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24th April 2013, Croke Park, Dublin

BetterBuilding

International Conference for
a Sustainable Built Environment



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IN ASSOCIATION WITH

Closing the Performance Gap: Beyond Stamford Brook

Dominic Miles-Shenton

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?

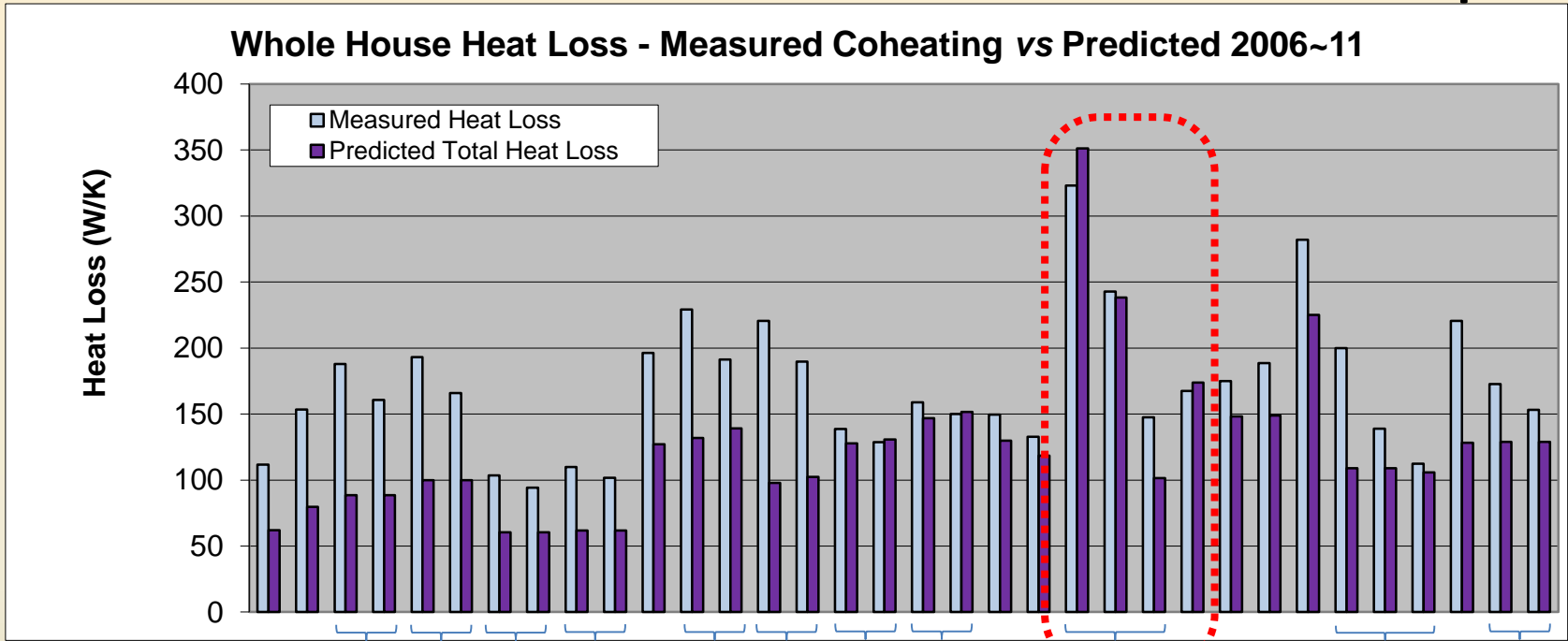
Regulatory Implications – so far...

Performance Gap for Retrofit

Closing the Loop

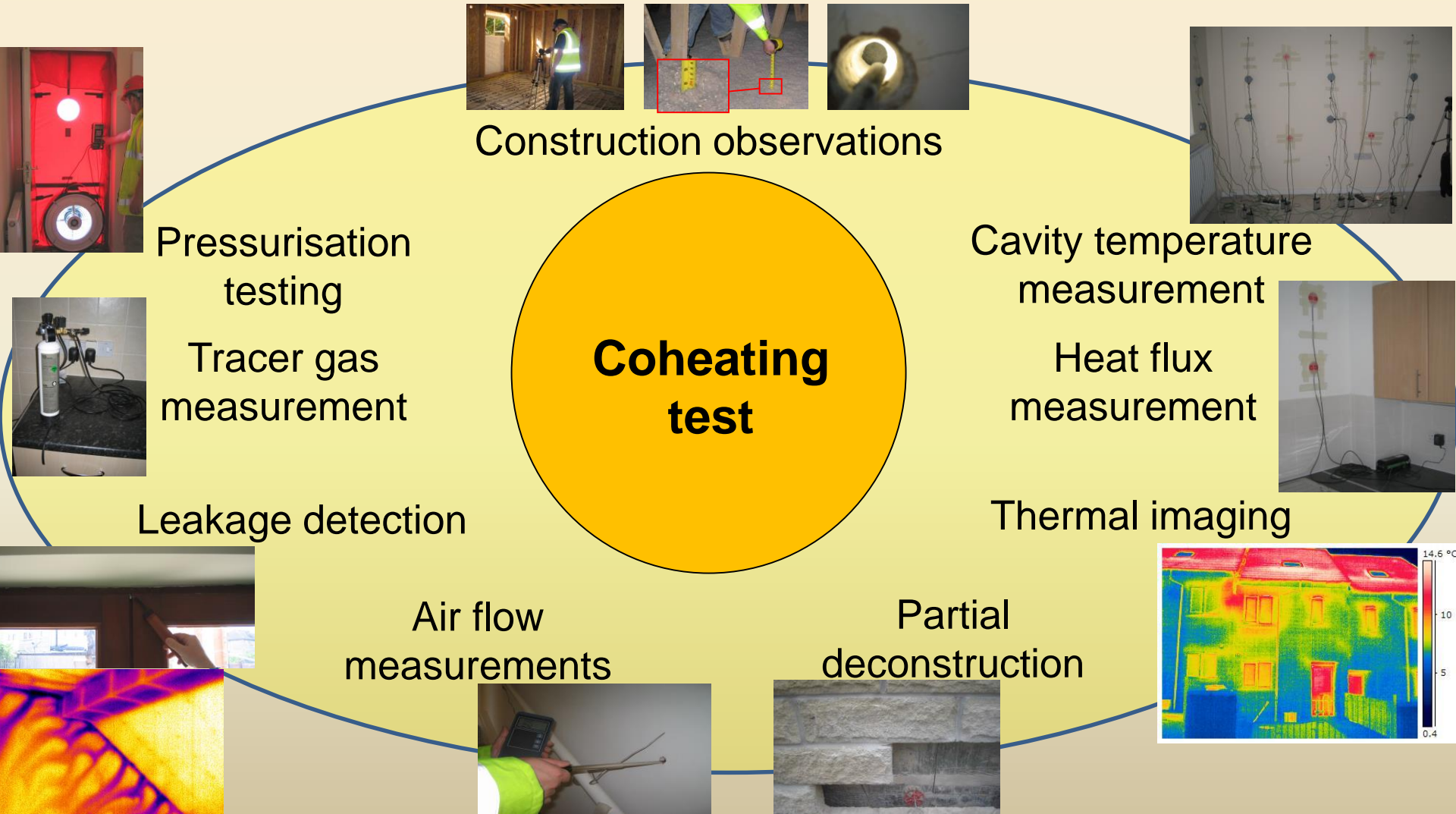
Simple Tests (do try this at home!)

Evidence for a fabric Performance Gap



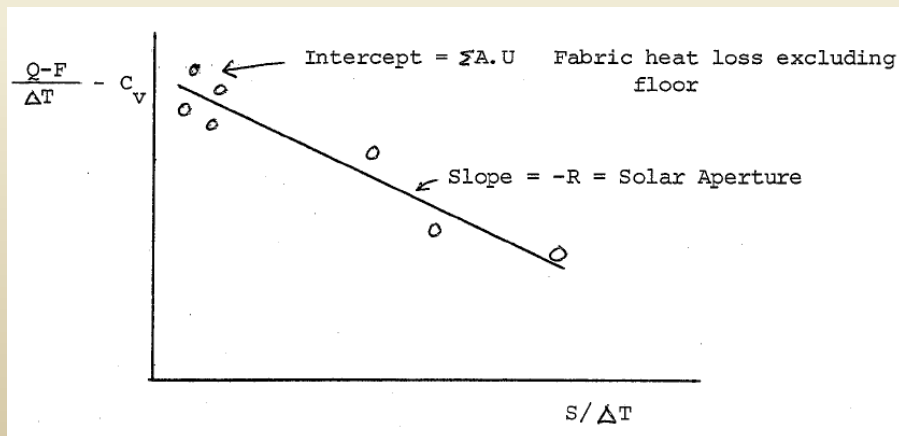
- The performance of the building fabric performance is very rarely understood and often taken for granted.
- Heat loss is often much higher than calculated during design.
- Highly dependent upon the design and installation of the insulation layers (Hens et al., 2007 and Doran, 2000).

Measuring the Performance Gap



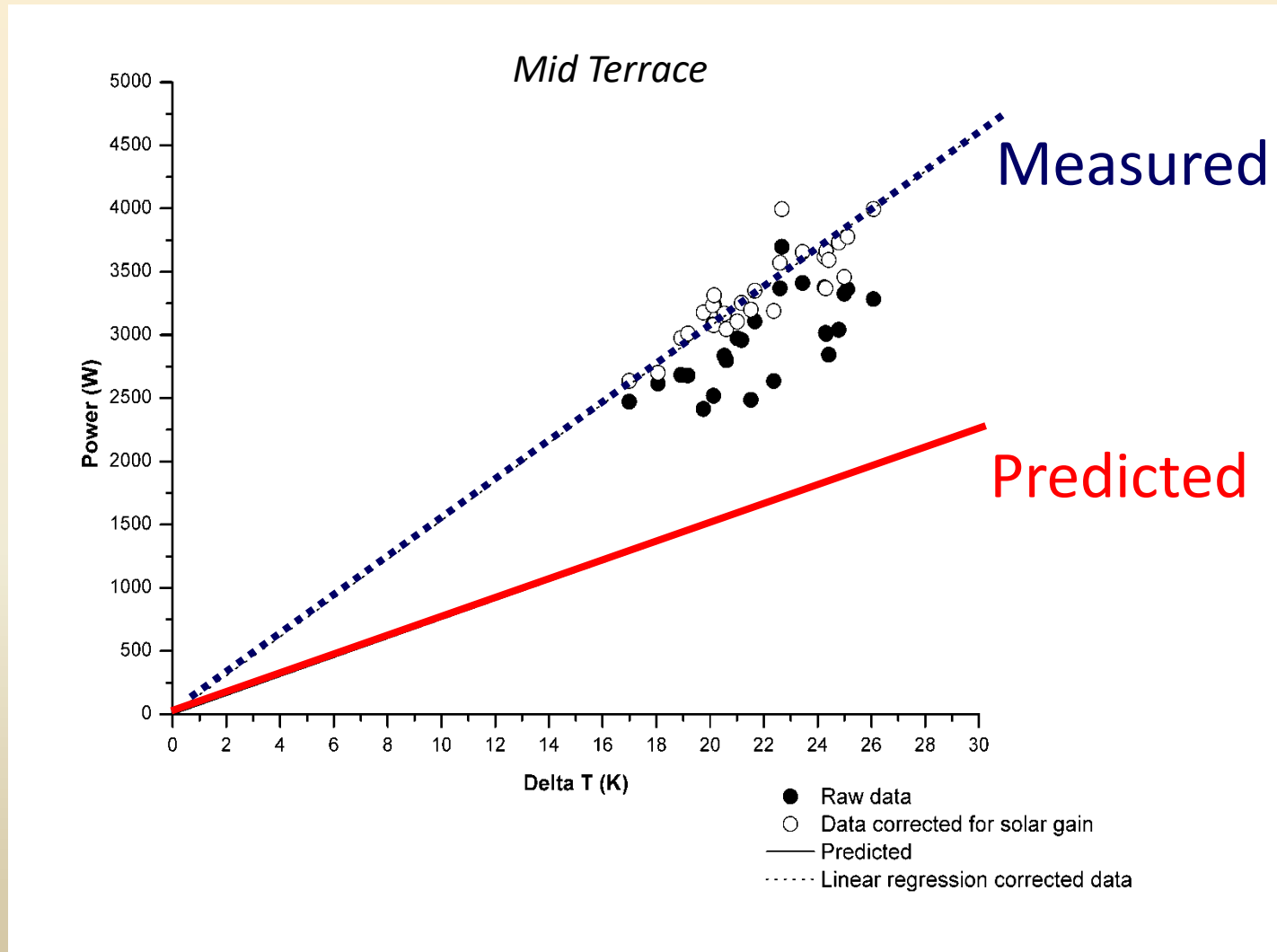
Coheating Testing

- 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

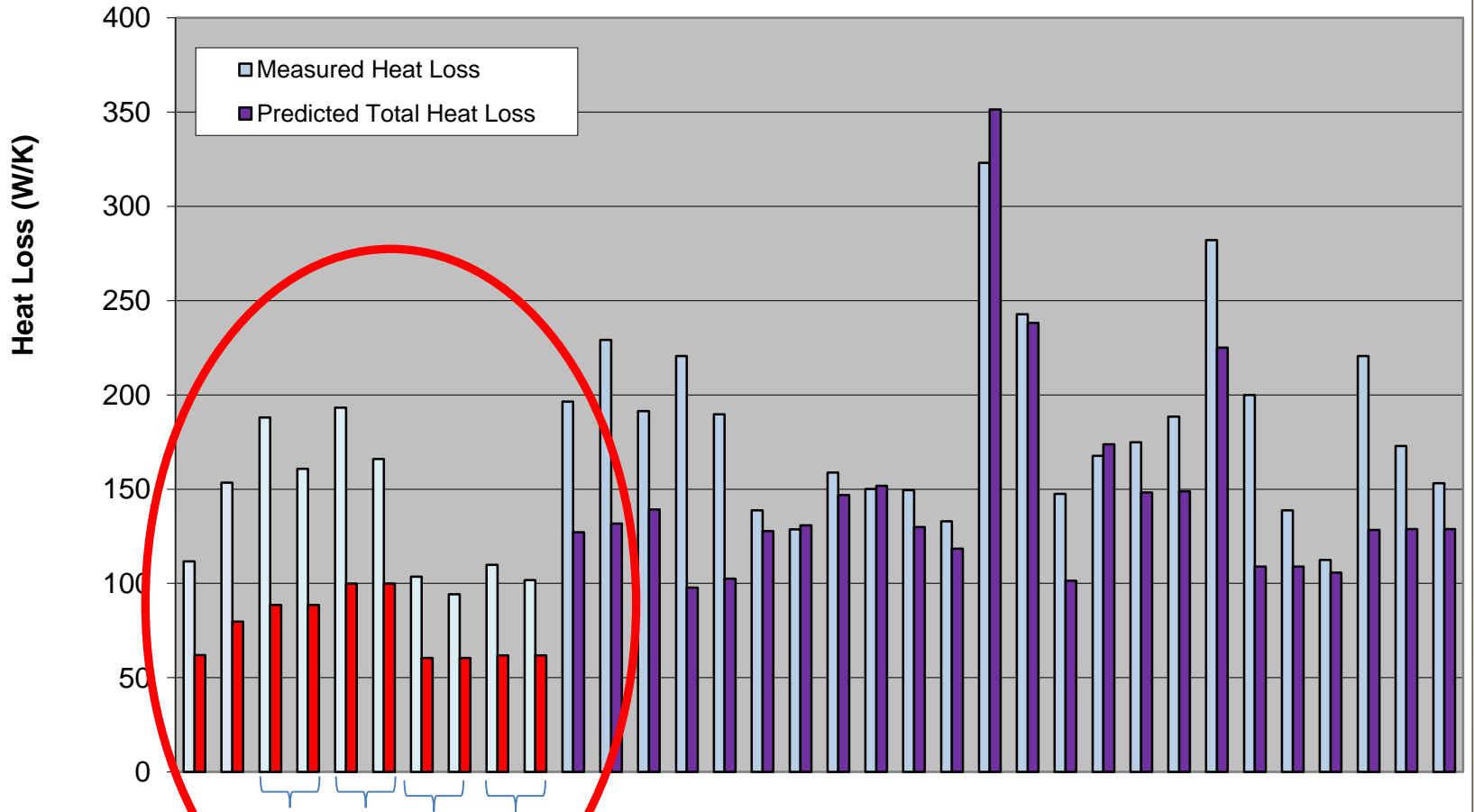


Sivour Analysis:
 (solar/ ΔT) vs. (power/ ΔT)
 Heat Loss = y intercept
 Solar Aperture = slope

Coheating Testing



Whole House Heat Loss - Measured Coheating versus Predicted



Party wall bypass investigations – Stamford Brook

Party wall bypass investigations – Stamford Brook

Mid Terrace

5000
4500

Measured Heat Loss = 153 W/K

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

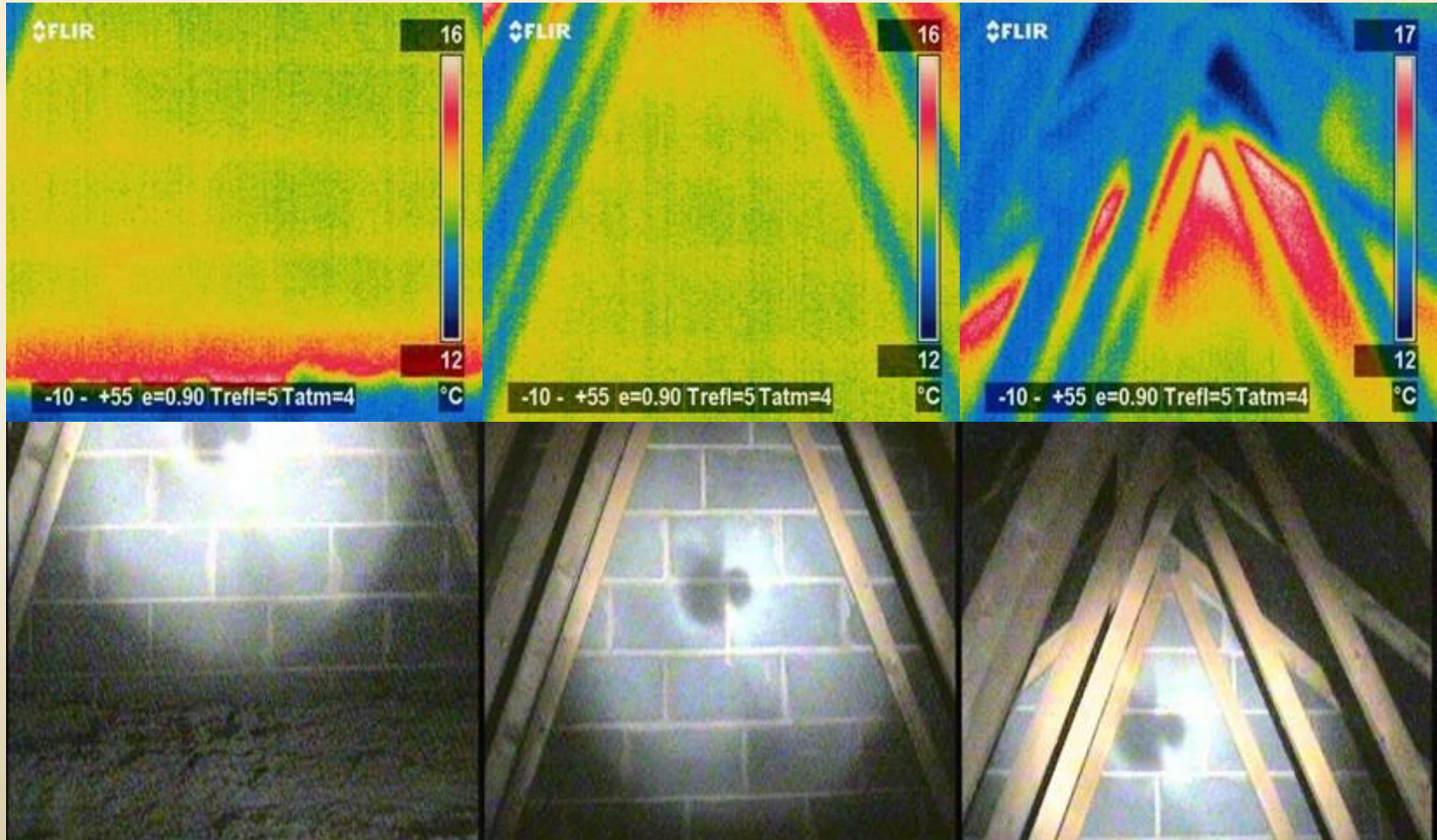
+75%

+104%

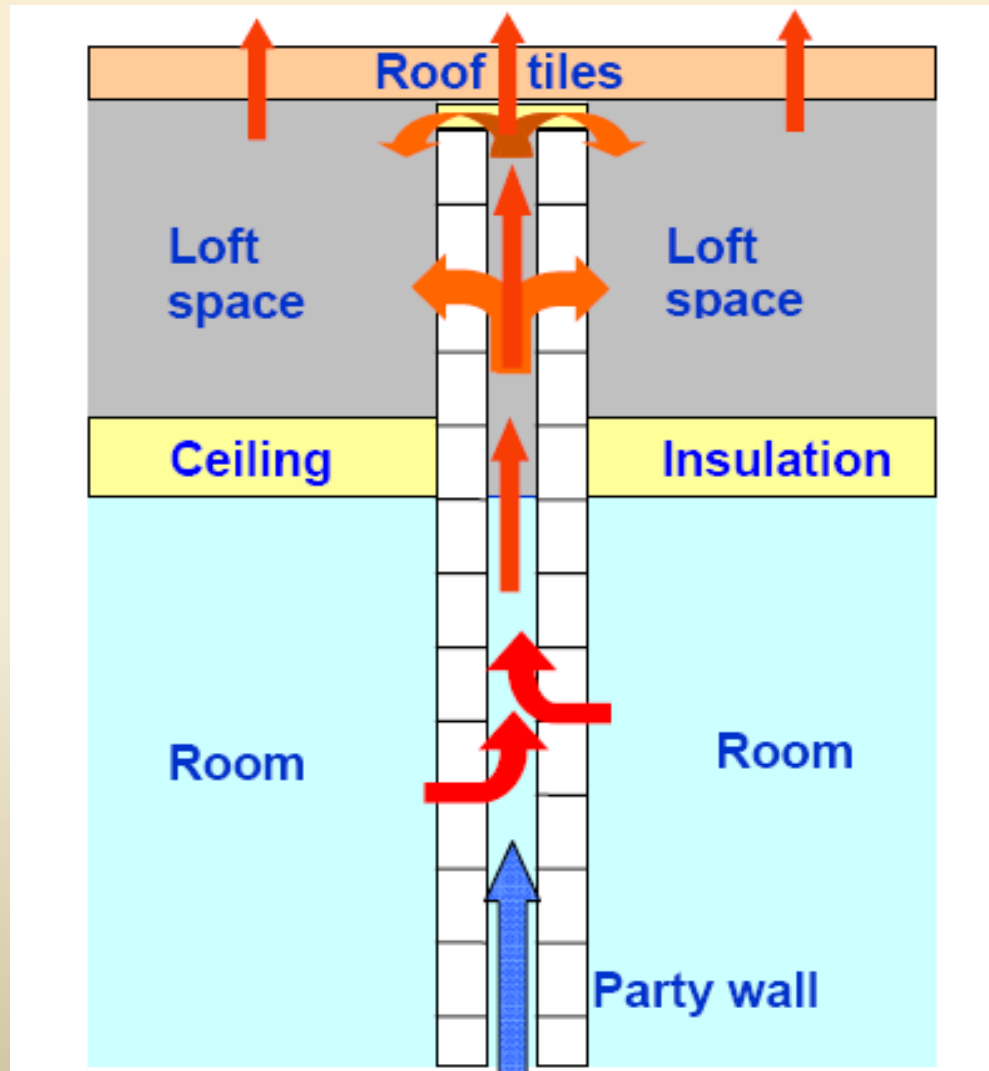
Delta T (K)

- Raw data
- Data corrected for solar gain
- Predicted
- Linear regression corrected data

Party wall bypass investigations – Stamford Brook



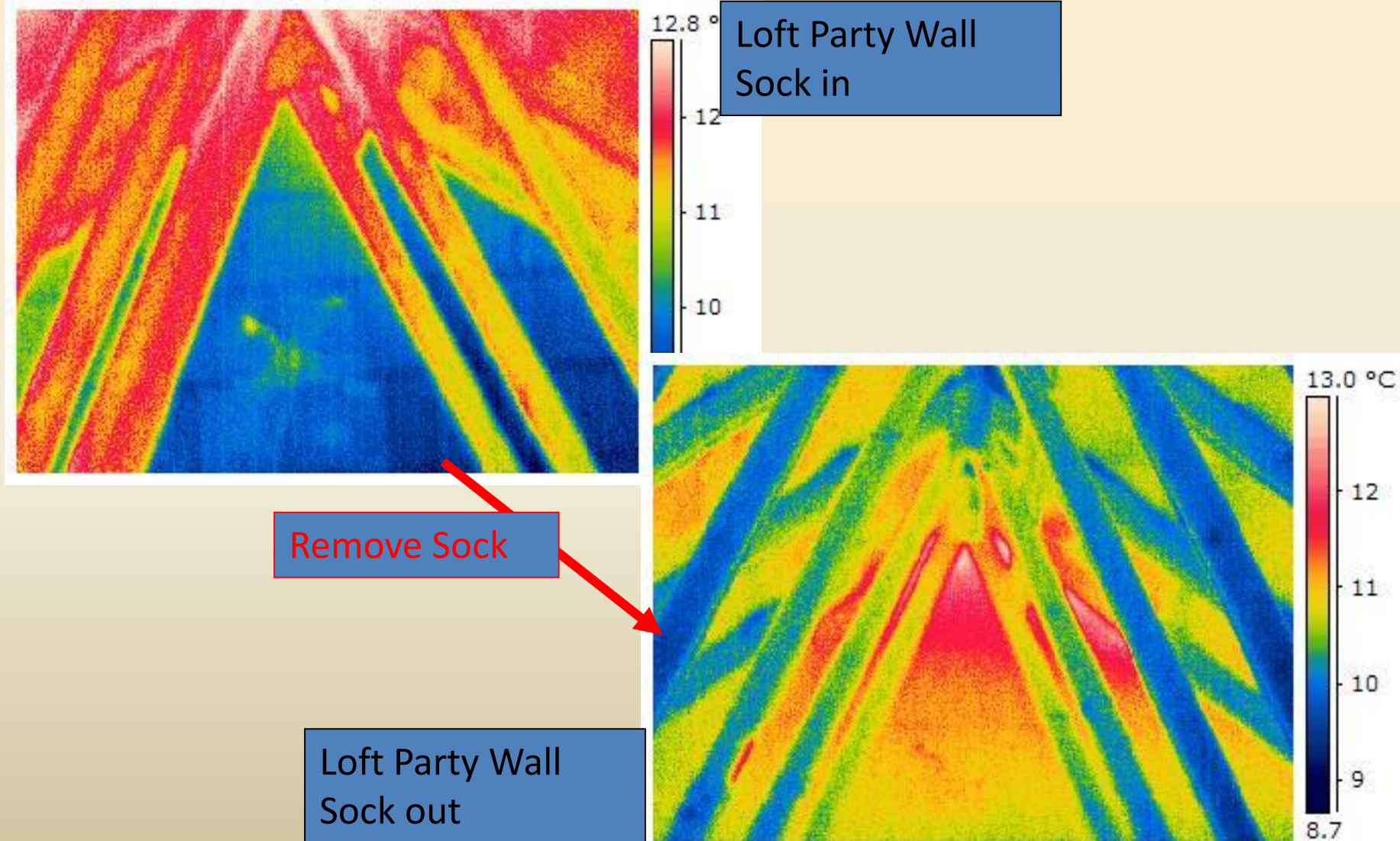
Party wall bypass investigations – Stamford Brook



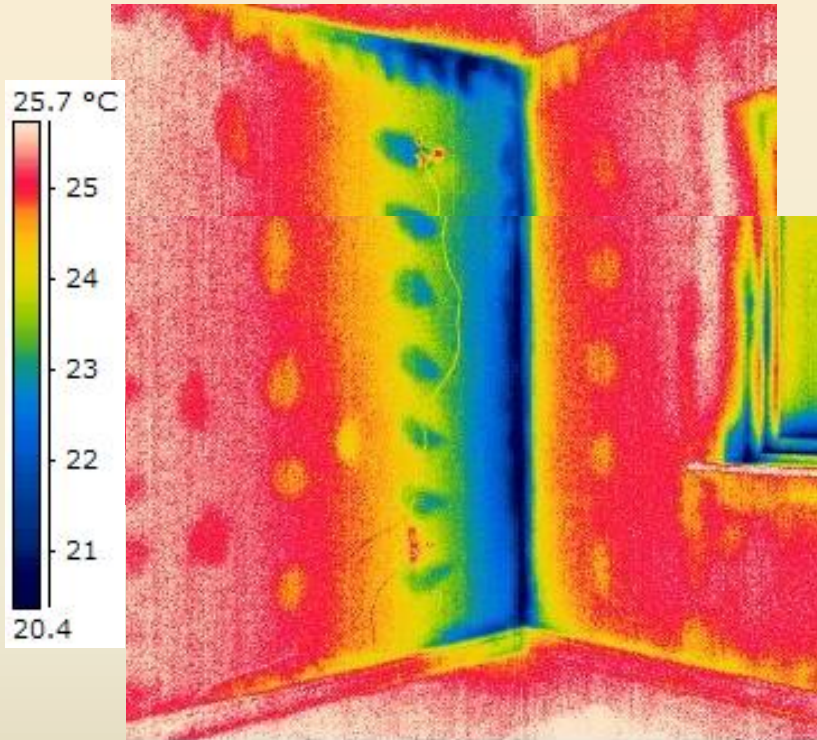
Party wall bypass investigations – Stamford Brook



Party wall bypass investigations – Stamford Brook



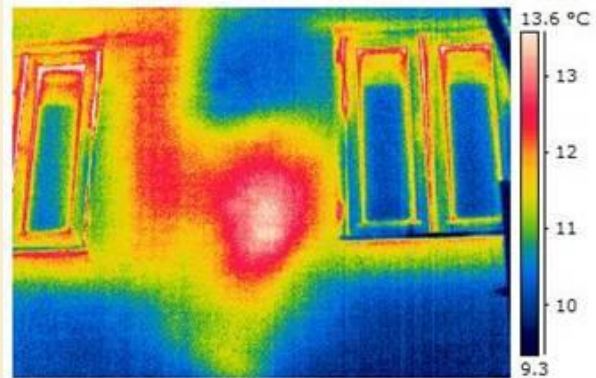
Party wall bypass investigations – Stamford Brook



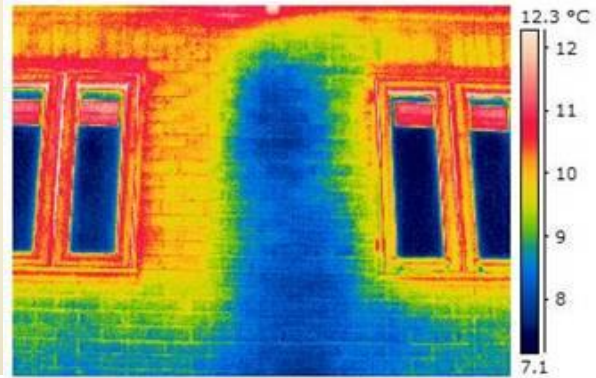
Second Floor – Party Wall to External
Wall Junction – Sock Out

Party wall bypass investigations – Stamford Brook

Party Wall Junction – Sock in Position



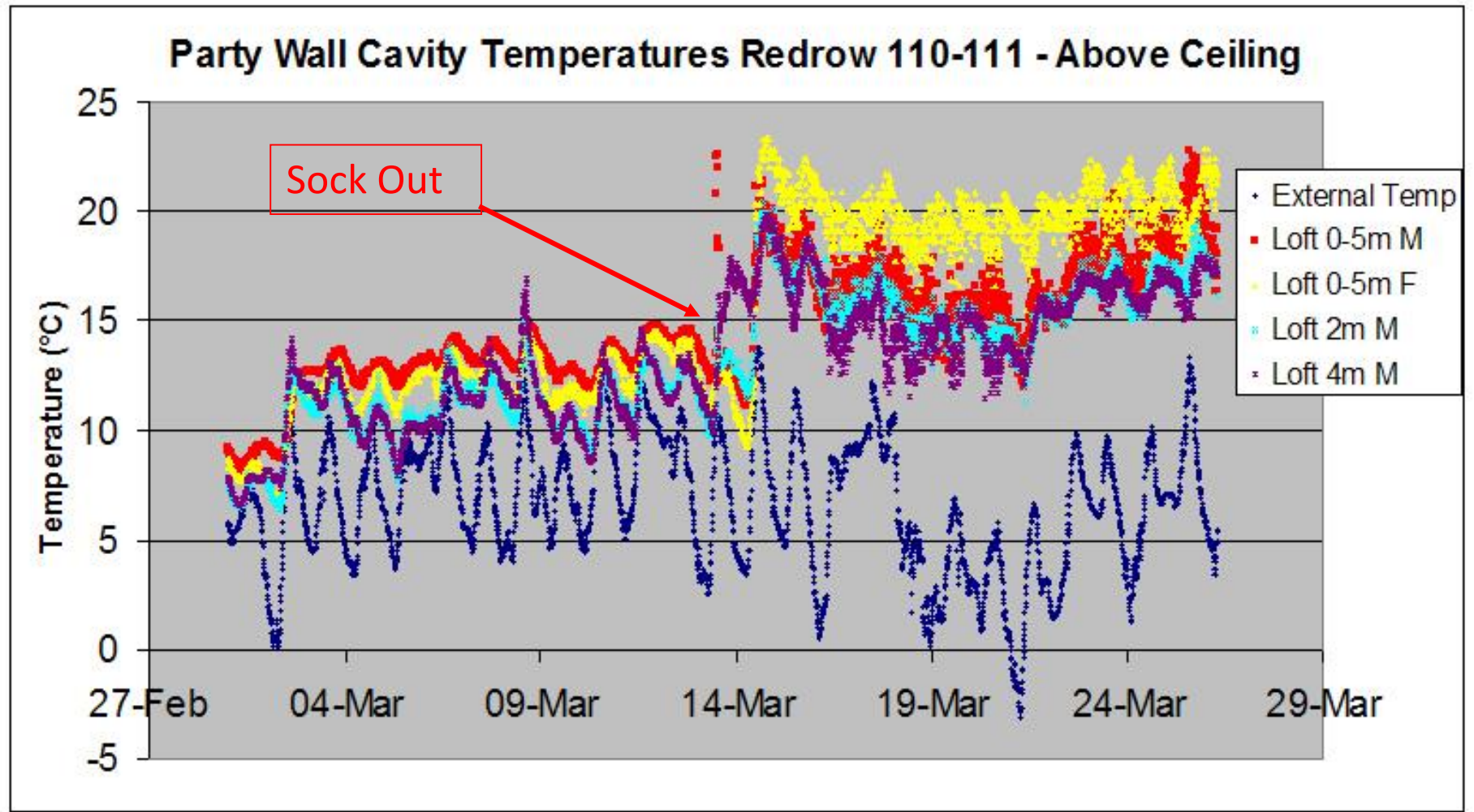
Party Wall Junction – Sock Removed



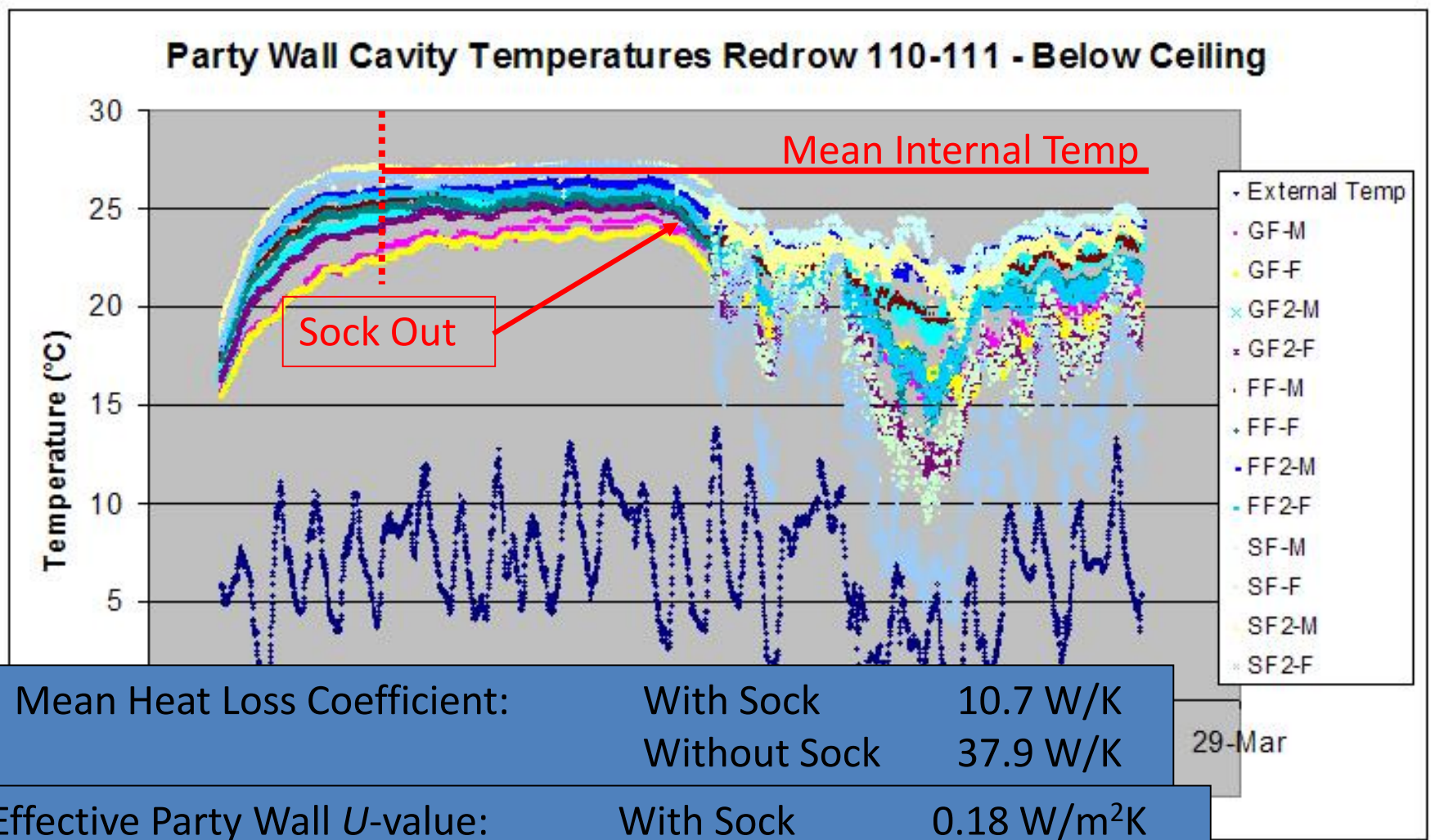
Party Wall Junction – Brick at Hot Spot Removed



Party wall bypass investigations – Stamford Brook

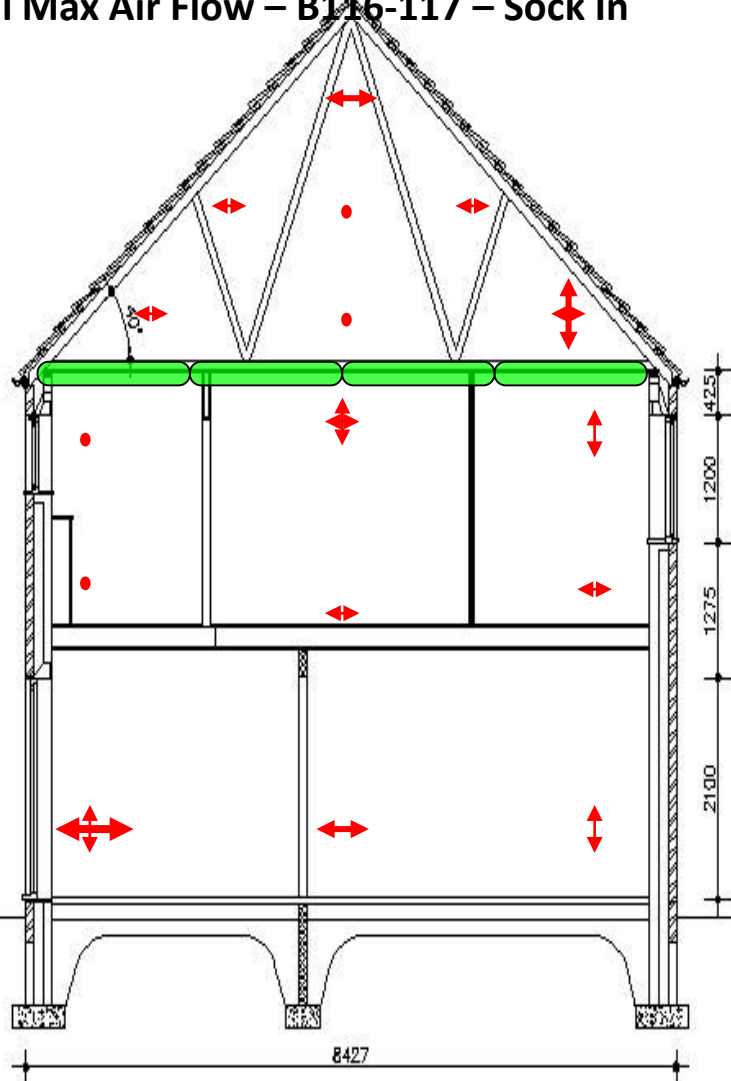


Party wall bypass investigations – Stamford Brook

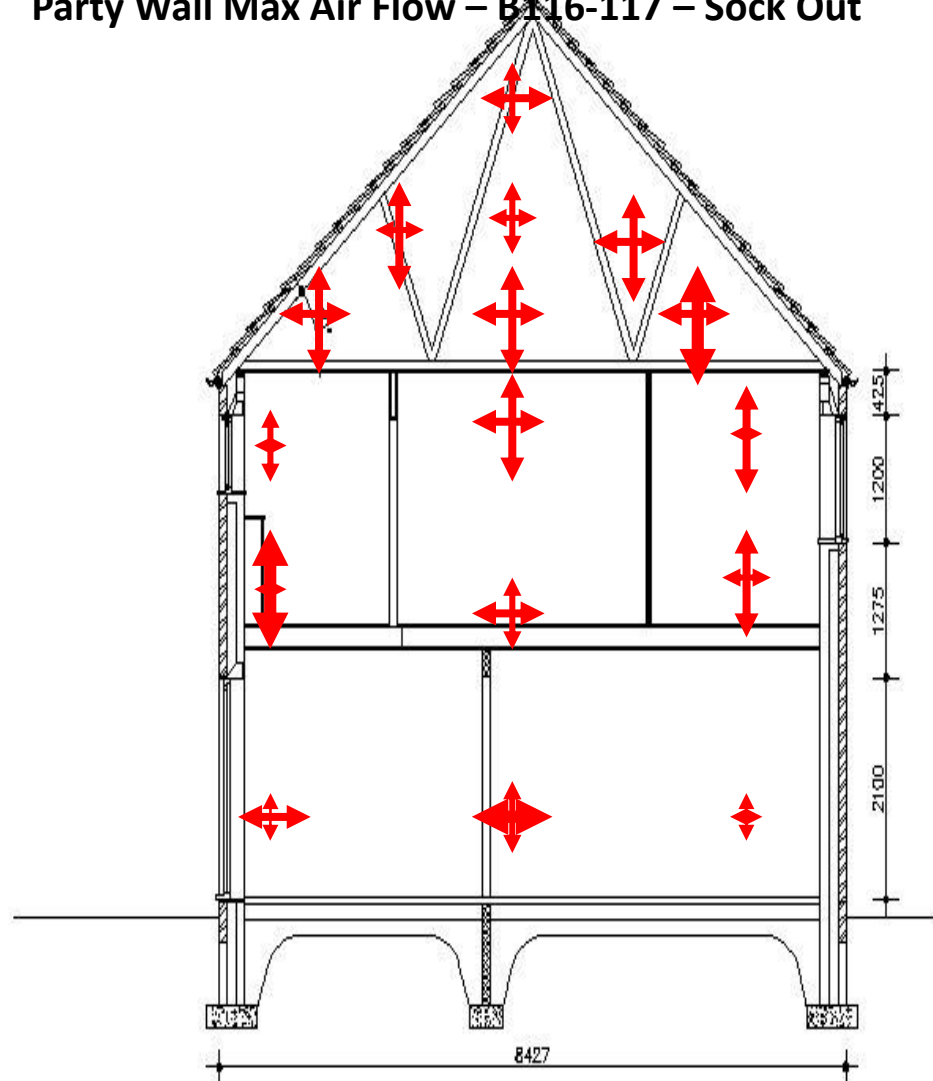


Party wall bypass investigations – Stamford Brook

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



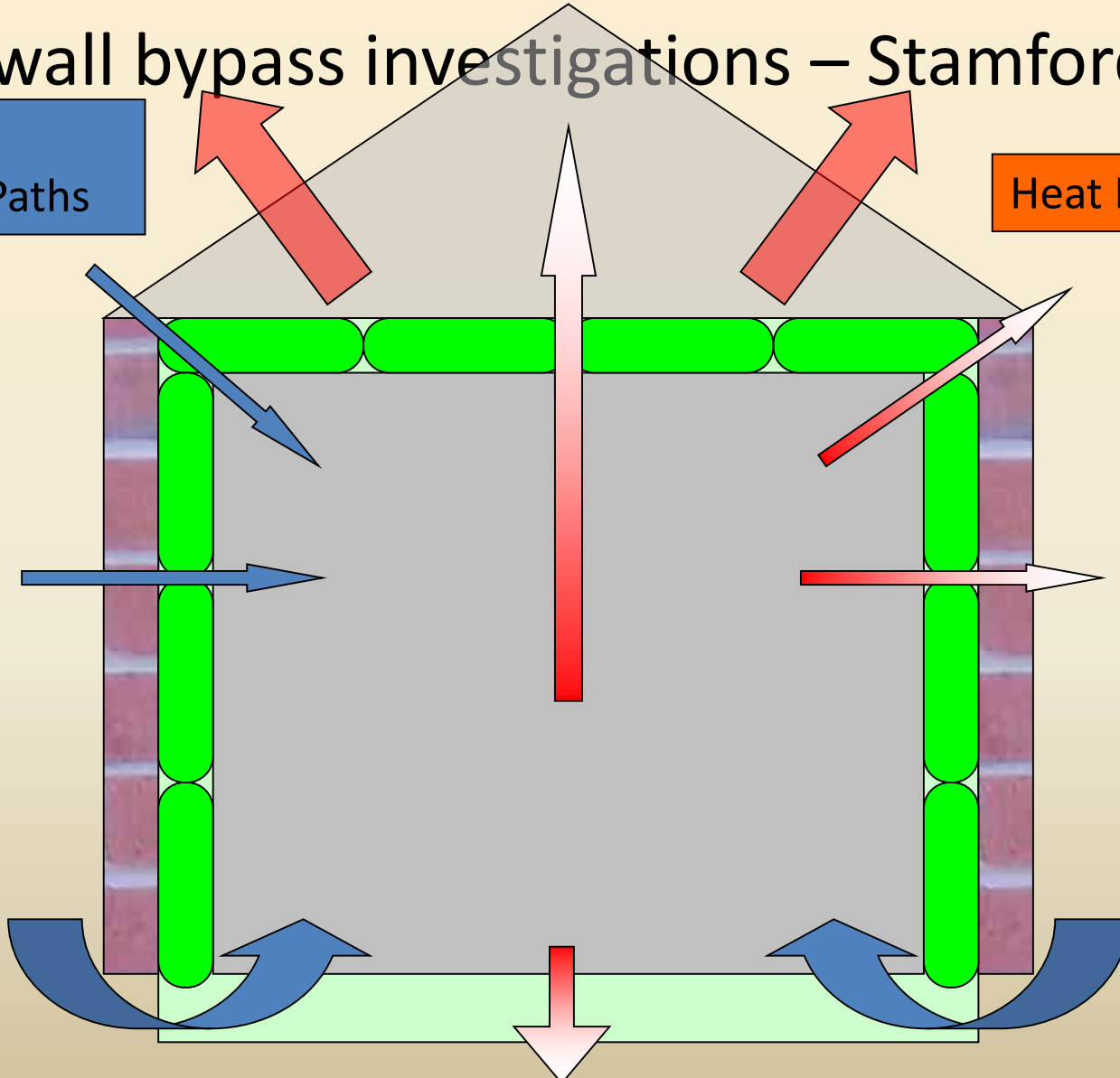
Party Wall Max Air Flow – B116-117 – Sock Out



Party wall bypass investigations – Stamford Brook

Cold Air Infiltration Paths

Heat Loss Paths



Party wall bypass investigations – Stamford Brook

Party Wall Bypass – Estimated UK CO₂ savings if bypass eliminated

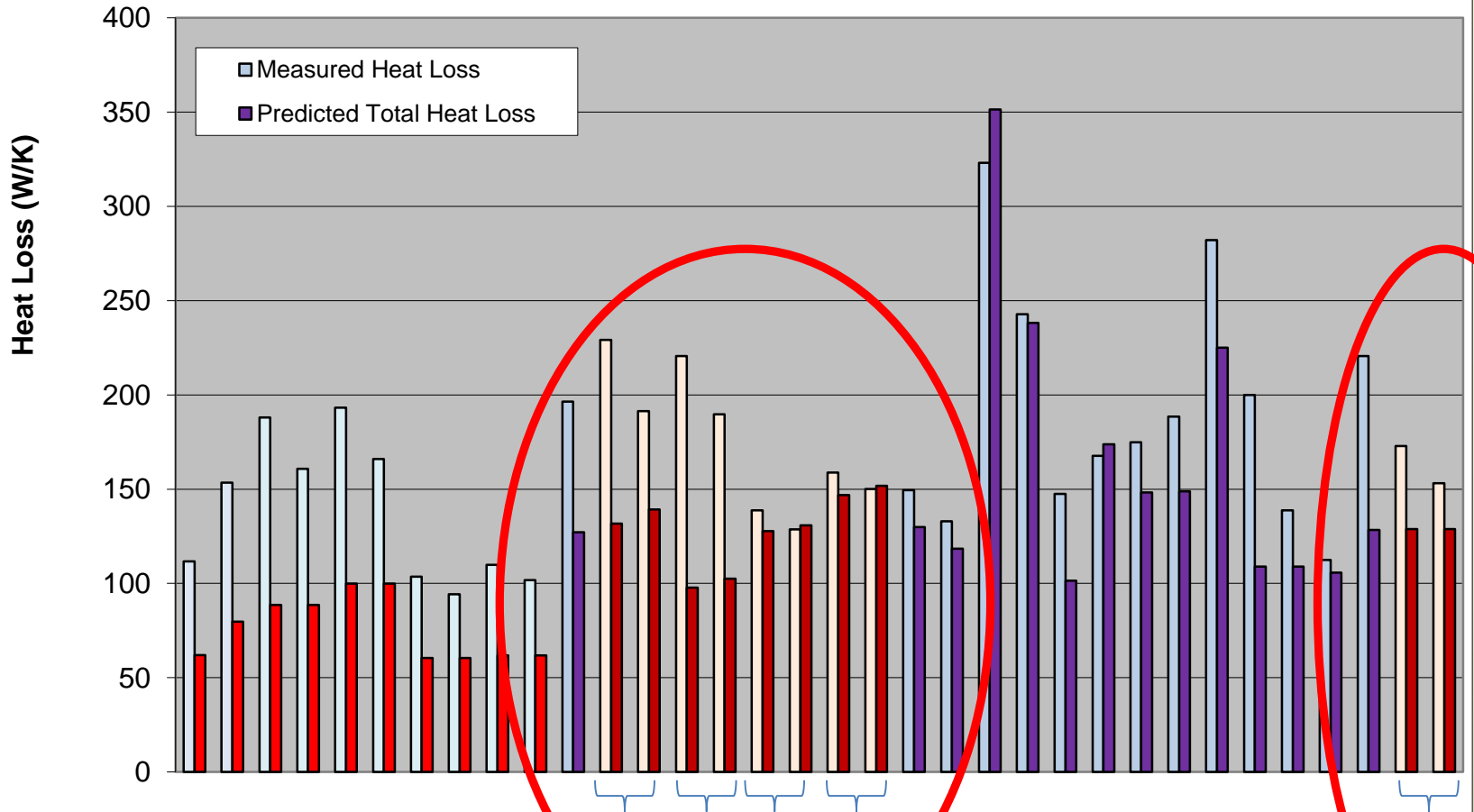
From New Housing built in One Year (~190,000 units)	18,000 tCO ₂ /a
From Existing Stock (built since 1965)	~750,000 tCO ₂ /a

Assumes Party Wall U -Value = 0.5 W/m²K

Assumes 10% semi-detached, 20% terrace in stock and new build

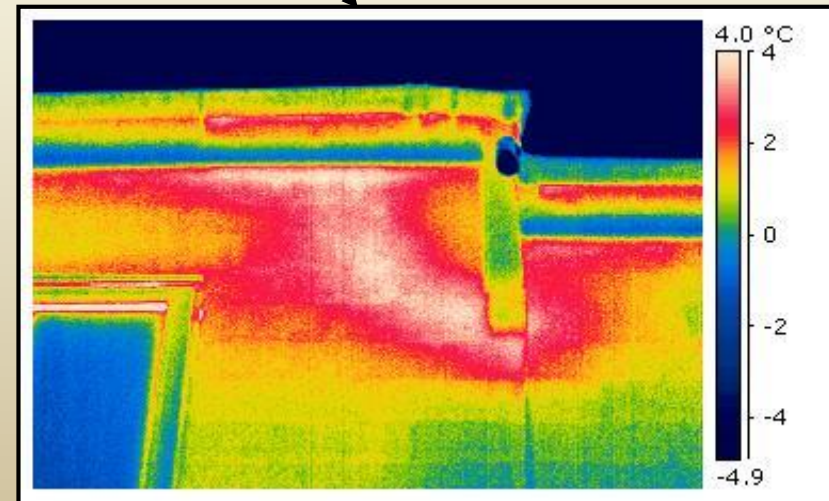
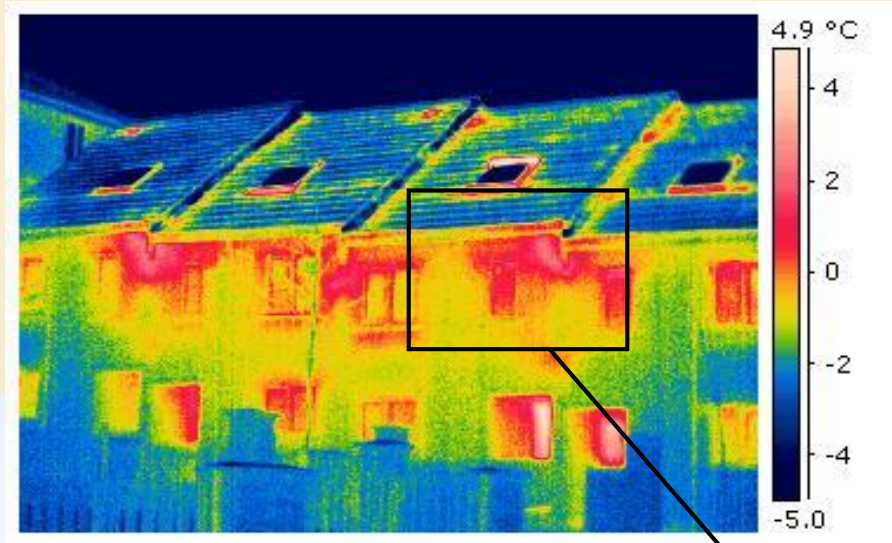
Calculations for semis and terraces only – no estimate for apartments

Whole House Heat Loss - Measured Coheating versus Predicted

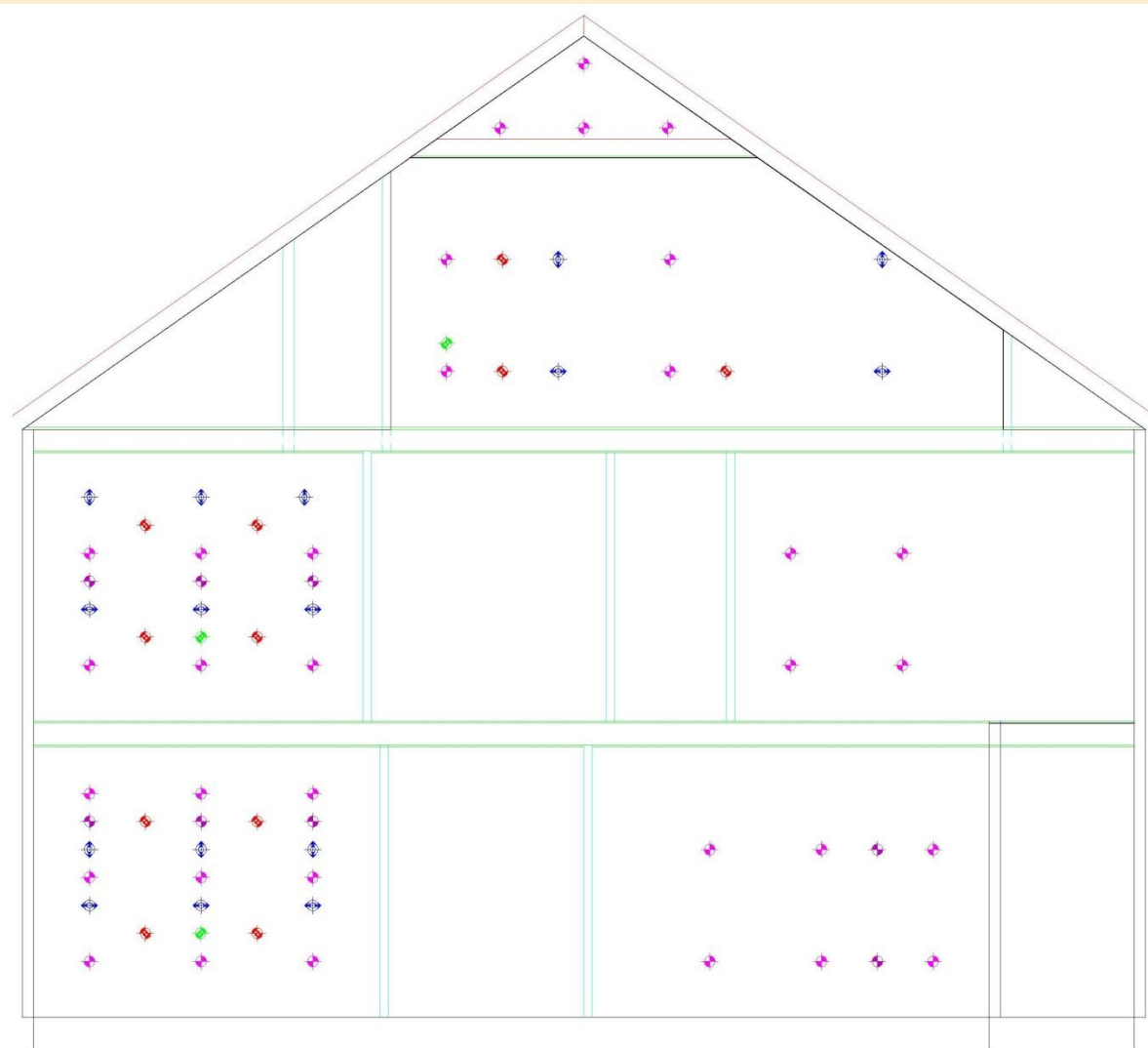
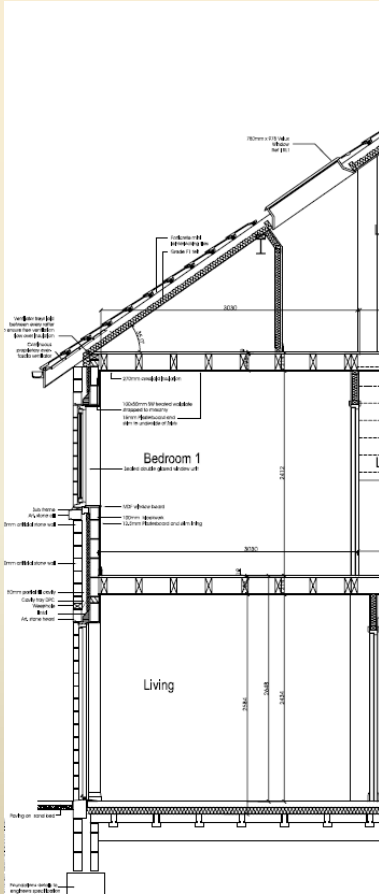


Party wall bypass investigations – EURISOL / MIMA

Party wall bypass investigations – EURISOL / MIMA



Party wall bypass investigations – EURISOL / MIMA



- ◆ Party wall cavity temperature
- ◆ Party wall surface temperature
- ◆ Internal/cavity differential pressure
- ◆ Heat flux
- ◆ Party wall cavity airflow - horizontal
- ◆ Party wall cavity airflow - vertical

Party wall bypass investigations – EURISOL / MIMA

Surface Thermocouple

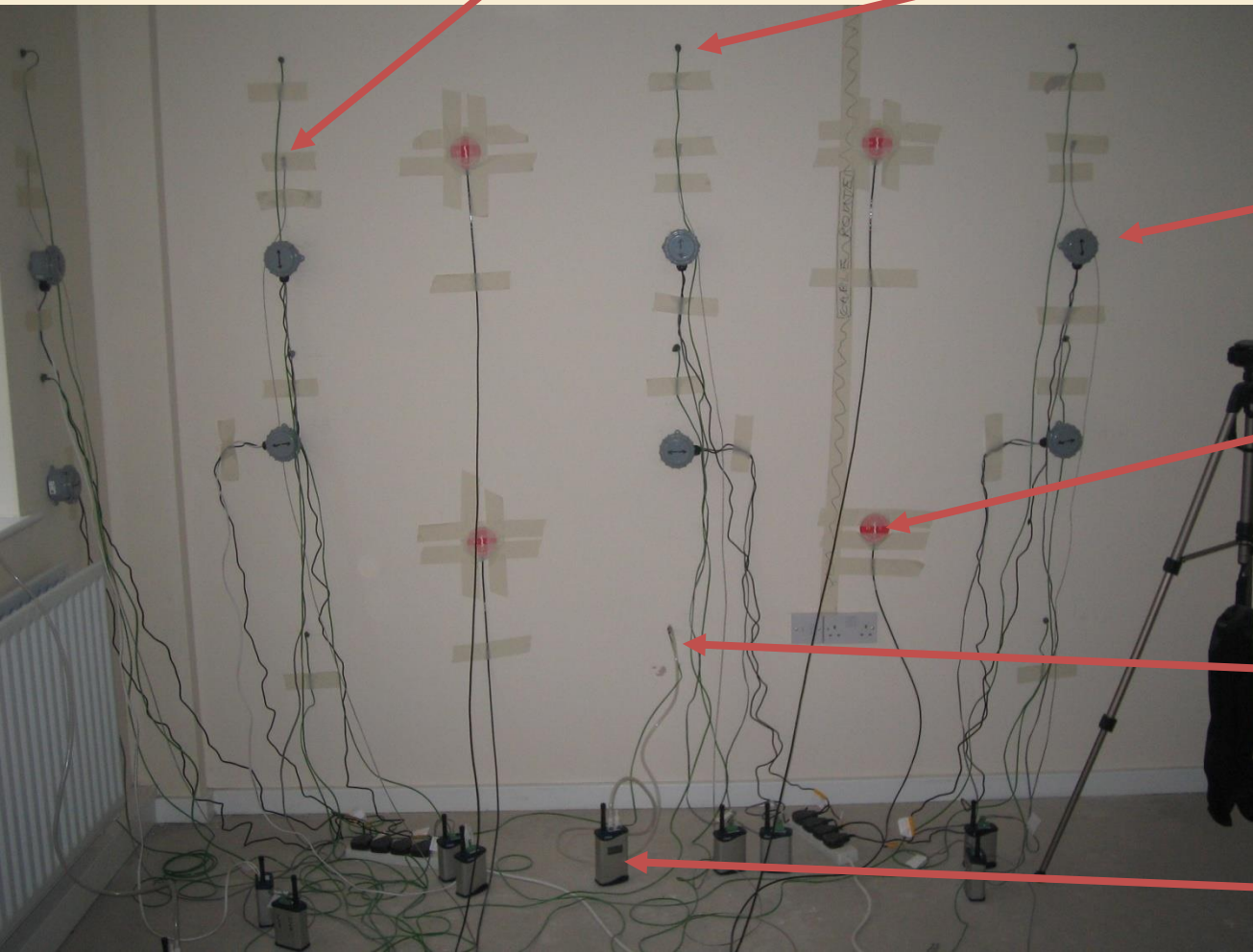
Cavity Thermocouple

Air Flow Transducer

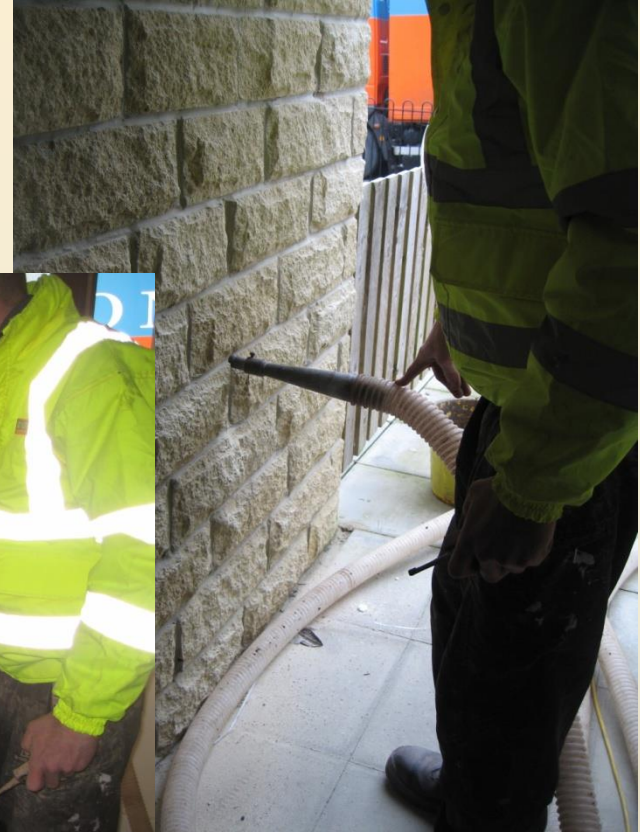
Heat Flux Plate

Differential Pressure

Transmitter

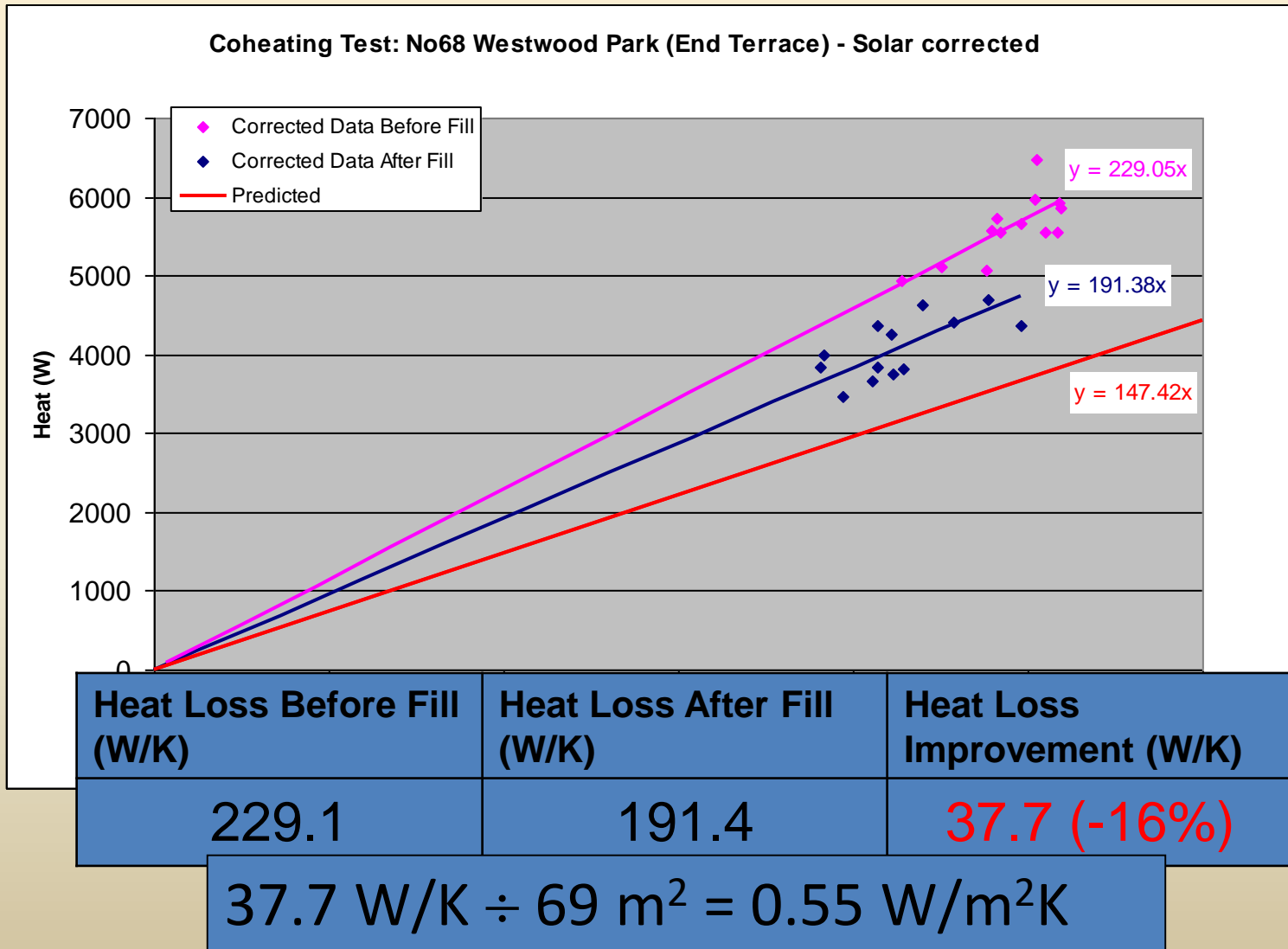


Party wall bypass investigations – EURISOL / MIMA



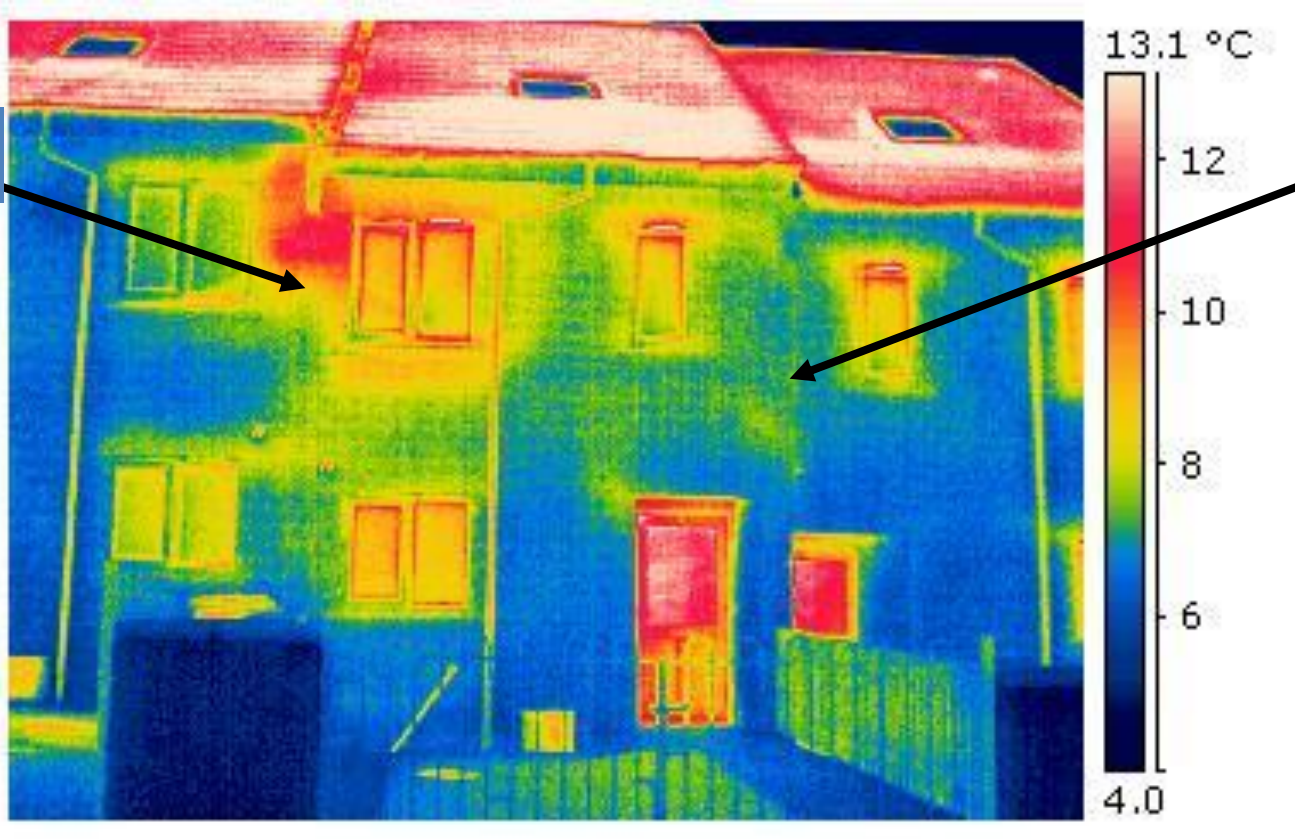
- Material: Knauf Supafil Plus 40
- Usage: ~6 bags = 106kg over ~72.4m² (Cavity ~75mm)
- Estimated fill density: ~19.6 kg/m³ (Volume ~ 5.4m³)

Party wall bypass investigations – EURISOL / MIMA



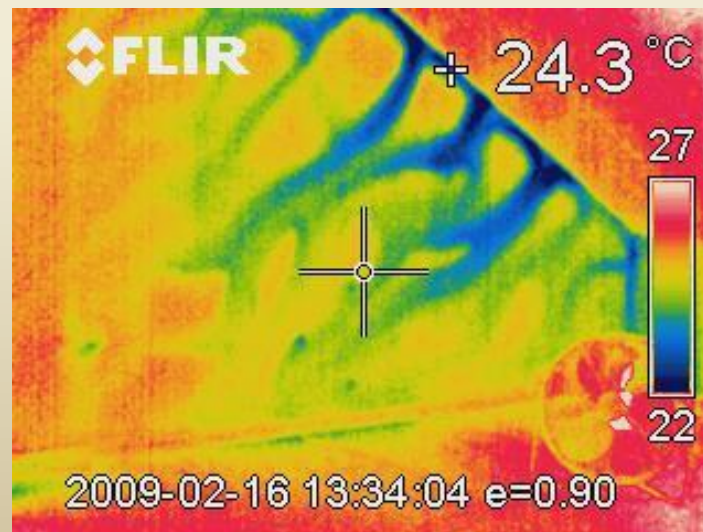
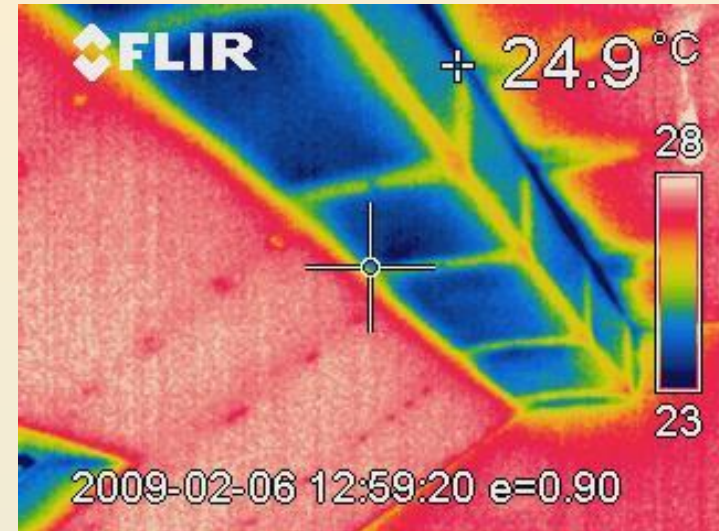
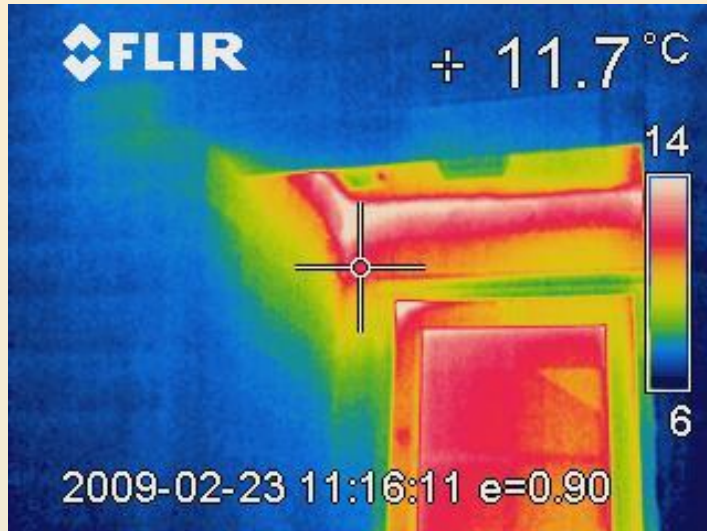
Party wall bypass investigations – EURISOL / MIMA

Unfilled



Filled

Party wall bypass investigations – EURISOL / MIMA



Implications for Building Regulations



L1A

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

L1A QUALITY OF CONSTRUCTION AND COMMISSIONING

Table 3 U-values for party walls

Party wall construction	U-value (W/m ² K)
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

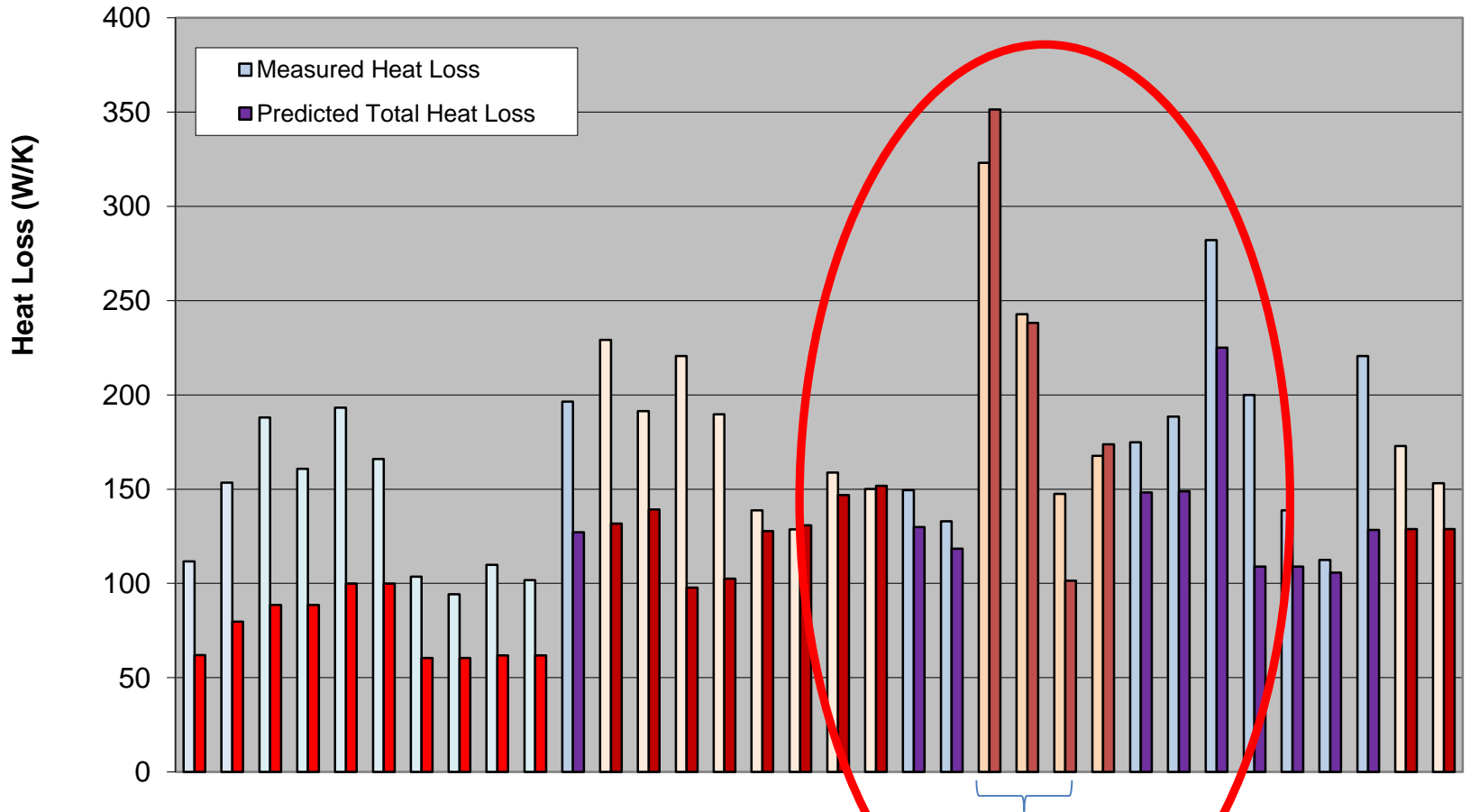
5.8 The party wall is a particular case of the more general thermal bypass problem that occurs where the air barrier and the insulation layer are not contiguous and the cavity between them is subject to air movement. To avoid the consequent reduction in thermal performance, either the insulation layer 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

Whole House Heat Loss - Measured Coheating versus Predicted

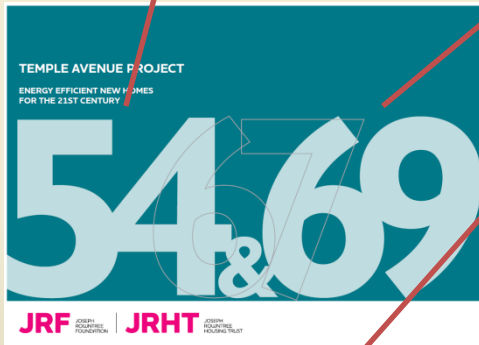


Existing dwellings

2009/10: Temple Avenue Project, York



Project funded by the Joseph Rowntree Housing Trust



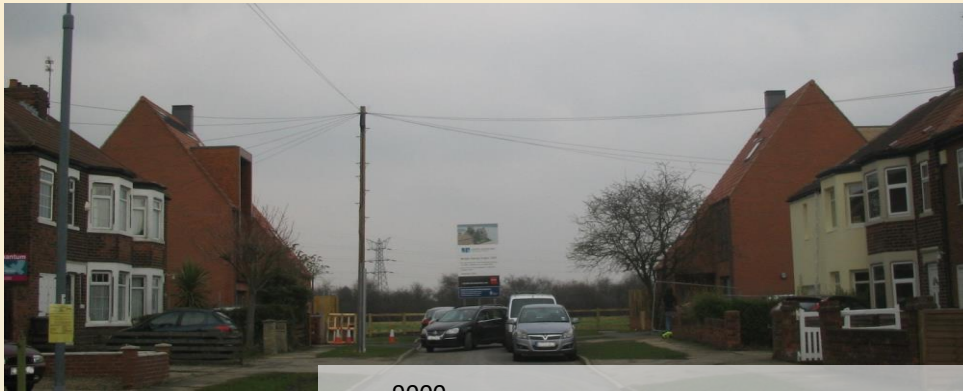
Thin-Joint Masonry & SIPs Construction
Code for Sustainable Homes Level 4
Prototypes for a 540-home development



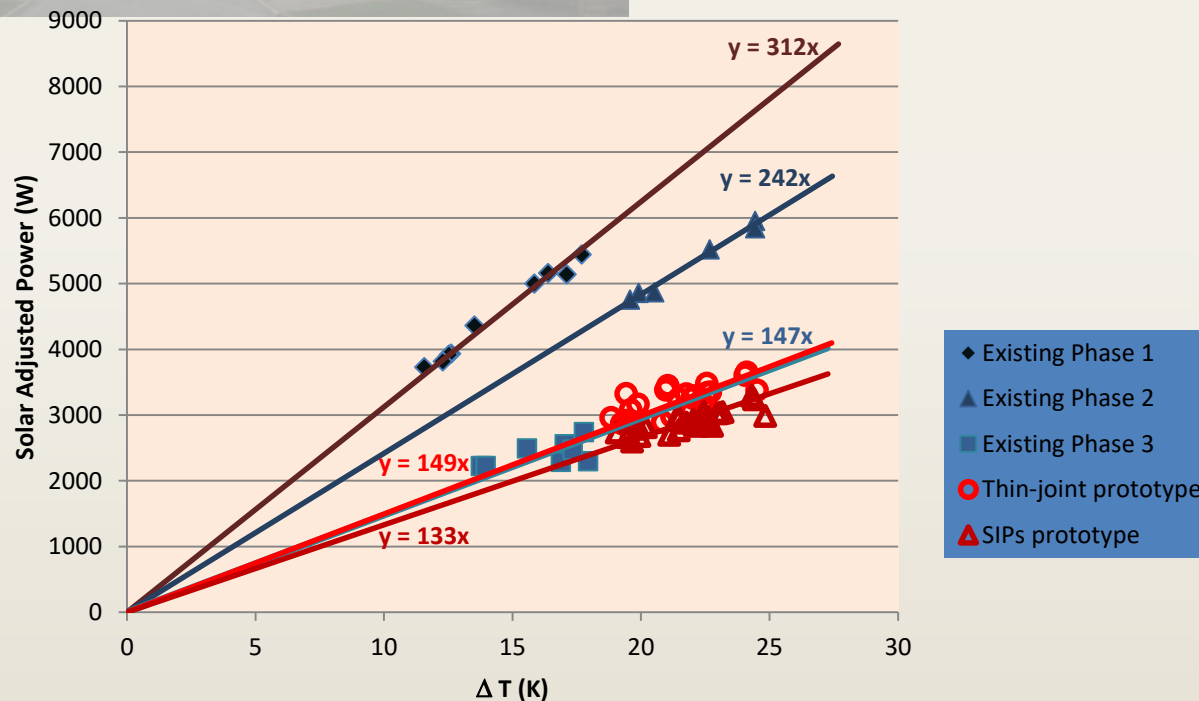
Standard 1930's semi-detached property
2-stage refurbishment:

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

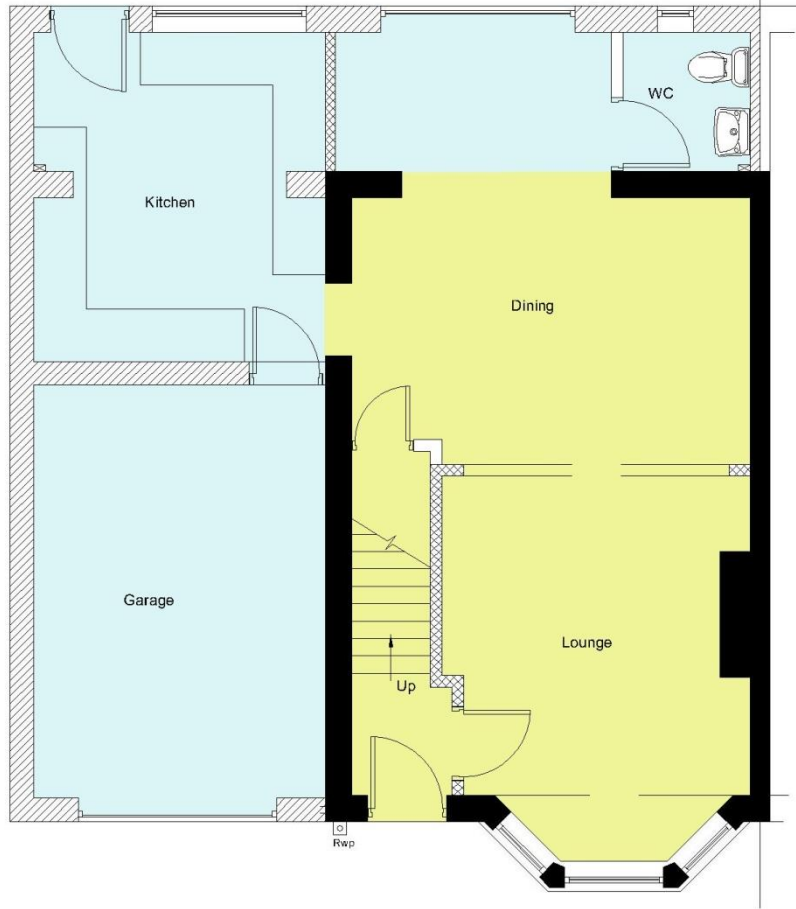
2009/10: Temple Avenue Project, York



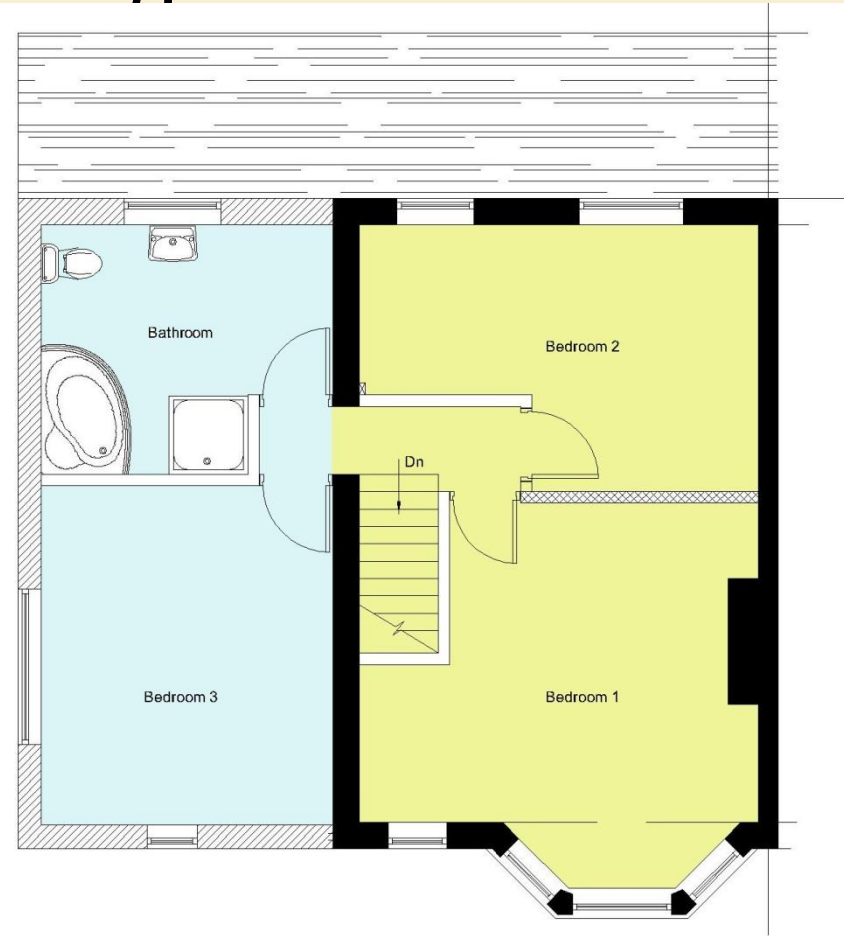
Project funded by the Joseph Rowntree Housing Trust



Existing dwelling - TAP

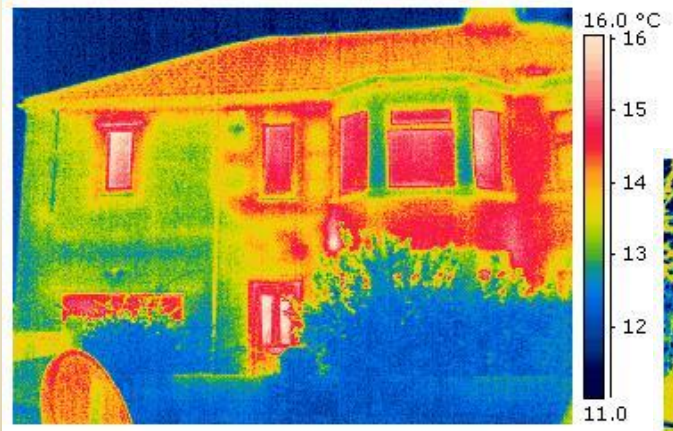


GROUND FLOOR PLAN

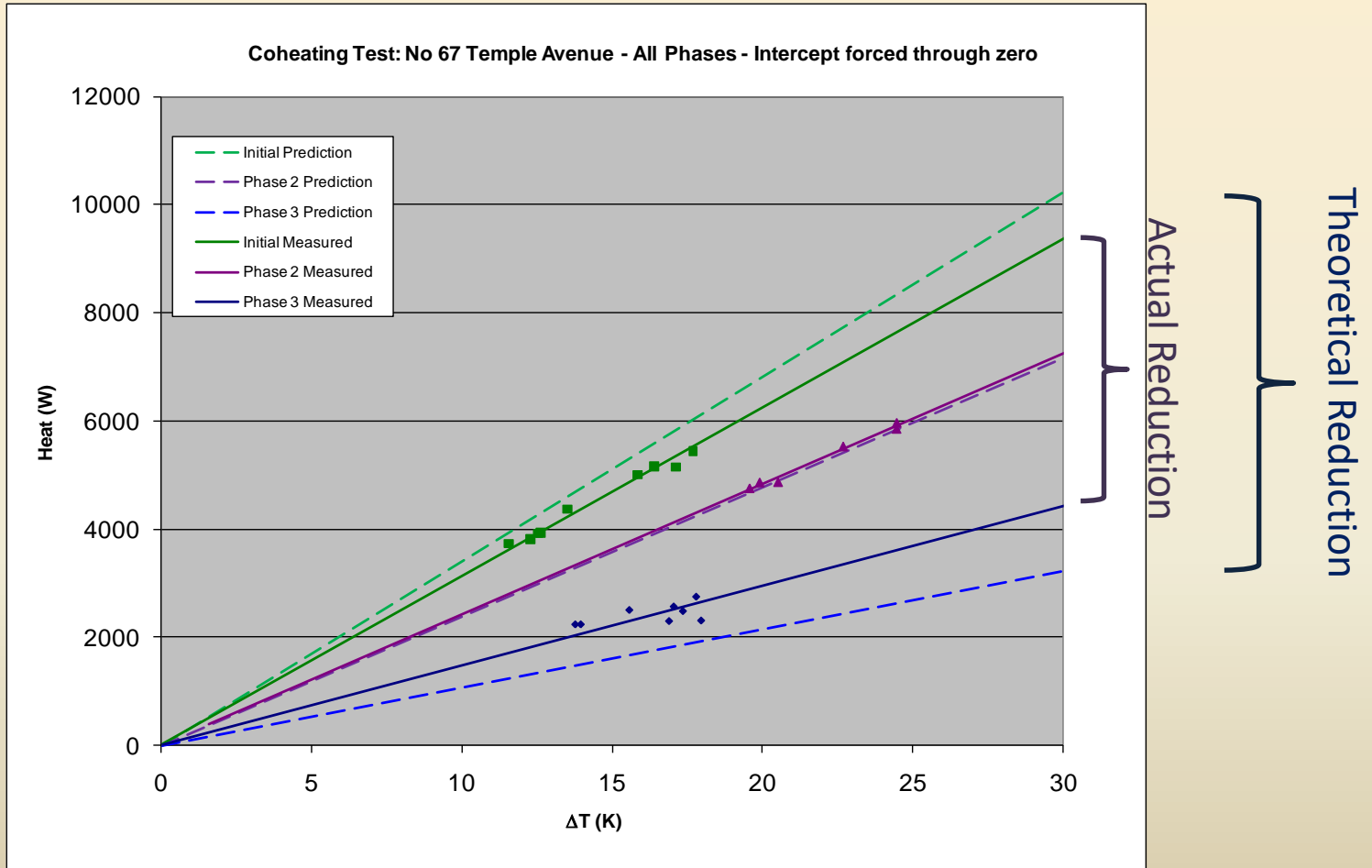


FIRST FLOOR PLAN

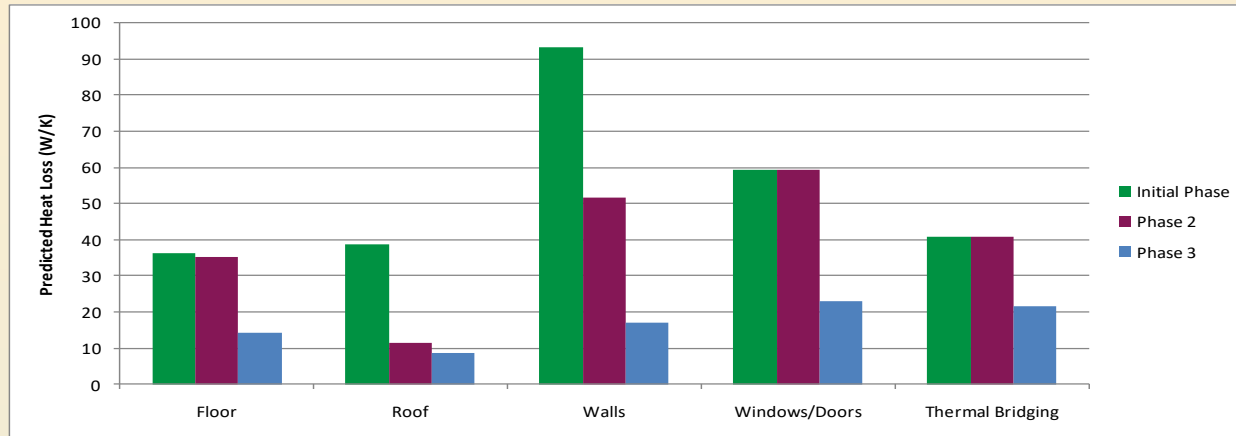
Existing dwellings - TAP



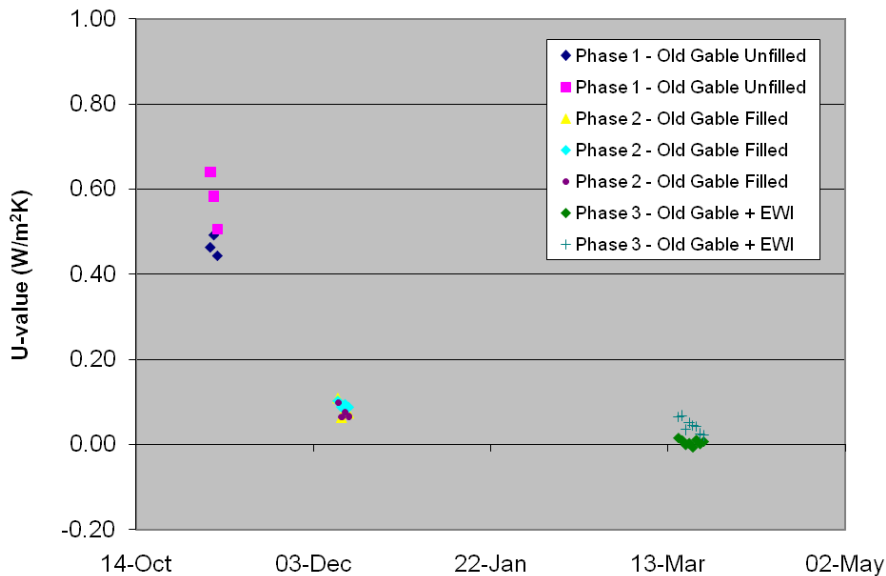
Existing dwelling - TAP



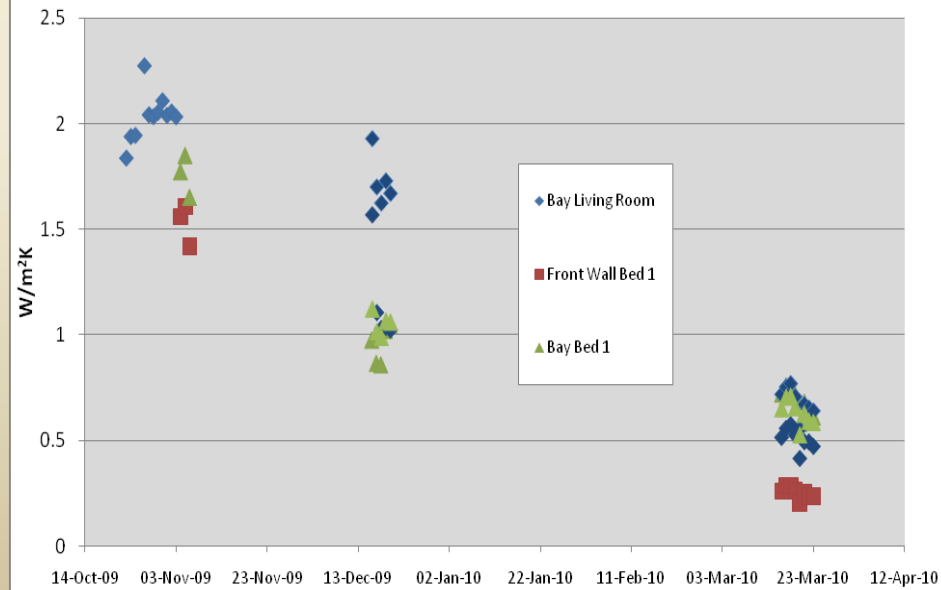
Existing dwellings - TAP



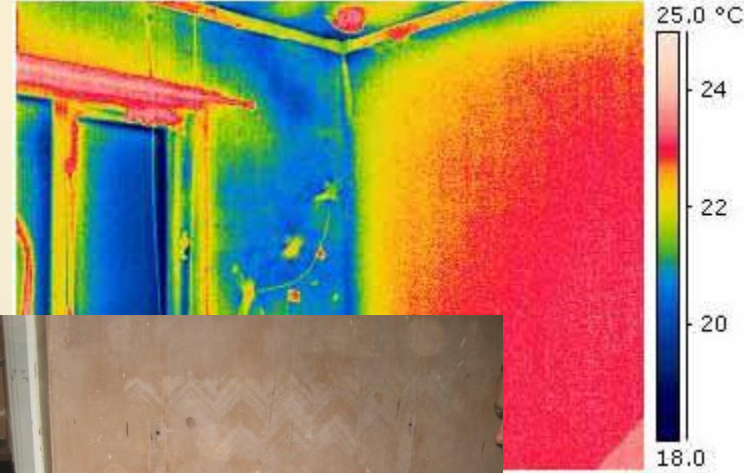
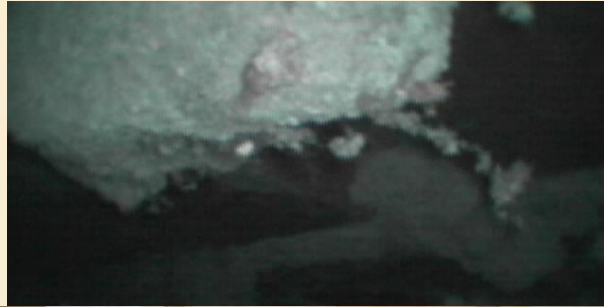
67 Temple Avenue Old Gable Wall - Before and After CWI & EWI



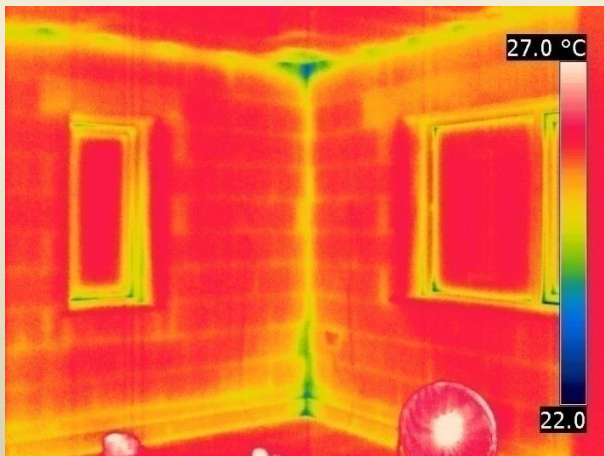
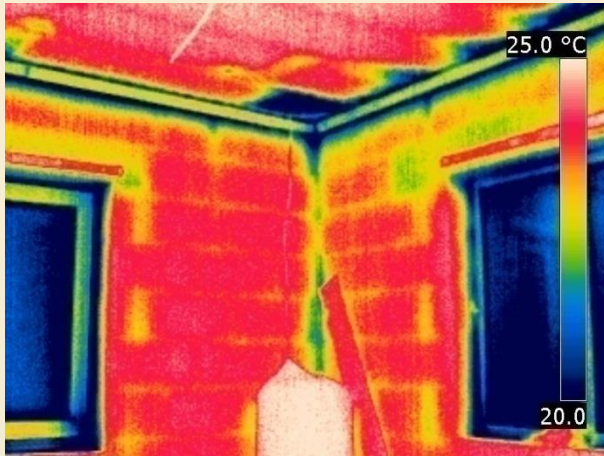
67 Temple Avenue - Measured wall U-values pre- and post-CWI & EWI



Existing dwellings - TAP



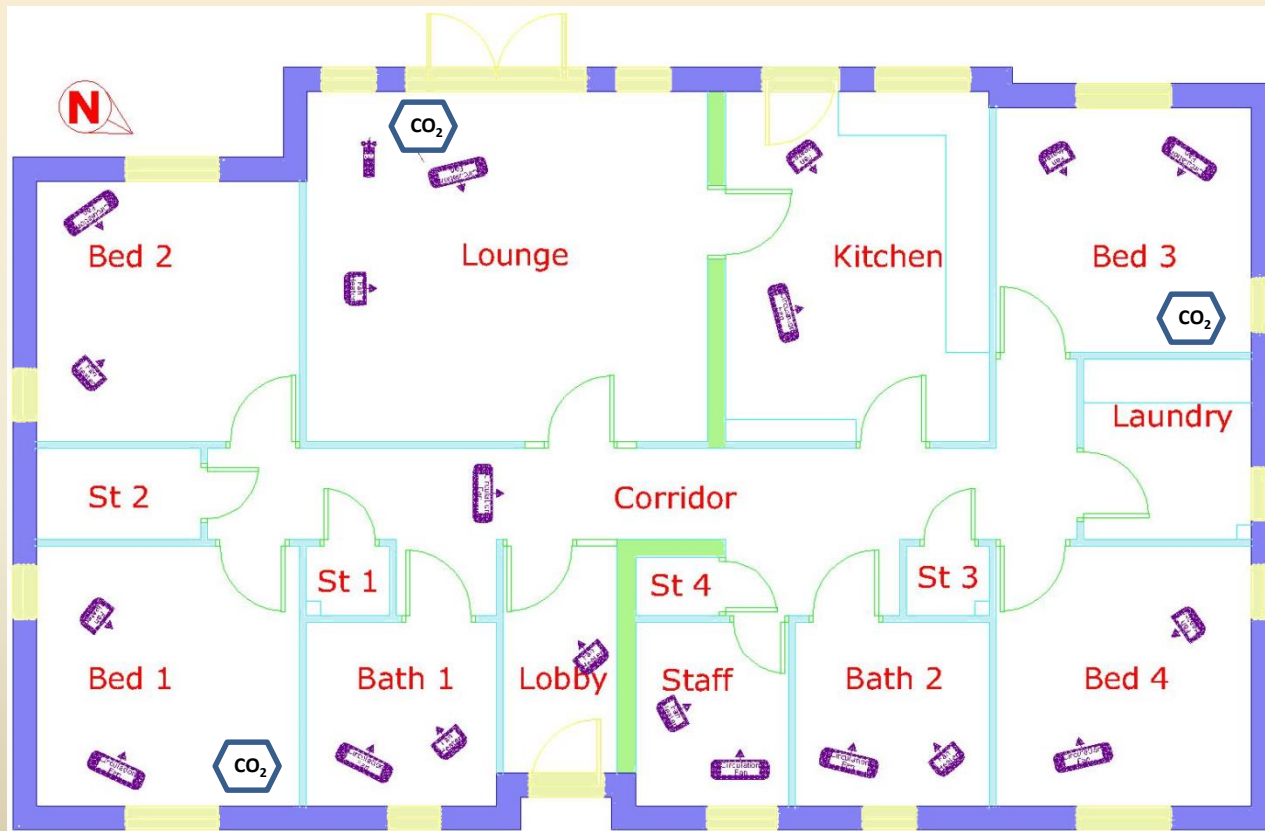
Existing dwellings - TAP



Existing dwellings - TAP



Closing the Loop



Closing the Loop

Ventilation Heat Loss

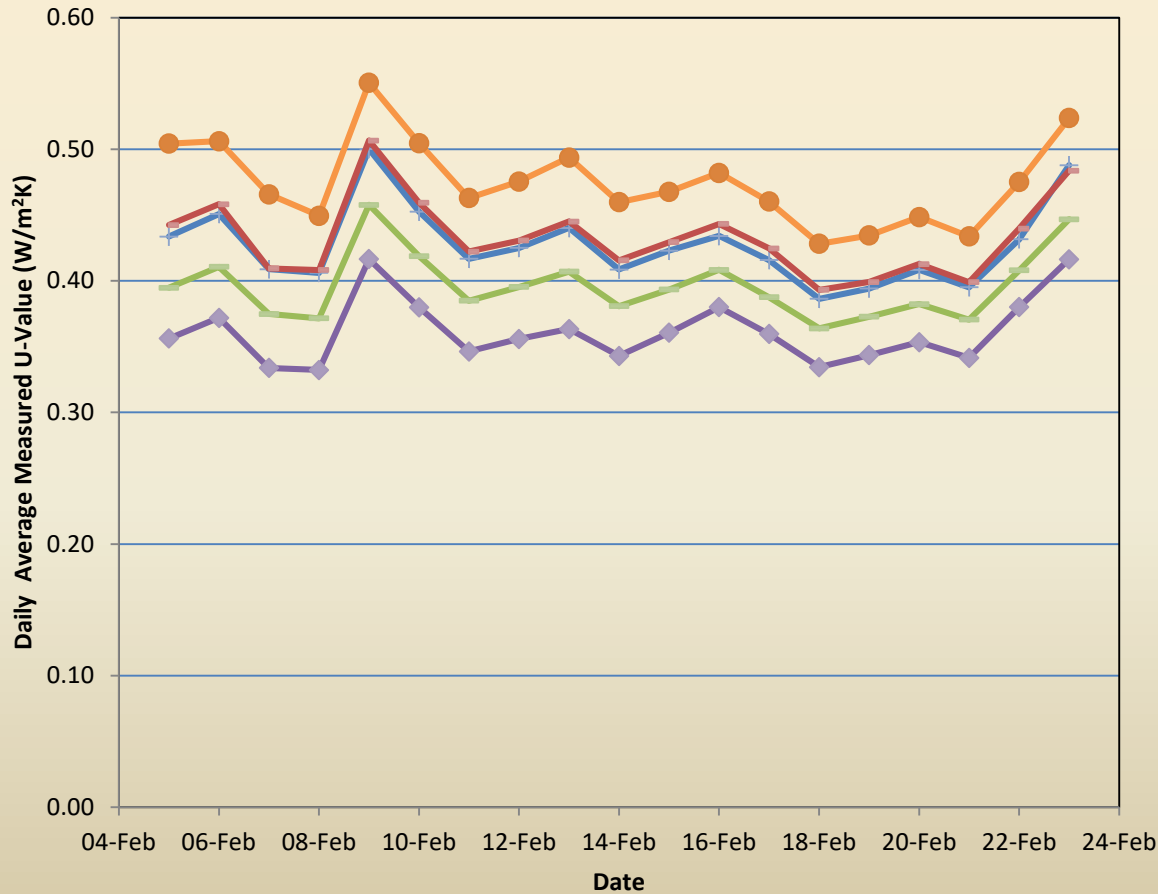
Air Permeability ($\text{m}^3/(\text{h} \cdot \text{m}^2)$ @ 50Pa)					Mean Permeability used for coheating calculations
Date	09-Nov-10	14-Jan-11	01-Feb-11	25-Feb-11	
Plot 6	9.28	3.85	4.31	4.48	4.395
	pre-completion	Building Regs compliance	pre-coheating	post-coheating	(5.15 h^{-1} @50Pa)

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



- K 1 - External wall 1
- + K 2 - External wall 2
- + K 3 - External wall 3
- + K 4 - External wall 4
- + K 5 - External wall 5



Closing the Loop

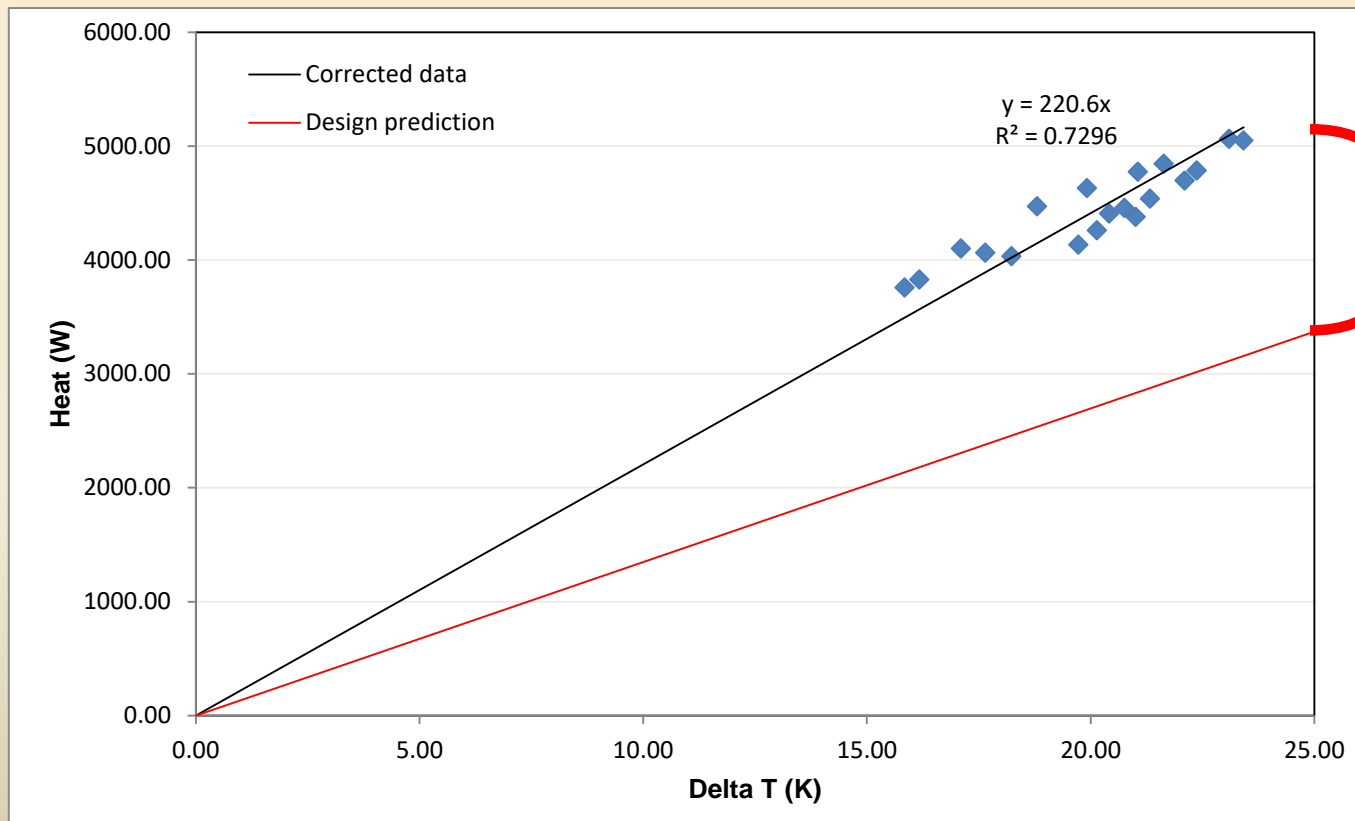
External Wall Measurements



4 5
3
1 2

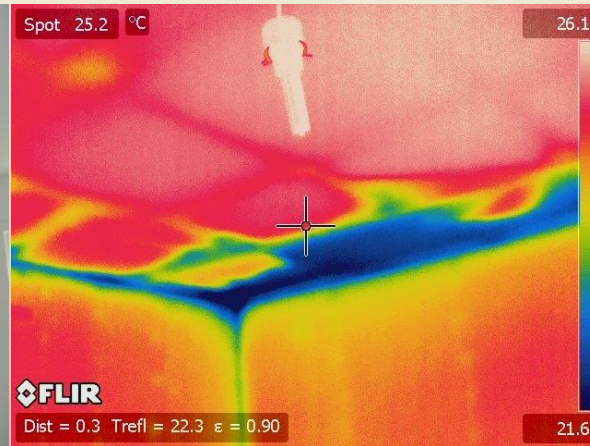
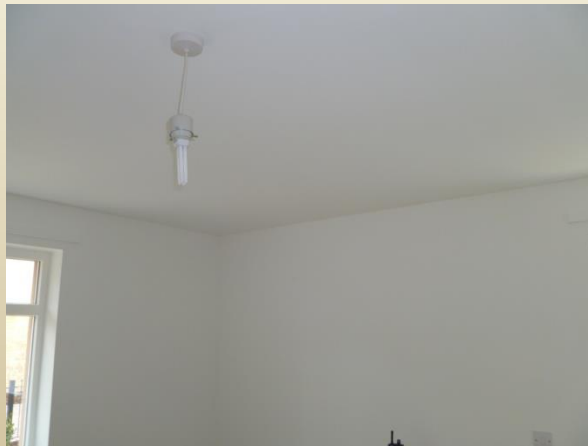
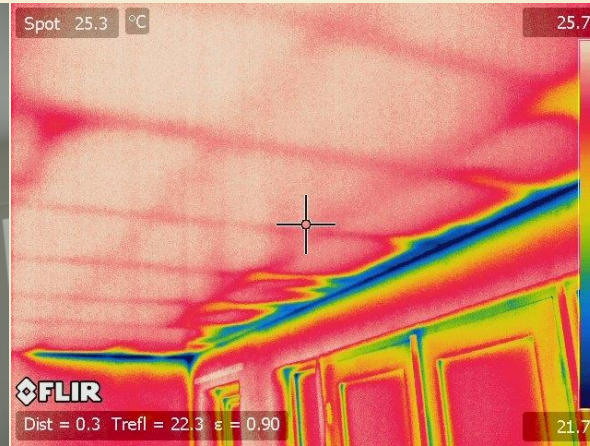


Closing the Loop



**64% greater
heat loss than
predicted**

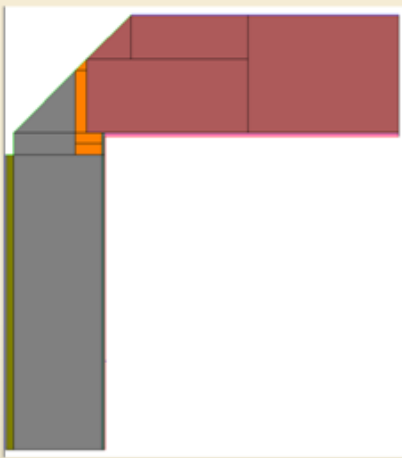
Closing the Loop Thermal Bridging



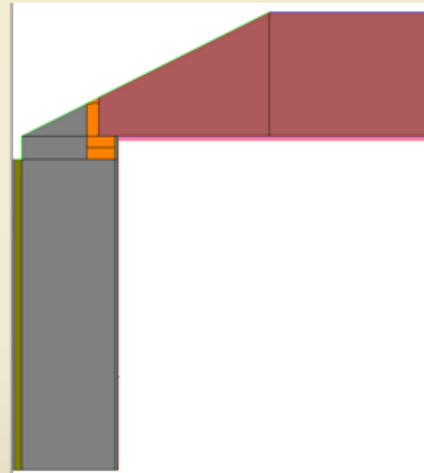
Closing the Loop

Thermal Bridging

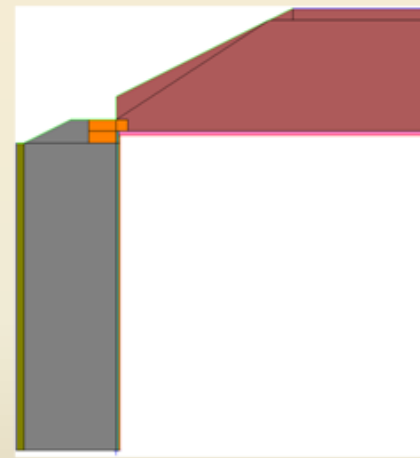
Therm 5.2 model: 300mm Hemcrete ($\lambda = 0.06$ W/mK), 89mm Timber stud ($\lambda = 0.13$ W/mK), 400mm Loft insulation ($\lambda = 0.042$ W/mK)



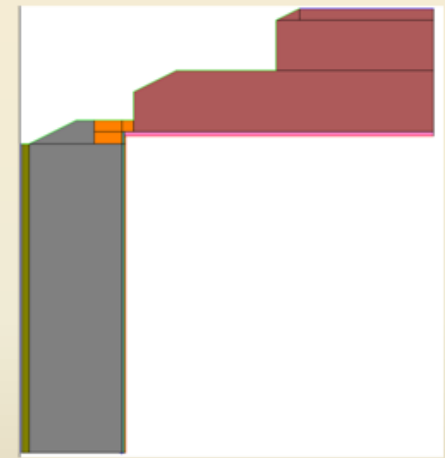
$\Psi = 0.026$ W/mK
45° Pitch



$\Psi = 0.043$ W/mK
30° Pitch



$\Psi = 0.084$ W/mK
'as-built' - ideal



$\Psi = 0.109$ W/mK
'as-built' - practice

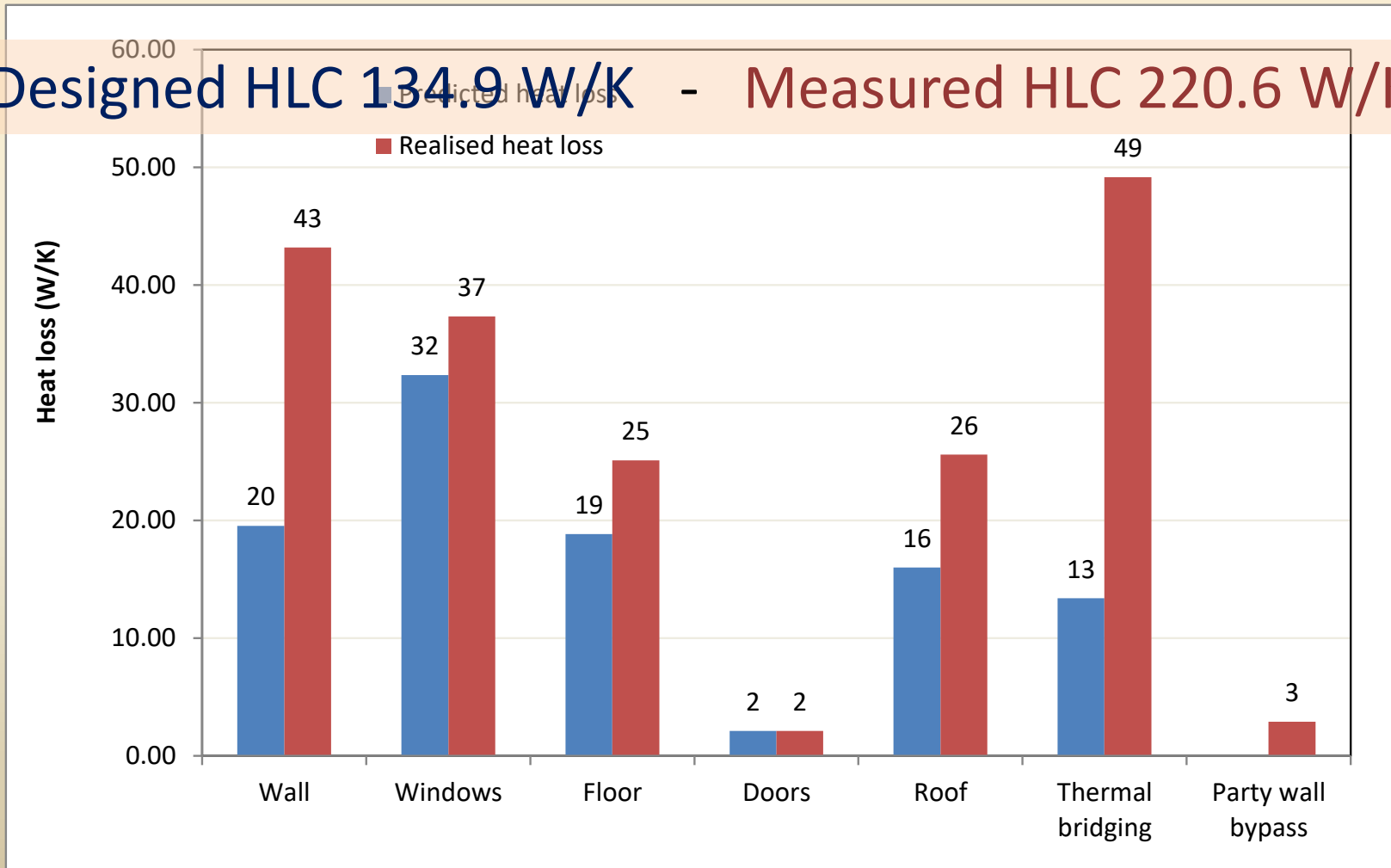
SAP 2009, Appendix Q, Table K1 :

Eaves detail to ACD
Default value

$\Psi = 0.06$ W/mK
 $\Psi = 0.12$ W/mK

Closing the Loop

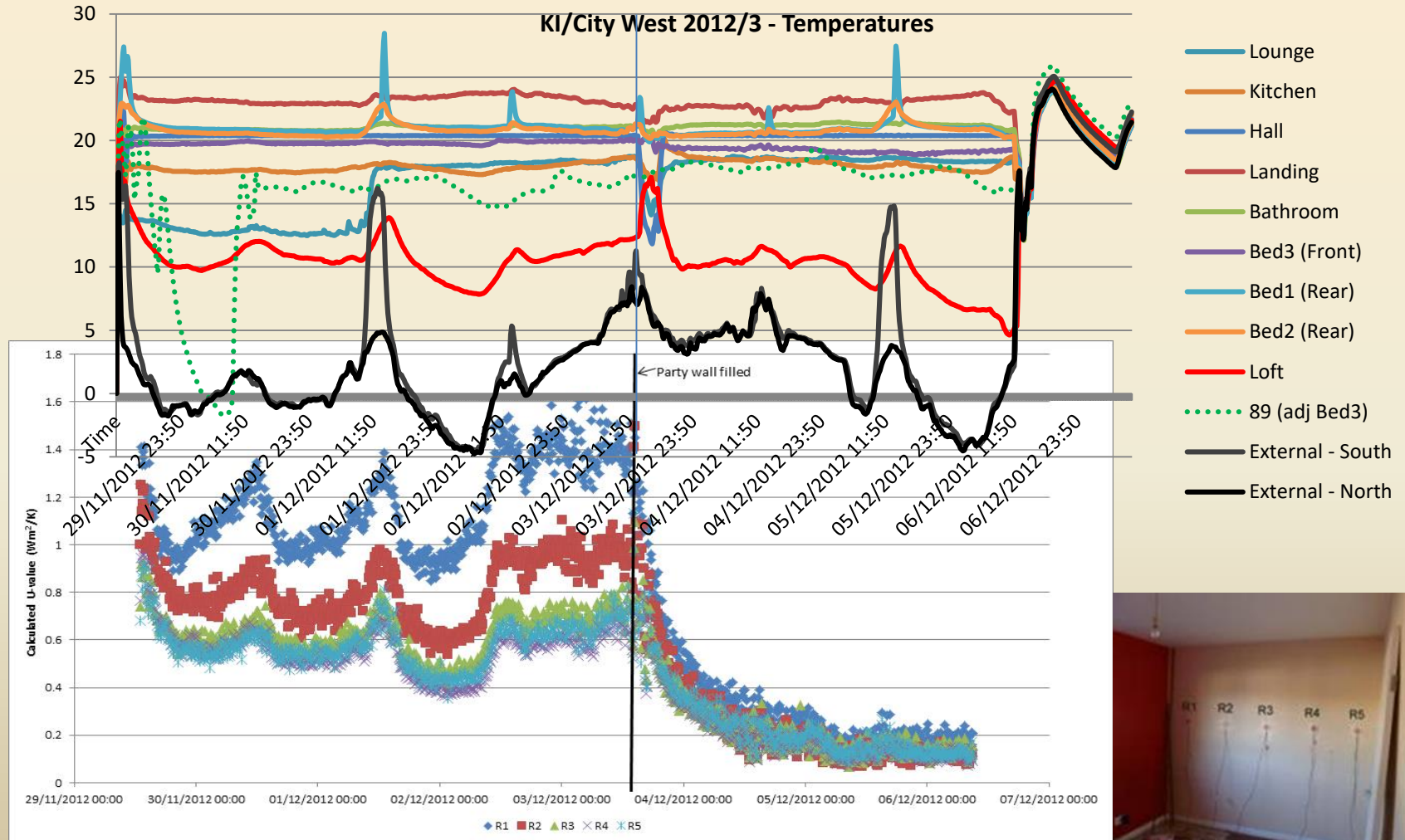
Designed HLC 134.9 W/K - Measured HLC 220.6 W/K



Simple Tests



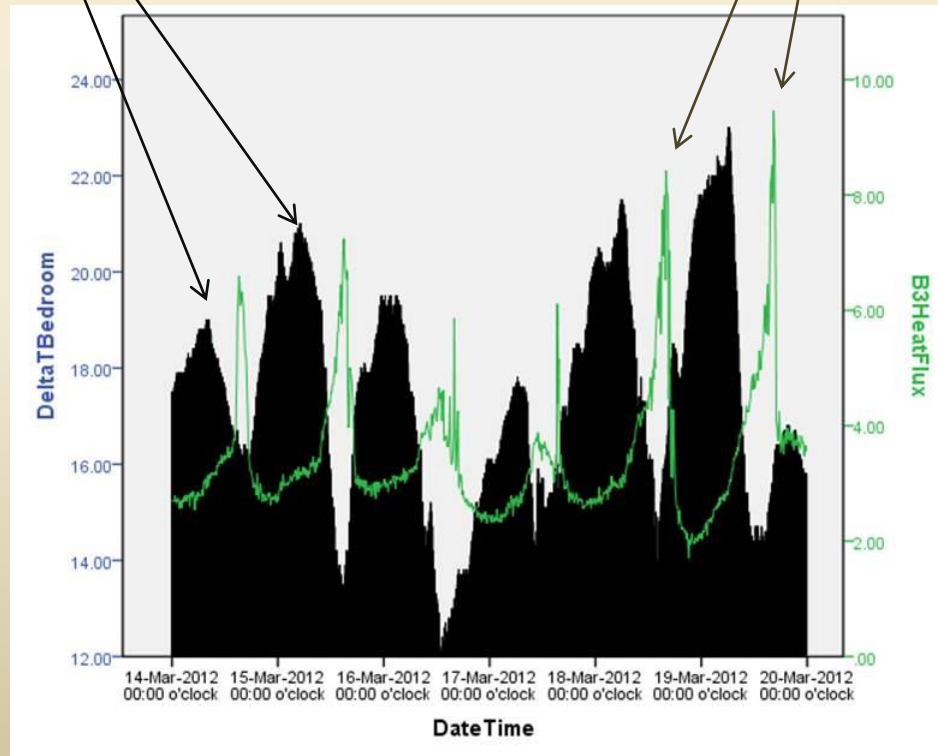
Simple Tests



Simple Test Issues: Thermal Lag

Maximum ΔT

Maximum Heat Flux





Whole House Heat Loss Test Method (Coheating)

Dr David Johnston, Centre for the Built Environment, Leeds Metropolitan University
Dominic Miles-Shenton, Centre for the Built Environment, Leeds Metropolitan University
Dr Jez Wingfield, Willmott Dixon Energy Services Limited
David Farmer, Centre for the Built Environment, Leeds Metropolitan University
Prof Malcolm Bell, Centre for the Built Environment, Leeds Metropolitan University

March – 2012

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

