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

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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

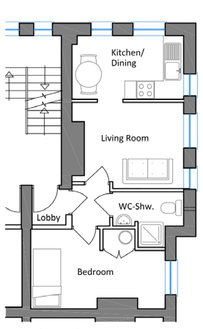
- The Iveagh Trust was a philanthropic trust set up by the Guinness Family 1890 to provide much need housing for the working-class people of Dublin, most of whom resided in city centre tenement slums.
- Construction on Blocks A-D was completed in 1901.
- **Blocks A-H** are on the Record of **Protected Structure RPS1011**, this concerns the façade of the building

Case Study Building – Baseline Specification

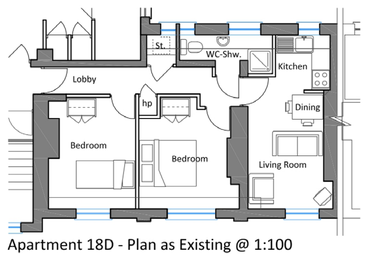
- The **External Wall** construction is generally **335 Solid Brickwork** with 15mm or so lime render internally. **U-Value 1.64W/M2k.**
- Internal **Walls to Unheated** Staircase **Brickwork** of varying thickness. **U-Value 1.13W/M2k.**
- The ground and intermediate floors were concrete.
- The **Roof is a mansard** roof with natural slates on what is assumed to be a traditional cut timber roof construction. U-Value The ceilings are assumed to be lath and lime plaster. **U-Value 1..94W/M2k.**
- The **windows** seem to be the original timber sliding sash with single glazing. **U-Value 1..94W/M2k.**
- Electric **Storage Heaters** and Immersion **Heating.**
- **Apartment 24D Second Floor - Apartment 18D Fourth Floor -Block D**

West Elevation (to Patrick Street) East Elevation

Block D- Partial Elevations as Existing



Apartment 24D - Plan as Existing @ 1:100



Apartment 18D - Plan as Existing @ 1:100

Floor Plans as Existing

BER G

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 the 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 **MHRV, 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 MHRV, 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

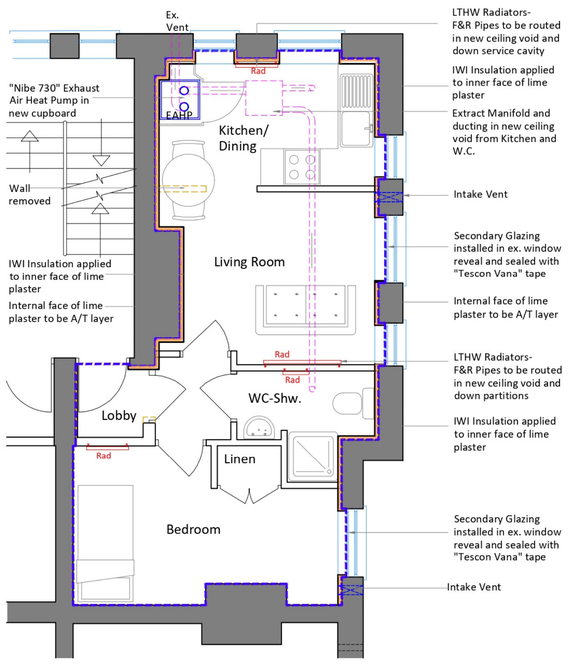
Strategy:-

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.

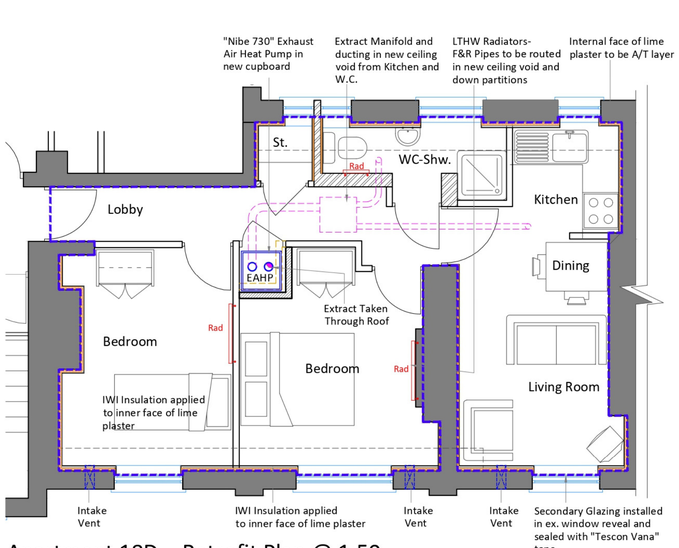
STAGE 2.1 DEAP Energy Analysis-Apartment 24D – 18D – Implementation of Retrofit Strategies for 7 Steps and NZEB IRL A2 Targets

7 Steps –Retrofit Strategy

Energy Analysis Upgrade Specification - 7 Steps		
Fabric	**Measure**	**U-value W/m2K**
External Walls	IWI – Calsitherm –with Adhesive and Kaelgatte Plaster	0.68
Walls to Unheated Space	IWI-PIR Insulation	0.25
Roof	Remove Lath and plaster, insulate above and between joists	0.14
Mansard Wall	Remove lath and Plaster, insulate inside and between timber studs/rafters.	0.25
Airtightness	AT Value Q50 0.6 or 0.03ach	
Thermal bridging	0.15W/MK	
Glazing	Retain Existing install secondary glazing.	1.13
Systems		
Space Heating	MHRV Nilan Compact P Warmair Heating	SFP 1.022; Eff- 72%
Ventilation	MHRV Nilan Compact P	
Water Heating	MHRV Nilan Compact P Warm air- 180L tank	Eff 94%
	Waste Water Recovery	Eff 0.61; UF 0.973
	Vented Pump- Flow Restrictor	



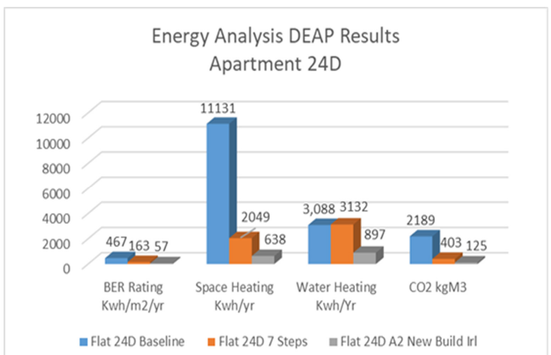
Apartment 24D - Retrofit Plan @ 1:50



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 Kaelgatte Plaster	0.68
Walls to Unheated Space	IWI-PIR Insulation	0.25
Roof	Remove Lath and plaster, insulate above and between joists	0.14
Mansard Wall	Remove lath and Plaster, insulate inside and between timber studs/rafters.	0.25
Airtightness	AT Value Q50 0.6 or 0.03ach	
Thermal bridging	0.15W/MK	
Glazing	Retain Existing install secondary glazing.	1.13
Systems		
Space Heating	Nibe 730 Exhaust Air Heat Pump - Radiators	Eff. 599%
Ventilation	Nibe 730 Whole house Extract 1 Passive Vent	
Water Heating	Nibe 730 Exhaust Air Heat Pump 180L tank	Eff. 233%
	Waste Water Recovery	Eff 0.61; UF 0.973
	Shower Unvented - Flow Restrictor	



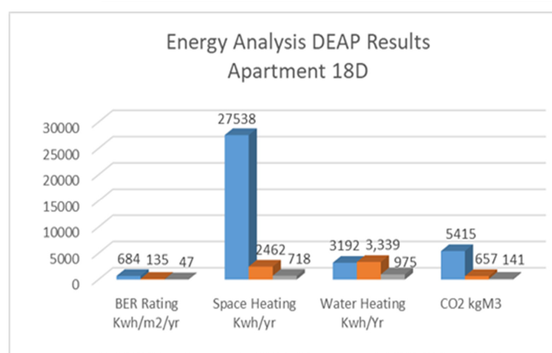
24D Results DEAP Energy Analysis

BER C1 → BER A3 → BER B3

7 Steps

NZEB IRL A2

BER A2



18D Results DEAP Analysis

7 Steps

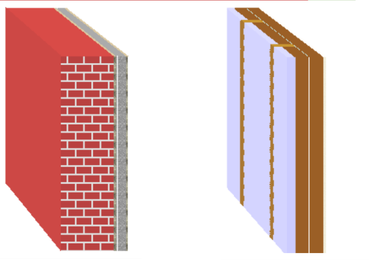
NZEB IRL A2

STAGE 2.2 Façade Study- Detailed Analysis of Natural and Synthetic Insulation Upgrades – Thermal Performance – Thermal Bridging – Hygrothermal – Environmental - Cost

Thermal Performance- Natural Insulation

Façade Study - Natural Insulation Option		
Element	**Measure – Natural Insulation**	**U-value W/m2K**
External Walls	IWI – 327.5mm Existing Solid Brick Wall with 15mm lime render internally, existing paint to be scored, 50mm "Calsitherm" calcium silicate board applied with Kleber KP adhesive to face of lime render and 15mm Kaelgatte Plaster.	0.68
Mansard Wall	Remove lath and Plaster from rafters, install 75mm "Gutex Thermoflex" wood fibre board between rafters with 50mm air gap maintained above. Install "Intello Plus" AVCL to underside of rafters with 80mm "Gutex Thermosafe WD" to the underside of rafters, finished with 12.5mm Plasterboard and skim	0.26
Airtightness	AT Value Q50 0.6 or 0.03ach	

BuildDesk U 3.4



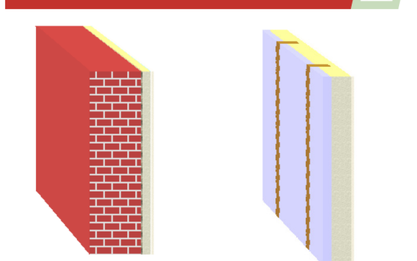
U = 0.68 W/(m²K)

U = 0.26 W/(m²K)

Thermal Performance- Synthetic Insulation

Façade Study - Synthetic Insulation Option		
Element	**Measure – Synthetic Insulation**	**U-value W/m2K**
External Walls	IWI – 327.5mm Existing Solid Brick Wall with 15mm lime render internally, existing paint to be scored, 50mm "Xtratherm Thin-R XT" PIR board mechanically fixed to wall, with AVCL and 12.5mm Plasterboard internally.	0.34
Mansard Wall	Remove lath and Plaster from rafters, install 75mm "Xtratherm XT" PIR board between rafters with 50mm air gap maintained above. Install "Intello Plus" AVCL to underside of rafters with 38mm "Xtratherm XT" to the underside of rafters, finished with 12.5mm Plasterboard and skim	0.22
Airtightness	AT Value Q50 0.6 or 0.03ach	

BuildDesk U 3.4

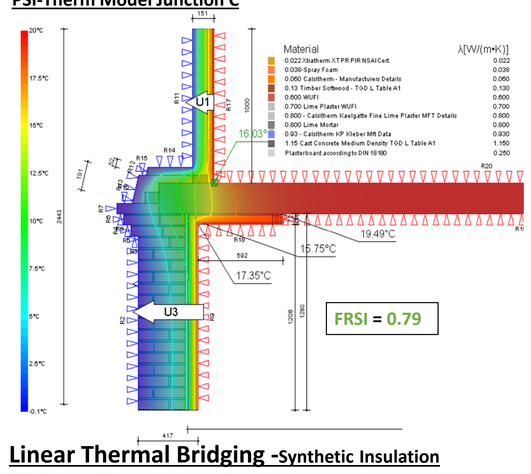


U = 0.34 W/(m²K)

U = 0.22 W/(m²K)

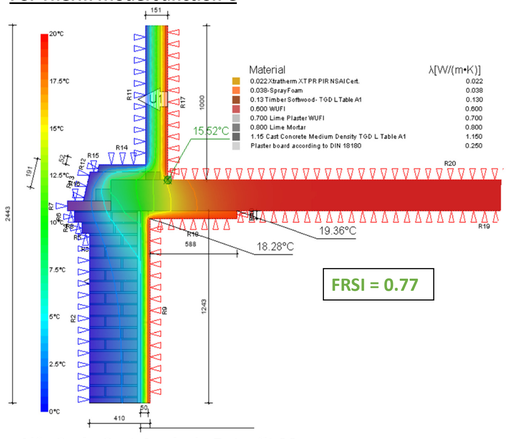
Linear Thermal Bridging -Natural Insulation

PSI-Therm Model Junction C



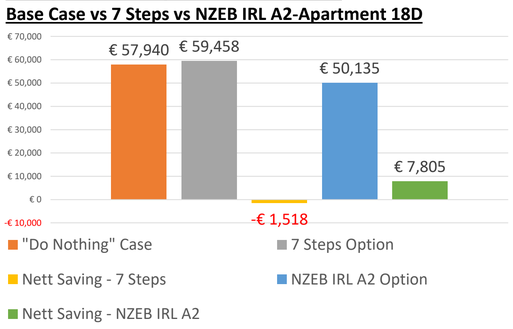
Linear Thermal Bridging -Synthetic Insulation

PSI-Therm Model Junction C



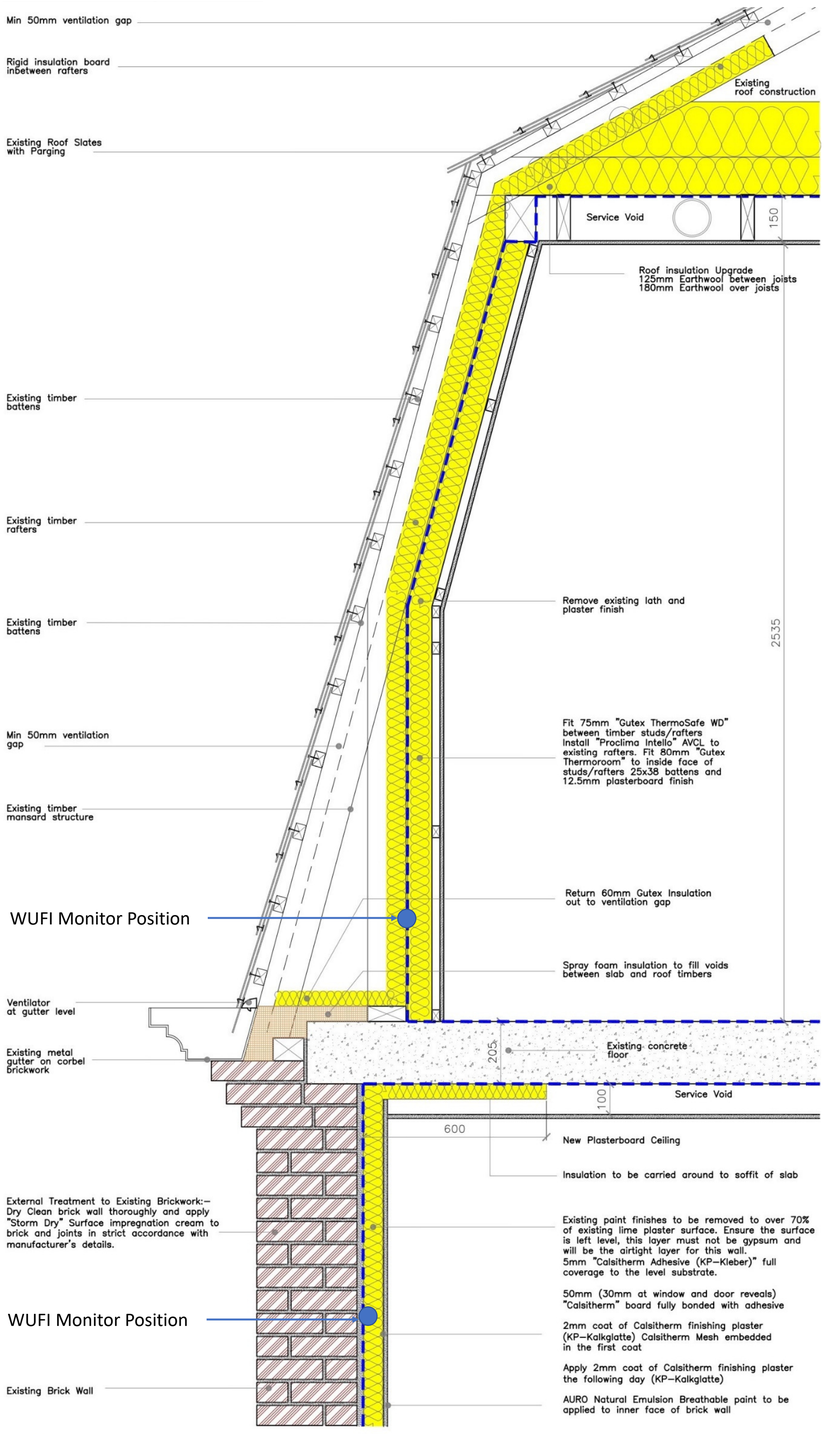
Life Cycle Cost Analysis-Retrofit Measures

Base Case vs 7 Steps vs NZEB IRL A2-Apartment 18D



Environmental Assessment Comparison of C02 from Insulation Upgrade vs Reduction in C02 Apartment 18D 7 Steps					
	Wall Area m2	**Upgrade C02 KgCO2 E /m2**	**Wall Upgade *C02 KgCO2 E/m2**	**Reduction Space Heating C02 KgC02 E/m2**	**Years for equalise CO2**
Xtratherm	33.46	19.478	651.734	461.015	1.4
Gutex	33.46	-7.031	-235.257	461.015	0
Calsitherm	33.46	157.452	5,268.34	461.015	11.43

Detail Drawing –Junction C



Junction C – Natural Insulation @ 1:10

North Mansard Roof

Assessed

Hygrothermal WUFI- Assessment Brick Wall- Dealing With Uncertainty- 2 Brick Types Assessed

North Mansard Wall Upgrades

Base Case Mansard Wall as Existing

Case-1-Gutex in-between Rafters-AVCL-Gutex Lime Plaster-Rain Ingress.

Case-2-PIR in-between Rafters-AVCL-PIR Plasterboard-Rain Ingress.

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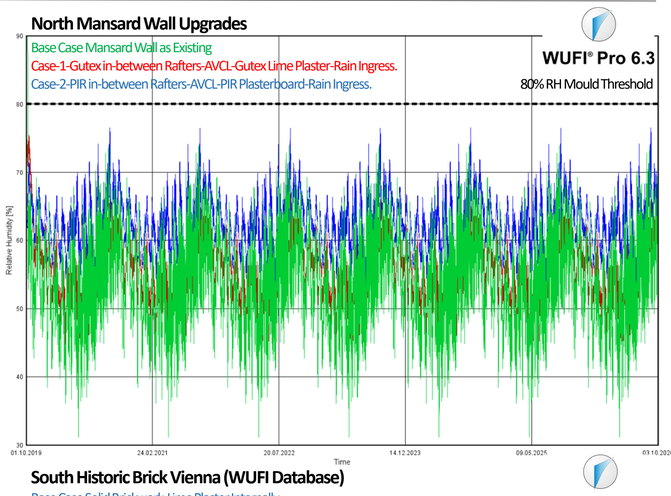
80% RH Mould Threshold



South Historic Brick Vienna (WUFI Database)

Base Case Solid Brickwork-Lime Plaster Internally

Case-1-Solid Brick-Adhesive-Calsitherm Insulation- Lime Plaster.

Case-2-Storm Dry Solid Brick-Adhesive-Calsitherm Insulation- Lime Plaster, stressed with 1% Driving Rain. .

Case-4-Stormdry-Solid Brick-Lime Plaster-PIR-Intello-Plasterboard, stressed with 1% Driving rain.

WUFI® Pro 6.3

South Historic Brick (WUFI Database)

Base Case Solid Brickwork-Lime Plaster Internally.

Case-1-Solid Brick-Adhesive-Calsitherm Insulation-Lime Plaster.

Case-2-Storm Dry Solid Brick-Adhesive-Calsitherm Insulation; Lime Plaster, stressed with 1% Driving Rain.

Case-3-Solid Brick-PIR-Intello-Plasterboard.

Case-4-Stormdry-Solid Brick-Lime Plaster-PIR-AVCL-Plasterboard, stressed with 1% Driving rain.

WUFI® Pro 6.3