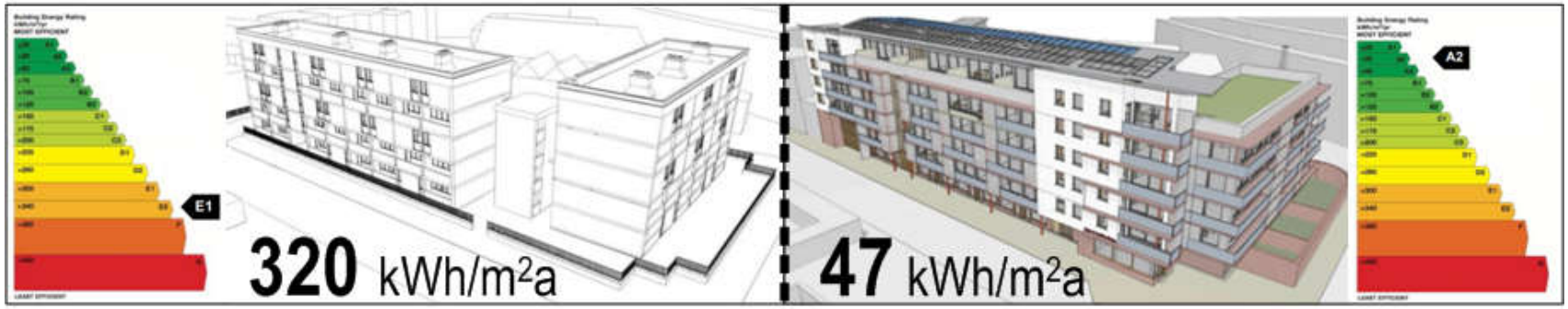
Definitions for Zero Energy Buildings

NZEB - *Net* Zero Energy Buildings are buildings that over a year deliver as much energy to the supply grids as they use from the grids.

nZEB - *Nearly* Zero Energy Buildings are buildings that have very high energy performance and provide, to a very significant extent , their energy needs from renewable sources.

In Ireland: **nZEB** = BER **A2**



Energy Performance of Buildings Directive

- Article 9
  - (a) by 31 December 2020, all new buildings are nearly zero-energy buildings; and
  - (b) after 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings
  - Member States shall draw up national plans for increasing the number of nearly zero-energy buildings. develop policies and take measures such as the setting of targets in order to stimulate the transformation of buildings that are refurbished into nearly zero-energy buildings, and
- Article 5
  - Cost optimal retrofitting
- Article 7
  - 25% of surface area retrofitted

Retrofitting Dwellings

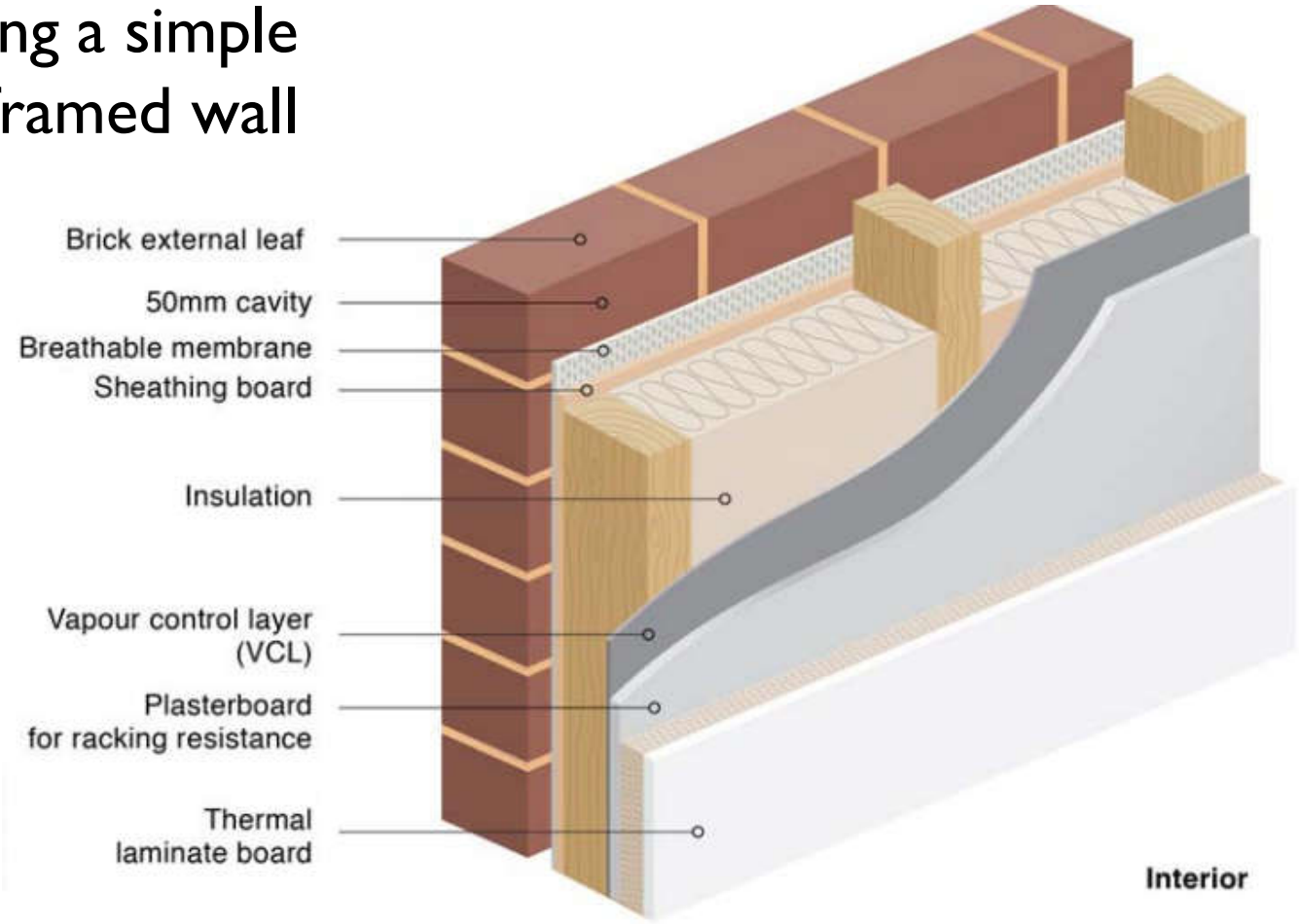
- DECLG is investing in retrofit of existing Social Housing Stock (130,000 units)
  - 2009 - 11m euro - 1,155 units
  - 2010 - 37m euro - 1,833 units
  - 2011 - 32m euro
  - target improvement to C1(150kWh/m2 per yr); sometimes less, exceeded where feasible.

- National Code of Practice on Retrofitting for designers and installers
  - consultation early in 2012.

Why the hesitation in relation to retrofit?

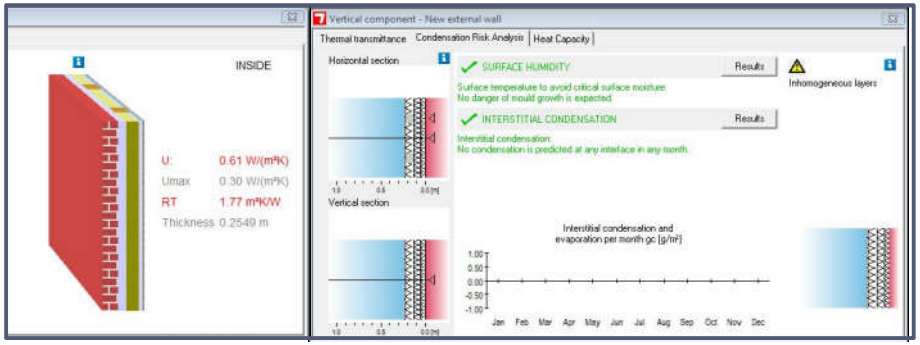
“Cost Optimal” – Timber framed wall upgrade

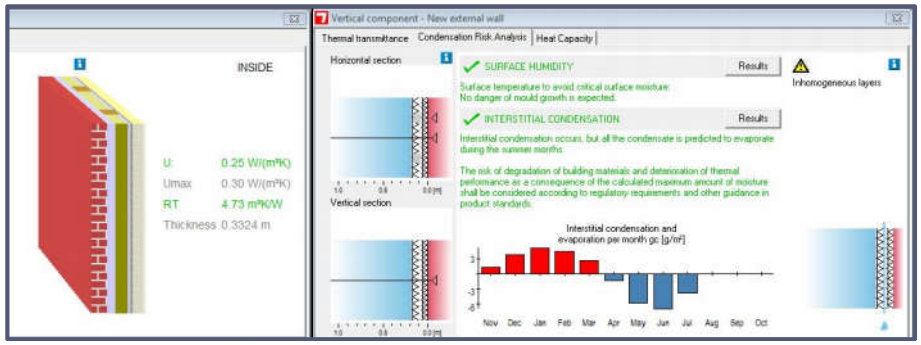
- Upgrading a simple timber framed wall

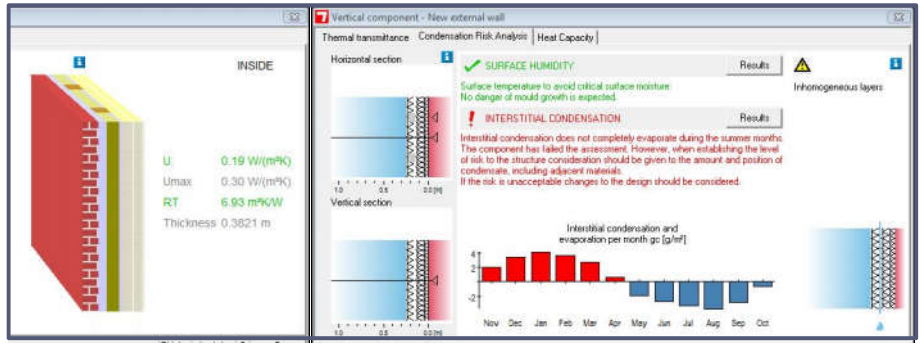


Timber Frame Wall

- Standard timber framed wall with VCL behind plasterboard
- STEP ONE: Dryline with 65mm insulated plasterboard
- Probable Mould Growth
- STEP TWO: Add a further 50mm insulated plasterboard
- Probable Structural Collapse
- No problem if you had removed the VCL in step one





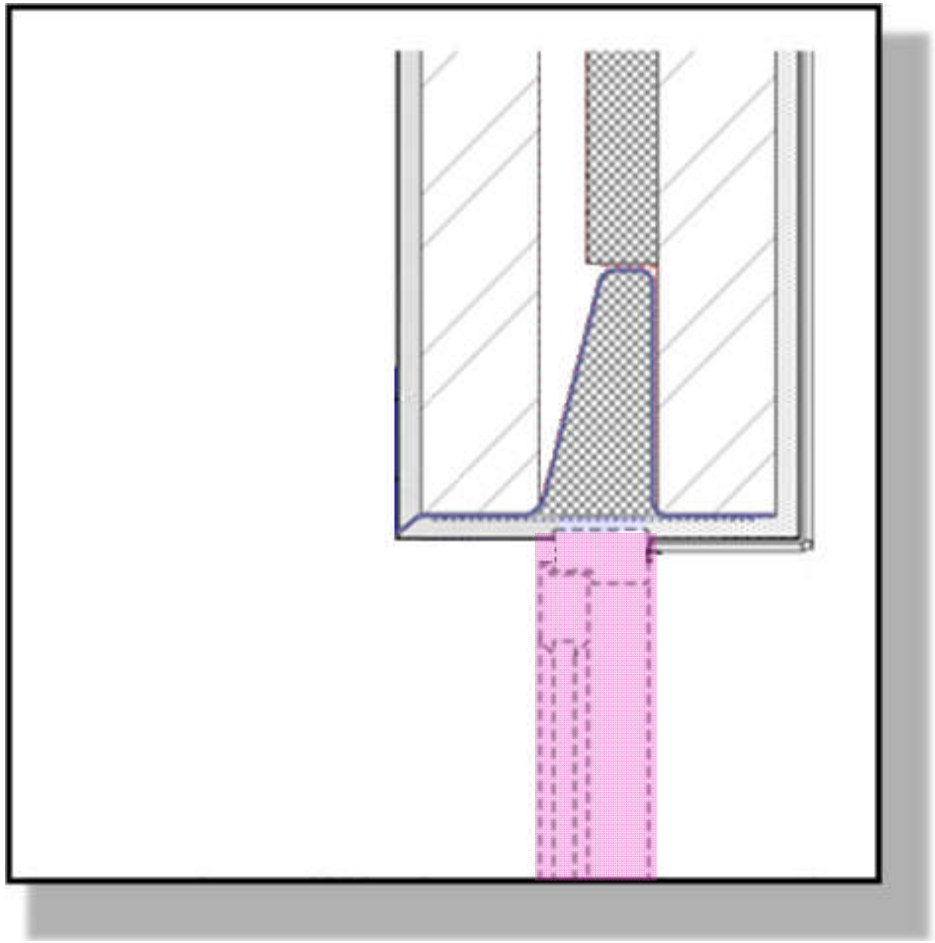


… but there is another problem


By half doing
something now,
you preclude doing
something better
in the future

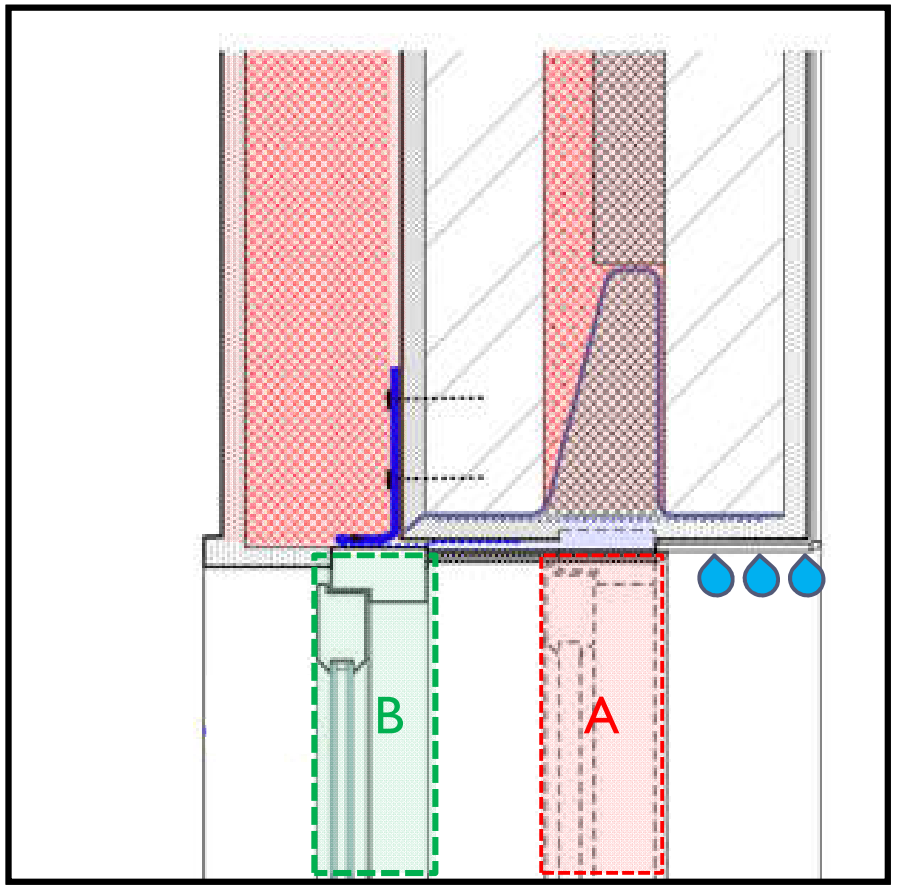
“Cost Optimal” – Window Replacement

- Change the windows to double glazed soft low E
- Where do you put them?



“Cost Optimal” – Window Replacement

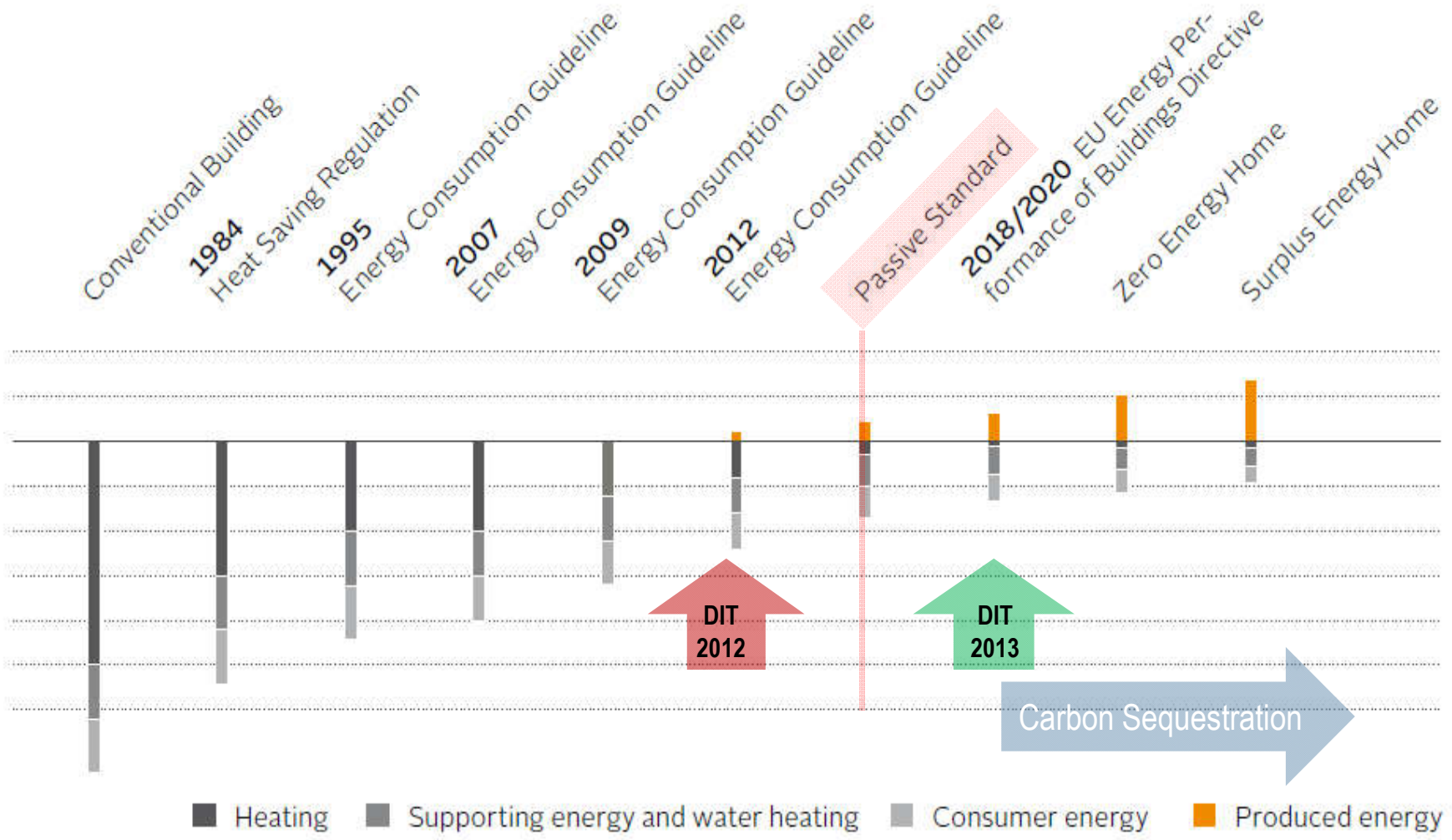
- Change the windows to double glazed soft low E
- Where do you put them?
- BER **C1** says at position A
- Anticipating future external insulation, demands B
- But A precludes solving the LTB problem later
- And surface condensation can be WORSE than it was for the uninsulated wall



2013 FlatTop Brief

EPBD nZEB 2018

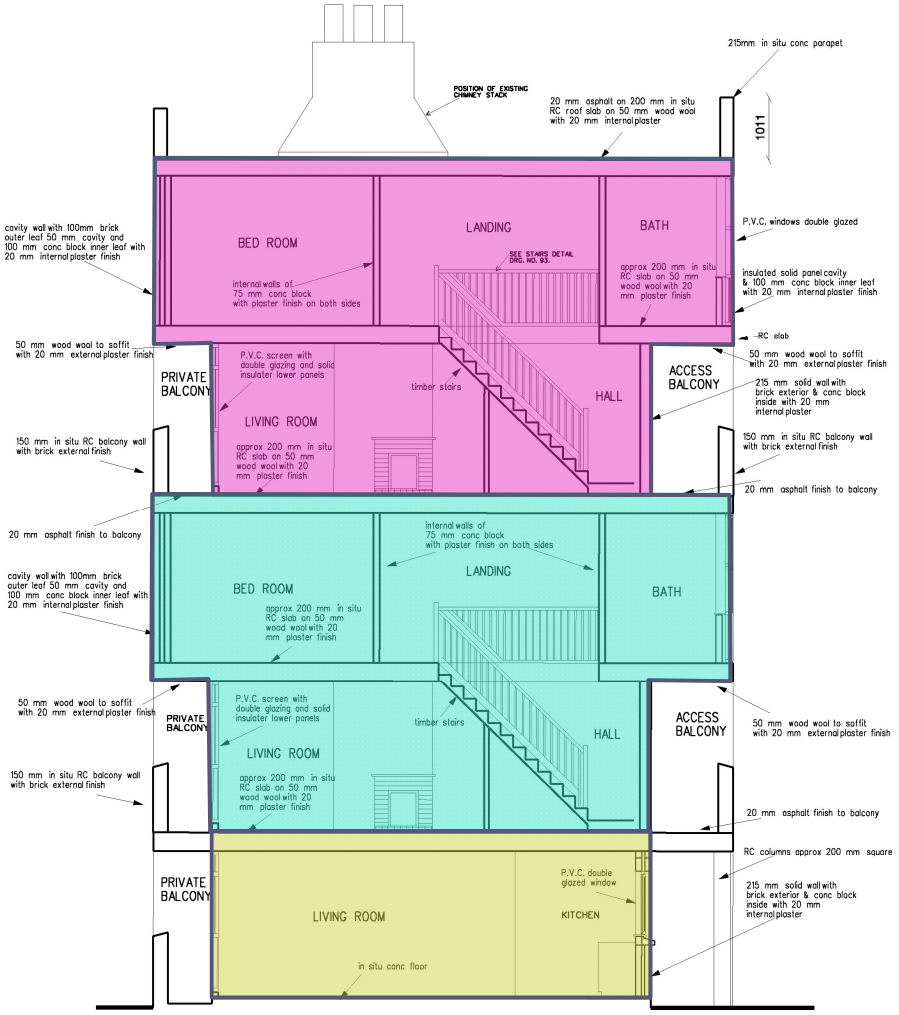
nZEB and beyond - LA's to lead the way



Flat-Top Block - project brief

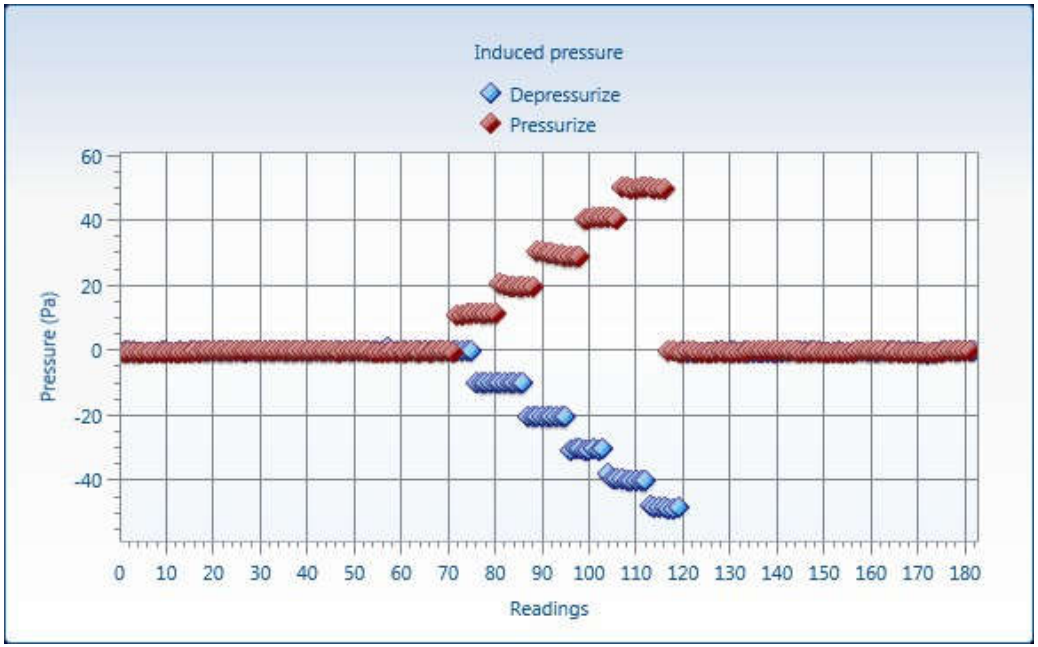
- Building Regs as if new build
- DoE space standards
- 60-100 year lifecycle
- BER of A2
- Calculated y-factor
- Hygrothermal analysis
- Surface temperature
- Condensation risk

Flat-Top Block

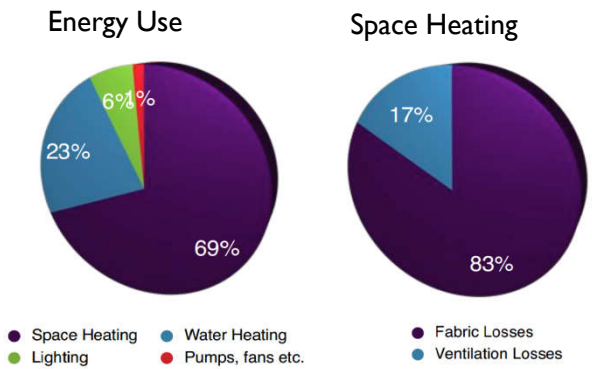


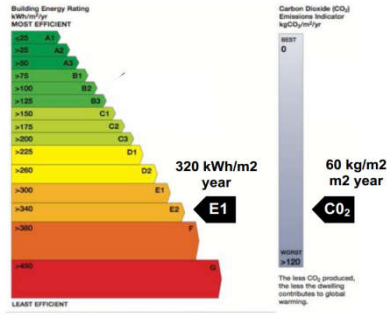
Flat-Top Block

	Results	95% Confidence Interval		Uncertainty
Air flow at 50 Pa, V_{50} [m^3/h]	1085	1060	1105	+/-2.0%
Air changes at 50 Pa, n_{50} [/h]	6.601	1.320	11.90	+/-80.0%
Permeability at 50 Pa, q_{50} [$m^3/h.m^2$]	**5.255**	1.050	9.461	+/-80.0%
Specific leakage at 50 Pa, w_{50} [$m^3/h.m^2$]	29.259	5.844	52.674	+/-80.0%

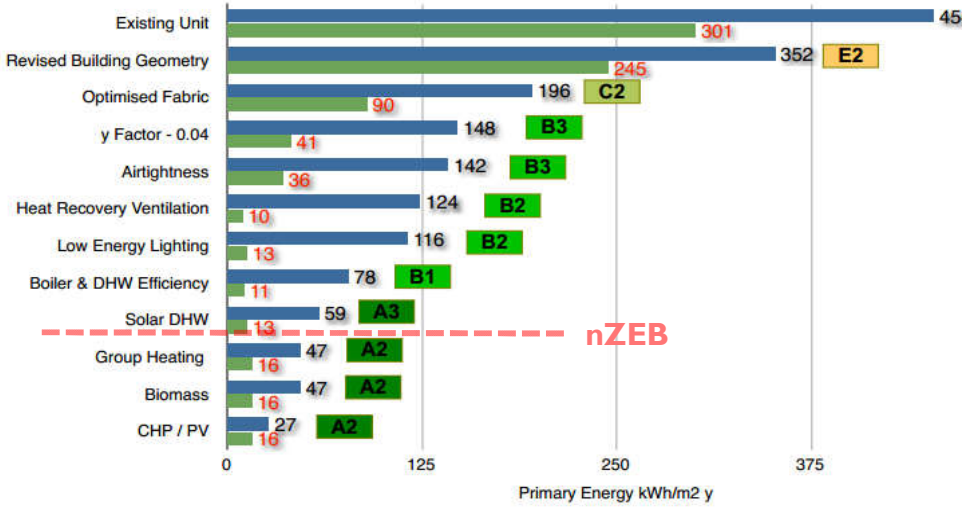


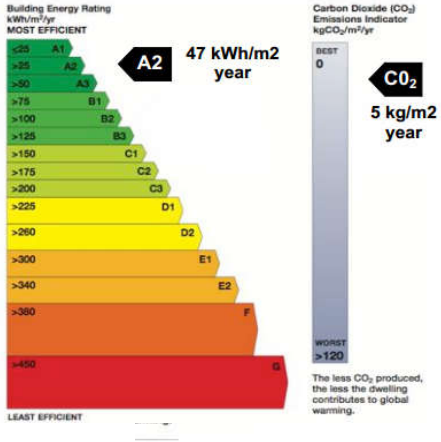
Outline



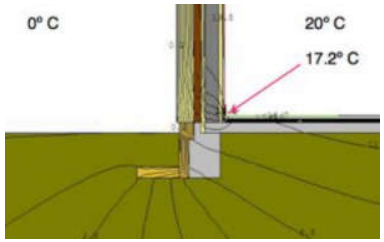


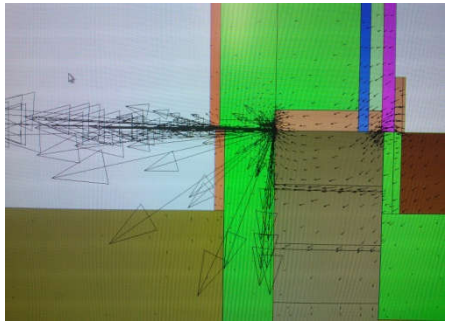
Above: Energy Use & Heat Losses within dwelling, Right: BER Rating

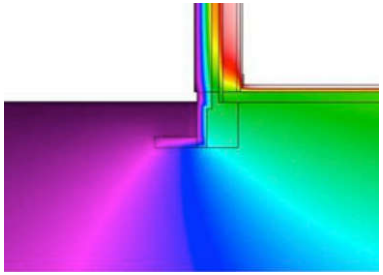


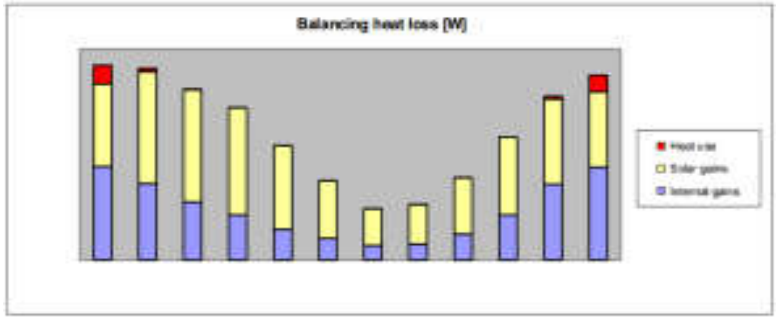


Digital energy analysis









Thermal transmittance (U-value) according to BS EN ISO 6946 Page 2/20
Source: **DC Architects Catalogue 1 - External walls**
Component: **ID-02 Panel Walls with EWI- RETROFIT**

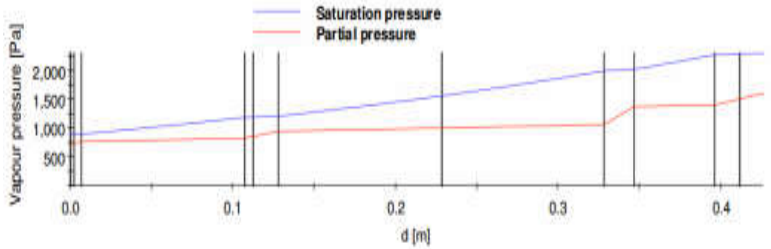
$R_T = (R_T' + R_T'')/2 = 8.99$ m²K/W

Correction to U-value for	according to	delta U [W/(m²K)]
Mechanical fasteners	BS EN ISO 6946 Annex D	0.008
Air gaps	BS EN ISO 6946 Annex D	0.002
		0.011

$U = 1/R_T + \Sigma\Delta U = 0.12$ W/(m²K)

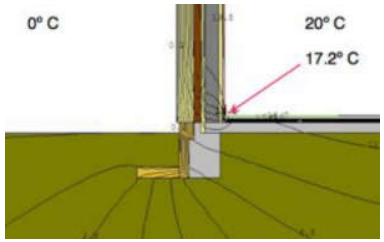
The physical values of the building materials has been graded by their level of quality. These 5 levels are the following
A: Data is entered and validated by the manufacturer or supplier. Data is continuously tested by 3rd party.
B: Data is entered and validated by the manufacturer or supplier. Data is certified by 3rd party
C: Data is entered and validated by the manufacturer or supplier.
D: Information is entered by BuildDesk without special agreement with the manufacturer, supplier or others.
E: Information is entered by the user of the BuildDesk software without special agreement with the manufacturer, supplier or others.

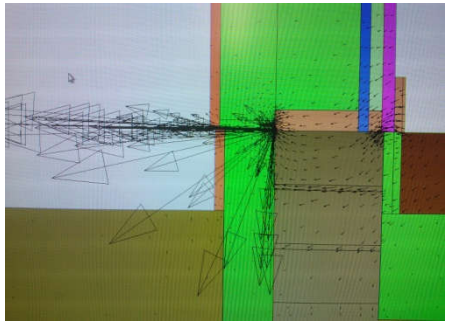
Vapour pressure distribution
Calculation according BS EN ISO 13788

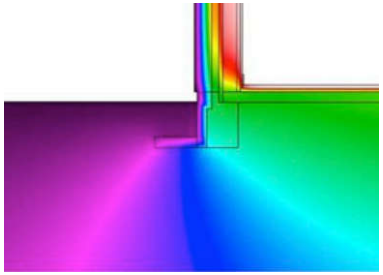


- BIM model Embodied Carbon
- Therm Surface Temperature, Psi- values
- BuildDesk Condensation risk, U-values
- DEAP Energy balance, carbon emissions

Digital energy analysis







- BIM model Embodied Carbon
- Therm Surface Temperature, Psi- values
- BuildDesk Condensation risk, U-values
- DEAP Energy balance, carbon emissions

Design Certificate

FORM OF CERTIFICATE OF COMPLIANCE (DESIGN)

Building Control Authority

OFFICIAL USE	
Data Received	
Register Ref.	
Entered on	
Enterered by	

1. This certificate relates to the following building works:

.....

.....

2. This certificate has been prepared in accordance with the Code of Practice for the Inspection and Certification of Building Works [as published by the Minister under section 3(7) of the Building Control Act 1990] or equivalent.

3. I confirm that I have been commissioned by the building owner to design, in conjunction with others, the works described above and to certify such design. I further confirm that I am a person named on a register maintained pursuant to Part 3 or Part 5 of the Building Control Act 2007 or Section 7 of the Institution of Civil Engineers of Ireland (Charter Amendment) Act 1969 and that I am competent to carry out my design and to coordinate the design of others for the works concerned.

… I am competent …

4. I confirm that the plans, calculations, specifications, ancillary certificates and particulars included in the schedule to the 7 Day Notice to which this certificate is relevant and which have been prepared exercising reasonable skill, care and diligence by me or by persons employed by me and by the specialist designers whose design activities I have coordinated, have been prepared to demonstrate compliance with the requirements of the Second Schedule to the Building Regulations insofar as they apply to the building works concerned.

… reasonable skill care and dilligence …

5. I certify that, having regard to the plans, calculations, specifications, ancillary certificates and particulars referred to in paragraph 4 of this certificate, the proposed design for the works or building is in compliance with the requirements of the Second Schedule to the Building Regulations insofar as they apply to the building works concerned.

I certify that … the design … is in compliance … with Building Regulations

Signature ..... **Date:** .....

Person's Name: ..... Registration No.: .....

On behalf of: ..... (company name where relevant)

Address: .....

.....

Tel: ..... Fax: ..... Email: .....

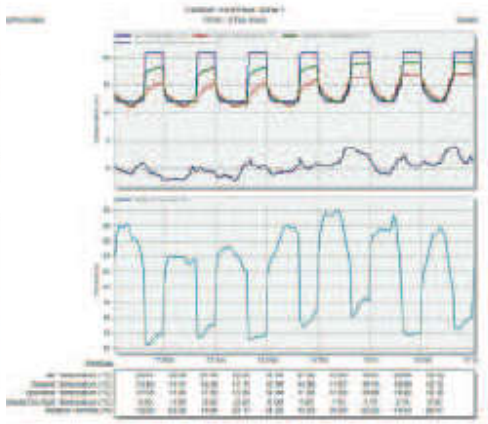
Digital Analysis of Existing Building

- The apartments are:

- Un-heatable (Part L)
- Un-healthy (Parts L&F)
- Un-visitable (Part M)
- Un-comfortable
- Non-compliant (Part B)
- Too small (DECLG standards)





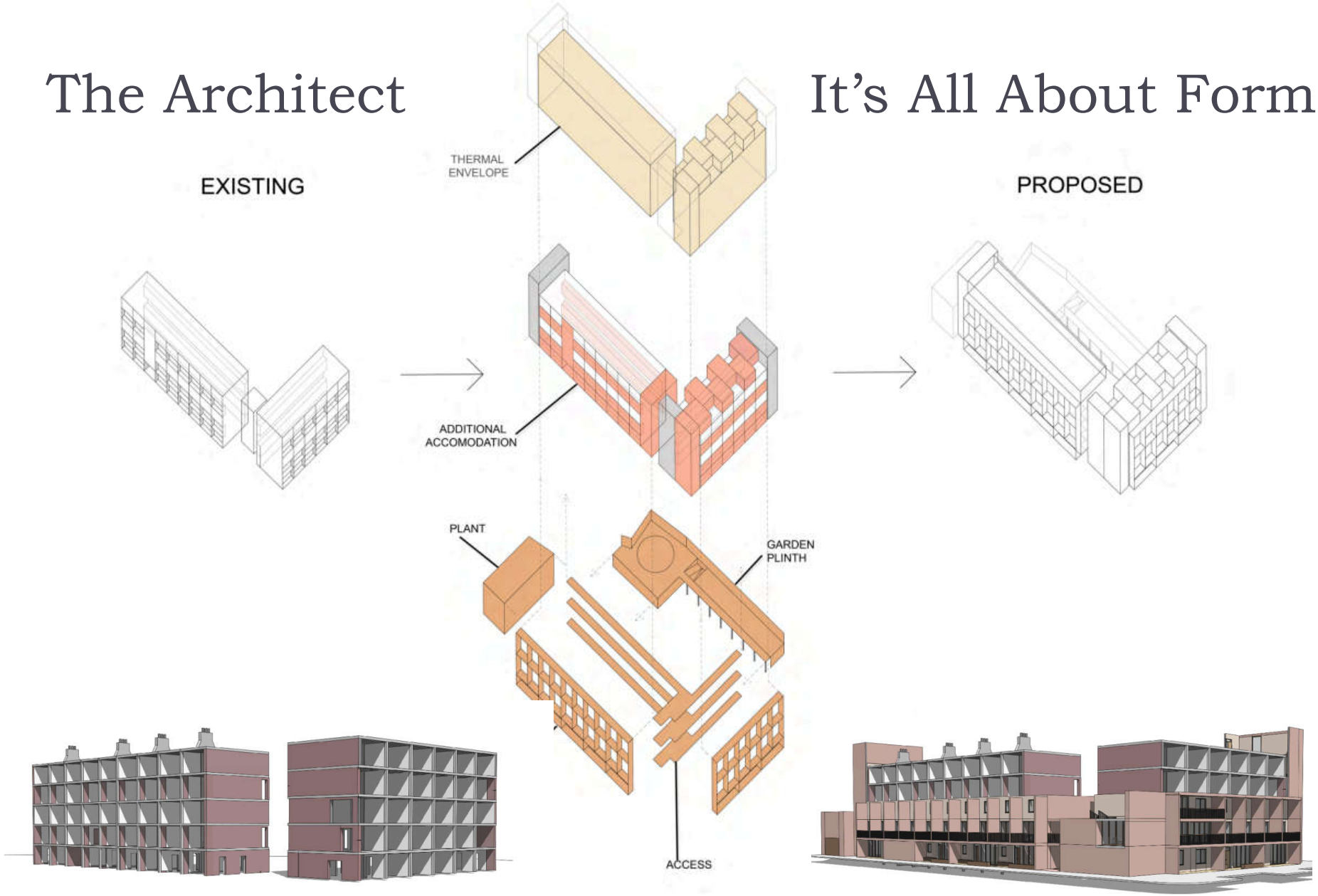



2013 student project work

Year 1 – Part-time, MSc (ERT)

The Architect

It's All About Form



The Architect's Systems

ENERGY OPTIONS FOR AVERAGE UNIT

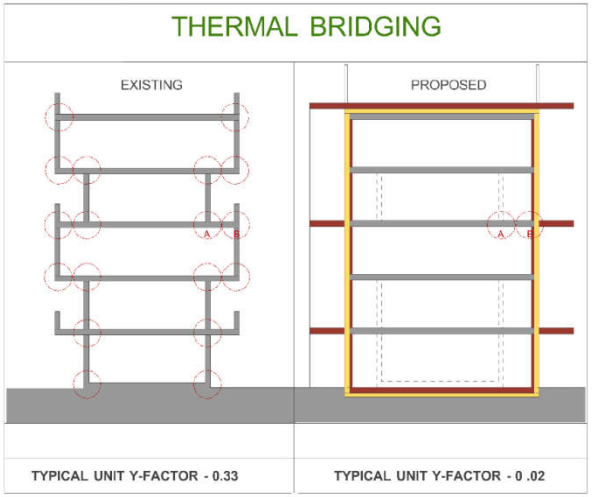
Space Heating	777 kWhr/y
Water Heating	1393 kWhr/y

LIMITED TO BIOMASS & ELECTRICAL ENERGY SOURCES

BER BAND	Energy Source	System	Renewables	BER	CO2
B1	Electricity	Electrical	-	85	1418
A3	Elec. & Biomass	Electric Radiators & Wood Pellet DHW	-	63	726
	Elec. & Biomass	Electric Radiators & CHP DHW	-	50	352
	Biomass	Wood Pellets	-	51	341
A2	Elec. &Biomass	Electric Radiators & Wood Pellet DHW	PV array	48	464
	Biomass	CHP (0.5, 0.3)	-	38	-293
	Electrical	Heat Pump (350%)	-	36	605
	Biomass	Wood Pellets	PV array	36	79
	Elec &Biomass	Electric Radiators & CHP DHW	PV array	35	90
A1	Biomass	CHP (0.5, 0.3)	PV array	22	-555
	Electrical	Heat Pump (350%)	PV array	21	343

The Architect's Sustainability Agenda

DAVID LEDWITH C0350991



FLAT TOP - REGENERATION

The Architect Measures

EXISTING		
Site Area		2075 sq.m
Private Floor Area		2138 sq.m
Communal Floor Area		0 sq.m
Plot Ratio		1.03
Private Open Space		120 sq.m
Communal Open Space		400 sq.m
Exposed Surfaces		3150 sq.m
Envelope : Area Ratio		1.47
Units		
Bed/Sit	2	
One Bed	8	
Two Bed	24	
Three Bed	3	
Four Bed	1	
Total		38
Primary Energy		684,862
CO2 Emissions		128,233
BER Rating		E1 – 320

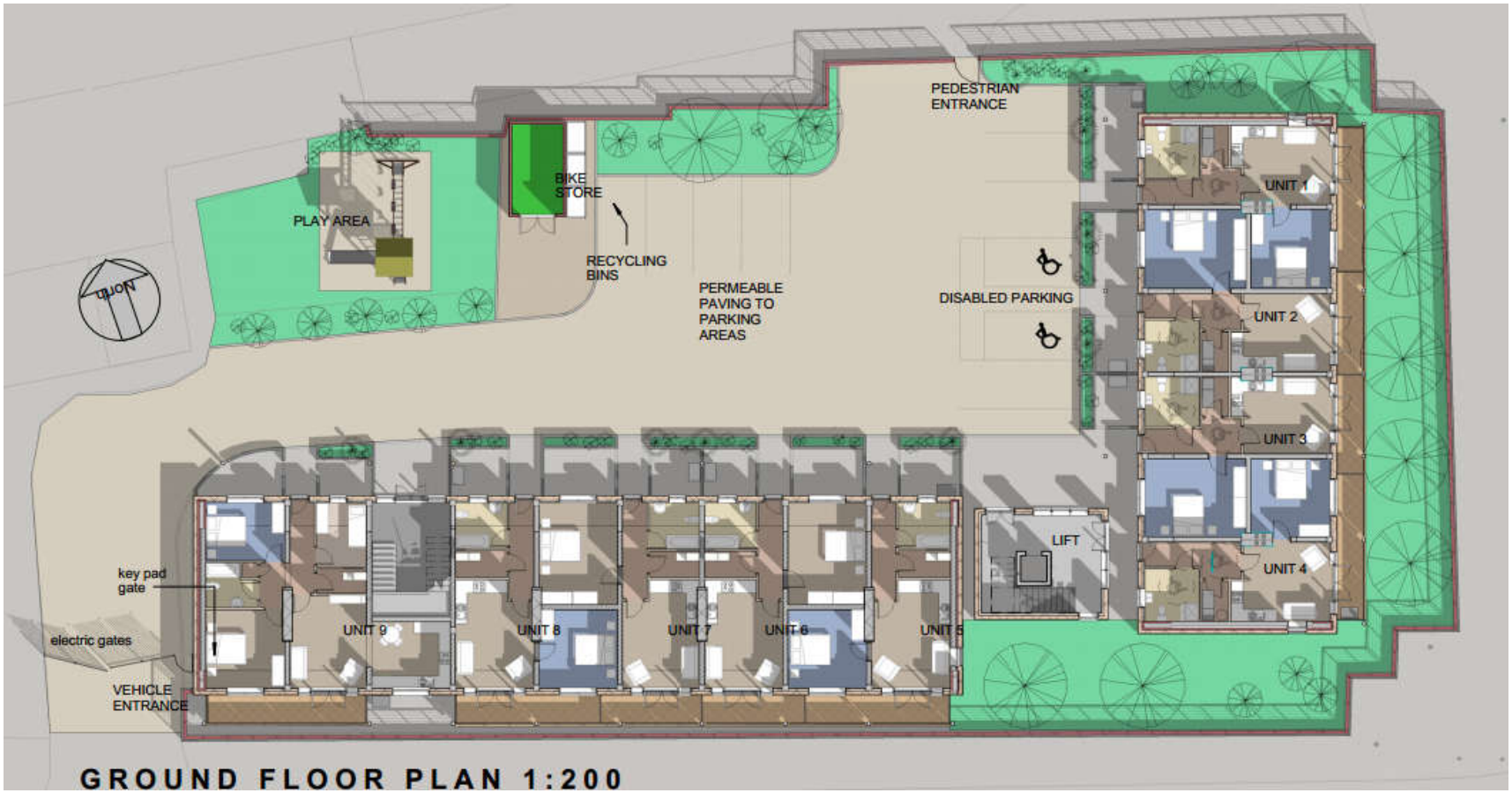
PROPOSED			
Site Area		2075 sq.m	-
Private Floor Area		2914 sq.m	+ 36%
Communal Floor Area		354 sq.m	-
Plot Ratio		1.58	+ 50%
Private Open Space		325 sq.m	+170%
Communal Open Space		1125 sq.m	+180%
Exposed Surfaces		3365 sq.m	+7%
Envelope: Area Ratio		1.15	- 22%
Units			
Bed Sit	0		
One Bed	3		
Two Bed	28		
Three Bed	3		
Four Bed	0		
Work / Live	4		
Total		38	SAME
Primary Energy		95,800 kWhr	86% reduction
CO2 Emissions		-11,000 kgs CO2	14 tonnes/ yr saved
BER Rating		A2 - 36	11 band improvement

The Architect's Energy Plan for Ireland

	STAGES TO ACHIEVING CLEAN ENERGY			TWhr	SAVINGS
1.	CURRENT CONSUMPTION	therm.	141	191	
		elec.	50		
2.	IMPROVE ELECTRICITY PRIMARY ENERGY FACTOR TO 1.5	therm.	141	171	10%
		elec.	30		
3.	CONVERT TRANSPORT TO ELECTRICITY (90%)	therm.	81	136	25%
		elec.	55		
4.	REDUCE THERMAL DEMANDS BY APPROX 55% ACROSS ENTIRE STOCK	therm.	40	95	50%
		elec.	55		
5.	MOVE TOWARDS ELECTRIC BASED HEATING SYSTEMS	therm.	20	95	
		elec.	75		

ENERGY TYPE	ENERGY TYPE	TW/hr
WIND - ON SHORE	20,000 wind mills - 1% of land area	17
WIND - OFF SHORE	20,000 wind mills - 1% of land area	25
BIOMASS	10% of farmland	20
WAVE / TIDE	150km of coast	4
PV	8 sq.m per person	4
BIOFUEL	2.5% of farmland	6
BIOGAS	waste/agriculture/anaerobic digestion	2
HYDRO	extra needed for peak demand	2
NUCLEAR / IMPORT	1 nuclear plant or import solar other countries	15
		95

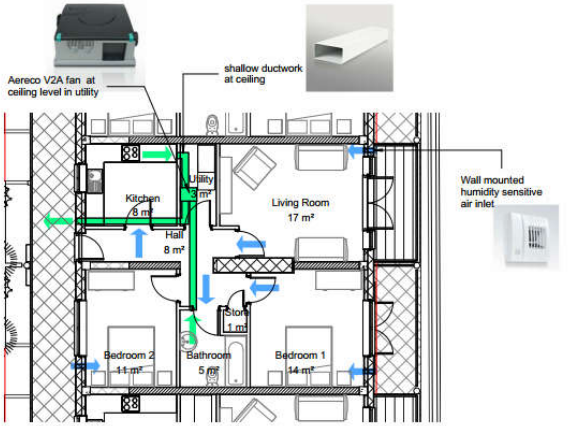
The Technologist



Flat-Top Block

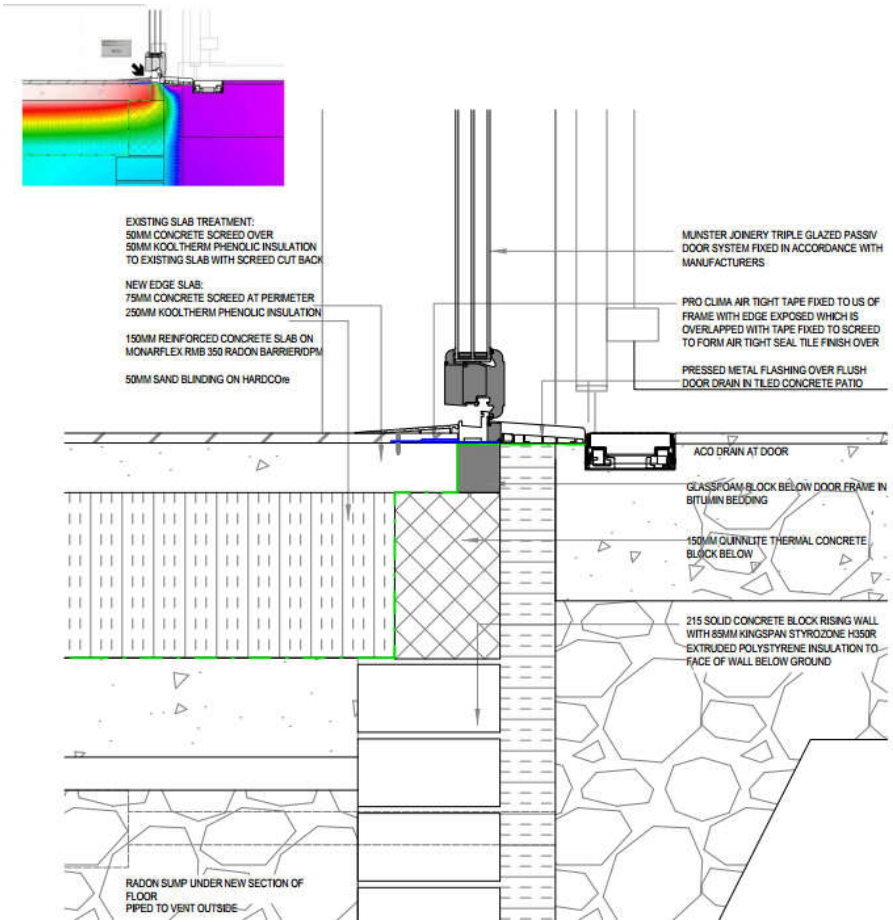
WEST ELEVATION 1:300

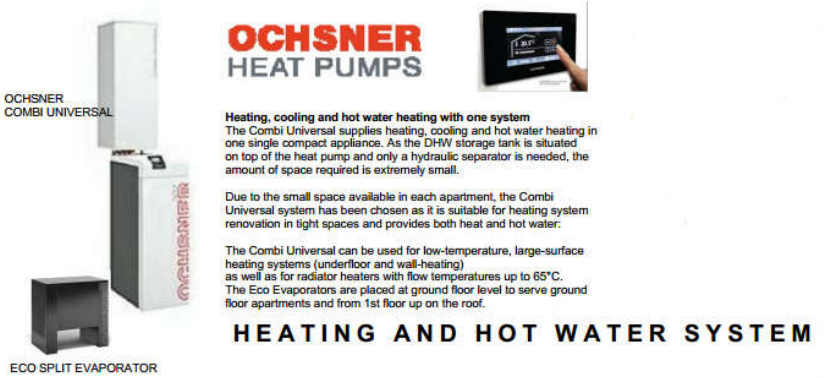
EAST ELEVATION 1:300



TYPICAL TWO BEDROOM APARTMENT

Technologists measure



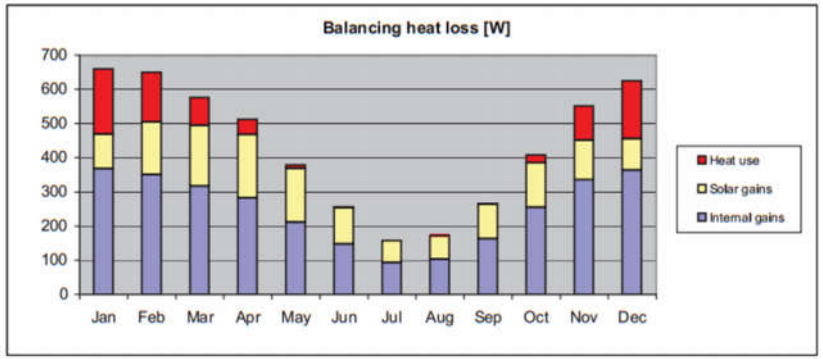


Each apartment is provided with either one in the case of mid units or two for all gable, ground and fourth floor apartments.

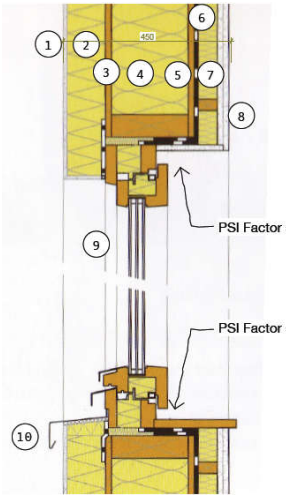
Ecologics SR-P660245 PV panel with 245W Max power output.
Panel size 1637mm x 992mm x 50mm.
45 degree pitch facing due south with no overshading

2 x 0.245 = 0.49
0.49 x 0.8 x 1072 x 1 = 420kWh/y for two panels

0.245 x 0.8 x 1072 x 1 = 210kWh/y for single panel



The Passive House Designer



TIMBER PANEL WALLS WITH EWI - 0.12 Wm2/K

1 - 15mm Silicate Plaster, on medium bed thin set

2 - 120mm Hemp / Mineral Wool insulation

3 - 28mm GUTEX Multiplex-top vapour permeable sarking board

4 - 200mm Hemp Flax / Cellulose Insulation

5 - 25mm OSB panel

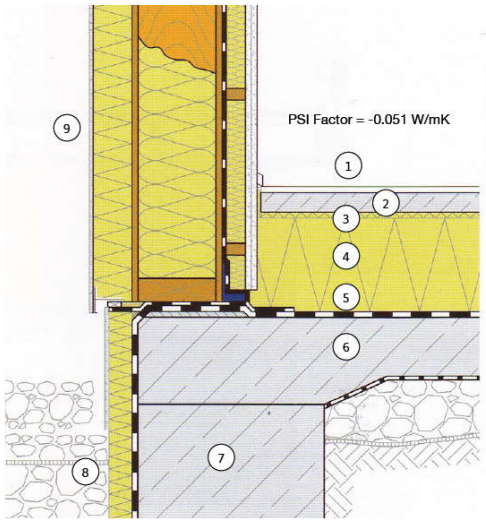
6 - Intellio air tight membrane / vapour barrier

7 - 50mm Thermafleece lambswool insulation between softwood battens

8 - 2 layer Gypsum Fiberboards / Fermacell

9 - Passivhaus standard triple glazed timber/aluminium window - $U_{w,eff}$-value ≤ 0.85 W/m2K

10 - Aluminium / stainless steel projecting window sill



GROUND FLOOR SLAB - 0.15 Wm2/K

1 - Natural Linoleum floor finish

2 - 30mm Fibre-reinforced poured Cement Screed

3 - PE Soft foam, with glued joints

4 - 220mm EPS Insulation / Perlite (50mm to existing floor slabs)

5 - Bitumen damp proof membrane

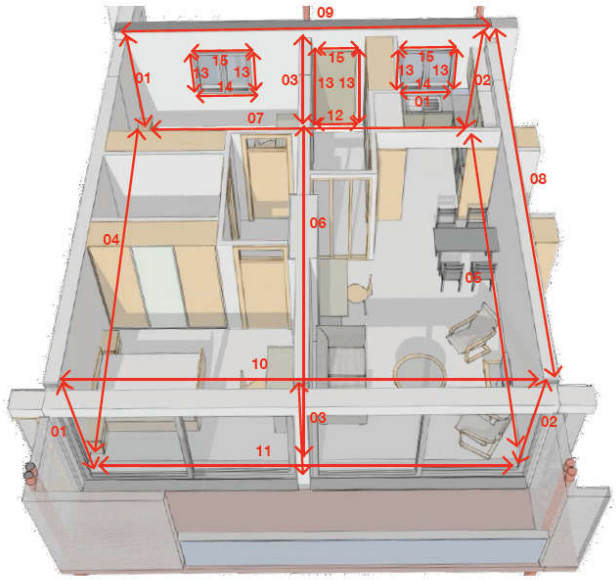
6 - 150mm Reinforced concrete slab (infill to edge)

7 - New reinforced concrete ground beam

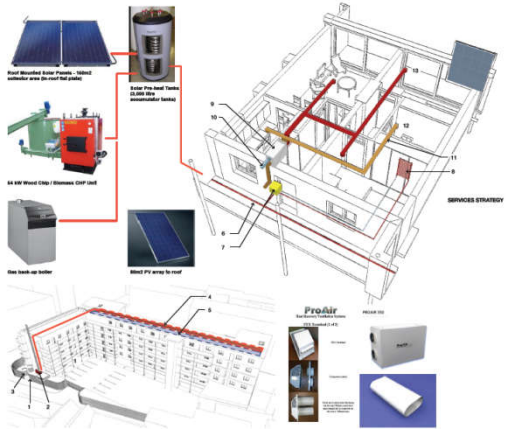
8 - 100mm XPS Vertical perimeter insulation to all edges, 800mm deep

9 - Silicate Plaster / Brick slip cladding on Hemp EWI, on insulated timber panels

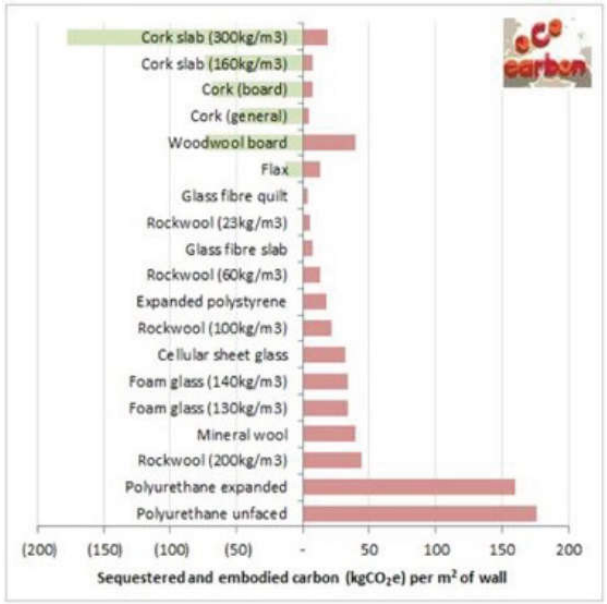
Typical Construction Details (Passivhaus Standards) & U-Value Calculations / Condensation Risk

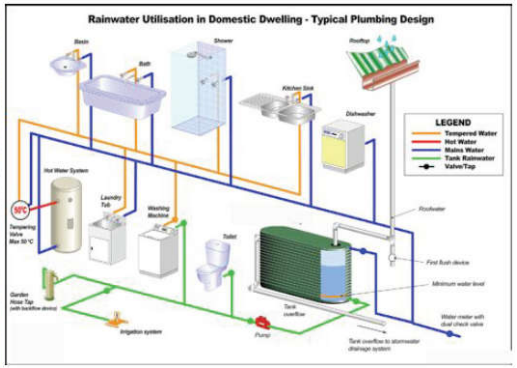


Linear Thermal Bridges - End Ground Unit (Unit 03)

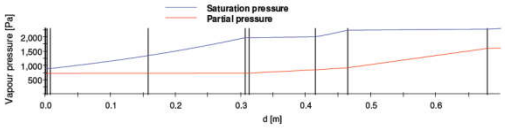


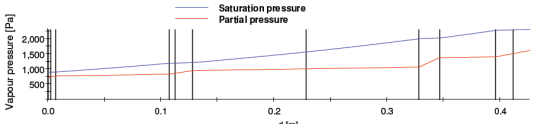
The Passive House Designer

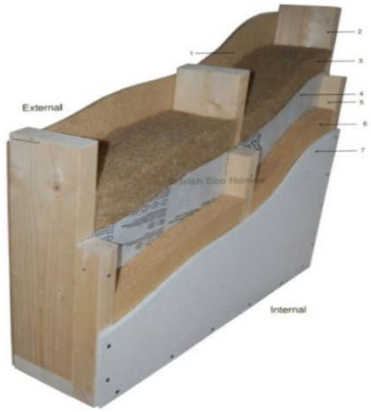


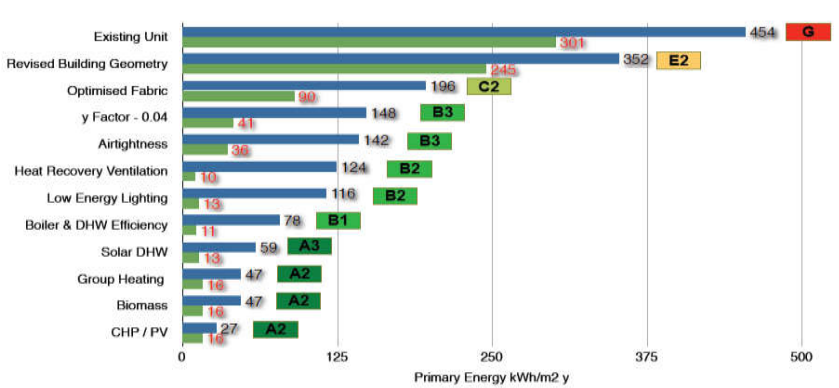


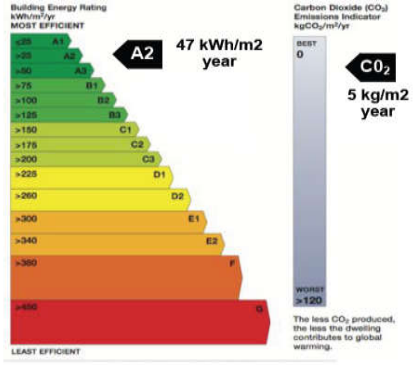
WATER RESOURCES & RECYCLING





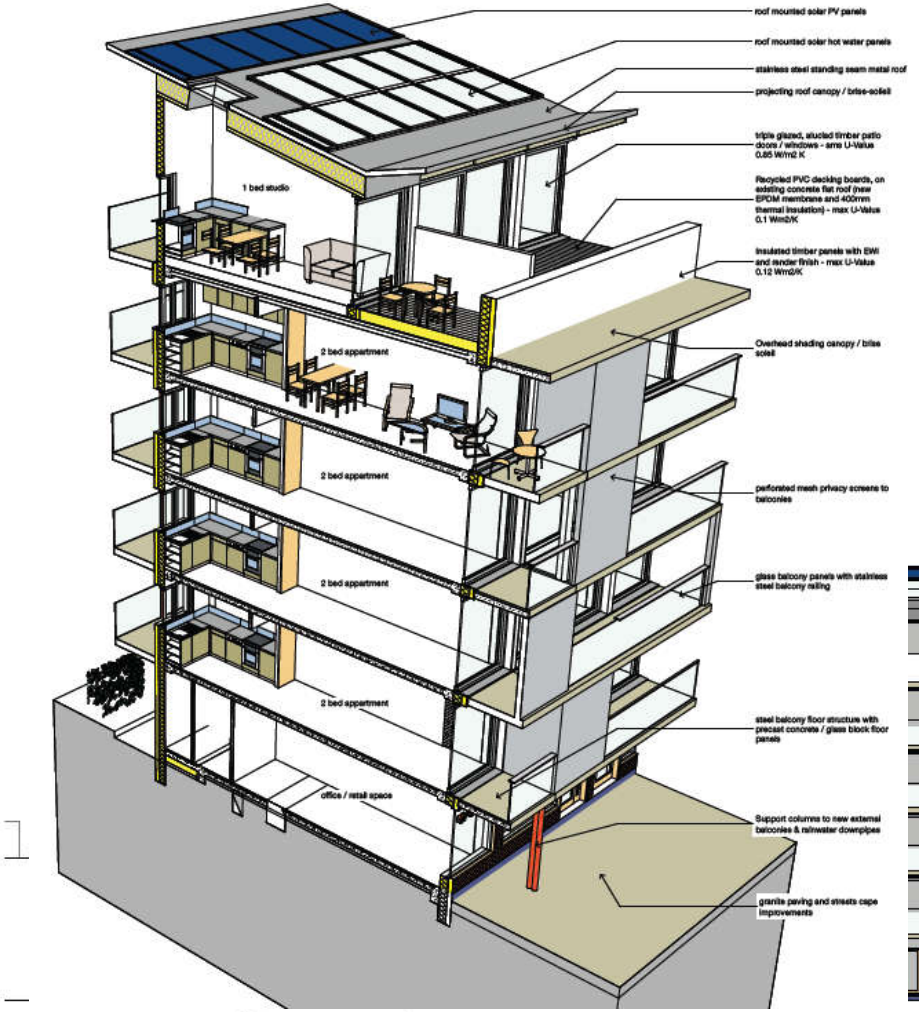


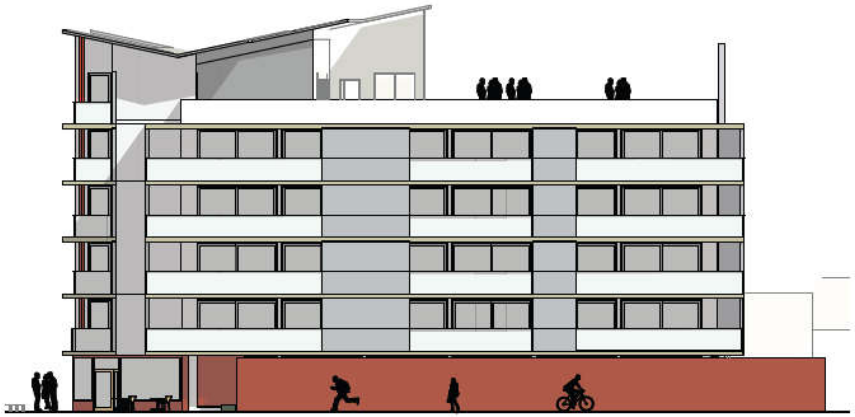




FROM G to A - DEAP ANALYSIS OF ENERGY RETROFIT MEASURES

The Passive House Designer





DIT Proposal -"Cost Optimal"?

- The buildings are:

Solved?
Yes
Yes
Yes
Yes
Yes
Yes

- Un-heatable (Part L)
- Un-healthy (Parts L&F)
- Un-visitable (Part M)
- Un-comfortable
- Non-compliant (Part B)
- Too small (DECLG)

Green Public Procurement

Measured Project Outcomes

- BER of A2, nZEB compliant
- 100% compliance as new build (Parts B, M, K & L)
- Zero Surface Condensation
- 90% fuel cost reduction (€1,486 to €156)
- 100% Replicable
- BREEAM "Outstanding"/ DGNB "Gold"/ LEED "Platinum"

Further Outcomes Anticipated

Social

- Fuel poverty eradication
- Employment creation
- Skills development
- Health cost reduction

Further Outcomes Anticipated

Social

- Fuel poverty
- Employment
- Skills
- Health

Economic

- Carbon saving/trading
- Self-funding
- Sustainable
- Fuel imports

Further Outcomes Anticipated

Social

- Fuel poverty
- Employment
- Skills
- Health

Economic

- Carbon saving/trading
- Self-funding
- Sustainable
- Fuel imports

The DT774 Team

Malachy Matthews / BIM

Patrick Daly / Energy

Trevor Woods / Quantities

The External Examiners

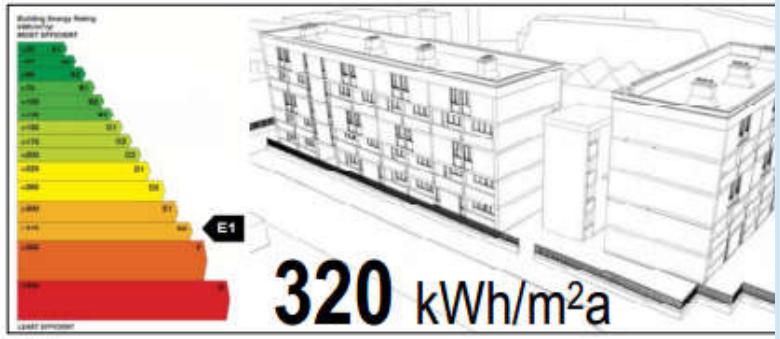
Prof Owen Lewis

Joseph Little

"The MSc Energy Retrofit Technology is a pioneering programme .. without parallel nationally and has few peers internationally.

"the examiners are convinced of the national importance of this MSc and related Postgraduate Certificate and Postgraduate Diploma. "

The Exhibition



Twitter: **@DT774**

Tweets

nZEB retrofit 2013 @DT774 — 1 Jun
Raymond O'Reilly's BREEAM Excellent Refurb (Domestic Buildings) design assessment of his DT774 FlatTop nZEB retrofit slideshare.net/rayoreilly1/ro...
View media

nZEB retrofit 2013 @DT774 — 1 Jun
Evelyn Moran's concise exploration of the BREEAM sustainability metric in relation to her DT774 FlatTop nZEB Retrofit slideshare.net/carraroe/flat-...
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nZEB retrofit 2013 @DT774 — 1 Jun
Eanna McManus' wonderfully iterative approach to the DT774 FlatTop block deep energy (nZEB) retrofit on @slideshare slideshare.net/eamcmanus/flat...
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nZEB retrofit 2013 @DT774 — 1 Jun
David Ledwith's inspired FlatTop 5-storey apartment Energy Retrofit on @slideshare #architecture #design slideshare.net/DavidLedwith/f...
View media

nZEB retrofit 2013 @DT774 — 31 May
Richard Callaghan explains the energy upgrade of a 5-storey "flat-Top" apartment building in Dublin slideshare.net/richcie/r-call...
View media

Thank You

Simon McGuinness MRIAI

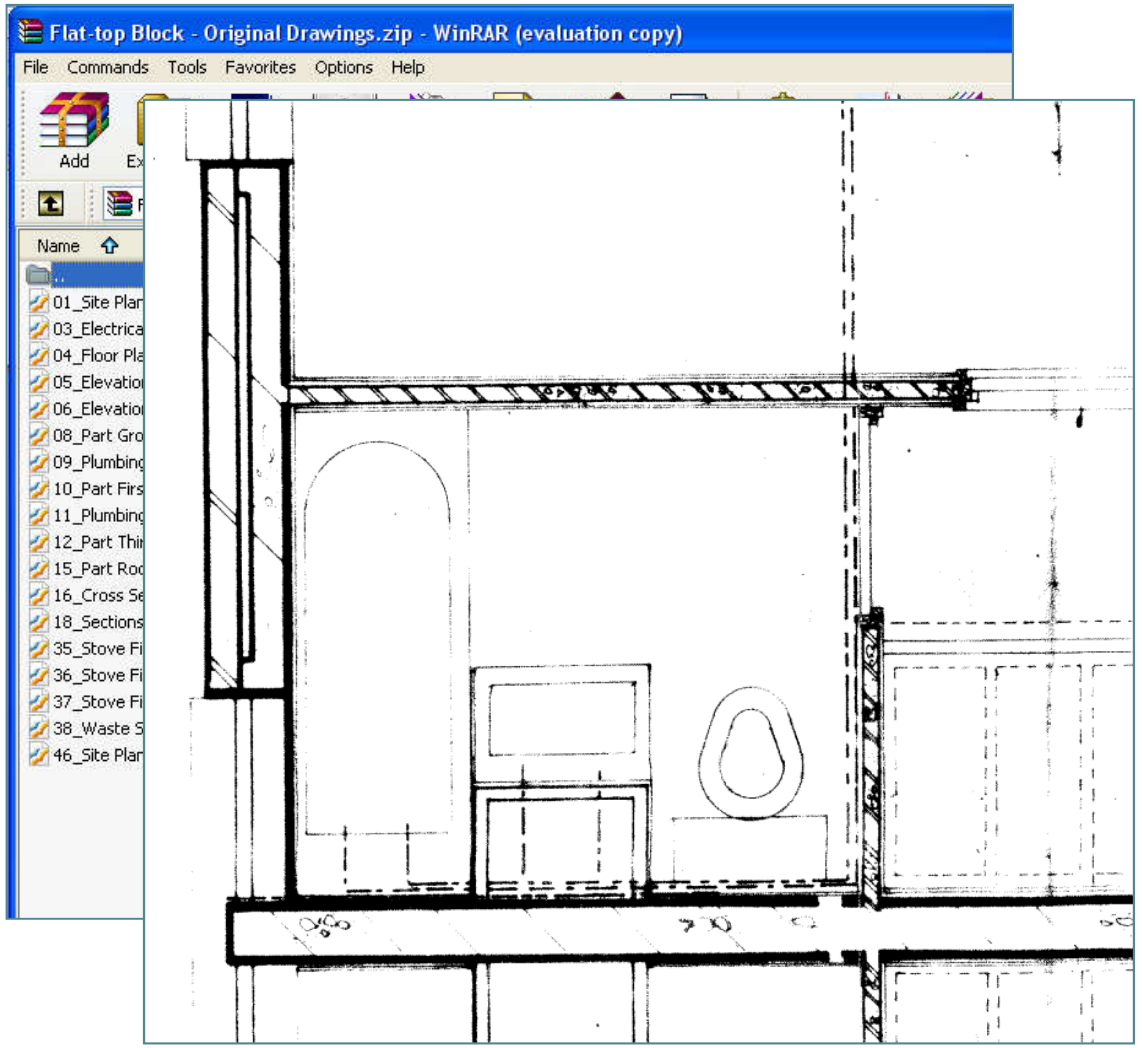
The Skills Deficit

Technical, Professional and Scientific

Key Skills for the Retrofit World

Conceptual

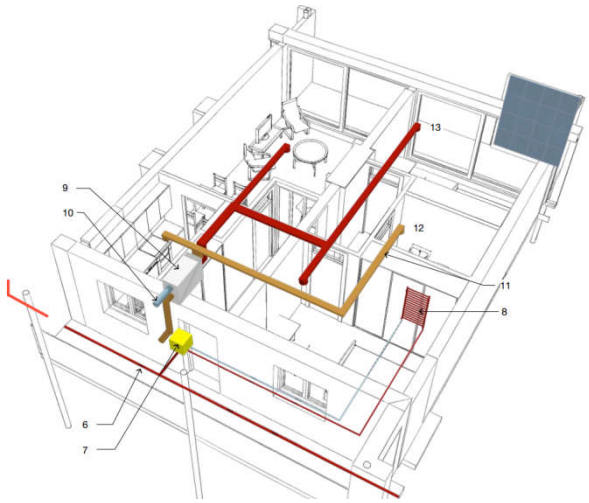
- BIM for:
- Forensic Investigation
- 3D assembly
- Lead the interrogation of data from photos, measurement, records, drawings, etc.

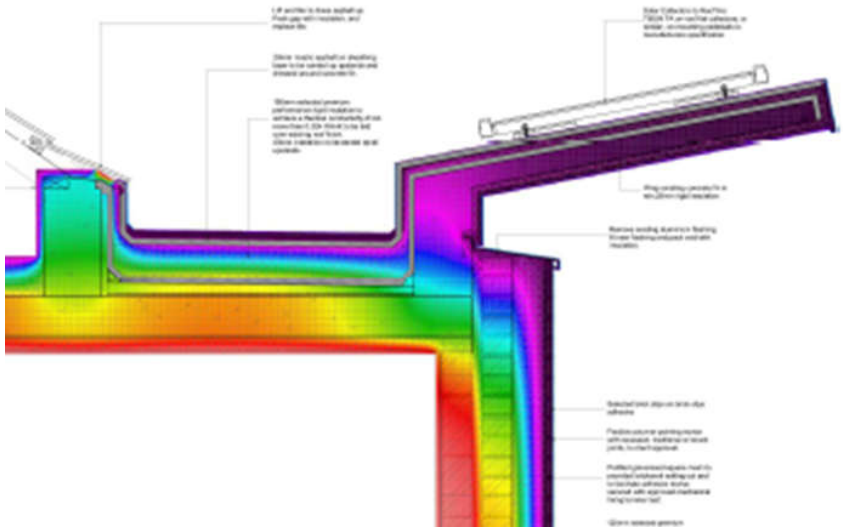


Key Skills for the Retrofit World

Technical

- Ability to see through walls and accurately model unseen construction in detail and in 3D
- Deploy high level computer energy simulations at 95% accuracy
- Undertake 3-D linear thermal bridge calculation in complex geometries at 95% accuracy

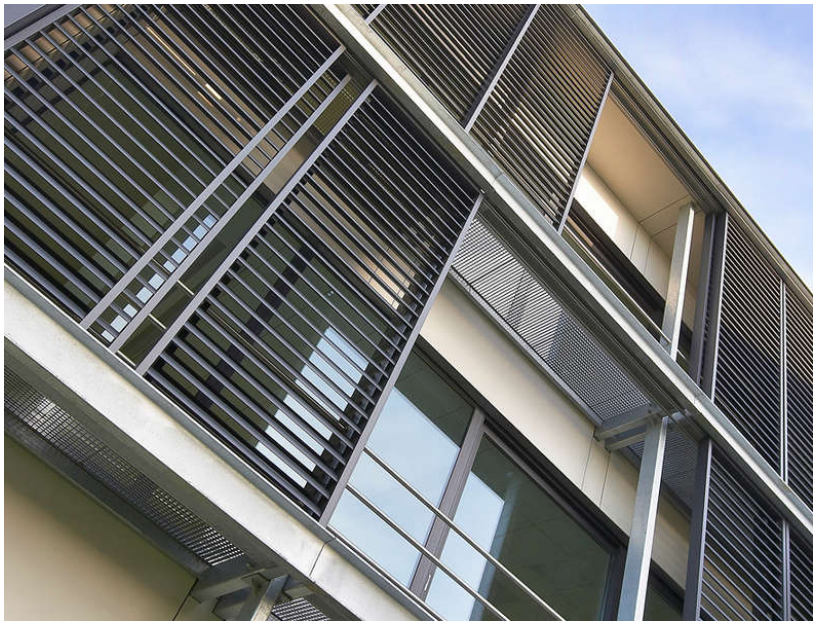




Key Skills for the Retrofit World

Technical

- Assess proposals for hygrothermal effects, condensation and mould growth using questionable standards
- Design mechanical ventilation systems to deliver good air quality at minimum energy
- Design good daylight solutions in the face of inadequate standards
- Prevent overheating



Key Skills for the Retrofit World

Economic

- Predict future usage patterns, future energy price, carbon taxes and convert all to NPV
- Predict lifecycle cost and advise on funding models not yet available using data not released
- Develop design schemes based on embodied carbon and embodied energy without national databases
- Do no harm to protected historic construction using untested materials & methods of construction

Acquiring the Key Skills

Education

- Bachelors degree in Architecture or Arch Technology
- 2 years site experience, plus study, plus professional exams
- 1 year full time Masers Degree

  Digital Analysis and Energy Retrofit with level 9 research dissertation, or

  Masters degree in linear thermal bridge and hygrothermal analysis with level 9 Building Physics research dissertation

- After 8 years full-time unpaid study the starting salary:
- Minimum wage

New Professions?

Risk mitigation strategy

GP	Orthopaedic Consultant	Orthopaedic Surgeon
Architect/	Retrofit Consultant - Energy modelling - Insulation & Condensation risk - Thermal bridge design - Hygrothermal design	Building Physicist - Hygrothermal validation - LTB validation - Materials testing - Research

DIT School of Architecture, Bolton St

Part time Postgraduate and CPD professional programmes:

- DT774 Postgraduate Certificate (Digital Analysis &Energy Retrofit)
- DT774a Postgraduate Diploma (Digital Analysis &Energy Retrofit)
- DT774b MSc (Energy Retrofit Technology)
- DT775 CPD Diploma (BIM Technologies)
- DT775a CPD Diploma (Collaborative BIM)
- DT775b CPD Certificate (Thermal Bridge Assessment)
- *DT775c Postgraduate Diploma (Thermal Performance Modelling)**
- *DT775d CPD Diploma (Building Environmental Assessment Methods)**

** Springboard 2013 funding application pending*