Aistriú

Transitioning towards a
Circular Economy for the
Built Environment

Circularity is nearer than you think!

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THE CHARTERED INSTITUTE OF BUILDING

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IGBC
IRISH GREEN BUILDING COUNCIL

9th April 2021

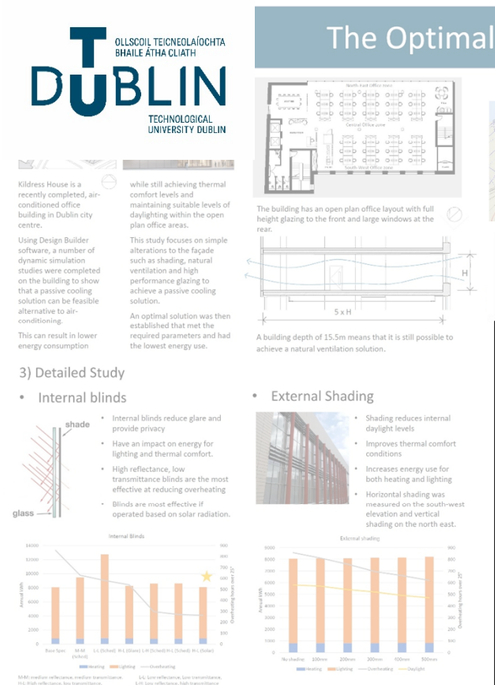
Joseph Little
Patrick Daly

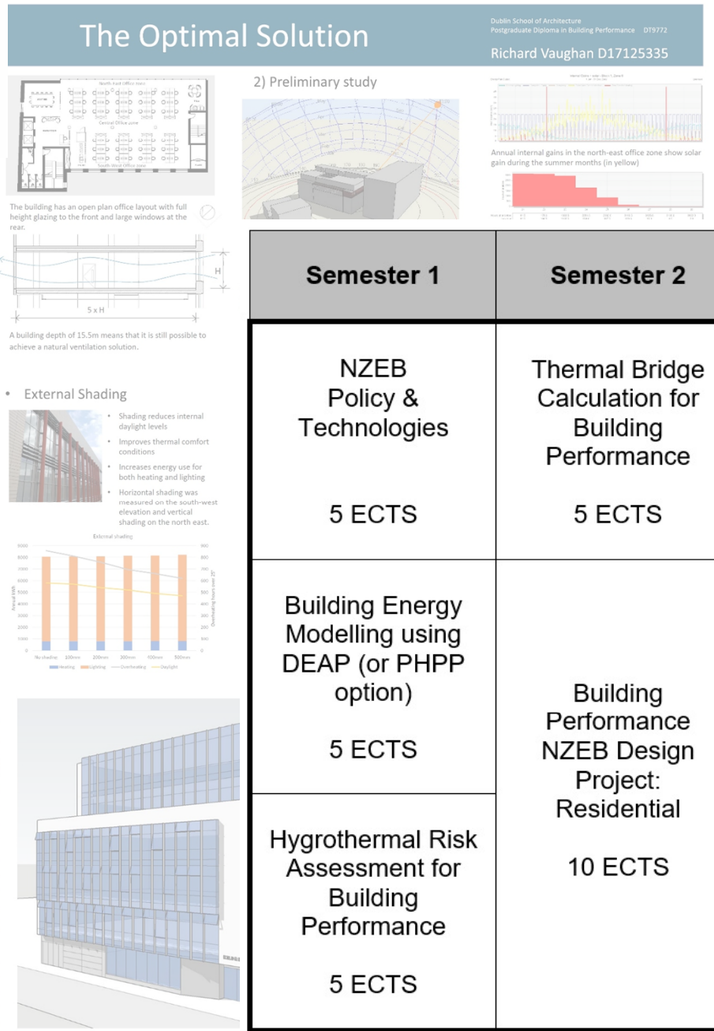
TU Dublin

DRIVE

TU DUBLIN
OLLSCOIL TEICNEOLAÍOCHTA BHAILE ÁTHA CLIATH
TECHNOLOGICAL UNIVERSITY DUBLIN

MSc in Building Performance (Energy Efficiency in Design)





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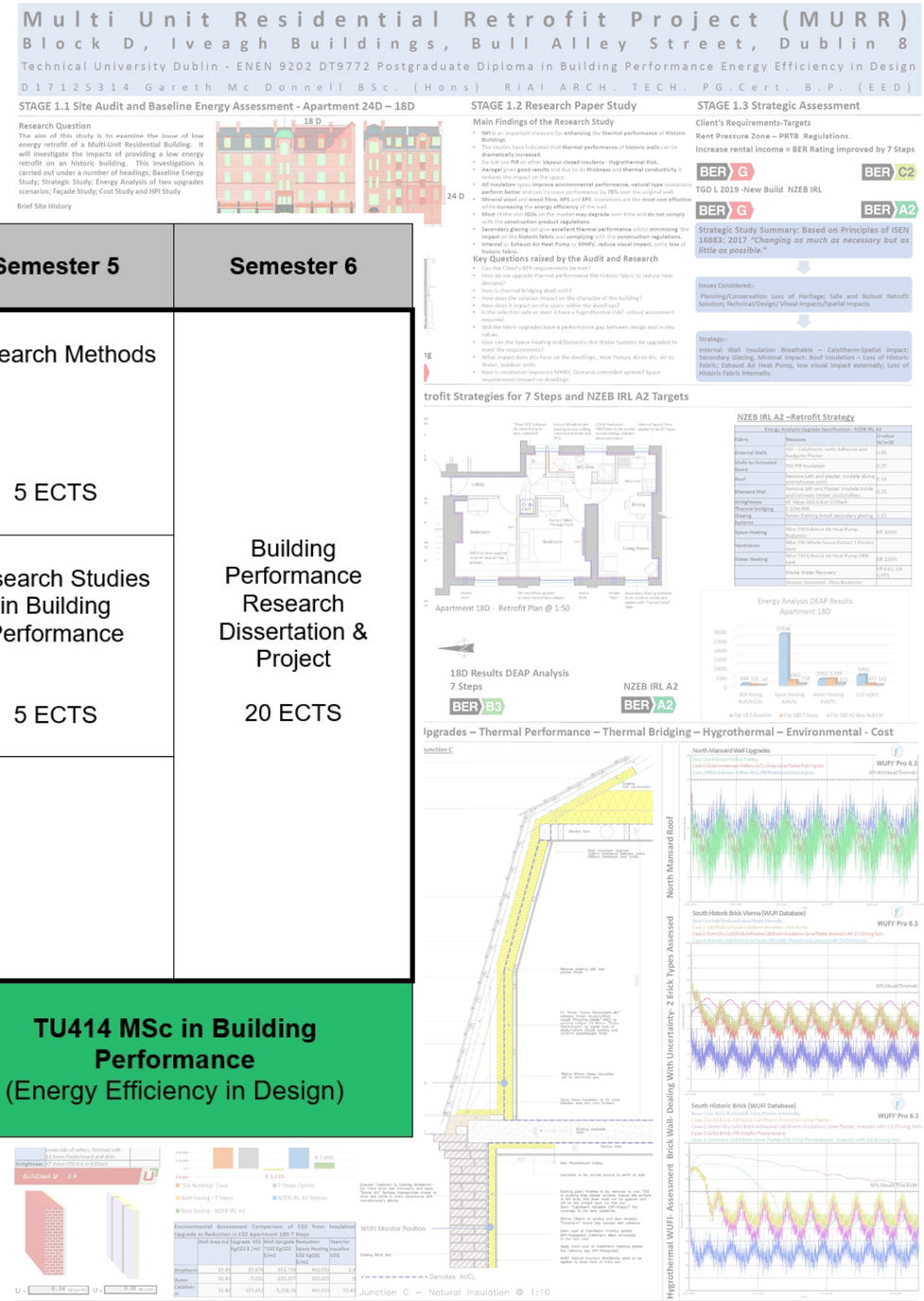

Fuel breakdown for a typical floor
Air-conditioned building: A3
Optimal solution: A2

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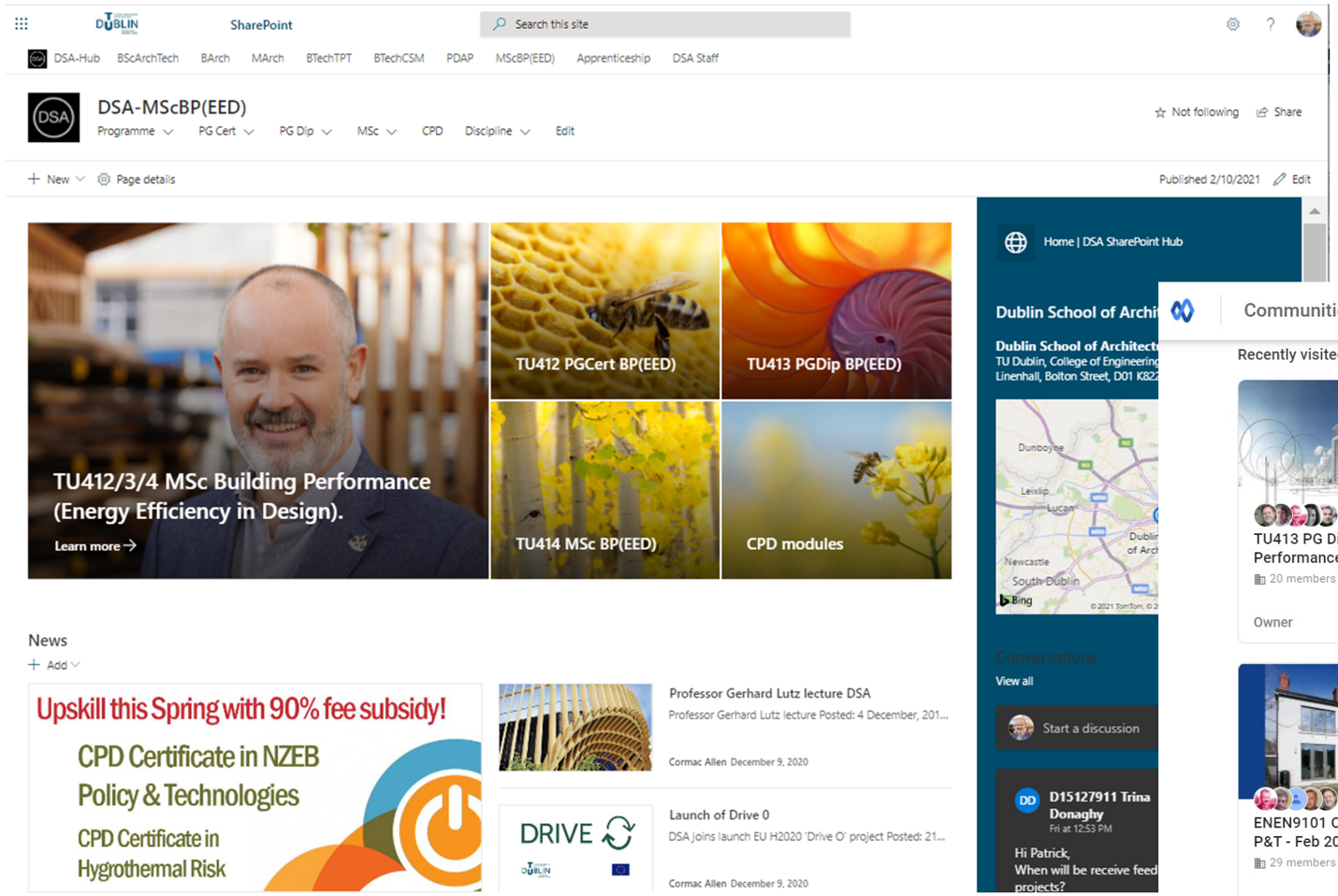

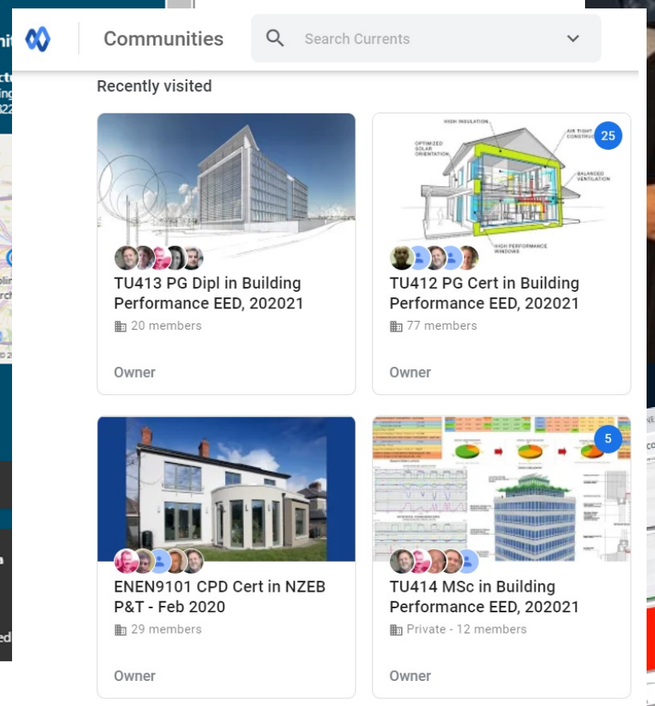

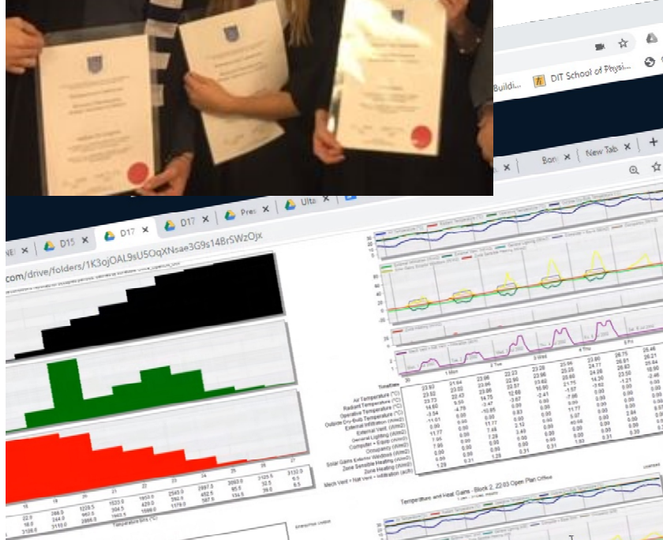

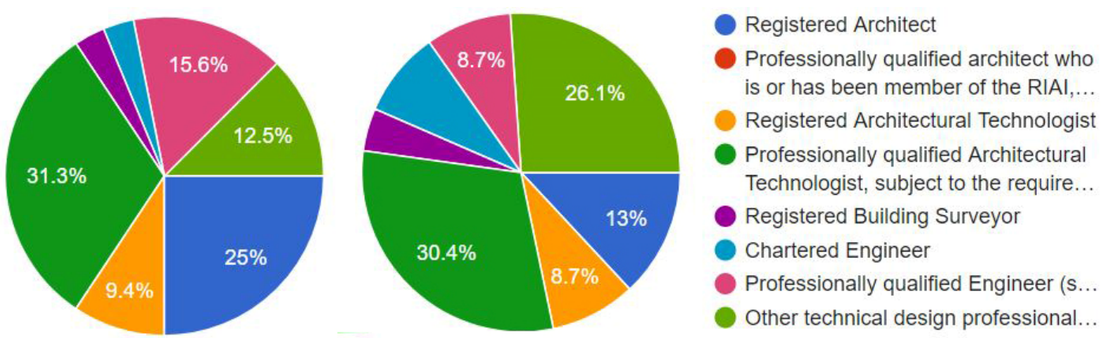

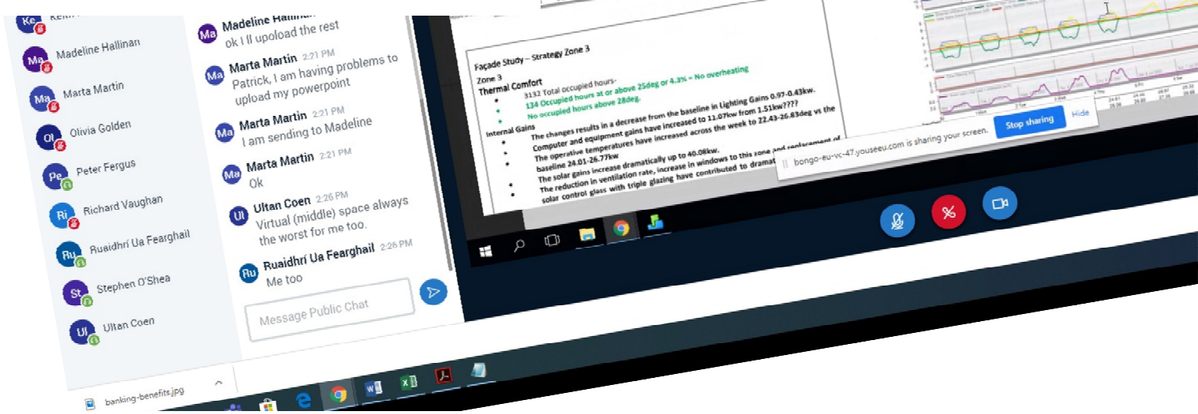

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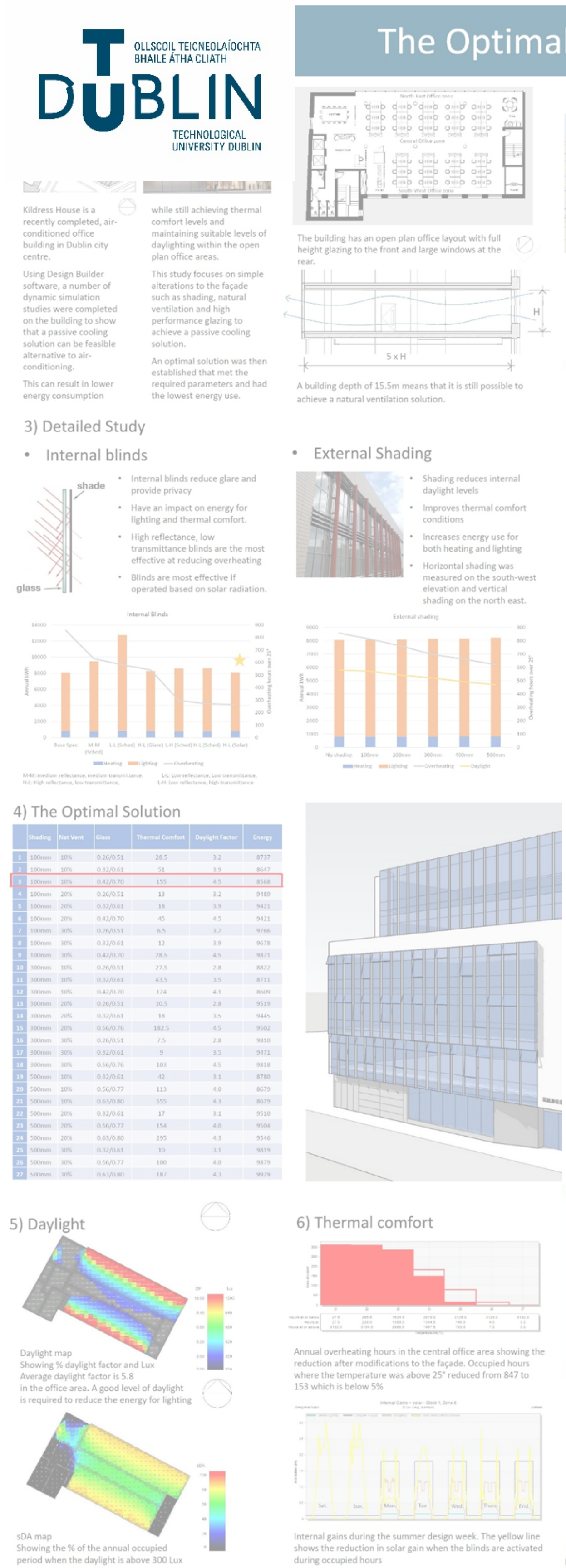

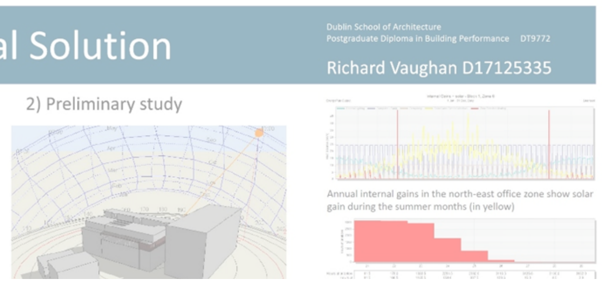

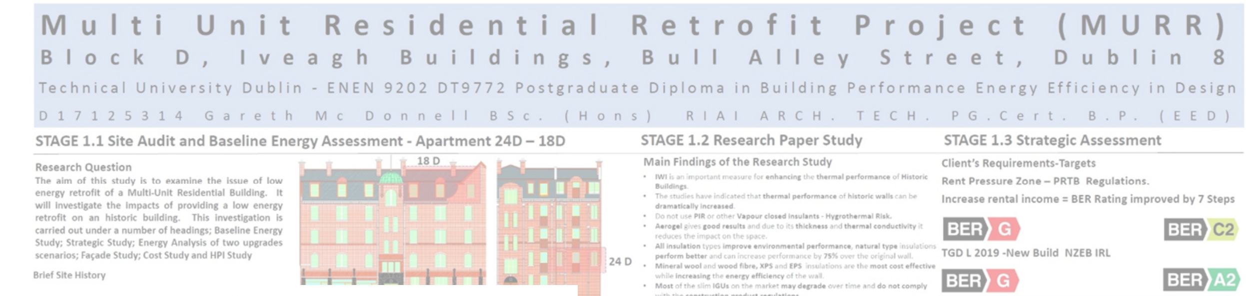

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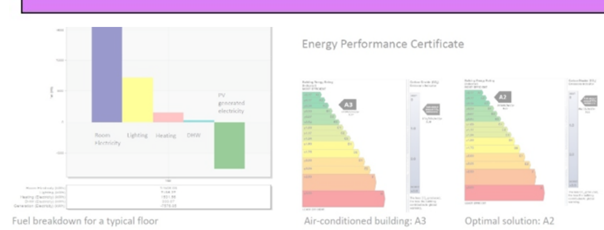
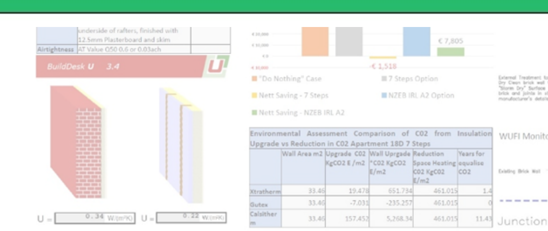


Building Energy Modelling



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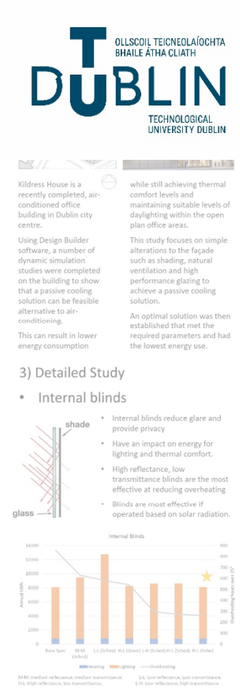

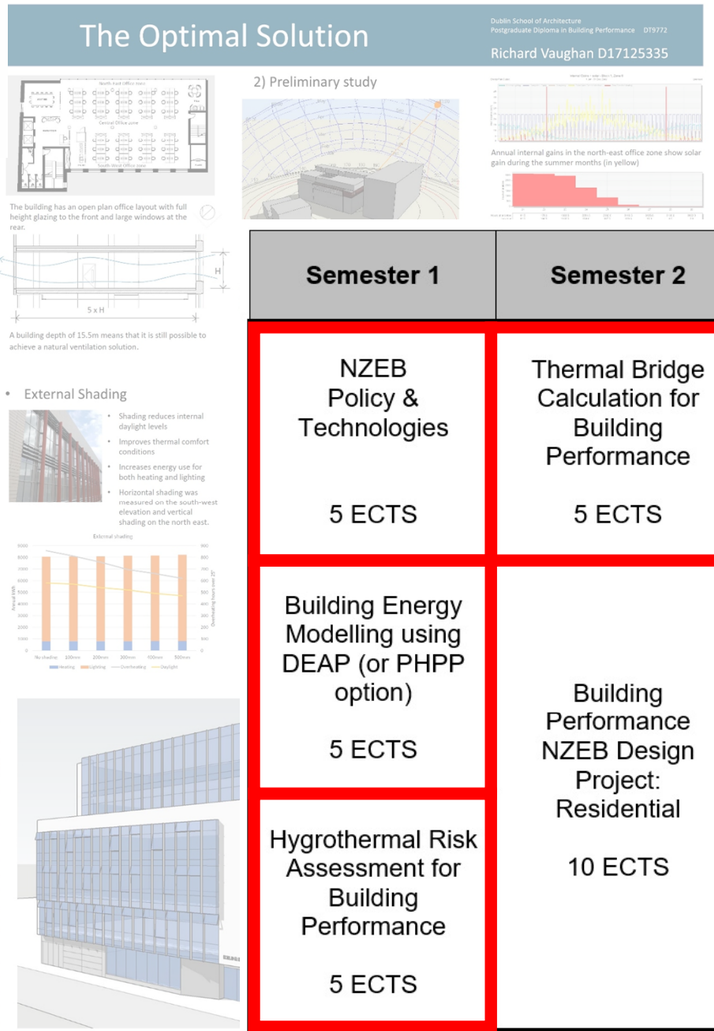

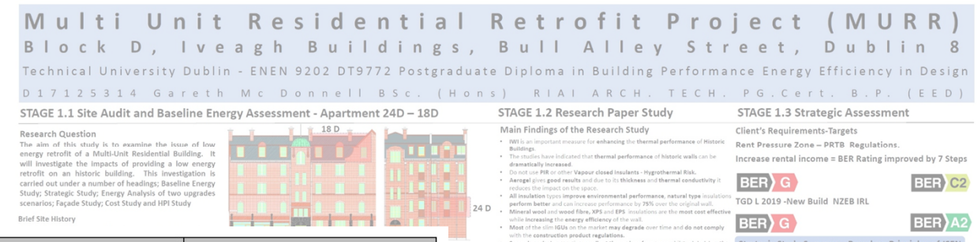

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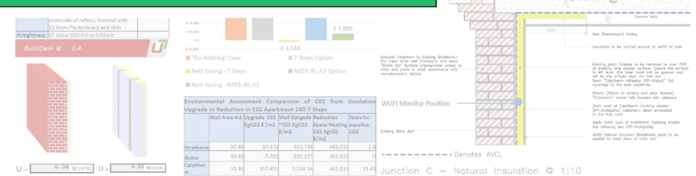
NZEB / regulatory skills & knowledge



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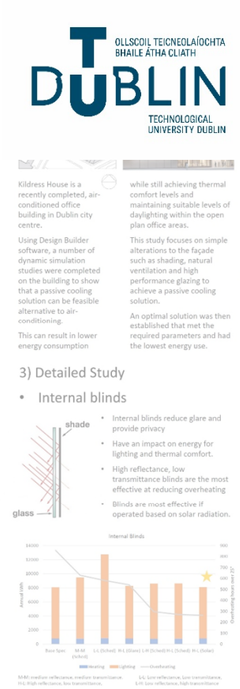

Kildress House is a recently completed, air-conditioned office building in Dublin city centre.

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This can result in lower energy consumption while still achieving thermal comfort levels and maintaining suitable levels of daylighting within the open plan office areas.

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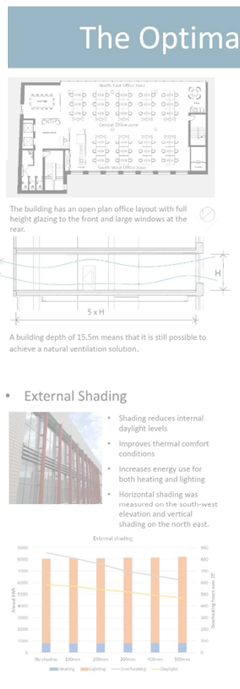
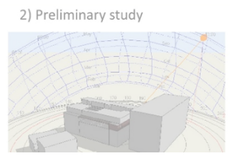
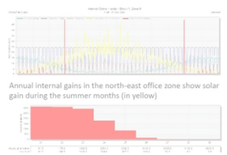


The building has an open plan office layout with full height glazing to the front and large windows at the rear.

A building depth of 15.5m means that it is still possible to achieve a natural ventilation solution.

2) Preliminary study





Annual internal gains in the north-east office zone show solar gain during the summer months (in yellow)

3) Detailed Study

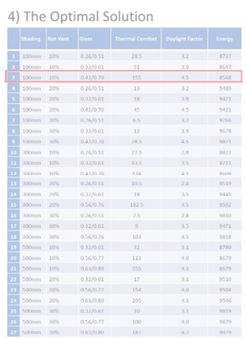
- Internal blinds

- Internal blinds reduce glare and provide privacy
- Have an impact on energy for lighting and thermal comfort.
- High reflectance, low transmittance blinds are the most effective at reducing overheating
- Blinds are most effective if operated based on solar radiation.

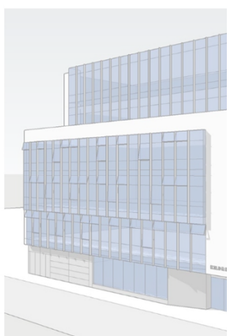
- External Shading

- Shading reduces internal daylight levels
- Improves thermal comfort conditions
- Increases energy use for both heating and lighting
- Horizontal shading was measured on the south-west elevation and vertical shading on the north east.

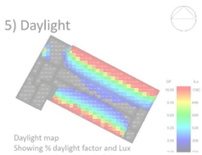
4) The Optimal Solution



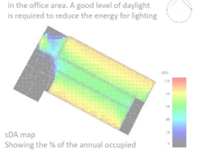
Shading	Net Vent	Glass	Thermal Comfort	Daylight Factor	Energy
1 100mm	10%	0.26/0.51	24.5	3.2	8737
2 100mm	20%	0.32/0.61	51	3.9	8627
3 100mm	30%	0.42/0.70	155	4.5	8568
4 100mm	20%	0.26/0.51	13	3.2	9589
5 100mm	20%	0.32/0.61	18	3.9	9421
6 100mm	20%	0.42/0.70	45	4.5	9421
7 100mm	30%	0.26/0.51	6.5	3.2	9766
8 100mm	30%	0.32/0.61	12	3.9	9678
9 100mm	30%	0.42/0.70	28.5	4.5	9673
10 300mm	10%	0.26/0.51	27.5	2.8	8822
11 300mm	10%	0.32/0.61	63.5	3.5	8731
12 300mm	10%	0.42/0.70	174	4.1	8609
13 300mm	20%	0.26/0.51	10.5	2.8	9539
14 300mm	20%	0.32/0.61	18	3.5	9445
15 300mm	20%	0.56/0.76	182.5	4.5	9502
16 300mm	30%	0.26/0.51	7.5	2.8	9850
17 300mm	30%	0.32/0.61	9	3.5	9571
18 300mm	30%	0.56/0.76	103	4.5	9816
19 500mm	10%	0.32/0.61	42	3.1	8790
20 500mm	10%	0.56/0.77	113	4.0	8679
21 500mm	10%	0.63/0.80	155	4.3	8679
22 500mm	20%	0.32/0.61	17	3.1	9510
23 500mm	20%	0.56/0.77	154	4.0	9504
24 500mm	20%	0.63/0.80	295	4.3	9546
25 500mm	30%	0.32/0.61	30	3.1	9819
26 500mm	30%	0.56/0.77	190	4.0	9879
27 500mm	30%	0.63/0.80	367	4.3	9879



5) Daylight



Daylight map
Showing % daylight factor and Lux
Average daylight factor is 5.8
in the office area. A good level of daylight is required to reduce the energy for lighting



sDA map
Showing the % of the annual occupied period when the daylight is above 300 Lux

6) Thermal comfort

Annual overheating hours in the central office area showing the reduction after modifications to the façade. Occupied hours where the temperature was above 25° reduced from 847 to 153 which is below 5%

Internal gains during the summer design week. The yellow line shows the reduction in solar gain when the blinds are activated during occupied hours

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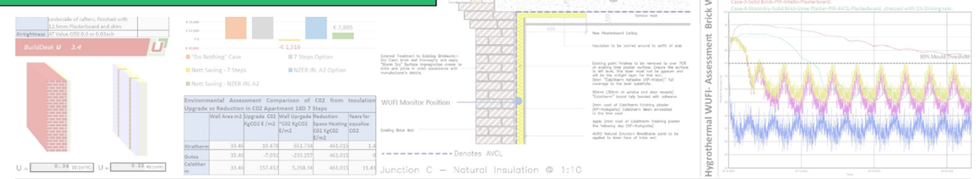
Fuel breakdown for a typical floor

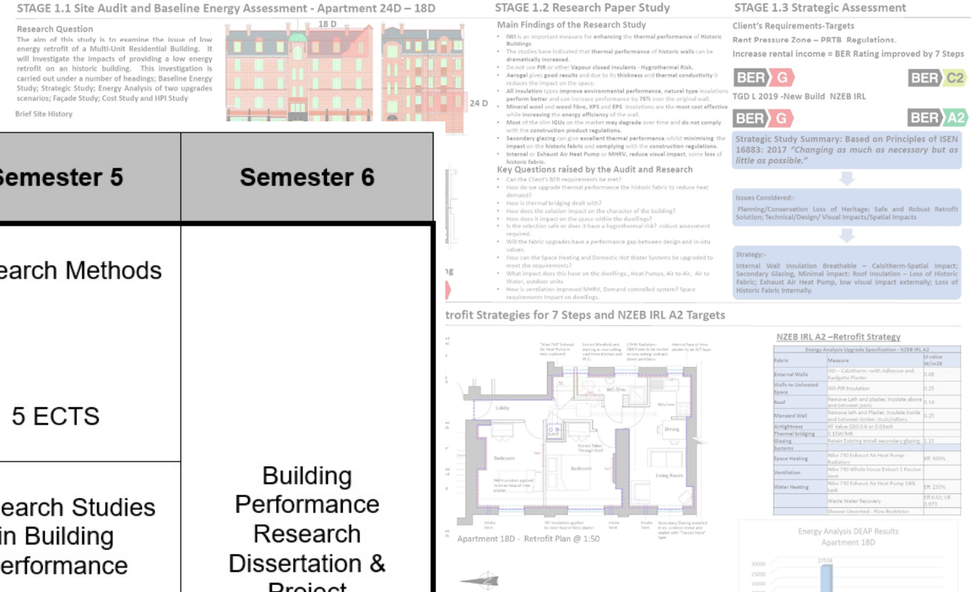
Air-conditioned building: A3 Optimal solution: A2

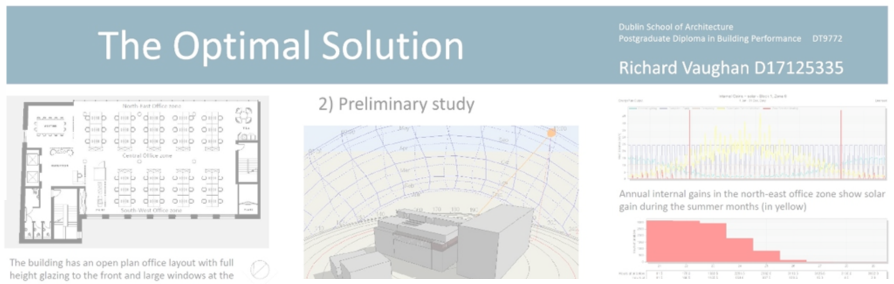
Simulation (transient & dynamic)

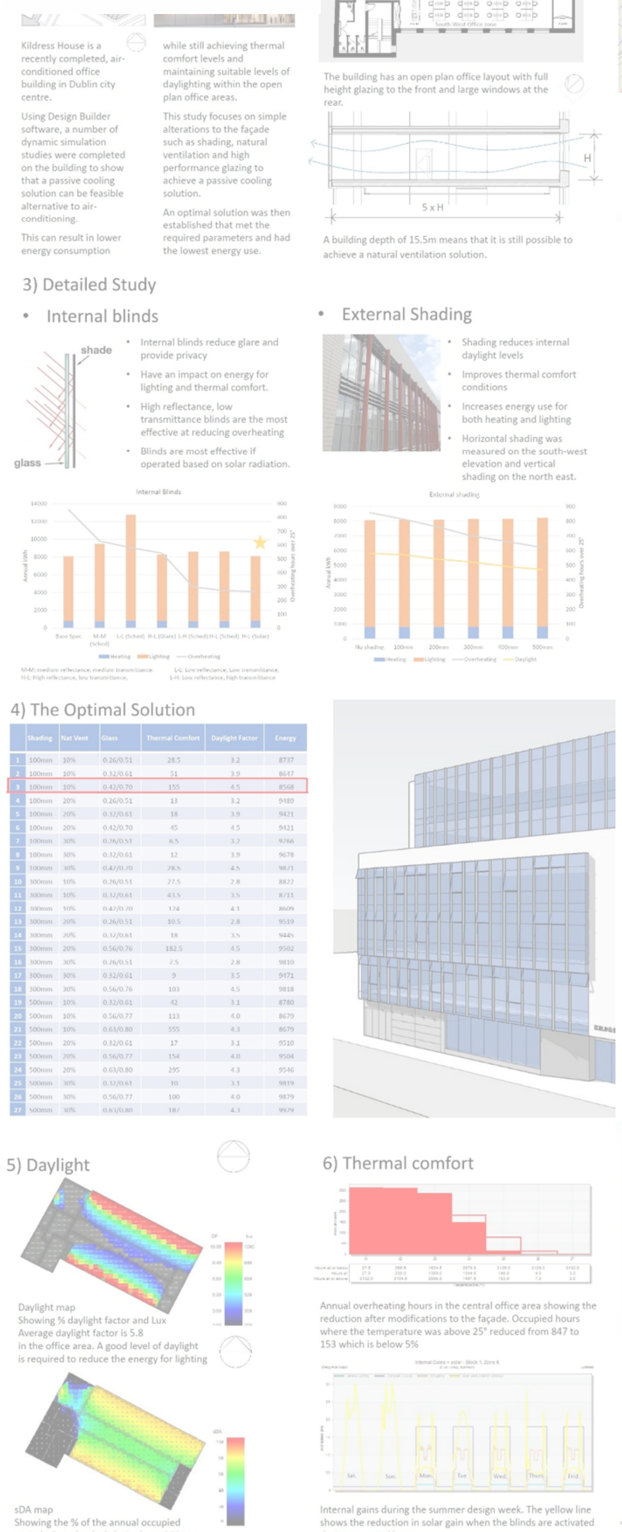


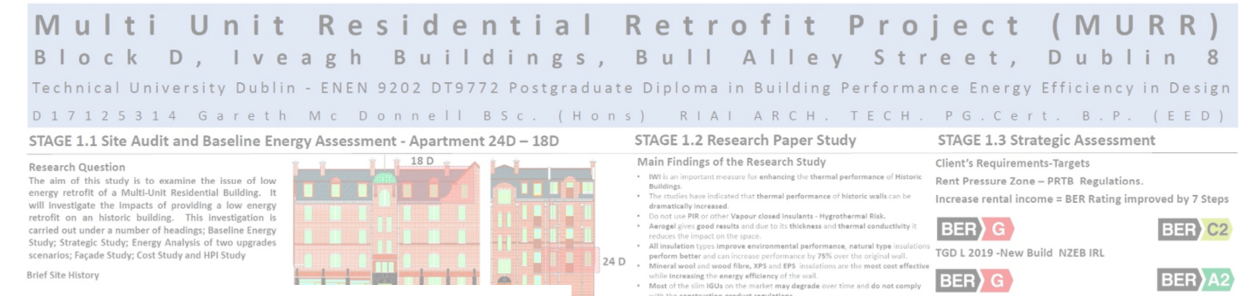
Junction C – Natural Insulation @ 1:10

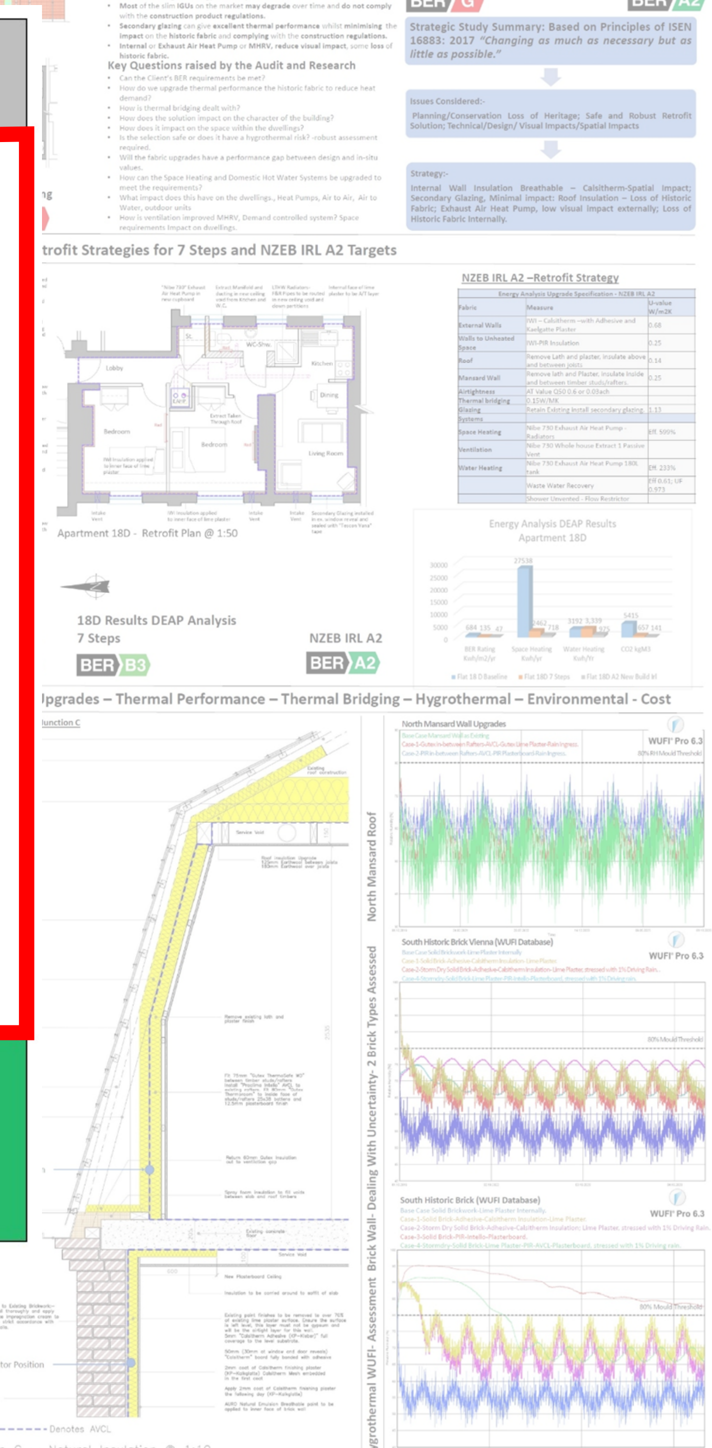
Multi Unit Residential Retrofit Project (MURR)
Block D, Iveagh Buildings, Bull Alley Street, Dublin 8
Technical University Dublin - ENEN 9202 DT9772 Postgraduate Diploma in Building Performance Energy Efficiency in Design
D17125314 Gareth Mc Donnell BSc. (Hons) RIAI ARCH. TECH. PG.Cert. B.P. (EED)











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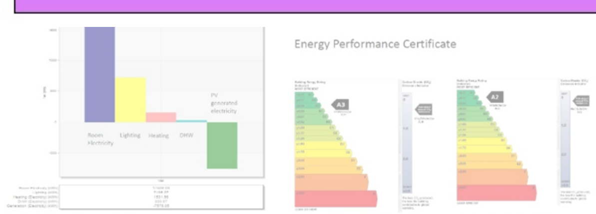
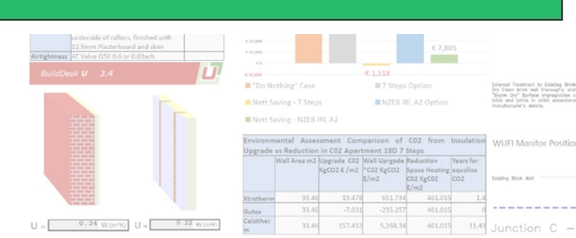


Integrated technical design projects



MSc in Building Performance (Energy Efficiency in Design)

The Optimal Solution

Dublin School of Architecture
Postgraduate Diploma in Building Performance DT9772

Richard Vaughan D17125335

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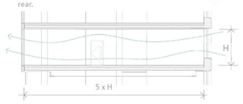

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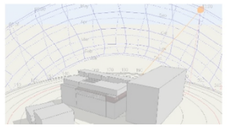

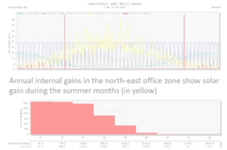

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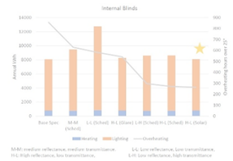

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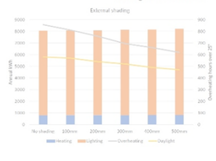

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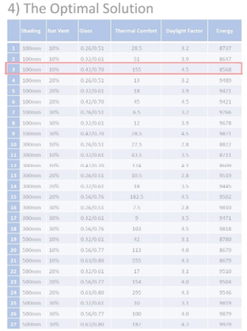
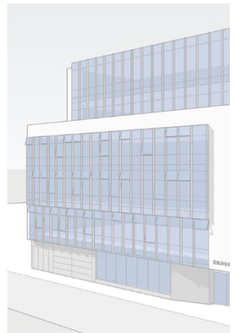
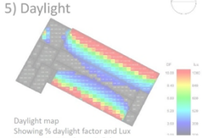
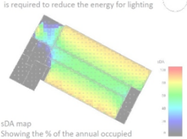




5) Daylight



Daylight map
Showing % daylight factor and Lux
Average daylight factor is 5.8
in the office area. A good level of daylight is required to reduce the energy for lighting



sDA map
Showing the % of the annual occupied period when the daylight is above 300 Lux

6) Thermal comfort

Annual overheating hours in the central office area showing the reduction after modifications to the façade. Occupied hours where the temperature was above 25° reduced from 847 to 153 which is below 5%

Internal gains during the summer design week. The yellow line shows the reduction in solar gain when the blinds are activated during occupied hours

Fuel breakdown for a typical floor

Semester 1	Semester 2	Semester 3	Semester 4	Semester 5	Semester 6
NZEB Policy & Technologies 5 ECTS	Thermal Bridge Calculation for Building Performance 5 ECTS	Building Environmental Assessment Methods 5 ECTS		Research Methods 5 ECTS	
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CPDs

Multi Unit Residential Retrofit Project (MURR)

Block D, Iveagh Buildings, Bull Alley Street, Dublin 8

Technical University Dublin - ENEN 9202 DT9772 Postgraduate Diploma in Building Performance Energy Efficiency in Design

D17125314 Gareth Mc Donnell BSc. (Hons) RIAI ARCH. TECH. PG.Cert. B.P. (EED)

STAGE 1.1 Site Audit and Baseline Energy Assessment - Apartment 24D – 18D

Research Question

The aim of this study is to examine the issue of low energy retrofit of a Multi-Unit Residential Building. It will investigate the impacts of providing a low energy retrofit on an historic building. This investigation is carried out under a number of headings; Baseline Energy Study; Strategic Study; Energy Analysis of two upgrades scenarios; Façade Study; Cost Study and HPI Study

Brief Site History

STAGE 1.2 Research Paper Study

Main Findings of the Research Study

- IWI is an important measure for enhancing the thermal performance of Historic Buildings.
- The studies have indicated that thermal performance of historic walls can be dramatically increased.
- Do not use PIR or other Vapour closed insulants - Hygrothermal Risk.
- Aerogel gives good results and due to its thickness and thermal conductivity it reduces the impact on the space.
- All insulation types improve environmental performance, natural type insulations perform better and can increase performance by 75% over their original wall.
- Mineral wool and wood fibre, XPS and EPS insulations are the most cost effective while increasing the energy efficiency of the wall.
- Most of the slim IGUs on the market may degrade over time and do not comply with the construction product regulations.
- Secondary glazing can give excellent thermal performance whilst minimising the impact on the historic fabric and complying with the construction regulations.
- Internal or Exhaust Air Heat Pump or MMHV, reduce visual impact, some loss of historic fabric.

Key Questions raised by the Audit and Research

- Can the Client's BER requirements be met?
- How do we upgrade thermal performance the historic fabric to reduce heat demand?
- How is thermal bridging dealt with?
- How does the solution impact on the character of the building?
- How does it impact on the space within the dwellings?
- Is the selection safe or does it have a hygrothermal risk? -robust assessment required.
- Will the fabric upgrades have a performance gap between design and in-situ values.
- How can the Space Heating and Domestic Hot Water Systems be upgraded to meet the requirements?
- What impact does this have on the dwellings., Heat Pumps, Air to Air, Air to Water), outdoor units.
- How is ventilation improved MMHV, Demand controlled system? Space requirements impact on dwellings.

STAGE 1.3 Strategic Assessment

Client's Requirements-Targets

Rent Pressure Zone – PRTB Regulations.

Increase rental income = BER Rating improved by 7 Steps

BER G → BER C2

TGD L 2019 -New Build NZEB IRL

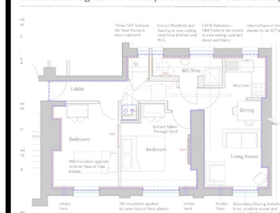
BER G → BER A2

Strategic Study Summary: Based on Principles of ISEN 16883: 2017 *"Changing as much as necessary but as little as possible."*

Issues Considered:-
Planning/Conservation Loss of Heritage; Safe and Robust Retrofit Solution; Technical/Design/ Visual Impacts/Spatial Impacts

Strategy:-
Internal Wall Insulation Breathable – Calsitherm-Spatial Impact; Secondary Glazing, Minimal Impact: Roof Insulation – Loss of Historic Fabric; Exhaust Air Heat Pump, low visual impact externally; Loss of Historic Fabric Internally.

trofit Strategies for 7 Steps and NZEB IRL A2 Targets

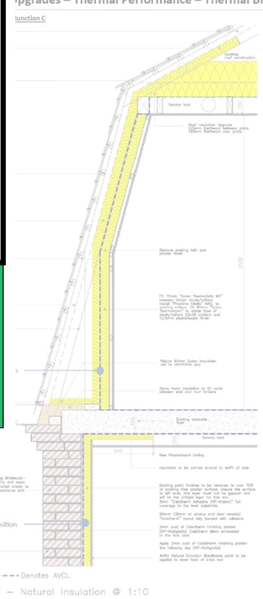


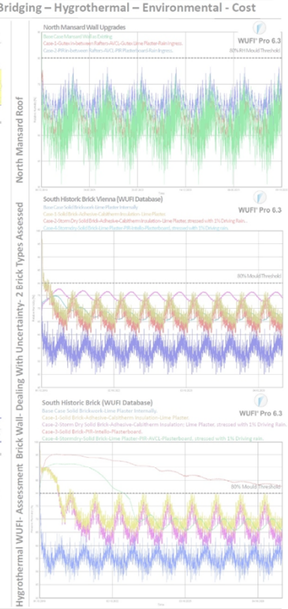
Apartment 18D - Retrofit Plan @ 1:50

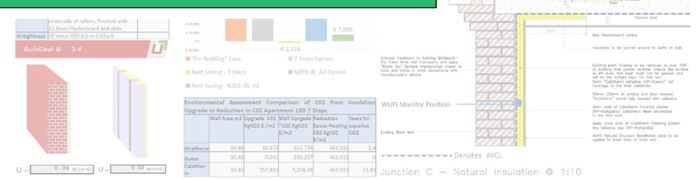
NZEB IRL A2 –Retrofit Strategy

Energy Analysis Upgrade Specification – NZEB IRL A2		
Fabric	Measure	U-value W/m2K
External Walls	IWI – Calsitherm –with Adhesive and Multiplate Plaster	0.68
Walls to Unheated Space	100-PIR Insulation	0.25
Roof	Remove Lath and plaster, insulate above and between joists	0.16
Mansard Wall	Remove lath and Plaster, insulate inside and between timber studs/rafters	0.25
Airtightness	AS Value 050.0 @ 0.05ach	
Thermal bridging	< 0.10W/k/K	
Glazing Systems	Retain/Existing/Install secondary glazing	1.33
Space Heating	Niltv 730 Exhaust Air Heat Pump-Radiators	SPF 300%
Ventilation	Niltv 730 Whole house Extract 1 Passive Vent	
Water Heating	Niltv 730 Exhaust Air Heat Pump 180L tank	SPF 233%
	Waste Water Recovery:	0.63
	Shower Unvented - Mixer Restrictor	0.373

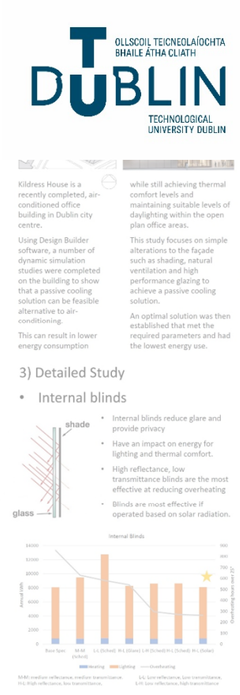
Upgrades – Thermal Performance – Thermal Bridging – Hygrothermal – Environmental - Cost

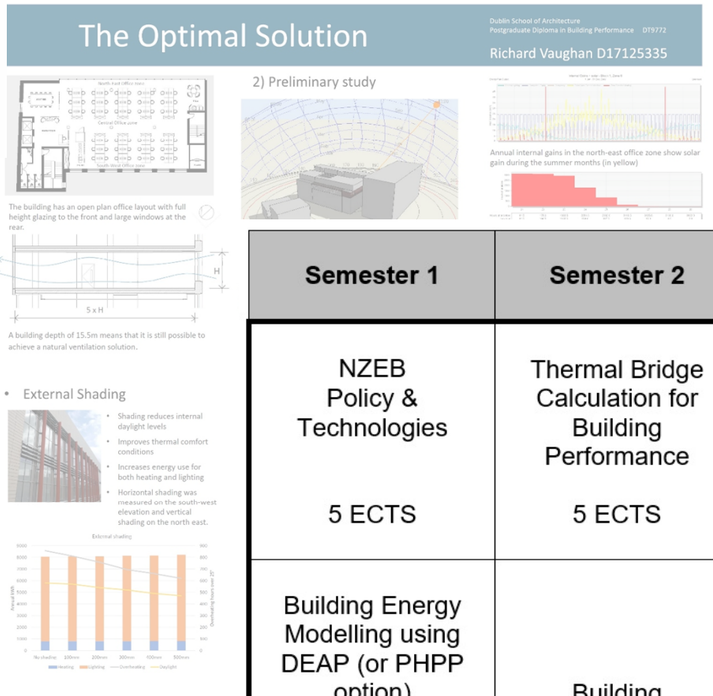


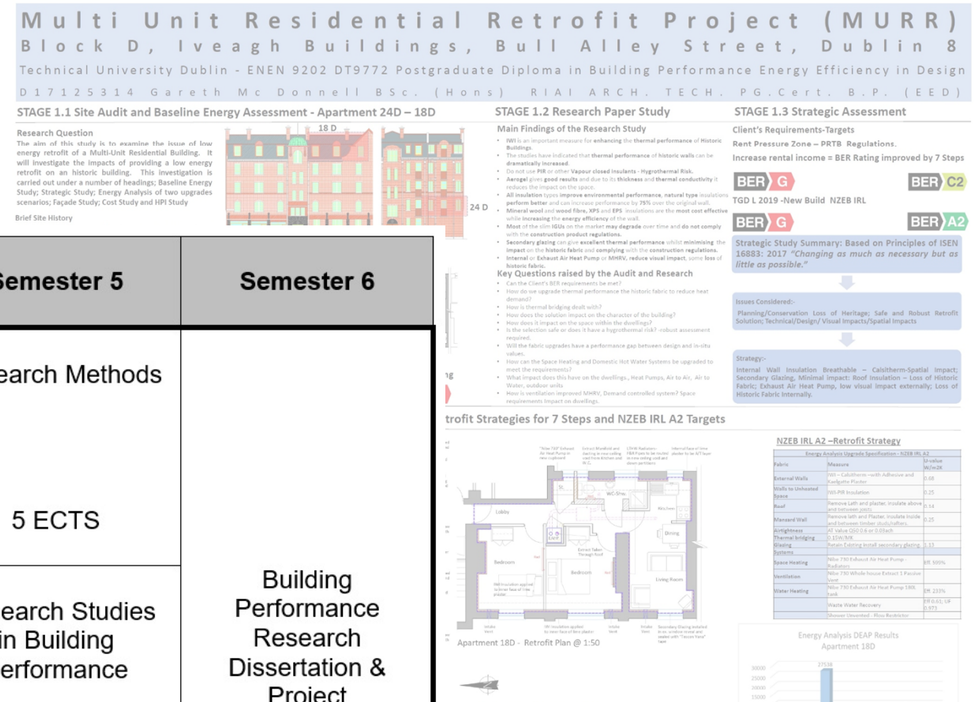




MSc in Building Performance (Energy Efficiency in Design)







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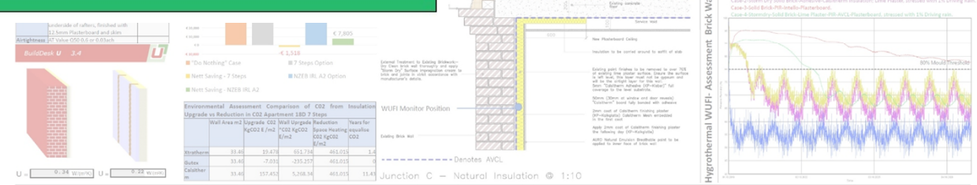
Environment & circularity



The environmental sustainability-focused modules in Year 2

The taught modules are 6 weeks in duration, ~20 hours commitment per week

9201 – Building Environmental Assessment Methods	
Knowledge (LEED, HPI etc) (4 weeks)	Project (2 weeks)

9205 - Circularity & Life Cycle Assessment		
Circularity (2 weeks)	Life Cycle Assessment (2 weeks)	Life Cycle Cost Analysis (2 weeks)

ENEN9205 - Circularity & Life Cycle Assessment in the Built Environment

On Completion of this module, the learner will be able to	
1	Discuss key concepts in circularity with reference to a range of key research papers
2	Discern a range of ways in which building designers can positively impact on the resource flows
3	Illustrate improved circularity in a building project they are familiar with through design or specification
4	Differentiate between the use and value of Life-cycle assessment (LCA) and life-cycle cost assessment (LCCA)
5	Use an LCA tool to help quantify & improve the circularity of a system.
6	Develop a project investment return
7	Assess the cost optimality of fabric interventions, services installations and renewable technologies in an nZEB residential project using standards-based methodologies.

The environmental sustainability-focused modules in Year 2

The taught modules are 6 weeks in duration, ~20 hours commitment per week

9201 – Building Environmental Assessment Methods

- Knowledge (LEED, HPI etc) (4 weeks)
- Project (2 weeks)

Focusing on concept, then in built environment, in buildings, then *design for disassembly*, & measuring circularity

9205 - Circularity & Life Cycle Assessment

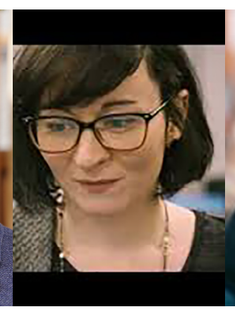
- Circularity (2 weeks)
  - Knowledge (1 week ~20 hrs, incl. 3 hrs lectures)
  - Case studies & design exercise (1 week ~20 hrs)
- Life Cycle Assessment (2 weeks)
- Life Cycle Cost Analysis (2 weeks)

Focusing on (a) circularity-focused case studies, (b) suppliers of circular materials and (c) a small technical design exercise.

Patrick Daly

Joseph Little

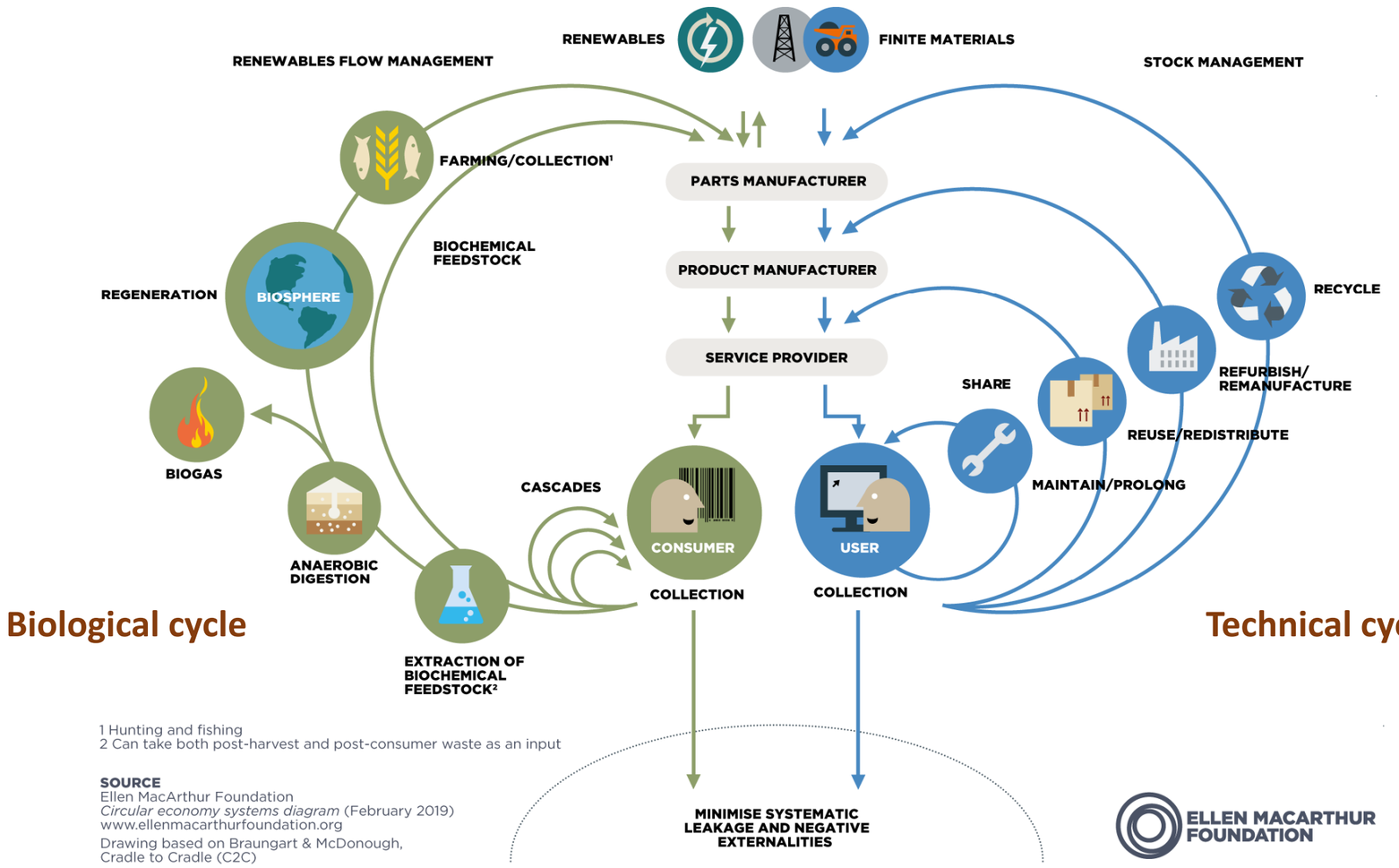
Sarah O'Dwyer



Daniel Coyle

ENEN9205 - Circularity & Life Cycle Assessment in the Built Environment

Learning circular design skills



The impact of approaches to jointing

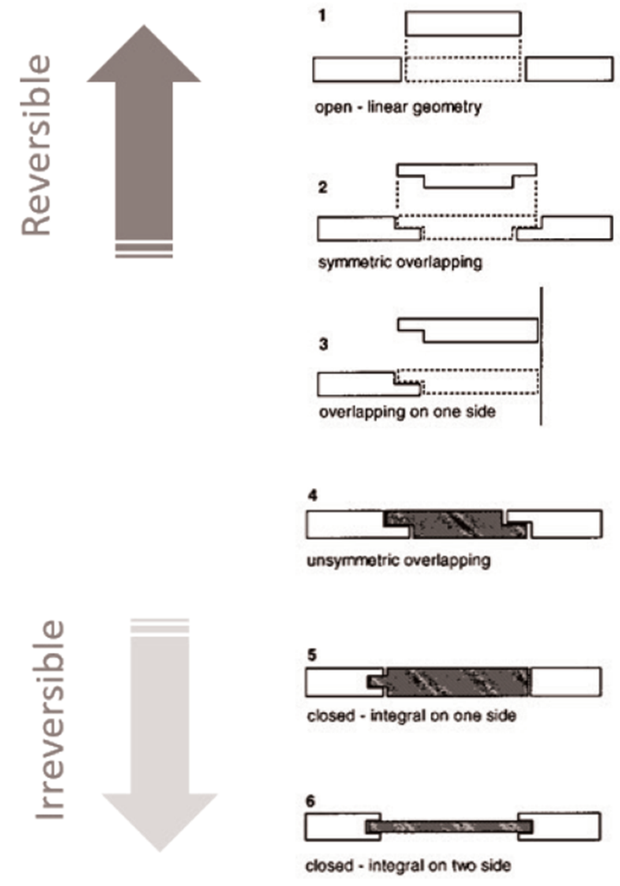
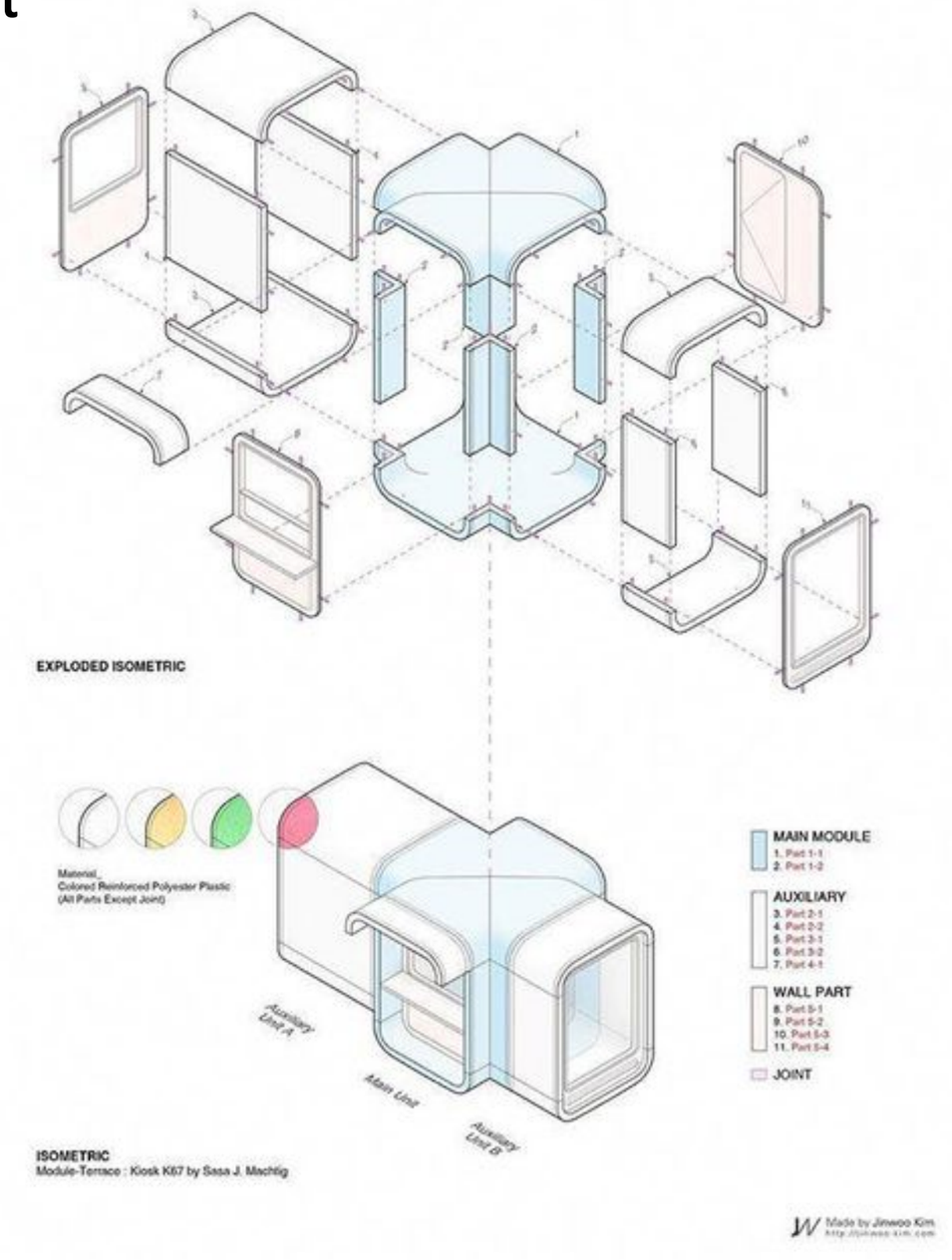


Figure 52 overview of principles geometries of product edge

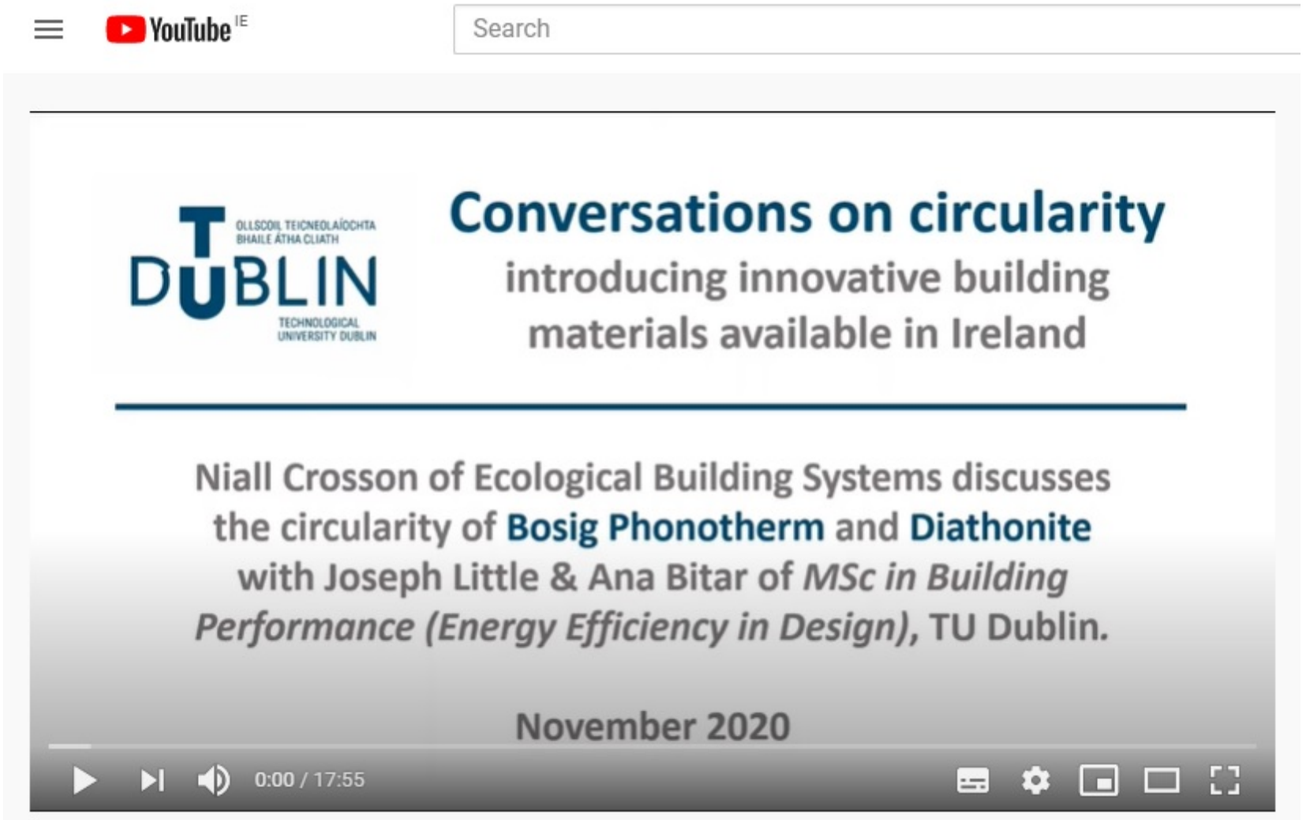
ENEN9205 - Circularity & Life Cycle Assessment in the Built Environment

Learning circular design skills

When Slovenian architect Saša Mächtig designed the K67 kiosk in 1966 he probably couldn't have imagined how ubiquitous it would become.



Manufacturers and importers interviewed



1. What is your product and in how many ways is it circular?
2. How did you manage to create a building product out of a waste material that can be certified as compliant under the Irish Building Control Regulations?
3. Do you reference a particular standard or quality assurance process to show it complies with a certain standard?
4. Was it difficult to achieve this? What were the obstructions?
5. Can your product compete with conventional products in terms of required performance and cost?
6. How are you convincing specifiers and client bodies to use your building product? Is their interest increasing?

Manufacturers and importers interviewed

Ecocel	Recycled newspaper as insulation (https://www.ecocel.ie/)
Ecological Building Systems	Bosig Phonotherm 200 insulation board is made entirely from upcycled polyurethane (https://www.ecologicalbuildingsystems.com/)
AM	Acoustic and structural boards made from Tetrapak waste (http://www.acousticmaterials.ie/)
Ovvo	Fixing system that facilitates demountability (https://ovvotech.com/)
Integrated Material Solutions	Creating certified aggregate from construction waste (https://www.imsirl.ie/)

1. What is your product and in how many ways is it circular?

2. How did you manage to create a building product out of a waste material that can be certified as compliant under the Irish Building Control Regulations?

3. Do you reference a particular standard or quality assurance process to show it complies with a certain standard?

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5. Can your product compete with conventional products in terms of required performance and cost?

6. How are you convincing specifiers and client bodies to use your building product? Is their interest increasing?

Aistriú

Transitioning towards a
Circular Economy for the
Built Environment

Thank you for listening

Joseph.little@tudublin.ie

CitA
Construction IT Alliance

CIOB
THE CHARTERED INSTITUTE OF BUILDING

GMIT
INSTITIÚID TEICNEOLAÍOCHTA NA GAILLIMHE-MAIGH EO
GALWAY-MAYO INSTITUTE OF TECHNOLOGY

IGBC
IRISH GREEN BUILDING COUNCIL

9th April 2021

Joseph Little
Patrick Daly

TU Dublin