SAVING ENERGY IN TRADITIONAL NORTH EAST HOMES

Barbara Lantschner
John Gilbert Architects

A Deep Retrofit Case Study: Canongate Block 2
30th November 2021

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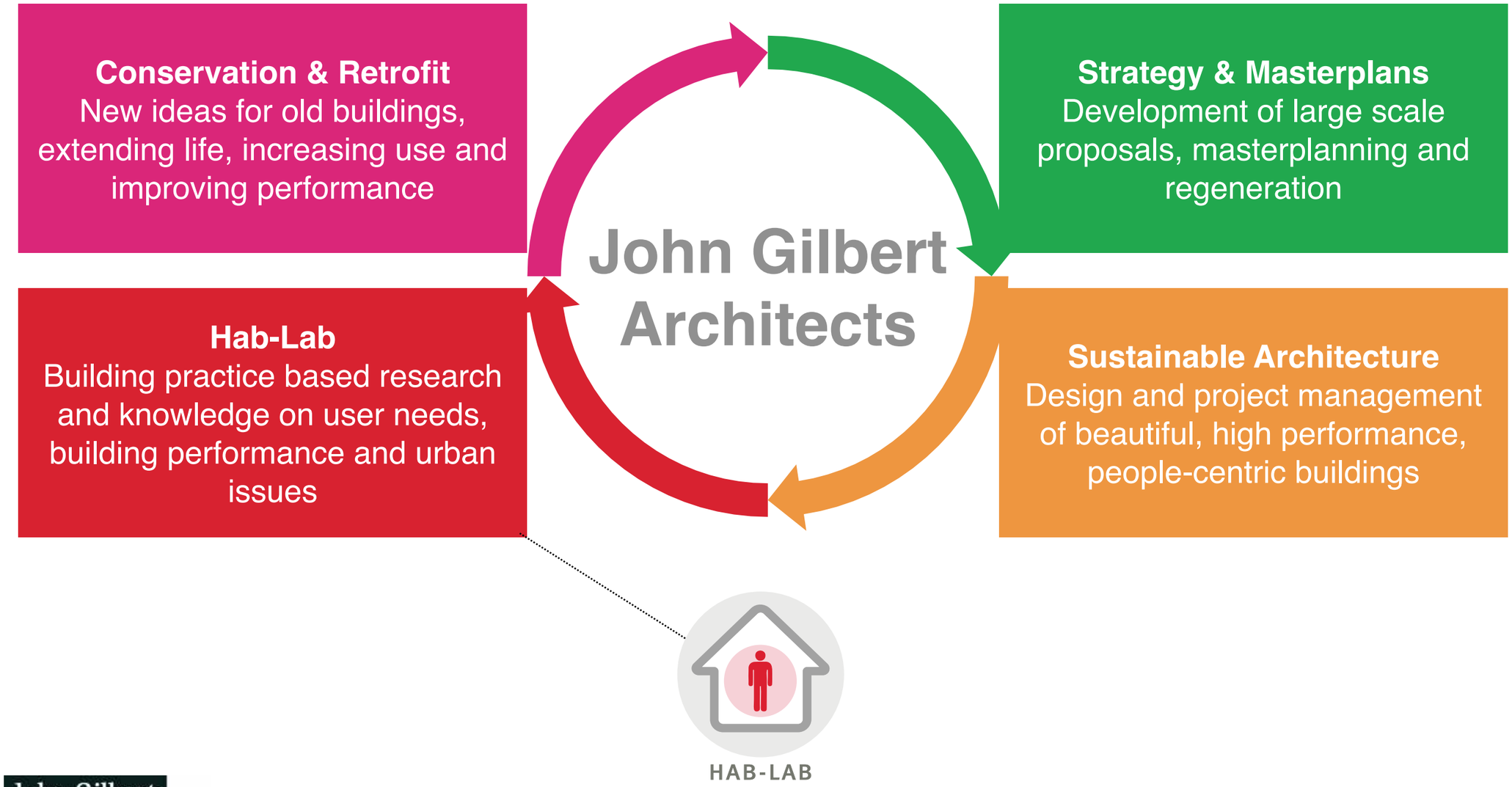
1. JGA & Hab-Lab



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1. JGA & Hab-Lab

Real world information & making POE accessible

Energy monitoring

Indoor environmental quality

Building fabric measurements

People

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HAB-LAB BPE/ on-site monitoring and measurement

2. Case Study: Canongate Block 2

Canongate

- Built 1969
- Designed by Sir Basil Spence
- B-listed
- Significant for its location, architect, aesthetic and materiality
- Problems noted by all residents including energy use, mould and dampness problems
- Key questions we were asked to answer:
  - What is causing the current problems with the building fabric?
  - How can we improve the building fabric without negatively impacting on the significance of the building?

Canmore Archive Picture, front elevation

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2. Case Study: Canongate Block 2

Canongate

- Appointed by the owner's group, the Canongate Development Owners Committee, supported by Edinburgh World Heritage who provided dedicated staff, advice and funding support to the project
- Also being supported by funding from Scottish Government, Scottish Power and Edinburgh City Council.
- Working on block 2: 12 flats and 2 businesses
- 32 persons involved including tenants and owners (incl. 2 vulnerable persons)
- 23 meetings prior to site start
    - 1 initial general meeting
    - 4 pre-design phase
    - 12 during design phase
    - 5 during tender process / financial closing

JGA+EWH+Client's meeting

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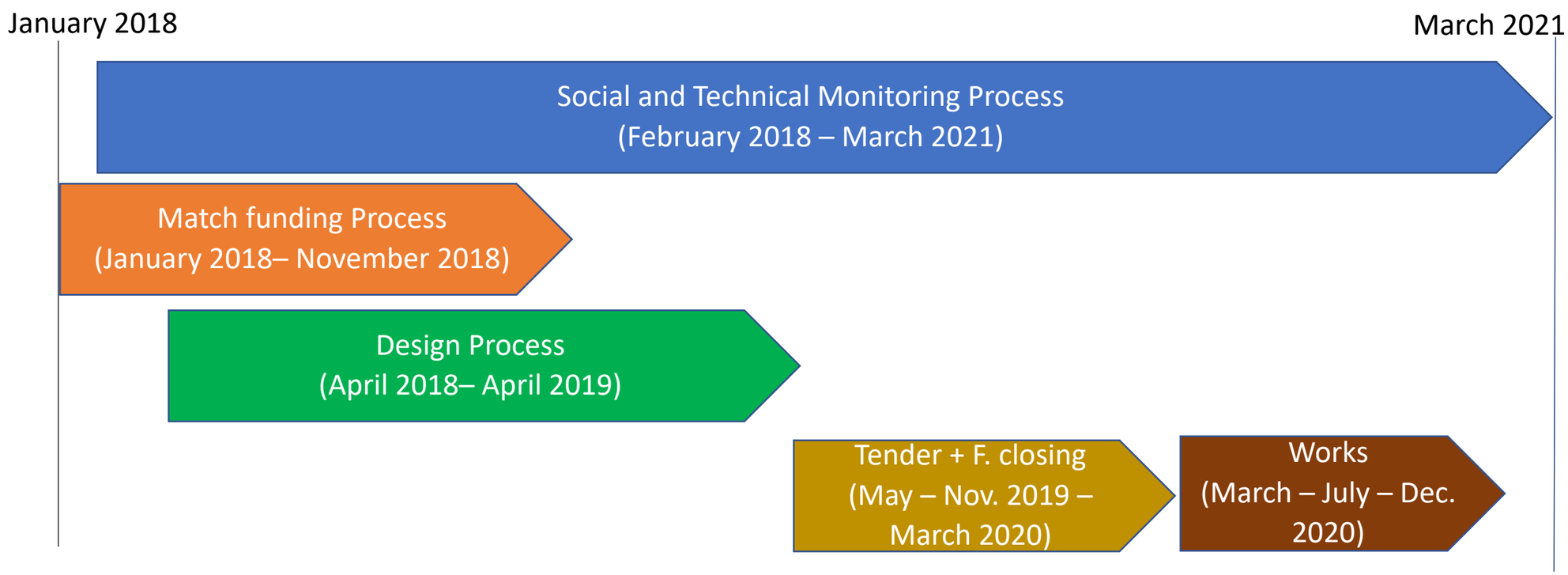
2. Case Study: Canongate Block 2

Canongate



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2. Case Study: Canongate Block 2

Canmore Archive Picture, Canongate 1960's

Canmore Archive Picture, Brown's Close, 1960's

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2. Case Study: Canongate Block 2

Stage 1: Retrofit Assessment

- Assessment methodologies adopted include:
  - Archive analysis and previous research
  - Thermography
  - Air-tightness testing
  - IAQ and energy monitoring
  - Live U-value analysis
  - Dynamic thermal modelling
  - Ventilation modelling
  - Wufi calculations
  - Materials analysis
  - Acoustic surveys

In-situ tests conducted by JGA/ Thermal Image UK

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2. Case Study: Canongate Block 2

Stage 1: Retrofit Assessment

Design Team Inspections:




JGA site photos

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2. Case Study: Canongate Block 2

Stage 1: Retrofit Assessment

Materials Analysis:

- Mortar analysis
- Petrographic analysis
- Concrete analysis
- Render analysis

MORTAR EXAMINATION AND ANALYSIS SAMPLE 8

Plate 1. Image showing the condition of the sample, as received.

Plate 2. Image showing a close-up of the surface. The concrete is dense and the coarse aggregate a mixture of crushed gravel and rounded grains.

PROCEDURE	OBSERVATIONS
PRELIMINARY VISUAL ANALYSIS OF SAMPLE	This sample is from a hard well compacted concrete. The sample is uncarbonated, but as there was no outer surface the impact of invasive carbonation cannot be determined.
EXAMINATION OF PREPARED SAMPLE BY BINOCULAR MICROSCOPE (X40 MAGNIFICATION)	Once dried the mortar was found to be 10YR 7/1 'light grey' when assessed against the Munsell Soil Colour Charts. The concrete is dense and the coarse aggregate a mixture of crushed gravel and rounded grains of various sizes.

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2. Case Study: Canongate Block 2

Stage 1: Retrofit Assessment

Paint Analysis:

- Book published by Fiona McLachlan alongside archive images from Canmore

Archives and Previous Research:

- Conservation Statement by Simpson and Brown

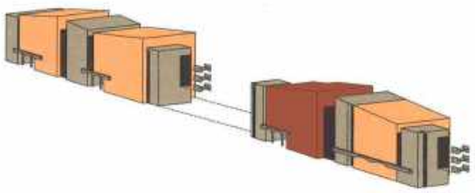

Figure 61 Elevations of block 2 showing levels of significance. *S&B*

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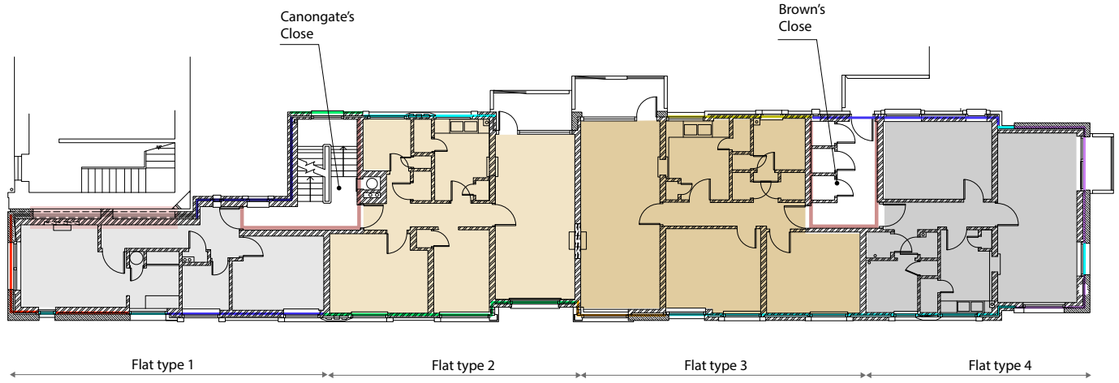
2. Case Study: Canongate Block 2

Stage 1: Retrofit Assessment

Boroscope Surveys and Wall Tie Scanning:

- Understanding of existing cavity sizes
- And distribution of wall ties

Borescope survey, conducted by Stanger



Typical floor-plan

Wall Types	Existing Wall U-values (un-insulated)	Proposed Wall U-values (+50mm CWI)
Wall type 1: 230mm sandstone + 90-120mm cavity + 216mm brickwork + 15mm hard plaster	1.31 W/m2K	0.48 W/m2K
Wall type 2: 25mm roughcast + 100mm brickwork + 60-80mm cavity + 230mm brickwork + 15mm hard plaster	1.41 W/m2K	0.51 W/m2K
Wall type 3: 25mm roughcast + 100mm brickwork + 60-80mm cavity + 127mm brickwork + 15mm hard plaster	1.91W/m2K	0.53 W/m2K
Wall type 4: 230mm sandstone + 90-120mm cavity + 127mm brickwork + 15mm hard plaster	1.91W/m2K	0.54 W/m2K
Wall type 5: 25mm rough-cast + 127mm brickwork + 60-80mm cavity + 76mm brickwork + 15mm hard plaster	2.31W/m2K	0.55 W/m2K
Wall type 6: 230mm sandstone + 90-120mm cavity + 230mm brickwork + 15mm hard plaster	1.41W/m2K	0.47 W/m2K
Wall type 7: 230mm sandstone + 90-120mm cavity + 100mm brickwork + 15mm hard plaster	2.1W/m2K	0.56 W/m2K
Wall type 8: 25mm roughcast + 230mm brickwork + 60-80mm cavity + 216 brickwork + 15mm hard plaster	1.46W/m2K	0.53 W/m2K
Close wall: solid brick wall		

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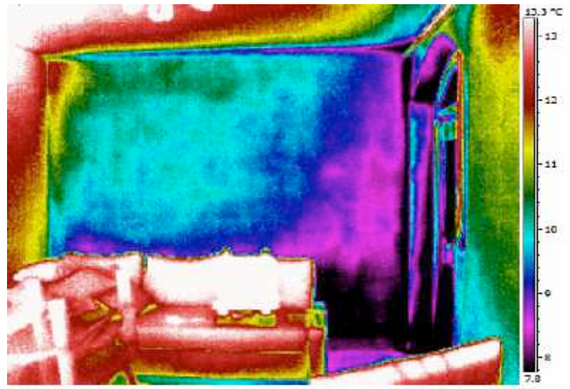
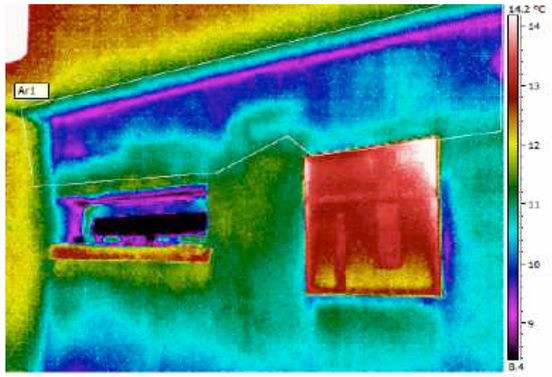
2. Case Study: Canongate Block 2

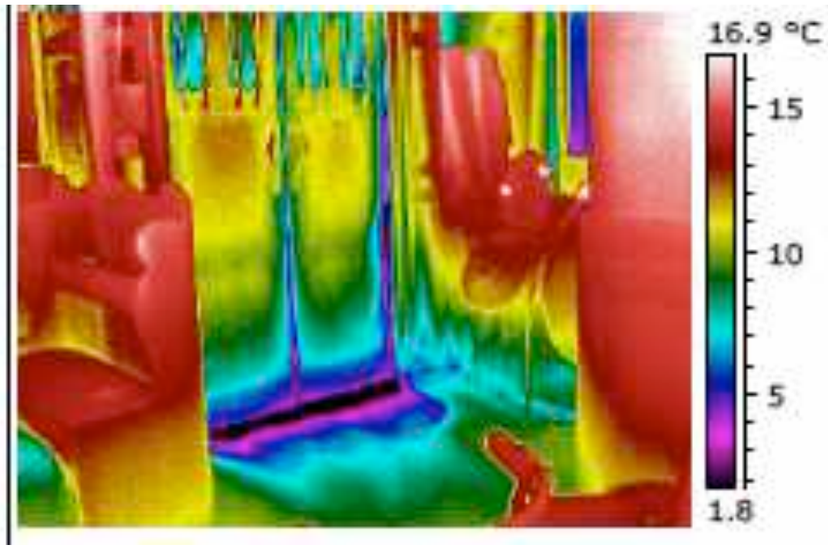
Stage 1: Retrofit Assessment

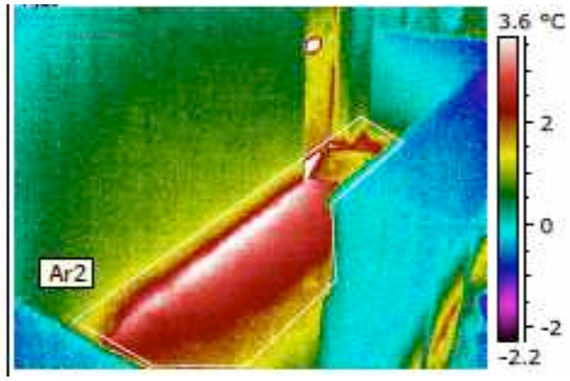
Thermography (conducted by IRT):

- poorly insulated, but its generally consistent and predictable
- primary issue is the structure of the building and the expressed concrete detailing
- some air leakage, typically at flue penetrations etc









External thermographic survey, conducted by IRT

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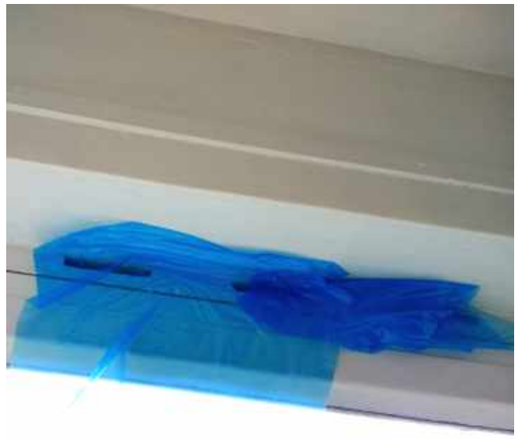
Stage 1: Retrofit Assessment

Airtightness Testing

- 71/6 Canongate – q50 = 5.12 m3/h/m2
- 2/3 Brown's Close – q50 = 3.02 m3/h/m2
- 2/2 Brown's Close – q50 = 5.36 m3/h/m2

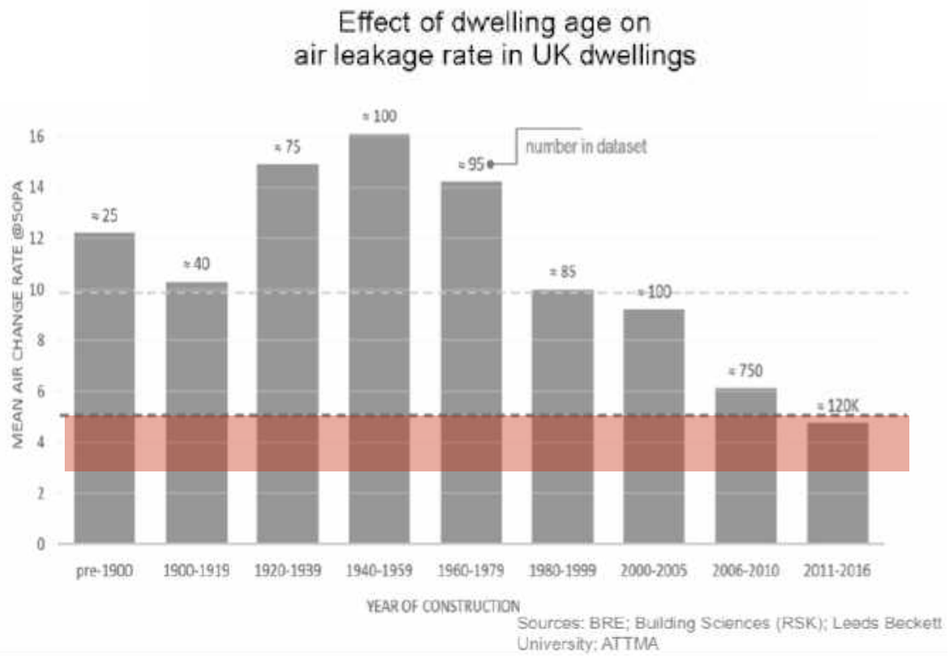
Smoke test in the cavity space

- Overall, this test helped us to identify whether there was any evidence of convection 'chimney effect.'
- During the test, strong air flows were visualised and recorded with smoke within the cavity, certainly at the locations where there were penetrations accessible externally that we could test.
- The existence of air flows within the cavity, limits the performance of internal or external wall insulation



Trickle ventilators located in the window frames were temporary taped closed for the testing

Gas fire place was temporary taped closed for the testing



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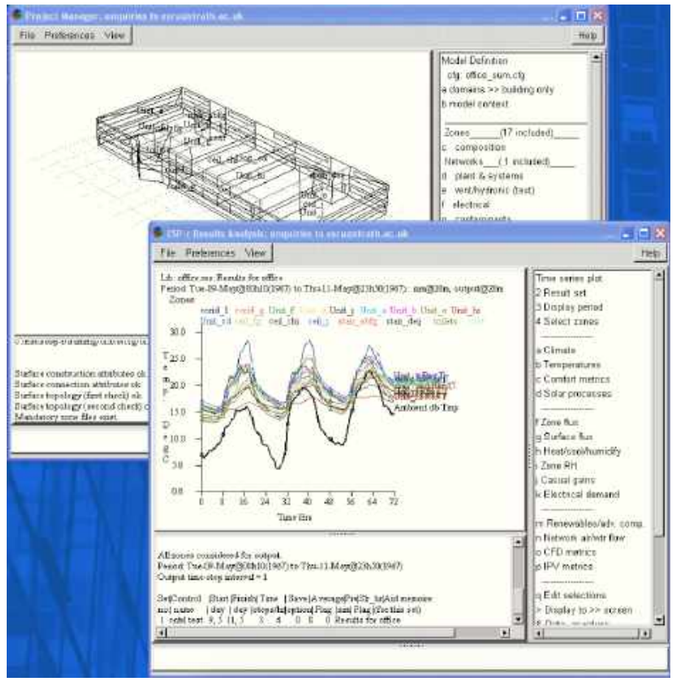
2. Case Study: Canongate Block 2

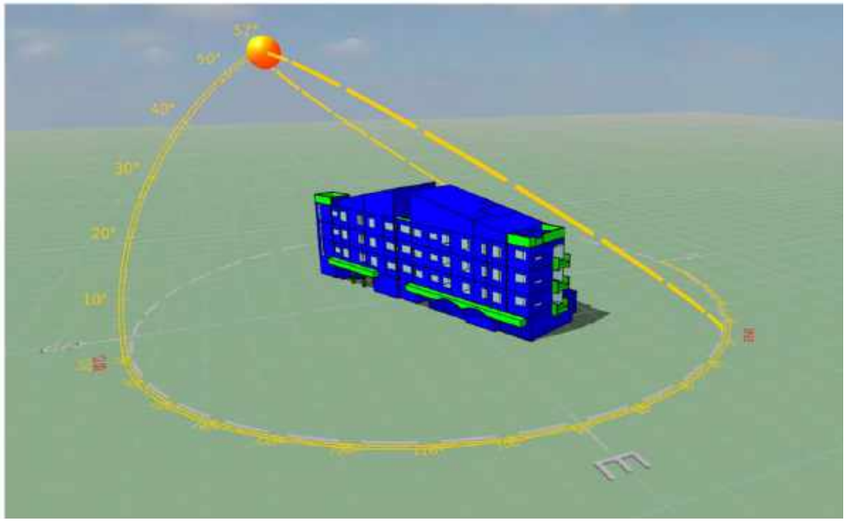
Stage 1: Retrofit Assessment

Indoor Air Quality Monitoring:

- **ESP-r modelling:**
- To test ventilation methods and condensation risk on internal surfaces
- **Dynamic thermal modelling:**
- To test heat load, methods of heating, viability of renewables and more
- The accurate simulation models was also be compared to the Standard Assessment Procedure (SAP) results and the real world data, to assess on performance gap issues and achieve the full potential of the potential retrofit measures



Ventilation modelling, conducted by Strathclyde University



IES Dynamic energy modelling, conducted by Atelier 10

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2. Case Study: Canongate Block 2

Stage 1: Retrofit Assessment

Wufi Calculations:

- Analysis of different insulation types and their impact on the performance of the wall

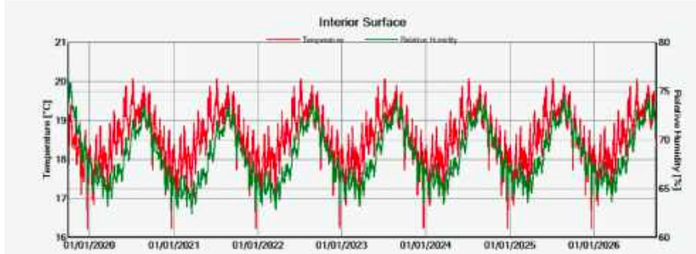


Figure 30: T&RH, Internal Surface, Existing Sandstone wall

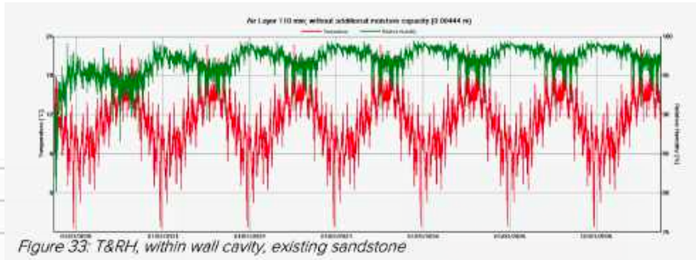


Figure 33: T&RH, within wall cavity, existing sandstone

Wufi simulations findings

A. Render on brick + brick cavity wall		Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
		As existing	EPS CWI only	Woodfibre IWI only	EPS CWI + Woodfibre IWI	Geocell CWI + Woodfibre IWI
Assessment 1	Internal surface condensation and consequent mould formation (within 80%)	No risk	No risk	Risk (not significant, between IWI layer and masonry)	No risk	No risk
Assessment 2	Deterioration of insulation material	N/A	No risk	Risk	No risk	No risk
Assessment 3	Spalling damage	No risk	Risk (not significant)	Risk (not significant)	Risk	No risk

B. Sanstone + brick cavity wall		Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
		As existing	EPS CWI only	Woodfibre IWI only	EPS CWI + Woodfibre IWI	Geocell CWI + Woodfibre IWI
Assessment 1	Internal surface condensation and consequent mould formation (within 80%)	No risk	No risk	No risk	No risk	No risk
Assessment 2	Deterioration of insulation material	N/A	No risk	Risk	No risk	No risk
Assessment 3	Spalling damage	No risk	No risk	No risk	No risk	No risk

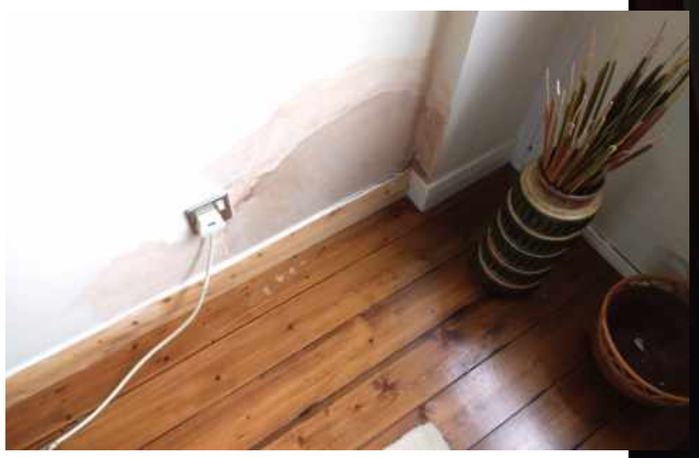
Wufi modelling results, conducted by Greengauge

2. Case Study: Canongate Block 2

Stage 2: Retrofit Strategy

Retrofit Targets:

- All properties improved from an EPC D/E to an EPC B
- Reduction in energy bills
- Improvements in occupant health
- Eradication of mould and damp
- Key areas of building fabric repaired
- Original architectural intent of the building more clearly legible



Dampness/ water ingress

Poorly maintained timber frame windows

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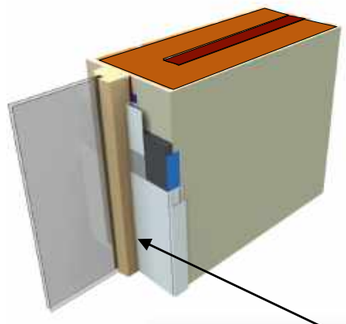
Stage 2: Retrofit Strategy

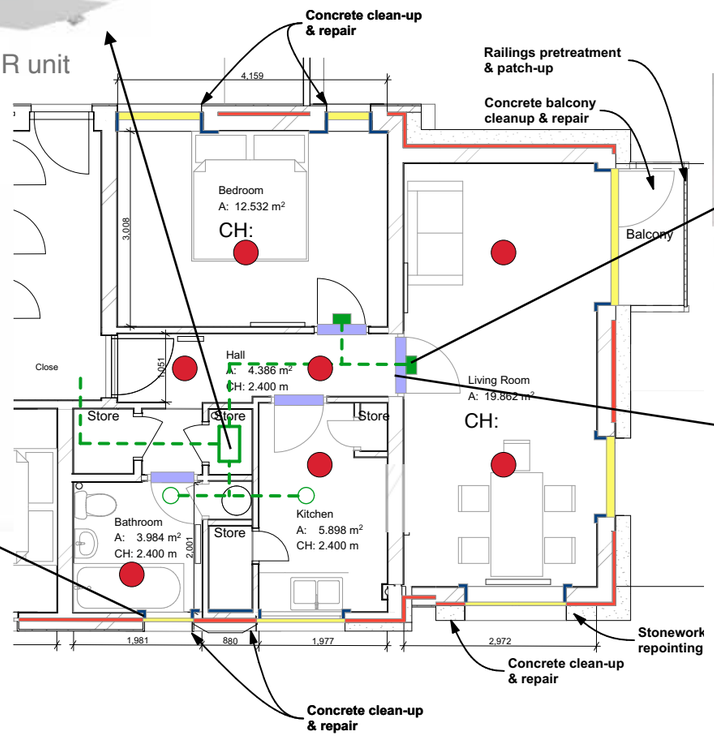
Key Strategies (in order of priority)

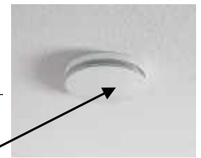
- Deal with structural issues
- Remediate external finishes and prevent staining
- Repair and repaint render
- Insulate walls without introducing unintended consequences
- Replace windows and improve air-tightness
- Ventilate right!

MVHR unit

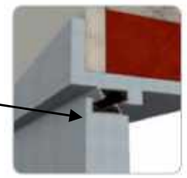


Internal wall insulation only around openings and weak points





MVHR air diffusers (ceiling or wall)



Door air transfer

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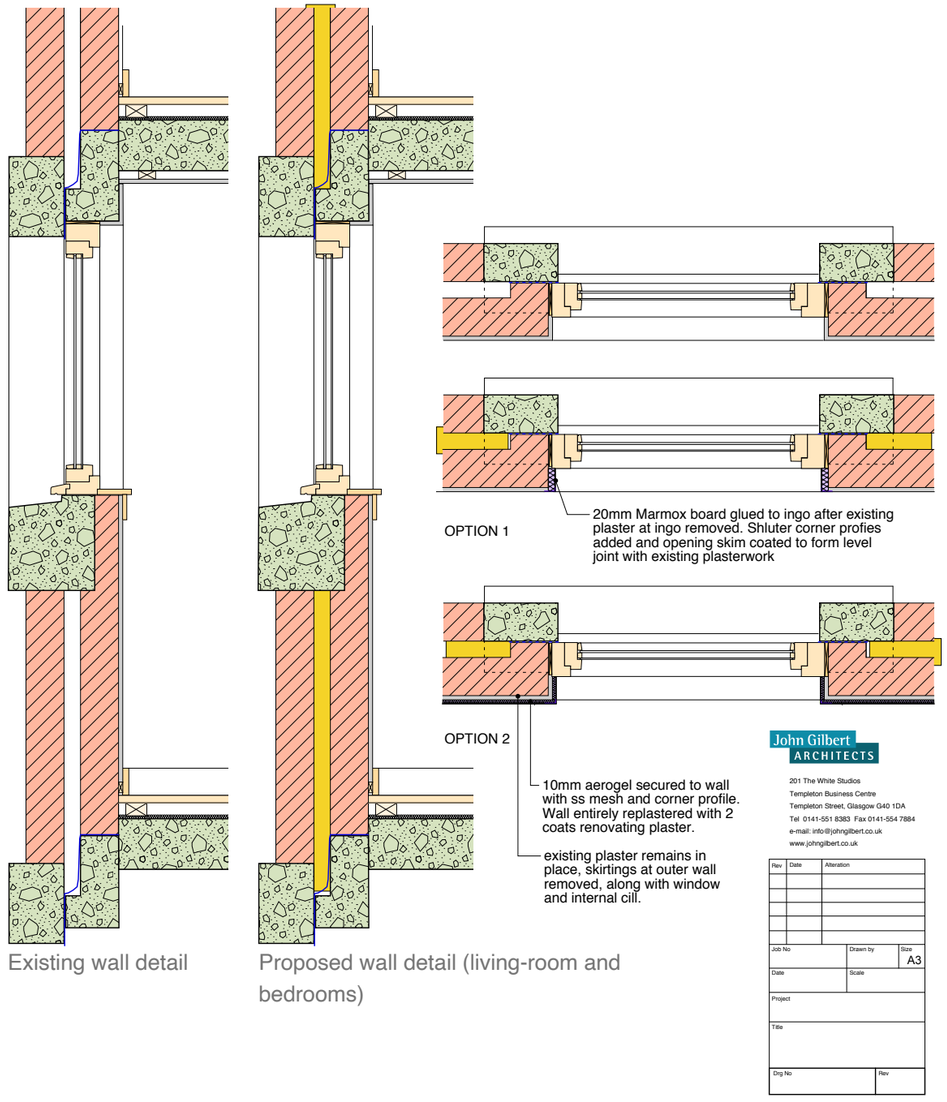
Stage 2: Retrofit Strategy

Evidence-based design example/ Wufi calcs:

- CWI alone does not present significant risks associated with moisture accumulation.
- The IWI strategy simulated present some risk of moisture accumulation at the interface between the wood fibre and the existing masonry which may lead to some mould growth
- Where CWI is combined with IWI, the issues associated with the outer surface of the IWI are not present, because the CWI keeps everything in board of it warmer and therefore drier.
- Warmer indoor environmental conditions improved comfort but warm air can exacerbate mould and condensation issues at thermal bridges that have not been properly dealt with.



Existing wall detail

Proposed wall detail (living-room and bedrooms)

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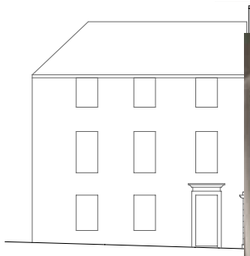
Stage 3: Installation

Window replacement:

Canongate Elevation 1:100



Reid's Court

North Elevation 1:100

Brown's Close 1:100

JGA site photos

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Stage 3: Installation

Concrete repair:

JGA site photos

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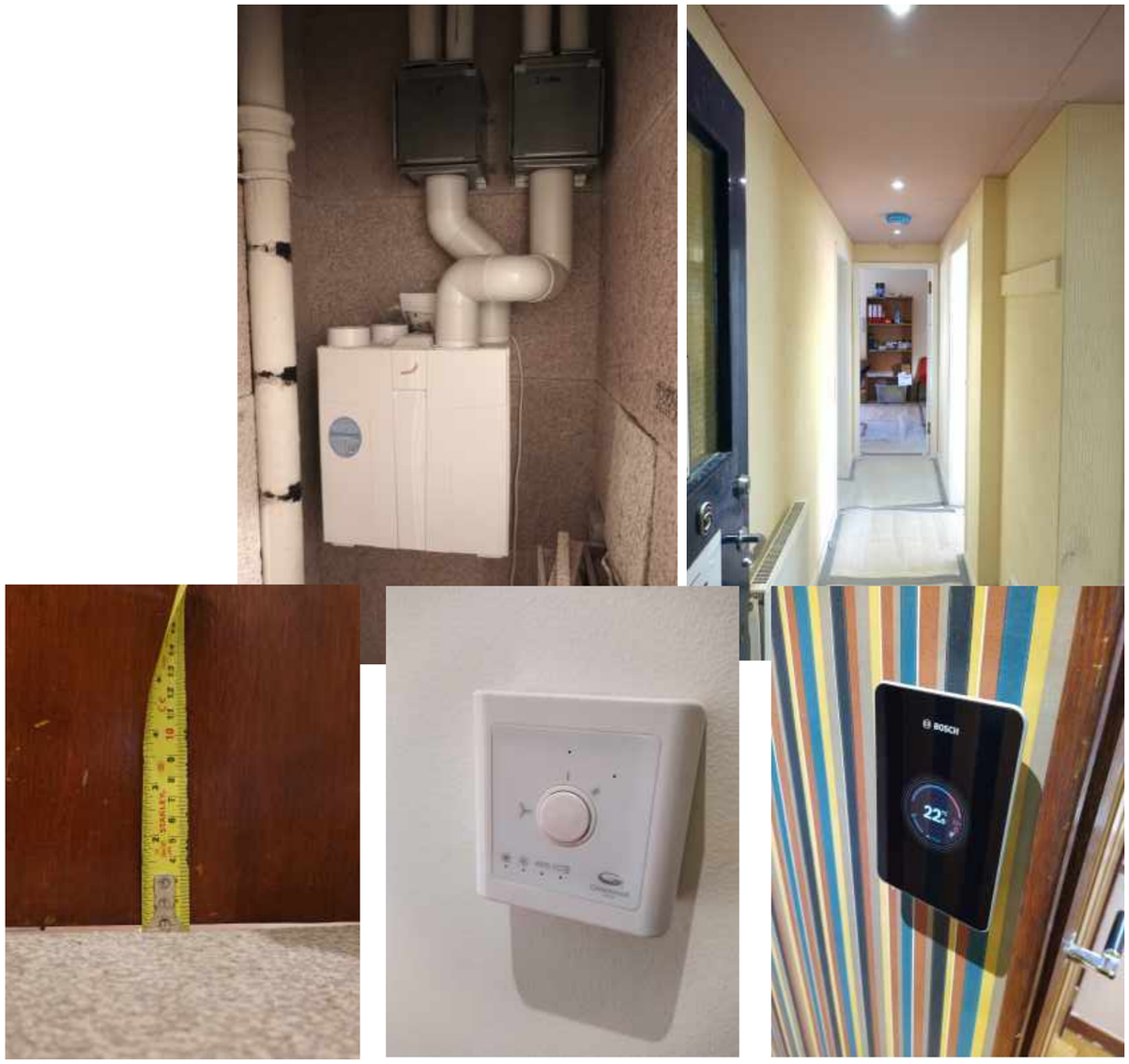
Stage 3: Installation

MVHR system:

- POE conducted by JGA and EWH: from December 2020 to May 2021
- Completion: January 2021
- Handover process: JGA & EWH, including Workshops with residents held on Zoom



JGA site photos

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2. Case Study: Canongate Block 2

Tom Manley, Canongate Block 1

Tom Manley, Canongate Block 2 (post-retrofit works)

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2. Case Study: Canongate Block 2

Tom Manley, Canongate Block 2 (post-retrofit works)

Tom Manley, Canongate Block 2 (post-retrofit works)

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3. Conclusions

Conclusions

- Importance of implementing a WHR strategy (Enerphit, PAS 2035, etc) to ensure a holistic approach

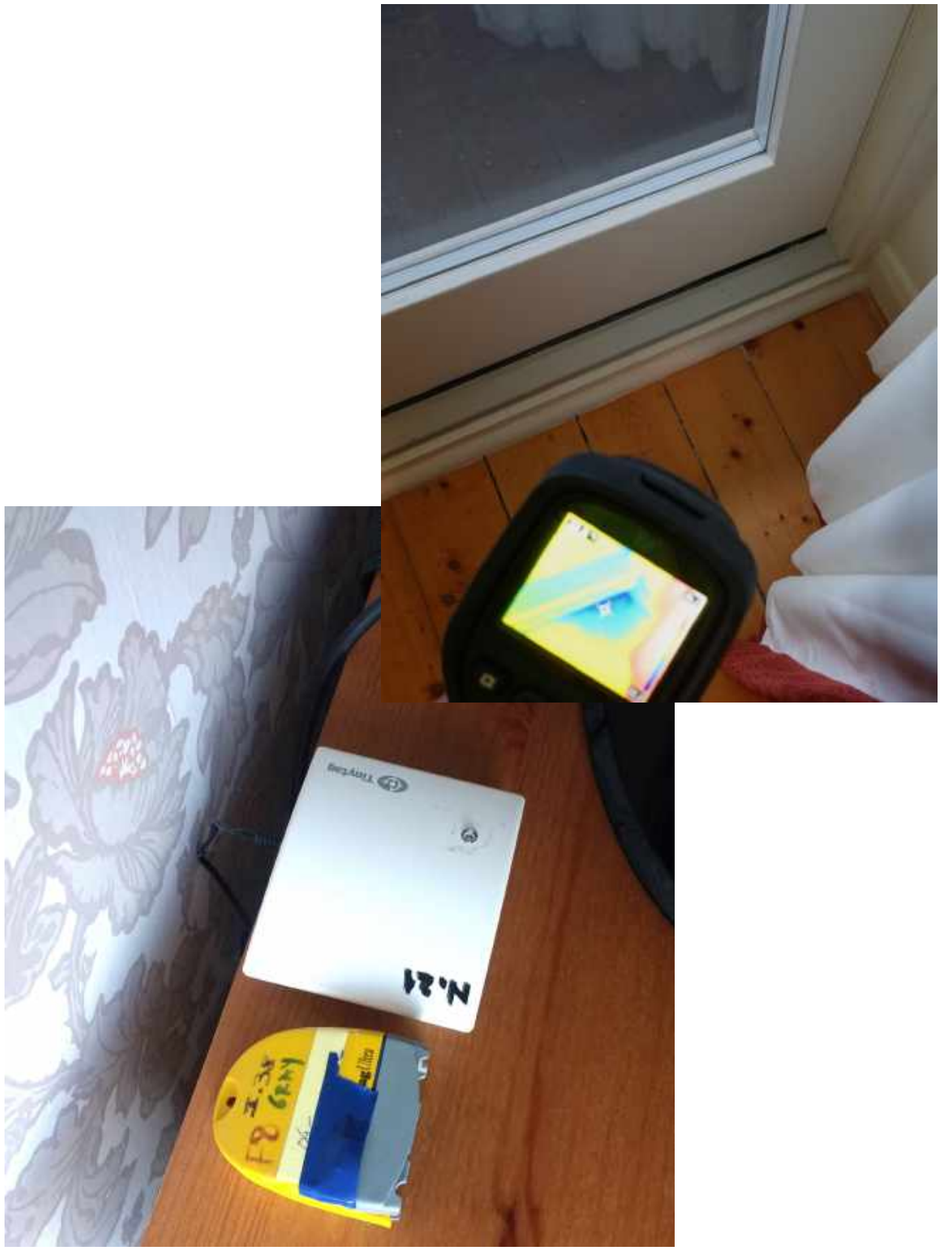
- Overlaying the BS7913 approach with this retrofit methodology allowed us to balance our decisions against our understanding of the significance of the building throughout

- Applying an evidence-based design methodology allowed us to

  - understand the building and the way it performs,

  - test methods for repair and retrofit,

  - and to reach consensus amongst a client group that included 14 owners by showing a clear logic for the decisions we were making.



IEQ monitoring (SEEP funding req)

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Thank you

barbara.lantschner@johngilbert.co.uk

@hab_lab / @johngilbertarch

www.johngilbert.co.uk

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