Green Retrofit of Listed Buildings

Oxford College Workshop

26 May 2020

5th studio

There are some key lessons but essentially it’s all about balance

- Know where you’re starting from
- Understand all of the impact
- Think holistically
- Learn from modelling
- Manage consent process
- Some misconceptions


ECML
Peterborough
Norwich
WM
Huntingdon
Northampton
CAMBRIDGE
Ipswich
HS2
MK
Oxford
EUS STP KGX LST SRA
LONDON
HS1
5th
studio

Retrofit of buildings from the 60s+70s

RIBA

RIBA Award Winner

Retrofit of Listed buildings from the 60s+70s

Retrofit of Historic and Listed Buildings

New Court: Trinity College

Brief

COLLEGE BRIEF
November 2009

Accommodation

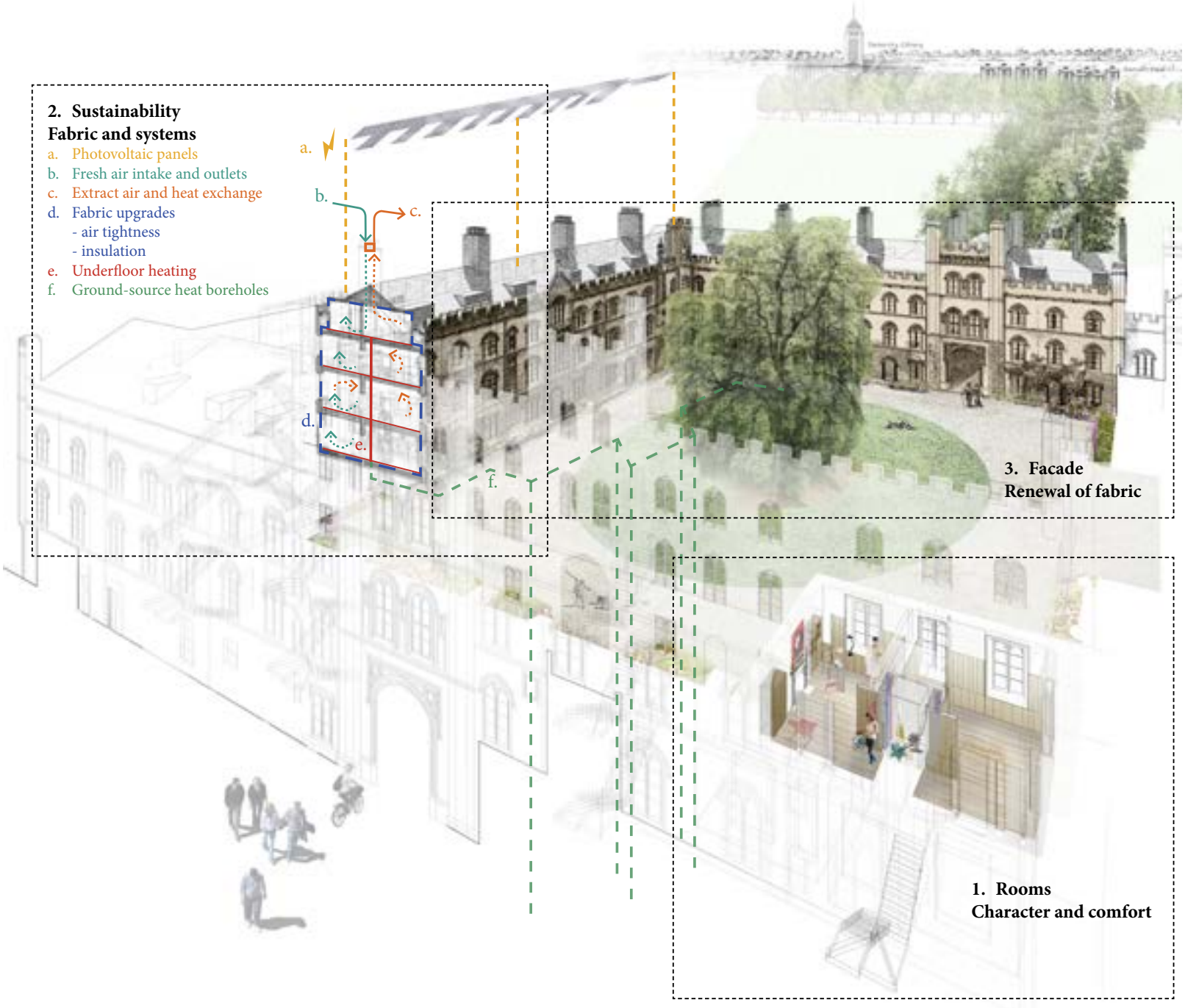
- 130 Study Bedrooms
  - 1/5 Ensuite rooms
  - 4/5 Shared facilities
  - 4 Accessible Rooms
- Tutorial Offices, Fellows teaching and residential sets
- Seminar Room

Compliance with Building, Fire and other Regulations

Complete new services installations

Renew facades and character of court and of rooms

Reduce energy use and carbon emissions in line with global targets



Exteriors

Interiors

Some key lessons

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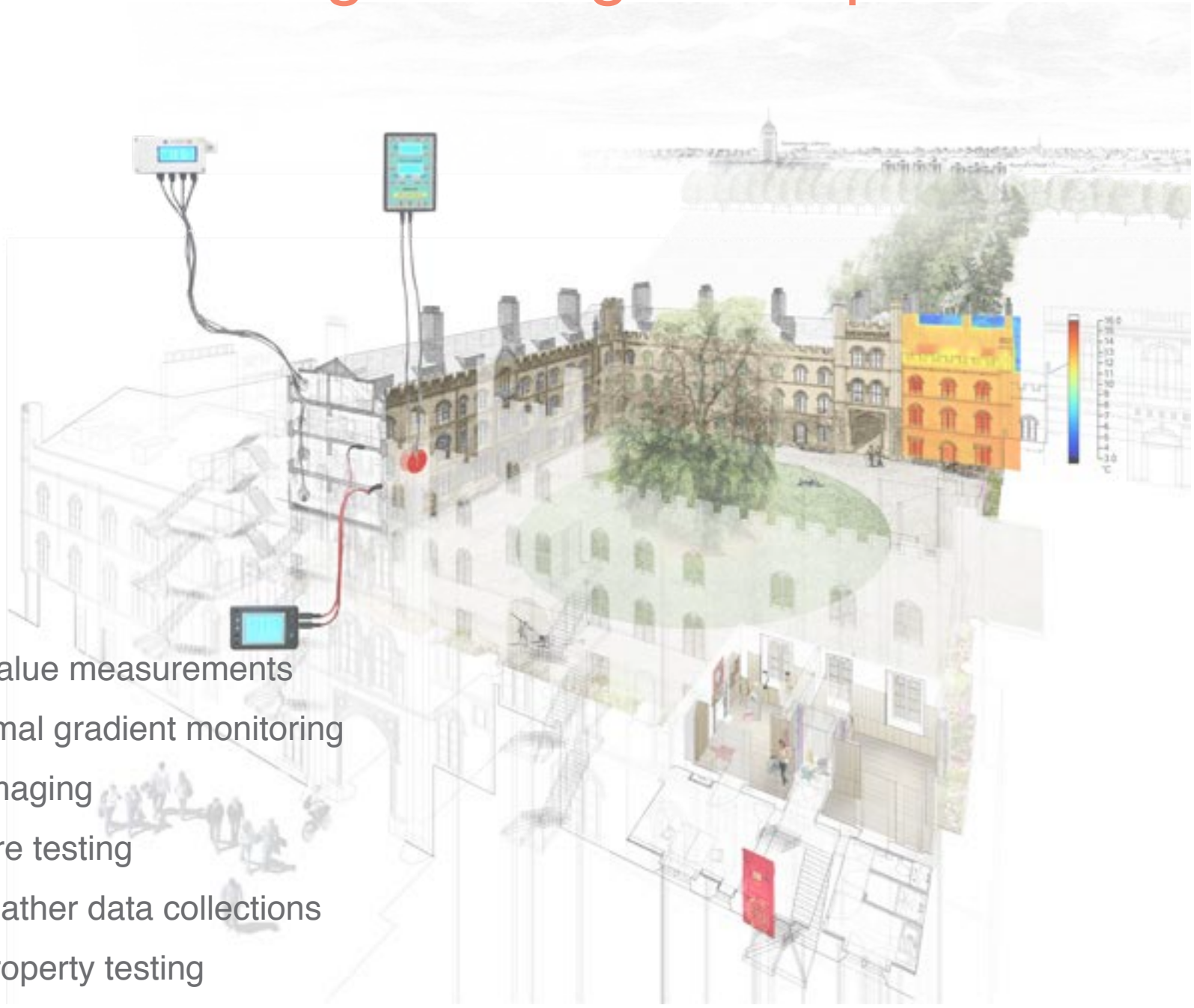
New Court. c.1865

Understanding existing fabric performance



- In-situ U-value measurements
- Hygrothermal gradient monitoring
- Thermal imaging
- Air pressure testing
- On site weather data collections
- Material property testing

In situ U-value measurement

For 8 walls measured

Range of measured U-values (ISO 9869)	0.59 – 0.78 W/m2K
Average measured U-value =	0.69 W/m2K
Standard U-value calculated for walls (ISO 6946) =	0.94 W/m2K

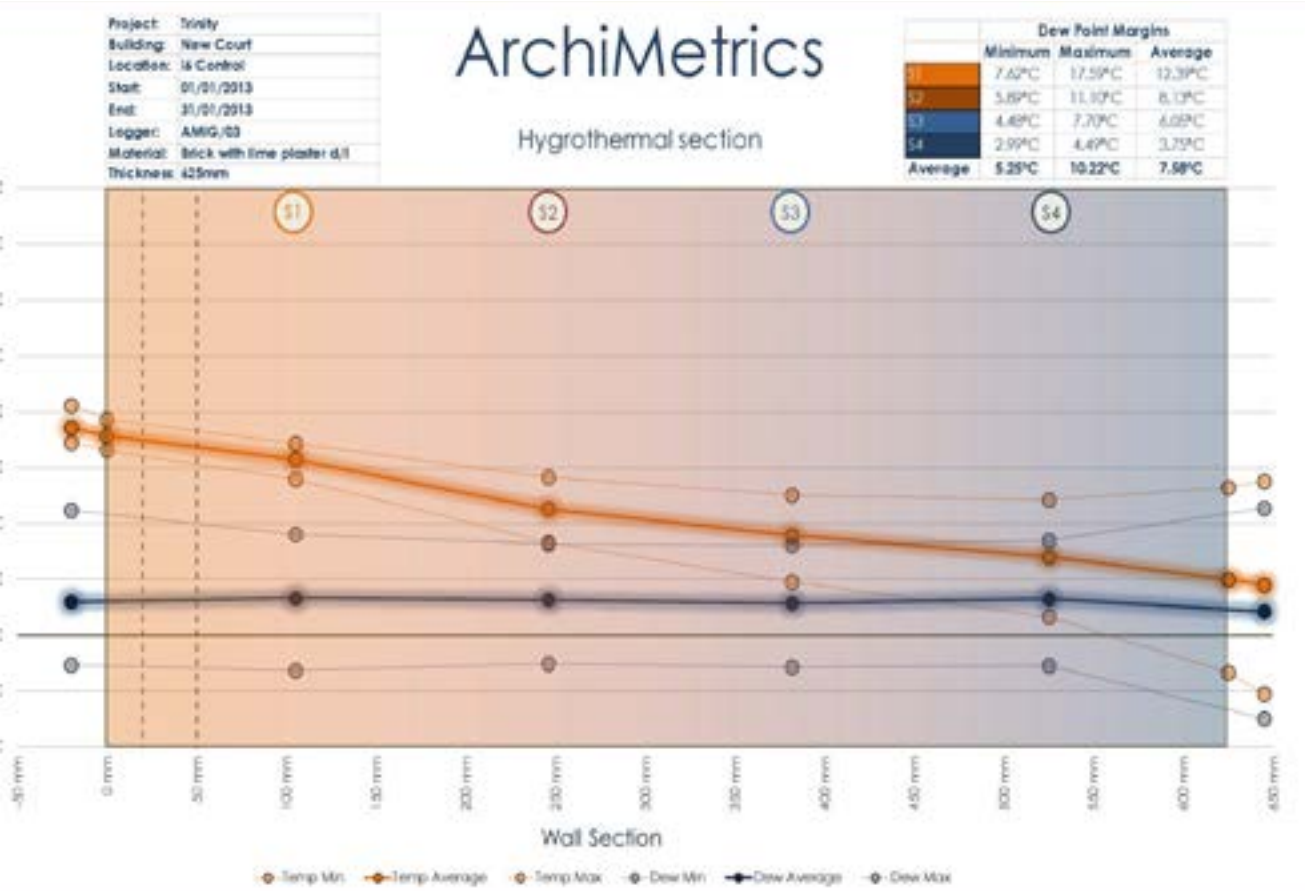
25% difference between measured/calculated U-values

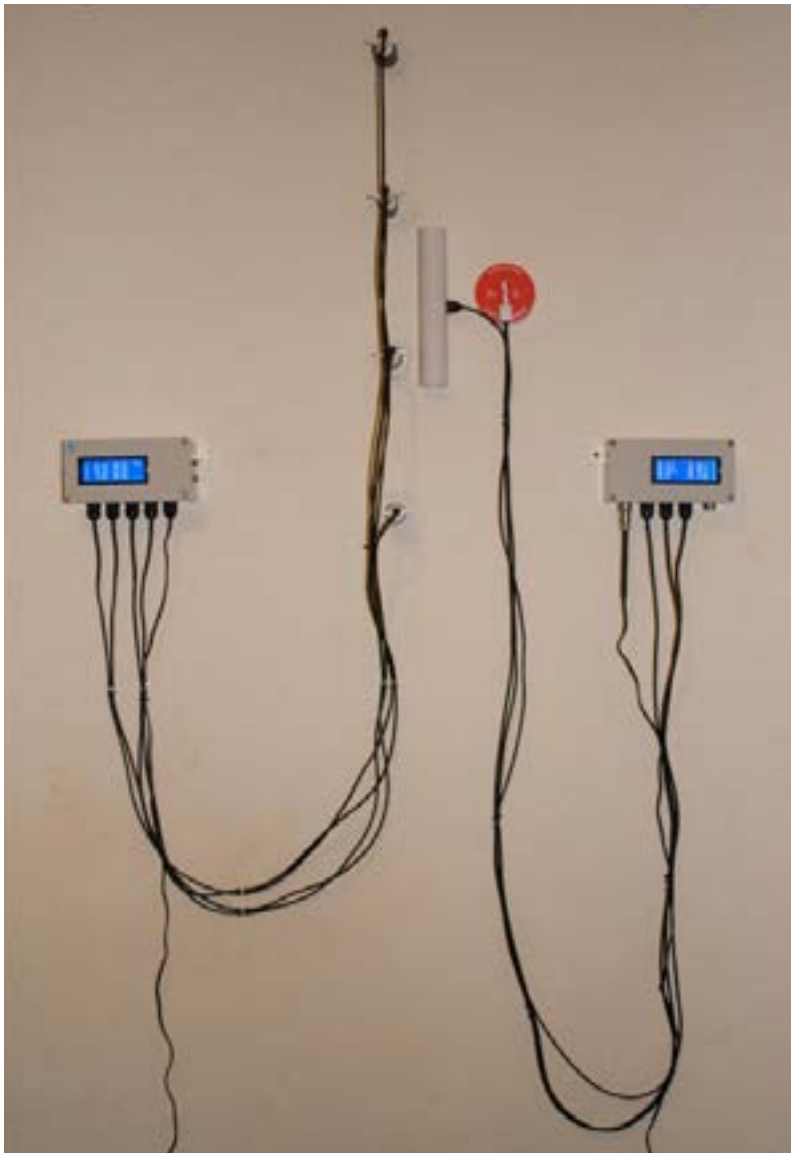
Project proposal	0.25W/m2°C.

For comparison:

a. Building Regulations. (Limiting Value for new buildings):	0.35W/m2°C.
b. Passivhaus Standards	
New build	0.15W/m2°C.
Enerphit for internal insulation	0.35W/m2°C.

Interstitial Hygrothermal Gradient Monitoring - IHGM





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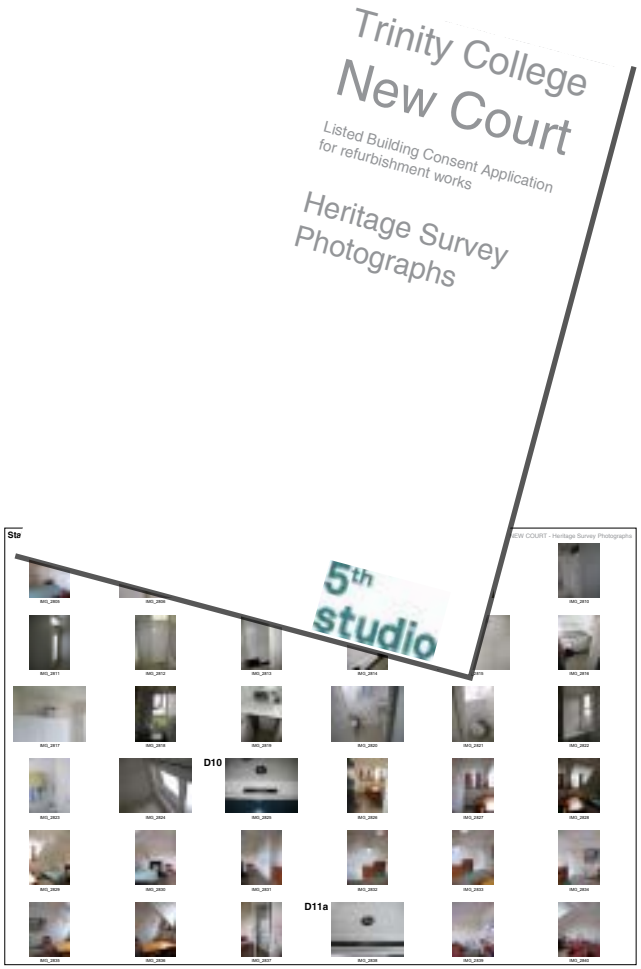
Architectural character: interiors



	Room Category, Prevalence and Significance	*Approach*	*Typical Room Appearance*
	Grand Rooms Rare (5 rooms) HIGH (Archway Rooms) N/A (New Seminar Room)	To preserve and repair the existing fabric and, only where necessary, to renew or adjust this to accommodate fabric upgrade. Some of these rooms have four external walls and an insulated lining would be added to each of these. To maintain the existing arrangement and details, this would be installed across the full extent of each wall, allowing a reinstatement/ like-for-like replacement of the existing cornice, picture rail (where present) and skirting details. Joinery pieces and the fireplace are to be refurbished and re-installed	
	Standard - formal 1/10 MODERATE	A lining would be added to accommodate insulation to external walls only. A similar lining element would accommodate the main service risers to internal walls - as shown on plan. Fitted furniture is envisaged as a distinct, subordinate, and removable timber intervention. This would be separate from the background wall/lining and it's maximum height keyed to door surround height.	
	Standard - normal / informal 1/4 MODERATE (/LOW - generally slightly lower significance than 'Standard - formal')	An insulated lining would be added to accommodate insulation to external walls only. A similar lining element would accommodate the main service risers to internal walls - as shown on plan. Fitted furniture is envisaged as a distinct, subordinate, and removable timber intervention. This would be separate from the background wall/lining and it's maximum height keyed to door surround height.	
	Attic Rooms 1/4 LOW	The existing sloped ceiling is to be lined-out to provide the additional insulation depth required - the junction detail between sloped ceiling and adjacent walls is to be maintained. Fitted furniture is envisaged as a distinct, subordinate, and removable timber intervention separate from the background wall/lining.	
	Back rooms 1/3 LOW	An insulated lining is to be added only to the outside walls. A similar lining would accommodate the main service risers to internal walls - as shown on plan. Fitted furniture is envisaged as a distinct, subordinate, and removable timber intervention. This would be separate from the background wall/lining and it's maximum height keyed to door surround height.	

increased 'significance

Heritage Significance

New Court
Trinity College

Heritage Survey Summary

2nd August 2010

5th studio

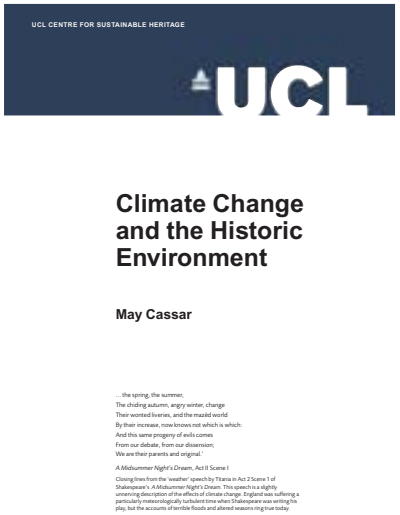
HERITAGE STATEMENT

NEW COURT
TRINITY COLLEGE

June 2012

5th studio
BEACON

Review of relevant research


UCL CENTRE FOR SUSTAINABLE HERITAGE

UCL

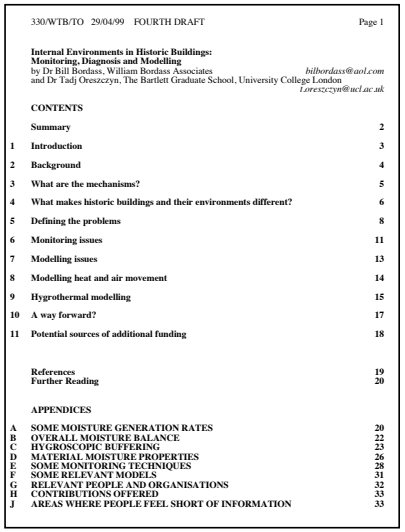
Climate Change and the Historic Environment

May Cassar

... the spring, the summer,
The chiding autumn, angry winter, change
Their wonted liveries, and the mazèd world
By their increase, now knows not which is which:
And this same progeny of evils comes
From our debate, from our dissension;
We are their parents and original.'

A Midsummer Night's Dream, Act II Scene I

Closing lines from the 'weather' speech by Titania in Act 2 Scene 1 of Shakespeare's *A Midsummer Night's Dream*. This speech is a slightly unnerving description of the effects of climate change. England was suffering a particularly meteorologically turbulent time when Shakespeare was writing his play, but the accounts of terrible floods and altered seasons ring true today.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Internal Environments in Historic Buildings: Monitoring, Diagnosis and Modelling

by Dr Bill Bordass, William Bordass Associates *bilbordass@aol.com*
and Dr Tadj Oreszczyn, The Bartlett Graduate School, University College London *t.oreszczyn@ucl.ac.uk*

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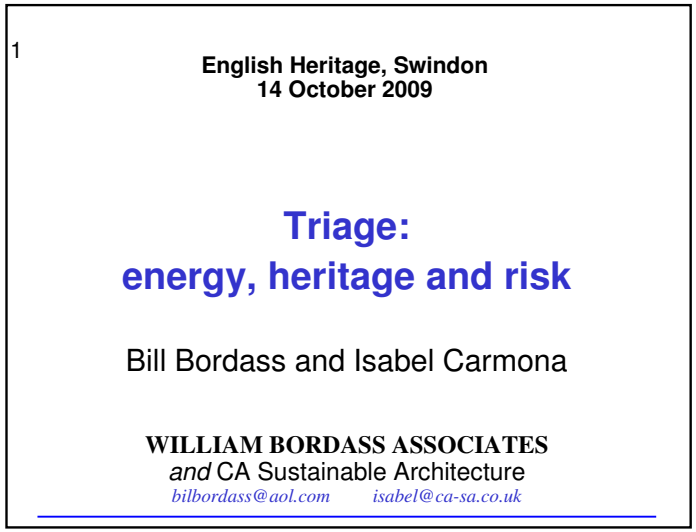
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English Heritage, Swindon
14 October 2009

Triage:
energy, heritage and risk

Bill Bordass and Isabel Carmona

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Building Life Consultancy
A SERVICE OF
Joseph Little Architects

Breaking the Mould 1

A study of condensation in single-leaf concrete wall upgrades

PUBLISHED IN 'CONSTRUCT IRELAND' ISSUE 6, VOL. 4 (MARCH - APRIL 09)

By,
Joseph Little
BArch, MRIAI, MEASCA, MSc Archit. Advanced Environmental + Energy Studies (Hons)

Introduction

This article is the first of a series looking at upgrade options and issues associated with single-leaf walls of existing houses. This article will focus on insulated dry-lined concrete block walls of the ubiquitous housing estate house. This will include the findings of software that dynamically models moisture movement through the wall over several years. The article following this will look at a range of options for replacing existing dry-lining or installing dry-lining where it never was before, be that for a solid block wall of a 1950s house or a solid brick wall of an 1850s house.

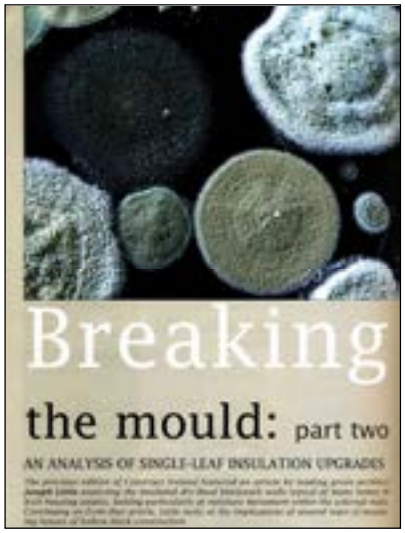
In the last while I've been struck by two things in my Practice: (1) how many middle class clients with good jobs are now in doubt as to how much finance they can commit to making their house more energy efficient due to the crisis in the banking sector and voluntary or imposed stringency measures and (2) how many of those (relatively) wealthy clients live in houses with no insulation at all, excluding perhaps 75mm of collapsed glasswool in the attic and less wrapped ineffectually around the cylinder. A six bedroom house in Fearrock, built in the mid 90's, with an appalling €5,000 a year heating bill comes to mind. The 'Home Energy Savings (HES) Scheme' [1] is coming at exactly the right time to give confidence and fiscal aid to those who wish to make their houses more energy-efficient and comfortable but have too high an income for the 'Warmer Homes Scheme', and also for a construction industry that badly needs employment.

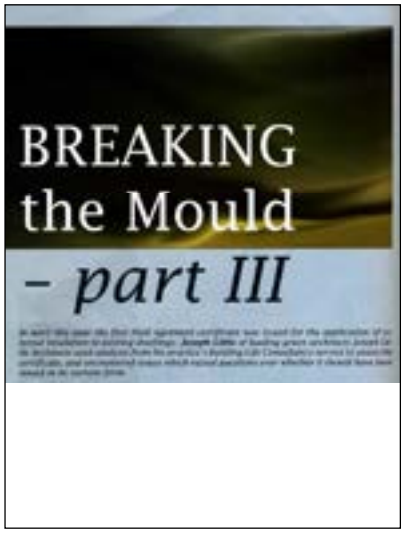
Therefore all praise to Minister John Gormley and SEI for launching the HES Scheme on February 8th. For the first time ever any owner of an existing home can access grant aid to insulate their houses better and heat them more efficiently. A total of €100M is allotted in 2009. If the Scheme is widely adopted it could have a huge positive impact on national carbon emissions, energy efficiency and health *if done well*. The caveat is key: for this Author 'done well' means renovating with a keen awareness of building physics, insulation, airtightness, moisture movement, potential mould growth, ventilation and health. Doing the work well means that Irish builders, designers and specifiers need to re-think some aspects of how we build. We must make sure not to repeat mistakes of the past and homeowners must be ready to challenge past solutions

Health & home

Why this focus on mould, ventilation and health when thermally upgrading a house? Here are two of many reasons: (1) Our population has the fourth highest incidence of asthma in the world and allergies are rising fast. Alarmingly things may be getting worse: recently the WHO has found that as many as 1/3 of Irish children now have asthma. (2) Studies in other countries have found a close correlation between these diseases and the environments we spend so much of our time in: homes, offices and schools. In one study of 328 homes in southeast France, selected

[1] http://www.seai.ie/Your_Home/Pilot_Home_Energy_Savings_Scheme/


Breaking the mould: part two
AN ANALYSIS OF SINGLE-LEAF INSULATION UPGRADES

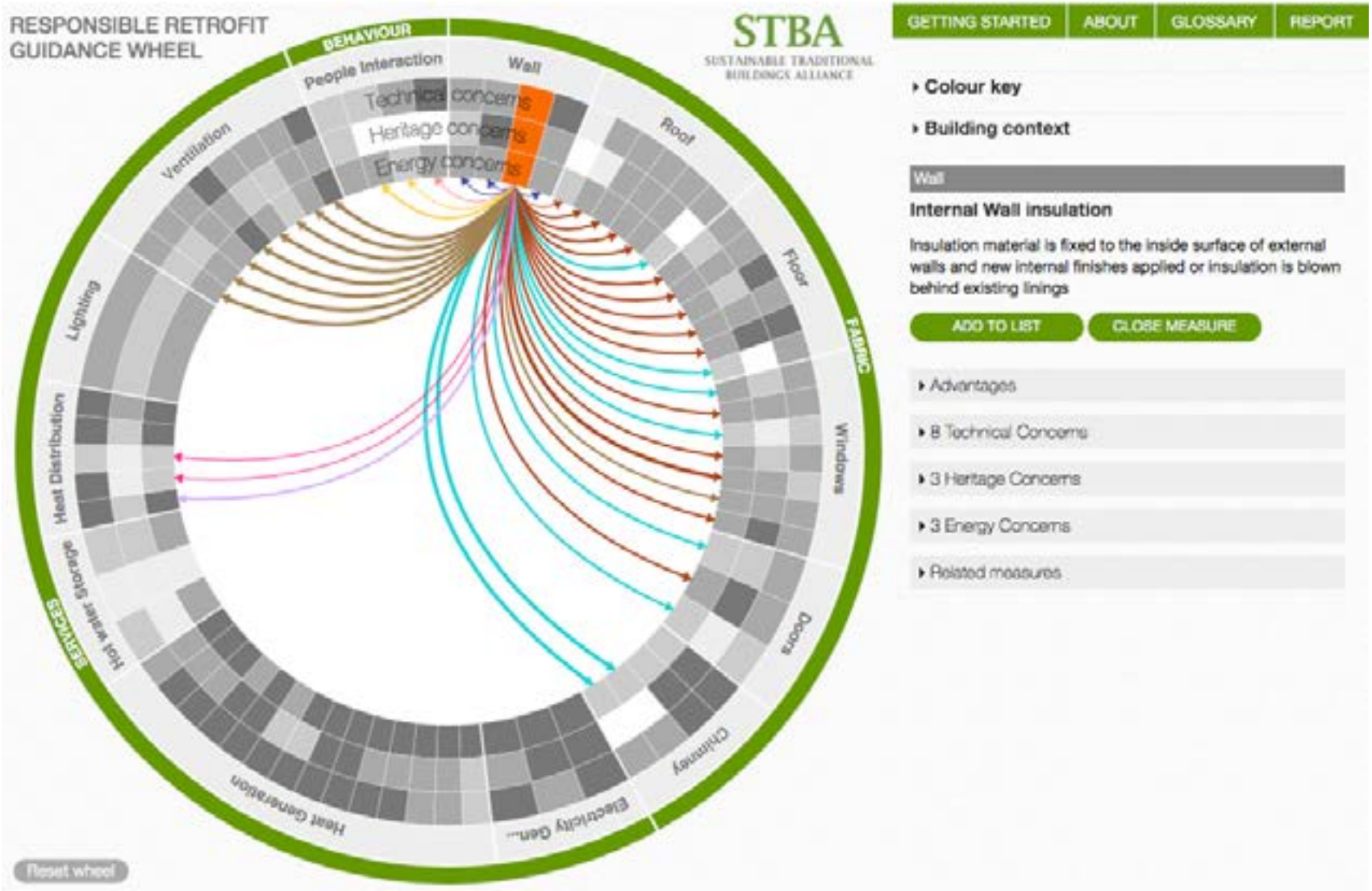

BREAKING the Mould – part III


BREAKING
THE MOULD – part IV
CONDENSATION RISK ANALYSIS - THE STANDARDS & THE ISSUES


Breaking the Mould – part V
COMPARATIVE SIMULATIONS OF INTERNAL INSULATION SYSTEMS

Retrofit Wheel

http://responsible-retrofit.org/wheel/



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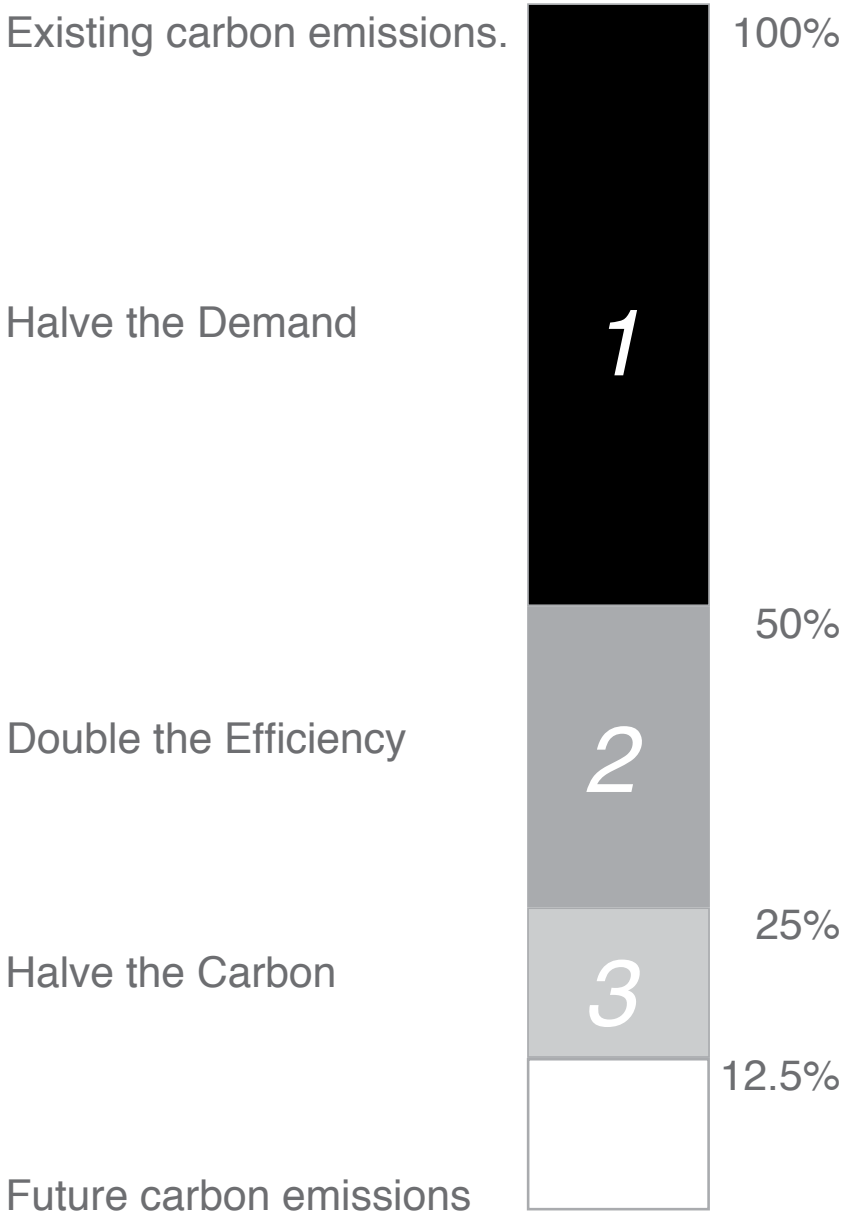
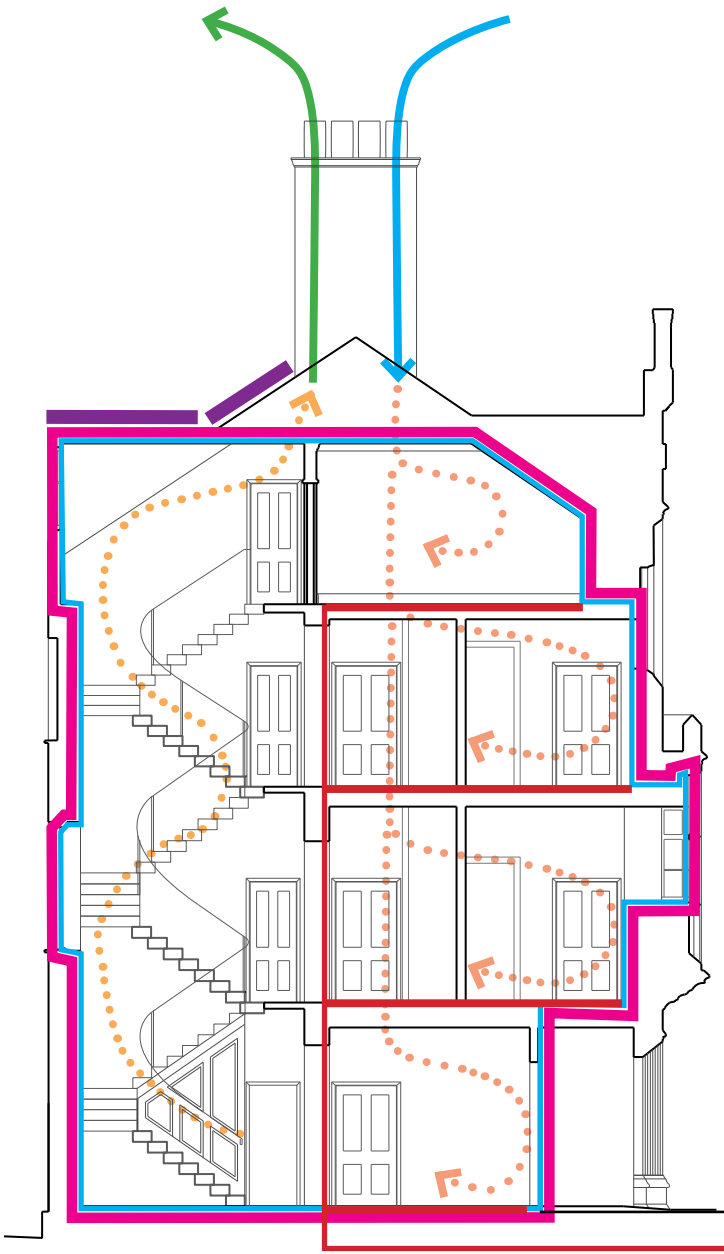
Target 3-step reduction of emissions



Proposed Strategy



Photovoltaics
A PV array mounted on the South-facing roof over Garret Hostel Lane will produce 14,000kWh electricity, saving 7,280 kg carbon, per year.

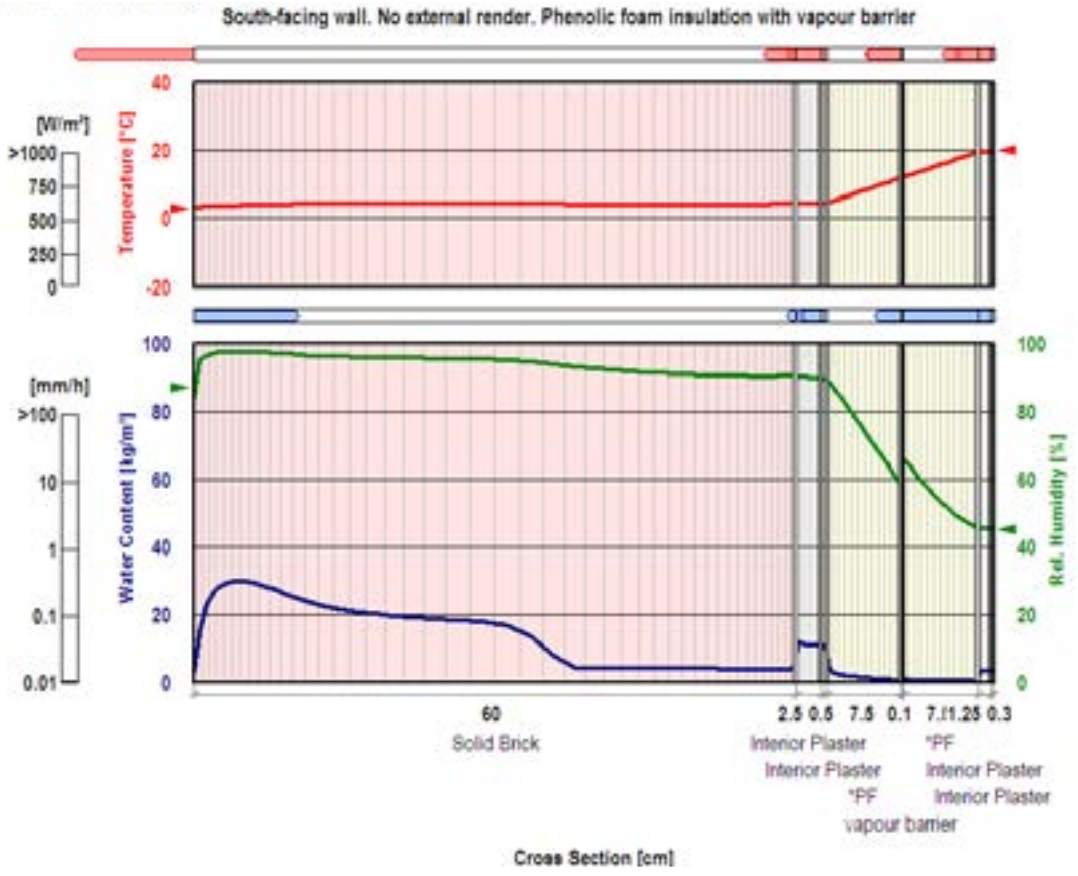
Air-Tightness
Penetrations around windows and through external and internal walls sealed, windows draught-stripped, new membranes to roof.
To achieve draught-sealing to 3.0m3/h/m2@50Pa

Insulation
Improvement of the thermal performance of roof, ground floor and external walls, using vapour-permeable insulation to achieve maximum thermal performance without risk to the existing fabric.

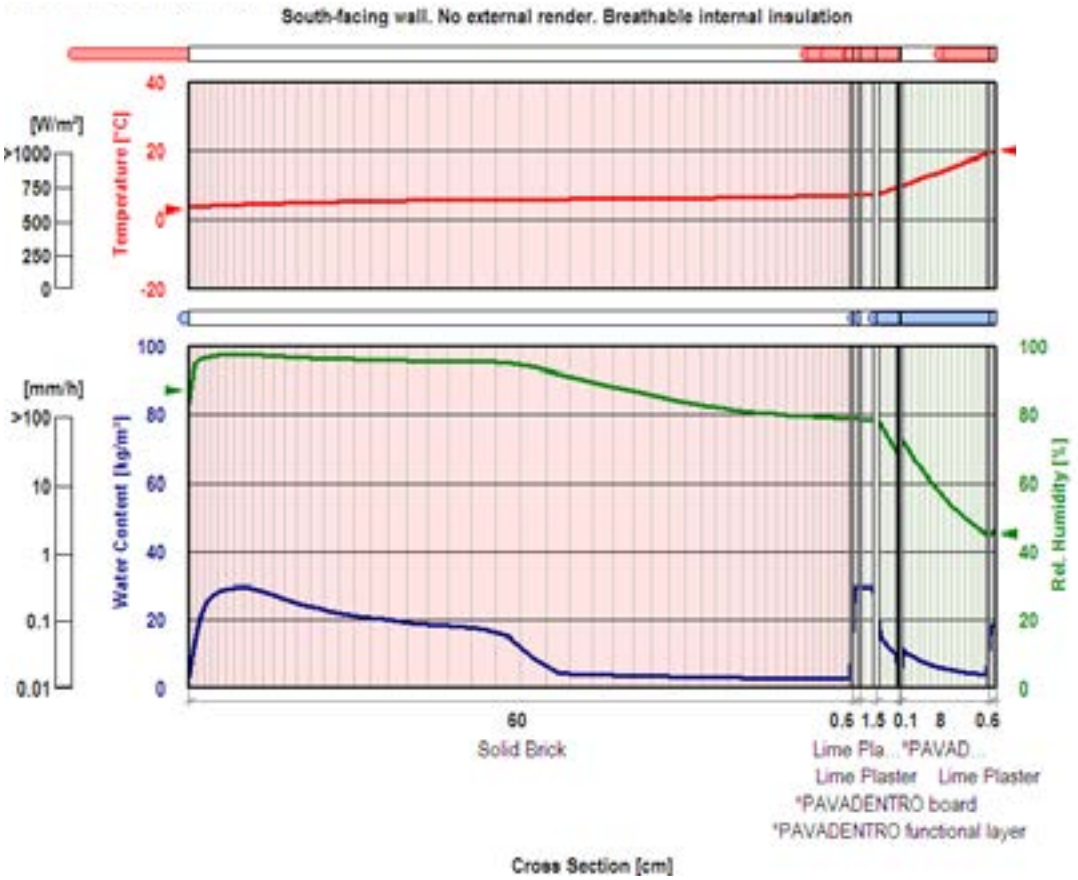
Mechanical Ventilation with Heat Recovery
Supply fresh tempered air to student rooms and extract air from the gyps, showers and wcs,re-purposing the otherwise redundant chimney flues.

Underfloor heating with Ground Source Heat Pump
The improved thermal performance will allow an underfloor heating system to be fed by a ground source heat pump from a borehole array within the courtyard.
This installation will provide up to 97% of the annual heating load.

WUFI model: comparing vapour permeability
A case of information or knowledge



150mm phenolic foam
+ vapour control layer



100mm woodfibre insulation
with 'functional layer'

WUFI model: mould is the significant risk

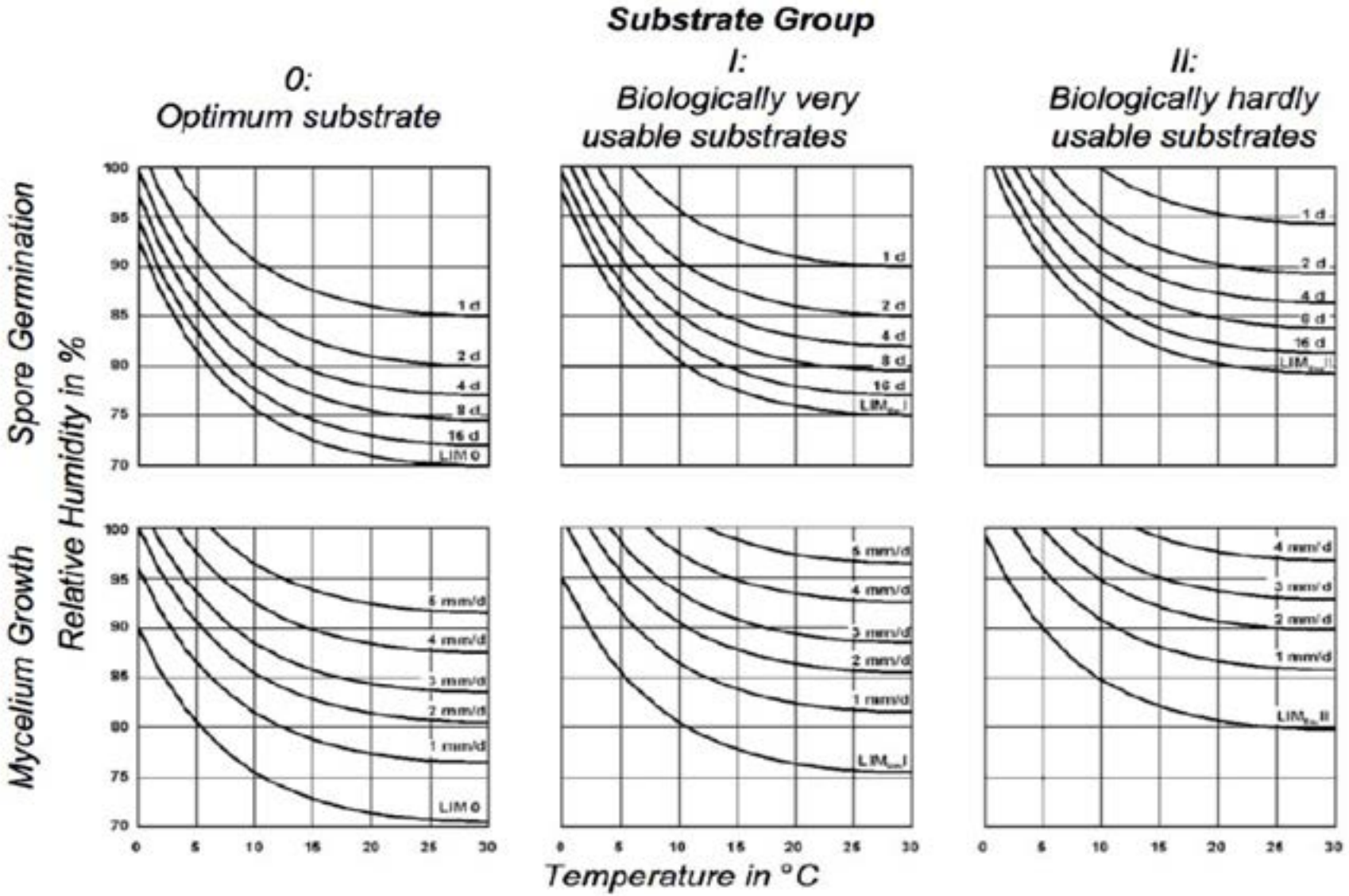


Figure 3.2 Isopleths published in Sedlbauer[3] showing the required temperature, humidity and duration of exposure for mould germination and growth.

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Manage consent process
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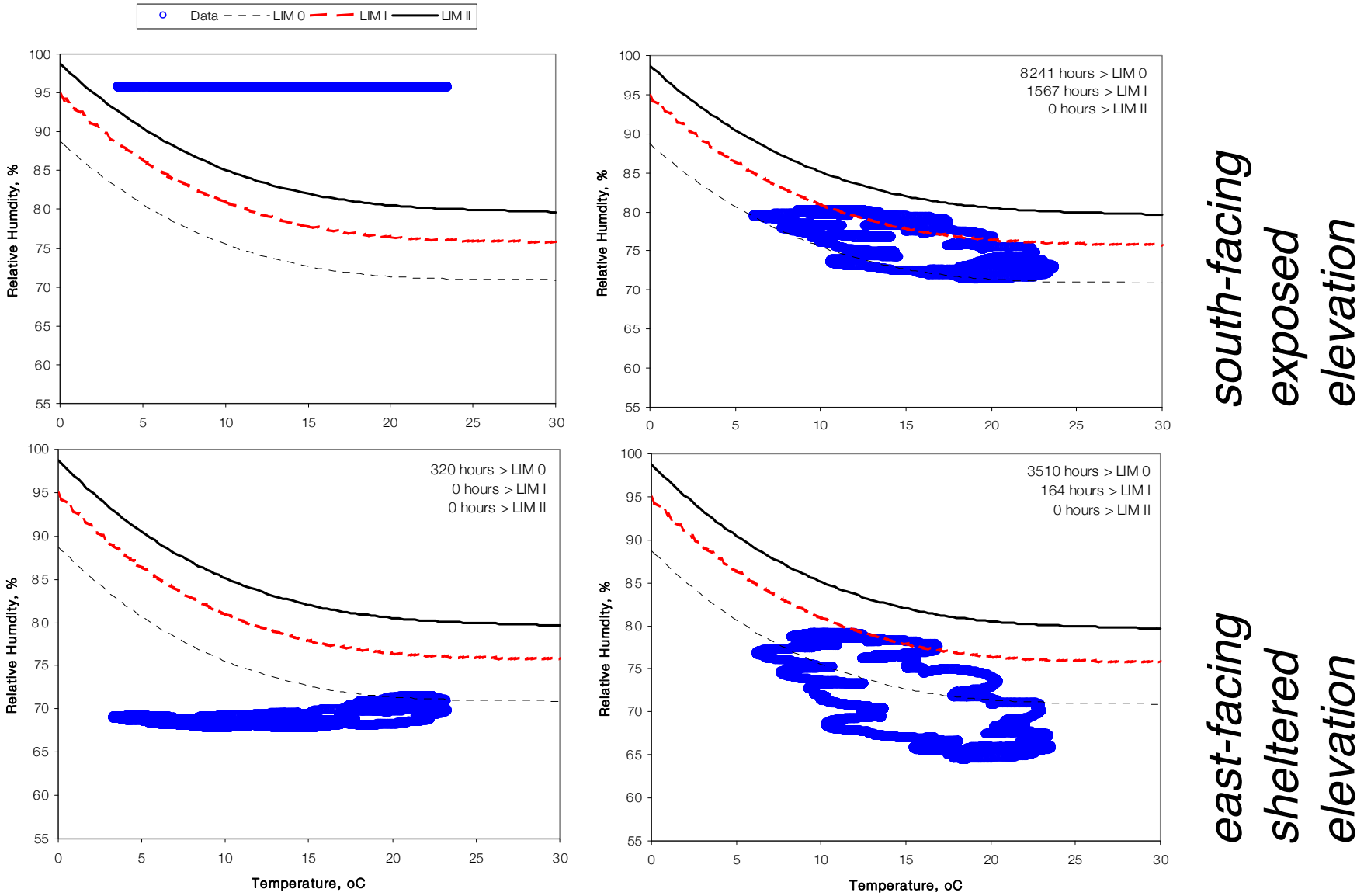
WUFI model: vapour open / closed insulations

150mm phenolic foam
+ vapour control layer

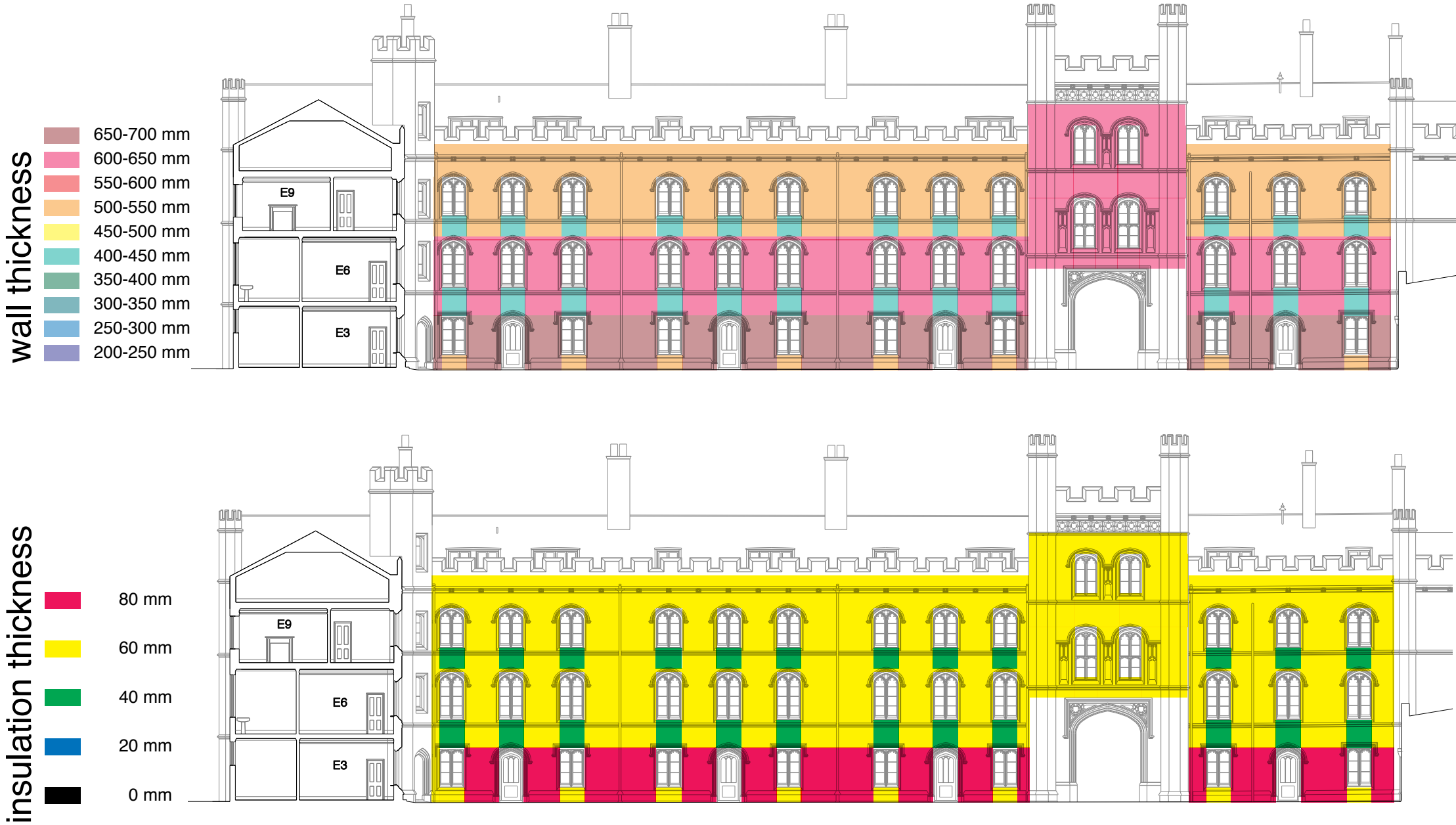
100mm woodfibre insulation
with 'functional layer'



south-facing exposed elevation

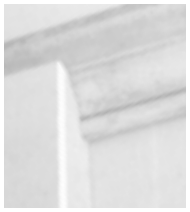
east-facing sheltered elevation

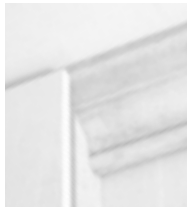
WUFI outputs: wall and insulation thicknesses



Model

Maquettes and model details



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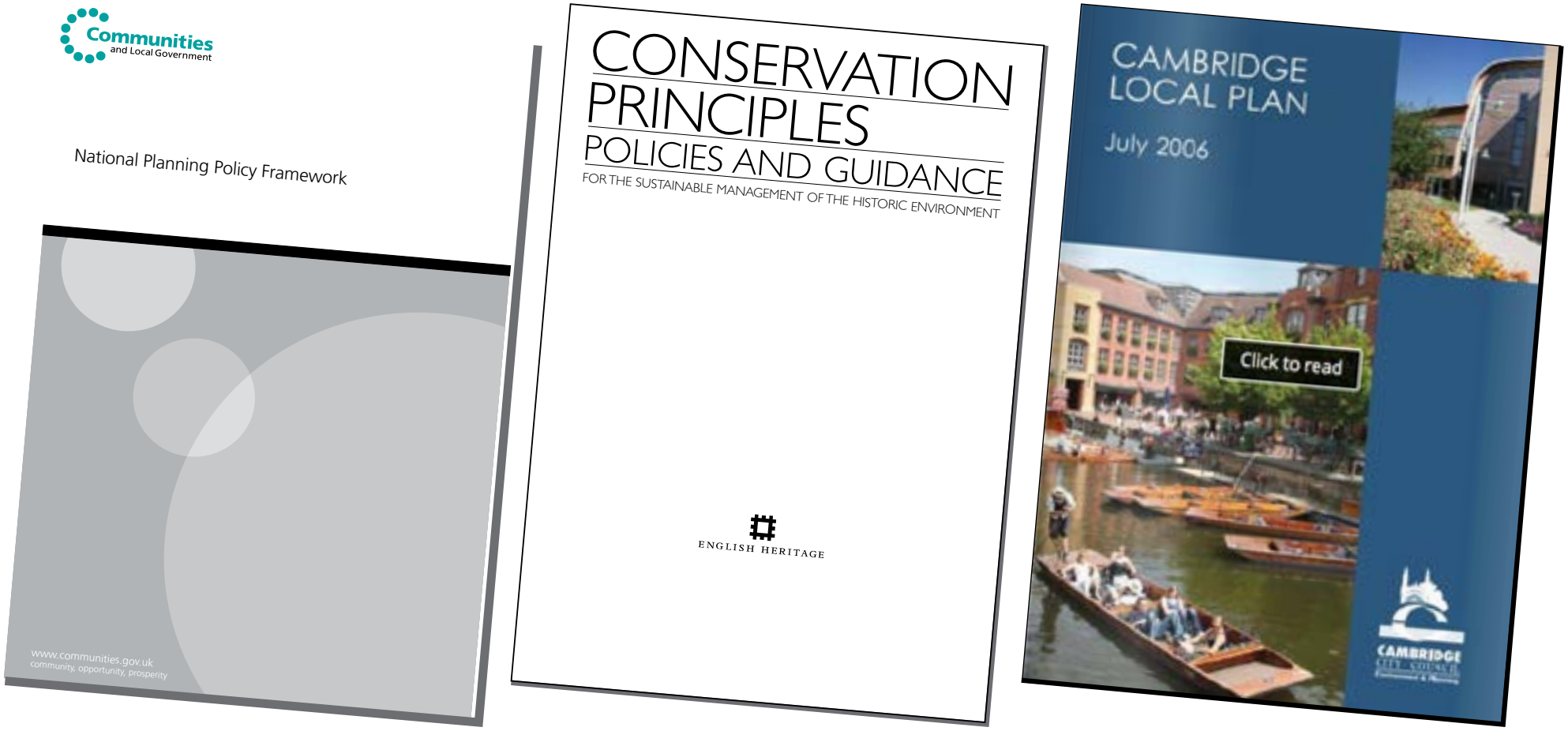
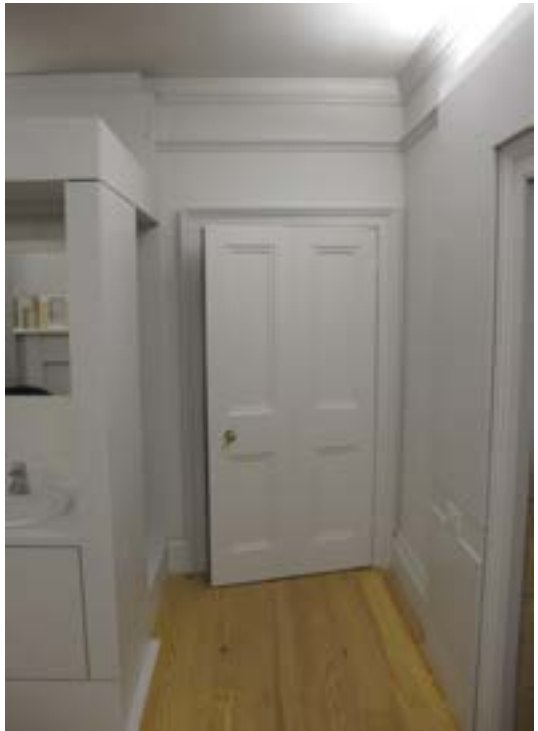
This is not an issue of interpretable policy or guidance, but of Criminal Law.
HE and Conservation Officers feel on much more solid ground in defending their positions.

National, Heritage and Local Policies



Mock-Up Room



Three questions:

1. What are the heritage values of the existing building and what are their relative significances?
   Including continuity of building use for optimum purpose, collegiality etc

2. To what extent will the proposals harm, or benefit, these values?
   What are the harms and to what values do they apply?
   What heritage benefits arise from the proposals (replacement of defective render, refurbishing and re-purposing of shutters etc)?

3. Are any harms outweighed or balanced by heritage or other benefits?
   What other benefits would arise from the proposals?
   Environmental sustainability, research and monitoring, knowledge transfer etc.

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Modelled Performance, metrics and badges

	Before	After
U-Value: W/m²K		
External Walls	0.685	0.25
WIndows	5.8	1.9
Roof	2.2	0.15
Ground Floor	1.7	0.25

Air Permeability m³/m²/hr@50Pa	11.0	3.0
Annual Space Heating Load TOTAL - kWh/a	857,000	124,000
kWh/m²a (5,340m² GIA)	160.5	23.22

Enerphit Table 2	Enerphit Table 3
0.35	
0.85	
0.35	
0.35	

1.0	1.0
	25

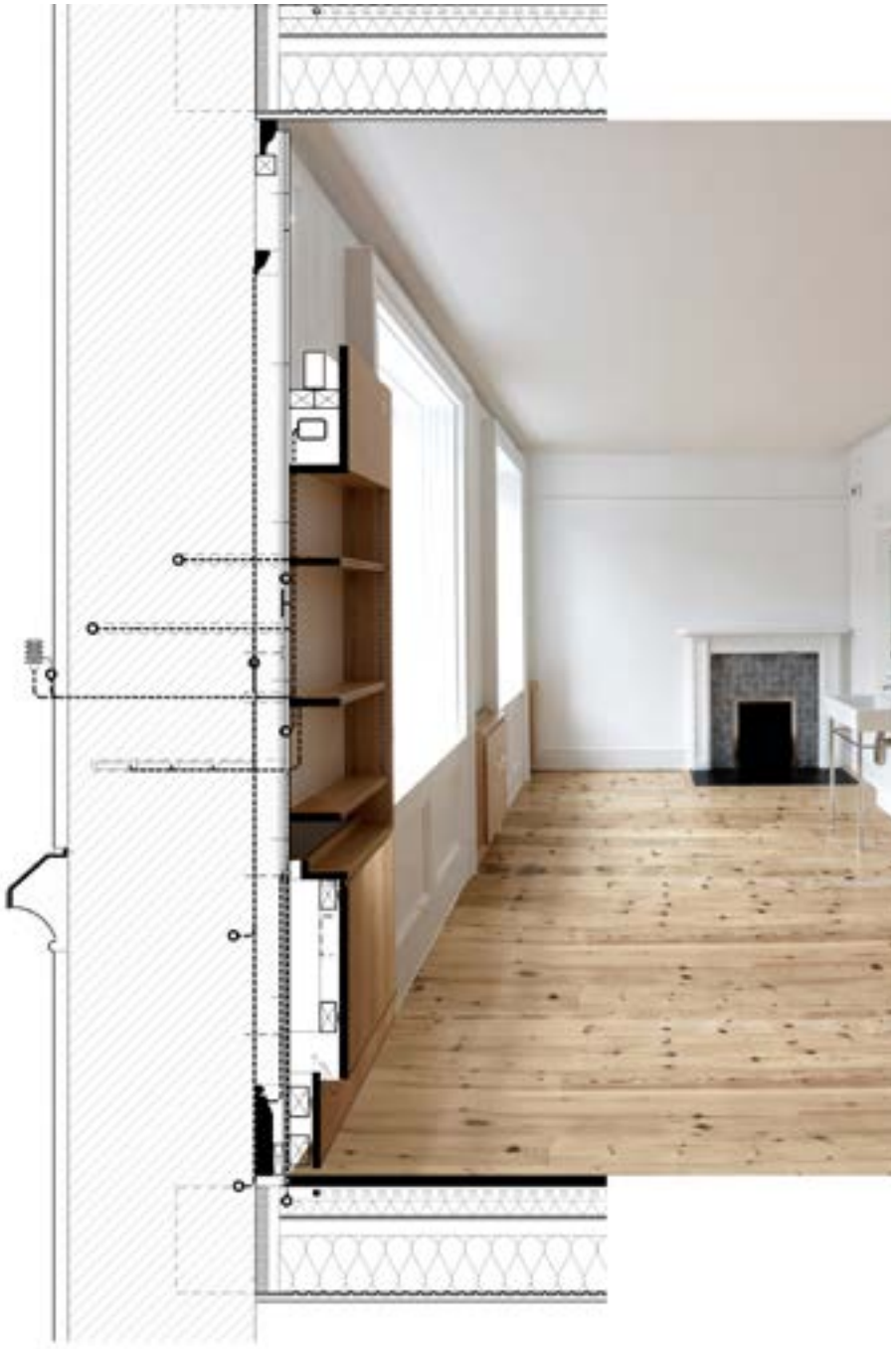
N.B.

Exemptions for EnerPHit

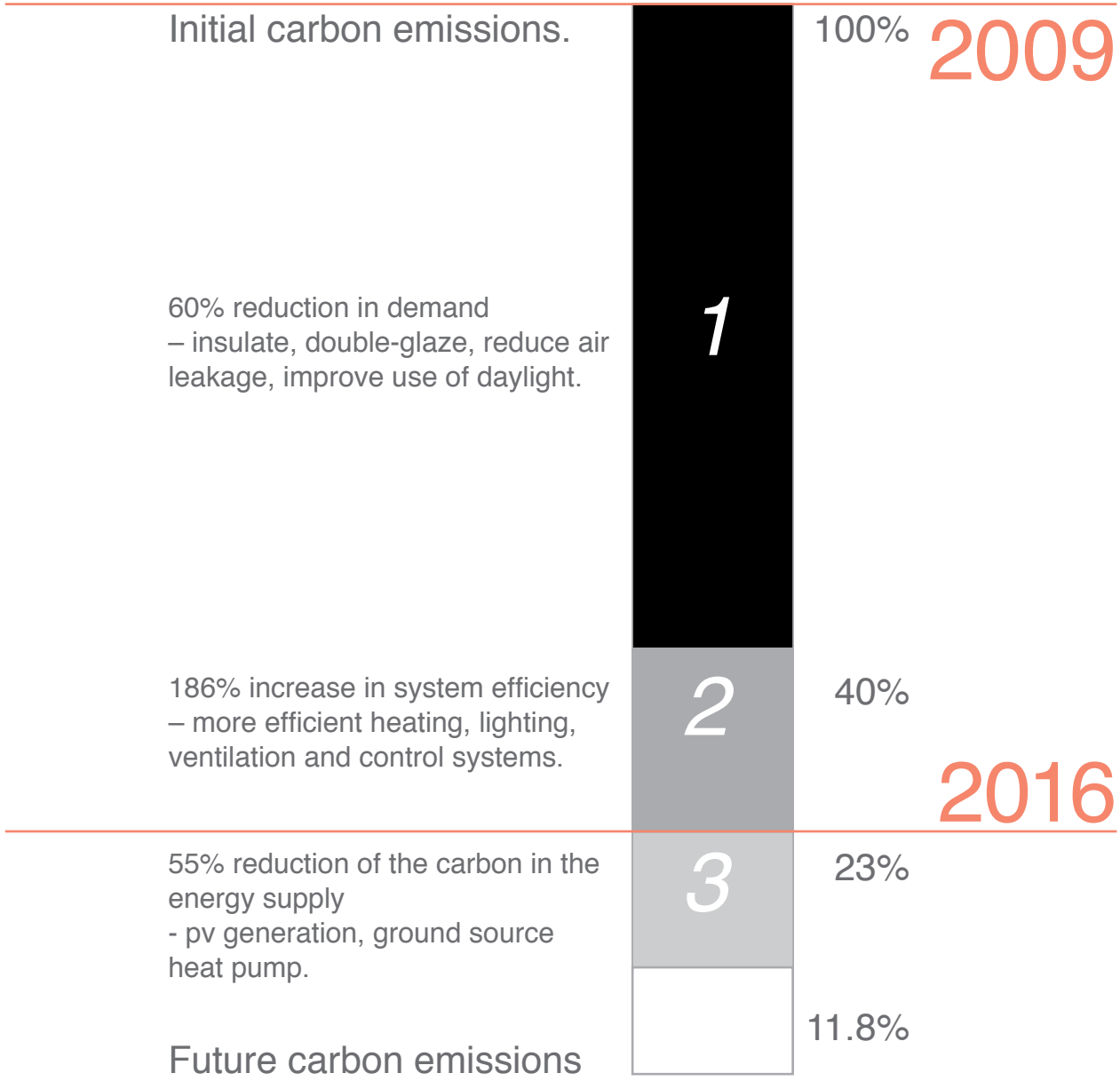
The limit values for the heat transfer coefficients of the exterior envelope building components may be exceeded if absolutely necessary based on one or more of the following compelling reasons:

- *If required by the historical building preservation authorities*

preserve character - reduce energy use



Actual 3-step reduction of emissions



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