CeBE Centre for the Built Environment

leeds metropolitan university

24th April 2013, Croke Park, Dublin

BetterBuilding

International Conference for a Sustainable Built Environment

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Closing the Performance Gap: Beyond Stamford Brook

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David Johnston, Jez Wingfield, David Farmer, Malcolm Bell

Closing the Performance Gap:
Beyond Stamford Brook

Evidence of a Fabric Performance Gap?
How can it be Measured?
Regulatory Implications – so far…
Performance Gap for Retrofit
Closing the Loop
Simple Tests (do try this at home!)

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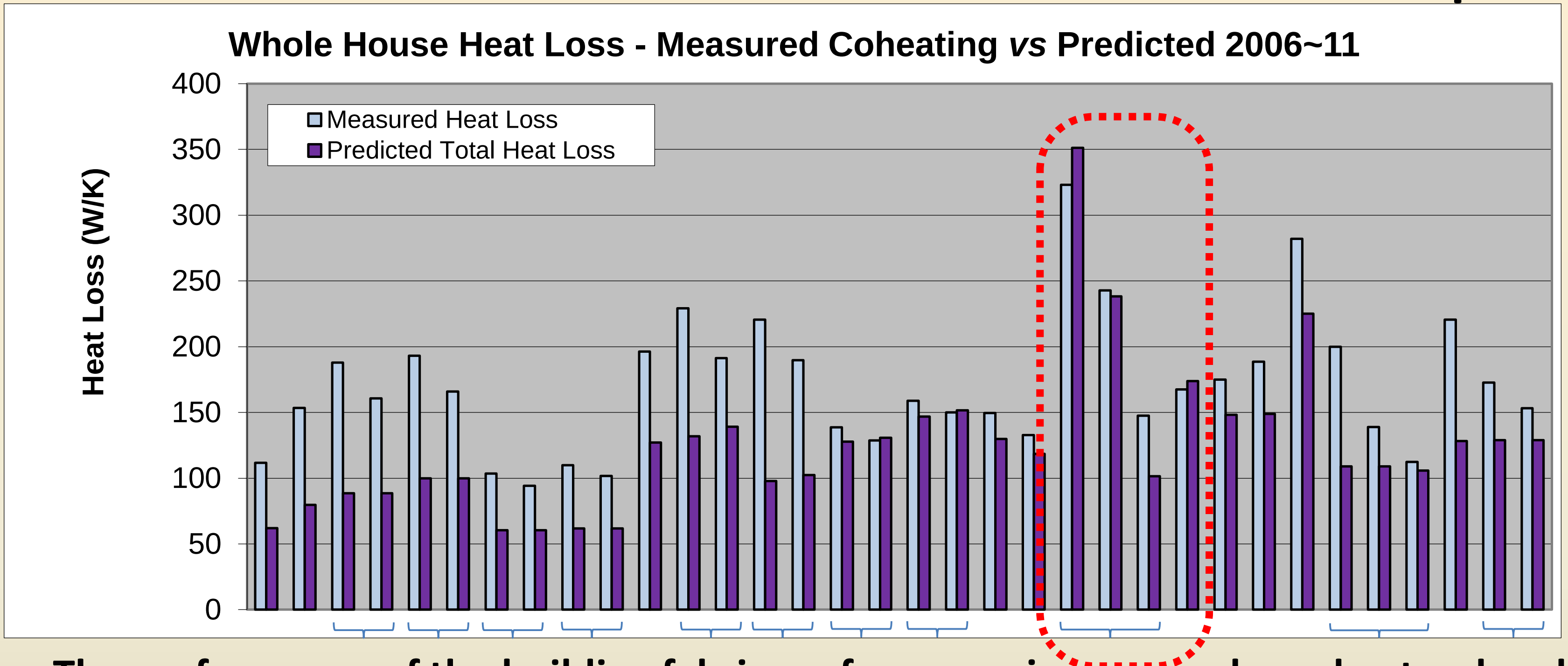
Evidence for a fabric Performance Gap



- The performance of the building fabric performance is very rarely understood and often taken for granted.
- Heat loss is often much higher than calculated during design.
- Highly dependent upon the design and installation of the insulation layers (Hens et al., 2007 and Doran, 2000).

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Measuring the Performance Gap

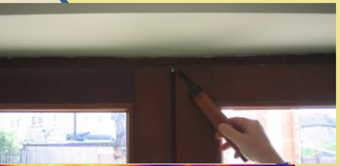


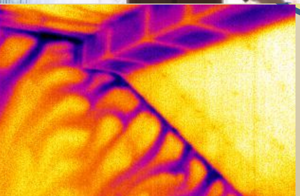
Construction observations

Pressurisation testing

Tracer gas measurement

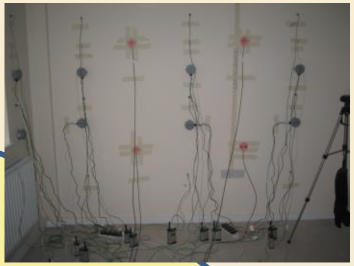
Leakage detection





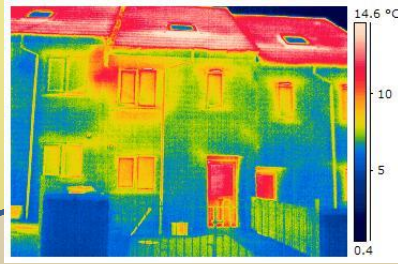
Coheating test

Cavity temperature measurement



Heat flux measurement

Thermal imaging

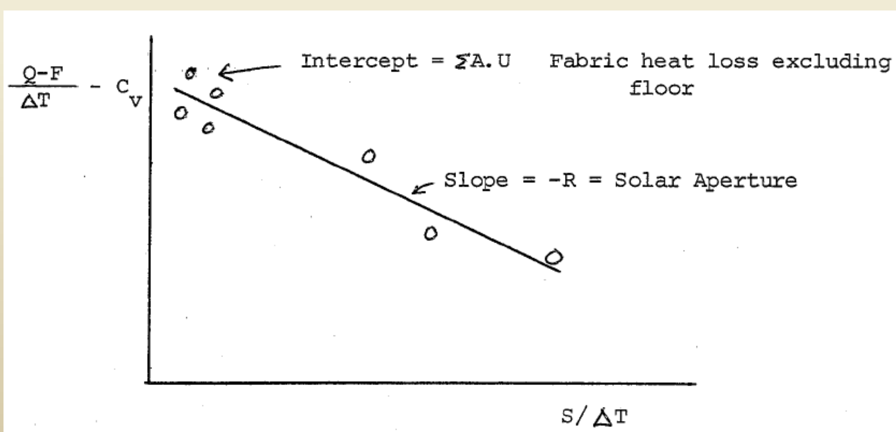


Air flow measurements

Partial deconstruction

Coheating Testing

- It is **NOT** a new concept, although it is in its infancy.
- Developed in the USA (LBL) in the late 1970’s in response to the energy crisis (see Sonderegger et al. 1979).
- Used in a small number of occasions in the UK in the 1980’s.
- Re-invented by Leeds Met at Stamford Brook 2005/6



Siviour Analysis:
(solar/ΔT) vs. (power/ΔT)
Heat Loss = y intercept
Solar Aperture = slope

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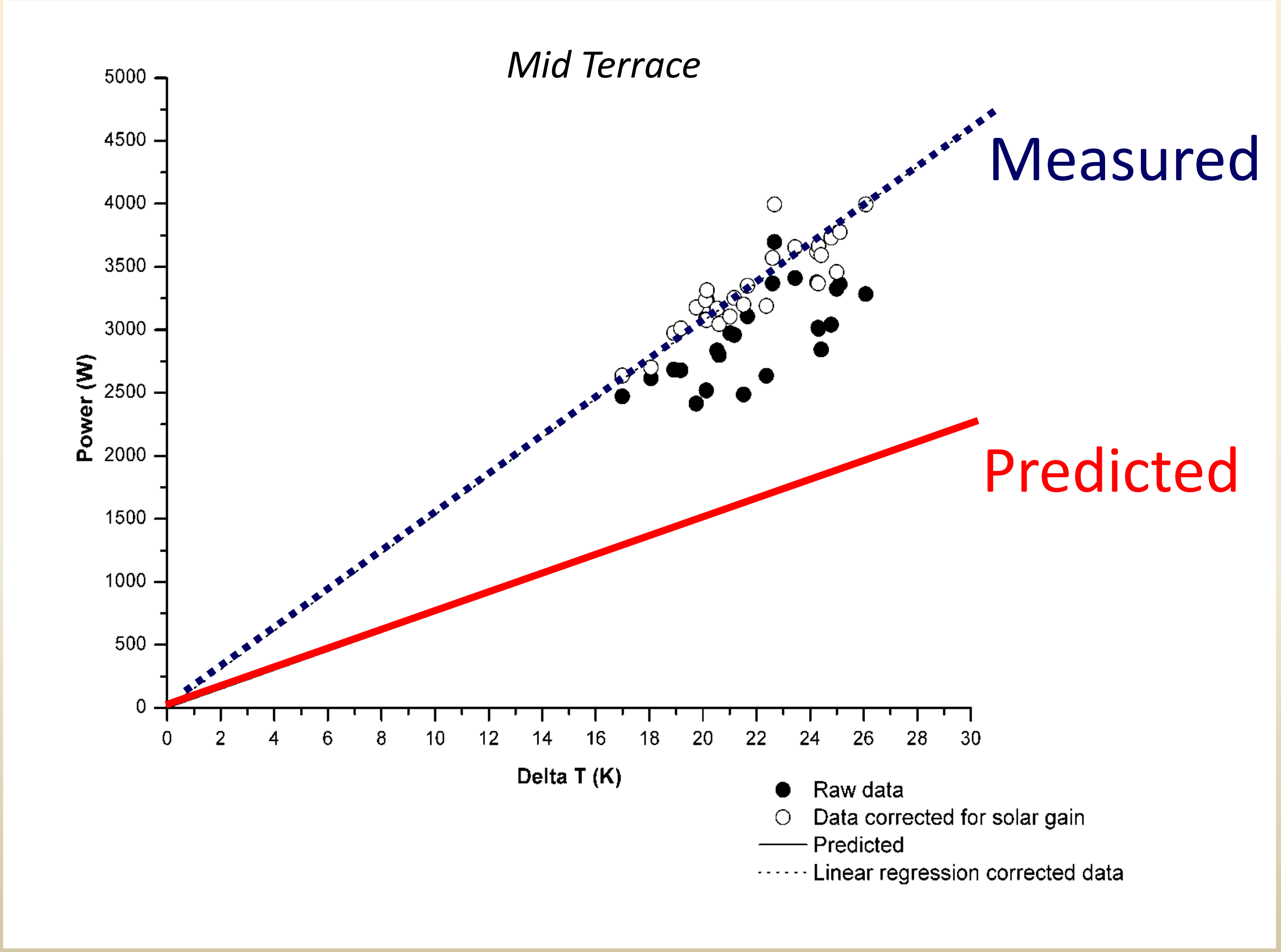
Coheating Testing



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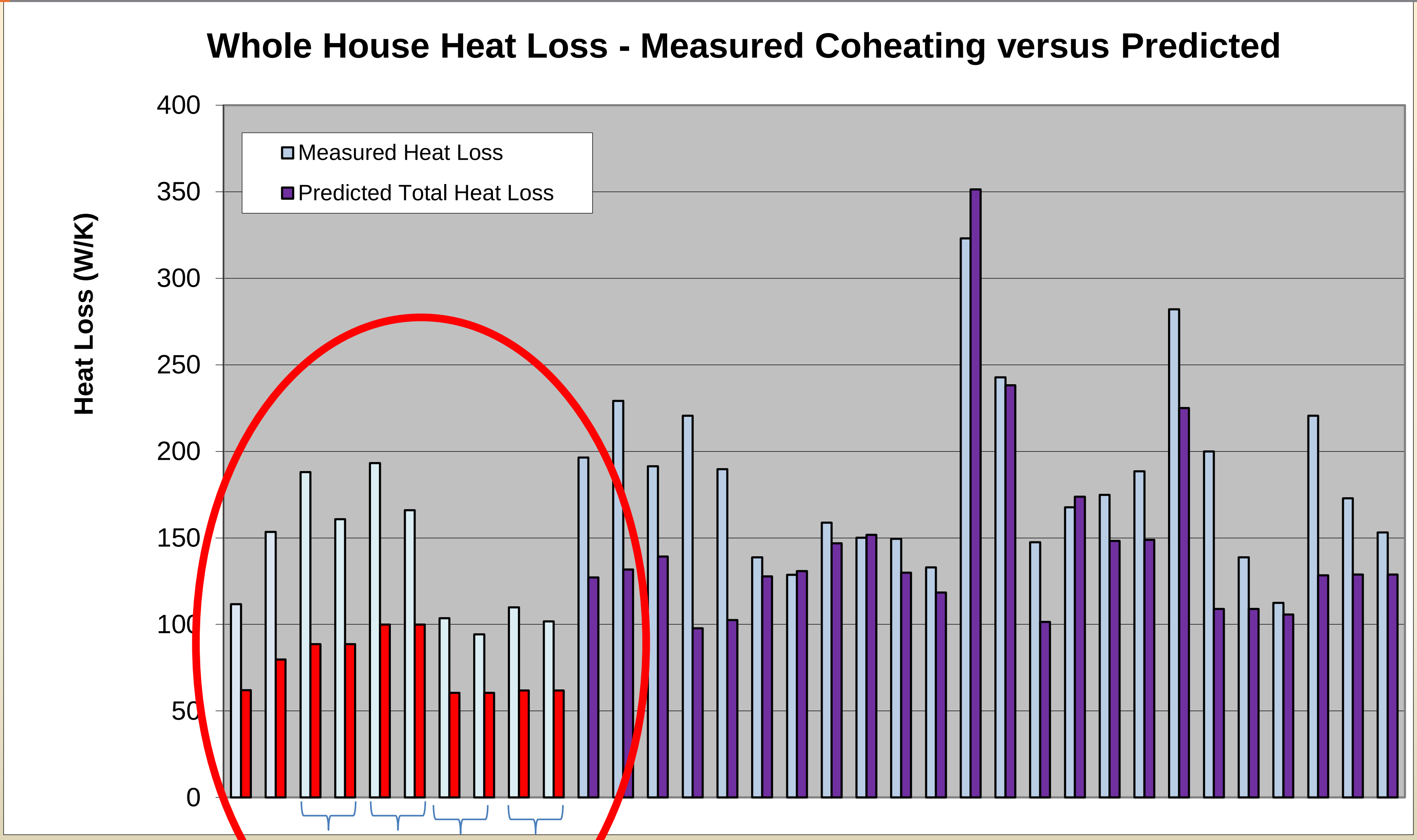
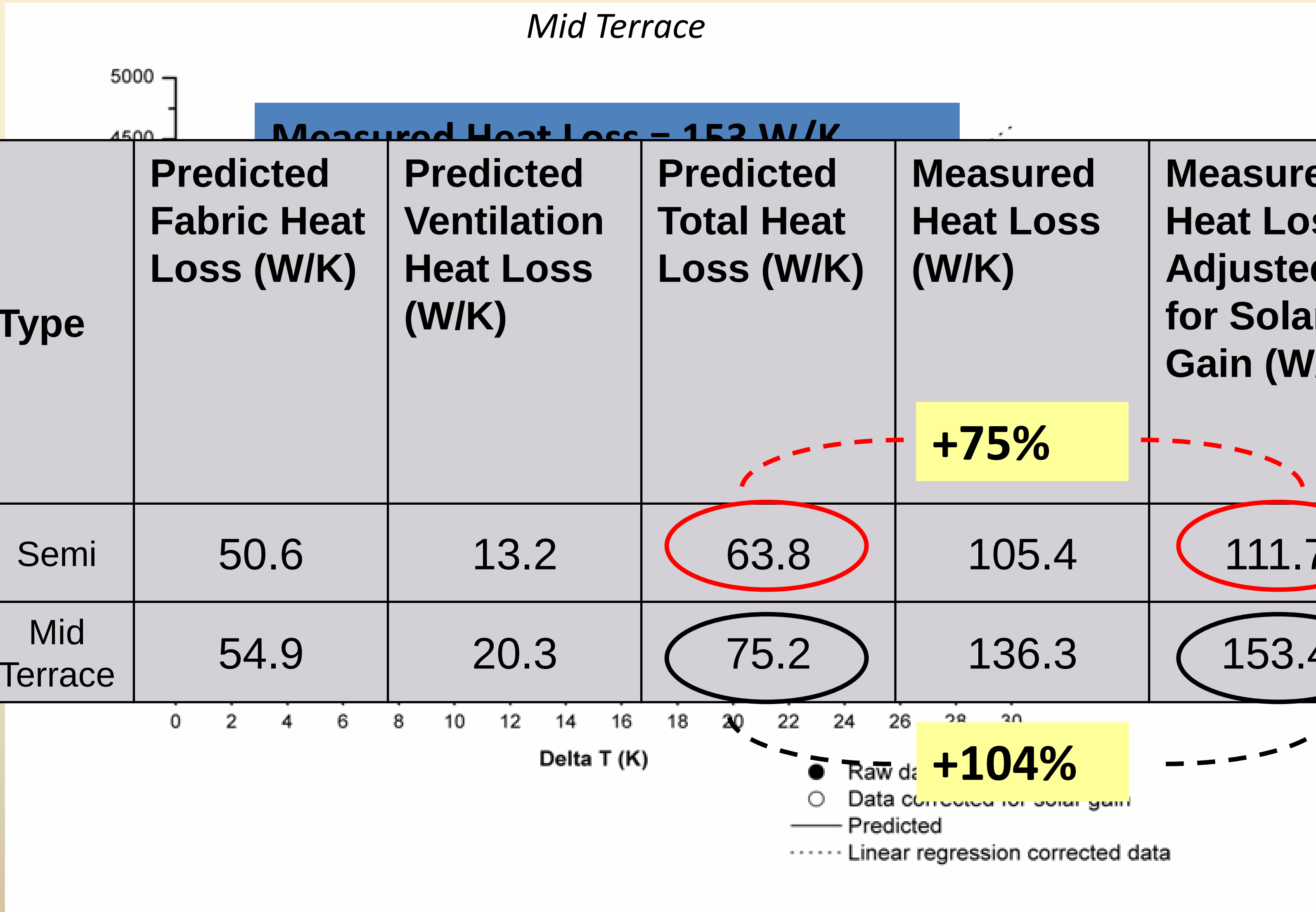


Party wall bypass investigations – Stamford Brook

Party wall bypass investigations – Stamford Brook

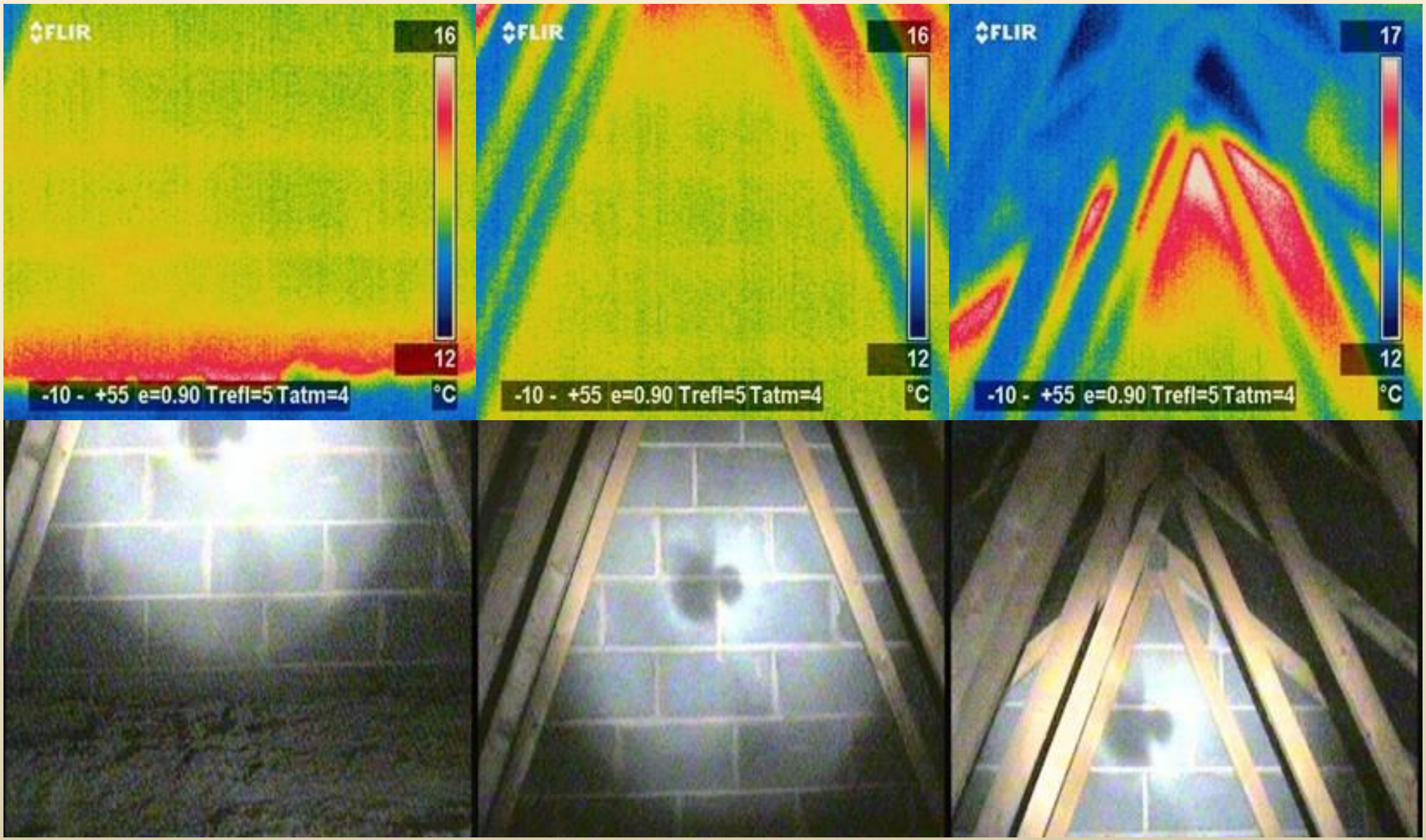


Type	Predicted Fabric Heat Loss (W/K)	Predicted Ventilation Heat Loss (W/K)	Predicted Total Heat Loss (W/K)	Measured Heat Loss (W/K)	Measured Heat Loss - Adjusted for Solar Gain (W/K)
Semi	50.6	13.2	63.8	105.4	111.7
Mid Terrace	54.9	20.3	75.2	136.3	153.4

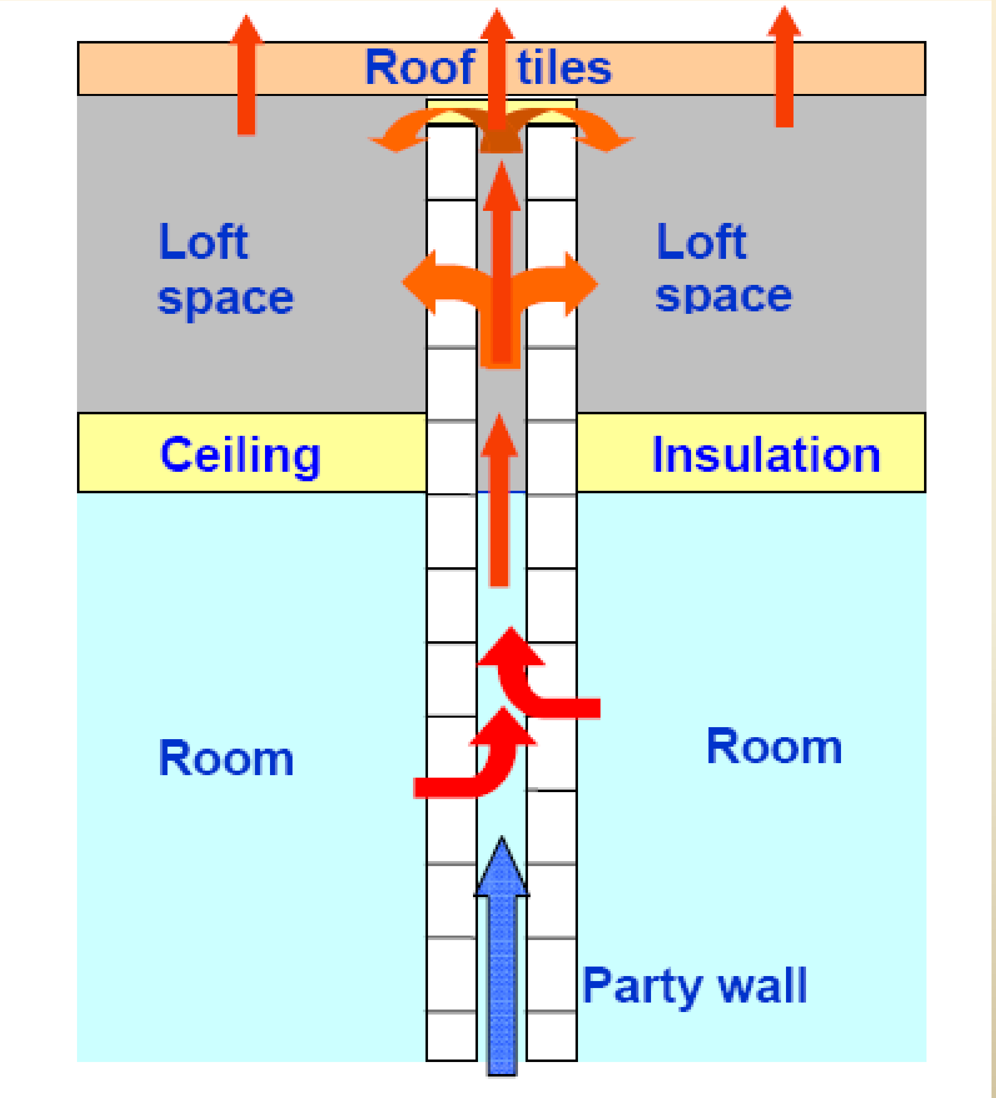
+75%

+104%

Party wall bypass investigations – Stamford Brook



Party wall bypass investigations – Stamford Brook



Party wall bypass investigations – Stamford Brook

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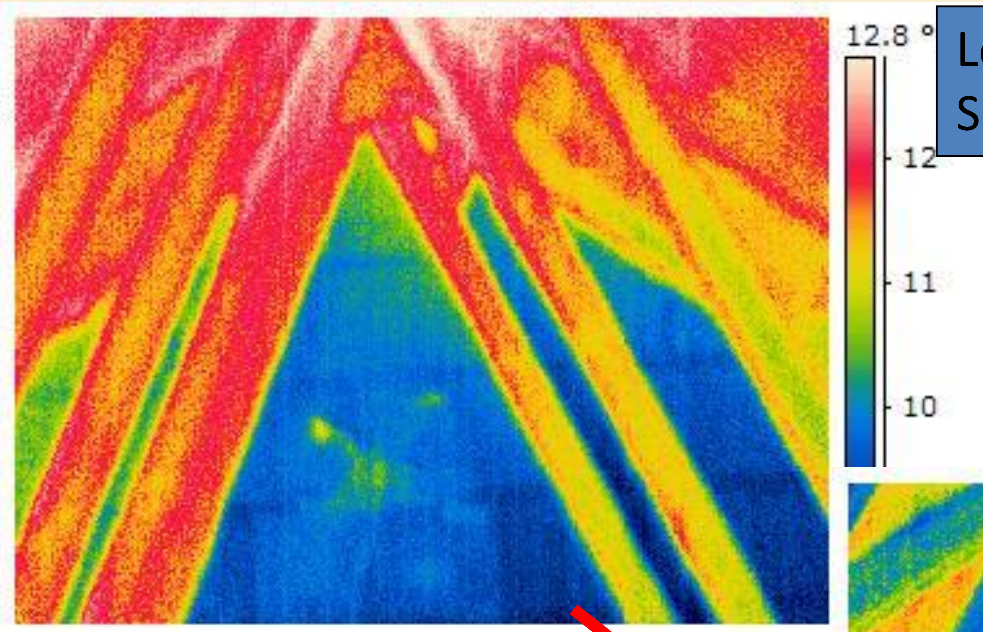
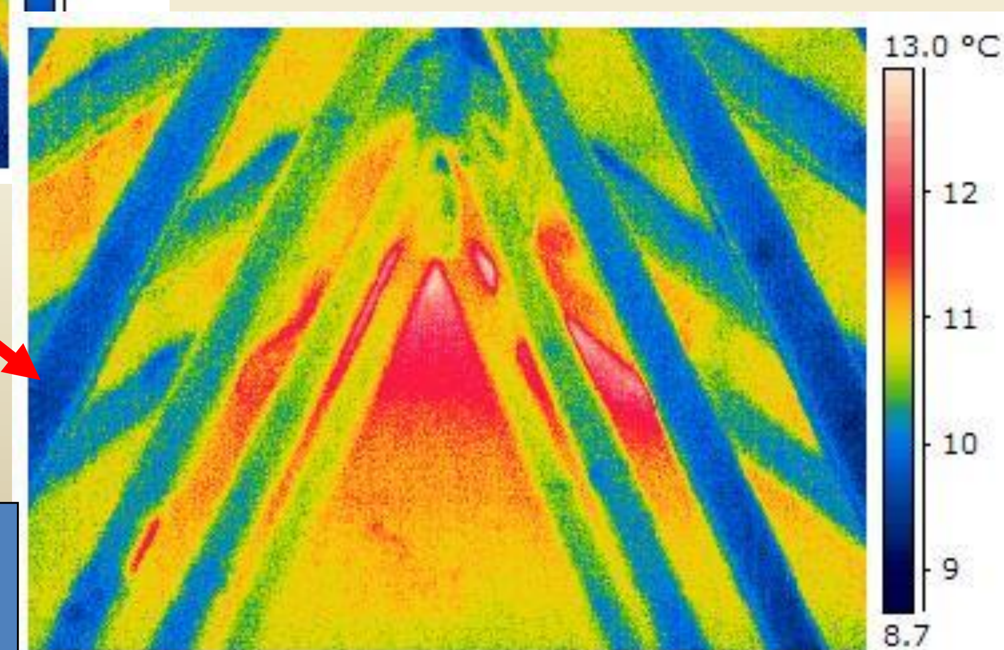


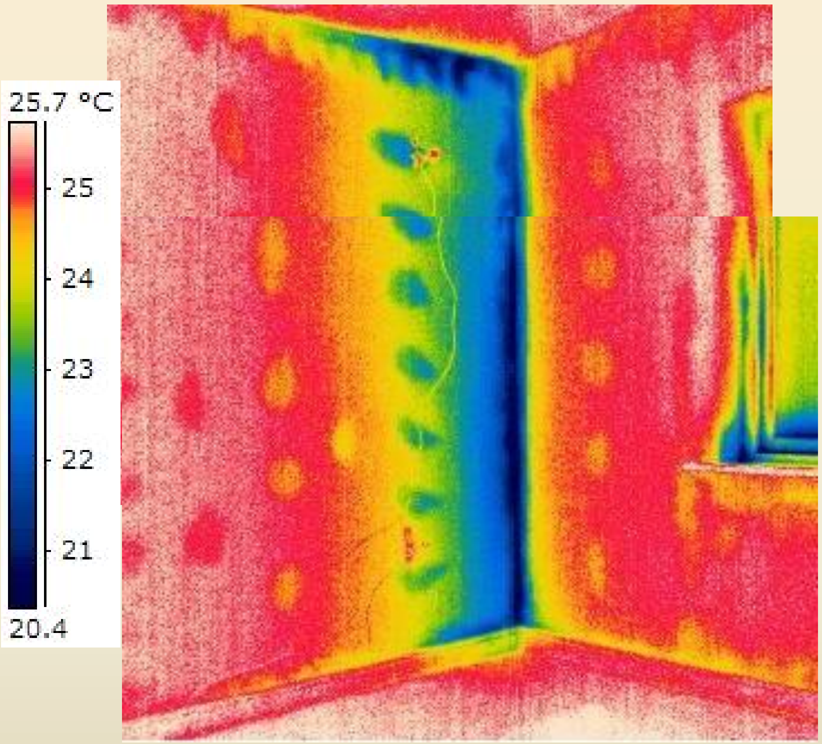
Loft Party Wall
Sock in

Remove Sock



Loft Party Wall
Sock out

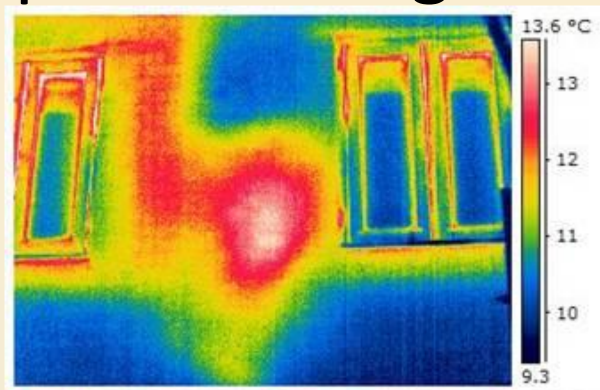
Party wall bypass investigations – Stamford Brook



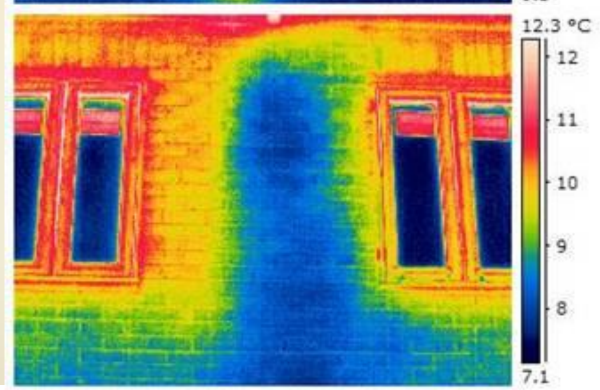
Second Floor – Party Wall to External Wall Junction – Sock Out

Party wall bypass investigations – Stamford Brook

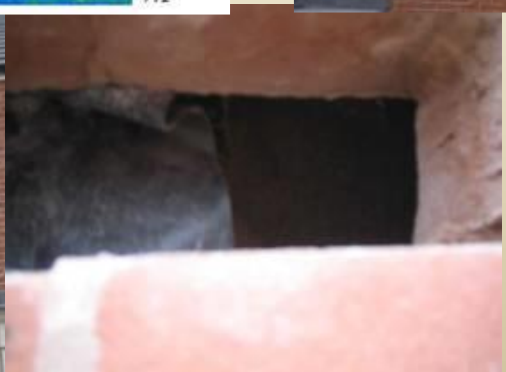
Party Wall Junction – Sock in Position



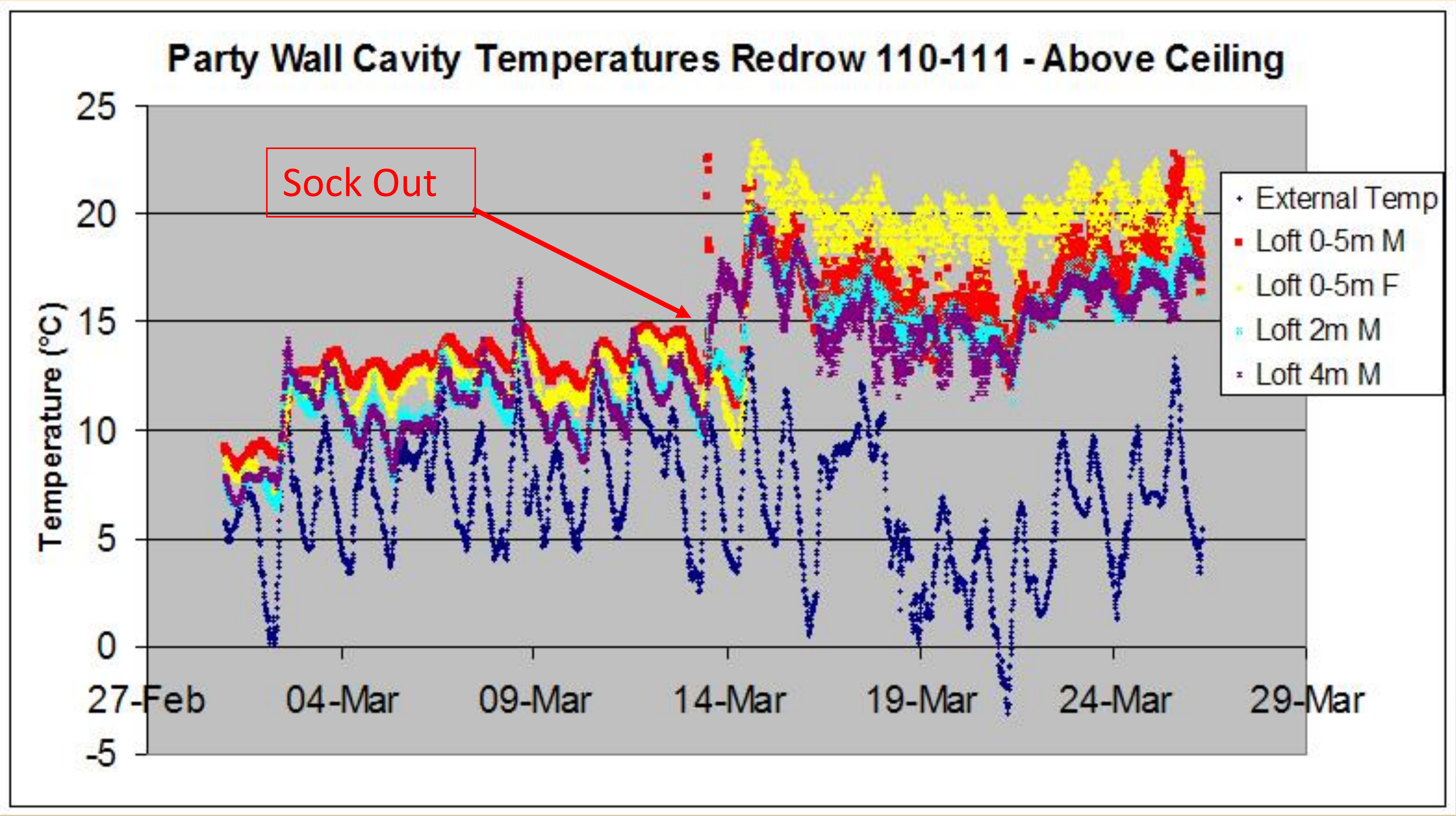
Party Wall Junction – Sock Removed



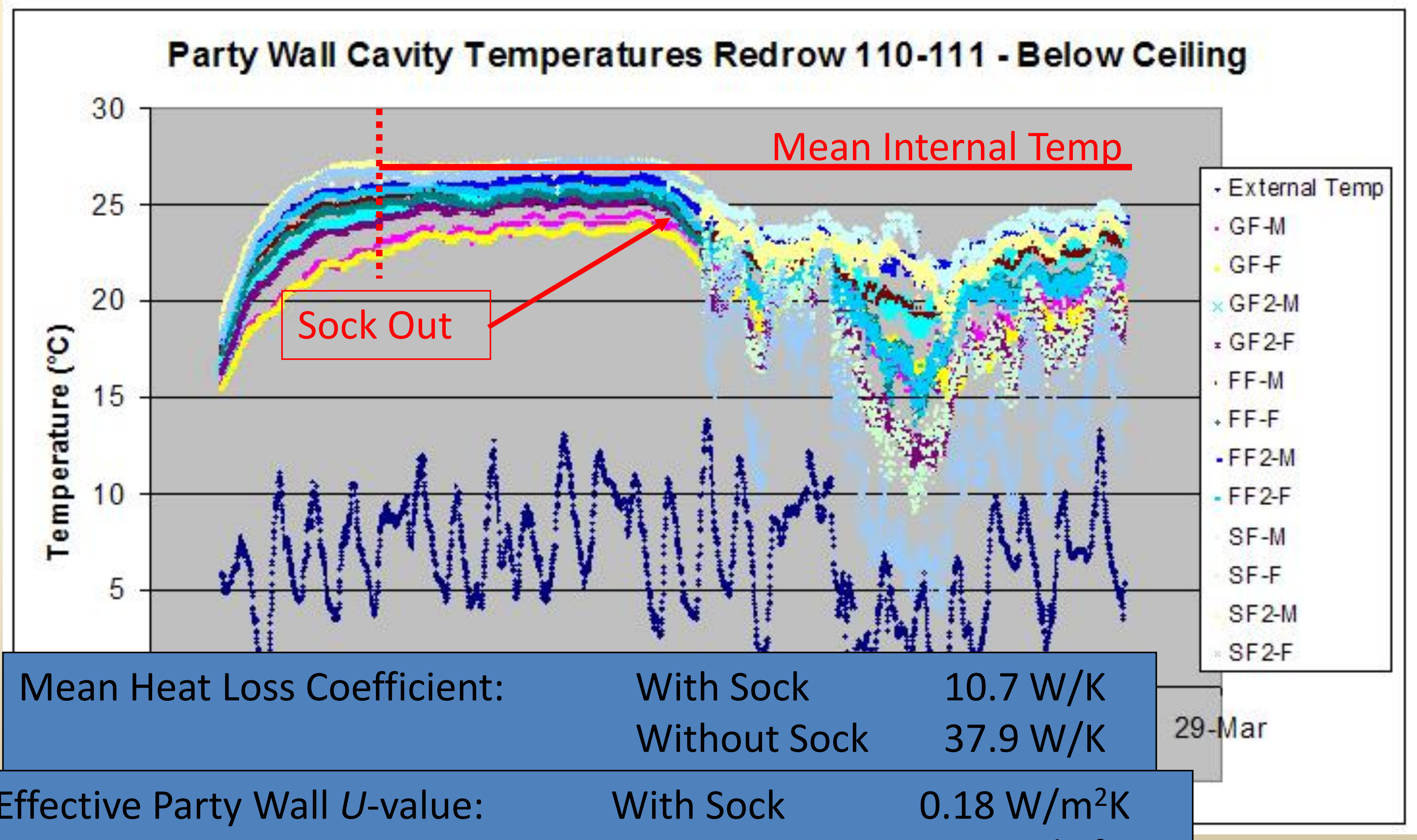
Party Wall Junction – Brick at Hot Spot Removed



Party wall bypass investigations – Stamford Brook



Party wall bypass investigations – Stamford Brook

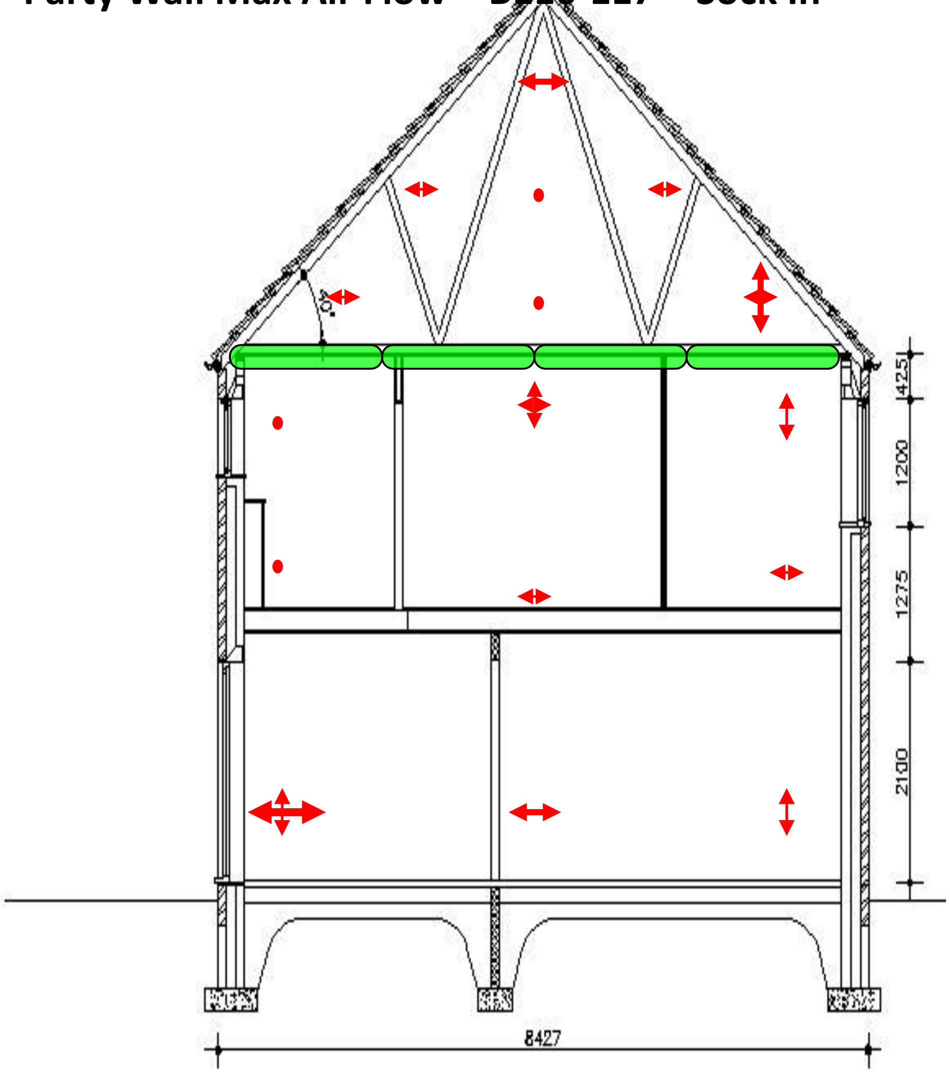


Mean Heat Loss Coefficient:	With Sock	10.7 W/K
	Without Sock	37.9 W/K

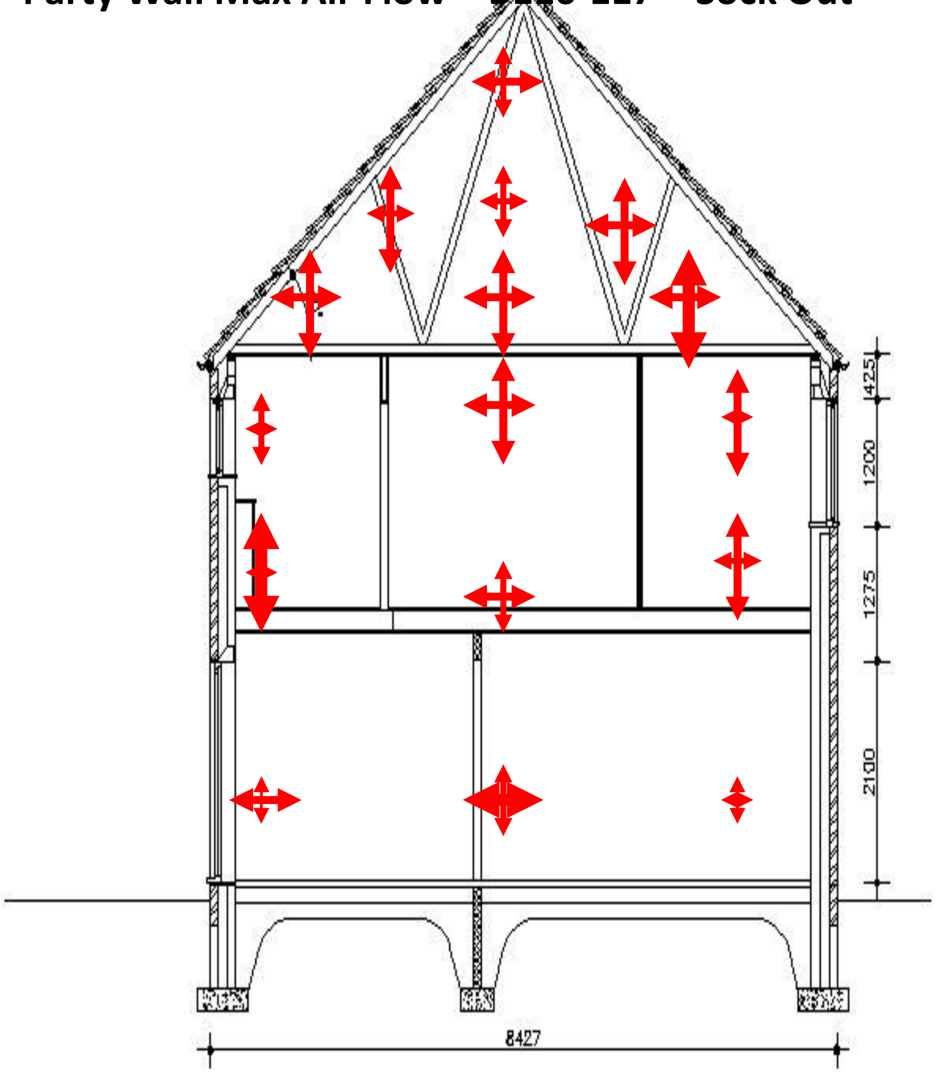
Effective Party Wall *U*-value:	With Sock	0.18 W/m²K
	Without Sock	0.63 W/m²K

Party wall bypass investigations – Stamford Brook

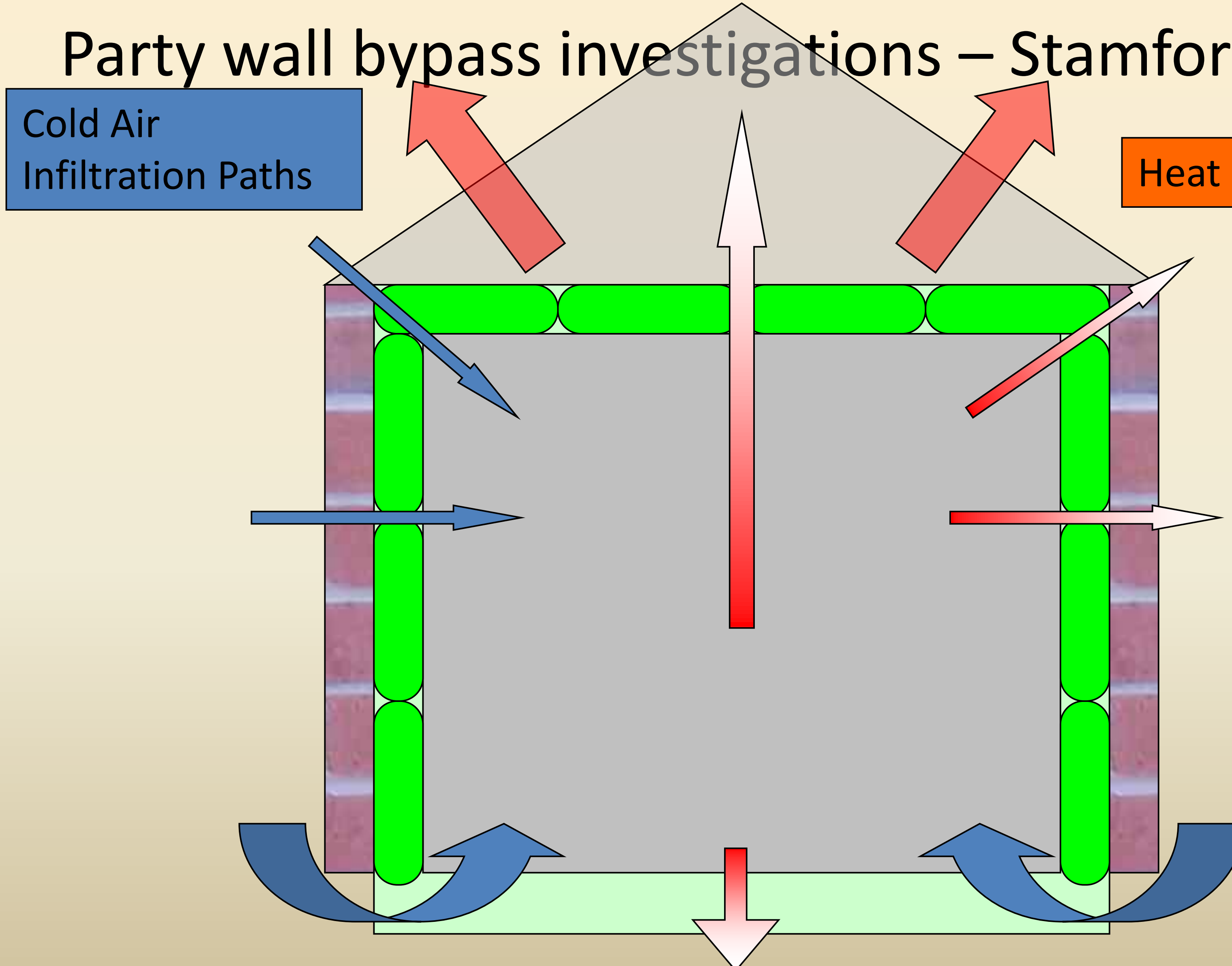
Party Wall Max Air Flow – B116-117 – Sock In



Party Wall Max Air Flow – B116-117 – Sock Out



Party wall bypass investigations – Stamford Brook



Party wall bypass investigations – Stamford Brook

Party Wall Bypass – Estimated UK CO_2 savings if bypass eliminated

From New Housing built in One Year (~190,000 units)	18,000 tCO_2/a
From Existing Stock (built since 1965)	~750,000 tCO_2/a

Assumes Party Wall *U*=Value = 0.5 W/m^2K
Assumes 10% semi-detached, 20% terrace in stock and new build
Calculations for semis and terraces only – no estimate for apartments

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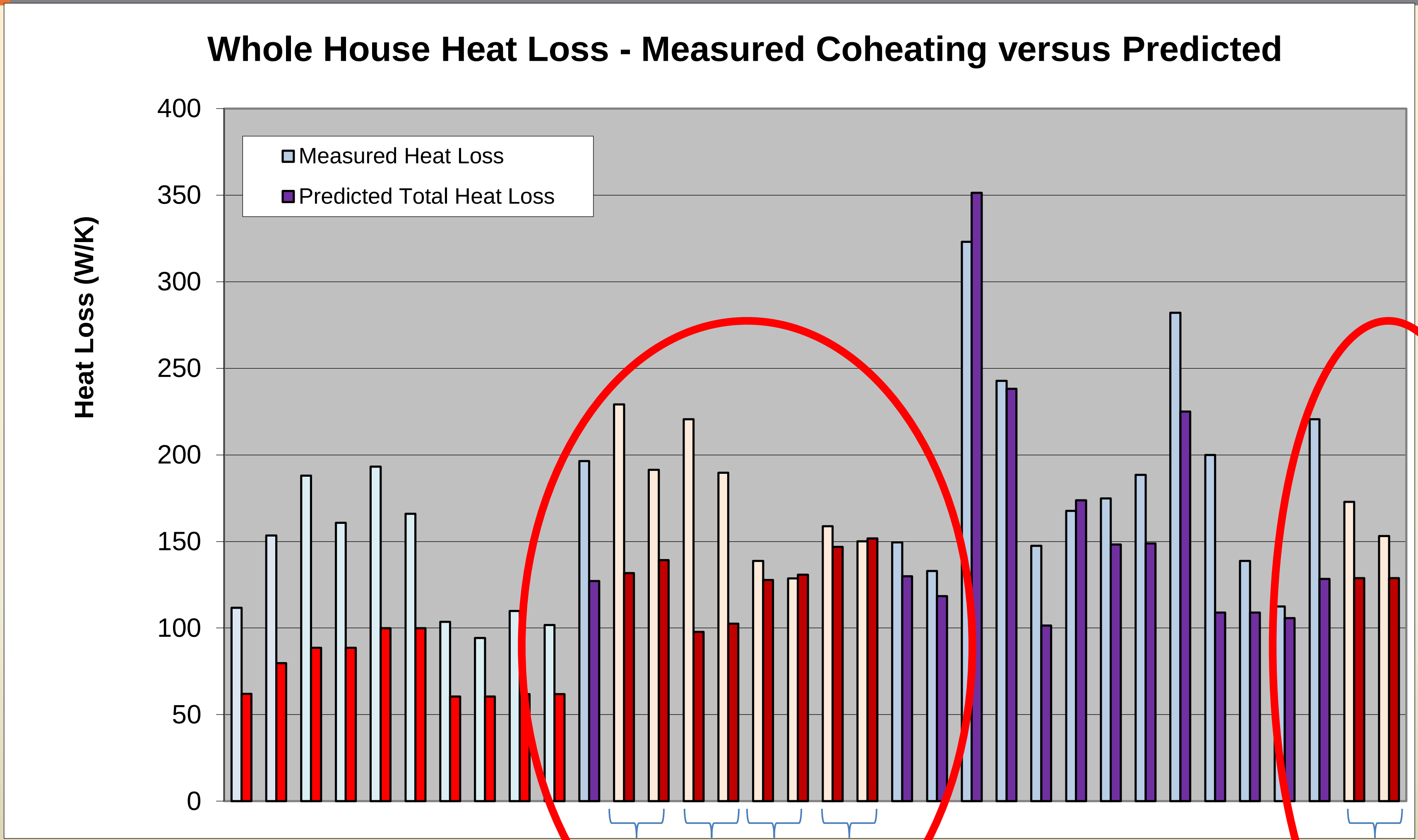

Party wall bypass investigations – EURISOL / MIMA

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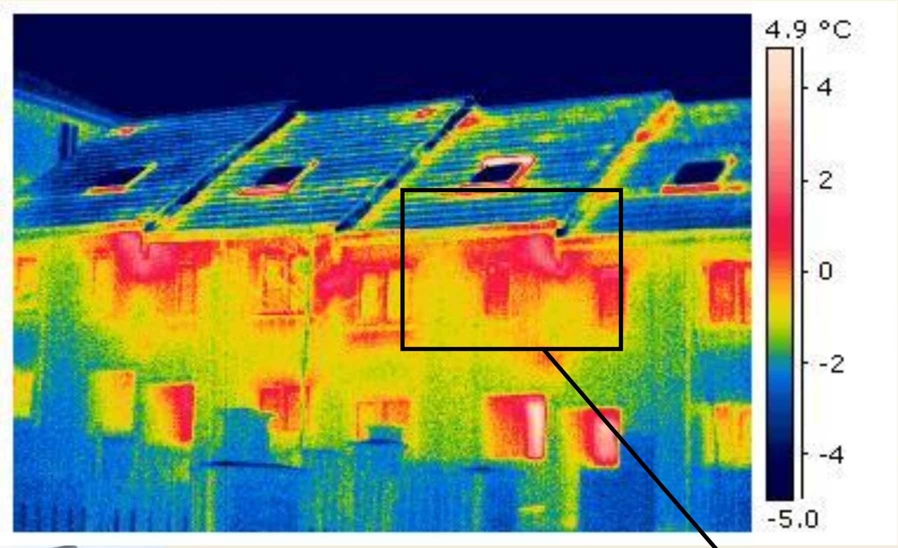

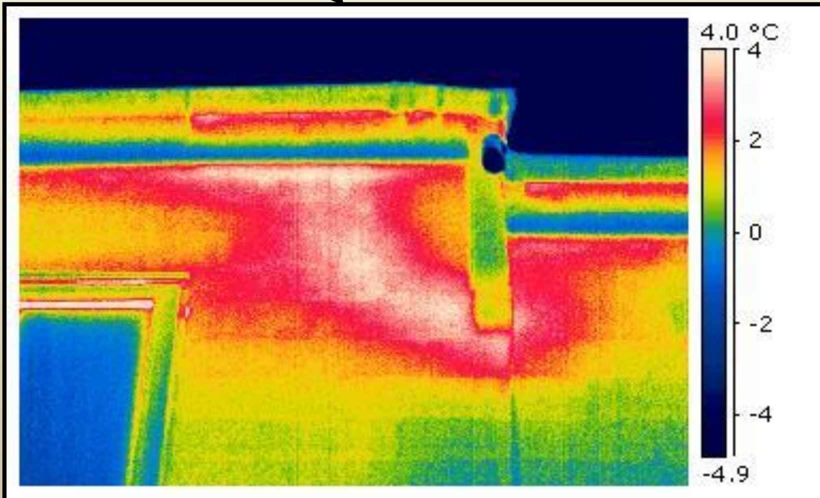

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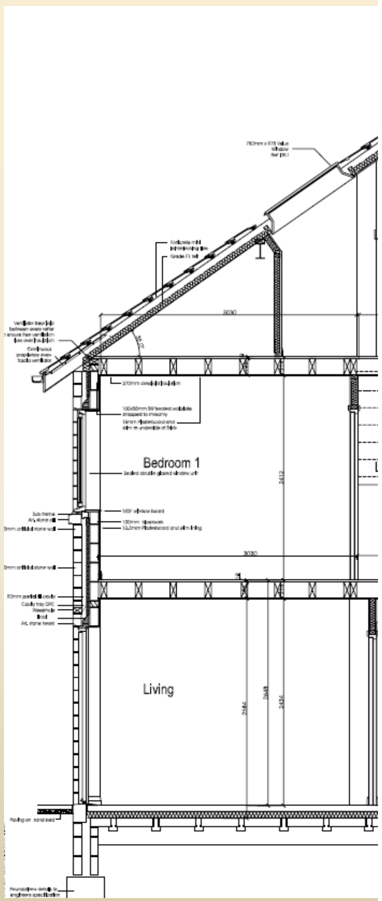
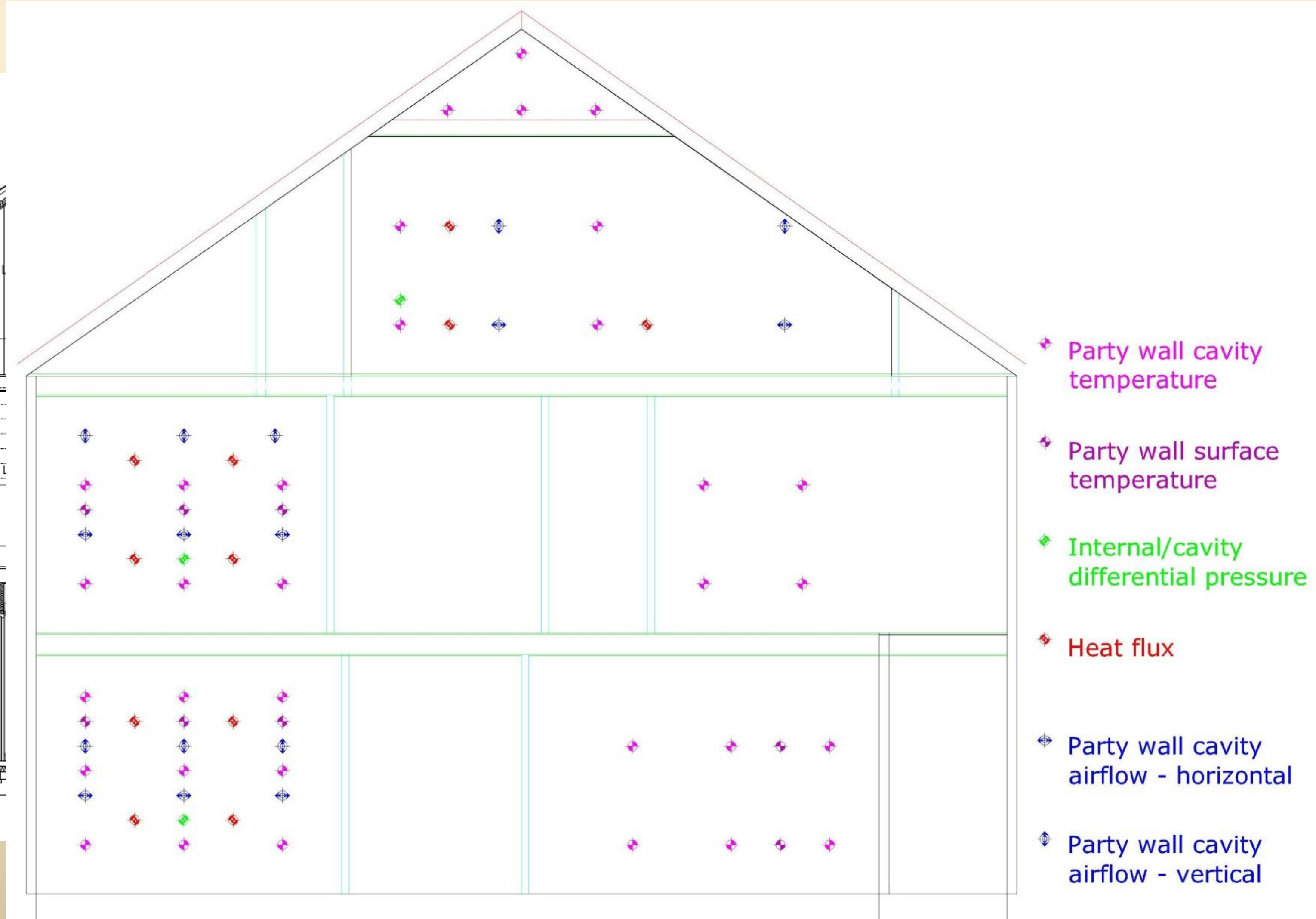
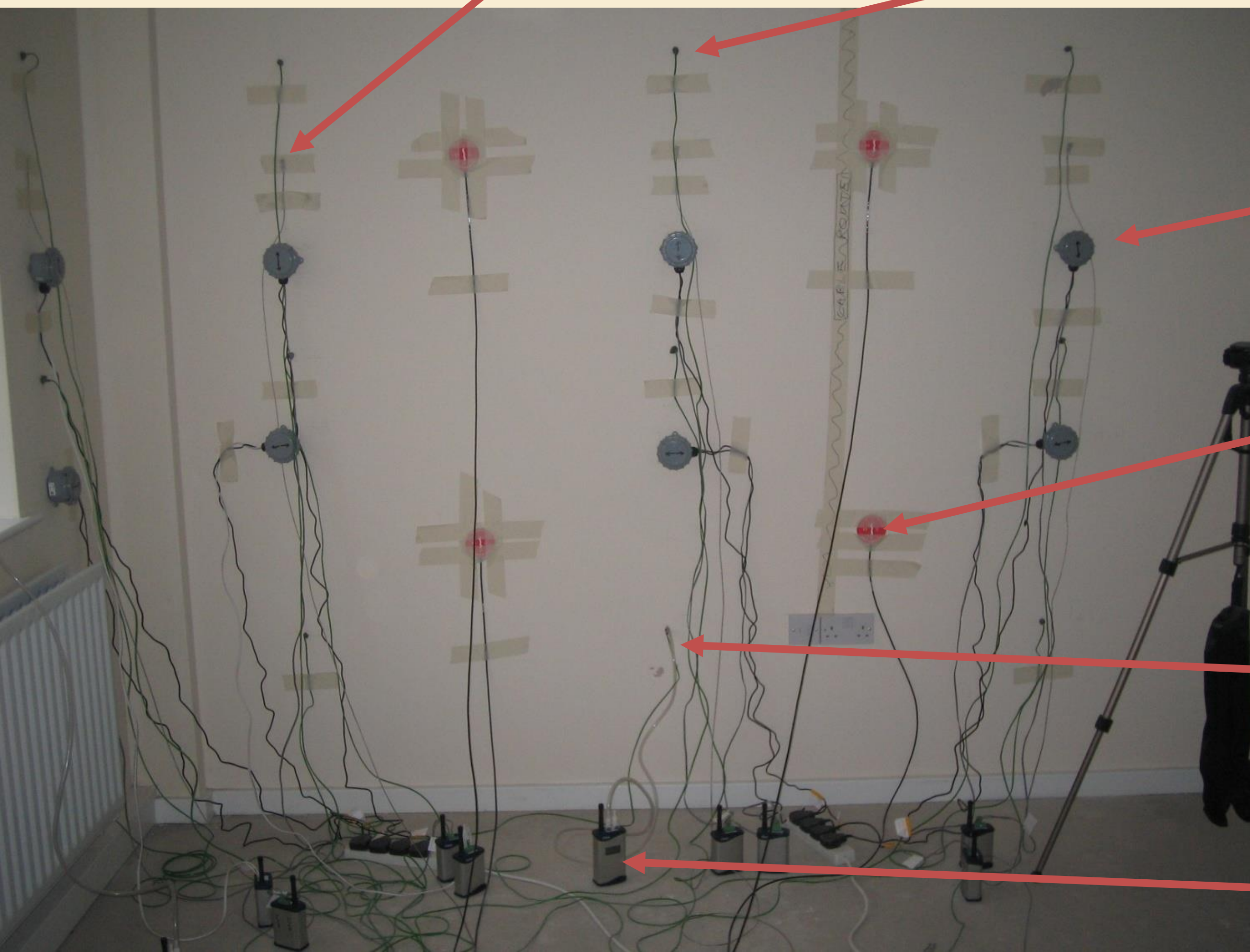




Party wall bypass investigations – EURISOL / MIMA

Surface Thermocouple

Cavity Thermocouple



Air Flow Transducer

Heat Flux Plate

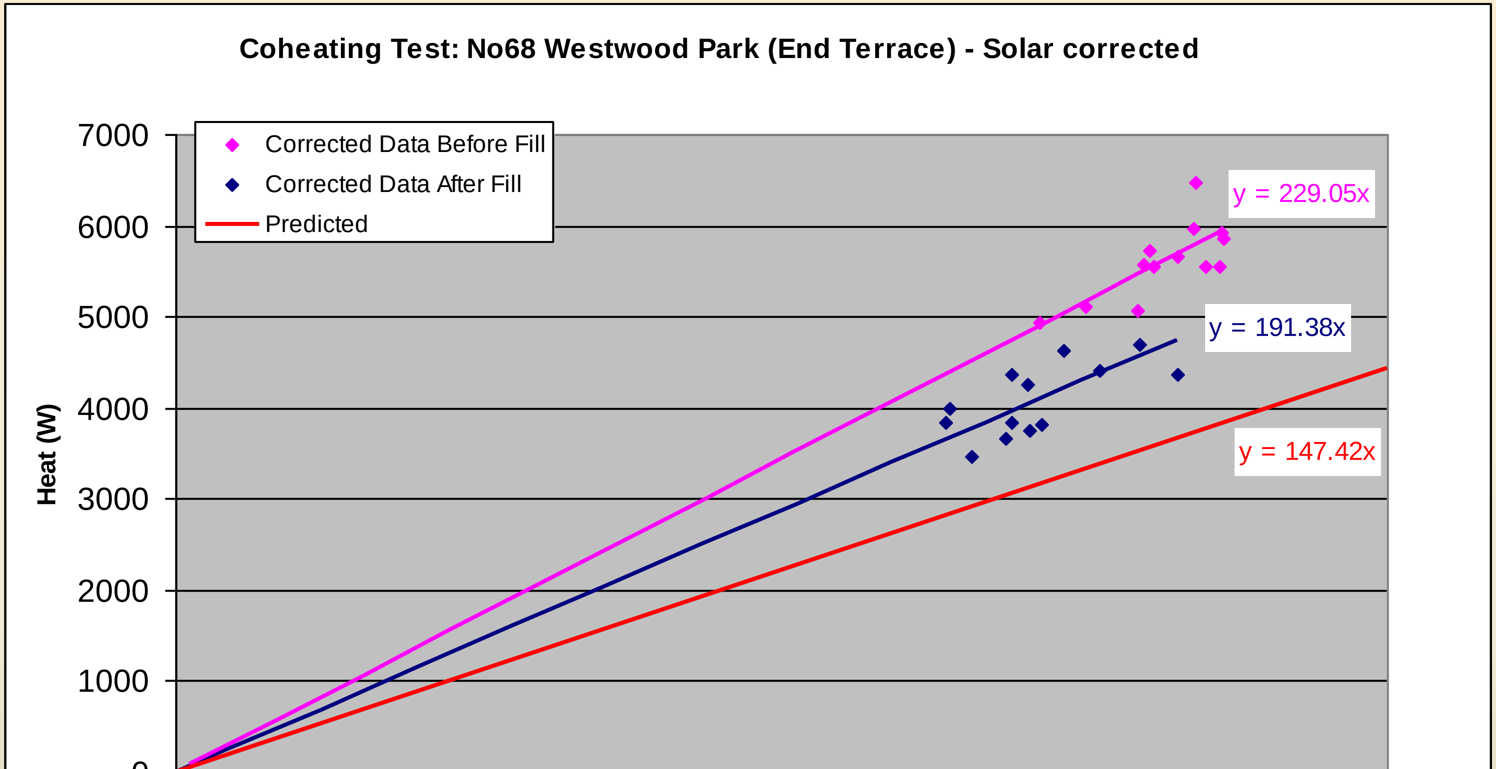
Differential Pressure

Transmitter

Party wall bypass investigations – EURISOL / MIMA

- Material: Knauf Supafil Plus 40
- Usage: ~6 bags = 106kg over ~72.4m^2 (Cavity ~75mm)
- Estimated fill density: ~19.6 kg/m^3 (Volume ~ 5.4m^3)

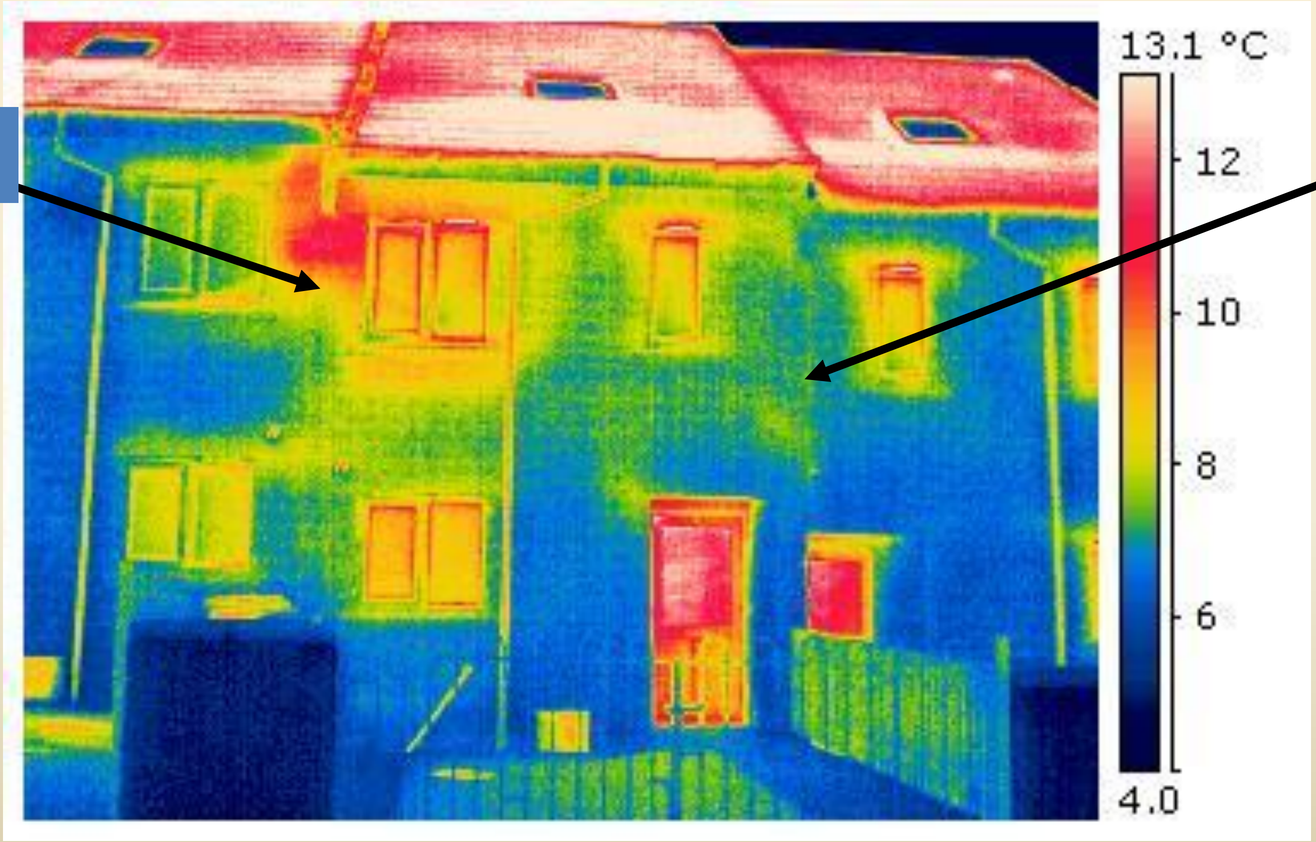
Party wall bypass investigations – EURISOL / MIMA



Heat Loss Before Fill (W/K)	Heat Loss After Fill (W/K)	Heat Loss Improvement (W/K)
229.1	191.4	37.7 (-16%)

$37.7\ W/K \div 69\ m^2 = 0.55\ W/m^2K$

Party wall bypass investigations – EURISOL / MIMA



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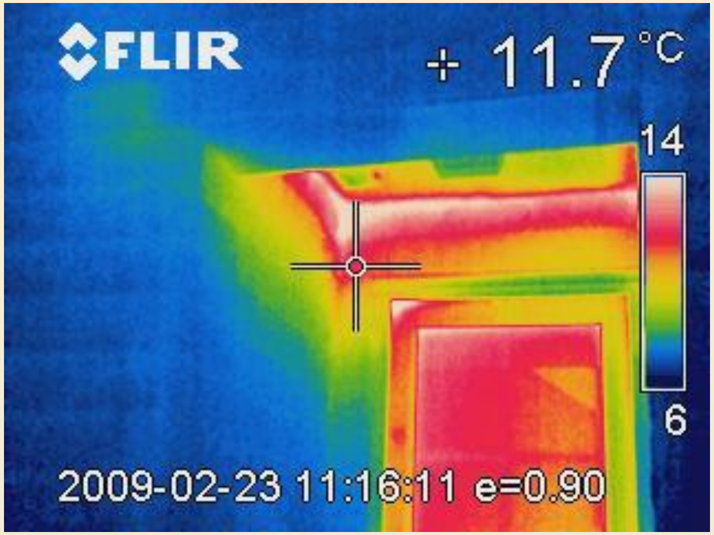

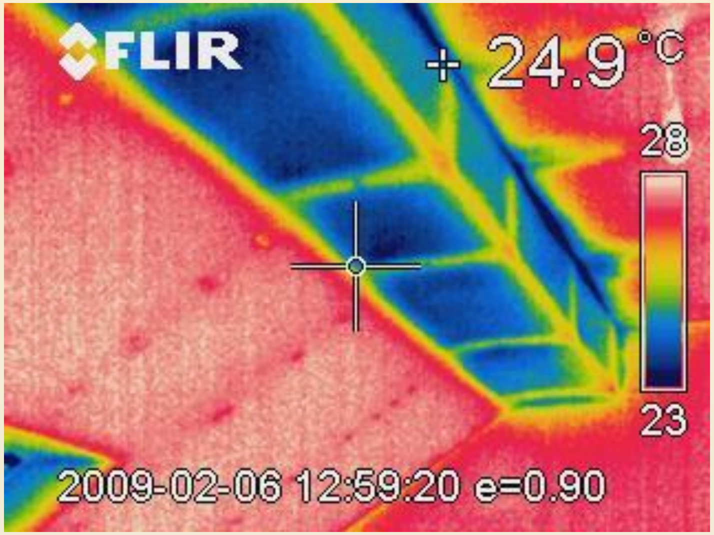

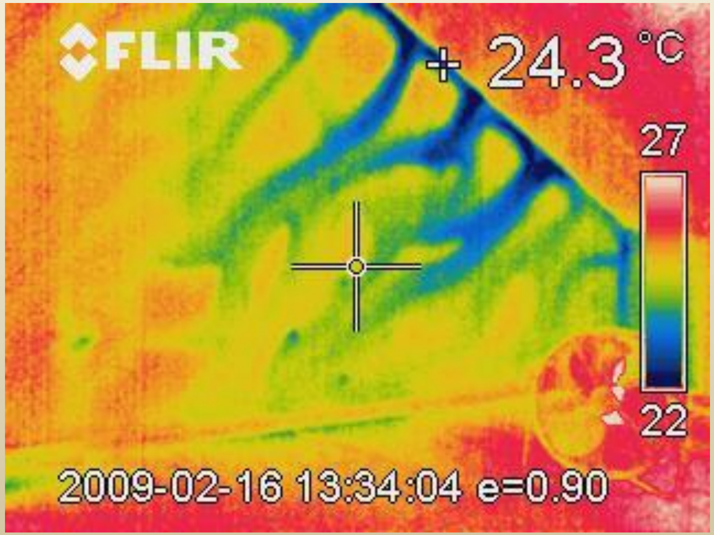

Implications for Building Regulations

HM Government

Section 5: Quality of construction and commissioning

CRITERION 4 – BUILDING PERFORMANCE CONSISTENT WITH *DER*

Fully filling the cavity may have implications for sound transmission through party walls. Developers who follow this route must satisfy the BCB that the requirements of Part E will be satisfied, either by adopting a full fill detail accredited under

Table 3 U-values for party walls

Party wall construction	U-value (W/m²K)
Solid	0.0
Unfilled cavity with no effective edge sealing	0.5
Unfilled cavity with effective sealing around all exposed edges and in line with insulation layers in abutting elements	0.2
A fully filled cavity with effective sealing at all exposed edges and in line with insulation layers in abutting elements	0.0

5.8 The party wall is a particular case of the more general thermal bypass problem that occurs where the air barrier and the insulation layer are not contiguous and the cavity between them is subject to air movement. To avoid the consequent reduction in thermal performance, either the insulation layer should be contiguous with the air barrier at all points in the building envelope, or the space between them should be filled with solid material such as in a masonry wall.

Thermal bridges

For new buildings, such scheme(s) accredit and quality assure the calculation of the linear thermal transmittance, accredit details in terms of buildability and have an associated quality assurance regime that inspects a sample of sites to confirm that the details are being implemented correctly. The use of such schemes may also allow a reduction in the Building Control charges.

b. To use details that have not been subject to independent assessment of the construction method. However, in this case, the linear thermal transmittance should still have been

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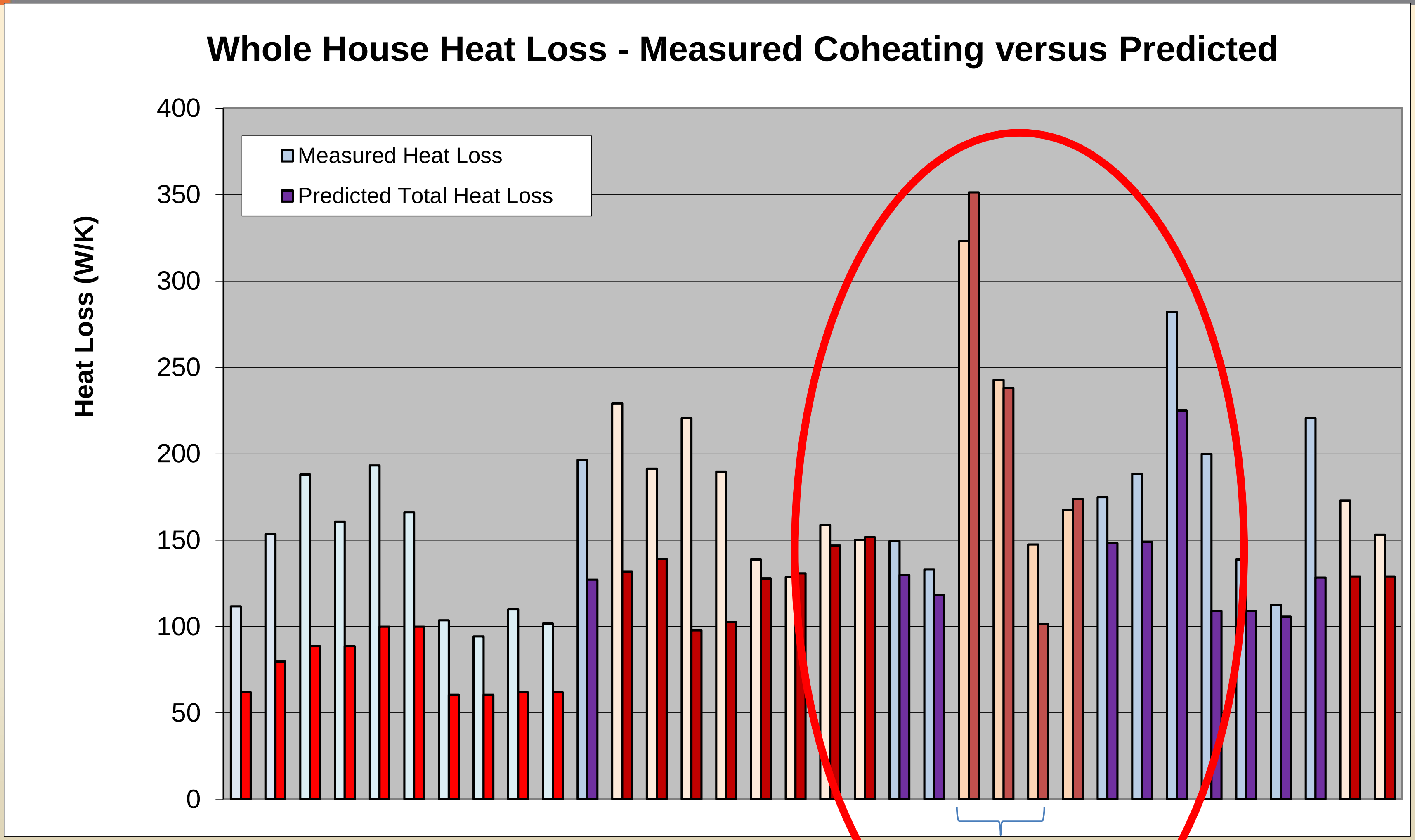
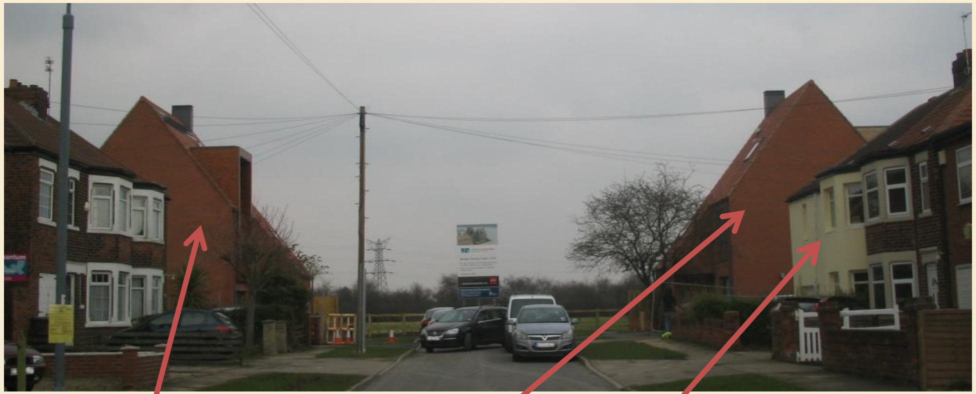


Existing dwellings

2009/10: Temple Avenue Project, York



Project funded by the Joseph Rowntree Housing Trust

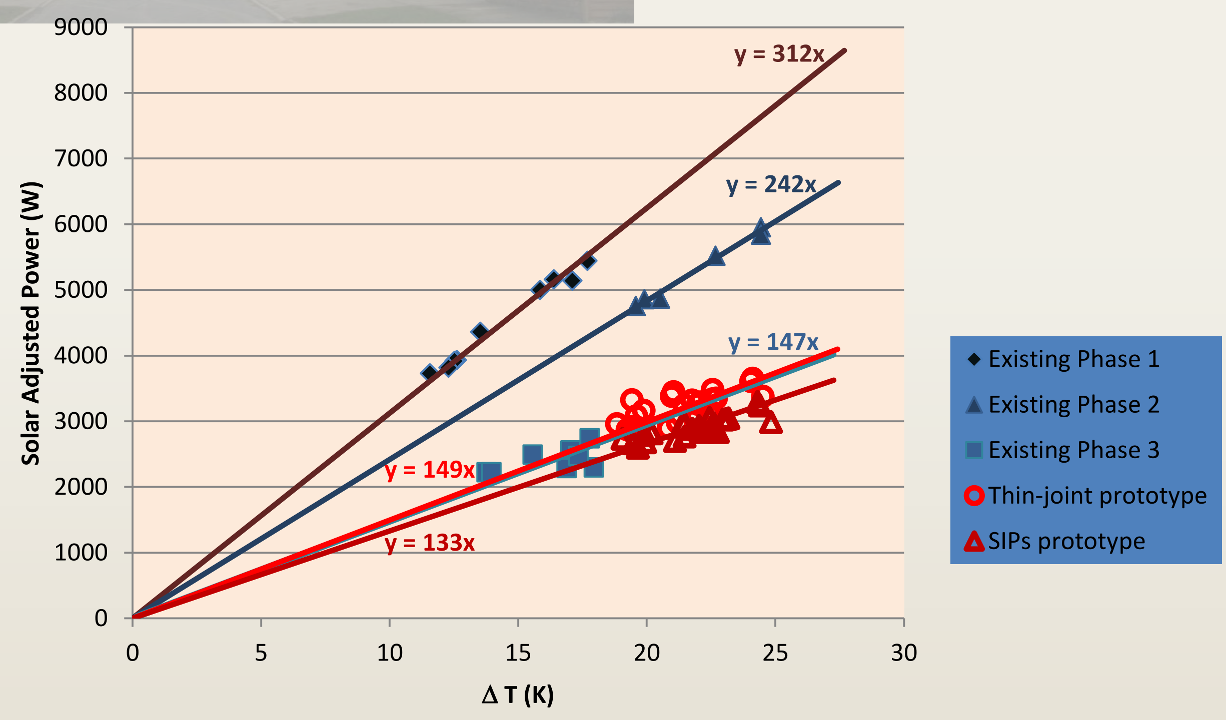
Thin-Joint Masonry & SIPs Construction
Code for Sustainable Homes Level 4
Prototypes for a 540-home development

Standard 1930's semi-detached property
2-stage refubishment:

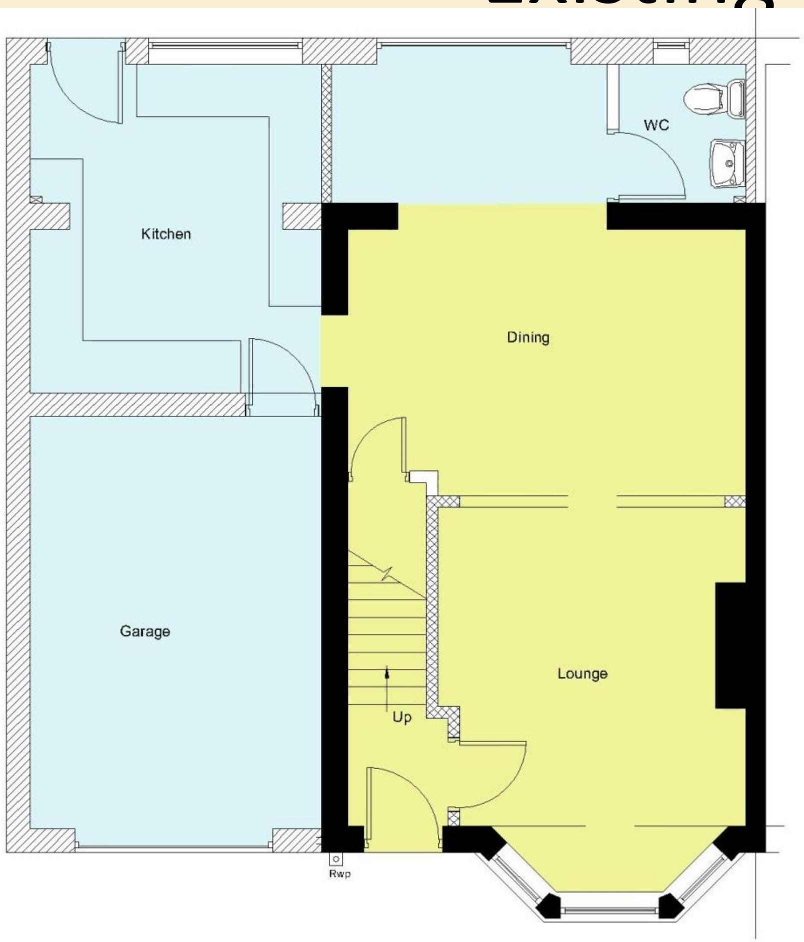
1. Standard decent homes upgrade
2. Enhance energy performance to the same level as the prototypes

2009/10: Temple Avenue Project, York

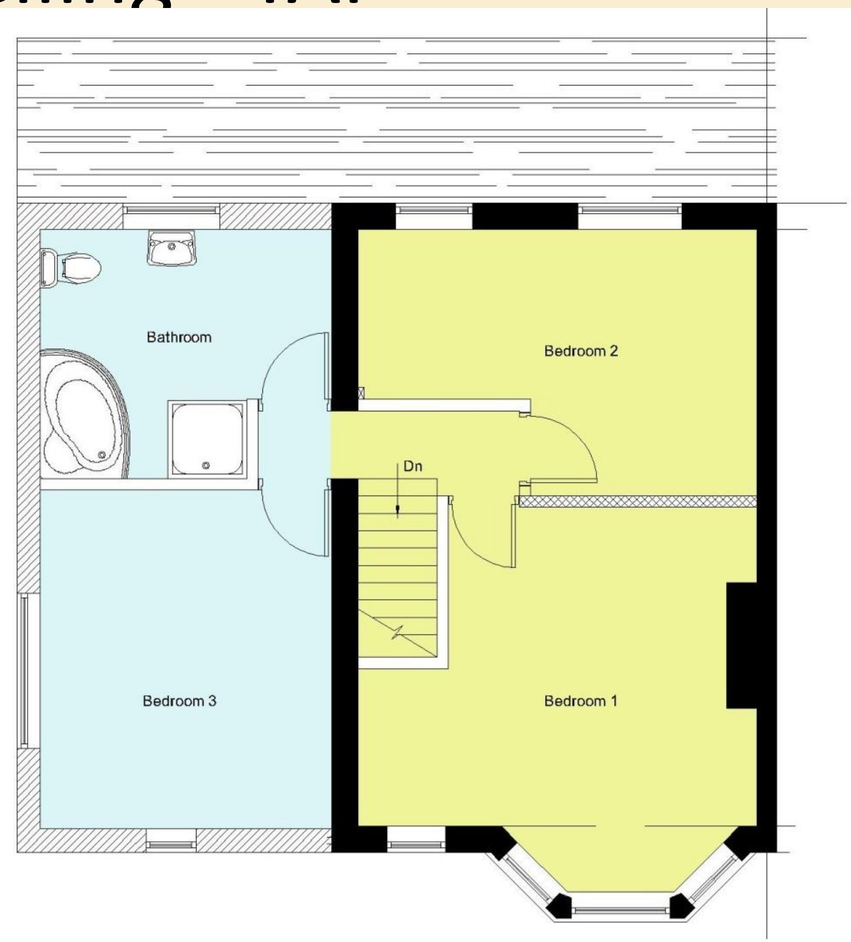
Project funded by the Joseph Rowntree Housing Trust



Existing dwelling - TAP

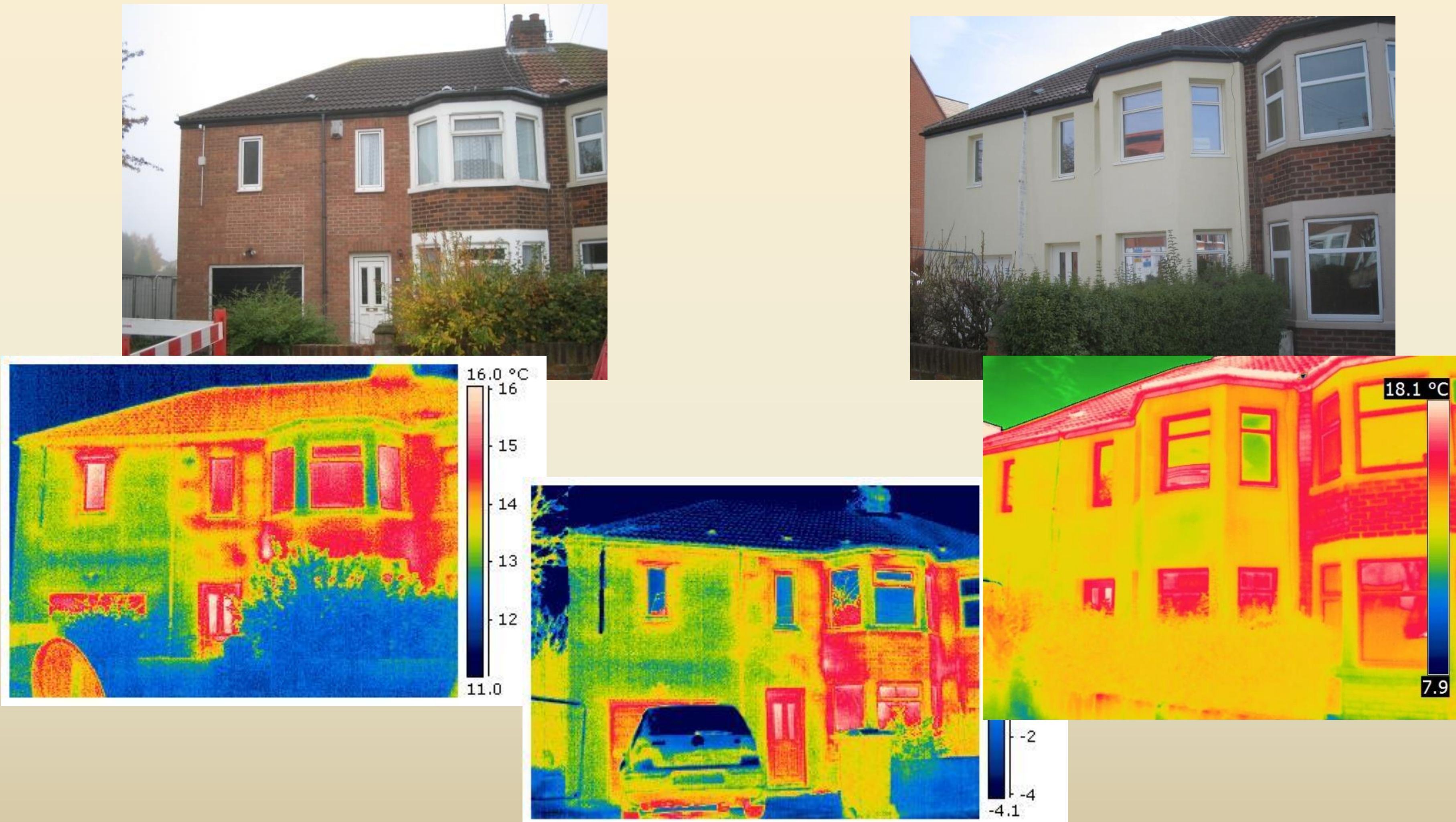


GROUND FLOOR PLAN

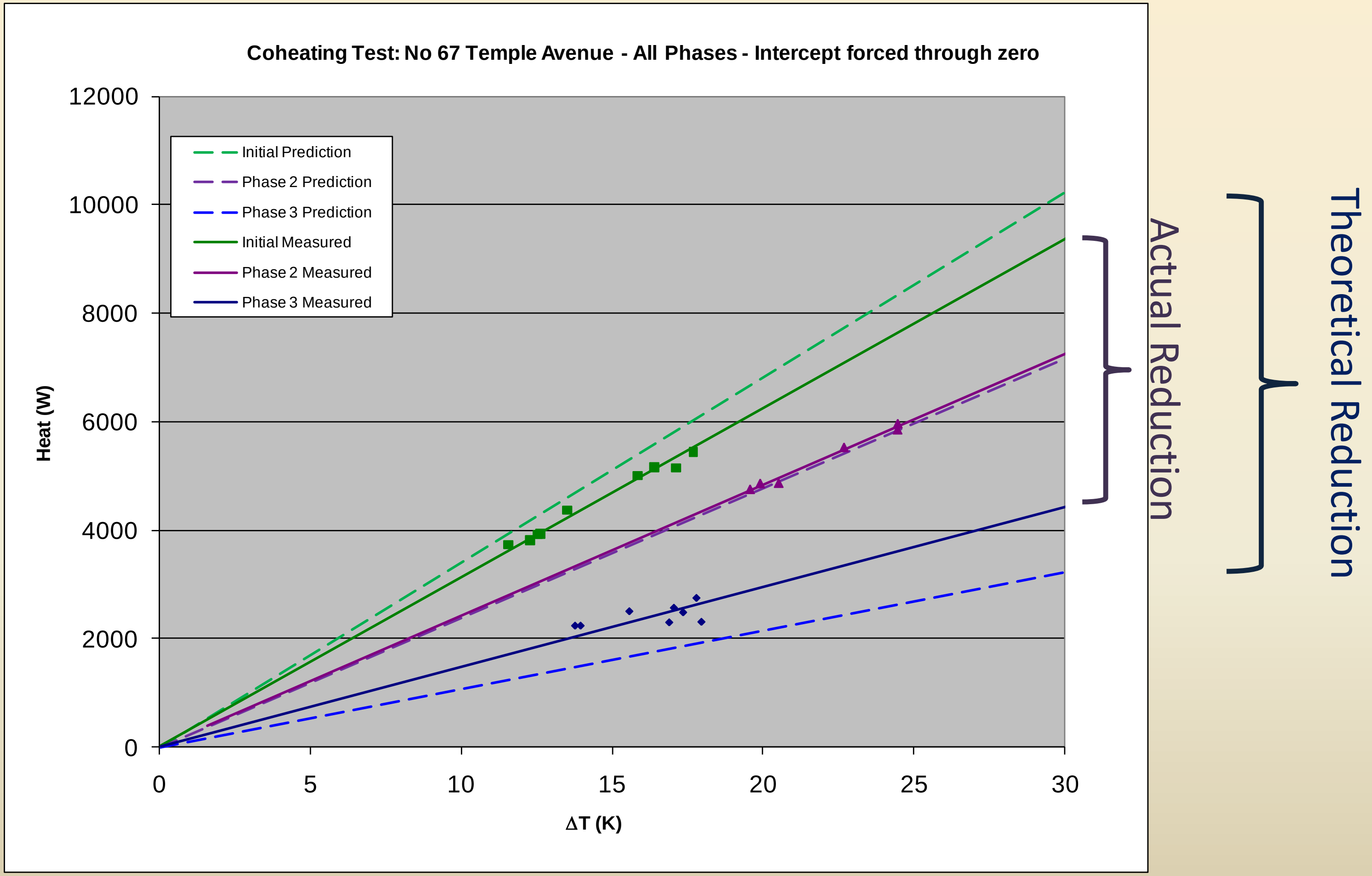


FIRST FLOOR PLAN

Existing dwellings - TAP



Existing dwelling - TAP



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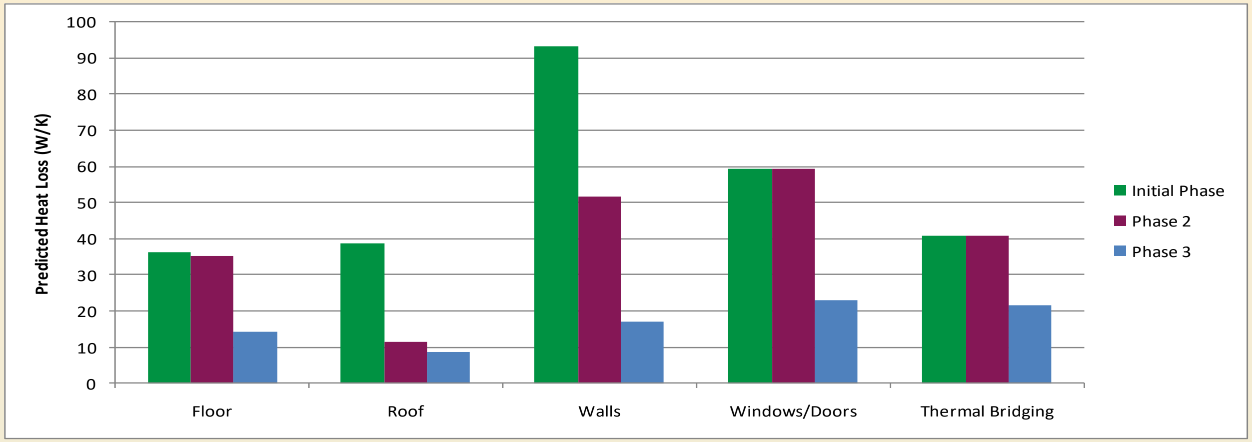

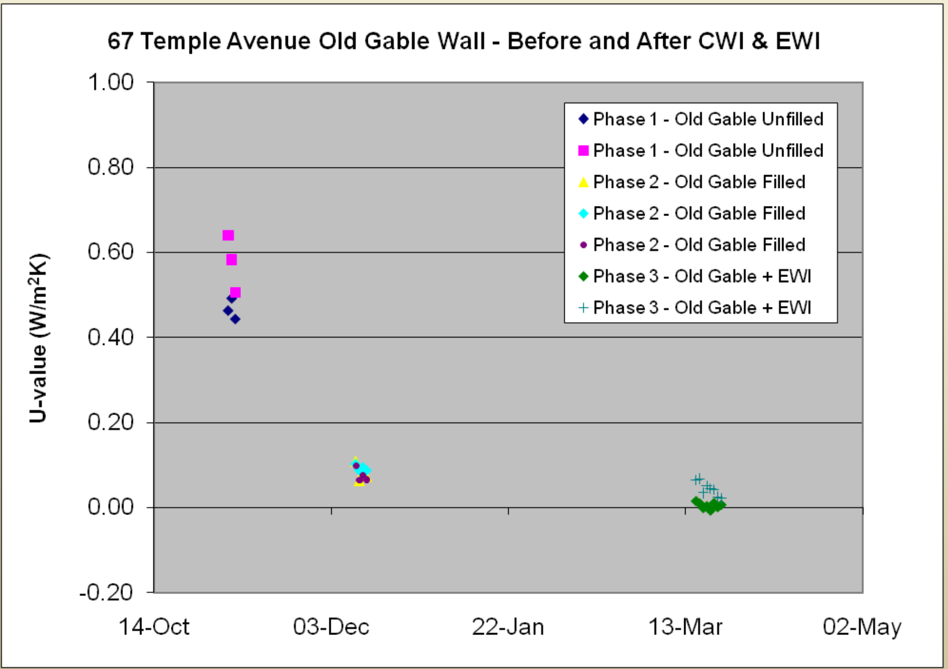

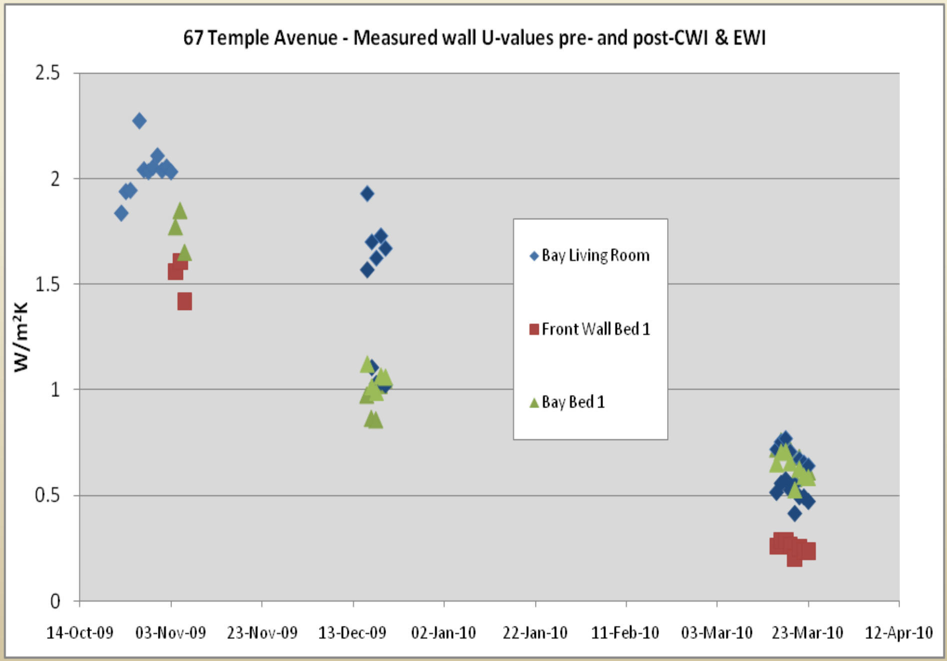

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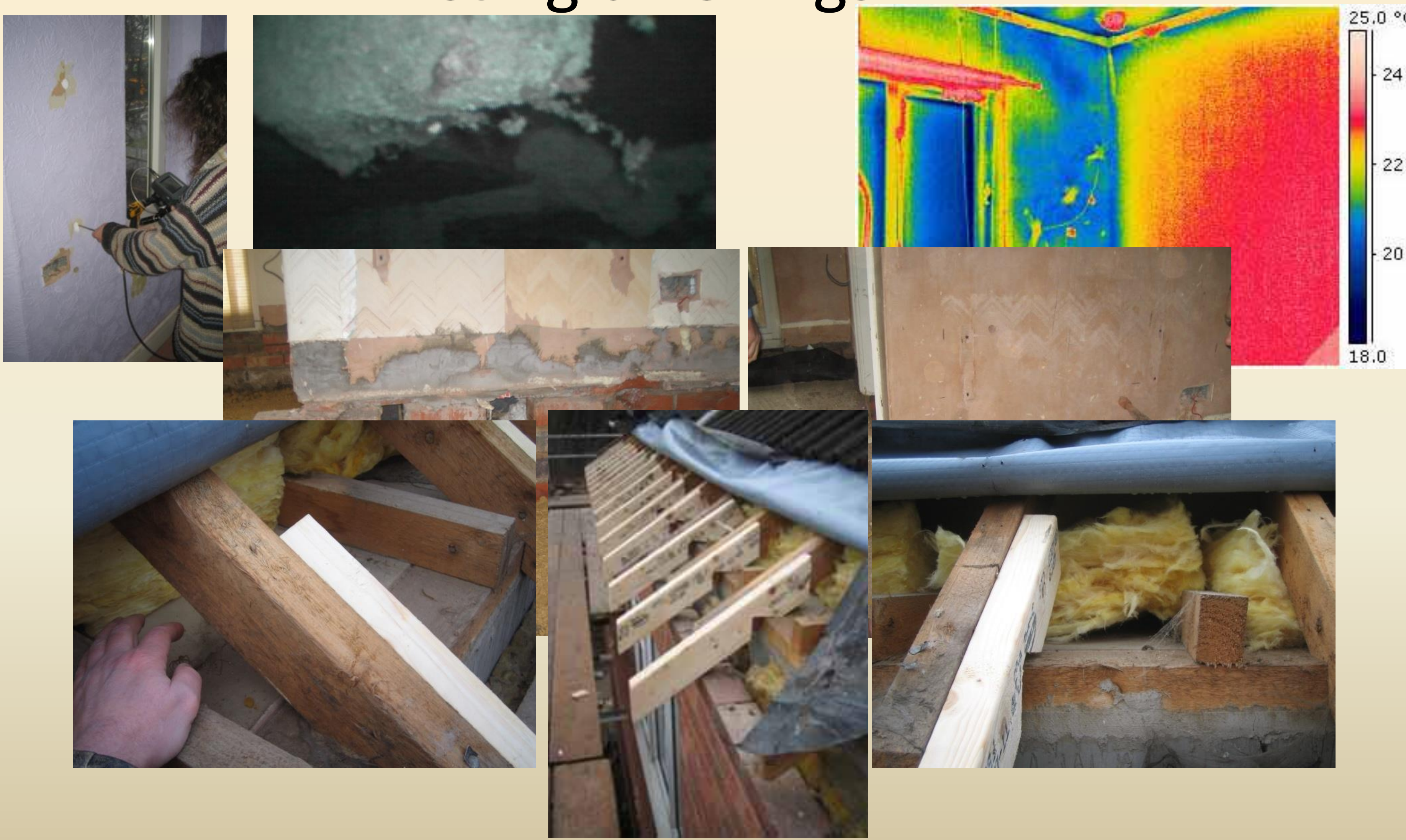
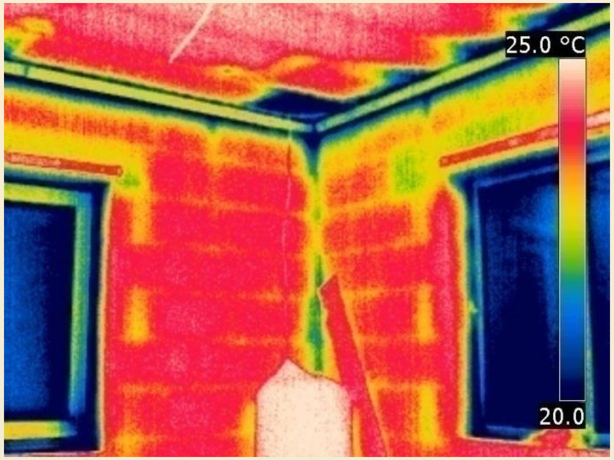
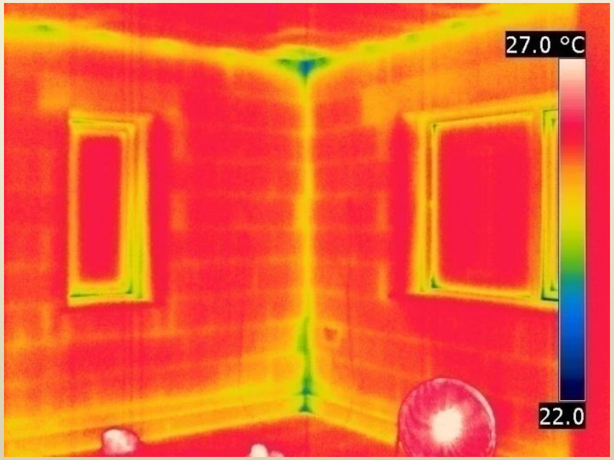


Existing dwellings - TAP





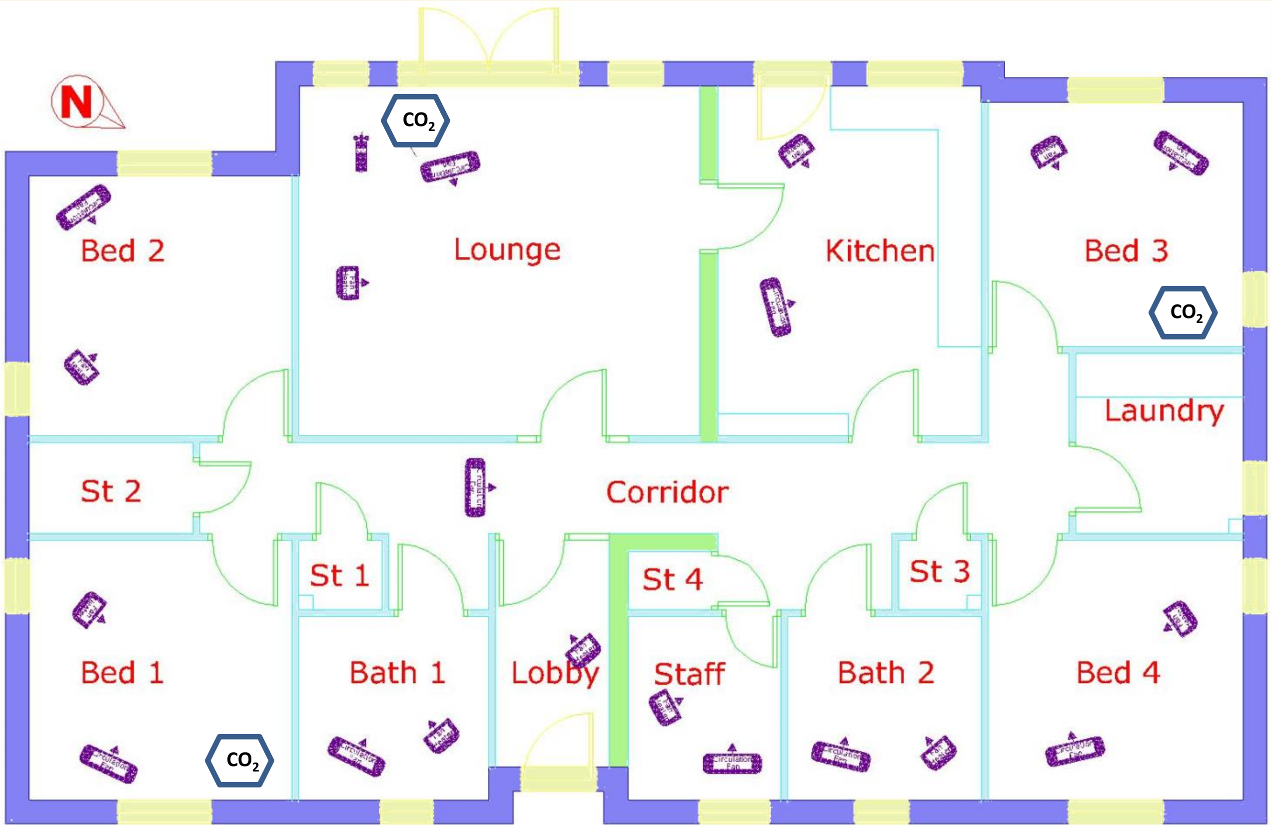
Existing dwellings - TAP







Closing the Loop



Closing the Loop

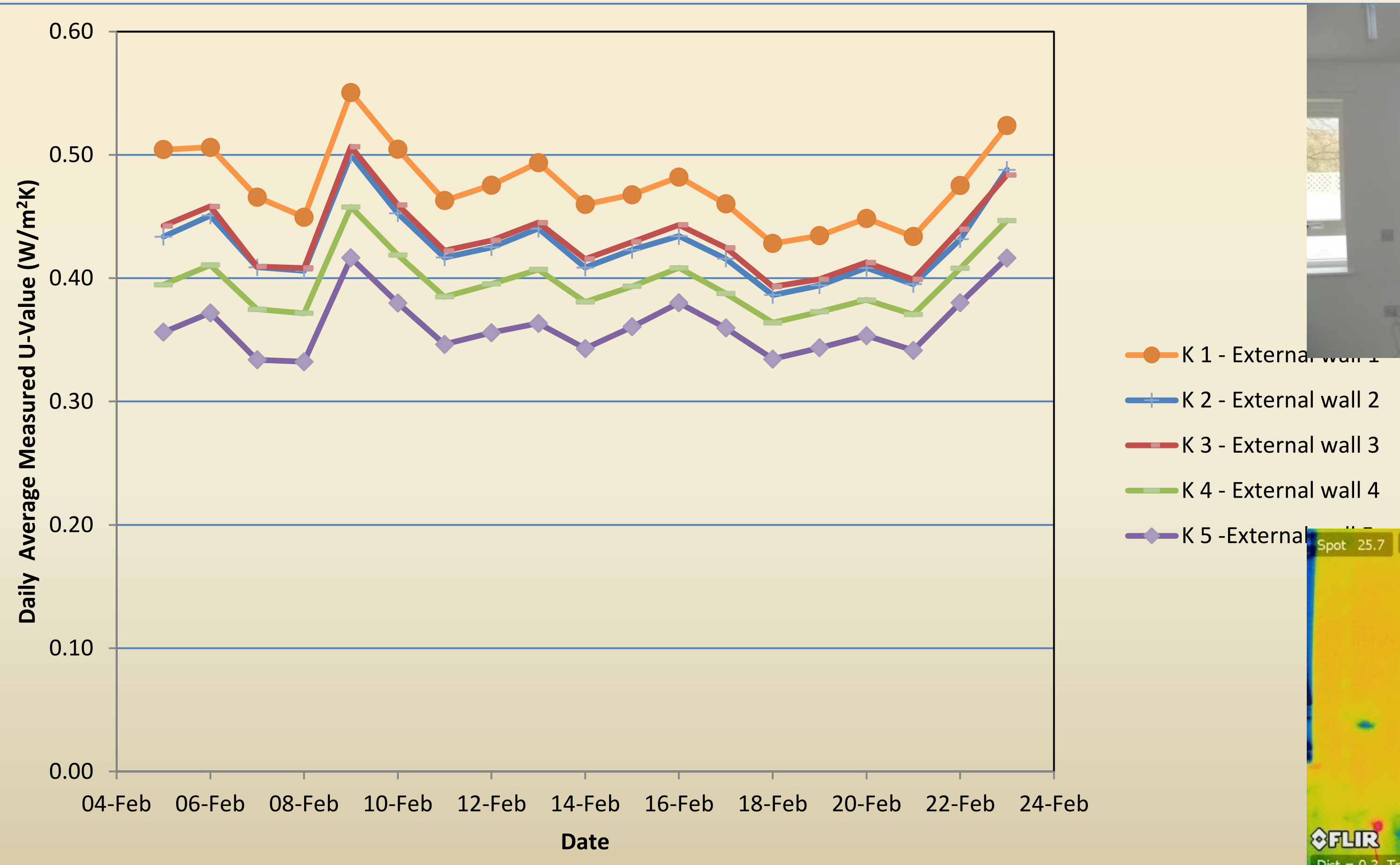
Ventilation Heat Loss

Air Permeability (m³/(h.m²) @ 50Pa)					Mean Permeability used for coheating calculations
Date	09-Nov-10	14-Jan-11	01-Feb-11	25-Feb-11	
Plot 6	9.28	3.85	4.31	4.48	4.395
	pre-completion	Building Regs compliance	pre-coheating	post-coheating	(5.15 h^{-1}@50Pa)

Ventilation Rate (h^{-1}, (Roulet & Foradini 2002))				Mean Wind Speed
Date	Bedroom 1	Lounge	Bedroom 3	
11 Feb	**0.31**	**0.32**	**0.31**	**1.02**
12 Feb	**0.29**	**0.31**	**0.30**	**1.75**
13 Feb	**0.35**	**0.38**	**0.35**	**2.64**
19 Feb	**0.35**	**0.34**	**0.34**	**1.74**
20 Feb	**0.35**	**0.37**	**0.34**	**2.04**

Closing the Loop

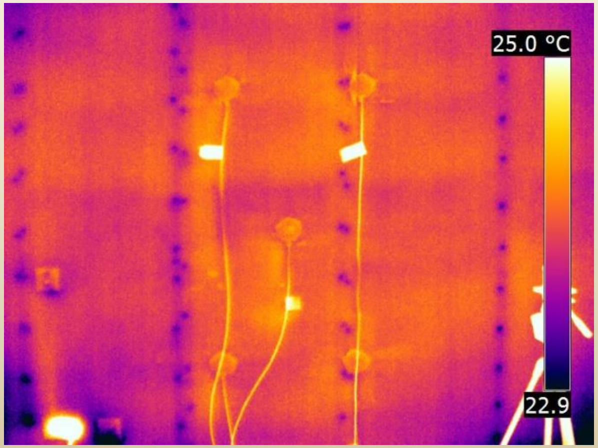
External Wall Measurements



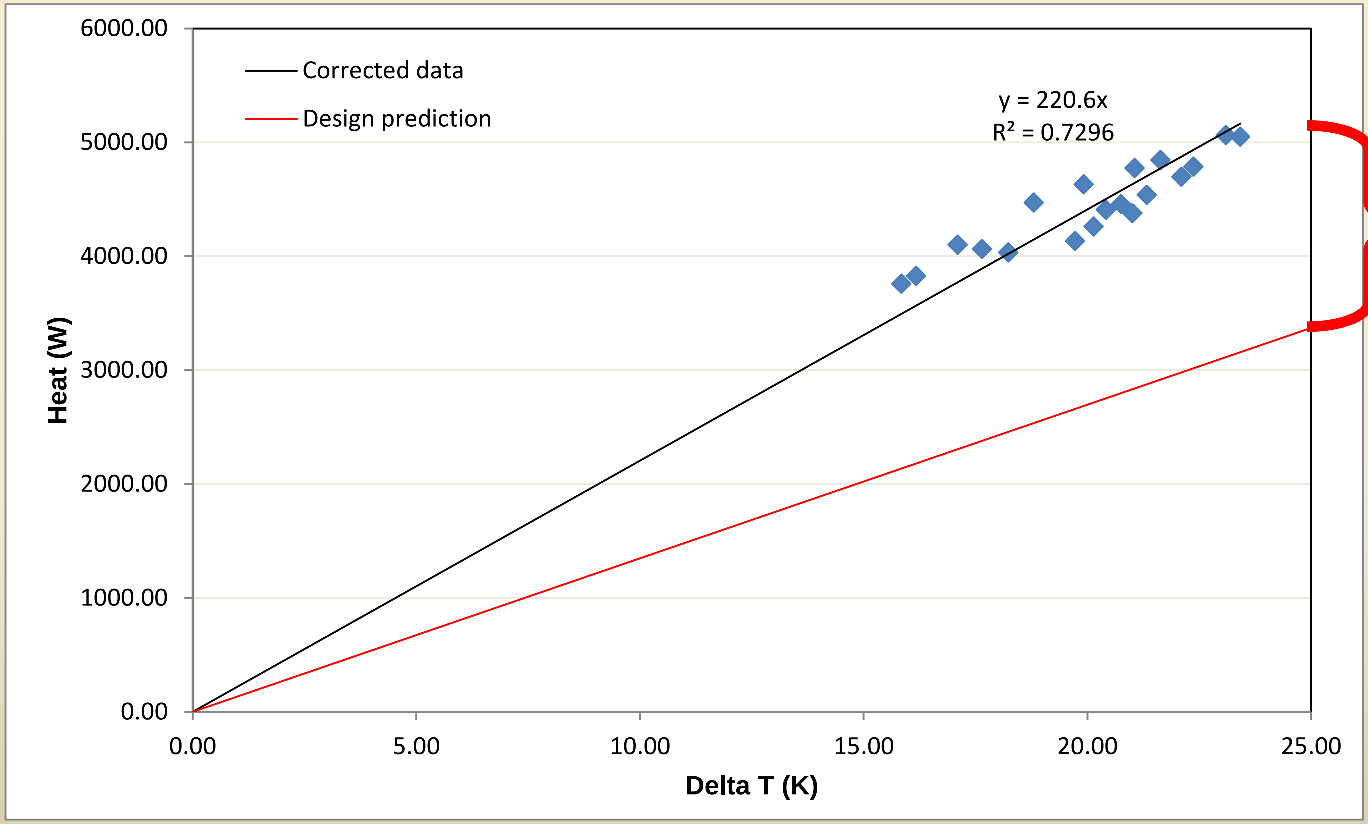
Closing the Loop

External Wall Measurements

4 5
3
1 2



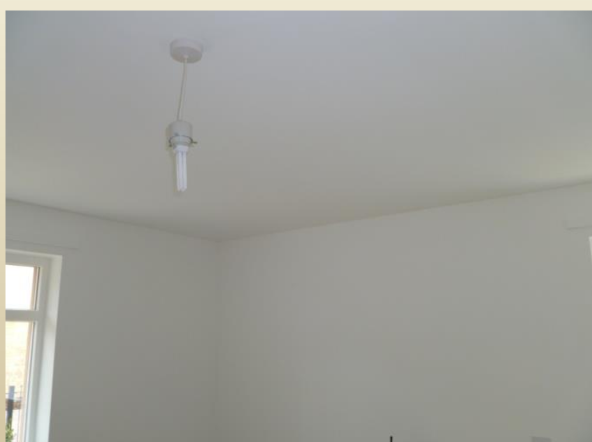
Closing the Loop

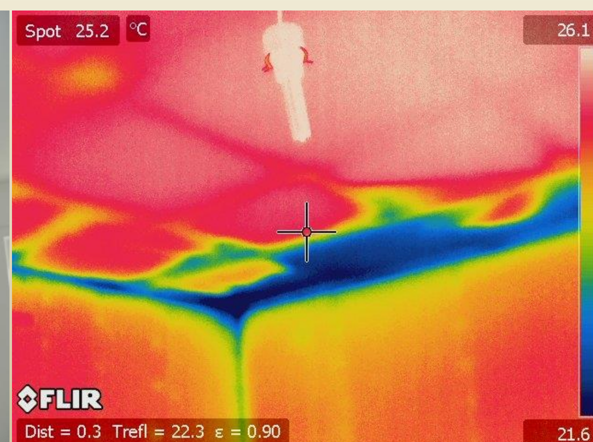


64% greater heat loss than predicted

Closing the Loop

Thermal Bridging

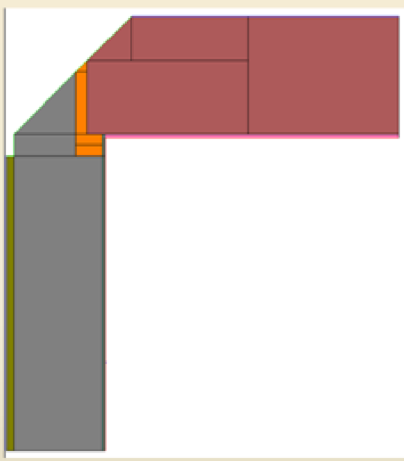




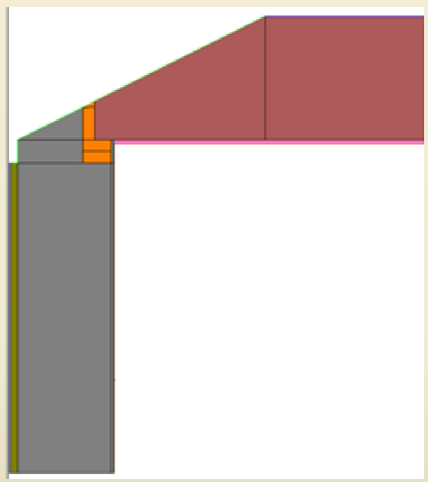
Closing the Loop

Thermal Bridging

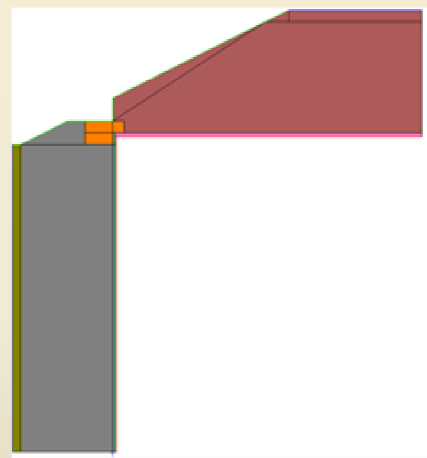
Therm 5.2 model: 300mm Hemcrete (λ= 0.06 W/mK), 89mm Timber stud (λ = 0.13 W/mK), 400mm Loft insulation (λ = 0.042 W/mK)



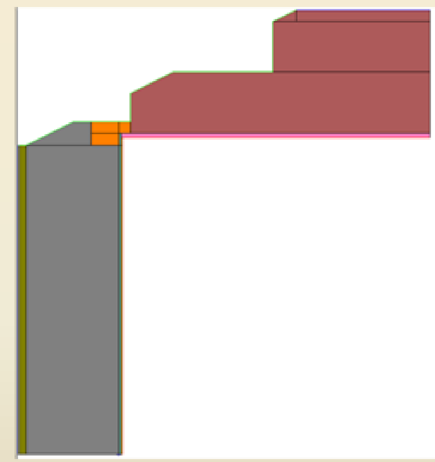
Ψ= 0.026 W/mK
45° Pitch



Ψ= 0.043 W/mK
30° Pitch



Ψ= 0.084 W/mK
'as-built' - ideal

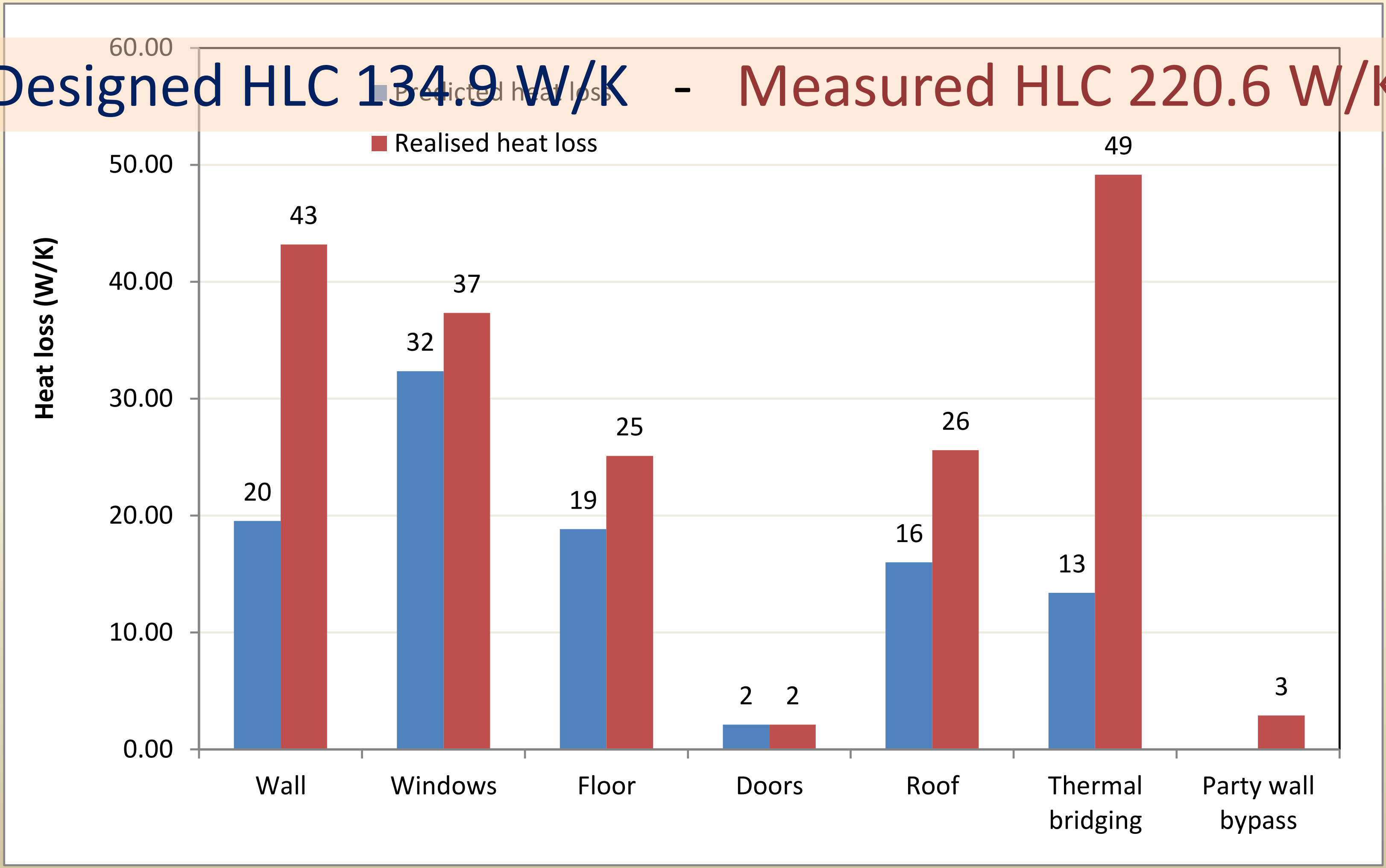


Ψ= 0.109 W/mK
'as-built' - practice

SAP 2009, Appendix Q, Table K1 :	Eaves detail to ACD	Ψ = 0.06 W/mK
	Default value	Ψ = 0.12 W/mK

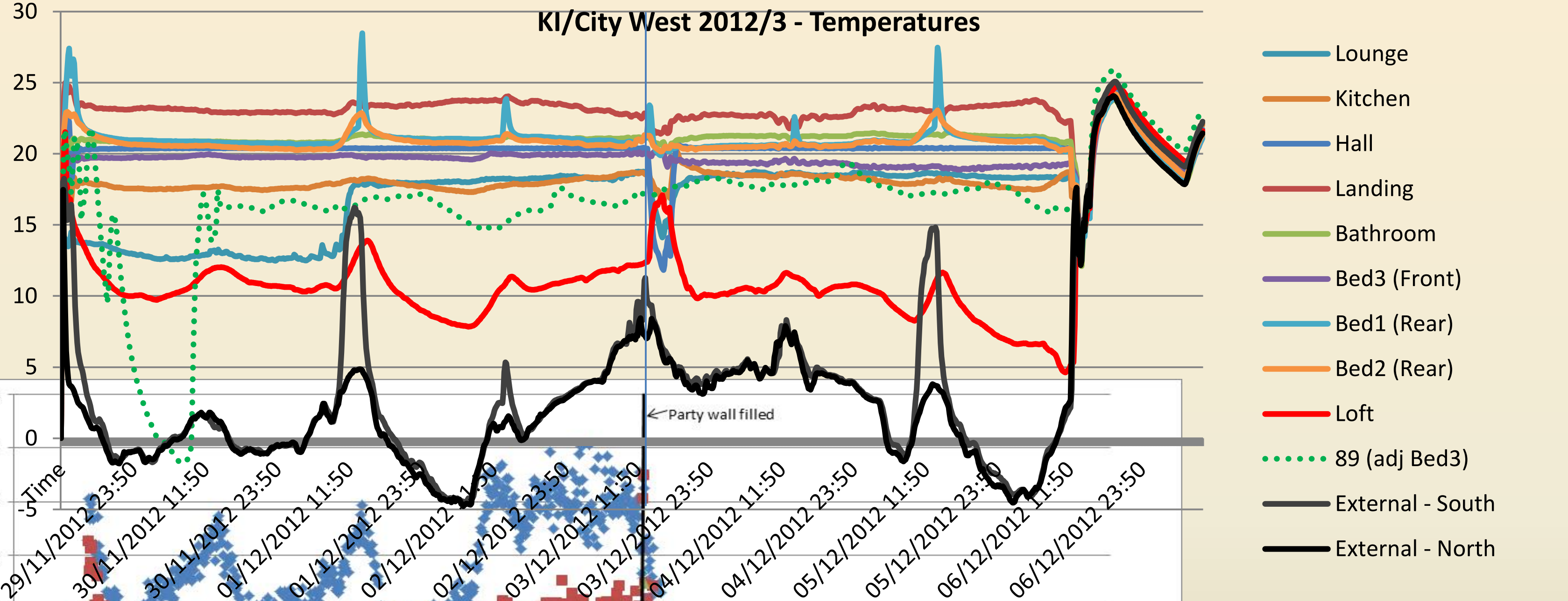
Closing the Loop

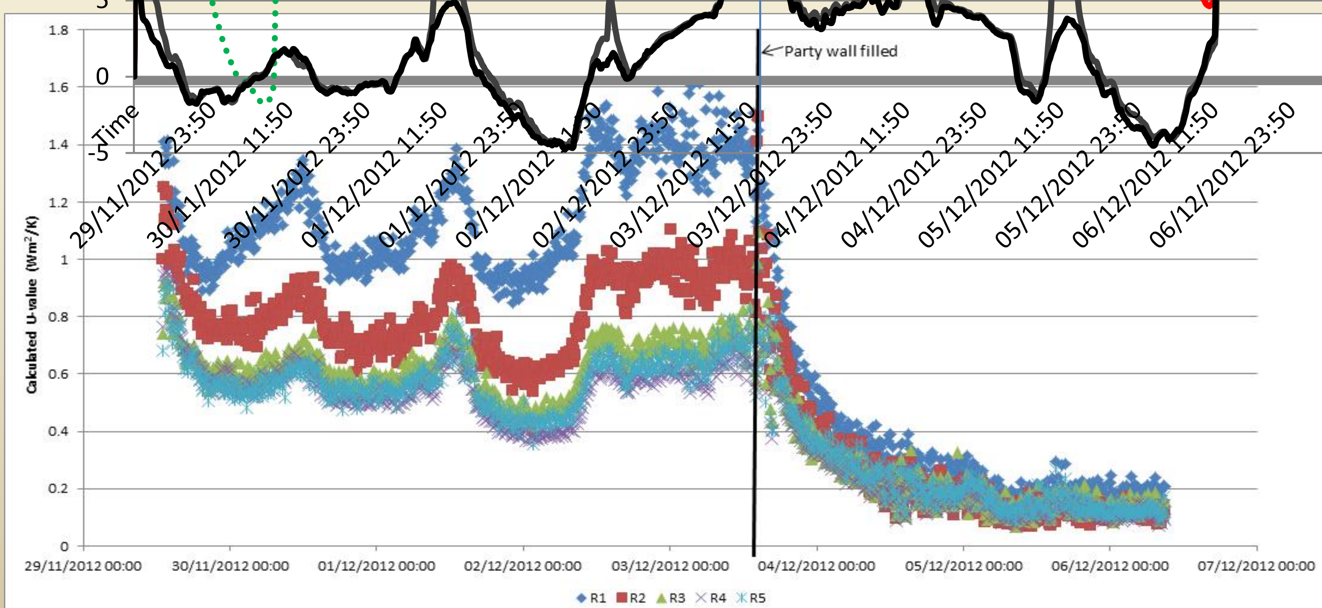
Designed HLC 134.9 W/K - Measured HLC 220.6 W/K



Simple Tests

Simple Tests

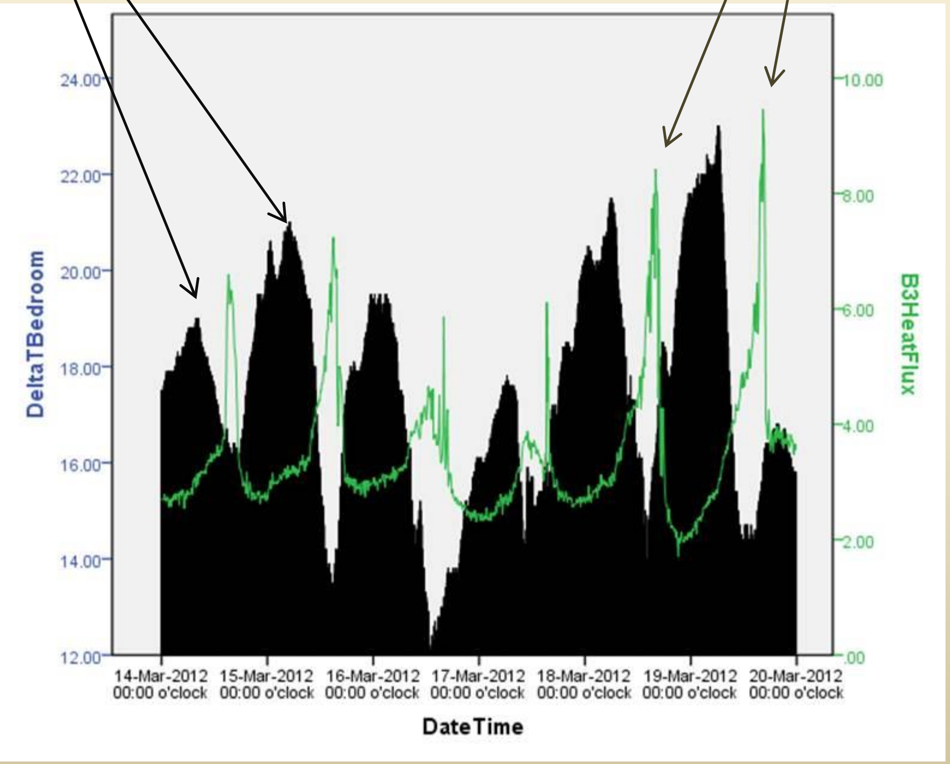




Simple Test Issues: Thermal Lag

Maximum ΔT

Maximum Heat Flux



CeBE Centre for the Built Environment

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Whole House Heat Loss Test Method (Coheating)

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March – 2012

http://www.leedsmet.ac.uk/as/cebe/index.htm

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