Low Energy Retrofit of Historic Timber Framed Buildings in the UK

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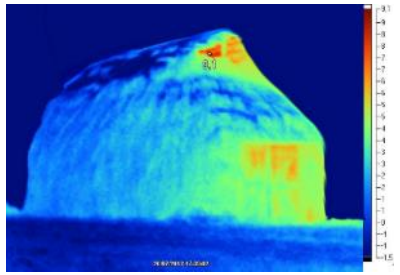
Christopher J. Whitman

1993-1999	B.Arch(Hons), Dip.Arch -Edinburgh College of Art
1999-2000	Architectural Assistant Part II, SEH, London
2000-2007	Architect, Director, Edward Cullinan Architects
2006-2007	Studio Tutor, 3rd Year, Nottingham University
2007-2014	Academic/Researcher Universidad Central de Chile, Universidad Andrés Bello & U. Católica de Temuco
2014-today	Deputy Course Leader MSc Sustainable Building Conservation, Welsh School of Architecture, PhD Staff Candidate

Previous Research

- Sustainable and energy efficient construction system for special interest tourism in the region of Araucanía Andina, Chile. (FONDEF)
- Environmental Comfort in the living heritage of the Araucanía, Chile. (FONDART)
- Hygrothermal properties of Traditional Chilean Adobe Construction. (UCEN)
- Environmentally Efficient Housing in Central-Southern Chile. (UCEN)
- Straw Bale Construction for Rural Central Chile. (UNAB)



Current Research

- Low Energy Retrofit of Historic Timber-Frame Buildings in the UK.

- Correlating maintenance, energy efficiency and fuel poverty for traditional buildings in the UK

Low Energy Retrofit of Historic Timber-Frame Buildings in the UK

- Quantify and locate surviving UK timber-framed buildings
- Identify possible retrofitting solutions
- Simulate interstitial hygrothermal conditions within walls
- Construct and monitor physical test panels
- In-situ measurement and monitoring
- Energy simulation of retrofit solutions

History, and Development

Sweet Track 3806 BC -Somerset Levels.
Source: Coles 2006

St Andrew's Church, Greensted, Essex. 9th Century AD
Source: Turner

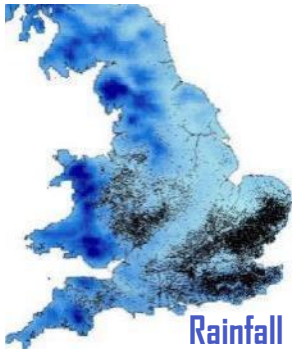
Close studding and Square framing
Sources: DBRG 2008, CAS 2010

Infill materials

Survival and Distribution

- Brick
- Plaster Infill
- Plastered
- Earthen
- Timber
- Tiled
- Mathematical tiles
- Slate
- Stone
- Flint
- C20th

Bedrock



Rainfall

UK Timber-Frame Distribution

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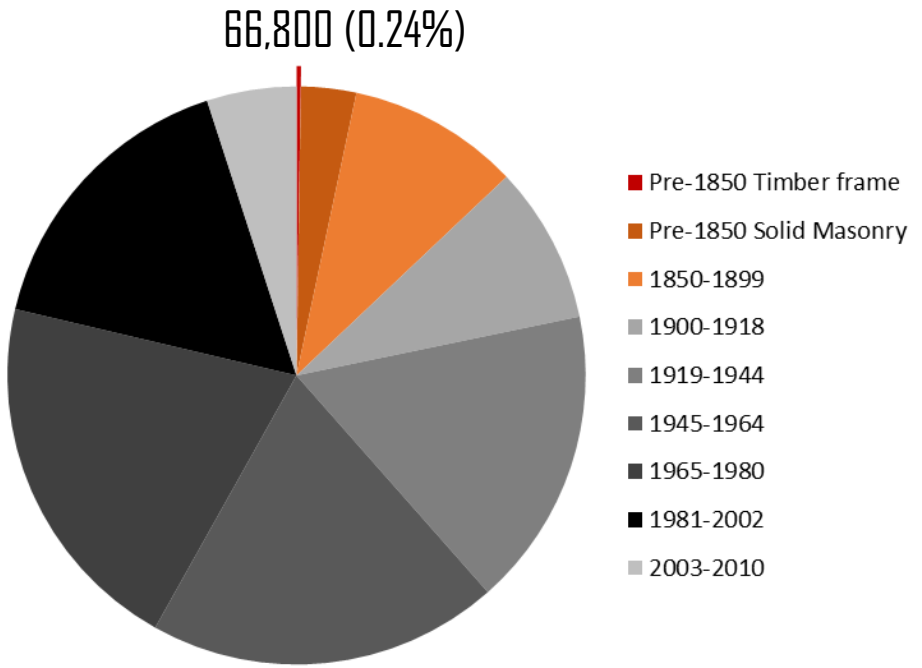

UK Domestic Building Stock

Source: Based on (Nicol et al. 2014)

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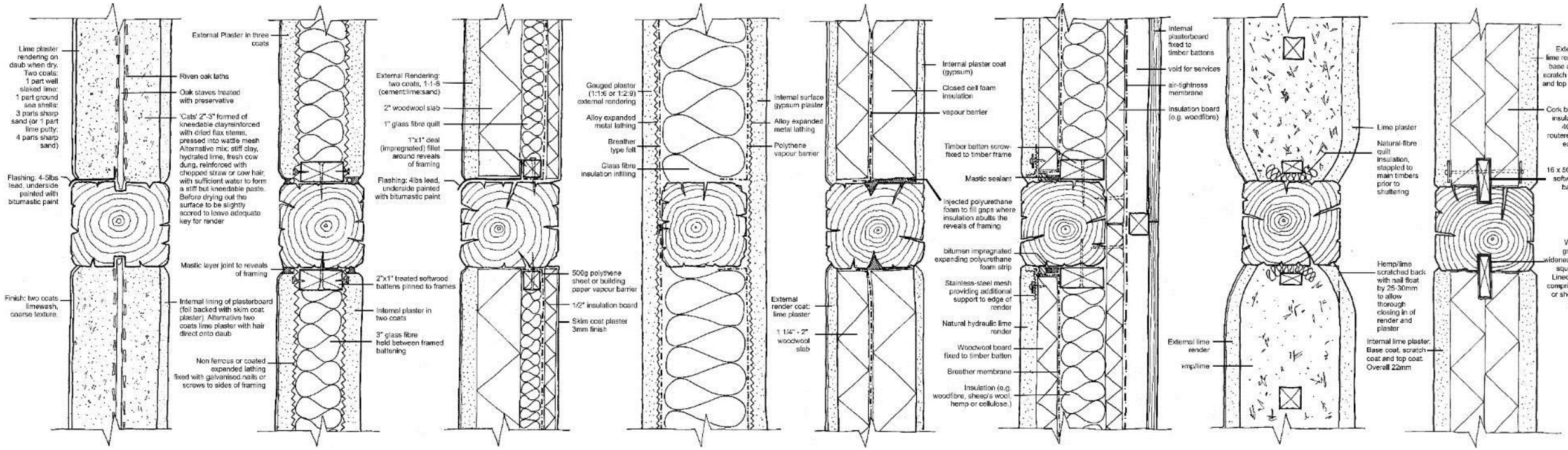
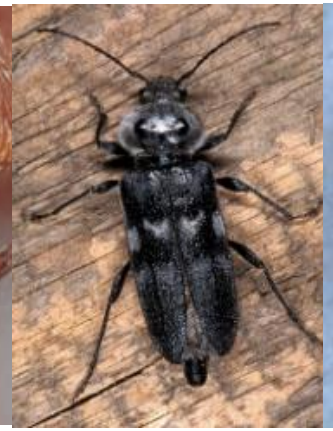
Retrofit Solutions



Possible Retrofit solutions based on (Reid 1989:McCaig & Ridout 2012:Ogley 2010)

Potential risks

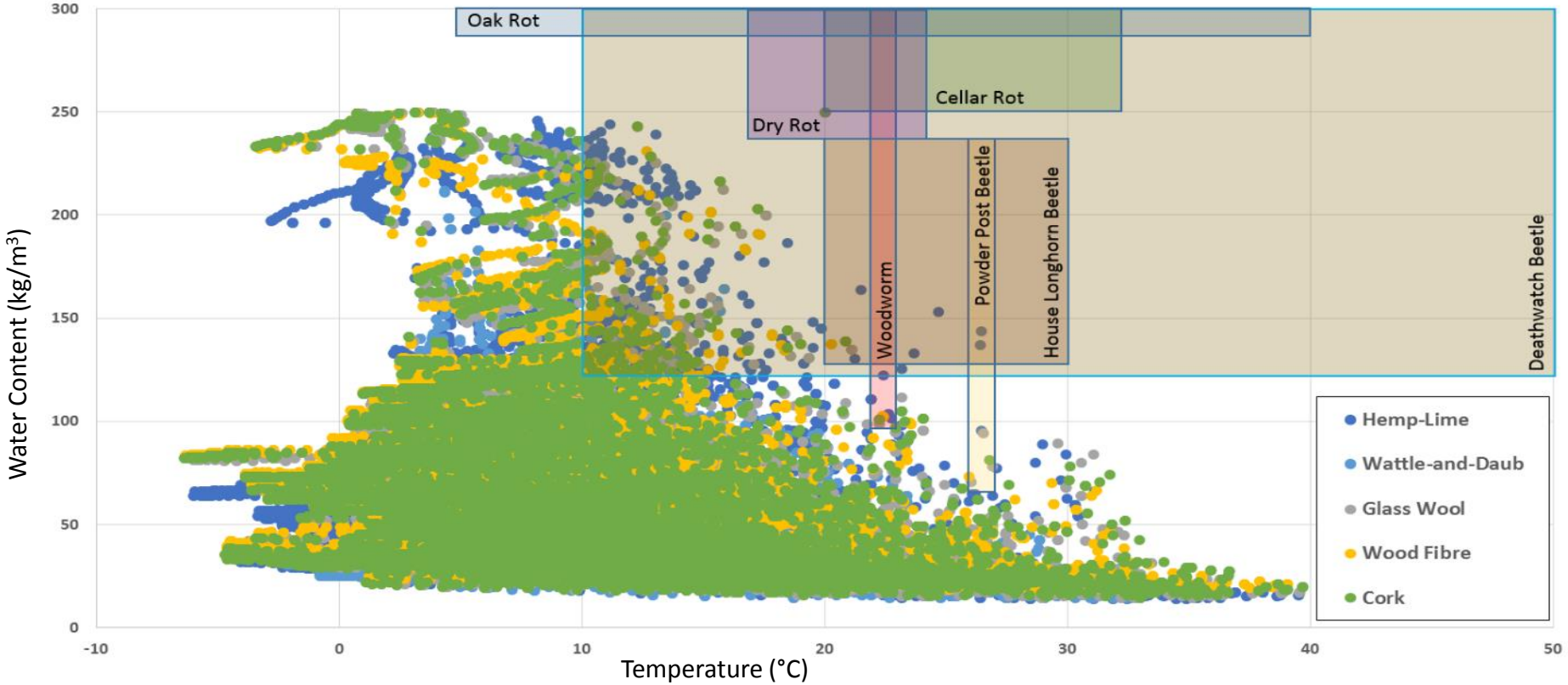






Powderpost	House Longhorn	Woodworm	Deathwatch	Dry Rot	Oak Rot	Cellar Rot
Lycus linearis Goeze & Lyctus brunneus	*Hylotrupesw bajulus*	*Anobium punctatum*	*Xestobium rufovillosum*	*Serpula lacrymans*	*Coniophora puteana*	*Coniophora puteana*
8-25°C	15°C-25°C	>12°C	>15°C	>25°C	>28°C	>25°C
26%	20-30%	22%	>10%	17-23%	5-40%	20-32%

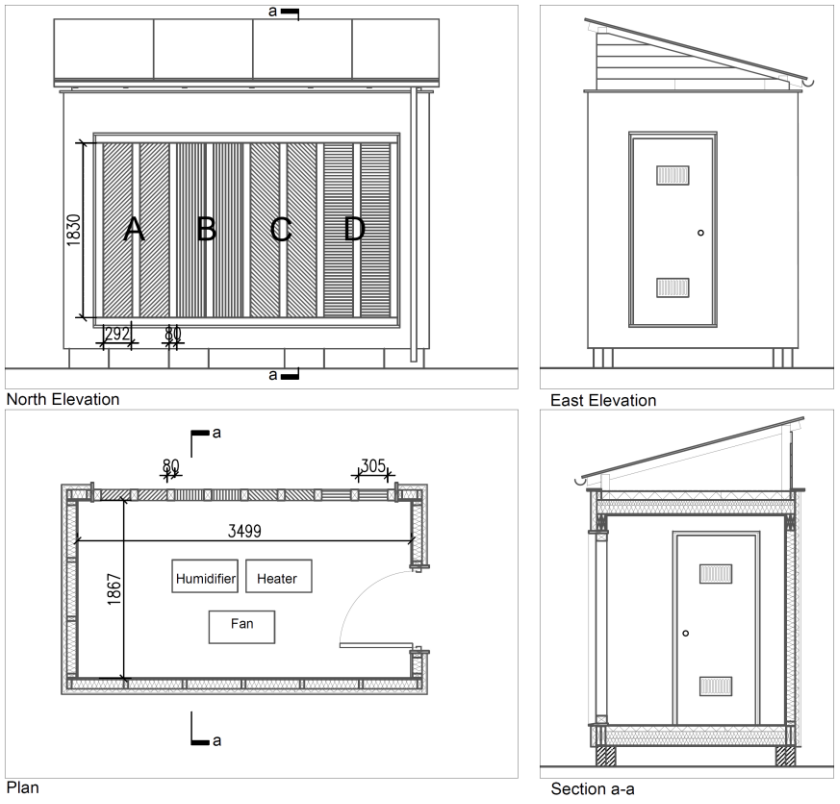
Hygrothermal parameters for insect attack and fungal decay. *Source: (McCaig & Ridout 2012)*

Interstitial Hygrothermal Simulations



Simulation of Hygrothermal performance: WUFI (Wärme und Feuchte Instationär (WUFI) software Results of simulation for Hereford, UK *Source: (Author's own, 2015)*

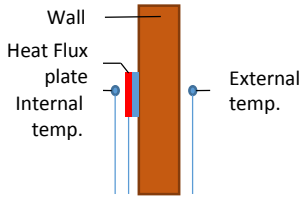
Interstitial Hygrothermal Measurement



Proposed physical test cell for measurement of interstitial hygrothermal conditions of replacement infill panels *Source: (Author's own, 2015)*

Dual climate chamber testing

In situ monitoring of case studies

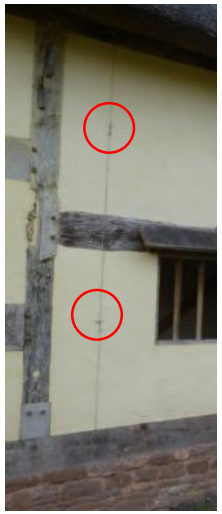


BS ISO 9869-1

Replacement Wattle and Daub

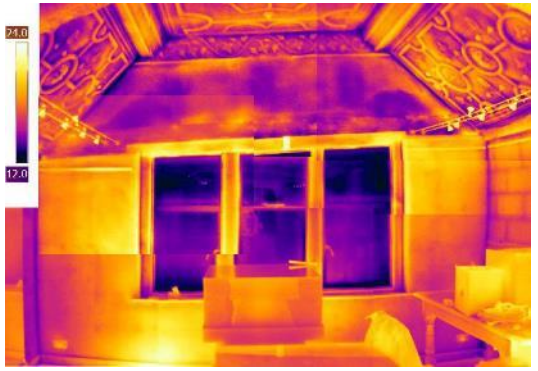
Repaired Lath and Plaster

Triso-mur 25mm + Lime plaster

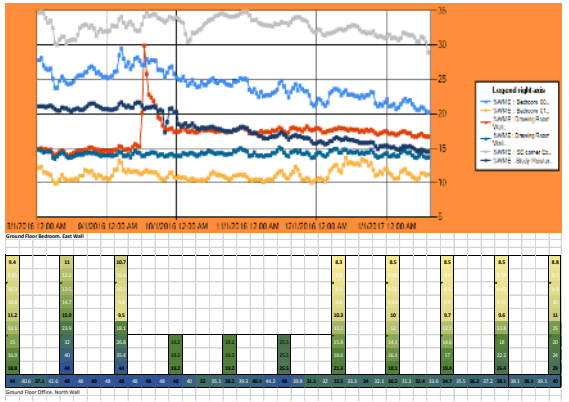


In situ U-Value monitoring *Source: (Author's own, 2015)*

Pressure testing *(Author's own, 2016)*



Thermography *Source: (Author's own, 2016)*



Moisture *Source: (Author's own, 2016)*

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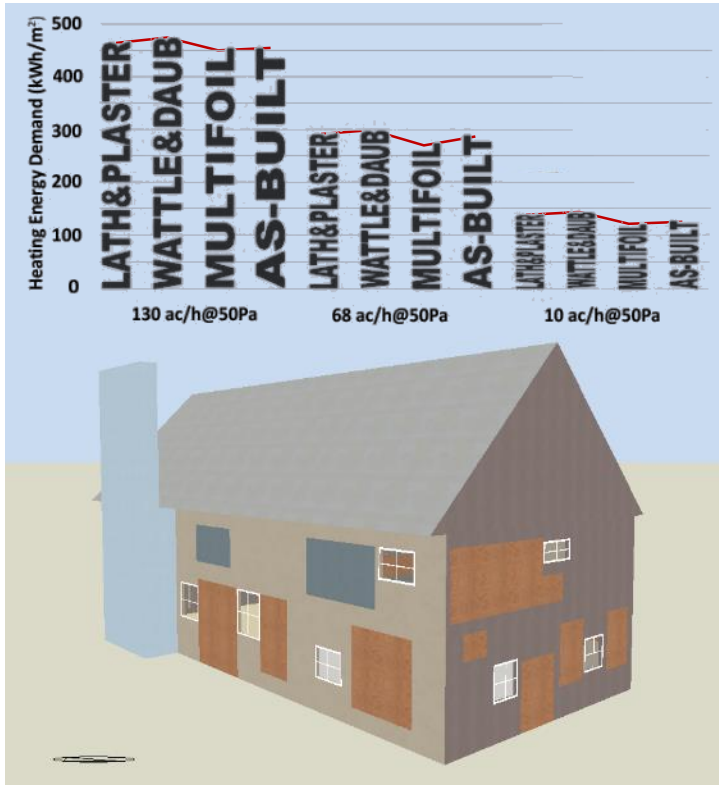
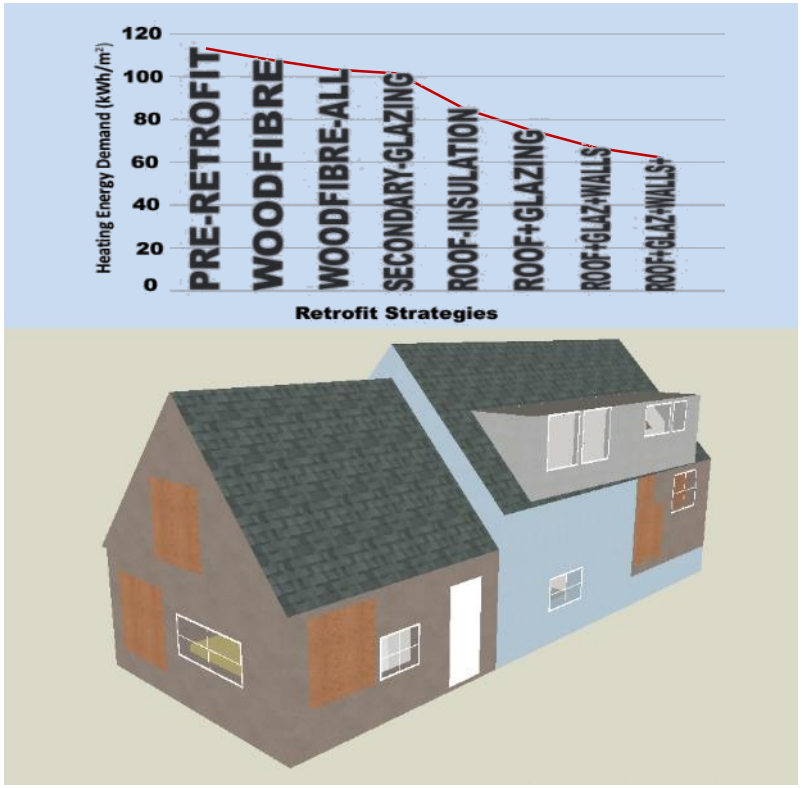
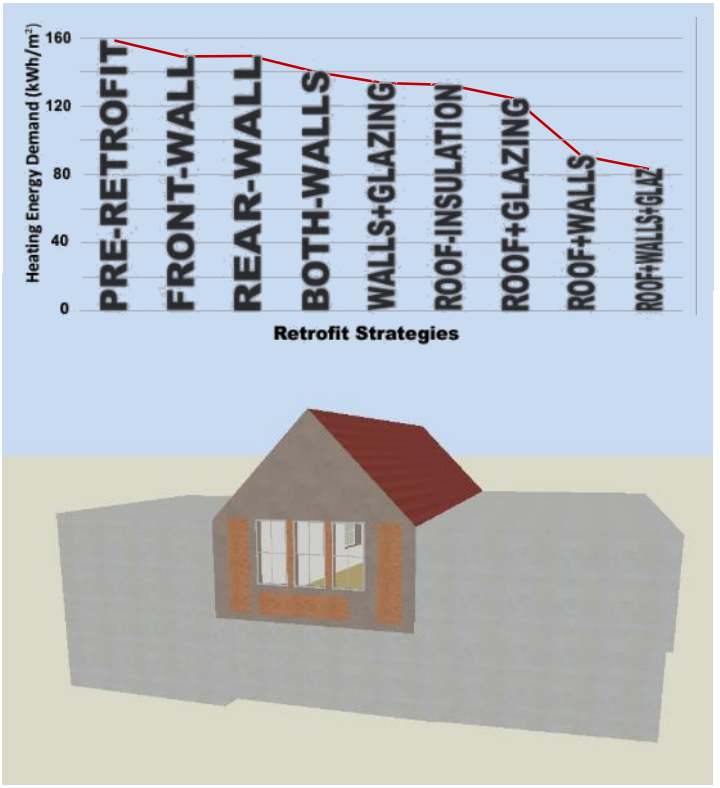
Energy Simulation of case studies







Energy simulation of case study buildings using DesignBuilder *Source: (Author's own, 2015)*

Conclusion

- Where historic infill is beyond repair there exists the opportunity to retrofit an alternative panel with a higher thermal resistance.
- Care must be taken not to increase interstitial moisture that can lead to fungal decay and insect attack.
- Simulations to date show no significant risks but are WUFI simulations reliable for heterogeneous, traditional construction techniques? Monitoring of physical test panels is therefore required.
- Air tightness remains a major issue for timber-framed buildings, especially when frame is exposed internally and externally.
- Retrofit strategies need to consider a holistic approach to achieve true energy savings

Key questions for debate in this session

- What are the key lesson in the UK and Egypt for retrofit of heritage buildings?
- Do we know the potential risks of retrofit to historic fabric?
- Could improved maintenance of historic and traditional buildings improve their energy performance?- One step before retrofit