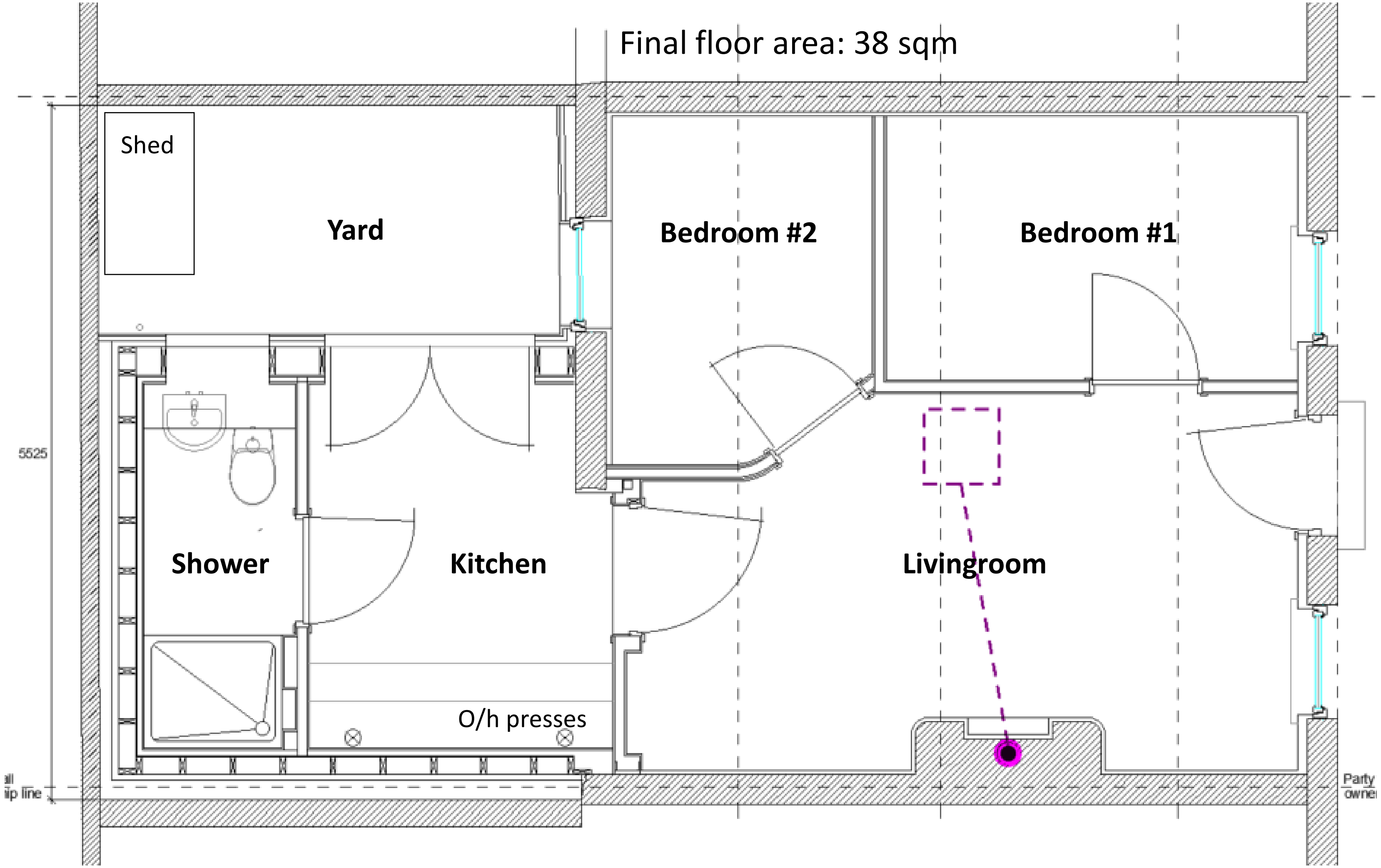
- Windows & doors: 9.25%
- Existing walls: 10.7%
- New walls: 16%
- Floor: 31.5%
- Roof: 32.5%

Response – optimise airtightness, roof and floor insulation

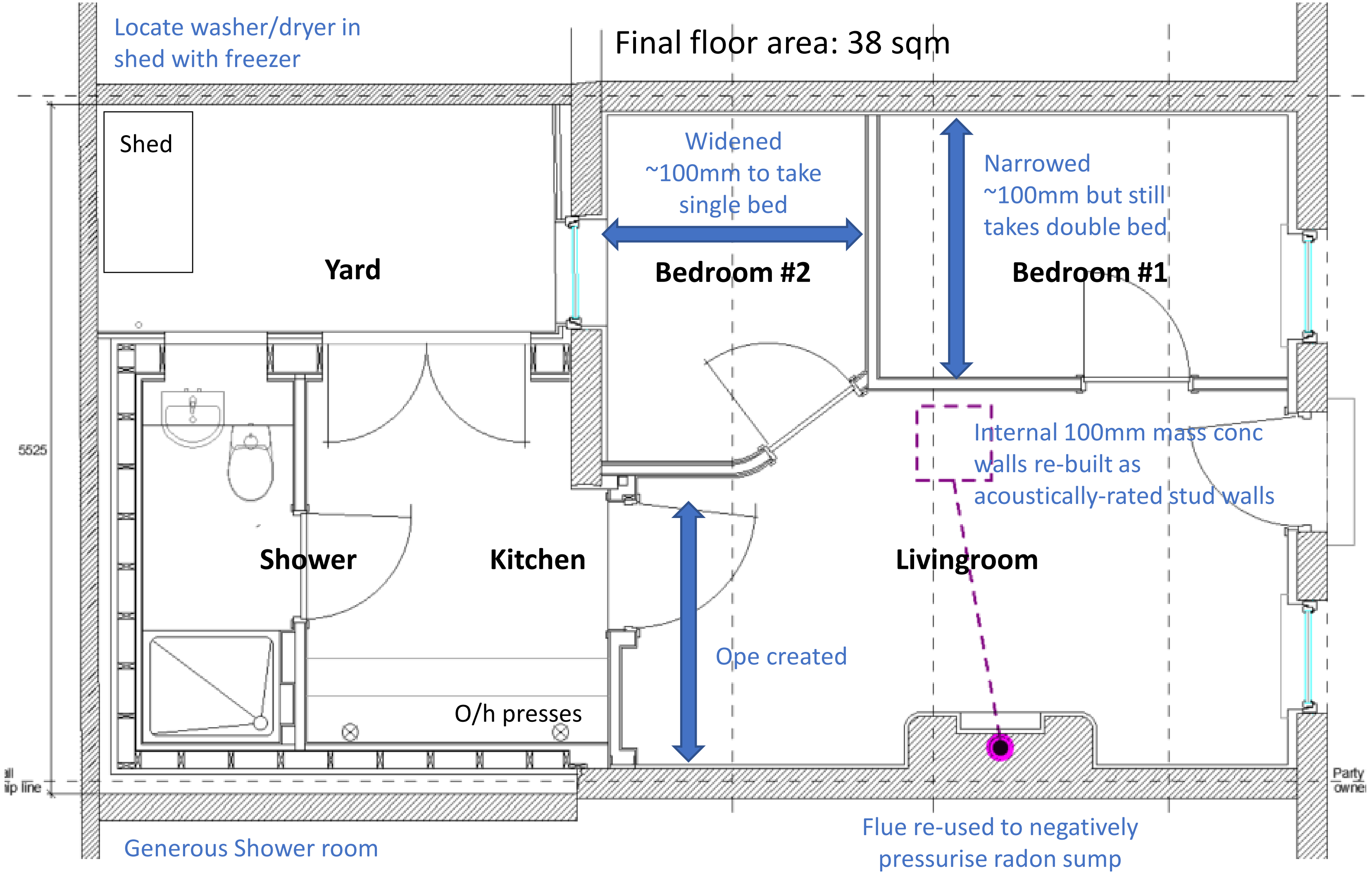


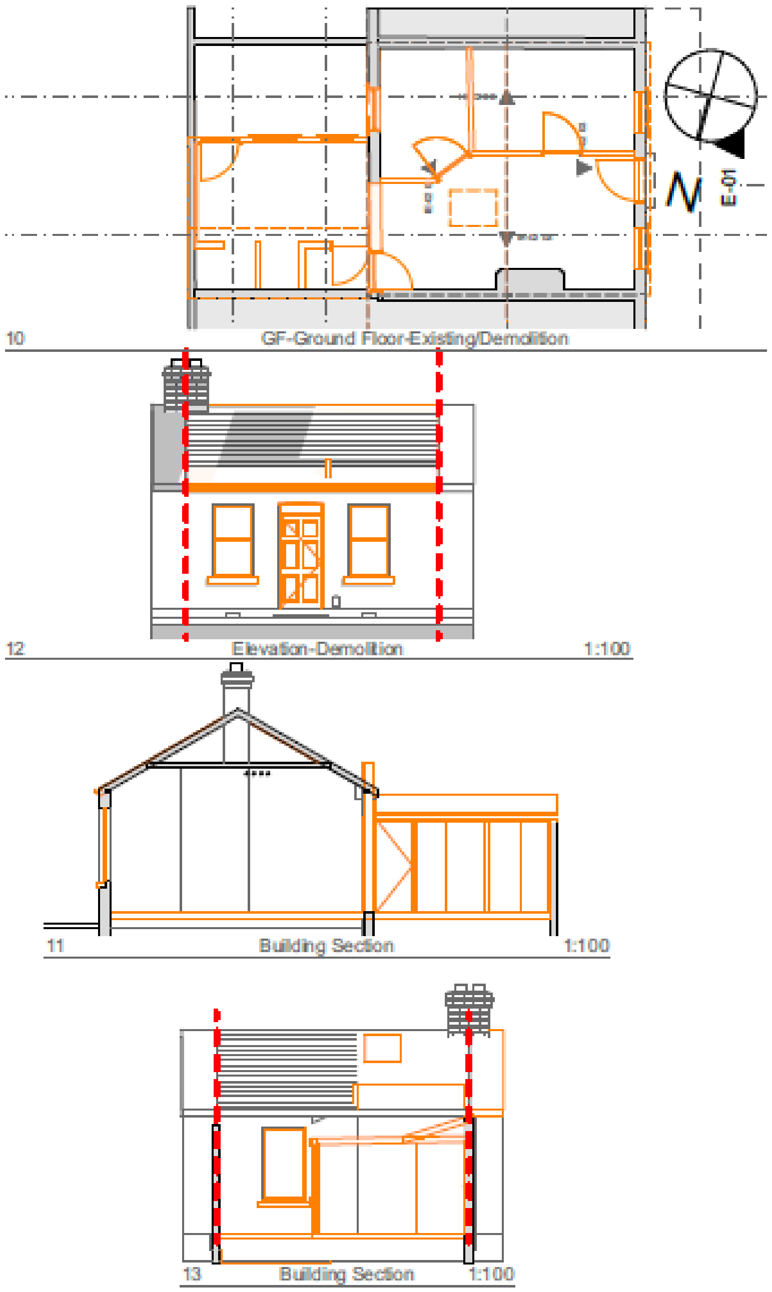
Extract "A Bristolian's Guide to Solid Wall Insulation" published by Bristol City Council

Demolitions, accommodation & design



Demolitions, accommodation & design





Detailing for low thermal bridging & & circularity

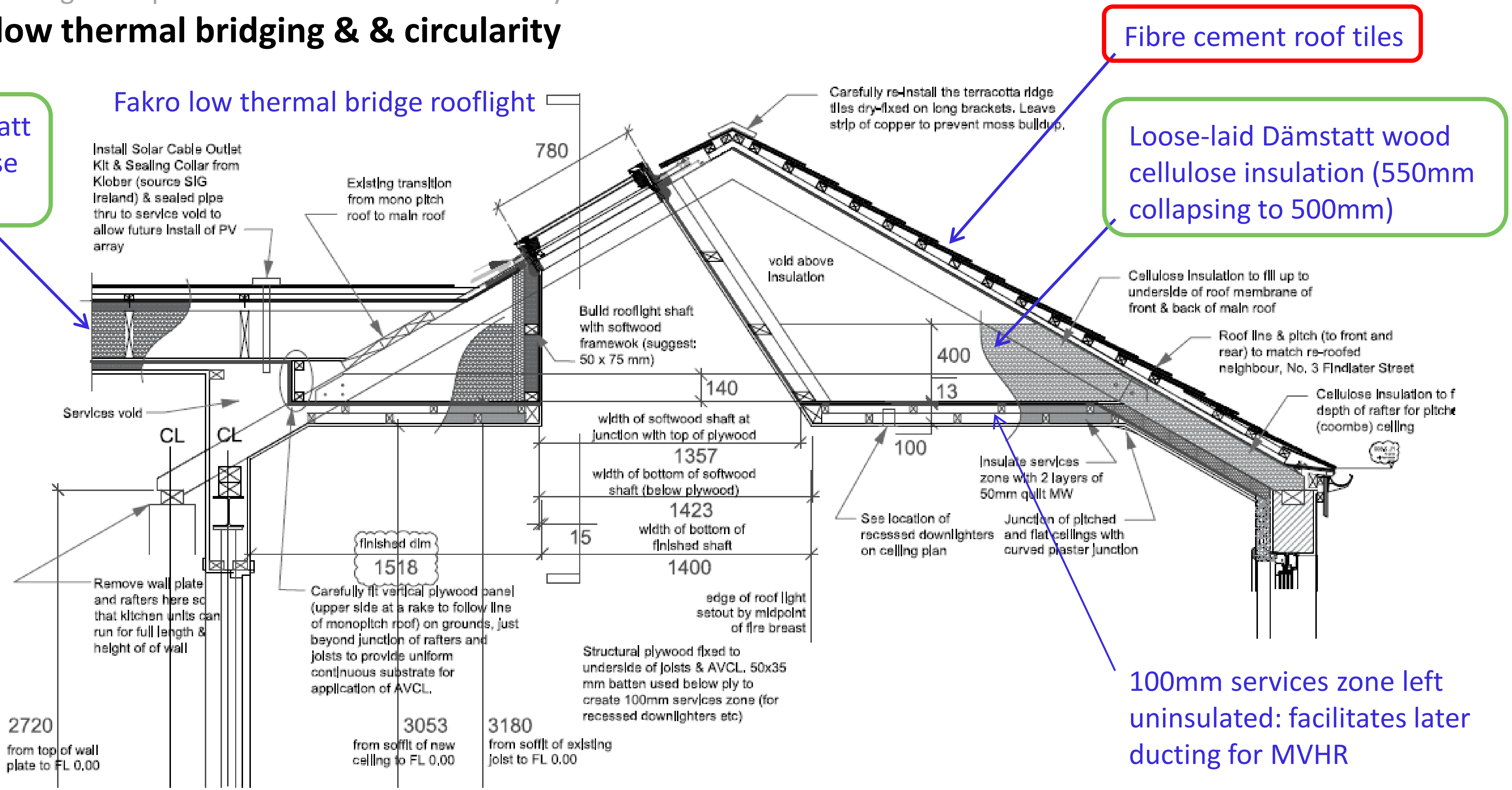
Energy Efficiency & decarbonising

- Super-low U-values in floors, roofs and timber frame extension
- Appropriate U-values for solid walls
- Airtightness: Q_{50} = <1.0 (m^3/m^2.hr) sought. Q_{50} = 1.6 achieved.
- Decarbonised heating and DCMEV ventilation on a tight budget.

Moisture-managing materials everywhere possible.

- No radon barriers or DPM and only capillary breaks where actually needed.
- Minimised petrochemically-based materials.
- Installed limecrete slab on 500mm foamed glass aggregate.
- Duct of radon sump rises up inside of lime-repointed chimney stack.
- 450mm paper cellulose in attic
- Rainscreen to rear

Detailing for low thermal bridging & & circularity



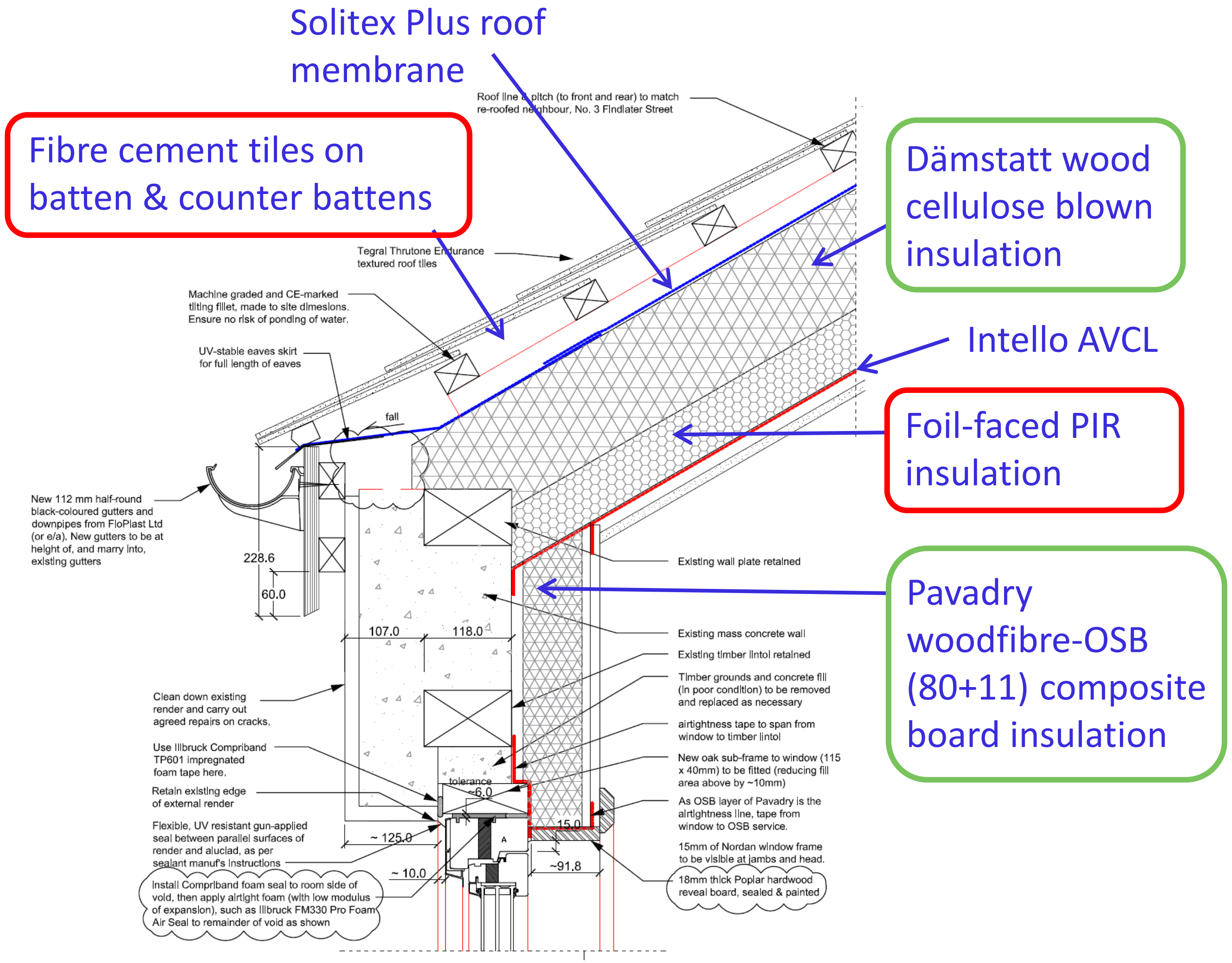
Biomaterial

Post consumer waste

High carbon

Element	Description	U-value (W/sqm.K)
Cottage roof	Attic void, services zone, 550mm paper cellulose (collapsing to 500mm)	0.08

Detailing for low thermal bridging & & circularity



Eaves detail over window of front solid wall

Biomaterial

Post consumer waste

High carbon

Element	Description	U-value (W/sqm.K)
Cottage front wall	Ext. render, mass concrete, 80+11 mm Pavadry	0.39
Cottage pitched roof	batten + counter batten, paper cellulose to depth of joists, PIR	0.15
Front door	Nordan Scand. Pine	1.10

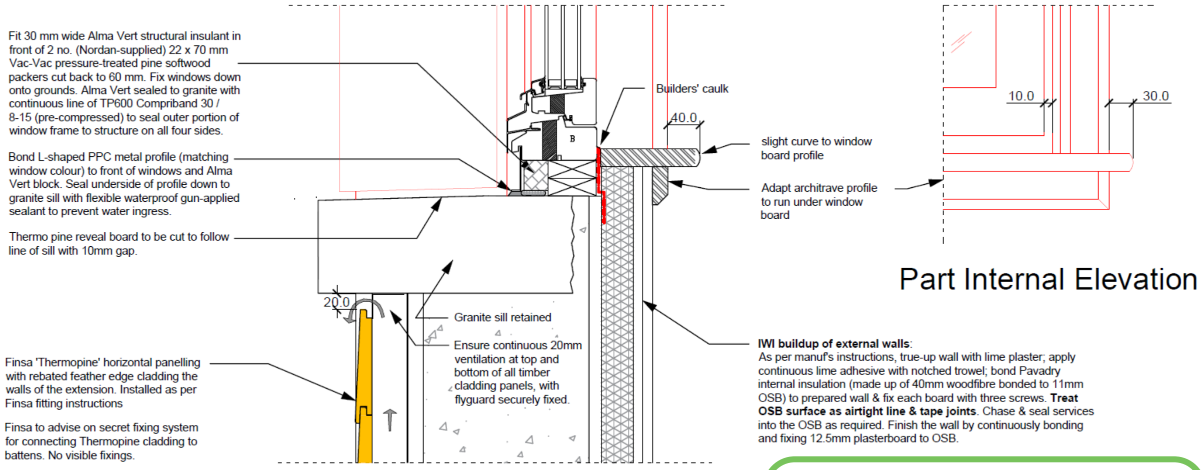
Detailing for low thermal bridging & & circularity

Biomaterial

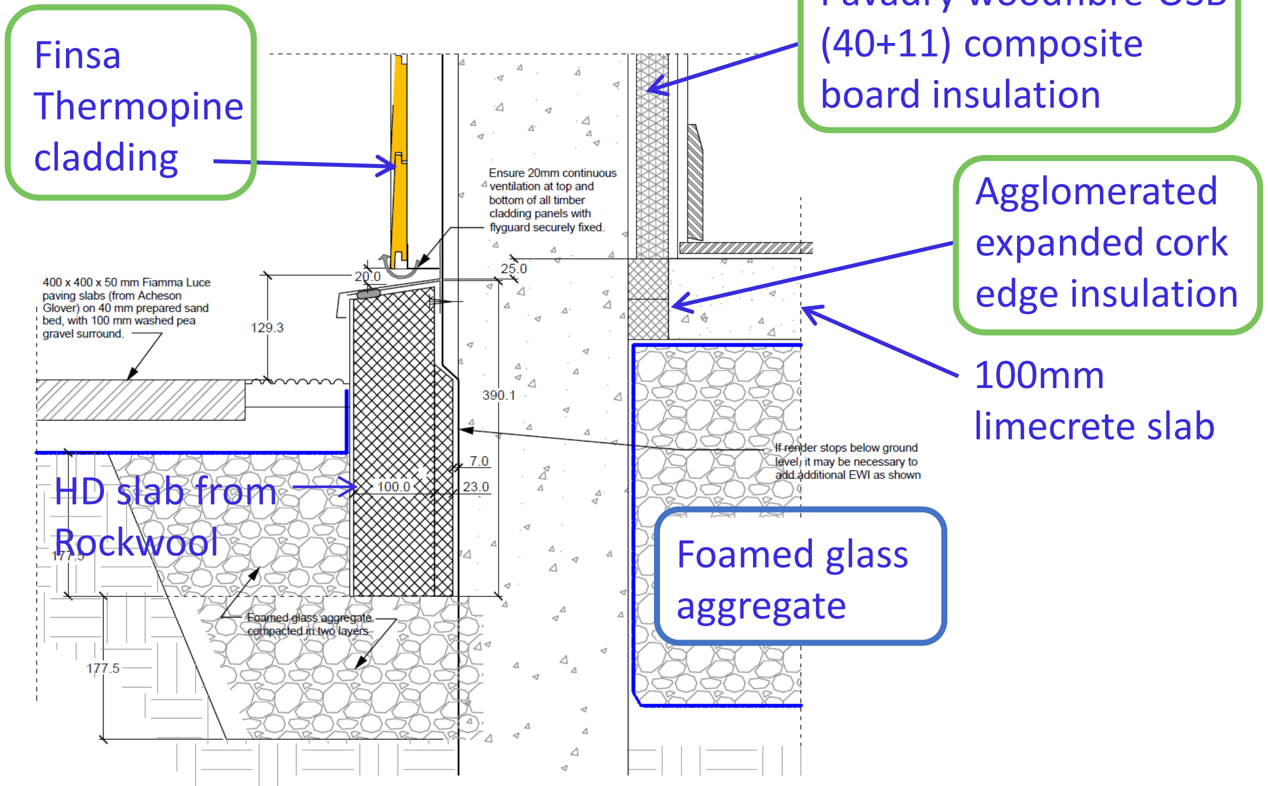
Post consumer waste

High carbon

Element	Description	U-value (W/sqm.K)
Cottage rear wall	Rainscreen, mass concrete, 40+11 mm Pavadry	0.52
Windows & patio door	Nordan PH Scand. Pine, triple glazed windows	0.77
Cottage & extension floor	510mm foamed glass aggregate, 100 limecrete slab with 50 cork edge insulation	0.12

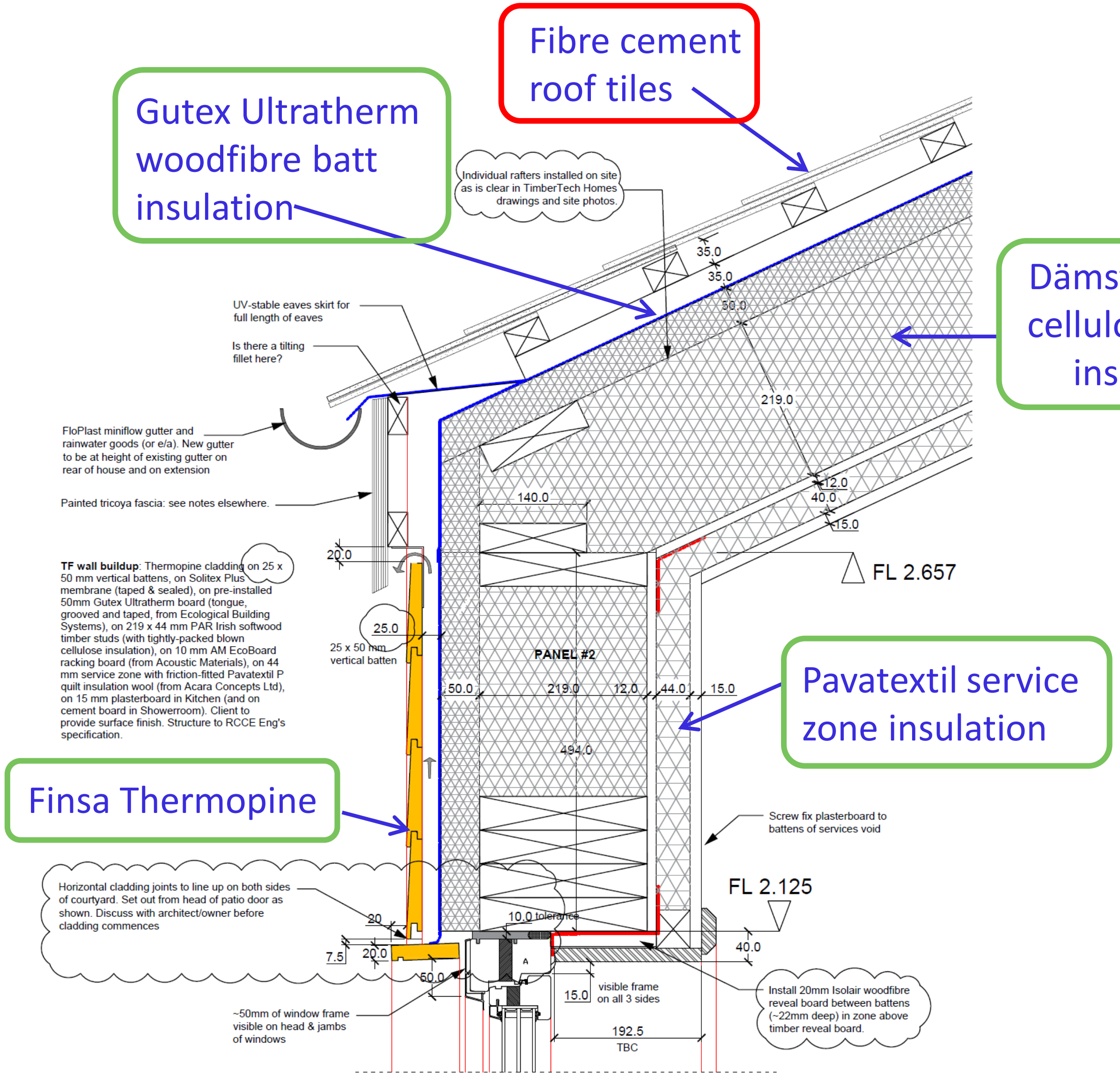


Nordan window sill W05



Base wall detail - front of house

Detailing for low thermal bridging & & circularity



Eaves detail over patio door of timber frame extension

Element	Description	U-value (W/sqm.K)
Windows & patio door	Nordan PH Scand. Pine, triple glazed windows	0.77
Extension walls	Rainscreen, 50mm woodfibre, timber stud with paper cellulose, Pavatextil services zone	0.16
Extension roof	Rainscreen, 50mm woodfibre, timber stud with paper cellulose, Pavatextil services zone	0.15

Detailing for low thermal bridging & & circularity

Biomaterial

Post consumer waste

High carbon

Element	Description	U-value (W/sqm.K)
Extension walls	Rainscreen, 50mm woodfibre, timber stud with paper cellulose, Pavatextil services zone	0.16
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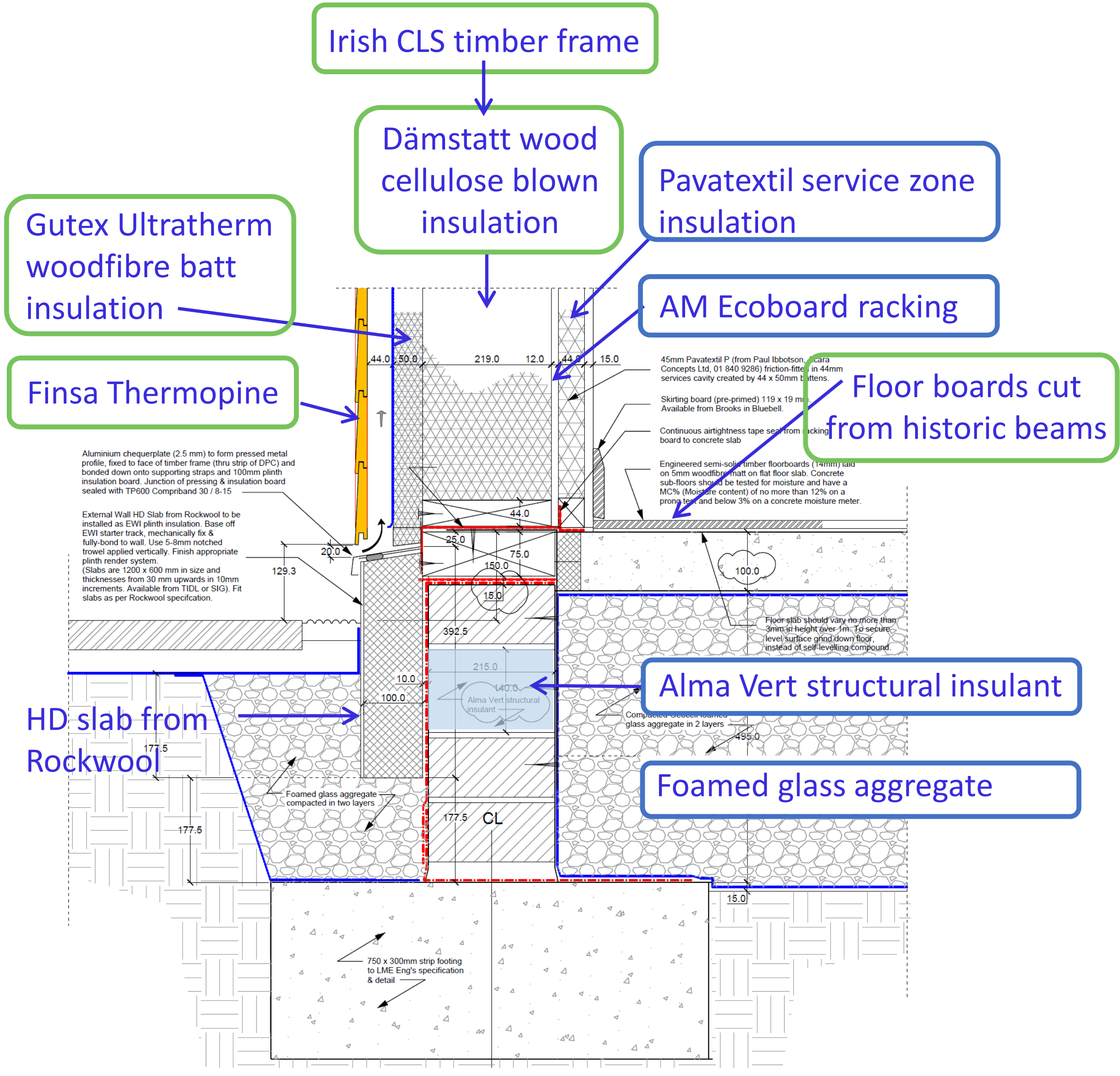
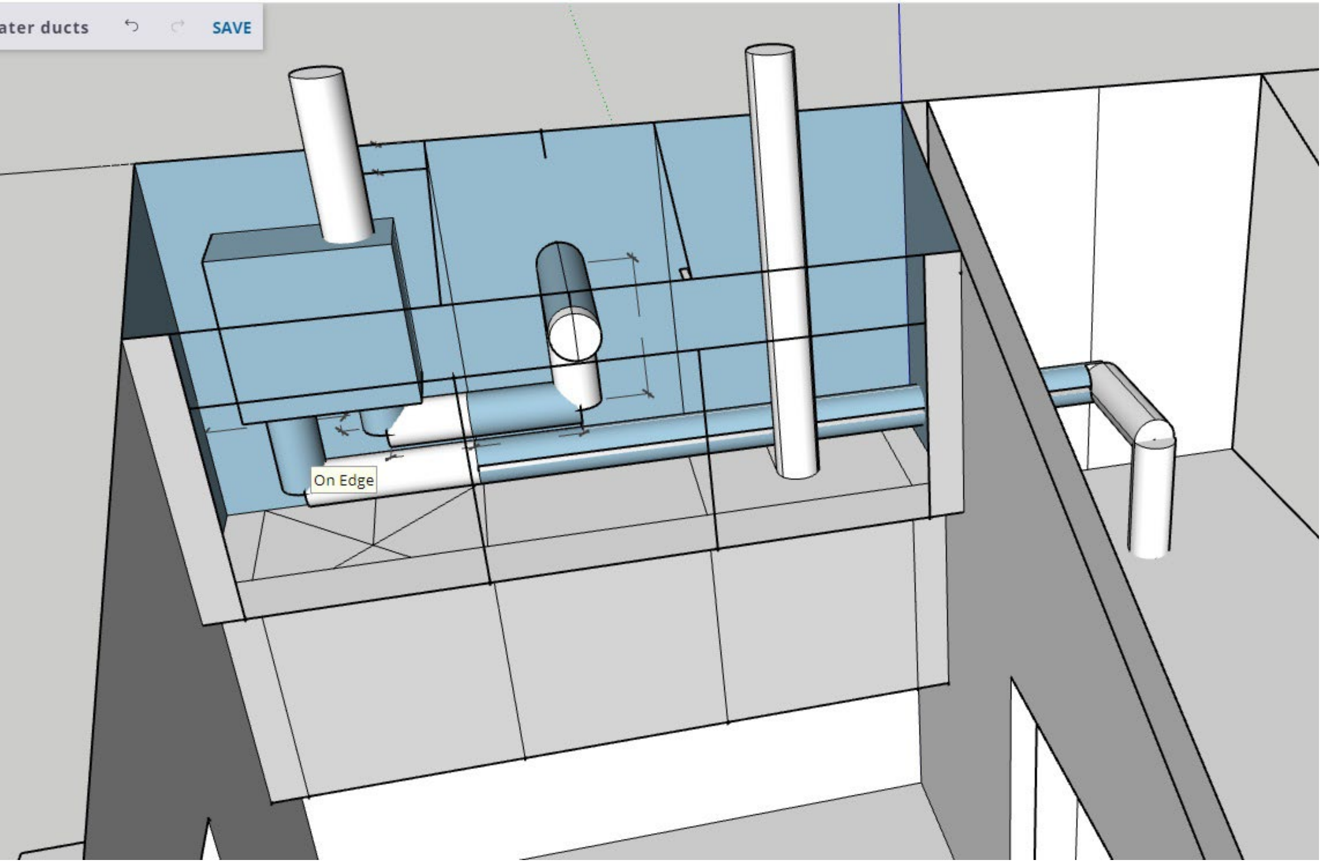


Base wall detail – Timber frame extension

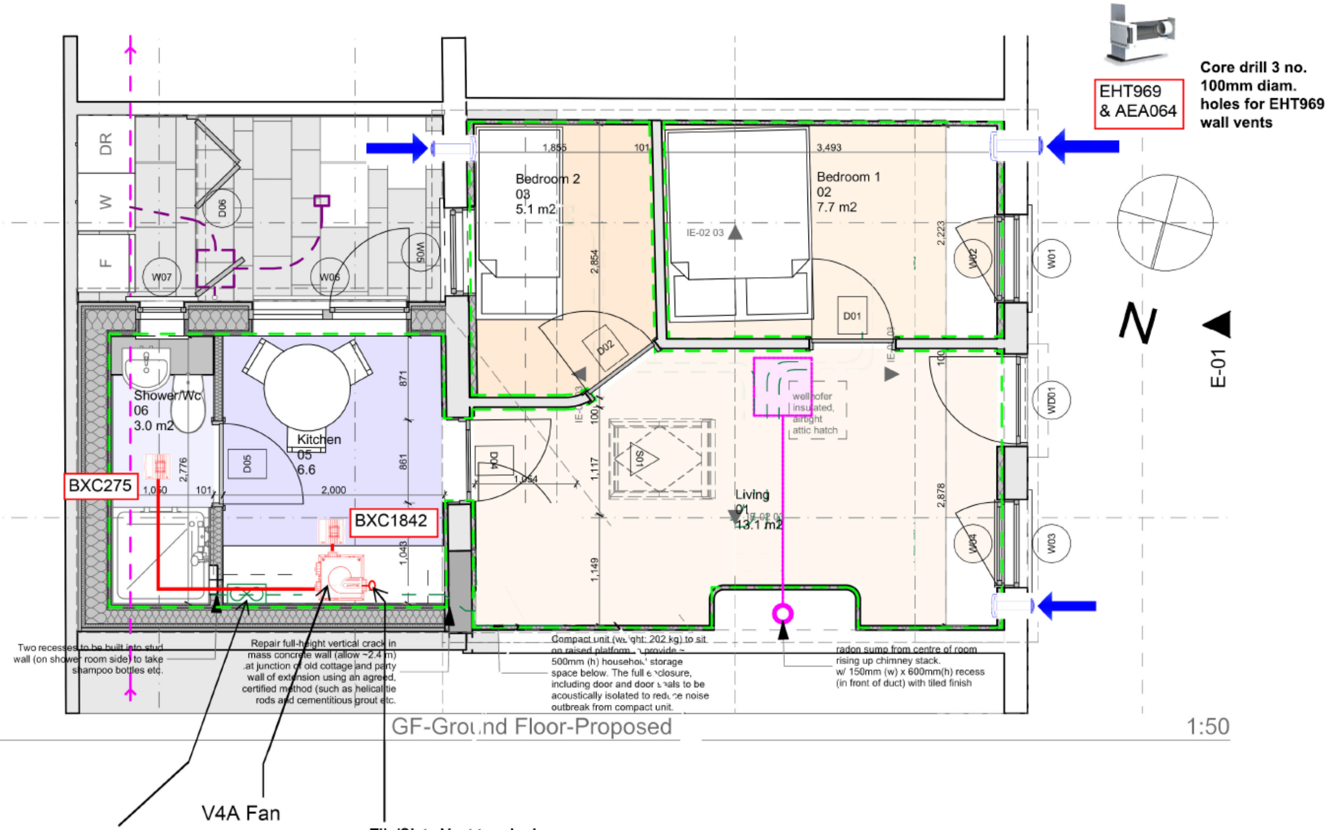
CL

Design decisions



Demand control mechanical Extract ventilation (DC MEV) from Aereco. Integration designed from outset

Design decisions



V4A fan is relatively quiet (35dB). To be wall-mounted with acousticaly attenuated fixings A good ductwork installation, will dissipate fan noise. Ensure min. 1.5m and 2 no. bends between fan and extract. See architect's sketch layout of ducting. A flexible connection at the fan would also help with any vibration transfer.
Ducting of kitchen extract duct & Aereco DCMEV to be:
a) 125mm diam., round & fully sealed.
b) ~9.5m run of round duct with 6 bends & 4 flexible connections to fans

Project Name: 4 Findlater Street, Dublin 7 - Rev1
Date: 26/02/21
Ref: 210273
Drawn by: CL
Total floor Area:37m²
Gen Rate:21l/s
System Cap: 29l/s
Fan Selection: 1No.V4a (58l/s)
Design as per TGD Part F 2019

AERECO air on demand

Revisions by JL 01/03/21

Ventilation Validation for Aereco System

Greenbuild testing & consultancy

Dwelling address	**4 Findlater Street, Dublin 7**
Dwelling type	**Mid Terrace, single storey**
Total floor area	**37.00** m^2
Ventilation system	Aereco DCMEV
Date of test	19/10/2022
Installer/builder (if applicable)	
System Capacity Requirement	**26.25 l/s**
Fan Name & Capacity	**Aereco V4a: 58 l/s**
Validation certificate number	1.92.001.22.247

Extract Unit	**Measured Pressure Above 60 Pa**		**Secondary Shutter Position**		**Boost function working? (where applicable)**	
	Yes	**No**	**Design**	**Checked**	**Yes**	**No**
Kitchen	82.00		0	0		
Bath room	81.00		0	0	x	
Bathroom/Ensuite (1)						
Sanitary accommodation (no bath or shower) (1)						
Bathroom/Ensuite (2)						
Bathroom/Ensuite (3)						
Other						
Fault Indicator extract grille BXC-hps	Location Room	kitchen		Is the light green	x	

Background Ventilator (supply air)	**Aereco Inlets Yes/No?**		**Correctly installed?**		**If not Aereco inlet >2500mm2?**	
	Yes	**No**	**Yes**	**No**	**Yes**	**No**
All	x		x			

Overall comments:-

Indicator light and PIR function battery operated

Comments on design:-

Section 3.24 of the NSAI Ventilation Validation scheme requires an assessment by the validator as to whether the system design is in accordance with the 2019 Building Regulations Part F.
As per TGD F 2019 section 1.2.1.10, the ventilation validation procedure is to ensure that the installed flows of a mechanical ventilation system match the flows required by the system design.
Assessing a system with the Ventilation Validation Procedure to the 2019 Part F does not mean that the installation is necessarily subject to that regulation.
For Aereco systems based on pressure the procedure then is principally to check that the pressures measured match or exceed the minimum pressures required by the design.
In this home, the pressures measured are acceptable when compared to the minimum agrément pressures
Other aspects of the 2019 Part F requirements are not part of the validation procedure but may be noted in the general comments section, above.

Reference fan capacities:	V2a: 22 l/s	V4a: 58 l/s	VAM: 69 l/s	V5S: 69 l/s

Validator	**Gavin Ó Sé - NSAI Reg no. 1.92.001**
Report print date & time	**27/10/2022 13:22**

Sheet template : version 10.11.2021 - 1.31

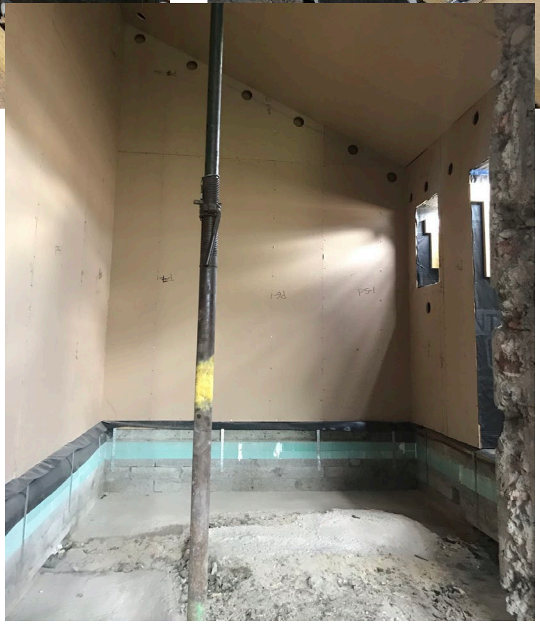
Technical design support and 3rd party certification

Construction works

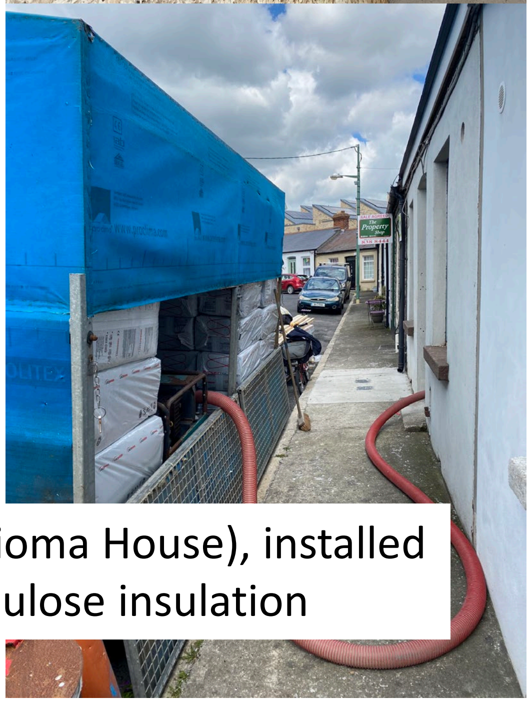
Construction works

Construction works

Construction works



Construction works



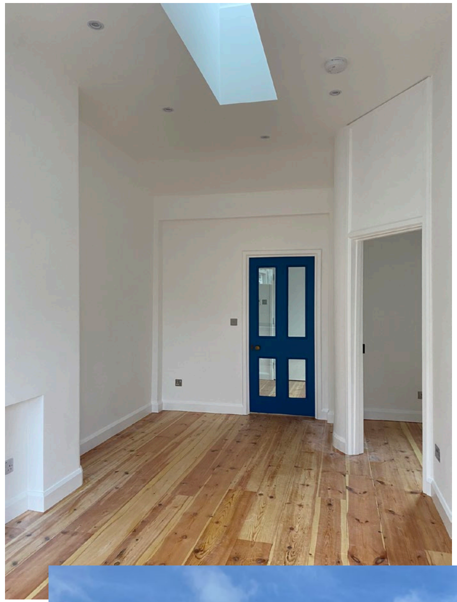
National expert Roman Szipura (& his team in Clioma House), installed the airtightness membranes and later blown cellulose insulation

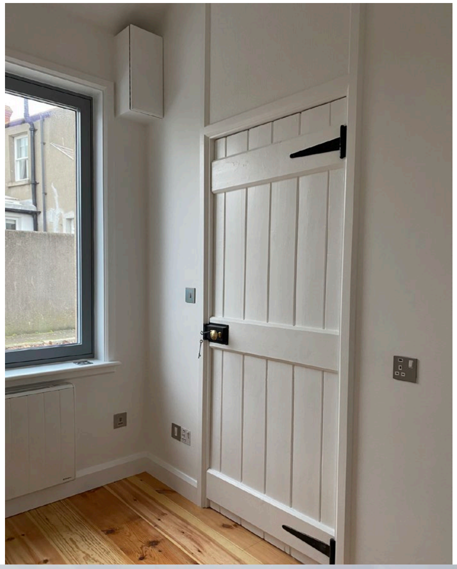
Construction works

Gavin Ó Sé (Greenbuild Energy Rating & Building Information Services Ltd) carried out two diagnostic air tightness testing (ATT) with on-hand support of builder and client.

A range of leaks were found and eradicated. Plenty of additional tape was necessary! The target of N_{50} = <1.0 was not achieved. We achieved Q_{50} = 1.6)

Almost there!!





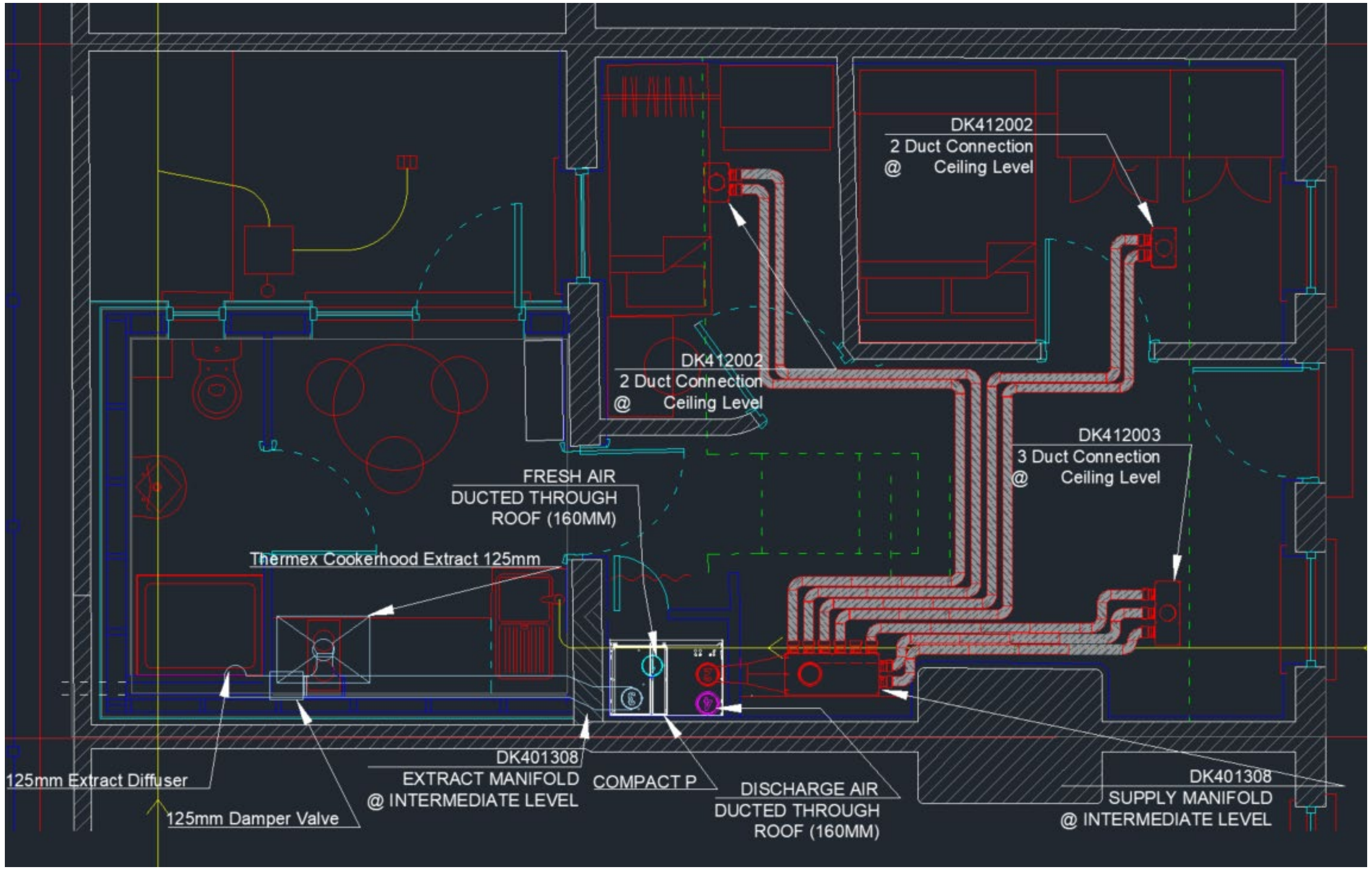
Circularity in action

1

RETHINK

HP & MVHR

Omitted these after review of space available & budget.

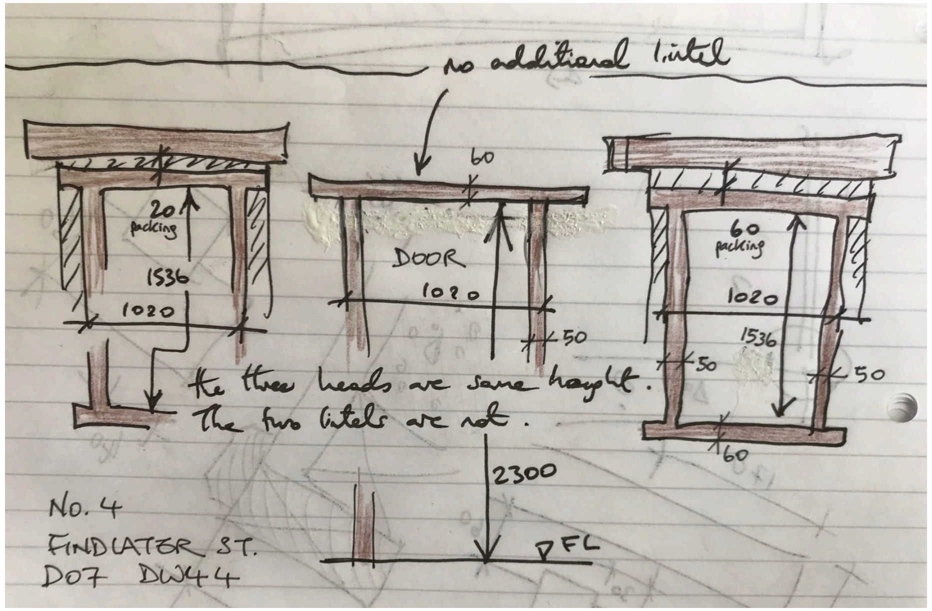


Circularity in action

1

RETHINK

Window sub-frames



Circularity in action

2

Roof structure:	Pressure from foreman and first engineer to demolish & replace roof structure
Internal doors:	Pressure to go with new internal doors

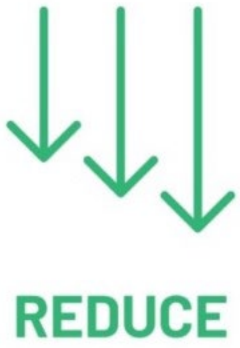
The first structural engineer and builder's foreman tried to persuade clients to remove all the original timber:

> Engineer: *'I won't certify the roof if it's not new structural timber.'*
> Foreman: *'Ah, you want a proper job. You need to have a roof structure that'll last another 100 years!'*

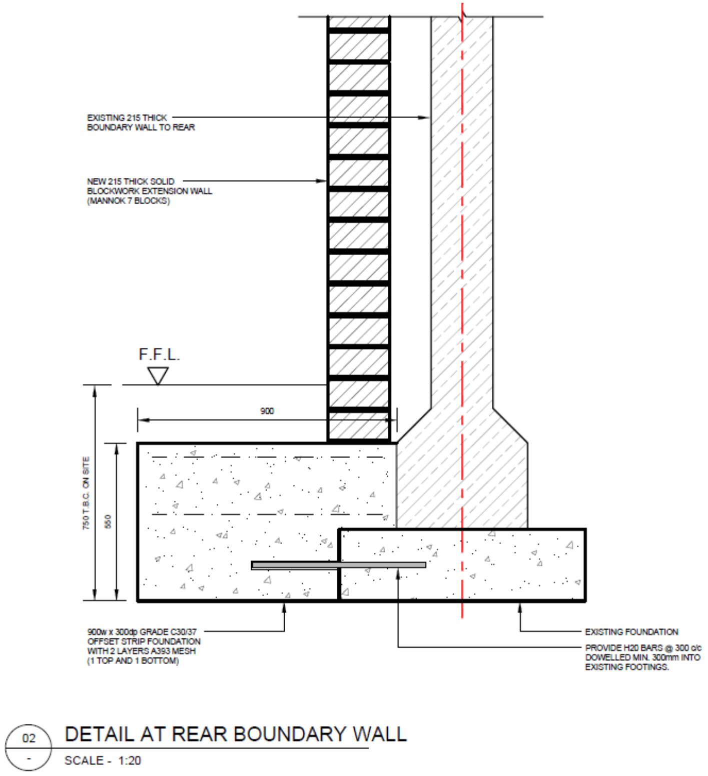
It was only when client and roofer were on scaffold looking at roof structure up close that it was clear original timbers were in excellent condition, even the wall plates. Only the timber eaves fascia were rotted or in poor condition.

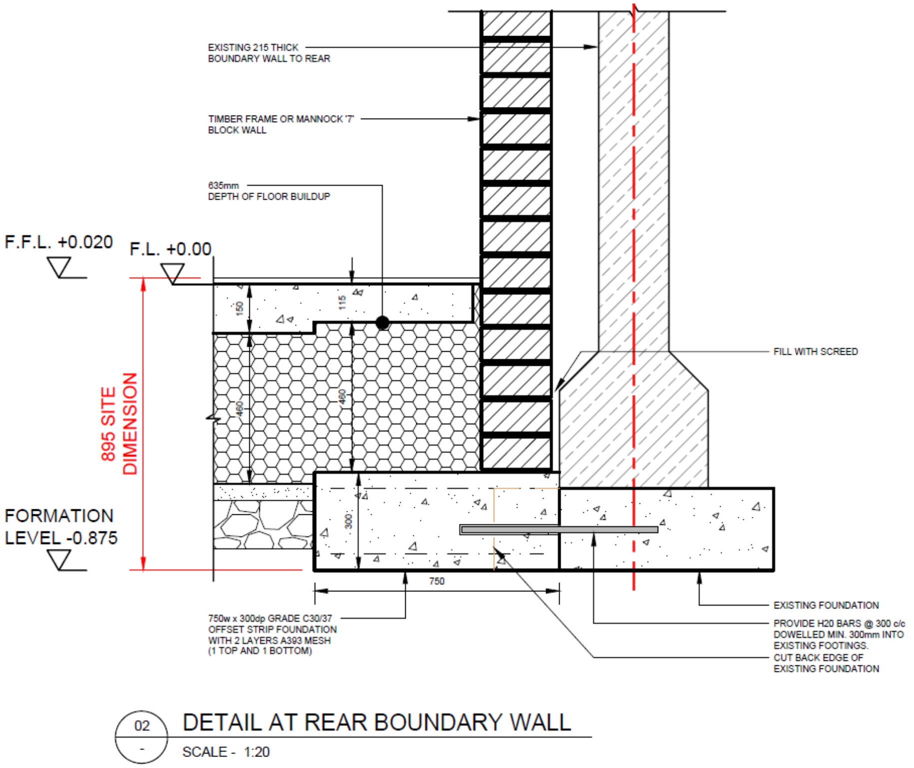
Circularity in action

3



Footings	Reduced footings of extension significantly
Slab thickness	Reduced from 150 to 100mm





Circularity in action

4

REUSE

Structure

External mass concrete solid walls & foundations.

Granite door threshold and sills

Baltic Pine roof structure (incl. wall plates)

Terracotta roof ridge tiles

Circularity in action

4

REUSE

Joinery & Fittings

Internal original ledged TGV doors

Retained original hinges of internal doors

Introduced door removed from parent-in-law’s house!

Design decisions

5

REPAIR

Walls	Installed about 15 stitching rods with repair mortar
Kitchen door	Tried to remove 10mm distortion: didn’t succeed. Adjusted door frame instead!

Circularity in action

5

REPAIR

Chimney

New pots, re-pointing,new haunch

Circularity in action

6

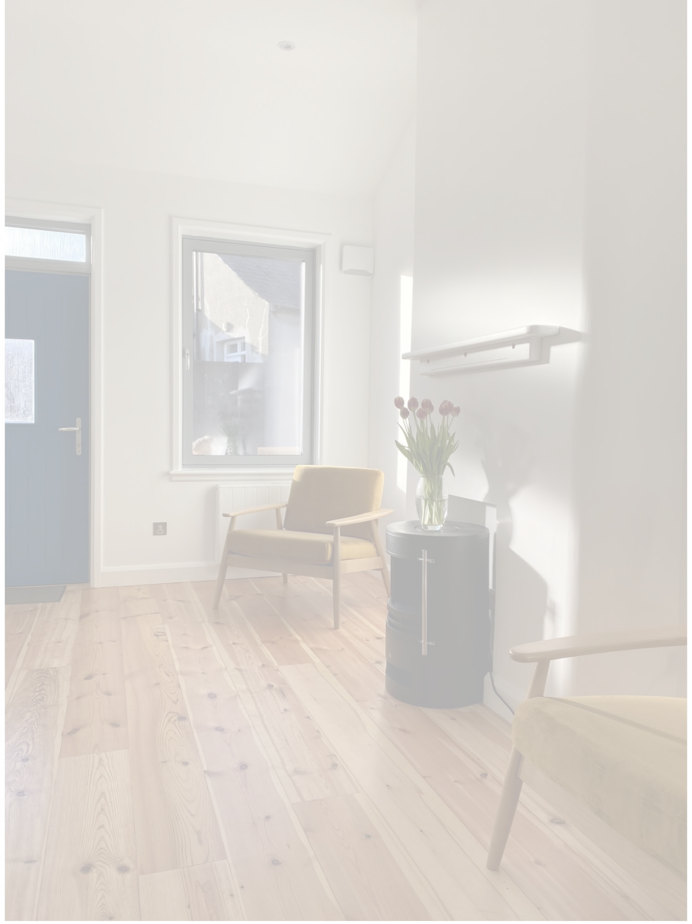
RECYCLE

Plastic bottles	Structural insulants
Glass bottles	Floor insulation, sub-floor structure & capillary break
Newspapers	Roof and timber frame wall insulation
Tetrapax	Racking board
Wood fibre waste	Woodfibre insulation
Jeans	Services zone insulation
Old pine beams	New floor boards

SEAI Energy Show - Exploring a Deep and Circular Retrofit Case Study

30th March

Thank you

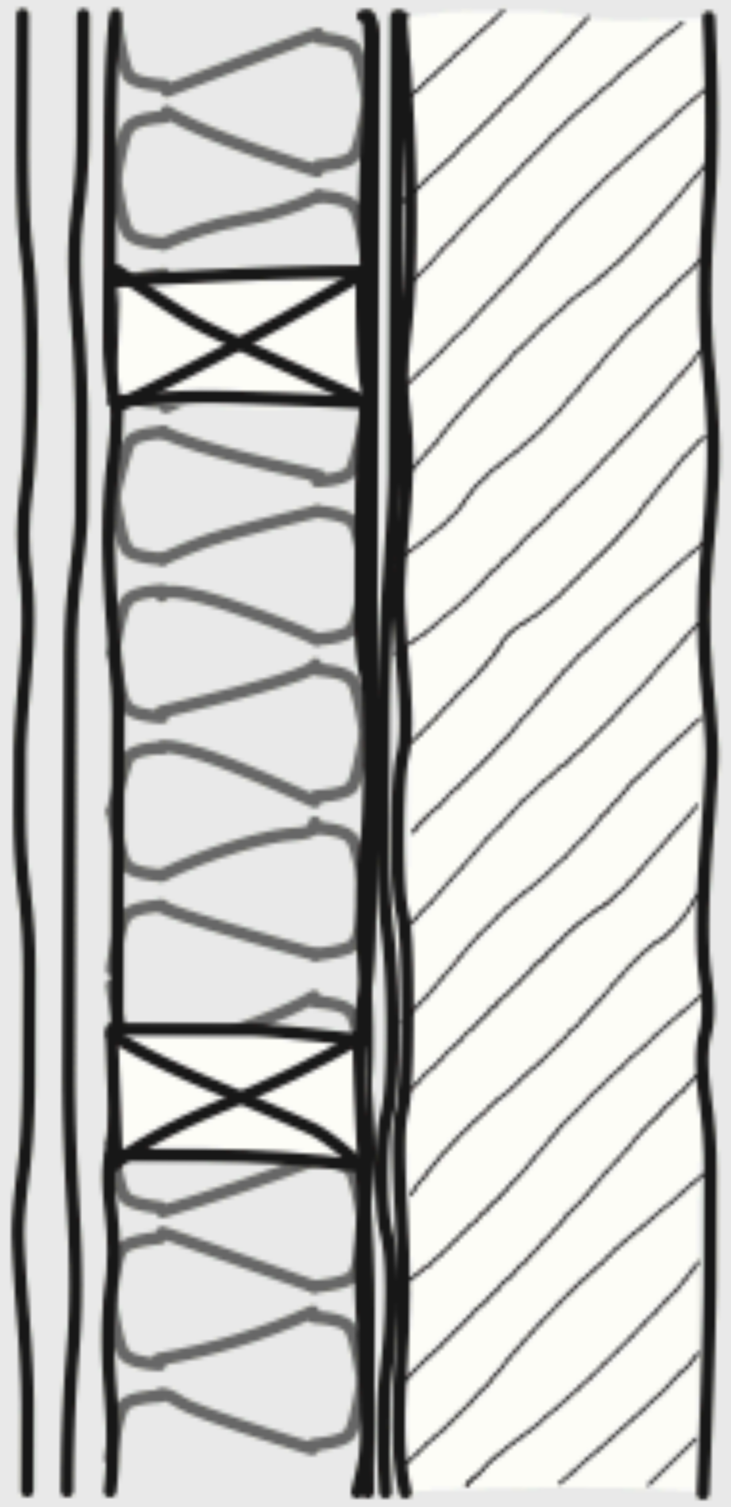


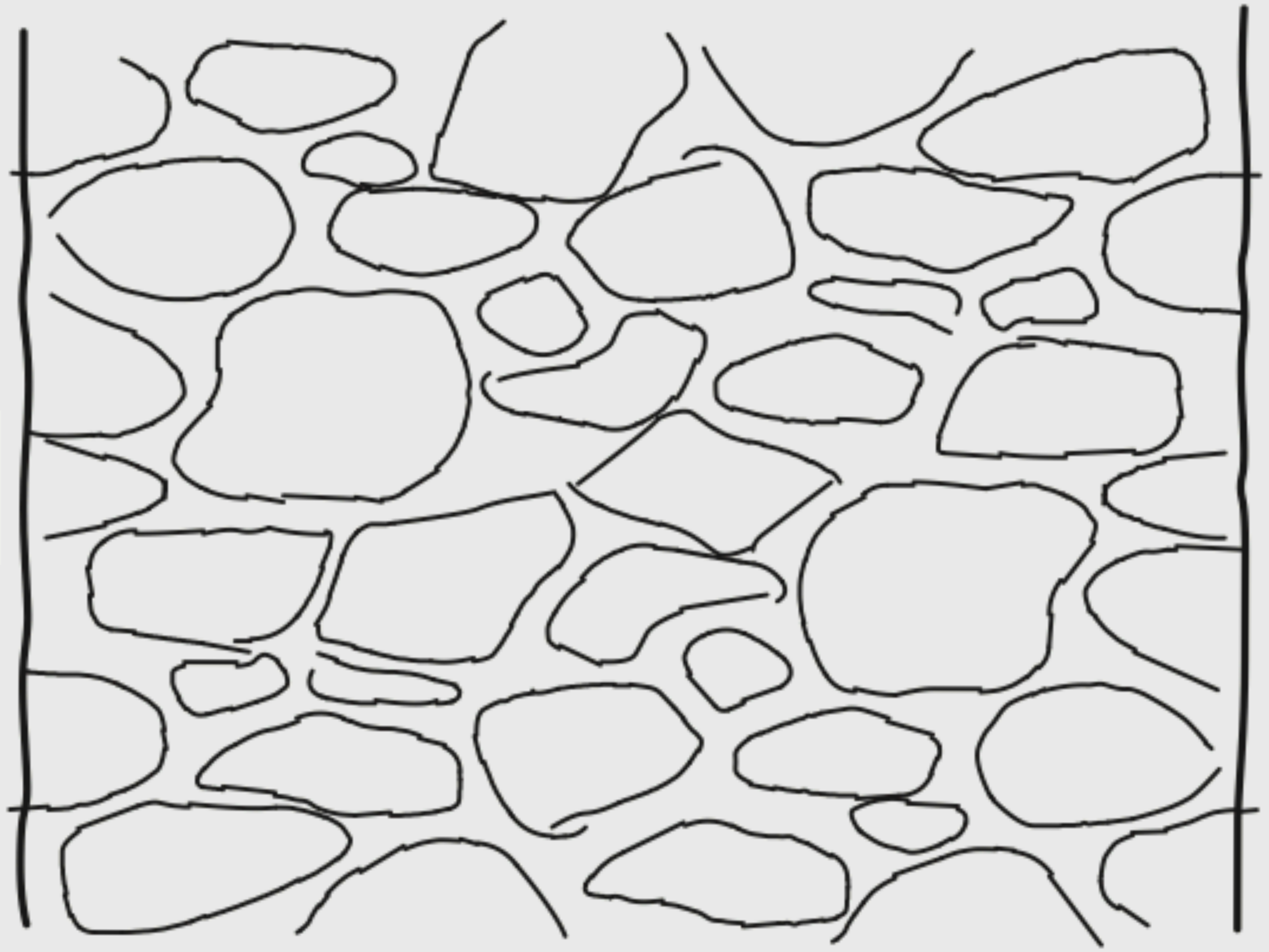
Joseph.little@tudublin.ie

FabTrads

Project Introduction

Oliver Kinnane, Rosanne Walker, Anna Hofheinz, Caroline Engel-Purcell. 30th March 2023.





GEOLOGICAL MAP OF
IRELAND
FOUNDED ON THE MAPS OF THE GEOLOGICAL SURVEY
OF SIR RICHARD GRIFFITH AND OF PROF^{R} J. BEETE JUKES.
BY EDWARD HULL, M.A. F.R.S.
Director of H.M. Geological Survey of Ireland.
CHARACTERS & ABBREVIATIONS
ATLANTIC OCEAN
NORTH CHANNEL
IRISH SEA
ST GEORGE'S CHANNEL
INDEX TO THE GEOLOGICAL COLOURS
AUTHORITIES
VISUAL

S5 Age bands

A set of age bands is defined according to Table S1 for the purposes of assigning U-values and other data.

Table S1: Age bands

Age band	Years of construction
A	before 1900
B	1900-1929
C	1930-1949
D	1950-1966
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J	2005 onwards (without BER certificate already)

Table S2: Building Regulations summary[1]

Year of regulations	Applicable age band	U-values (W/m^2K)		
		Roof	Wall	Floor
1976 (Draft)	F[2]	0.4	1.1	0.6
1981 (Draft)	G	0.4	0.6	0.6
1991	H[3]	0.35	0.55	0.45/0.6
1997	I	0.35	0.55	0.45/0.6
2002	J	0.25	0.37	0.37

S6 Constructional types and U-values

U-values of construction elements are determined from the constructional type and date of construction. U-values are assessed separately for the main part of the dwelling and for any extension. Where Building Regulations are available, the associated U-value from Table S2 is used. Any other walls with insulation can have non default U-values entered.

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This section details default wall U-values where there is insufficient information to enter non-default U-values. Lookup of the defaults in Tables S3 and S3a are automatically referenced by DEAP software. Values from Table S3b are entered into DEAP by the user.

Table S3: Exposed wall U-values[1]

Age Band	A	B	C	D	E	F	G	H	I	J
Wall type										
Stone	2.1	2.1	2.1	2.1	2.1	1.1	0.6	0.55	0.55	0.37
225mm solid brick	2.1	2.1	2.1	2.1	2.1	1.1	0.6	0.55	0.55	0.37
325mm solid brick	1.64	1.64	1.64	1.64	1.64	1.1	0.6	0.55	0.55	0.37
300mm cavity	2.1	1.78	1.78	1.78	1.78	1.1	0.6	0.55	0.55	0.37
300mm filled cavity	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.55	0.55	0.37
solid mass concrete	2.2	2.2	2.2	2.2	2.2	1.1	0.6	0.55	0.55	0.37
concrete hollow block	2.4	2.4	2.4	2.4	2.4	1.1	0.6	0.55	0.55	0.37
timber frame	2.5	1.9	1.9	1.1	1.1	1.1	0.6	0.55	0.55	0.37
Unknown	2.1	2.1	2.1	2.1	2.1	1.1	0.6	0.55	0.55	0.37
425 mm Cavity Wall	1.73	1.51	1.51	1.51	1.51	1.1	0.6	0.55	0.55	0.37
425 mm filled cavity	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.55	0.55	0.37

If the dwelling is of age band F or G but the roof of the dwelling is shown to have no insulation, then the wall must be assumed to be age band E (no insulation)

[1] These U-values may be used as a starting point for calculating U-values of similar walls with insulation provided evidence is available to substantiate the insulation levels used in any U-value calculations.

DEAP

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300mm cavity	2.1	1.78	1.78	1.78	1.78	1.1	0.6	0.55	0.55	0.37
300mm filled cavity	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.55	0.55	0.37
solid mass concrete	2.2	2.2	2.2	2.2	2.2	1.1	0.6	0.55	0.55	0.37
concrete hollow block	2.4	2.4	2.4	2.4	2.4	1.1	0.6	0.55	0.55	0.37
timber frame	2.5	1.9	1.9	1.1	1.1	1.1	0.6	0.55	0.55	0.37
Unknown	2.1	2.1	2.1	2.1	2.1	1.1	0.6	0.55	0.55	0.37
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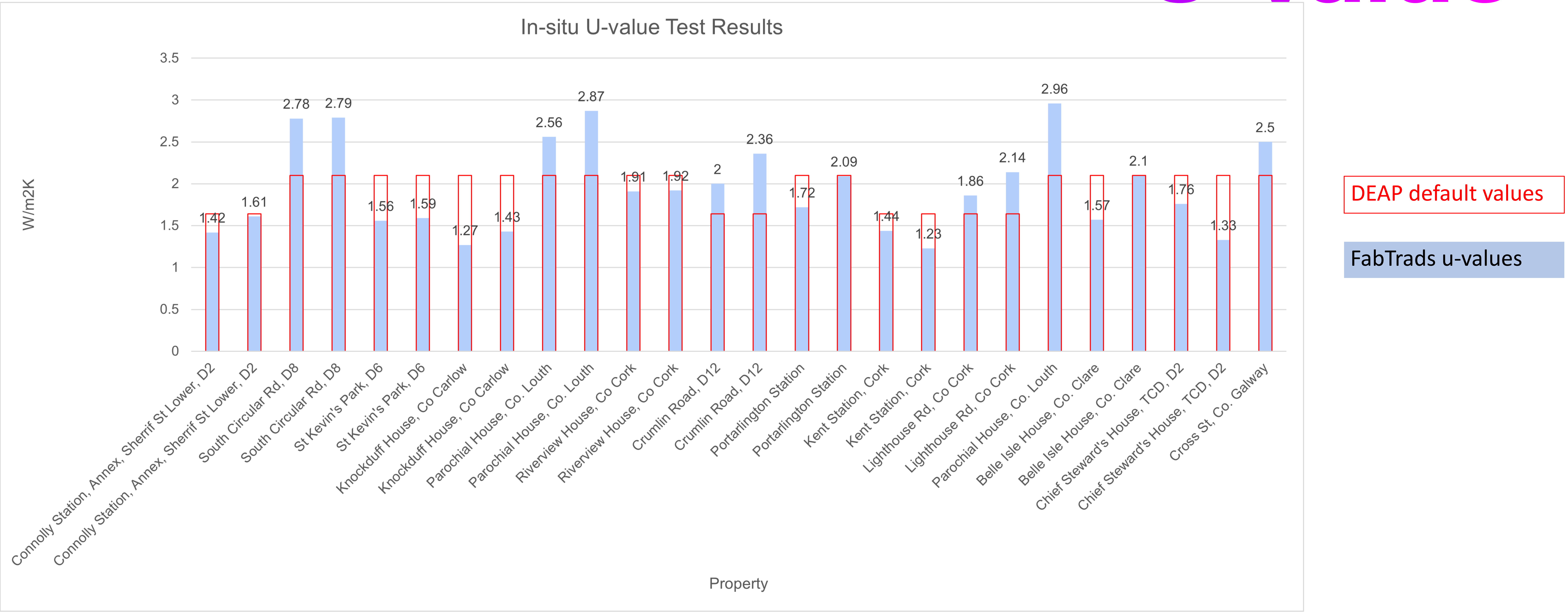
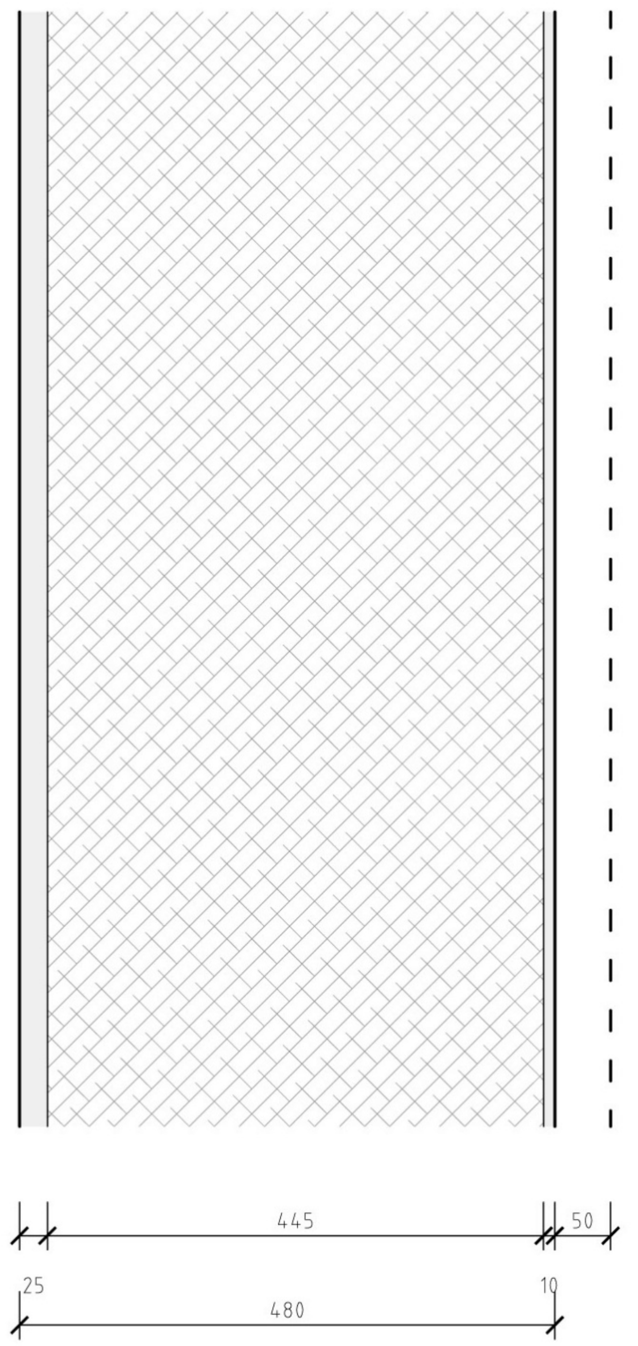
In-situ U-value



Knockduff House, Co. Carlow

- c. 1740
- U-value testing: 13-12-2022
- 1.35 W/m²K

DETAIL SECTION



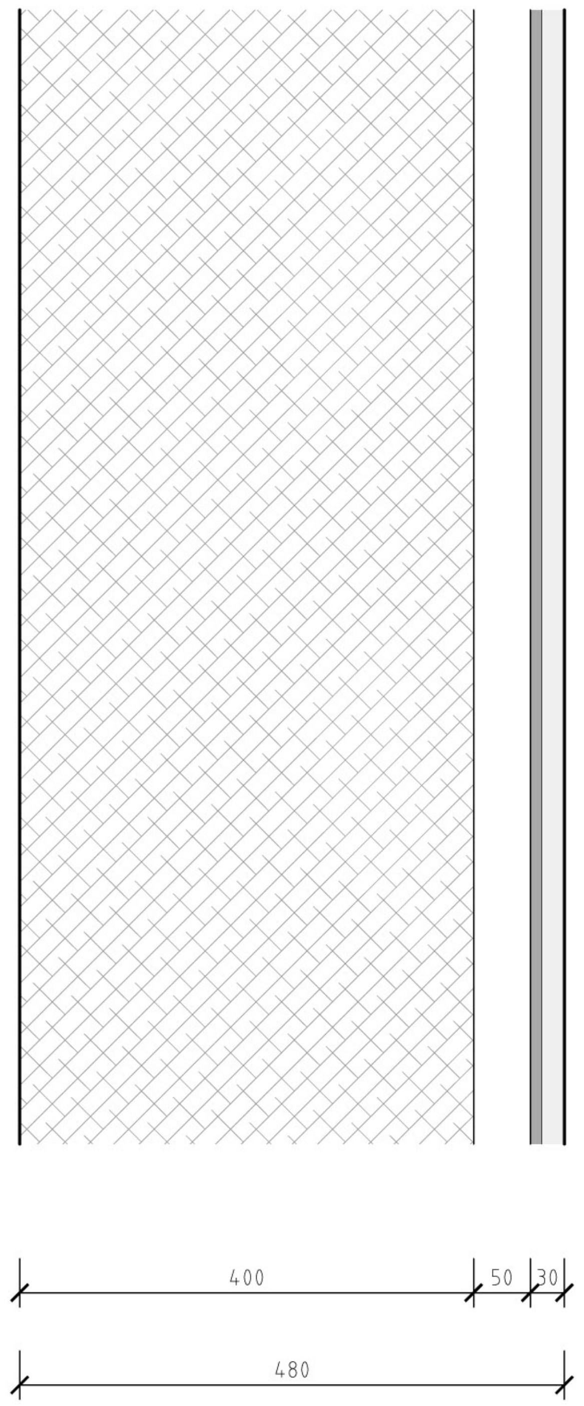
KNOCKDUFF HOUSE, CO. CARLOW

OVERALL DEPTH: 480MM
ASSUMED ASSEMBLY:
25MM EXTERNAL LIME RENDER
445MM GRANITE RUBBLE WALL (G1 GRANITE AND LIME MORTAR)
10MM INTERNAL LIME SCUD COAT
(50MM PROPOSED DIATHONITE CORK LIME INSULATING PLASTER)

Portarlington Station, Co. Laois

- ca. 1850
- U-value testing: 24-01-2023
- 1.91 W/m²K

DETAIL SECTION



PORTARLINGTON STATION, CO. LAOIS

OVERALL DEPTH: 480MM
ASSUMED ASSEMBLY:
400MM LIMESTONE RUBBLE WALL (L2 LIMESTONE AND LIME MORTAR)
50MM TIMBER BATTENS / UNVENTILATED CAVITY
30MM LATH AND LIME PLASTER

Stone

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From site to lab

Main focus of work in laboratory testing

- sequence of testing (taking into account destructive nature of some tests)
  - Capillary absorption (water absorption coefficient)
  - Bulk density (apparent density / open porosity)
  - Free saturation
  - Vapour permeability (vapour diffusion resistance factor)
  - Thermal Conductivity
  - Drying test (redistribution)
  - Moisture adsorption (sorption isotherms)

- Phase 1 testing (11 samples) – main elements complete, with drying test, vapour diffusion resistance & thermal conductivity at ca. 90%, moisture adsorption outstanding (combine with Phase 2)

- Phase 2 testing (9 samples) – ongoing, capillary absorption complete

Material lab tests

Thermal conductivity testing

- To ASTM 5334:2022 (transient line source) vs EN 12664 (steady state, guarded hot plate)
- At 30-50% RH, 80% and saturation (tbc)
- approach discussed and agreed with Fraunhofer IBP / WUFI
- Issues:
  - Highly inhomogeneous materials (bricks) lead to high variability in results
  - Ensuring sufficient contact with paste

Capillary absorption testing

- ISO 15148:2002
- Different setups for highly absorptive and unabsorptive samples required
- Issues:
  - evaporation on unabsorptive samples (sleeves / cowls and covering between reads)
  - Capillary action between foil and sample (bottom 2cm uncovered)

Vapour permeability

- To ISO 12572:2016
- Moisture transfer through sample from 50% RH (chamber) to 0% RH (over salt) – dry cup

- extended to include testing of vapour permeability of water repellent / hydrophobising treatments

Material lab tests

Bulk Density testing

- EN 1936:2006
- Vacuum chambers with water inlets
- underfloor weighing of sample submerged in water and weight of wet dabbed sample

Moisture adsorption

- To ISO 12572:2012
- Moisture content at equilibrium at different RH in climate chamber
- 50%, 80%, 95%, 98% tbc
- Phase 1 and 2 (possibly 3 and 4) to be combined due to small size of samples
- Equipment issue ongoing

Free Saturation

- To EN13755:2008
- Water absorption at atmospheric pressure
- To be established – at which point is free saturation exceeded by diffusion into pores (assumed 3days)
- Expression of results in accordance with WUFI kg/m3

Comparison preliminary FabTrads results with literature values (incl. WUFI)

source	material	apparent density (kg/m3)	porosity (% vol)	thermal conductivity (dry) (W/mK)	water vapour diffusion resistance factor (dry)	water absorption coefficient (kg/m2s0.5)	free water saturation (kg/m3)	reference water content (80% RH) (kg/m3)
GRANITE								
ISO 10456 design values	Granite (lower value)	2500.00		2.80	10000.00			
ISO 10456 design values	Granite (upper value)	2700.00		2.80	10000.00			
Brachot (industry)	Tarn granite (France)	2670.00	0.20					
Brachot (industry)	Rose de la Clarté granite (France)	2710.00	0.50					
WUFI MASEA database	Granite (TU Dresden)	2453.00	9.50	1.66	54.00	0.0086	50.00	7.30
FabTrads - Carlow Granite	G1_KH_CW_2022-5-22	2553.69	3.00	2.29	tbc	0.0042	23.84	tbc
LIMESTONE								
ISO 10456 design values	limestone (extra soft)	1600.00		0.85	30.00			
ISO 10456 design values	limestone (extra hard)	2600.00		2.30	250.00			
Siegesmund, Graue, 2011	Muschelkalk (German)	2250.00	16.03		60.35	1.3000		
Brachot (industry)	Kilkenny limestone	2680.00	0.40					
WUFI Fraunhofer IBP database	Krensheimer Shelly limestone (inhomogeneous)	2440.00	13.00	2.25	140.00	0.0000	75.00	2.50
WUFI LTH Lund University database	Limestone Öland (reddish brown)	2650.00	0.04	3.00	35.70	n/a	n/a	11.00
FabTrads - Laois Blue Limestone	L2_PS_LS_2022-08-03	2673.70	0.52	2.51	tbc	0.0003	3.92	tbc
	L3	2634.06	1.19	tbc	tbc	0.0004	tbc	tbc
FabTrads - Portland stone	L6	2178.66	18.52	tbc	tbc	0.0825	tbc	tbc
SANDSTONE								
ISO 10456 design values	sandstone (silica)	2600		2.30	40			
Siegesmund, Graue, 2011	sandstone (German)	2143.33	18.76		17.42	4.9467		
WUFI Fraunhofer IBP database	Worzeldorfer Sandstone (German)	2263.00	13.00	1.80	26.00	0.0160	110.00	10.40
WUFI Fraunhofer IBP database	Zeitzer Sandstone (German)	2300.00	5.00	2.30	70.00	0.0030	40.00	6.00
WUFI Fraunhofer IBP database	Oberkirchner Sandstone (German)	2150.00	14.00	2.30	32.00	0.0500	110.00	3.40
WUFI MASEA database	Sandstone (TU Dresden)	2224.00	17.00	1.68	73.00	0.0816	89.00	2.60
FabTrads - Howth Sandstone	S1_HC_D_2022-08-17	2592.85	2.15	4.37	tbc	0.0017	16.79	tbc
FabTrads - West Limerick red Sandstone	S2	2503.75	5.21	tbc	tbc	0.0029	tbc	tbc
FabTrads - West Limerick yellow Sandstone	S3	2290.10	13.15	tbc	tbc	0.0153	tbc	tbc

Some Noteworthy Contrasts

… between WUFI and FabTrads values

Comparison preliminary FabTrads results with literature values (incl. WUFI)

GRANITE

source	material	apparent density (kg/m3)	porosity (% vol)	thermal conductivity (dry) (W/mK)	water vapour diffusion resistance factor (dry)	water absorption coefficient (kg/m2s0.5)	free water saturation (kg/m3)	reference water content (80% RH) (kg/m3)
ISO 10456 design values	Granite (lower value)	2500.00		2.80	10000.00			
ISO 10456 design values	Granite (upper value)	2700.00		2.80	10000.00			
Brachot (industry)	Tarn granite (France)	2670.00	0.20					
Brachot (industry)	Rose de la Clarté granite (France)	2710.00	0.50					
WUFI MASEA database	Granite (TU Dresden)	2453.00	9.50	1.66	54.00	0.0086	50.00	7.30
FabTrads - Carlow Granite	G1_KH_CW_2022-5-22	2553.69	3.00	2.29	tbc	0.0042	23.84	tbc

LIMESTONE

source	material	apparent density (kg/m3)	porosity (% vol)	thermal conductivity (dry) (W/mK)	water vapour diffusion resistance factor (dry)	water absorption coefficient (kg/m2s0.5)	free water saturation (kg/m3)	reference water content (80% RH) (kg/m3)
ISO 10456 design values	limestone (extra soft)	1600.00		0.85	30.00			
ISO 10456 design values	limestone (extra hard)	2600.00		2.30	250.00			
Siegesmund, Graue, 2011	Muschelkalk (German)	2250.00	16.03		60.35	1.3000		
Brachot (industry)	Kilkenny limestone	2680.00	0.40					
WUFI Fraunhofer IBP database	Krensheimer Shelly limestone (inhomogeneous)	2440.00	13.00	2.25	140.00	0.0000	75.00	2.50
WUFI LTH Lund University database	Limestone Öland (reddish brown)	2650.00	0.04	3.00	35.70	n/a	n/a	11.00
FabTrads - Laois Blue Limestone	L2_PS_LS_2022-08-03	2673.70	0.52	2.51	tbc	0.0003	3.92	tbc
	L3	2634.06	1.19	tbc	tbc	0.0004	tbc	tbc
FabTrads - Portland stone	L6	2178.66	18.52	tbc	tbc	0.0825	tbc	tbc

SANDSTONE

source	material	apparent density (kg/m3)	porosity (% vol)	thermal conductivity (dry) (W/mK)	water vapour diffusion resistance factor (dry)	water absorption coefficient (kg/m2s0.5)	free water saturation (kg/m3)	reference water content (80% RH) (kg/m3)
ISO 10456 design values	sandstone (silica)	2600		2.30	40			
Siegesmund, Graue, 2011	sandstone (German)	2143.33	18.76		17.42	4.9467		
WUFI Fraunhofer IBP database	Worzeldorfer Sandstone (German)	2263.00	13.00	1.80	26.00	0.0160	110.00	10.40
WUFI Fraunhofer IBP database	Zeitzer Sandstone (German)	2300.00	5.00	2.30	70.00	0.0030	40.00	6.00
WUFI Fraunhofer IBP database	Oberkirchner Sandstone (German)	2150.00	14.00	2.30	32.00	0.0500	110.00	3.40
WUFI MASEA database	Sandstone (TU Dresden)	2224.00	17.00	1.68	73.00	0.0816	89.00	2.60
FabTrads - Howth Sandstone	S1_HC_D_2022-08-17	2592.85	2.15	4.37	tbc	0.0017	16.79	tbc
FabTrads - West Limerick red Sandstone	S2	2503.75	5.21	tbc	tbc	0.0029	tbc	tbc
FabTrads - West Limerick yellow Sandstone	S3	2290.10	13.15	tbc	tbc	0.0153	tbc	tbc

Some Noteworthy Contrasts

... between WUFI and FabTrads values

Comparison preliminary FabTrads results with literature values (incl. WUFI)

GRANITE

source	material	apparent density (kg/m3)	porosity (% vol)	thermal conductivity (dry) (W/mK)	water vapour diffusion resistance factor (dry)	water absorption coefficient (kg/m2s0.5)	free water saturation (kg/m3)	reference water content (80% RH) (kg/m3)
ISO 10456 design values	Granite (lower value)	2500.00		2.80	10000.00			
ISO 10456 design values	Granite (upper value)	2700.00		2.80	10000.00			
Brachot (industry)	Tarn granite (France)	2670.00	0.20					
Brachot (industry)	Rose de la Clarté granite (France)	2710.00	0.50					
WUFI MASEA database	Granite (TU Dresden)	2453.00	9.50	1.66	54.00	0.0086	50.00	7.30
FabTrads - Carlow Granite	G1_KH_CW_2022-5-22	2553.69	3.00	2.29	tbc	0.0042	23.84	tbc

LIMESTONE

source	material	apparent density (kg/m3)	porosity (% vol)	thermal conductivity (dry) (W/mK)	water vapour diffusion resistance factor (dry)	water absorption coefficient (kg/m2s0.5)	free water saturation (kg/m3)	reference water content (80% RH) (kg/m3)
ISO 10456 design values	limestone (extra soft)	1600.00		0.85	30.00			
ISO 10456 design values	limestone (extra hard)	2600.00		2.30	250.00			
Siegesmund, Graue, 2011	Muschelkalk (German)	2250.00	16.03		60.35	1.3000		
Brachot (industry)	Kilkenny limestone	2680.00	0.40					
WUFI Fraunhofer IBP database	Krensheimer Shelly limestone (inhomogeneous)	2440.00	13.00	2.25	140.00	0.0000	75.00	2.50
WUFI LTH Lund University database	Limestone Öland (reddish brown)	2650.00	0.04	3.00	35.70	n/a	n/a	11.00
FabTrads - Laois Blue Limestone	L2_PS_LS_2022-08-03	2673.70	0.52	2.51	tbc	0.0003	3.92	tbc
	L3	2634.06	1.19	tbc	tbc	0.0004	tbc	tbc
FabTrads - Portland stone	L6	2178.66	18.52	tbc	tbc	0.0825	tbc	tbc

SANDSTONE

source	material	apparent density (kg/m3)	porosity (% vol)	thermal conductivity (dry) (W/mK)	water vapour diffusion resistance factor (dry)	water absorption coefficient (kg/m2s0.5)	free water saturation (kg/m3)	reference water content (80% RH) (kg/m3)
ISO 10456 design values	sandstone (silica)	2600		2.30	40			
Siegesmund, Graue, 2011	sandstone (German)	2143.33	18.76		17.42	4.9467		
WUFI Fraunhofer IBP database	Worzeldorfer Sandstone (German)	2263.00	13.00	1.80	26.00	0.0160	110.00	10.40
WUFI Fraunhofer IBP database	Zeitzer Sandstone (German)	2300.00	5.00	2.30	70.00	0.0030	40.00	6.00
WUFI Fraunhofer IBP database	Oberkirchner Sandstone (German)	2150.00	14.00	2.30	32.00	0.0500	110.00	3.40
WUFI MASEA database	Sandstone (TU Dresden)	2224.00	17.00	1.68	73.00	0.0816	89.00	2.60
FabTrads - Howth Sandstone	S1_HC_D_2022-08-17	2592.85	2.15	4.37	tbc	0.0017	16.79	tbc
FabTrads - West Limerick red Sandstone	S2	2503.75	5.21	tbc	tbc	0.0029	tbc	tbc
FabTrads - West Limerick yellow Sandstone	S3	2290.10	13.15	tbc	tbc	0.0153	tbc	tbc

Some Noteworthy Contrasts

… between WUFI and FabTrads values

Comparison preliminary FabTrads results with literature values (incl. WUFI)

source	material	apparent density (kg/m3)	porosity (% vol)	thermal conductivity (dry) (W/mK)	water vapour diffusion resistance factor (dry)	water absorption coefficient (kg/m2s0.5)	free water saturation (kg/m3)	reference water content (80% RH) (kg/m3)
GRANITE								
ISO 10456 design values	Granite (lower value)	2500.00		2.80	10000.00			
ISO 10456 design values	Granite (upper value)	2700.00		2.80	10000.00			
Brachot (industry)	Tarn granite (France)	2670.00	0.20					
Brachot (industry)	Rose de la Clarté granite (France)	2710.00	0.50					
WUFI MASEA database	Granite (TU Dresden)	2453.00	9.50	1.66	54.00	0.0086	50.00	7.30
FabTrads - Carlow Granite	G1_KH_CW_2022-5-22	2553.69	3.00	2.29	tbc	0.0042	23.84	tbc
LIMESTONE								
ISO 10456 design values	limestone (extra soft)	1600.00		0.85	30.00			
ISO 10456 design values	limestone (extra hard)	2600.00		2.30	250.00			
Siegesmund, Graue, 2011	Muschelkalk (German)	2250.00	16.03		60.35	1.3000		
Brachot (industry)	Kilkenny limestone	2680.00	0.40					
WUFI Fraunhofer IBP database	Krensheimer Shelly limestone (inhomogeneous)	2440.00	13.00	2.25	140.00	0.0000	75.00	2.50
WUFI LTH Lund University database	Limestone Öland (reddish brown)	2650.00	0.04	3.00	35.70	n/a	n/a	11.00
FabTrads - Laois Blue Limestone	L2_PS_LS_2022-08-03	2673.70	0.52	2.51	tbc	0.0003	3.92	tbc
	L3	2634.06	1.19	tbc	tbc	0.0004	tbc	tbc
FabTrads - Portland stone	L6	2178.66	18.52	tbc	tbc	0.0825	tbc	tbc
SANDSTONE								
ISO 10456 design values	sandstone (silica)	2600		2.30	40			
Siegesmund, Graue, 2011	sandstone (German)	2143.33	18.76		17.42	4.9467		
WUFI Fraunhofer IBP database	Worzeldorfer Sandstone (German)	2263.00	13.00	1.80	26.00	0.0160	110.00	10.40
WUFI Fraunhofer IBP database	Zeitzer Sandstone (German)	2300.00	5.00	2.30	70.00	0.0030	40.00	6.00
WUFI Fraunhofer IBP database	Oberkirchner Sandstone (German)	2150.00	14.00	2.30	32.00	0.0500	110.00	3.40
WUFI MASEA database	Sandstone (TU Dresden)	2224.00	17.00	1.68	73.00	0.0816	89.00	2.60
FabTrads - Howth Sandstone	S1_HC_D_2022-08-17	2592.85	2.15	4.37	tbc	0.0017	16.79	tbc
FabTrads - West Limerick red Sandstone	S2	2503.75	5.21	tbc	tbc	0.0029	tbc	tbc
FabTrads - West Limerick yellow Sandstone	S3	2290.10	13.15	tbc	tbc	0.0153	tbc	tbc

Some Noteworthy Contrasts

... between WUFI and FabTrads values

Comparison preliminary Fabtrads results with literature values (incl. WUFI)

source	material	apparent density (kg/m3)	porosity (% vol)	thermal conductivity (dry) (W/mK)	water vapour diffusion resistance factor (dry)	water absorption coefficient (kg/m2s0.5)	free water saturation (kg/m3)	reference water content (80% RH) (kg/m3)
GRANITE								
ISO 10456 design values	Granite (lower value)	2500.00		2.80	10000.00			
ISO 10456 design values	Granite (upper value)	2700.00		2.80	10000.00			
Brachot (industry)	Tarn granite (France)	2670.00	0.20					
Brachot (industry)	Rose de la Clarté granite (France)	2710.00	0.50					
WUFI MASEA database	Granite (TU Dresden)	2453.00	9.50	1.66	54.00	0.0086	50.00	7.30
FabTrads - Carlow Granite	G1_KH_CW_2022-5-22	2553.69	3.00	2.29	tbc	0.0042	23.84	tbc
LIMESTONE								
ISO 10456 design values	limestone (extra soft)	1600.00		0.85	30.00			
ISO 10456 design values	limestone (extra hard)	2600.00		2.30	250.00			
Siegesmund, Graue, 2011	Muschelkalk (German)	2250.00	16.03		60.35	1.3000		
Brachot (industry)	Kilkenny limestone	2680.00	0.40					
WUFI Fraunhofer IBP database	Krensheimer Shelly limestone (inhomogeneous)	2440.00	13.00	2.25	140.00	0.0000	75.00	2.50
WUFI LTH Lund University database	Limestone Öland (reddish brown)	2650.00	0.04	3.00	35.70	n/a	n/a	11.00
FabTrads - Laois Blue Limestone	L2_PS_LS_2022-08-03	2673.70	0.52	2.51	tbc	0.0003	3.92	tbc
	L3	2634.06	1.19	tbc	tbc	0.0004	tbc	tbc
FabTrads - Portland stone	L6	2178.66	18.52	tbc	tbc	0.0825	tbc	tbc
SANDSTONE								
ISO 10456 design values	sandstone (silica)	2600		2.30	40			
Siegesmund, Graue, 2011	sandstone (German)	2143.33	18.76		17.42	4.9467		
WUFI Fraunhofer IBP database	Worzeldorfer Sandstone (German)	2263.00	13.00	1.80	26.00	0.0160	110.00	10.40
WUFI Fraunhofer IBP database	Zeitzer Sandstone (German)	2300.00	5.00	2.30	70.00	0.0030	40.00	6.00
WUFI Fraunhofer IBP database	Oberkirchner Sandstone (German)	2150.00	14.00	2.30	32.00	0.0500	110.00	3.40
WUFI MASEA database	Sandstone (TU Dresden)	2224.00	17.00	1.68	73.00	0.0816	89.00	2.60
FabTrads - Howth Sandstone	S1_HC_D_2022-08-17	2592.85	2.15	4.37	tbc	0.0017	16.79	tbc
FabTrads - West Limerick red Sandstone	S2	2503.75	5.21	tbc	tbc	0.0029	tbc	tbc
FabTrads - West Limerick yellow Sandstone	S3	2290.10	13.15	tbc	tbc	0.0153	tbc	tbc

Some Noteworthy Contrasts

... between WUFI and FabTrads values

Comparison preliminary Fabtrads results with literature values (incl. WUFI)

source	material	apparent density (kg/m3)	porosity (% vol)	thermal conductivity (dry) (W/mK)	water vapour diffusion resistance factor (dry)	water absorption coefficient (kg/m2s0.5)	free water saturation (kg/m3)	reference water content (80% RH) (kg/m3)
GRANITE								
ISO 10456 design values	Granite (lower value)	2500.00		2.80	10000.00			
ISO 10456 design values	Granite (upper value)	2700.00		2.80	10000.00			
Brachot (industry)	Tarn granite (France)	2670.00	0.20					
Brachot (industry)	Rose de la Clarté granite (France)	2710.00	0.50					
WUFI MASEA database	Granite (TU Dresden)	2453.00	9.50	1.66	54.00	0.0086	50.00	7.30
FabTrads - Carlow Granite	G1_KH_CW_2022-5-22	2553.69	3.00	2.29	tbc	0.0042	23.84	tbc
LIMESTONE								
ISO 10456 design values	limestone (extra soft)	1600.00		0.85	30.00			
ISO 10456 design values	limestone (extra hard)	2600.00		2.30	250.00			
Siegesmund, Graue, 2011	Muschelkalk (German)	2250.00	16.03		60.35	1.3000		
Brachot (industry)	Kilkenny limestone	2680.00	0.40					
WUFI Fraunhofer IBP database	Krensheimer Shelly limestone (inhomogeneous)	2440.00	13.00	2.25	140.00	0.0000	75.00	2.50
WUFI LTH Lund University database	Limestone Öland (reddish brown)	2650.00	0.04	3.00	35.70	n/a	n/a	11.00
FabTrads - Laois Blue Limestone	L2_PS_LS_2022-08-03	2673.70	0.52	2.51	tbc	0.0003	3.92	tbc
	L3	2634.06	1.19	tbc	tbc	0.0004	tbc	tbc
FabTrads - Portland stone	L6	2178.66	18.52	tbc	tbc	0.0825	tbc	tbc
SANDSTONE								
ISO 10456 design values	sandstone (silica)	2600		2.30	40			
Siegesmund, Graue, 2011	sandstone (German)	2143.33	18.76		17.42	4.9467		
WUFI Fraunhofer IBP database	Worzeldorfer Sandstone (German)	2263.00	13.00	1.80	26.00	0.0160	110.00	10.40
WUFI Fraunhofer IBP database	Zeitzer Sandstone (German)	2300.00	5.00	2.30	70.00	0.0030	40.00	6.00
WUFI Fraunhofer IBP database	Oberkirchner Sandstone (German)	2150.00	14.00	2.30	32.00	0.0500	110.00	3.40
WUFI MASEA database	Sandstone (TU Dresden)	2224.00	17.00	1.68	73.00	0.0816	89.00	2.60
FabTrads - Howth Sandstone	S1_HC_D_2022-08-17	2592.85	2.15	4.37	tbc	0.0017	16.79	tbc
FabTrads - West Limerick red Sandstone	S2	2503.75	5.21	tbc	tbc	0.0029	tbc	tbc
FabTrads - West Limerick yellow Sandstone	S3	2290.10	13.15	tbc	tbc	0.0153	tbc	tbc

Some Noteworthy Contrasts

… between different limestones

Comparison preliminary Fabtrads results with literature values (incl. WUFI)

GRANITE

source	material	apparent density (kg/m3)	porosity (% vol)	thermal conductivity (dry) (W/mK)	water vapour diffusion resistance factor (dry)	water absorption coefficient (kg/m2s0.5)	free water saturation (kg/m3)	reference water content (80% RH) (kg/m3)
ISO 10456 design values	Granite (lower value)	2500.00		2.80	10000.00			
ISO 10456 design values	Granite (upper value)	2700.00		2.80	10000.00			
Brachot (industry)	Tarn granite (France)	2670.00	0.20					
Brachot (industry)	Rose de la Clarté granite (France)	2710.00	0.50					
WUFI MASEA database	Granite (TU Dresden)	2453.00	9.50	1.66	54.00	0.0086	50.00	7.30
FabTrads - Carlow Granite	G1_KH_CW_2022-5-22	2553.69	3.00	2.29	tbc	0.0042	23.84	tbc

LIMESTONE

source	material	apparent density (kg/m3)	porosity (% vol)	thermal conductivity (dry) (W/mK)	water vapour diffusion resistance factor (dry)	water absorption coefficient (kg/m2s0.5)	free water saturation (kg/m3)	reference water content (80% RH) (kg/m3)
ISO 10456 design values	limestone (extra soft)	1600.00		0.85	30.00			
ISO 10456 design values	limestone (extra hard)	2600.00		2.30	250.00			
Siegesmund, Graue, 2011	Muschelkalk (German)	2250.00	16.03		60.35	1.3000		
Brachot (industry)	Kilkenny limestone	2680.00	0.40					
WUFI Fraunhofer IBP database	Krensheimer Shelly limestone (inhomogeneous)	2440.00	13.00	2.25	140.00	0.0000	75.00	2.50
WUFI LTH Lund University database	Limestone Öland (reddish brown)	2650.00	0.04	3.00	35.70	n/a	n/a	11.00
FabTrads - Laois Blue Limestone	L2_PS_LS_2022-08-03	2673.70	0.52	2.51	tbc	0.0003	3.92	tbc
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FabTrads - Portland stone	L6	2178.66	18.52	tbc	tbc	0.0825	tbc	tbc

SANDSTONE

source	material	apparent density (kg/m3)	porosity (% vol)	thermal conductivity (dry) (W/mK)	water vapour diffusion resistance factor (dry)	water absorption coefficient (kg/m2s0.5)	free water saturation (kg/m3)	reference water content (80% RH) (kg/m3)
ISO 10456 design values	sandstone (silica)	2600		2.30	40			
Siegesmund, Graue, 2011	sandstone (German)	2143.33	18.76		17.42	4.9467		
WUFI Fraunhofer IBP database	Worzeldorfer Sandstone (German)	2263.00	13.00	1.80	26.00	0.0160	110.00	10.40
WUFI Fraunhofer IBP database	Zeitzer Sandstone (German)	2300.00	5.00	2.30	70.00	0.0030	40.00	6.00
WUFI Fraunhofer IBP database	Oberkirchner Sandstone (German)	2150.00	14.00	2.30	32.00	0.0500	110.00	3.40
WUFI MASEA database	Sandstone (TU Dresden)	2224.00	17.00	1.68	73.00	0.0816	89.00	2.60
FabTrads - Howth Sandstone	S1_HC_D_2022-08-17	2592.85	2.15	4.37	tbc	0.0017	16.79	tbc
FabTrads - West Limerick red Sandstone	S2	2503.75	5.21	tbc	tbc	0.0029	tbc	tbc
FabTrads - West Limerick yellow Sandstone	S3	2290.10	13.15	tbc	tbc	0.0153	tbc	tbc

Some Noteworthy Contrasts

... between different limestones

Comparison preliminary Fabtrads results with literature values (incl. WUFI)

source	material	apparent density (kg/m3)	porosity (% vol)	thermal conductivity (dry) (W/mK)	water vapour diffusion resistance factor (dry)	water absorption coefficient (kg/m2s0.5)	free water saturation (kg/m3)	reference water content (80% RH) (kg/m3)
GRANITE								
ISO 10456 design values	Granite (lower value)	2500.00		2.80	10000.00			
ISO 10456 design values	Granite (upper value)	2700.00		2.80	10000.00			
Brachot (industry)	Tarn granite (France)	2670.00	0.20					
Brachot (industry)	Rose de la Clarté granite (France)	2710.00	0.50					
WUFI MASEA database	Granite (TU Dresden)	2453.00	9.50	1.66	54.00	0.0086	50.00	7.30
FabTrads - Carlow Granite	G1_KH_CW_2022-5-22	2553.69	3.00	2.29	tbc	0.0042	23.84	tbc
LIMESTONE								
ISO 10456 design values	limestone (extra soft)	1600.00		0.85	30.00			
ISO 10456 design values	limestone (extra hard)	2600.00		2.30	250.00			
Siegesmund, Graue, 2011	Muschelkalk (German)	2250.00	16.03		60.35	1.3000		
Brachot (industry)	Kilkenny limestone	2680.00	0.40					
WUFI Fraunhofer IBP database	Krensheimer Shelly limestone (inhomogeneous)	2440.00	13.00	2.25	140.00	0.0000	75.00	2.50
WUFI LTH Lund University database	Limestone Öland (reddish brown)	2650.00	0.04	3.00	35.70	n/a	n/a	11.00
FabTrads - Laois Blue Limestone	L2_PS_LS_2022-08-03	2673.70	0.52	2.51	tbc	0.0003	3.92	tbc
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FabTrads - Portland stone	L6	2178.66	18.52	tbc	tbc	0.0825	tbc	tbc
SANDSTONE								
ISO 10456 design values	sandstone (silica)	2600		2.30	40			
Siegesmund, Graue, 2011	sandstone (German)	2143.33	18.76		17.42	4.9467		
WUFI Fraunhofer IBP database	Worzeldorfer Sandstone (German)	2263.00	13.00	1.80	26.00	0.0160	110.00	10.40
WUFI Fraunhofer IBP database	Zeitzer Sandstone (German)	2300.00	5.00	2.30	70.00	0.0030	40.00	6.00
WUFI Fraunhofer IBP database	Oberkirchner Sandstone (German)	2150.00	14.00	2.30	32.00	0.0500	110.00	3.40
WUFI MASEA database	Sandstone (TU Dresden)	2224.00	17.00	1.68	73.00	0.0816	89.00	2.60
FabTrads - Howth Sandstone	S1_HC_D_2022-08-17	2592.85	2.15	4.37	tbc	0.0017	16.79	tbc
FabTrads - West Limerick red Sandstone	S2	2503.75	5.21	tbc	tbc	0.0029	tbc	tbc
FabTrads - West Limerick yellow Sandstone	S3	2290.10	13.15	tbc	tbc	0.0153	tbc	tbc

Some Noteworthy Contrasts

... between different limestones

Comparison preliminary Fabtrads results with literature values (incl. WUFI)

source	material	apparent density (kg/m3)	porosity (% vol)	thermal conductivity (dry) (W/mK)	water vapour diffusion resistance factor (dry)	water absorption coefficient (kg/m2s0.5)	free water saturation (kg/m3)	reference water content (80% RH) (kg/m3)
GRANITE								
ISO 10456 design values	Granite (lower value)	2500.00		2.80	10000.00			
ISO 10456 design values	Granite (upper value)	2700.00		2.80	10000.00			
Brachot (industry)	Tarn granite (France)	2670.00	0.20					
Brachot (industry)	Rose de la Clarté granite (France)	2710.00	0.50					
WUFI MASEA database	Granite (TU Dresden)	2453.00	9.50	1.66	54.00	0.0086	50.00	7.30
FabTrads - Carlow Granite	G1_KH_CW_2022-5-22	2553.69	3.00	2.29	tbc	0.0042	23.84	tbc
LIMESTONE								
ISO 10456 design values	limestone (extra soft)	1600.00		0.85	30.00			
ISO 10456 design values	limestone (extra hard)	2600.00		2.30	250.00			
Siegesmund, Graue, 2011	Muschelkalk (German)	2250.00	16.03		60.35	1.3000		
Brachot (industry)	Kilkenny limestone	2680.00	0.40					
WUFI Fraunhofer IBP database	Krensheimer Shelly limestone (inhomogeneous)	2440.00	13.00	2.25	140.00	0.0000	75.00	2.50
WUFI LTH Lund University database	Limestone Öland (reddish brown)	2650.00	0.04	3.00	35.70	n/a	n/a	11.00
FabTrads - Laois Blue Limestone	L2_PS_LS_2022-08-03	2673.70	0.52	2.51	tbc	0.0003	3.92	tbc
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FabTrads - Portland stone	L6	2178.66	18.52	tbc	tbc	0.0825	tbc	tbc
SANDSTONE								
ISO 10456 design values	sandstone (silica)	2600		2.30	40			
Siegesmund, Graue, 2011	sandstone (German)	2143.33	18.76		17.42	4.9467		
WUFI Fraunhofer IBP database	Worzeldorfer Sandstone (German)	2263.00	13.00	1.80	26.00	0.0160	110.00	10.40
WUFI Fraunhofer IBP database	Zeitzer Sandstone (German)	2300.00	5.00	2.30	70.00	0.0030	40.00	6.00
WUFI Fraunhofer IBP database	Oberkirchner Sandstone (German)	2150.00	14.00	2.30	32.00	0.0500	110.00	3.40
WUFI MASEA database	Sandstone (TU Dresden)	2224.00	17.00	1.68	73.00	0.0816	89.00	2.60
FabTrads - Howth Sandstone	S1_HC_D_2022-08-17	2592.85	2.15	4.37	tbc	0.0017	16.79	tbc
FabTrads - West Limerick red Sandstone	S2	2503.75	5.21	tbc	tbc	0.0029	tbc	tbc
FabTrads - West Limerick yellow Sandstone	S3	2290.10	13.15	tbc	tbc	0.0153	tbc	tbc

Bricks

Comparison preliminary Fabtrads results with literature values (incl. WUFI)

source	material	apparent density (kg/m3)	porosity (% vol)	thermal conductivity (dry) (W/mK)	water vapour diffusion resistance factor (dry)	water absorption coefficient (kg/m2s0.5)	free water saturation (kg/m3)	reference water content (80% RH) (kg/m3)
BRICK								
ISO 10456 design values	fired clay (lower value)	1000.00			16.00			
ISO 10456 design values	fired clay (upper value)	2400.00			16.00			
Pavia, Bolton, Stone, Brick and Mortar	Irish 17th c. handmade		37.13					
Pavia, Bolton, Stone, Brick and Mortar	Irish 18th c. handmade		37.47					
Pavia, Bolton, Stone, Brick and Mortar	Spanish 16th c. handmade		35.17					
Pavia, Bolton, Stone, Brick and Mortar	Spanish 17th c. handmade		36.75					
Pavia, Bolton, Stone, Brick and Mortar	contemporary machined (lower)		24.60					
Pavia, Bolton, Stone, Brick and Mortar	contemporary machined (upper)		48.90					
WUFI Fraunhofer IBP database	solid brick masonry (WUFI default incl. mortar joints)	1900.00	24.00	0.60	10.00	0.1100	190.00	18.00
WUFI Fraunhofer IBP database	solid brick, extruded (modern)	1650.00	41.00	0.60	9.50	0.4000	370.00	9.20
WUFI Fraunhofer IBP database	solid brick, historical (Stralsund 1500s)	1800.00	31.00	0.60	15.00	0.3600	230.00	4.50
WUFI Fraunhofer IBP database	solid brick, handformed	1725.00	38.00	0.60	17.00	0.3000	200.00	2.70
WUFI MASEA database	red solid brick ARB (TU Dresden),	1807.00	32.00	0.70	10.00	0.2500	161.00	1.50
WUFI MASEA database	red solid brick ZD (TU Dresden)	1611.00	39.00	0.39	10.00	0.1830	216.00	3.60
WUFI MASEA database	red solid brick ZE (TU Dresden)	1642.00	38.00	0.58	13.00	0.2160	254.00	4.70
WUFI MASEA database	yellow solid brick ZI (TU Dresden)	1722.00	35.00	0.40	21.00	0.0300	246.00	30.00
WUFI MASEA database	yellow solid brick ZO (TU Dresden)	1873.00	29.00	0.91	45.00	0.0680	126.00	3.40
WUFI University of Technology Vienna	Solid brick, historical Vienna c. 1900	1560.00	38.00	0.60	14.93	0.5830	368.97	11.80
WUFI University of Technology Vienna	Solid brick, extruded	1630.00	35.00	0.60	9.50	0.2670	333.01	8.71
FabTrads - Red Brick with voids, Dublin	B1_21OP_D_2022-08-04	1649.32	39.30	0.53	33.90	0.1373	309.53	tbc
FabTrads - Yellow Brick (internal), Dublin	B2_21OP_D_2022-08-04	1493.01	44.96	0.44	10.96	0.3289	369.84	tbc
FabTrads - yellow/red brick, Laois	B3_PS_LS_2022-08-03	1684.66	29.62	0.95	35.06	0.0365	141.17	tbc
FabTrads - yellow brick (internal), Dublin	B4_AC_D_2022	1351.06	46.29	0.37	13.08	0.2540	322.11	tbc
FabTrads - Yellow Brick, Dublin	B5_BS_D_2022-08-10	1349.53	48.64	0.44	8.07	0.4308	351.85	tbc
FabTrads - Yellow Brick, Dublin	B6_PD_D_2022-08-10	1594.36	39.13	0.44	21.50	0.1187	270.19	tbc
FabTrads - Red Brick, Dublin	B7_RR_D_2022-10-03	1548.73	40.82	0.41	16.22	0.4403	284.93	tbc
FabTrads - Red brick with voids, Cork	B8_KS_CO_2022	1679.78	37.77	0.45	23.06	0.1541	327.02	tbc

Bricks

Comparison preliminary Fabtrads results with literature values (incl. WUFI)

source	material	apparent density (kg/m3)	porosity (% vol)	thermal conductivity (dry) (W/mK)	water vapour diffusion resistance factor (dry)	water absorption coefficient (kg/m2s0.5)	free water saturation (kg/m3)	reference water content (80% RH) (kg/m3)
BRICK								
ISO 10456 design values	fired clay (lower value)	1000.00			16.00			
ISO 10456 design values	fired clay (upper value)	2400.00			16.00			
Pavia, Bolton, Stone, Brick and Mortar	Irish 17th c. handmade		37.13					
Pavia, Bolton, Stone, Brick and Mortar	Irish 18th c. handmade		37.47					
Pavia, Bolton, Stone, Brick and Mortar	Spanish 16th c. handmade		35.17					
Pavia, Bolton, Stone, Brick and Mortar	Spanish 17th c. handmade		36.75					
Pavia, Bolton, Stone, Brick and Mortar	contemporary machined (lower)		24.60					
Pavia, Bolton, Stone, Brick and Mortar	contemporary machined (upper)		48.90					
WUFI Fraunhofer IBP database	solid brick masonry (WUFI default incl. mortar joints)	1900.00	24.00	0.60	10.00	0.1100	190.00	18.00
WUFI Fraunhofer IBP database	solid brick, extruded (modern)	1650.00	41.00	0.60	9.50	0.4000	370.00	9.20
WUFI Fraunhofer IBP database	solid brick, historical (Stralsund 1500s)	1800.00	31.00	0.60	15.00	0.3600	230.00	4.50
WUFI Fraunhofer IBP database	solid brick, handformed	1725.00	38.00	0.60	17.00	0.3000	200.00	2.70
WUFI MASEA database	red solid brick ARB (TU Dresden),	1807.00	32.00	0.70	10.00	0.2500	161.00	1.50
WUFI MASEA database	red solid brick ZD (TU Dresden)	1611.00	39.00	0.39	10.00	0.1830	216.00	3.60
WUFI MASEA database	red solid brick ZE (TU Dresden)	1642.00	38.00	0.58	13.00	0.2160	254.00	4.70
WUFI MASEA database	yellow solid brick ZI (TU Dresden)	1722.00	35.00	0.40	21.00	0.0300	246.00	30.00
WUFI MASEA database	yellow solid brick ZO (TU Dresden)	1873.00	29.00	0.91	45.00	0.0680	126.00	3.40
WUFI University of Technology Vienna	Solid brick, historical Vienna c. 1900	1560.00	38.00	0.60	14.93	0.5830	368.97	11.80
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FabTrads - yellow/red brick, Laois	B3_PS_LS_2022-08-03	1684.66	29.62	0.95	35.06	0.0365	141.17	tbc
FabTrads - yellow brick (internal), Dublin	B4_AC_D_2022	1351.06	46.29	0.37	13.08	0.2540	322.11	tbc
FabTrads - Yellow Brick, Dublin	B5_BS_D_2022-08-10	1349.53	48.64	0.44	8.07	0.4308	351.85	tbc
FabTrads - Yellow Brick, Dublin	B6_PD_D_2022-08-10	1594.36	39.13	0.44	21.50	0.1187	270.19	tbc
FabTrads - Red Brick, Dublin	B7_RR_D_2022-10-03	1548.73	40.82	0.41	16.22	0.4403	284.93	tbc
FabTrads - Red brick with voids, Cork	B8_KS_CO_2022	1679.78	37.77	0.45	23.06	0.1541	327.02	tbc

Bricks

Comparison preliminary Fabtrads results with literature values (incl. WUFI)

source	material	apparent density (kg/m3)	porosity (% vol)	thermal conductivity (dry) (W/mK)	water vapour diffusion resistance factor (dry)	water absorption coefficient (kg/m2s0.5)	free water saturation (kg/m3)	reference water content (80% RH) (kg/m3)
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Pavia, Bolton, Stone, Brick and Mortar	contemporary machined (lower)		24.60					
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WUFI Fraunhofer IBP database	solid brick, extruded (modern)	1650.00	41.00	0.60	9.50	0.4000	370.00	9.20
WUFI Fraunhofer IBP database	solid brick, historical (Stralsund 1500s)	1800.00	31.00	0.60	15.00	0.3600	230.00	4.50
WUFI Fraunhofer IBP database	solid brick, handformed	1725.00	38.00	0.60	17.00	0.3000	200.00	2.70
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WUFI MASEA database	red solid brick ZE (TU Dresden)	1642.00	38.00	0.58	13.00	0.2160	254.00	4.70
WUFI MASEA database	yellow solid brick ZI (TU Dresden)	1722.00	35.00	0.40	21.00	0.0300	246.00	30.00
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FabTrads - Yellow Brick (internal), Dublin	B2_21OP_D_2022-08-04	1493.01	44.96	0.44	10.96	0.3289	369.84	tbc
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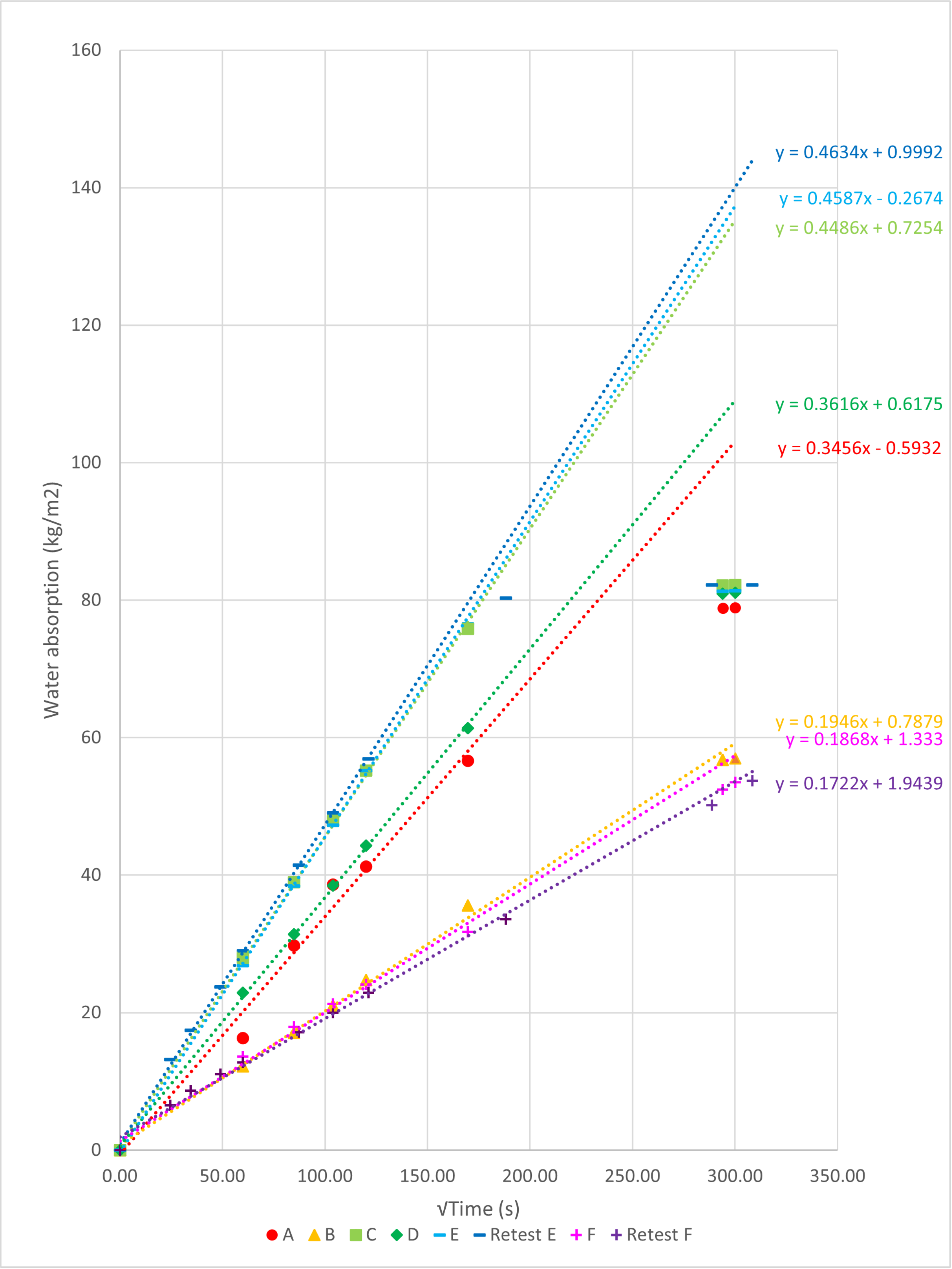
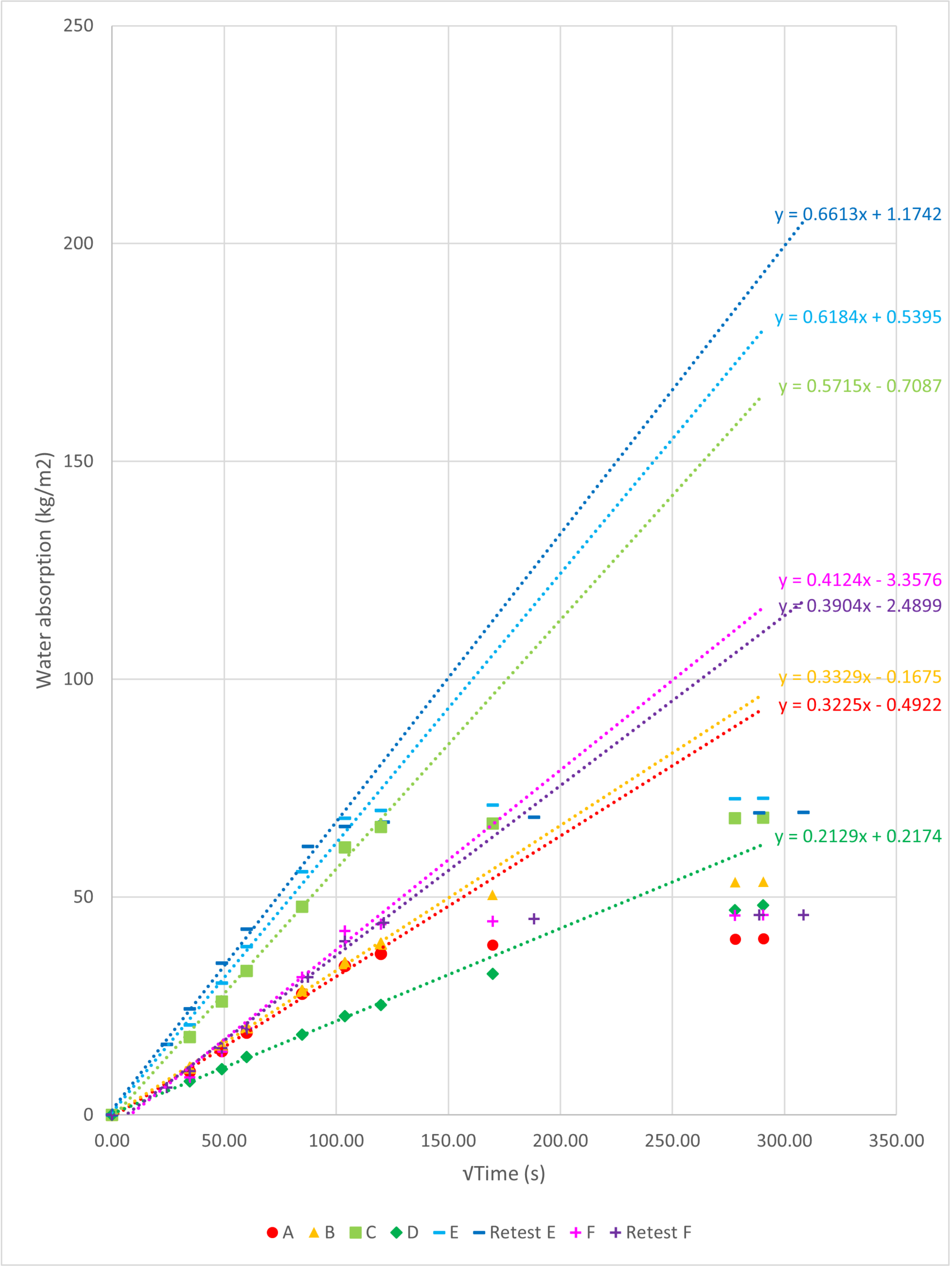
FabTrads - yellow brick (internal), Dublin	B4_AC_D_2022	1351.06	46.29	0.37	13.08	0.2540	322.11	tbc
FabTrads - Yellow Brick, Dublin	B5_BS_D_2022-08-10	1349.53	48.64	0.44	8.07	0.4308	351.85	tbc
FabTrads - Yellow Brick, Dublin	B6_PD_D_2022-08-10	1594.36	39.13	0.44	21.50	0.1187	270.19	tbc
FabTrads - Red Brick, Dublin	B7_RR_D_2022-10-03	1548.73	40.82	0.41	16.22	0.4403	284.93	tbc
FabTrads - Red brick with voids, Cork	B8_KS_CO_2022	1679.78	37.77	0.45	23.06	0.1541	327.02	tbc



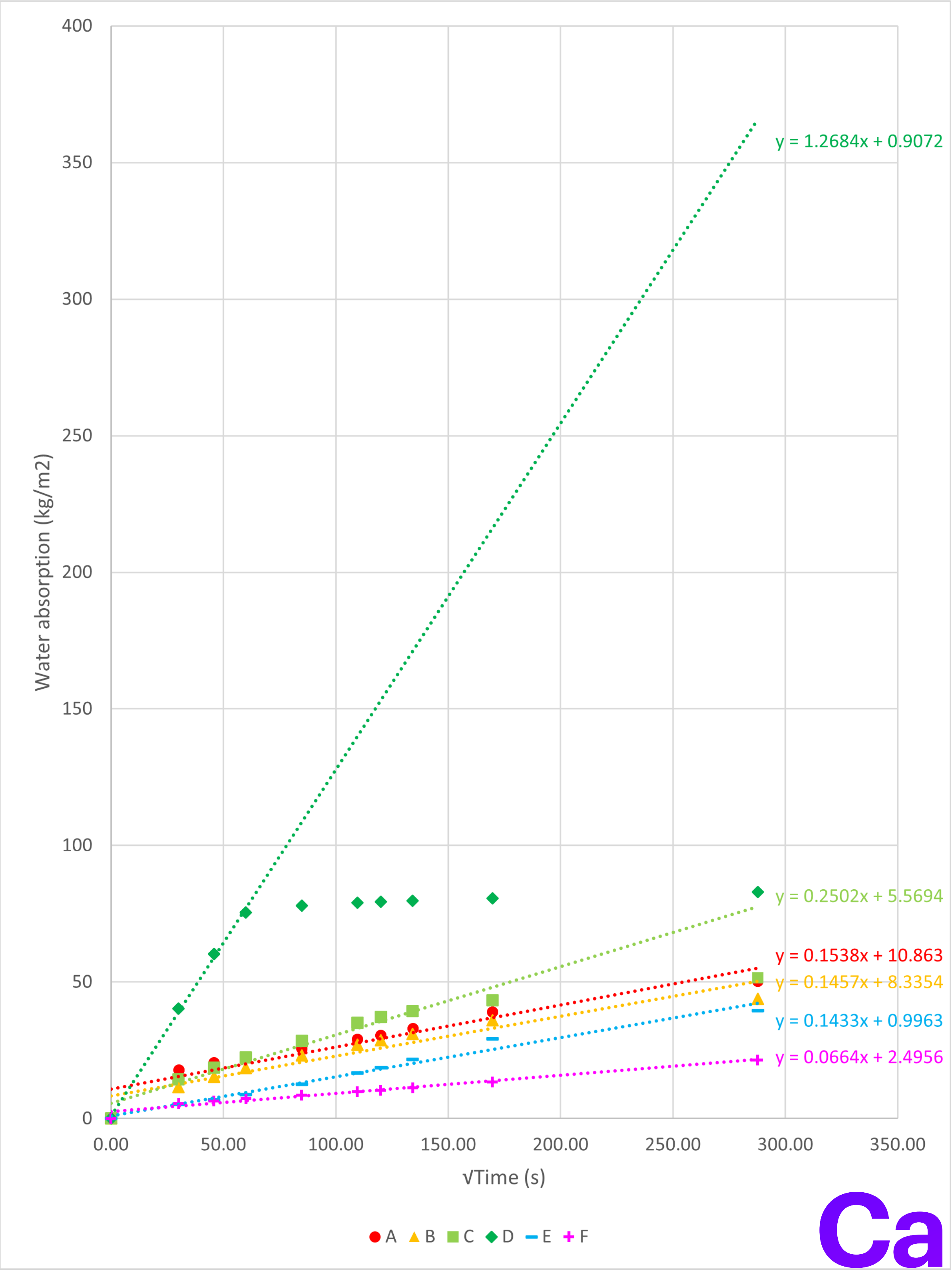
Capillary absorption – preliminary results - brick



B2



B7

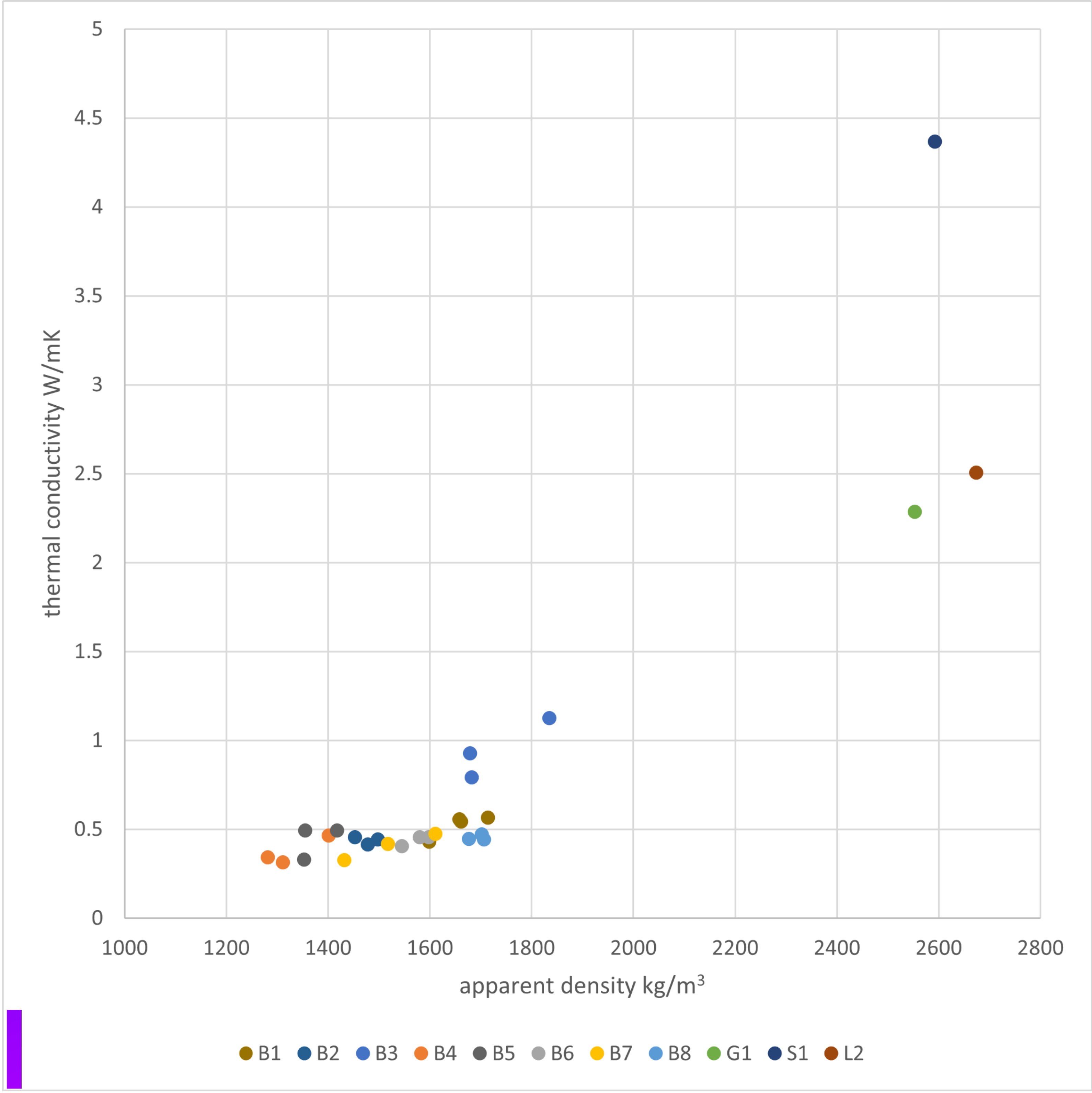


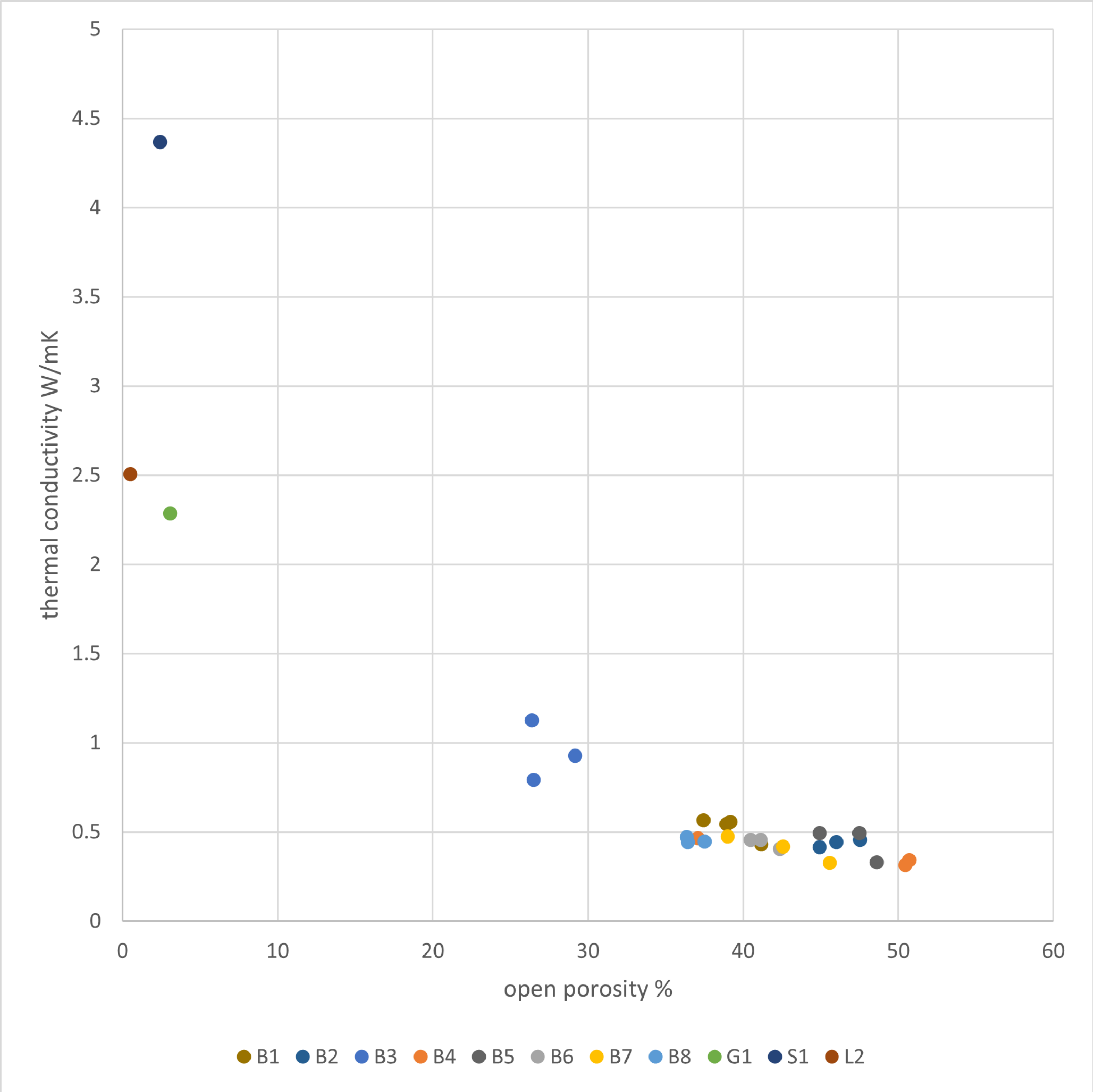
B10

Capillary absorption Vs Time (square root of)

Thermal conductivity prelim. results,

plotted against apparent density / open porosity



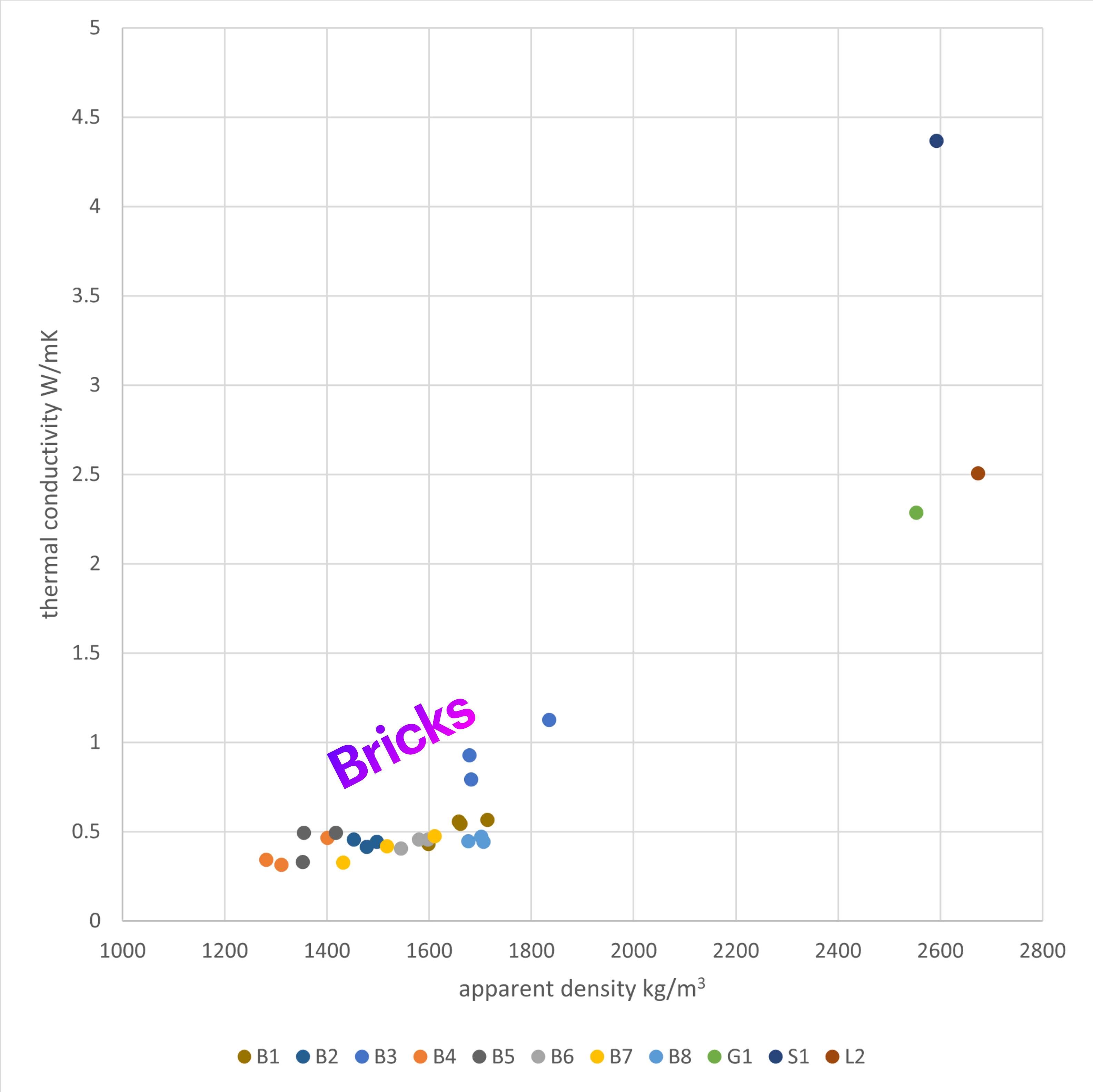


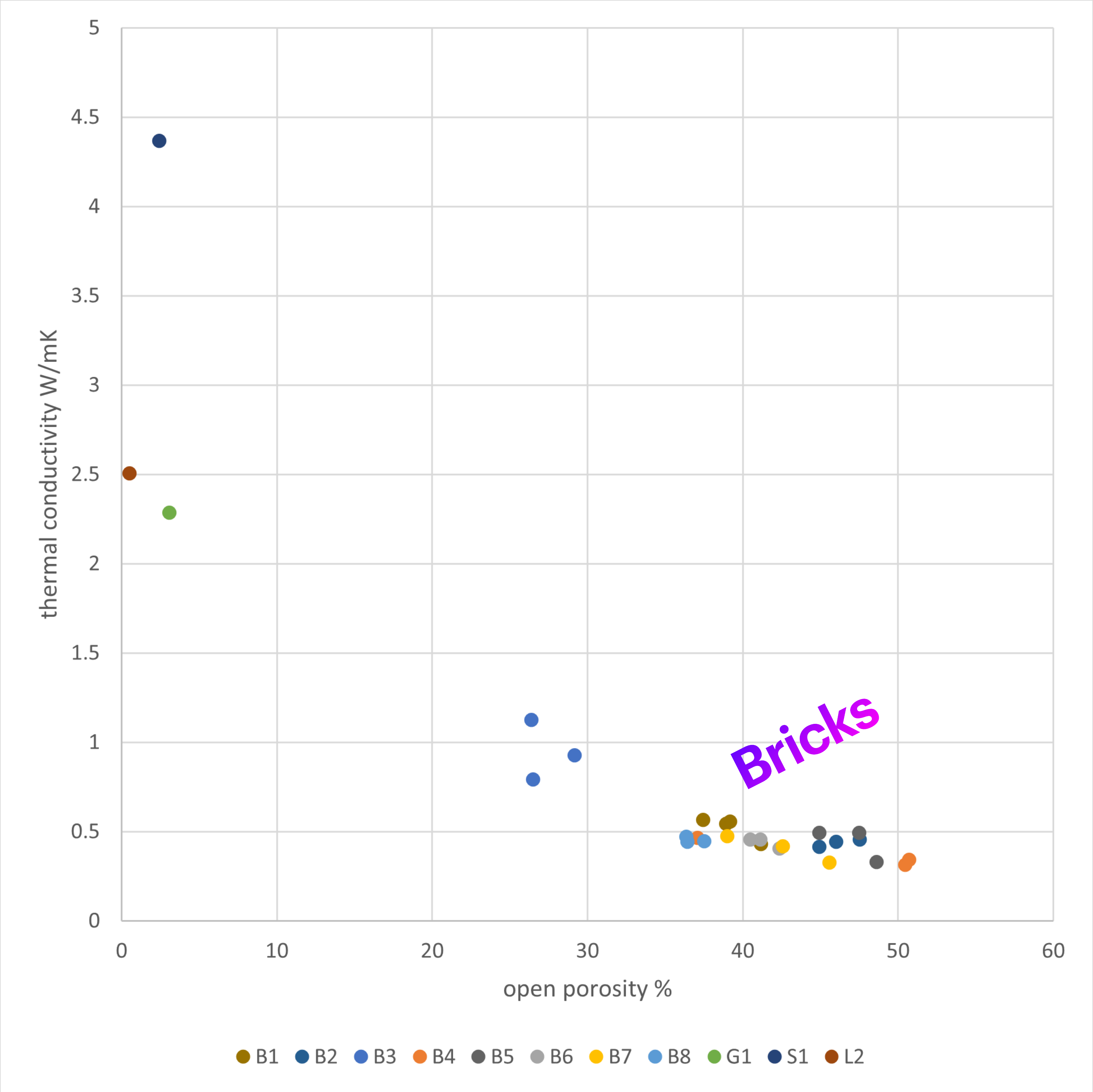
Thermal conductivity Vs Apparent density

Thermal conductivity Vs Porosity

Thermal conductivity prelim. results,

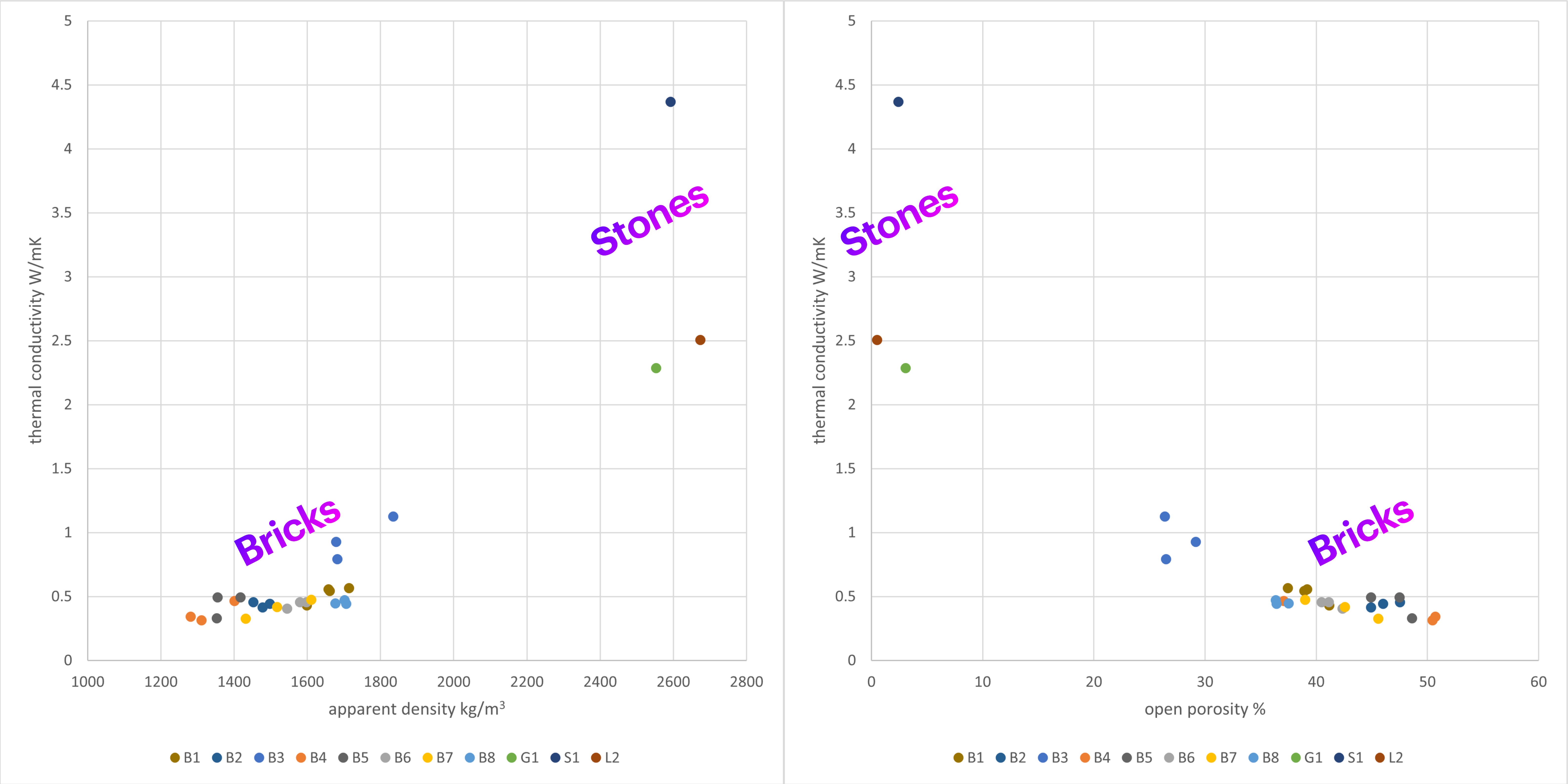
plotted against apparent density / open porosity





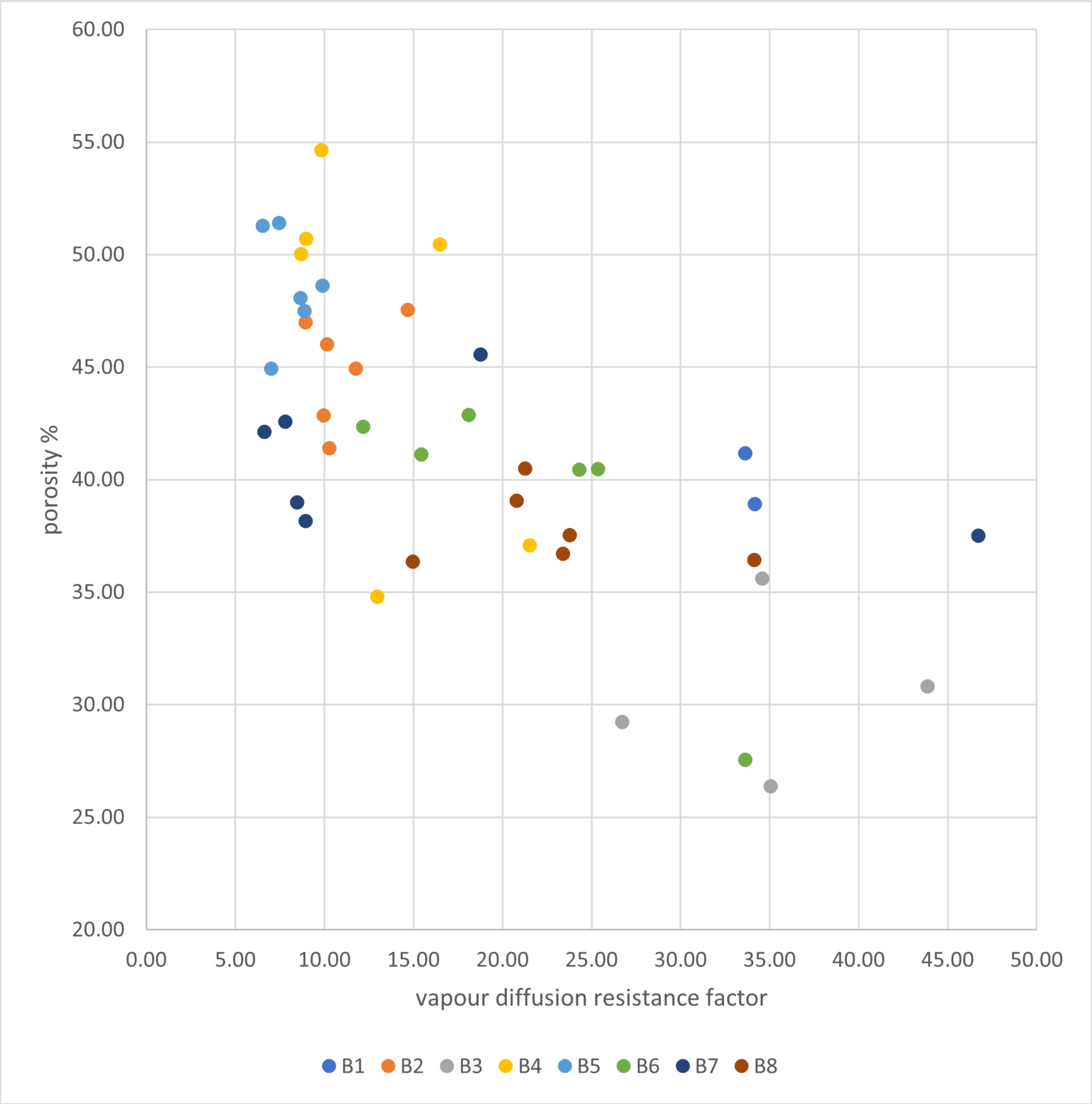
Thermal conductivity prelim. results,

plotted against apparent density / open porosity



Porosity Vs Vapour diffusion resistance

Vapour diffusion resistance factor prelim. results, plotted against open porosity

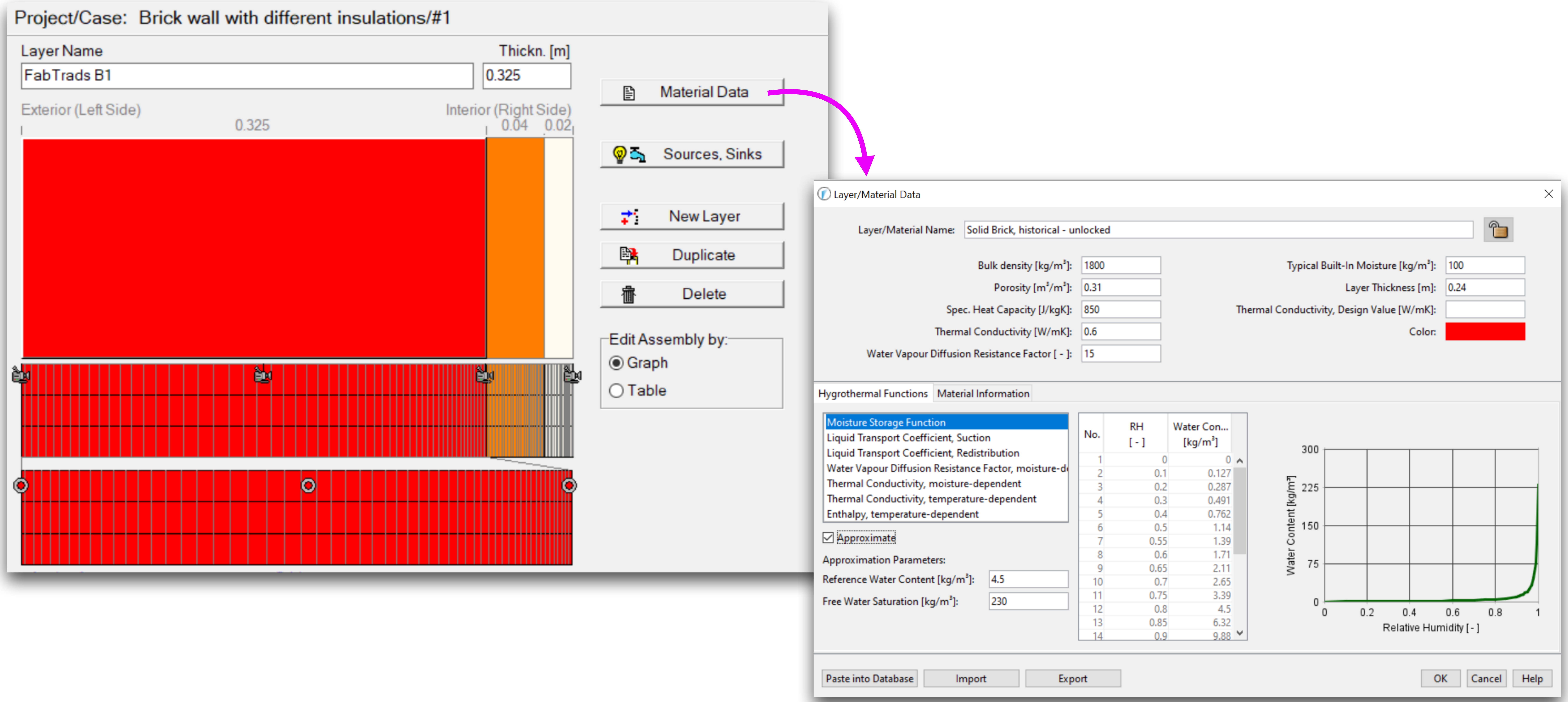


Brick Datasheets

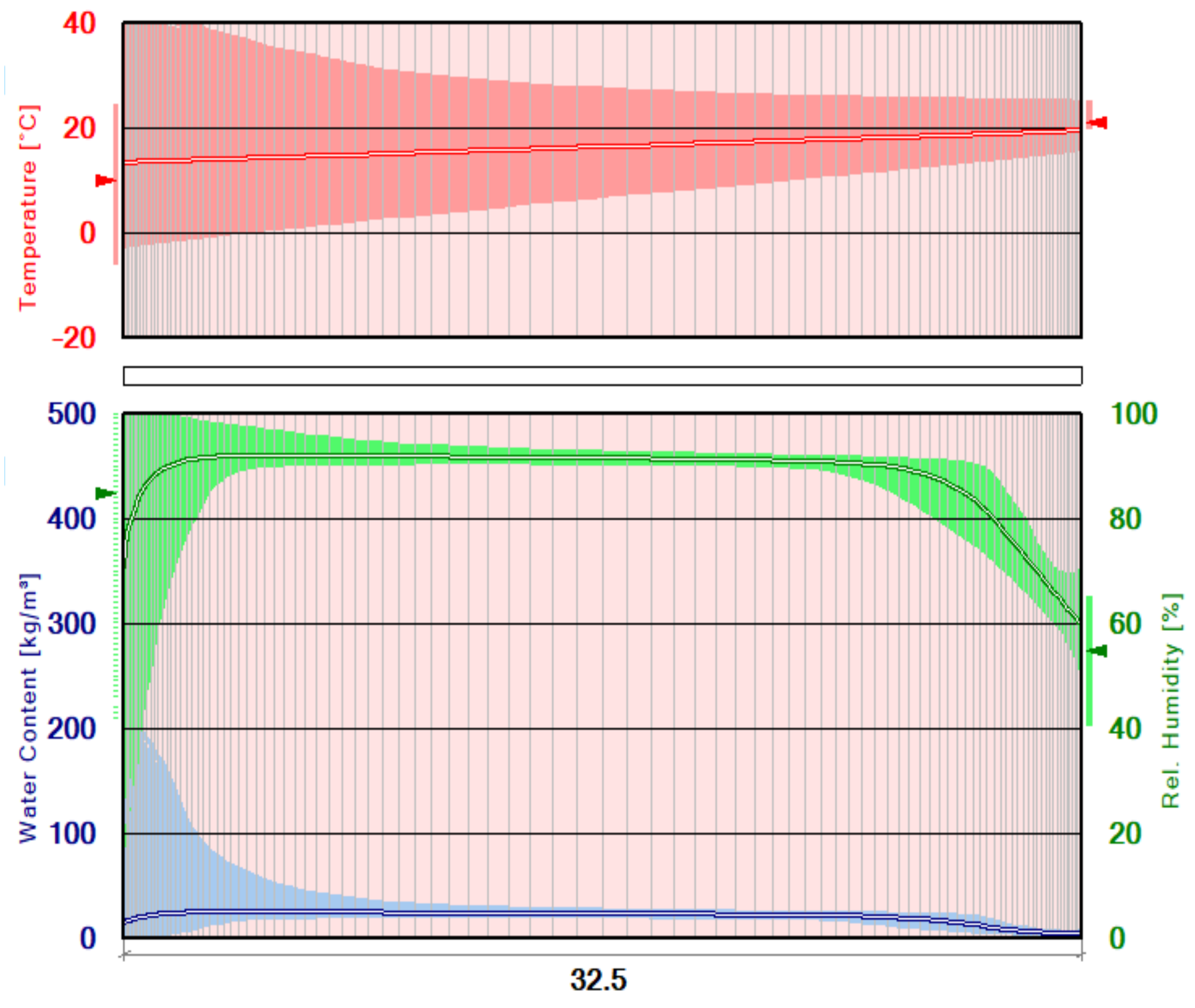
Type of Brick	Solid red brick
Likely date of manufacture	c.1700-1730
Dimensions	approx
Location collected from	Ryder Row, Capel Street, Dublin 1
Background information	Hand-made brick, likely made in Dublin
	
Physical Properties (WUFI input values)	
Bulk density	$1549kg/m^3$
Open Porosity	40.8%
Water adsorption at 50%, 80% 95% and 98%	tbc
Free Saturation	$270.2kg/m^3$
Vapour Diffusion Resistance Factor	21.5
Capillary absorption	$0.41kg/m^2s^{1/2}$
Thermal conductivity	0.41W/mK
In-situ properties	
Water absorption (Karsten tube)	tbc
Internal reference number	B7_RR_D_2022-10-03

Type of Brick	Red brick, perforated with 20 holes
Likely date of manufacture	c.1870-1910
Dimensions	approx 23.5x11.5x6.5cm
Location collected from	Victorian house, Rathgar, Dublin 6
Background information	Machine-made brick, likely manufactured in Dublin but may have been imported
	
Physical Properties (WUFI input values)	
Bulk density	$1644kg/m^3$
Open Porosity	39.3%
Water adsorption at 50%, 80% 95% and 98%	tbc
Free Saturation	$309.5kg/m^3$
Vapour Diffusion Resistance Factor	33.9
Capillary absorption	$0.14kg/m^2s^{1/2}$
Thermal conductivity	0.51W/mK
In-situ properties	
Water absorption (Karsten tube)	tbc
Internal reference number	B2_21OP_D_2022_08_04

Hydrothermal testing using WUFI

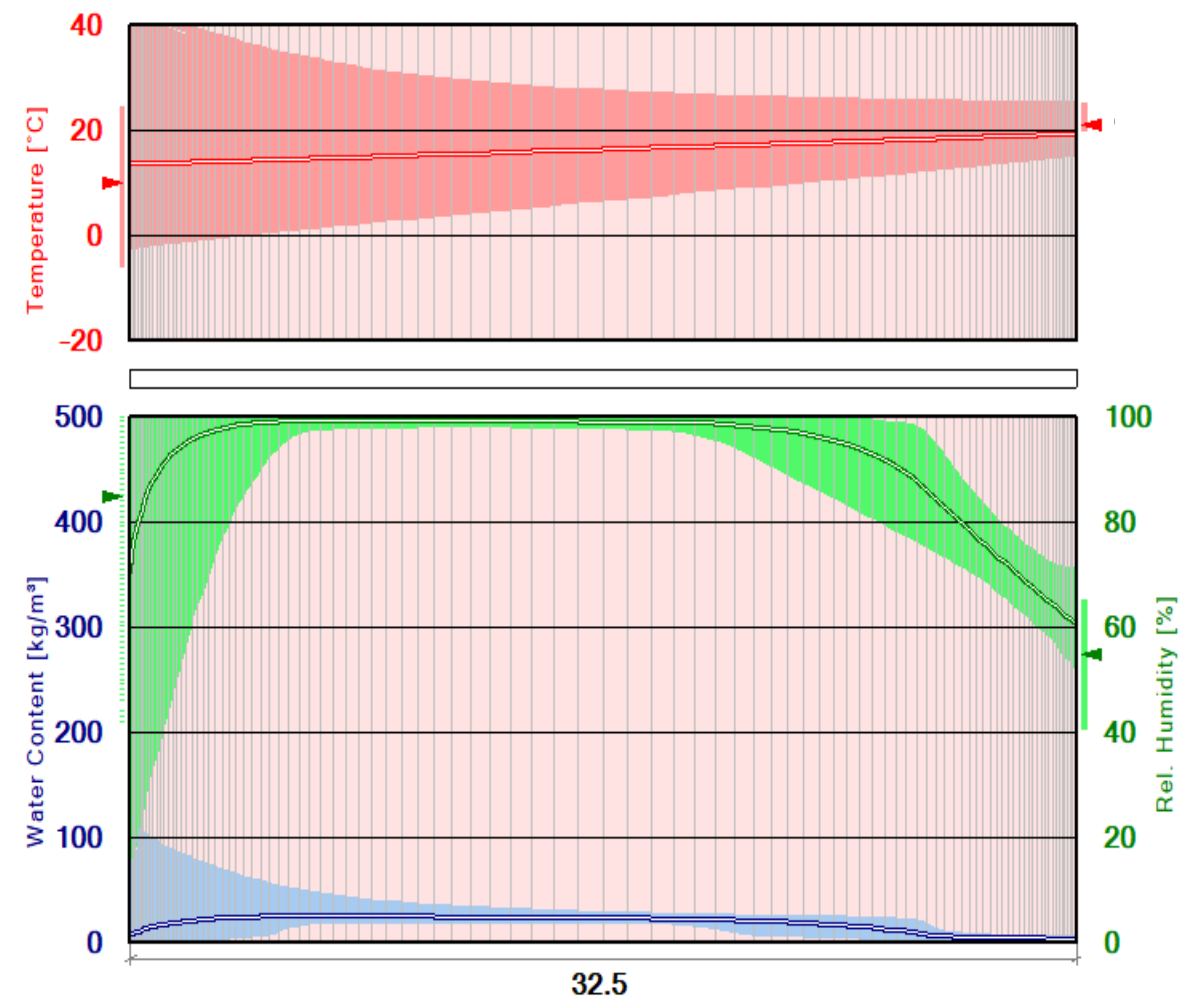


FabTrads vs WUFI



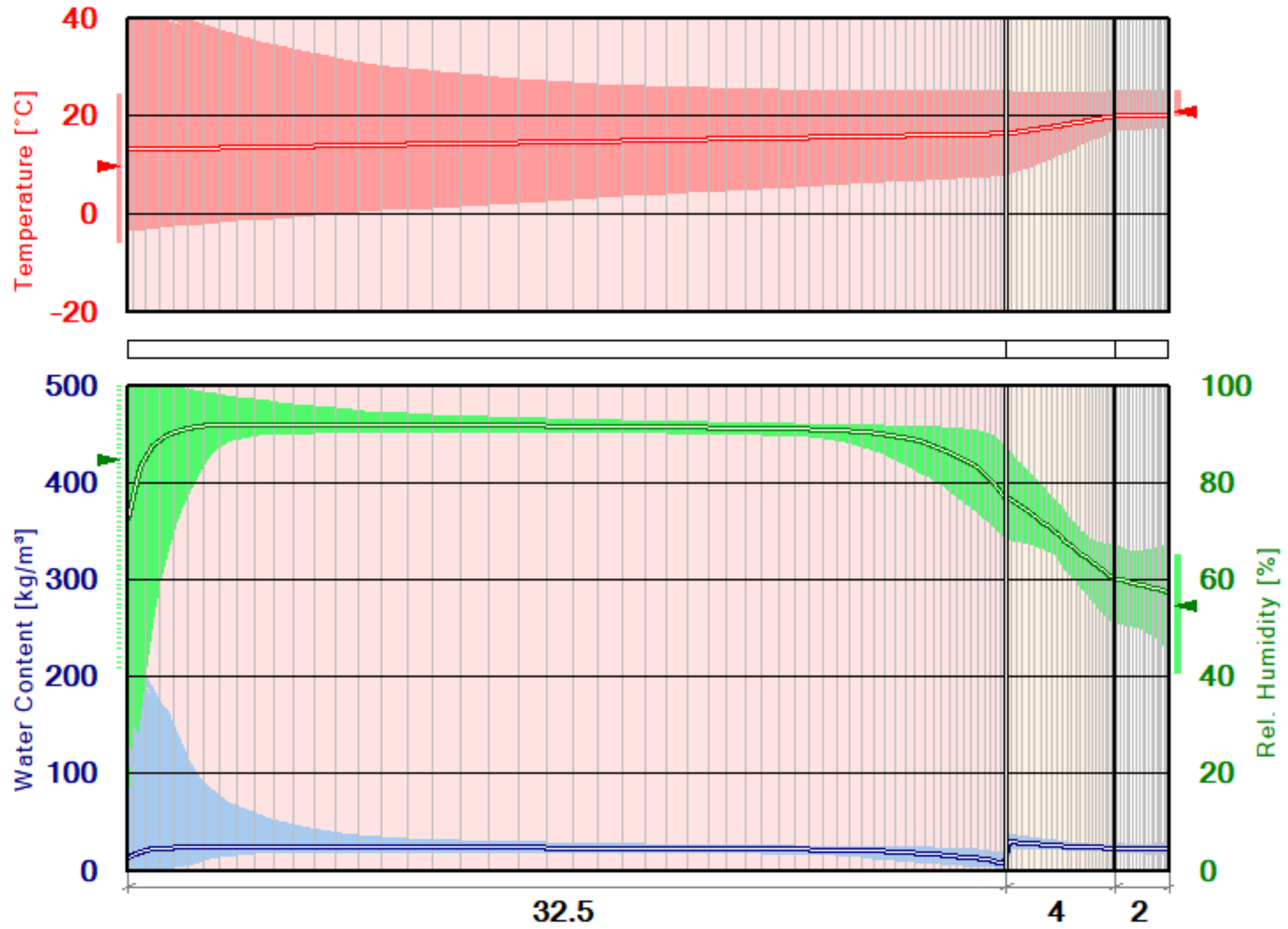
uninsulated brick wall

B1 FabTrads preliminary

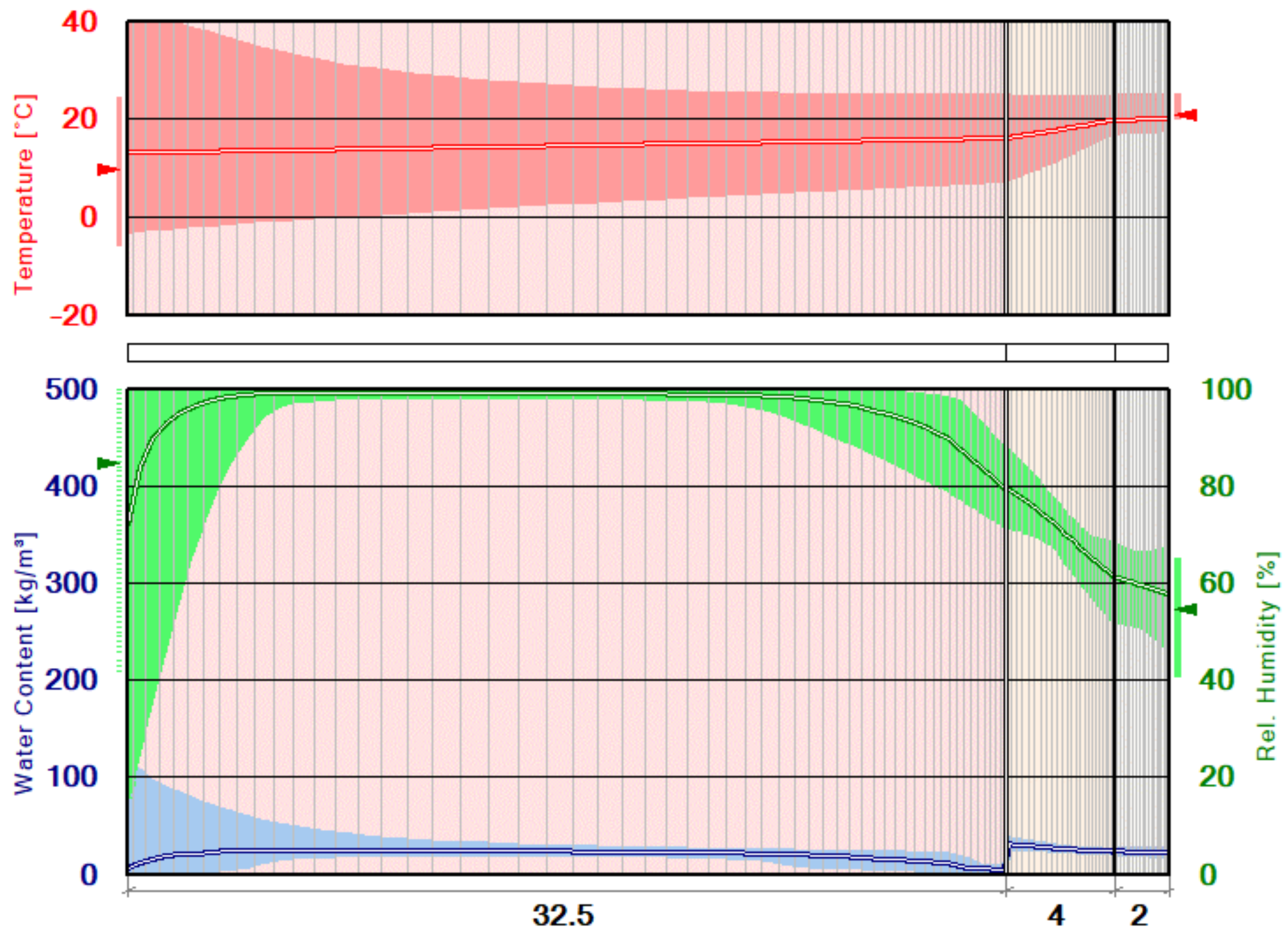


WUFI solid brick historical

uninsulated brick wall

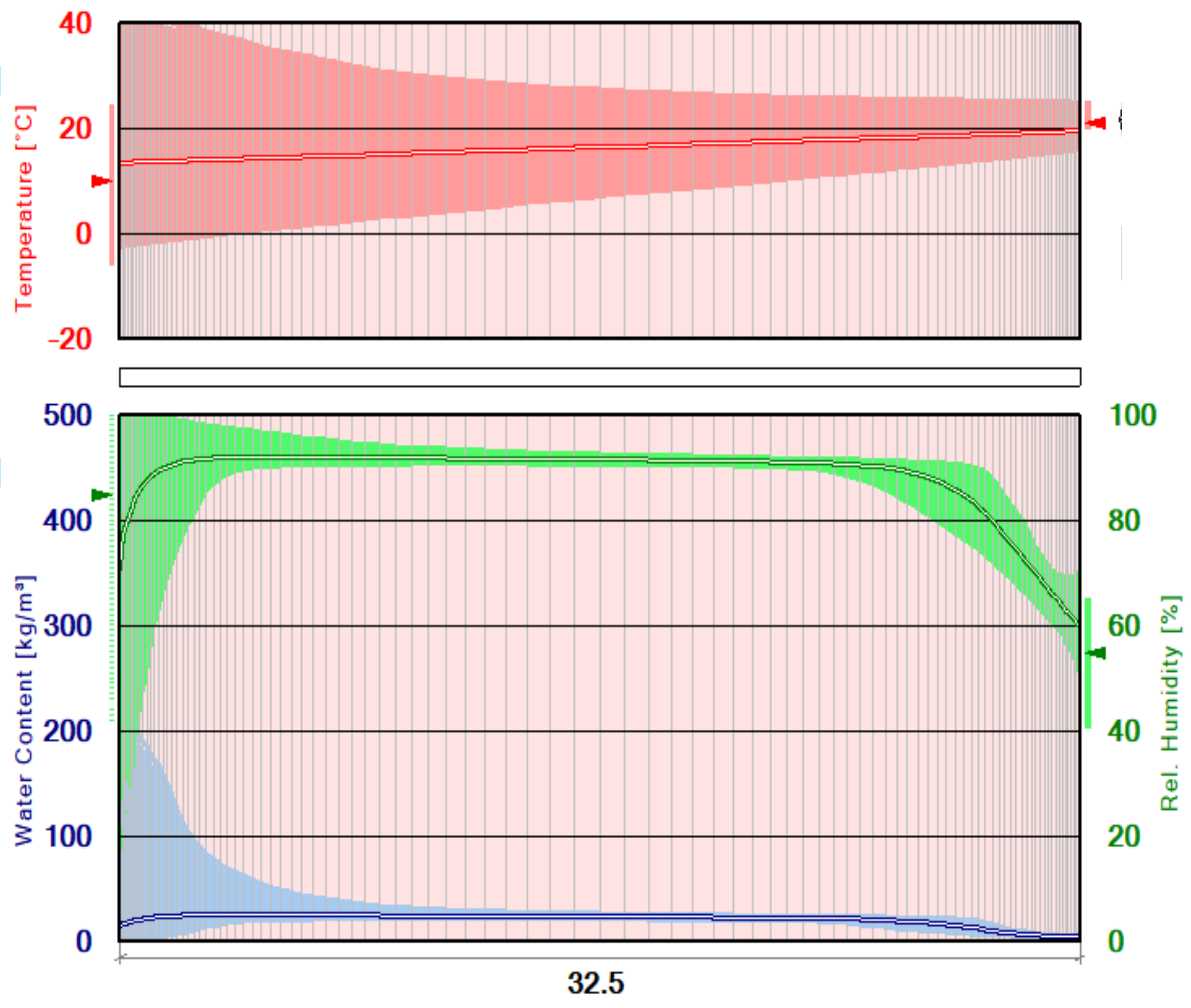


drylined brick wall (cork + lime render)



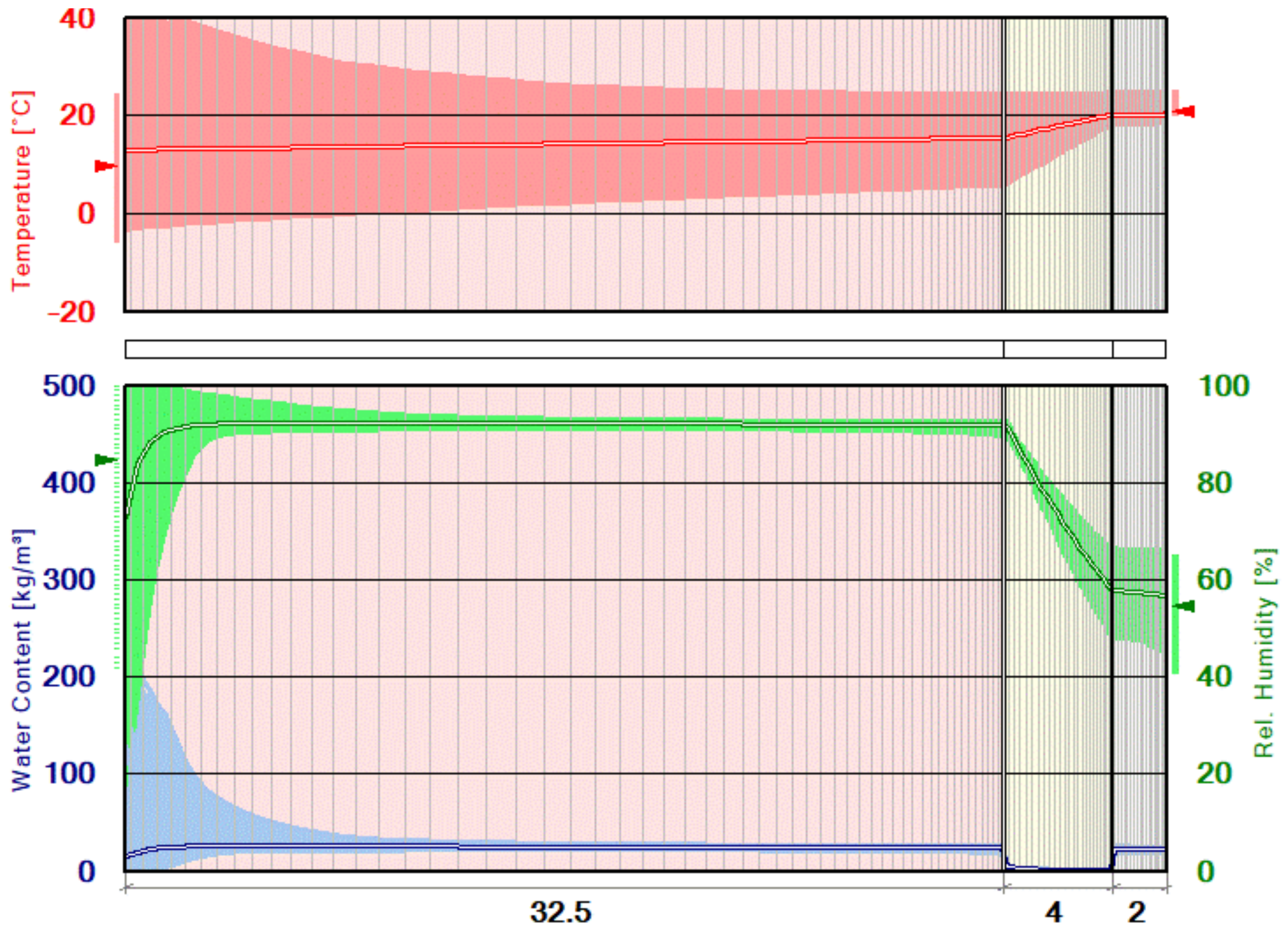
drylined brick wall (cork + lime render)

Assessment of retrofit options



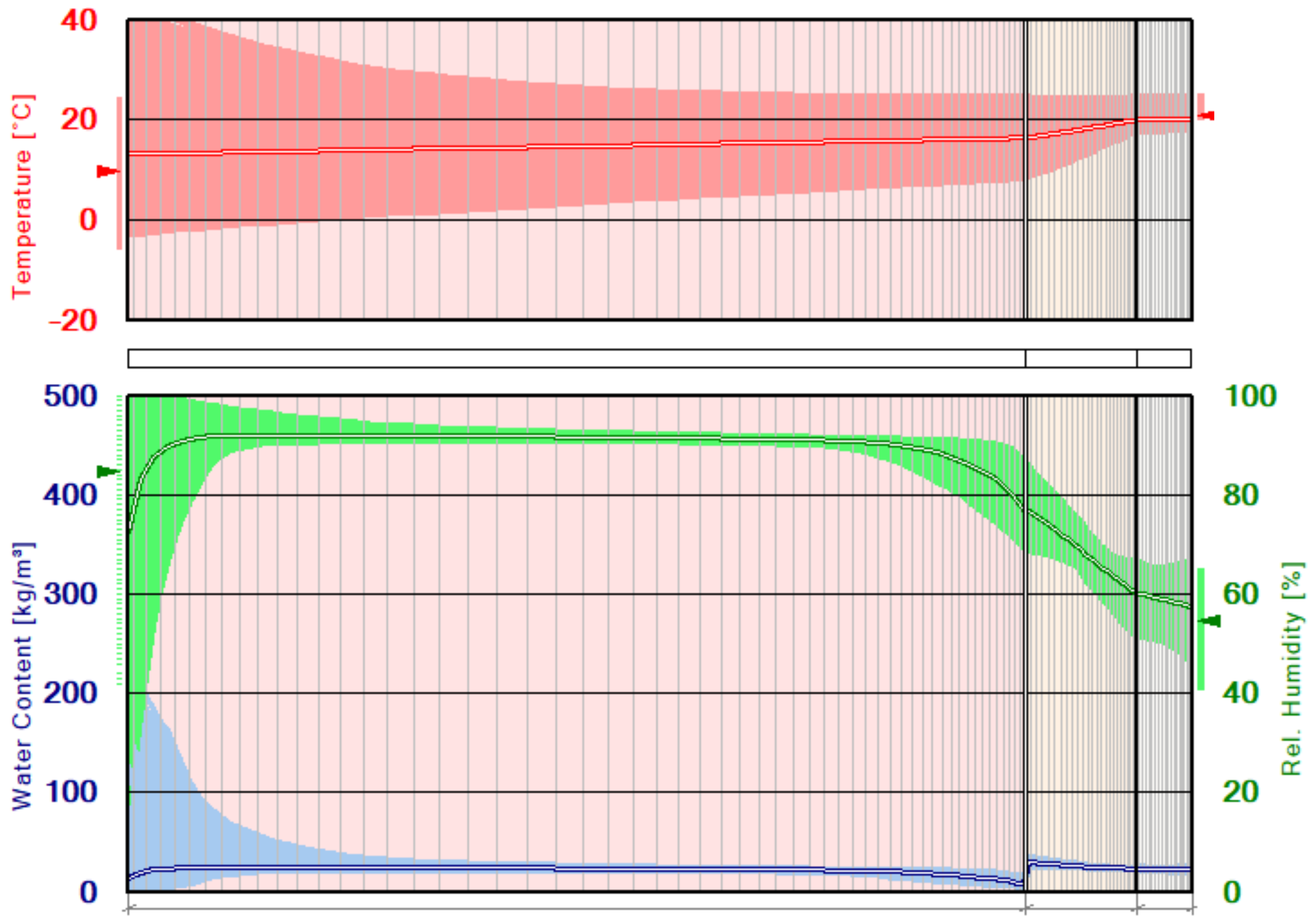
uninsulated brick wall

EPS insulation

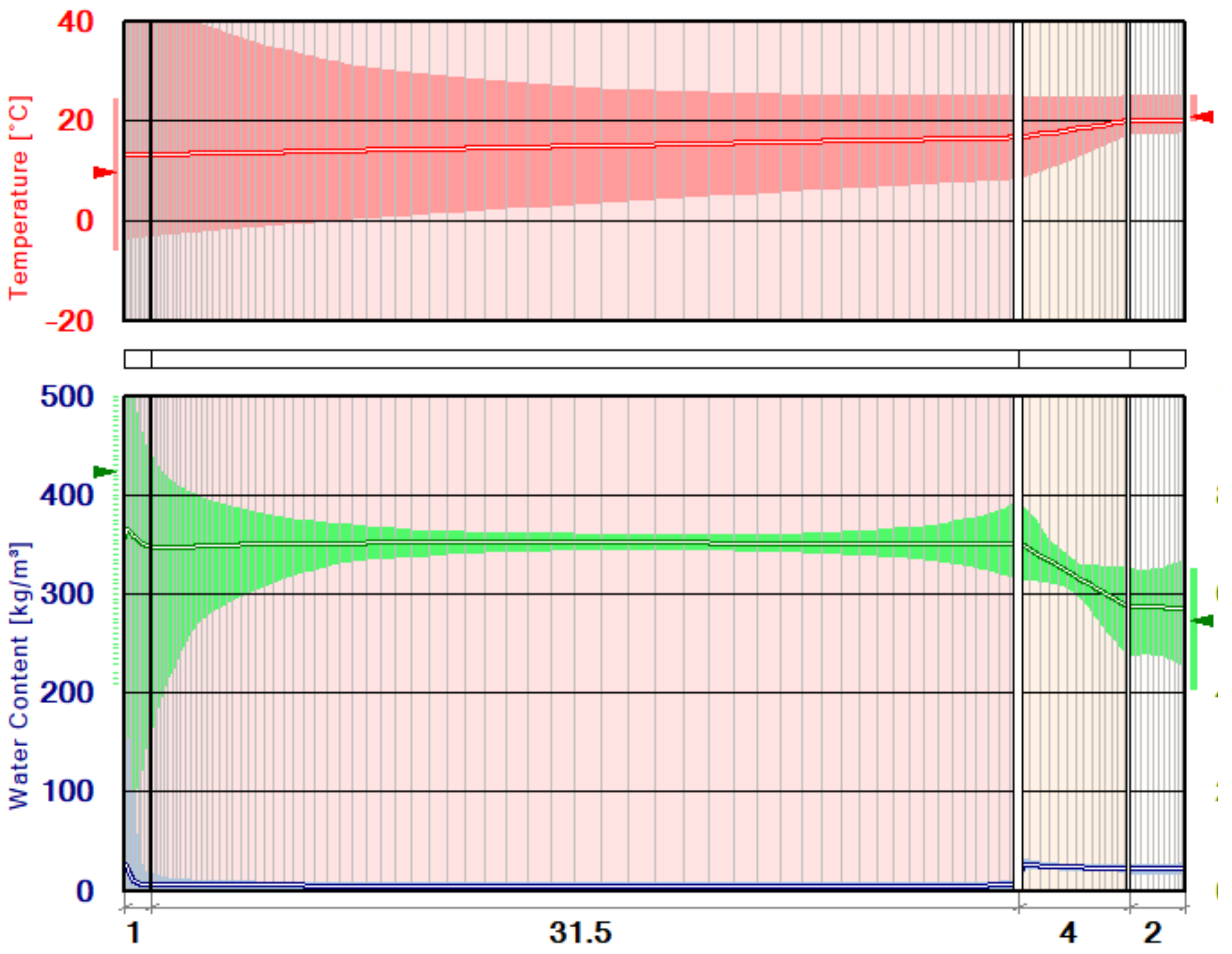


drylined brick wall

drylined brick wall – impact of water repellent



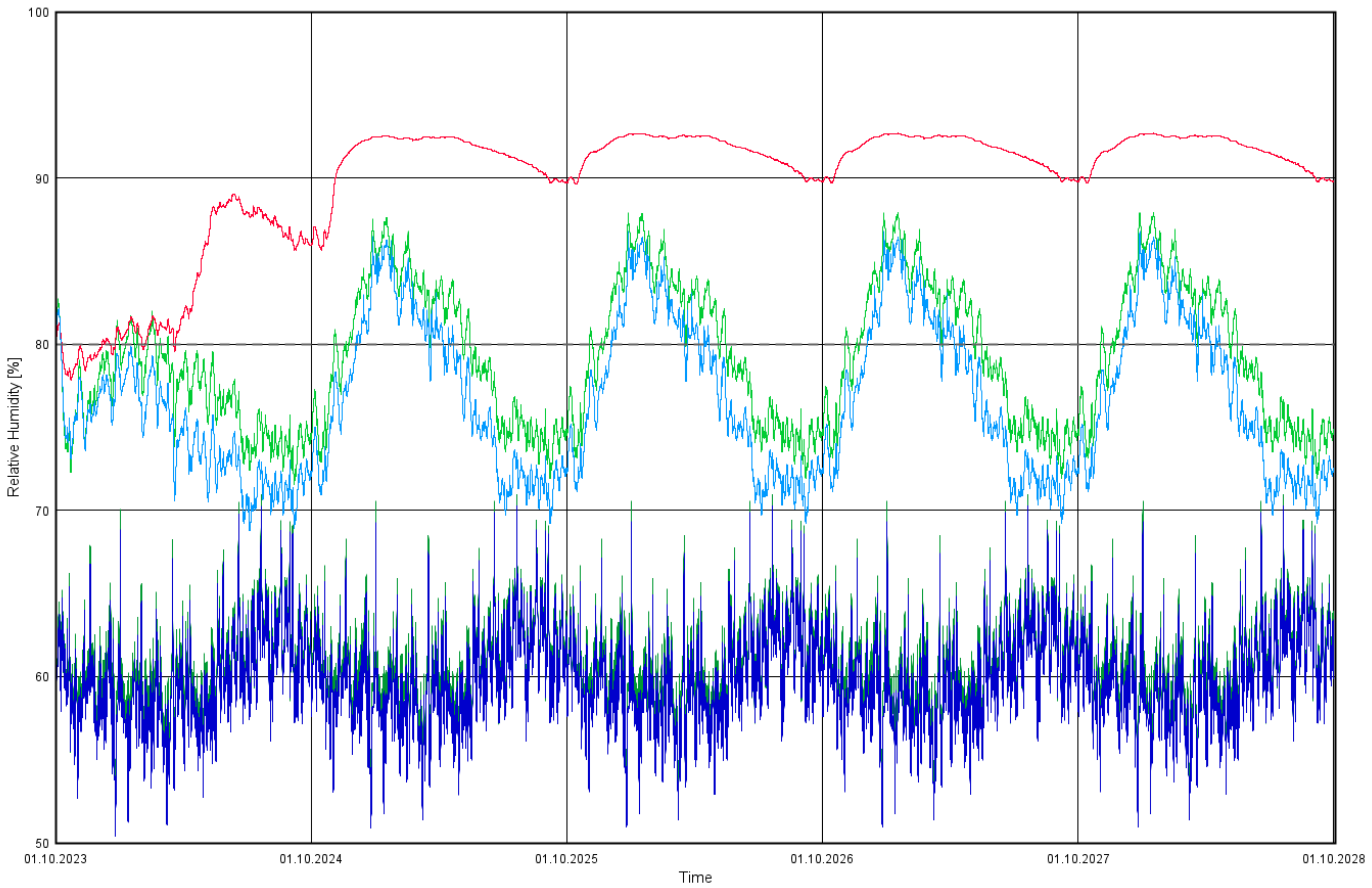
cork + lime render



B1 FabTrads preliminary

RH at interface with insulation

Relative Humidity at inner face of brick (at interface with insulation)



B1 Fabtrads preliminary – EPS

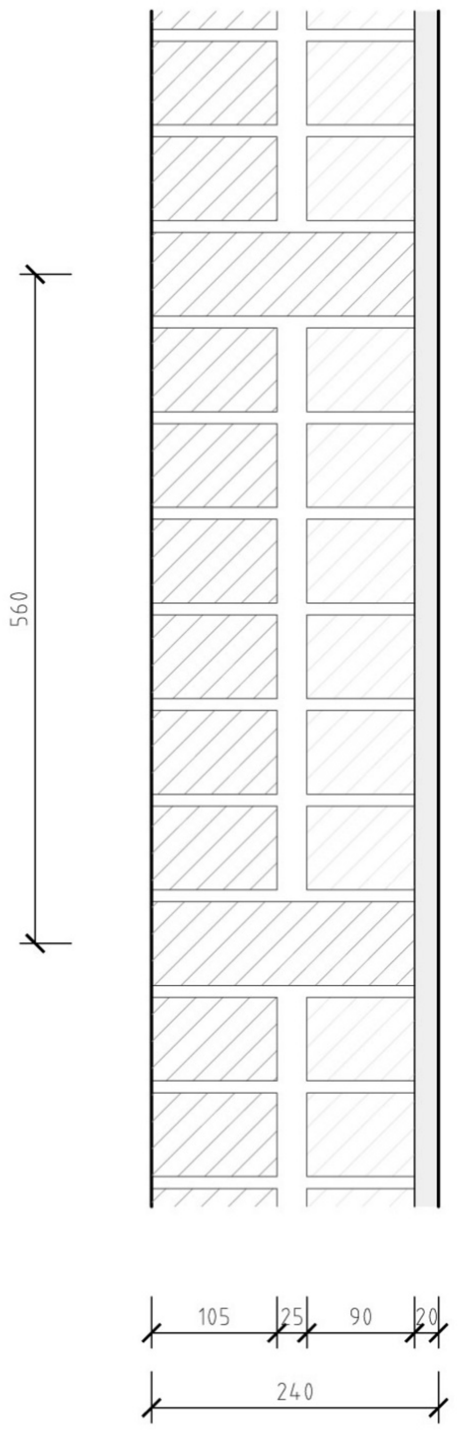
80% RH risk threshold for mould growth

WUFI Solid brick historical – cork + lime
B1 Fabtrads preliminary – cork + lime

WUFI Solid brick historical – no insulation
B1 Fabtrads preliminary – no insulation

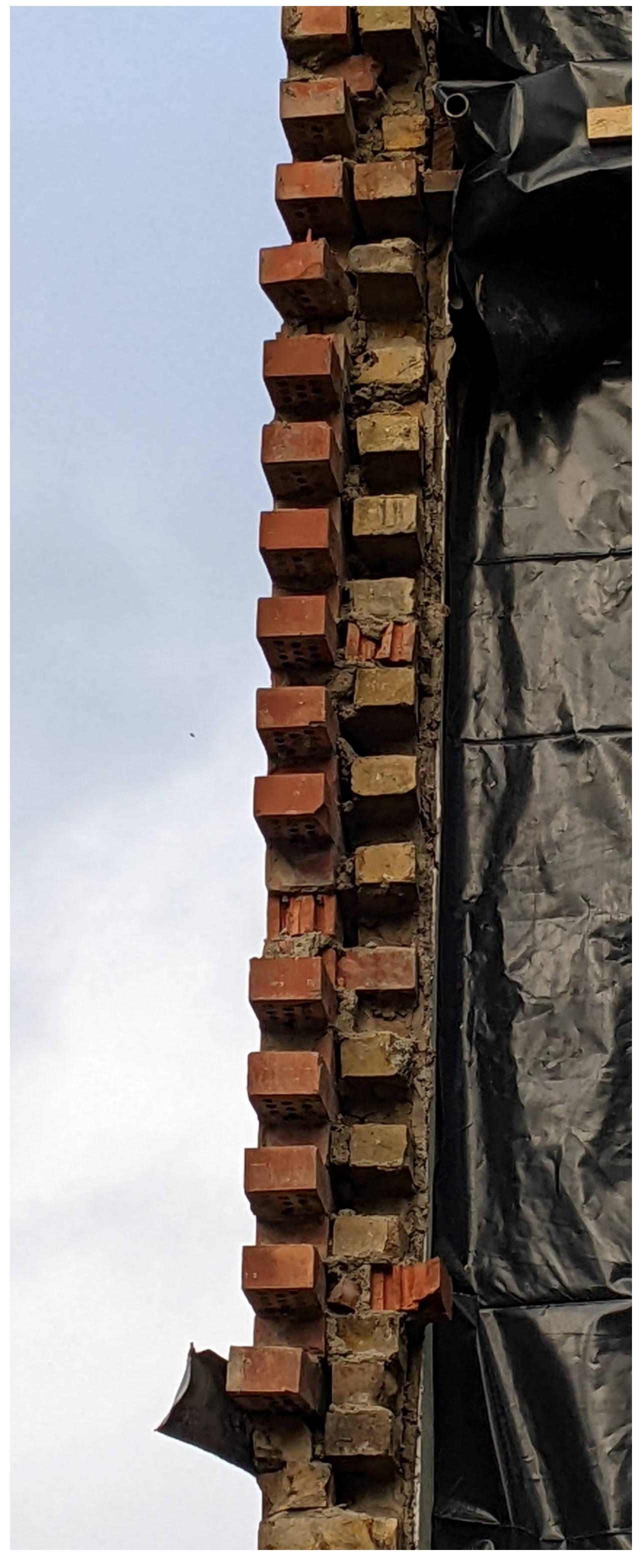
24 St. Kevin's Park, Dublin 6

- ca. 1910
- U-value testing: 05-12-2022
- 1.58 W/m²K



24 ST. KEVIN'S PARK, DUBLIN 6

OVERALL DEPTH: 240MM
ASSUMED ASSEMBLY:
220MM COMPOSITE BRICK WALL, HEADER TIES EVERY 7TH COURSE
(B11 RED FACING BRICK AND B12 YELLOW INTERNAL BRICK, LIME MORTAR)
20MM INTERNAL LIME PLASTER



Bricks

S5 Age bands

A set of age bands is defined according to Table S1 for the purposes of assigning U-values and other data.

Table S1: Age bands

Age band	Years of construction
A	before 1900
B	1900-1929
C	1930-1949
D	1950-1966
E	1967-1977
F	1978-1982
G	1983-1993
H	1994-1999
I	2000-2004
J	2005 onwards (without BER certificate already)

Table S2: Building Regulations summary[1]

Year of regulations	Applicable age band	U-values (W/m²K)		
		Roof	Wall	Floor
1976 (Draft)	F[2]	0.4	1.1	0.6
1981 (Draft)	G	0.4	0.6	0.6
1991	H[3]	0.35	0.55	0.45/0.6
1997	I	0.35	0.55	0.45/0.6
2002	J	0.25	0.37	0.37

S6 Constructional types and U-values

U-values of construction elements are determined from the constructional type and date of construction. U-values are assessed separately for the main part of the dwelling and for any extension. Where Building Regulations are available, the associated U-value from Table S2 is used. Any other walls with insulation can have non default U-values entered.

S6.1 U-values of walls

This section details default wall U-values where there is insufficient information to enter non-default U-values. Lookup of the defaults in Tables S3 and S3a are automatically referenced by DEAP software. Values from Table S3b are entered into DEAP by the user.

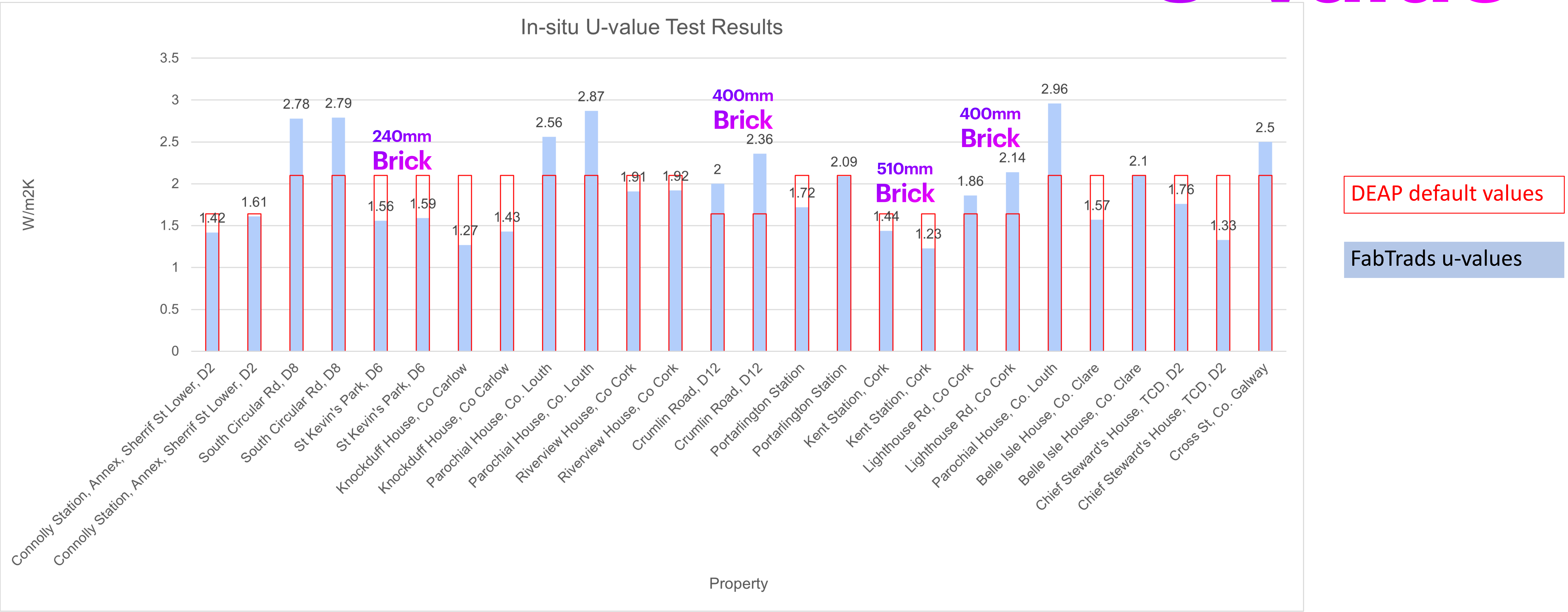
Table S3: Exposed wall U-values[1]

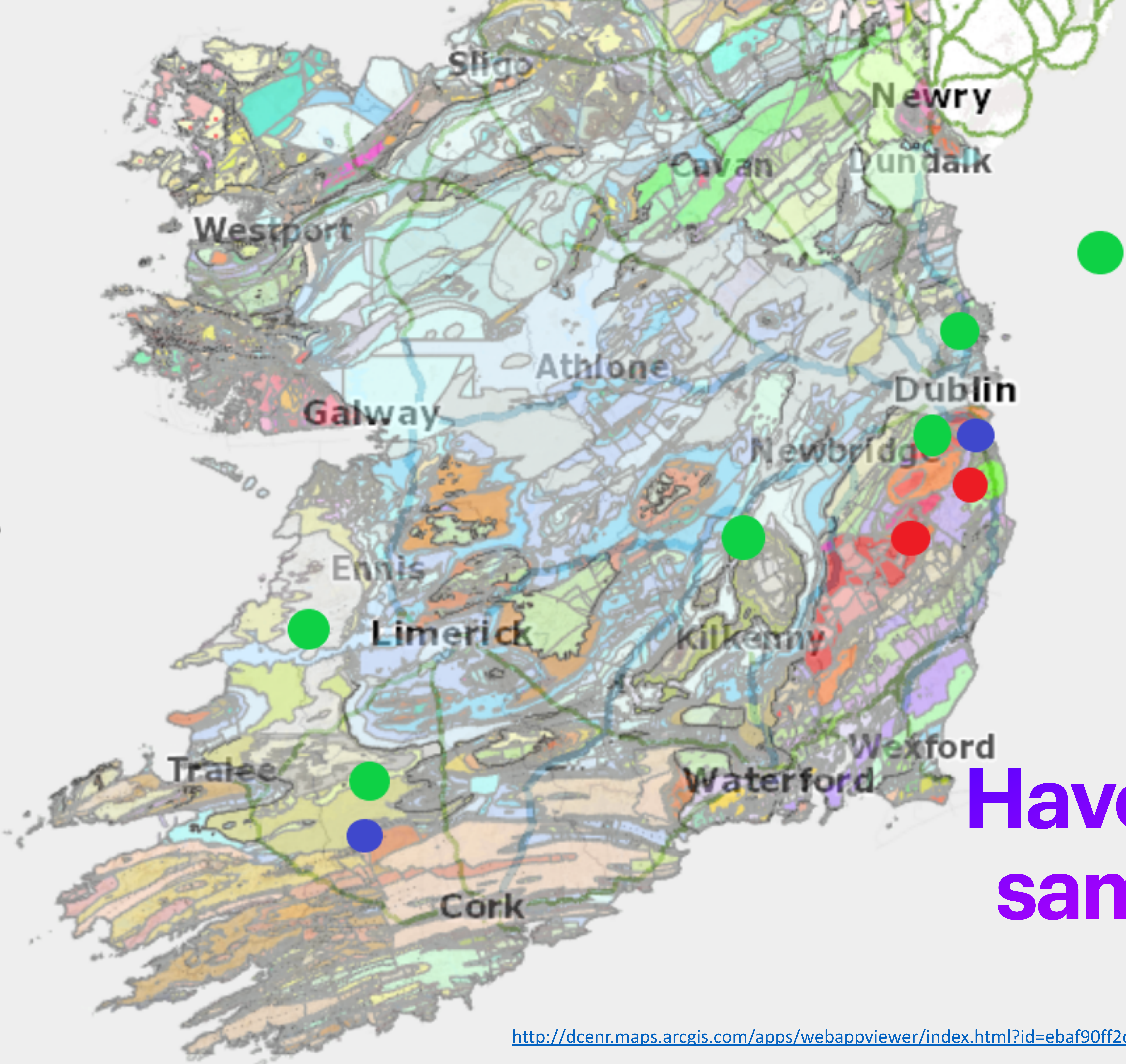
Age Band	A	B	C	D	E	F	G	H	I	J
Wall type										
Stone	2.1	2.1	2.1	2.1	2.1	1.1	0.6	0.55	0.55	0.37
225mm solid brick	2.1	2.1	2.1	2.1	2.1	1.1	0.6	0.55	0.55	0.37
325mm solid brick	1.64	1.64	1.64	1.64	1.64	1.1	0.6	0.55	0.55	0.37
300mm cavity	2.1	1.78	1.78	1.78	1.78	1.1	0.6	0.55	0.55	0.37
300mm filled cavity	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.55	0.55	0.37
solid mass concrete	2.2	2.2	2.2	2.2	2.2	1.1	0.6	0.55	0.55	0.37
concrete hollow block	2.4	2.4	2.4	2.4	2.4	1.1	0.6	0.55	0.55	0.37
timber frame	2.5	1.9	1.9	1.1	1.1	1.1	0.6	0.55	0.55	0.37
Unknown	2.1	2.1	2.1	2.1	2.1	1.1	0.6	0.55	0.55	0.37
425 mm Cavity Wall	1.73	1.51	1.51	1.51	1.51	1.1	0.6	0.55	0.55	0.37
425 mm filled cavity	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.55	0.55	0.37

If the dwelling is of age band F or G but the roof of the dwelling is shown to have no insulation, then the wall must be assumed to be age band E (no insulation)

[1] These U-values may be used as a starting point for calculating U-values of similar walls with insulation provided evidence is available to substantiate the insulation levels used in any U-value calculations.

In-situ U-value





- limestone
- granite
- sandstone

Portland Limestone

Have you any samples for us?

http://dcenr.maps.arcgis.com/apps/webappviewer/index.html?id=ebaf90ff2d554522b438ff313b0c197a&scale=0