Building Better Buildings

22nd March 2016

Cardiff

ZERO CARBON HUB

Innovate UK

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BUILDING BETTER BUILDINGS BREAKFAST SEMINAR

ZERO CARBON HUB

22th. March, 2016

ROLE OF THE ZERO CARBON HUB

PURPOSE AND STRATEGIC OBJECTIVES

Facilitate the mainstream delivery of low and zero carbon homes working across boarders

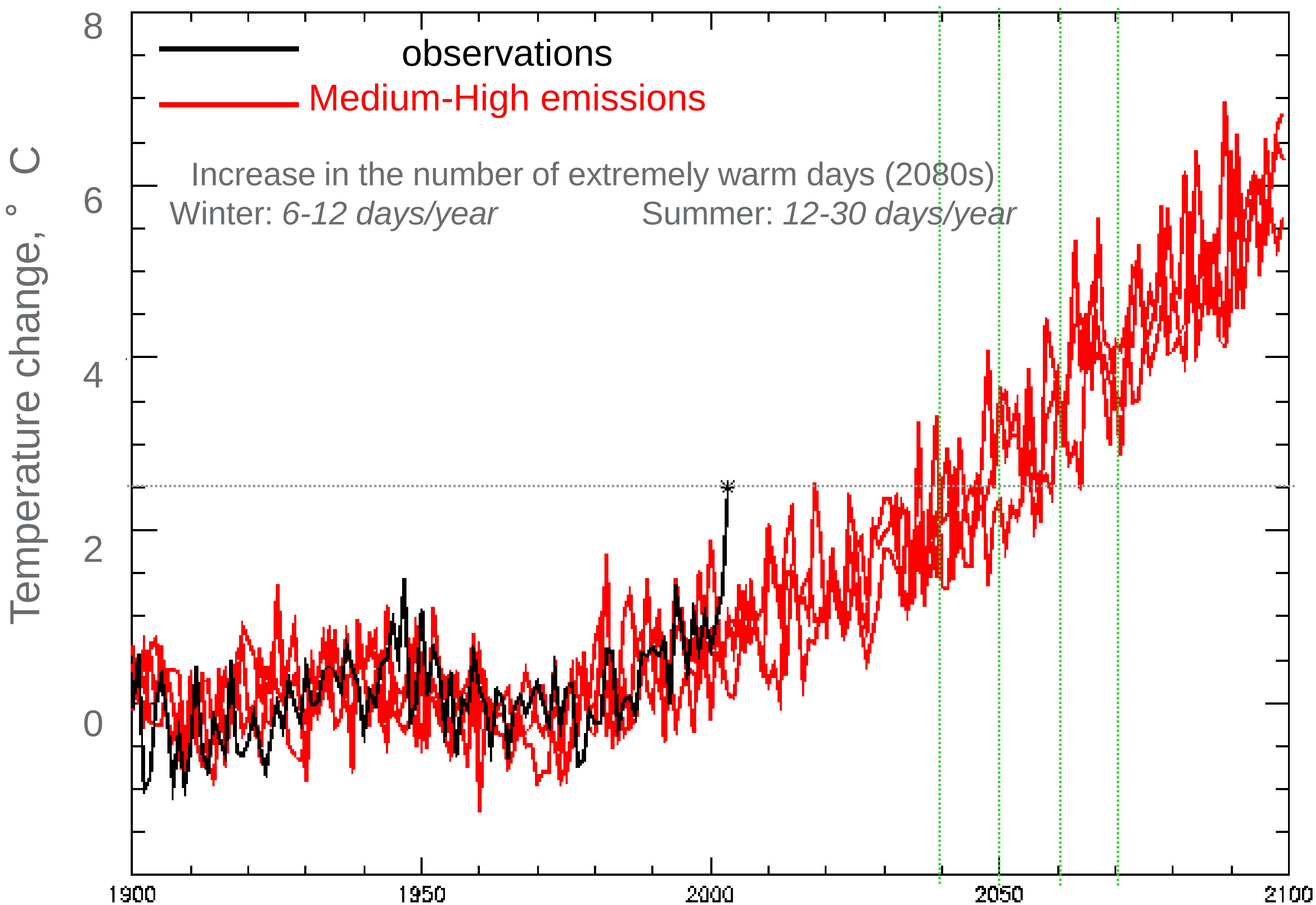
- Provide leadership and create confidence
- Reduce risk
- Disseminate information

CLIMATE CHANGE

The Road to Zero Carbon

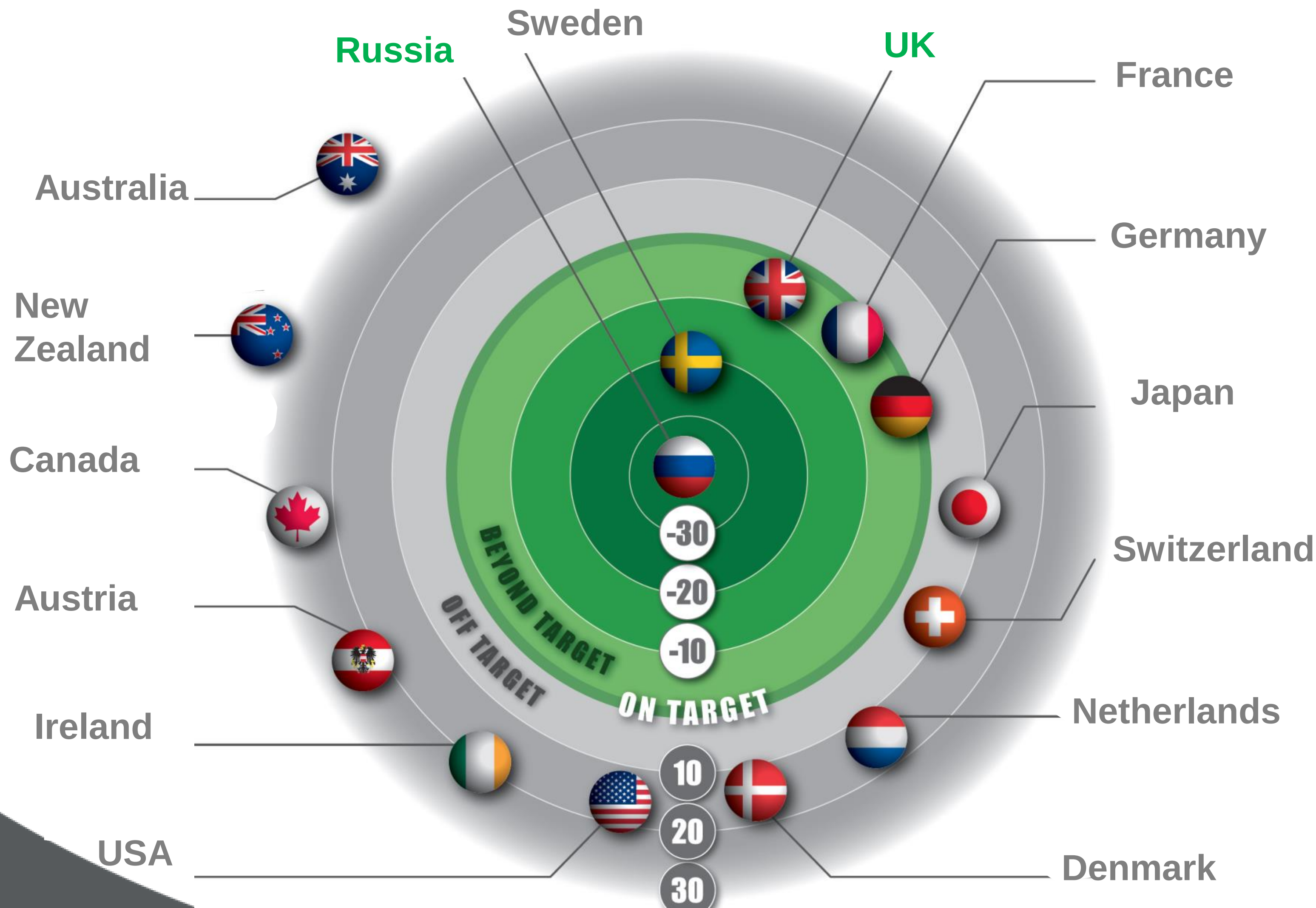
ZERO CARBON HUB

CLIMATE CHANGE – EXPECTED INCREASE IN TEMPERATURE



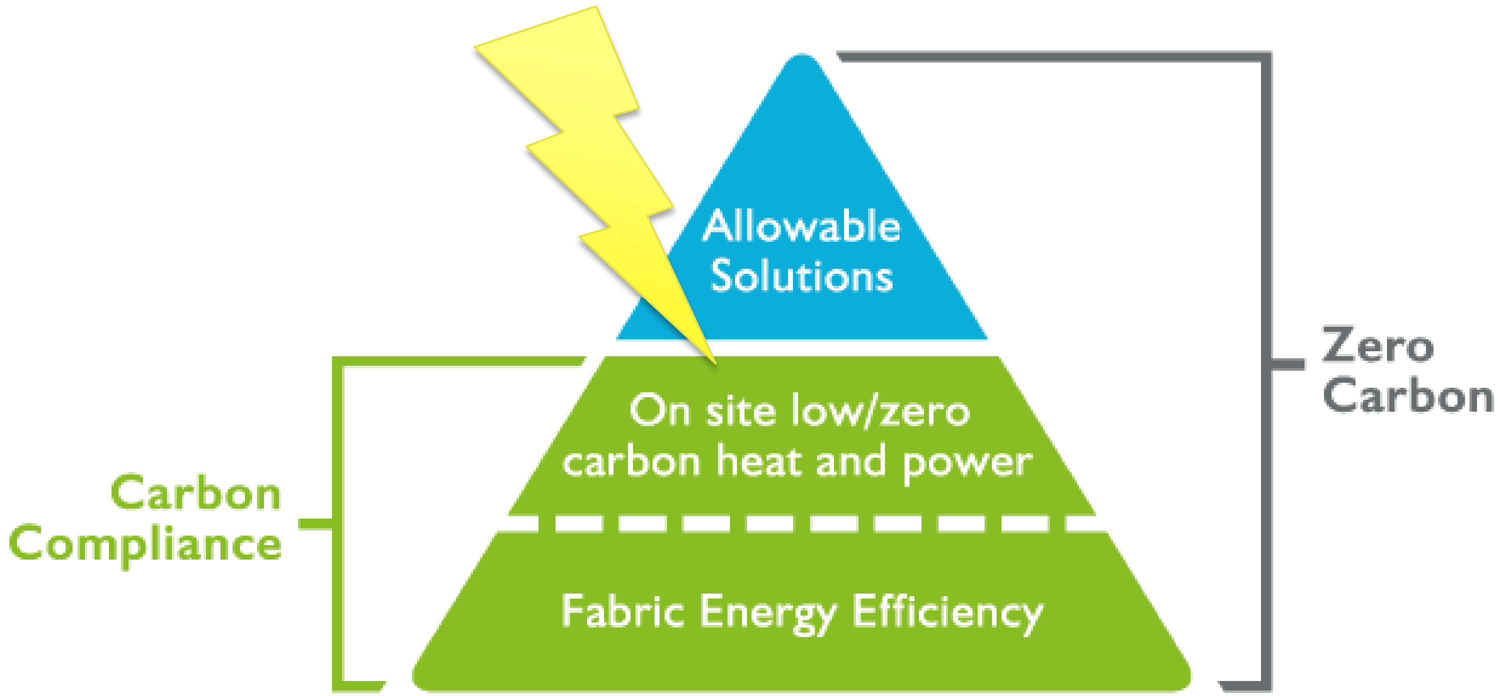

Kazakhstan
Aral Sea
Syr Darya
Uzbekistan
Caspian Sea
Turkmenistan
Amu Darya

KYOTO – WHO'S ON TARGET

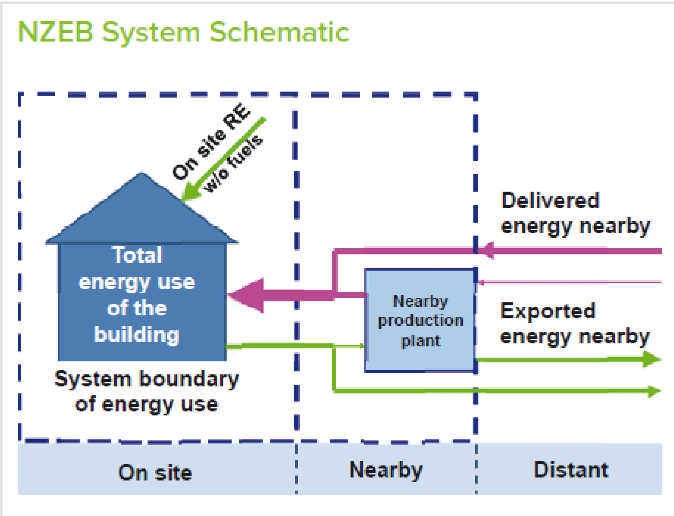


POLICY:
A ‘EUROPEAN’ CONTEXT

An interesting time for new buildings ....



Nearly zero-energy Buildings



EPBD Article 2, NZEB definition:

[..] 'nearly zero-energy building' means a building that has a very high energy performance [..]. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby.[..]

Article 9 Nearly zero-energy buildings – EPBD

1. Member States shall ensure that:

(a) By 31 December 2020, all new buildings are nearly zero-energy buildings; and

(b) After 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings.

(b) Set targets in order to stimulate the transformation of buildings that are refurbished into nearly zero-energy buildings

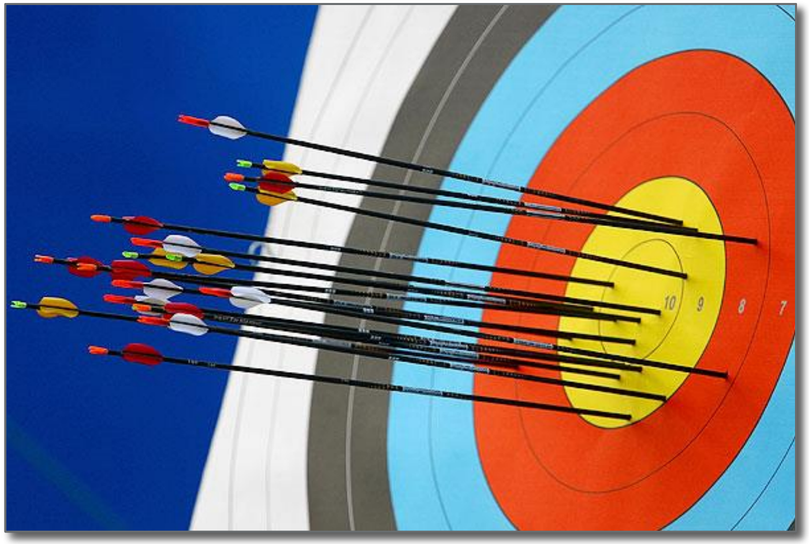
CARBON CULPRITS

CARBON CULPRITS IN UK BUILDINGS

Culprits: most CO2 from buildings stems from heating. Houses are particularly energy-inefficient

RISKS

- **Performance gap** – moving to solutions
- **Ventilation** – encouraging best practice
- **Overheating** – understanding the issues



THE PERFORMANCE GAP


Golf TDI Clean Diesel
2009 World Car of the Year
NOT A CONCEPT CAR

WHAT ARE CONSUMERS EXPECTING?

This is why the performance gap matters

	Victorian with some modern day improvements	New Build built to 2013 regulations	New Build 2016 aspirations
4-bed Detached house	£2,460	£1,050	£620
3-bed Semi-detached	£1,670	£780	£450
3-bed Mid-terrace house	£1,430	£760	£480
1-bed Ground Floor Flat	£940	£500	£380

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Core Work Groups

WG0:	Process
WG1:	Concept & Planning
WG2a:	Design
WG2b:	Tools
WG3a:	Materials & Procurement
WG3b:	Procurement
WG4:	Construction
WG5a:	Verification
WG5b:	Testing
WG5c:	CJDs

Closing the Performance Gap – the 2020 Ambition:

"From 2020, be able to demonstrate that at least 90% of all new homes meet or perform better than the designed energy / carbon performance"

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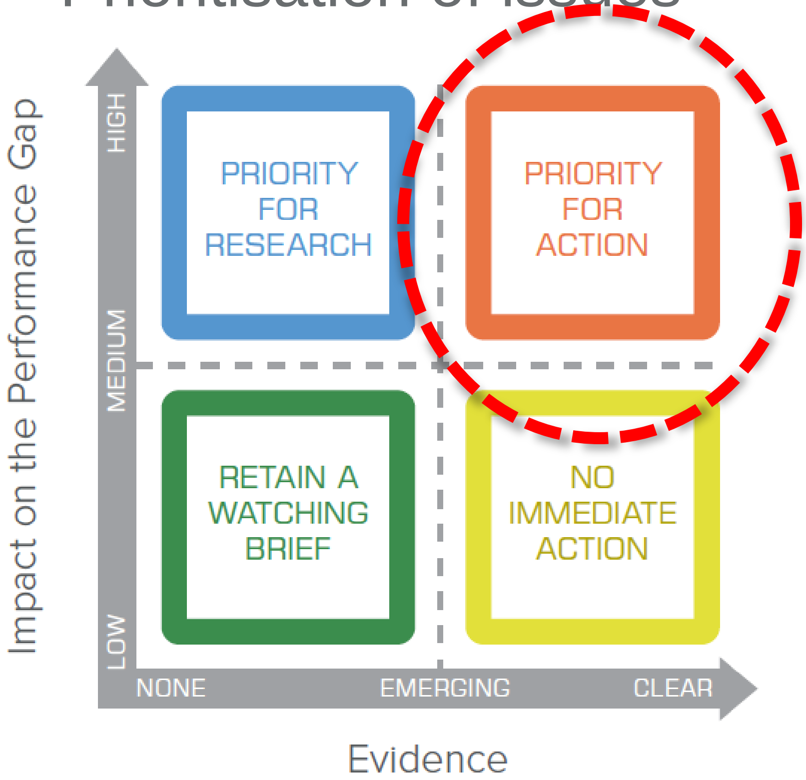
Literature Review

- **State of the industry (*aggregated data*)**
  - NHBC, LABC, SAP software providers, professional institutions, house builders, manufacturers
- **Compliance processes**
  - As-built SAPs, ACD/ECD use, Air pressure tests, commissioning
- **Field trials**
  - TSB Building Performance Evaluation, EST Heat pump trials
- **Academic studies**
  - Stamford Brook, Elmtree Mews, Temple Avenue
- **"Secret" knowledge**
  - Manufacturers, Universities

Prioritisation of issues - **15 Priority for Action**



AND cross-cutting themes

- KNOWLEDGE & SKILLS
- RESPONSIBILITY
- COMMUNICATION

Evidence Review Report

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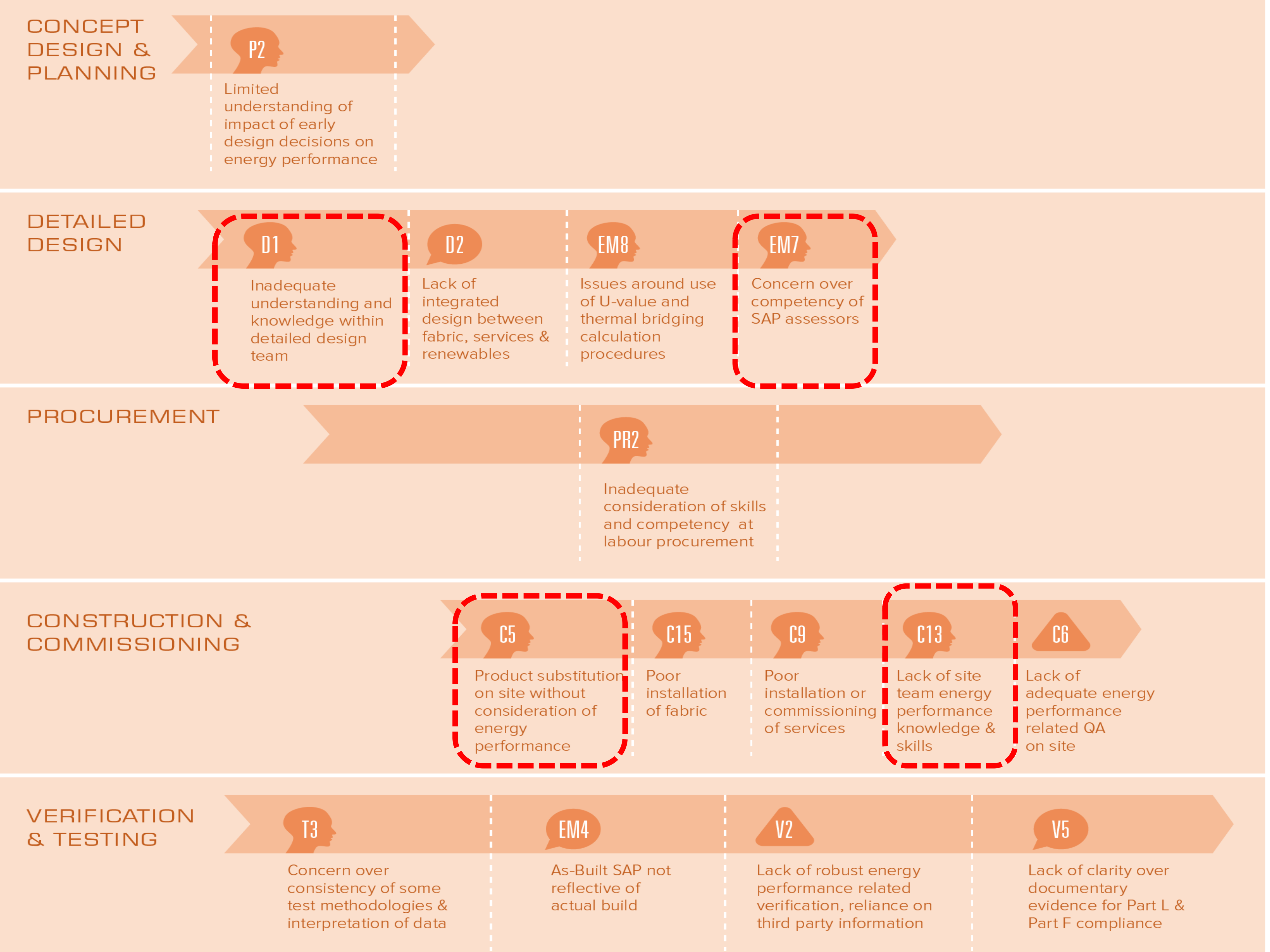

CONCEPT DESIGN & PLANNING
P2
Limited understanding of impact of early design decisions on energy performance
DETAILED DESIGN
D1
Inadequate understanding and knowledge within detailed design team
D2
Lack of integrated design between fabric, services & renewables
EM8
Issues around use of U-value and thermal bridging calculation procedures
EM7
Concern over competency of SAP assessors
PROCUREMENT
PR2
Inadequate consideration of skills and competency at labour procurement
CONSTRUCTION & COMMISSIONING
C5
Product substitution on site without consideration of energy performance
C15
Poor installation of fabric
C9
Poor installation or commissioning of services
C13
Lack of site team energy performance knowledge & skills
C6
Lack of adequate energy performance related QA on site
VERIFICATION & TESTING
T3
Concern over consistency of some test methodologies & interpretation of data
EM4
As-Built SAP not reflective of actual build
V2
Lack of robust energy performance related verification, reliance on third party information
V5
Lack of clarity over documentary evidence for Part L & Part F compliance

Inadequate Understanding & Knowledge within Design Team

Impact on:

- Buildability
- Compatibility of systems, materials and services
- Thermal detailing

Typical examples:

- Details into which insulation is impossible to fit
- No detail on support of screed at ground floor perimeters
- No consideration of thermal bridges for rooms over garages

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Concern over Competency of SAP Assessors

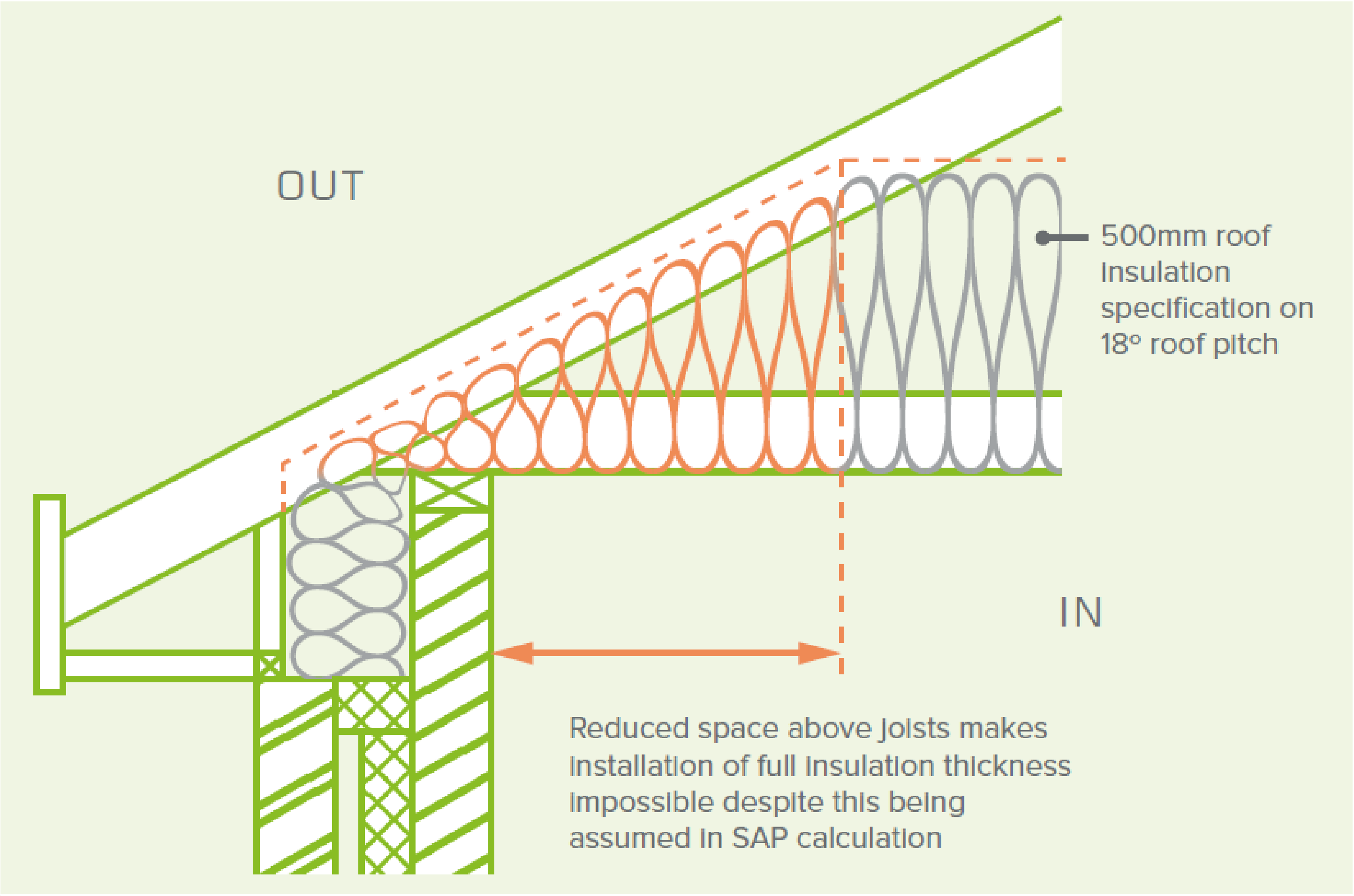
Problems with:

- Accuracy of inputs
- Following conventions
- Validating assumptions
- Evidencing assessments

Massive impact where they are giving design advice

How is the u-value calculated?

Can’t assume same thickness across entire roof



Lack of Site Team Energy Performance Related Knowledge and Skills and/or Care

Literature Review -

- *"The lack of proper training of the workforce......resulted in significant construction faults, unplanned design solutions and wrong system commissioning"*

  Oxford Brookes University, *Understanding the Gap between As Designed and As Built Performance*, 2013

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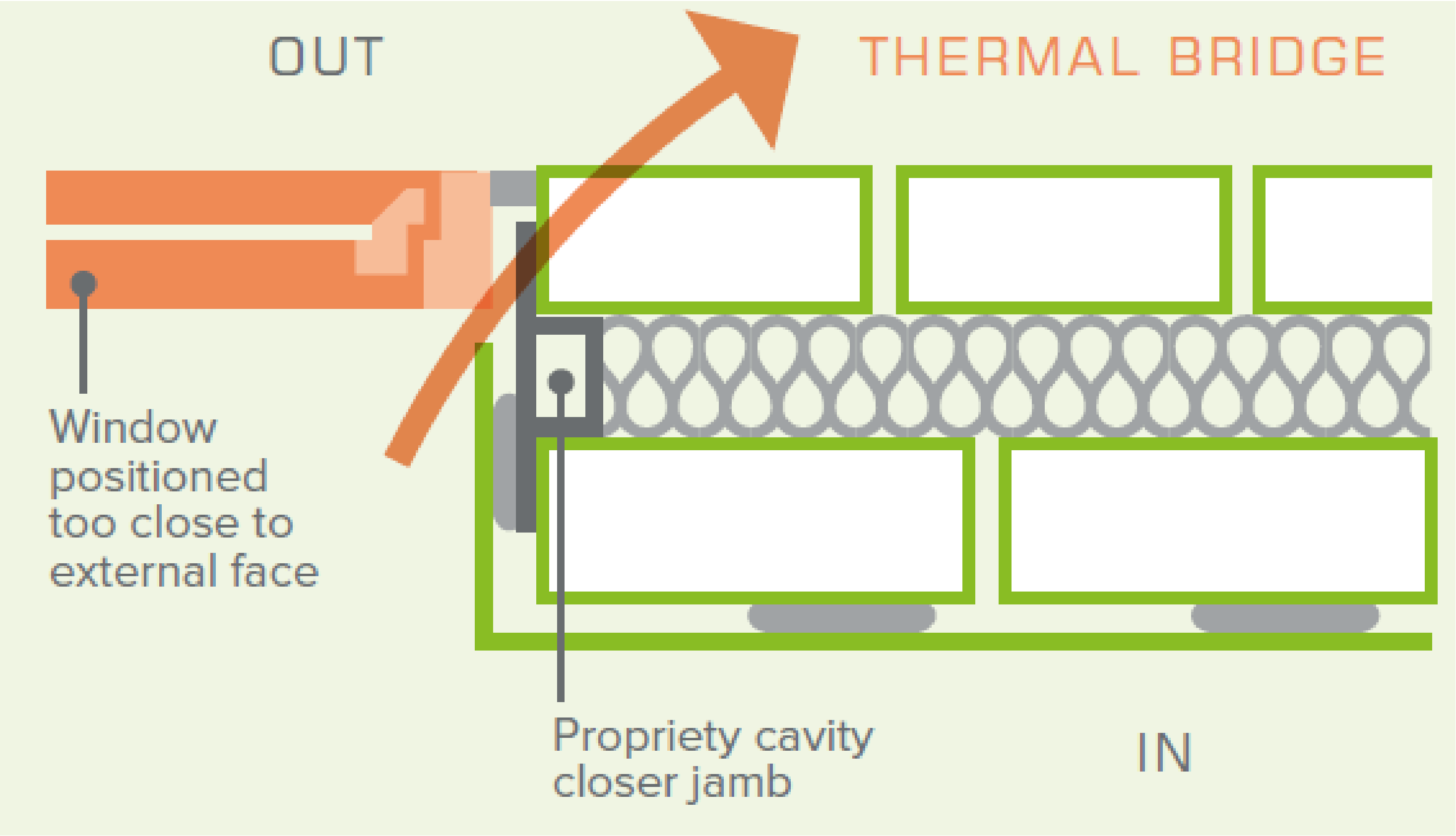
Windows located in front of design positions

- Insufficient overlap with cavity closer
- **<u>All</u>** sites visited had the window in the wrong place



Product Substitution On Site

Literature Review -

- *"The most striking observation about the application of materials and components were the number of occasions on which materials intended for one location were used in another"*

  Leeds Metropolitan University, Lessons from Stamford Brook, 2008

Performance Assessment R&D

Skills and Knowledge Development

Construction Details Scheme

Continued Evidence Gathering

INDUSTRY RECOMMENDATIONS

Signal Clear Direction

Stimulate Industry Investment

Strengthen Compliance Regime

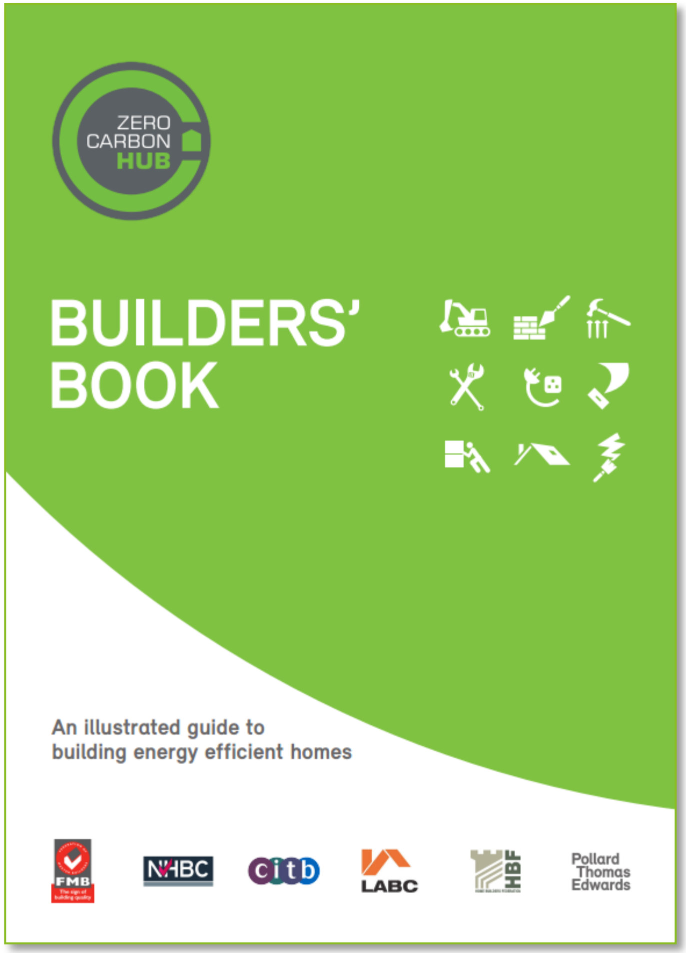
Support Skills & Knowledge Development

GOVERNMENT RECOMMENDATIONS

How to address the Performance Gap?

- Provide a good practice guide in simple, clear format

- Use with on site toolbox talks, site manager training, builder's merchants, building control, designer awareness, specifications, warranty providers .... And students !



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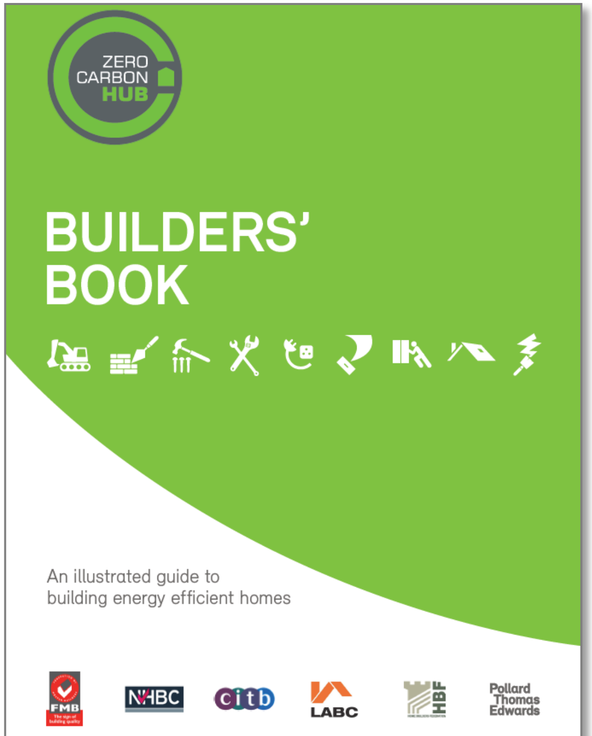
Performance gap - First step to solutions

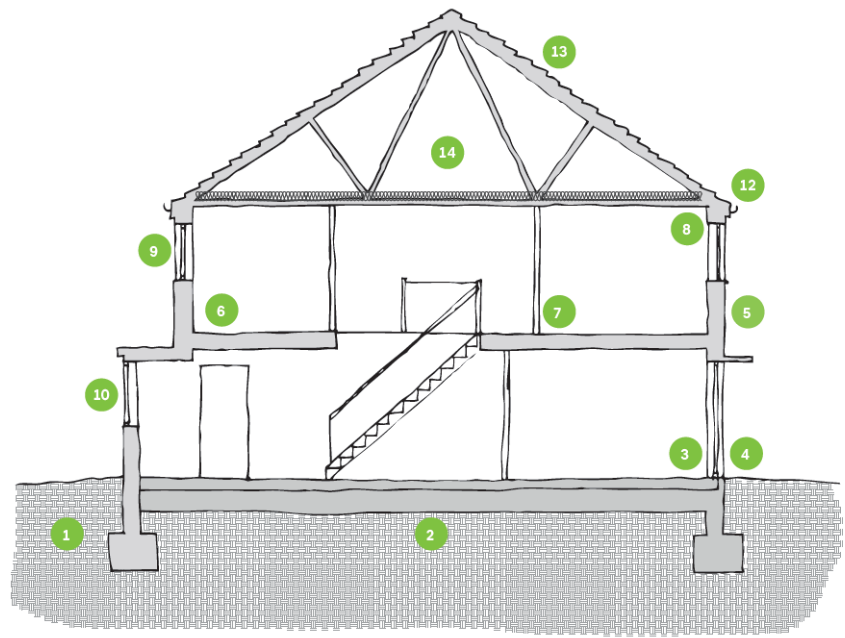


Common themes on site

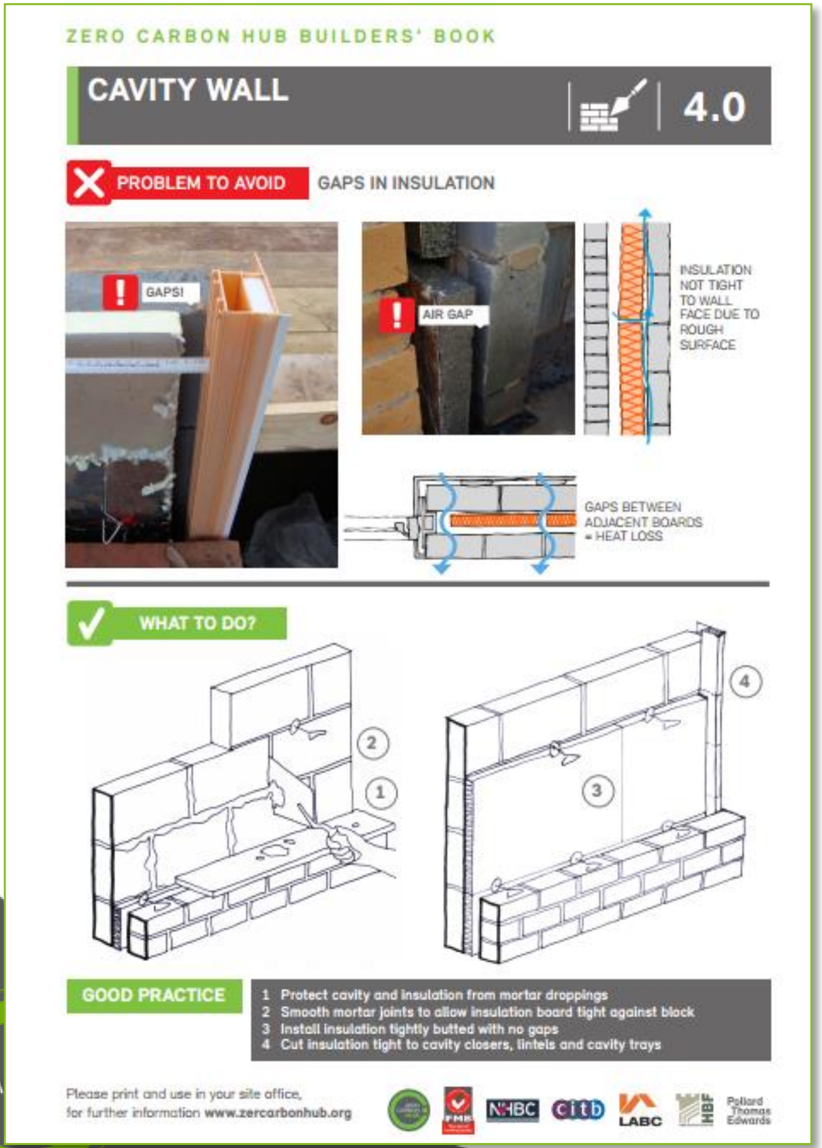
Site Posters - Fabric and Services

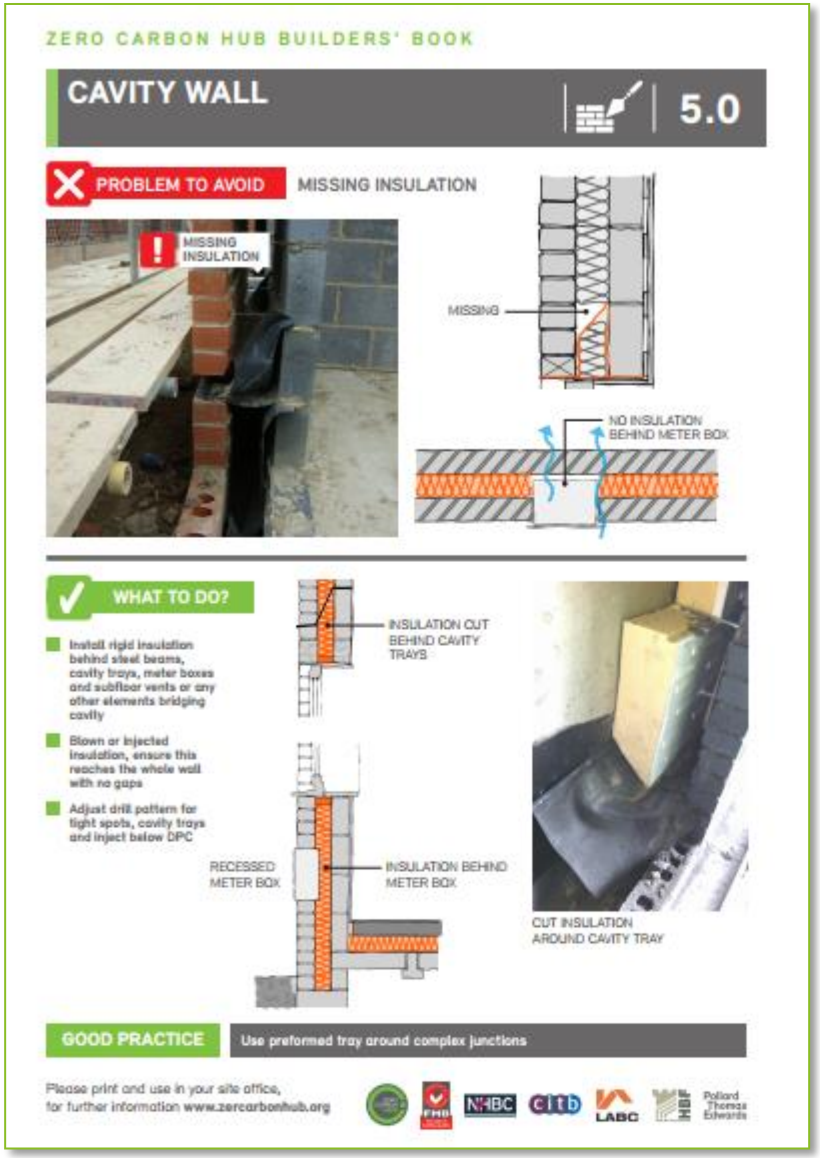
Fabric

1 Groundworks
2 Beam and Block Floor
3 Door Threshold
4 Cavity Wall – partial fill
5 Cavity wall – full fill
6 Floor Joists
7 Separating wall
8 Lintels
9 Windows
10 Bay windows
11 Projecting windows
12 Eaves
13 Roof
14 Dryline
15 Ventilation
16 Heating / hotwater
17 Finals



Site posters

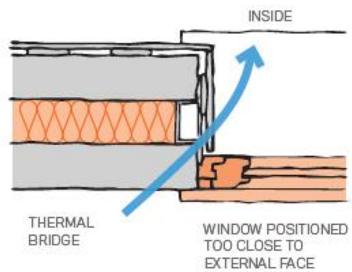




ZERO CARBON HUB BUILDERS' BOOK

WINDOW INSTALLATION 9.0

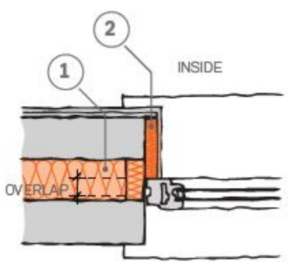
PROBLEM TO AVOID WINDOWS INSTALLED FORWARD OF DESIGN POSITION



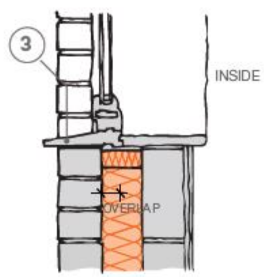
NO OVERLAP OF WINDOW AND CAVITY

WHAT TO DO?

- Close the cavity with tightly packed insulation (1)
- Insulation to window reveal (2)
- Window fitter to provide non standard large cill (3)
- Overlap frame with cavity as much as possible - minimum 30mm
- Check trickle vent sizes as design
- Less than 10mm tolerance around window frame and structural opening



PLAN



WINDOW CILL

GOOD PRACTICE A large overlap with cavity will improve thermal performance
For improved airtightness, use air barrier tapes between the window/door and structure

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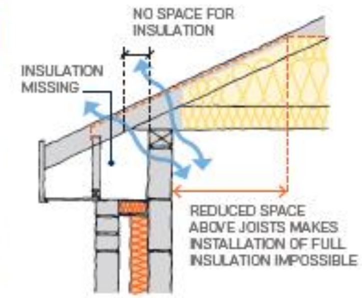
EAVES 12.0

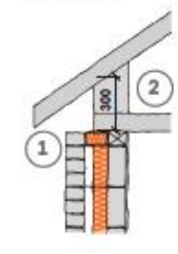
PROBLEM TO AVOID NO INSULATION AT EAVES



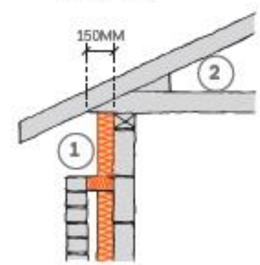
WHAT TO DO?

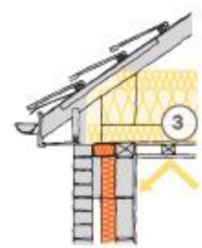
- Install rigid insulation to top of the wall plate (1)
- Truss design to accommodate space for insulation at eaves (2)
- Lay mineral wool insulation into eaves (3)
- Cut insulation around eaves lintels

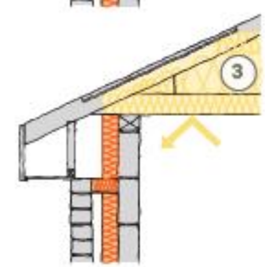
OPTION 1



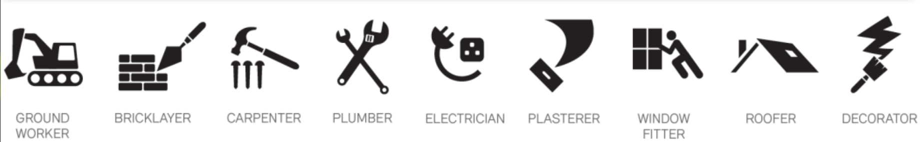
OPTION 2



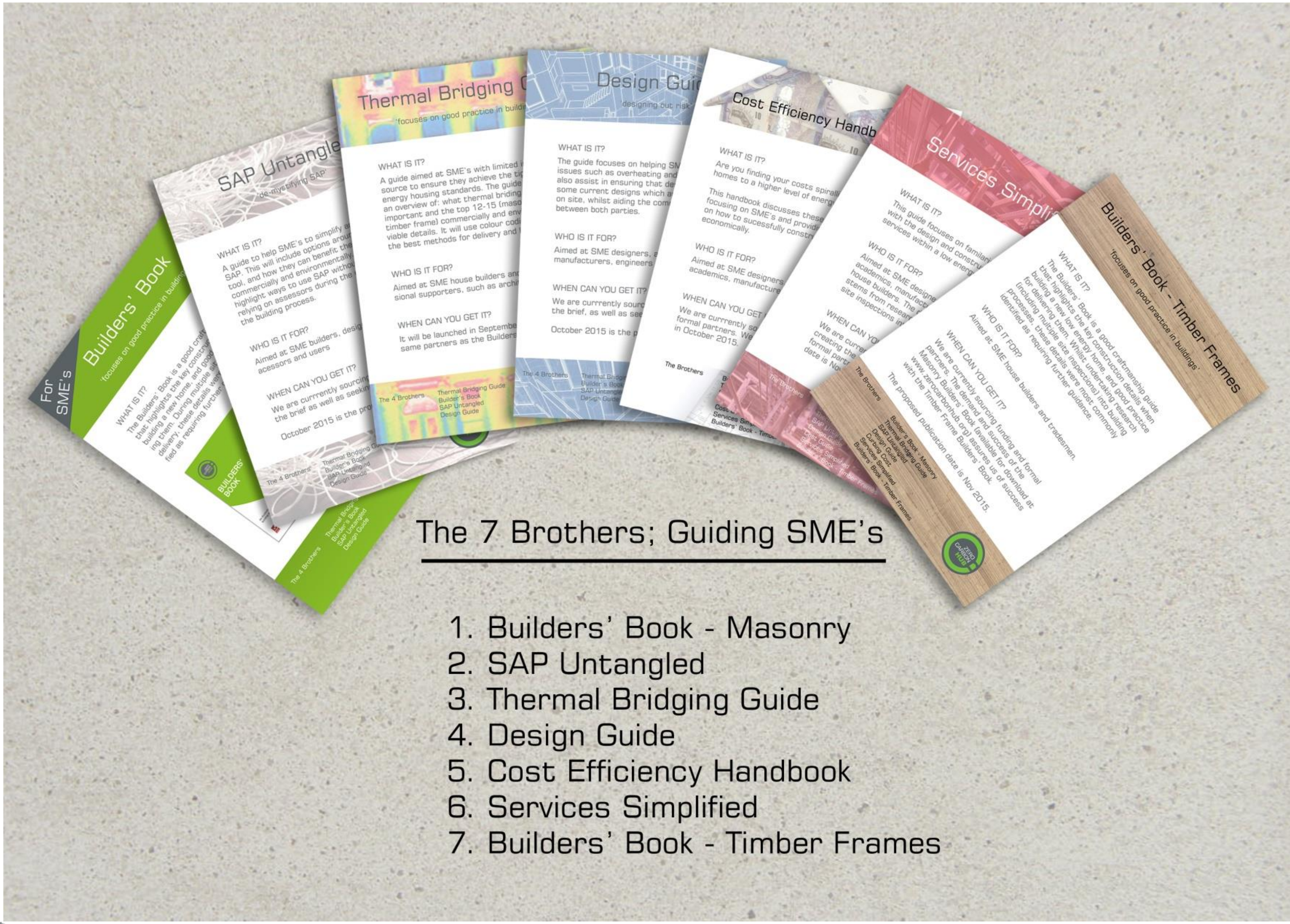




GOOD PRACTICE Install insulation before eaves are inaccessible



Zero Carbon Hub Guides



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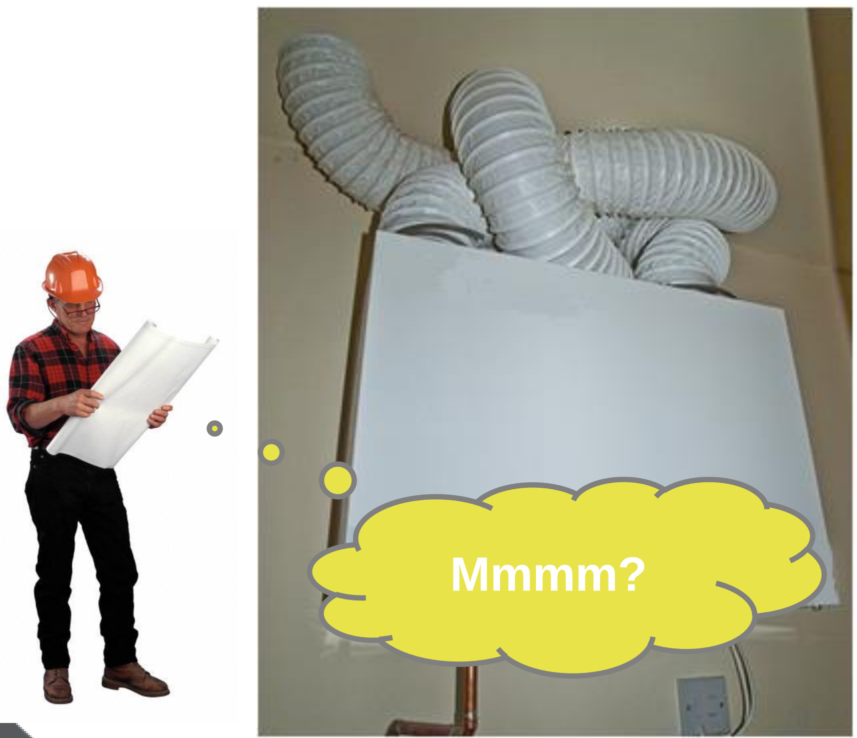
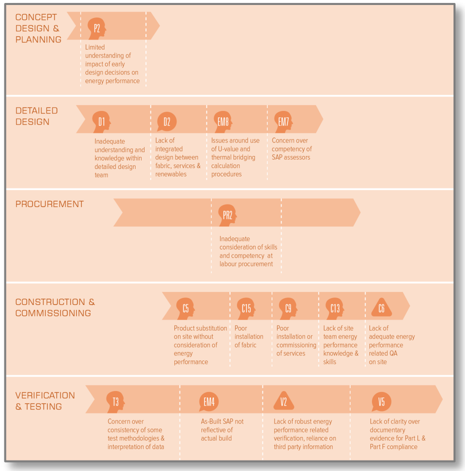
VENTILATION

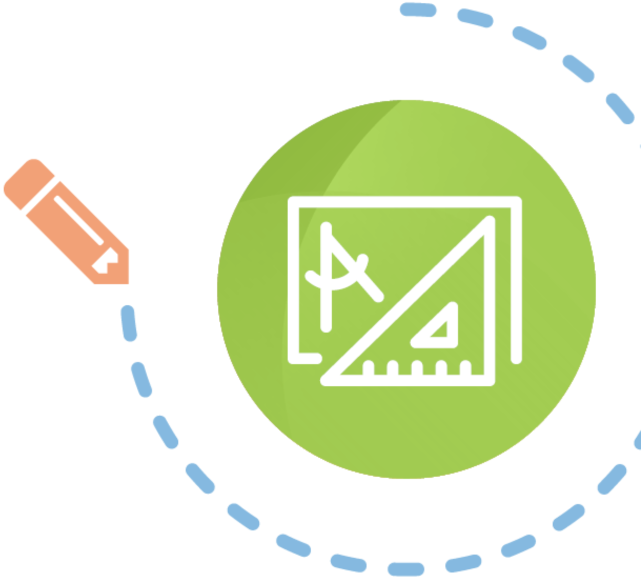
Ventilation – delivery improvements



Ventilation Field Study

- Focus on MEV and MVHR
- Site walkthrough investigations
- Interviews with key people:
  - Installers
  - Site management
  - Designers
  - Manufacturers
  - Residents

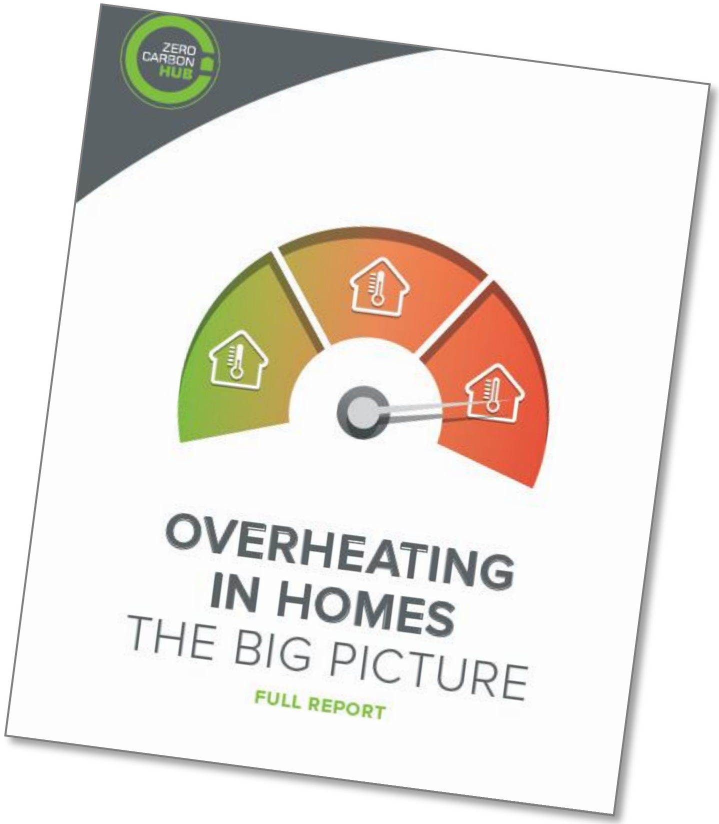




OVERHEATING

OVERHEATING – a few numbers

- 20% — No of homes in England & Wales are already O/Htg
- 1 in 3 — 2,000 excess deaths in UK every third year by 2040
- 9° C — Biggest recorded Urban Heat Island Effect (London v rural)
- £100K — Cost to one builder to rectify an O/Htg apartment block
- 7,000 — Estimate of 2050 annual heat related deaths
- 100 — Estimated hospital admissions for every heat related death



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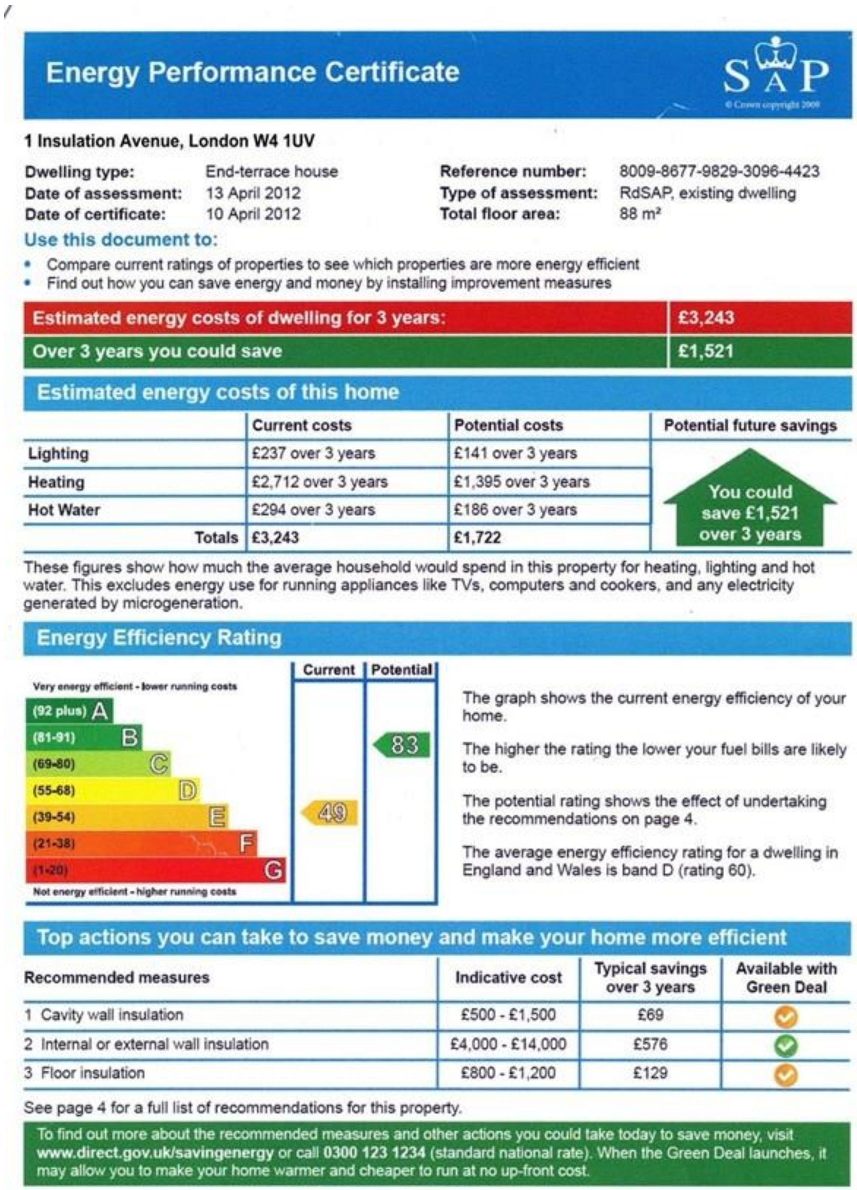
Helping the Consumer

Are the running costs as presented by the EPC of any use?

Are homes today comfortable?

Are we creating ‘stuffy’ homes?



Energy Performance Certificate

SAP

© Crown copyright 2009

1 Insulation Avenue, London W4 1UV

Dwelling type:	End-terrace house	**Reference number:**	8009-8677-9829-3096-4423
Date of assessment:	13 April 2012	**Type of assessment:**	RdSAP, existing dwelling
Date of certificate:	10 April 2012	**Total floor area:**	88 m²

Use this document to:

- Compare current ratings of properties to see which properties are more energy efficient
- Find out how you can save energy and money by installing improvement measures

Estimated energy costs of dwelling for 3 years:	**£3,243**
Over 3 years you could save	**£1,521**

Estimated energy costs of this home

	Current costs	Potential costs	Potential future savings
Lighting	£237 over 3 years	£141 over 3 years	You could save £1,521 over 3 years
Heating	£2,712 over 3 years	£1,395 over 3 years	
Hot Water	£294 over 3 years	£186 over 3 years	
Totals	£3,243	£1,722	

These figures show how much the average household would spend in this property for heating, lighting and hot water. This excludes energy use for running appliances like TVs, computers and cookers, and any electricity generated by microgeneration.

Energy Efficiency Rating

	Current	Potential
Very energy efficient - lower running costs		
(92 plus) A		
(81-91) B		83
(69-80) C		
(55-68) D		
(39-54) E	49	
(21-38) F		
(1-20) G		
Not energy efficient - higher running costs		

The graph shows the current energy efficiency of your home.

The higher the rating the lower your fuel bills are likely to be.

The potential rating shows the effect of undertaking the recommendations on page 4.

The average energy efficiency rating for a dwelling in England and Wales is band D (rating 60).

Top actions you can take to save money and make your home more efficient

Recommended measures	Indicative cost	Typical savings over 3 years	Available with Green Deal
1 Cavity wall insulation	£500 - £1,500	£69	✓
2 Internal or external wall insulation	£4,000 - £14,000	£576	✓
3 Floor insulation	£800 - £1,200	£129	✓

See page 4 for a full list of recommendations for this property.

To find out more about the recommended measures and other actions you could take today to save money, visit **www.direct.gov.uk/savingenergy** or call **0300 123 1234** (standard national rate). When the Green Deal launches, it may allow you to make your home warmer and cheaper to run at no up-front cost.

http://www.zerocarbonhub.org/recent-publications

Stay in touch:

www.zerocarbonhub.org

Rob.pannell@zerocarbonhub.org

Thank you

Building Performance Evaluation: In-use Post Occupancy Evaluation – a Welsh Case Study

Aberfawr Terrace, Abertridwr, Wales

Building Better Buildings - Cardiff

22nd March 2016
Dr John Littlewood*^
***Director* – Sustainable Construction Monitoring & Research Ltd**
^Head of the EBERE group, Cardiff Metropolitan University

scmr2410@gmai.com and jlittlewood@cardiffmet.ac.uk

Project partners

United Welsh Housing Association (BPE grant winner), Caerphilly, Wales

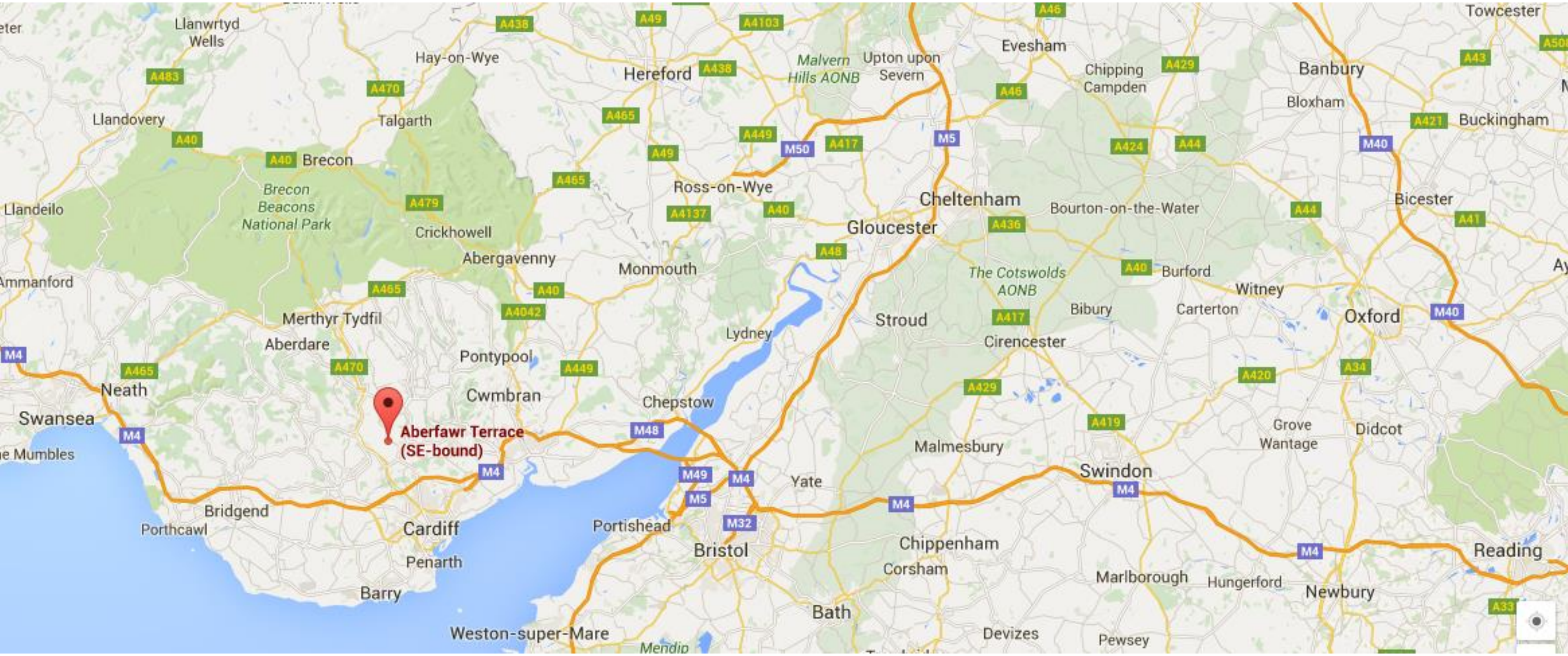
InnovateUK

Sustainable Construction Monitoring & Research Ltd, Dinas Powys (2012-date)

Cardiff Metropolitan University (2011-2012, 2015-date), Cardiff, Wales

Thanks to: Richard Mann, Ivan Smallwood, Mat Colmer, Alex Moody

Introduction – Aberfawr Twerrace, Abertridwr



Altitude is 155 metres above sea level, side of a river valley.
Orientation is north/south (flats) and west/east (houses).
Designed and constructed as a package deal with a Welsh contractor.
Occupied from December 2010: nine single-storey flats, four two-storey houses and one fly-over maisonette.
BPE study: two flats (single occupancy), one two-storey house, two bedrooms (2 adults/1 child) and one two-storey house, three bedrooms (multiple occupancy).

Introduction – Aberfawr Terrace: Dwellings

- All houses CfSH level 3+ and flats CfSH level: 4, latterly DECC grant during construction in 2010.

- Flat construction - 0.2, 0.1 and 0.25 W/m²K U values for exterior walls, roof and ground floor, timber frame, sheeps wool insulation, cedar clad, triple glazing, 1 kW PV;
- House Construction: 0.18, 0.1 and 0.2 W/m²K U values for exterior walls, roof and ground floor; brick/block cavity construction, double glazing, no PV.

- Heating/Ventilation: electric only: NIBE EASHPs + underfloor heating

Litttewood et al, (2014, 2016)

Key questions: Design Intent Vs Actual Building Performance.

1. How does timber frame versus brick/block construction effect dwelling internal comfort conditions, space heating energy use and carbon emissions?

2. Do NIBE EASHPs lead to high energy usage and associated costs/carbon emissions for space/water heating, and how to occupants engage with such systems and their controls.

3. How can the handover/tenant education be developed and used on other schemes and can any lessons be learnt from the contractor's direct supply approach?

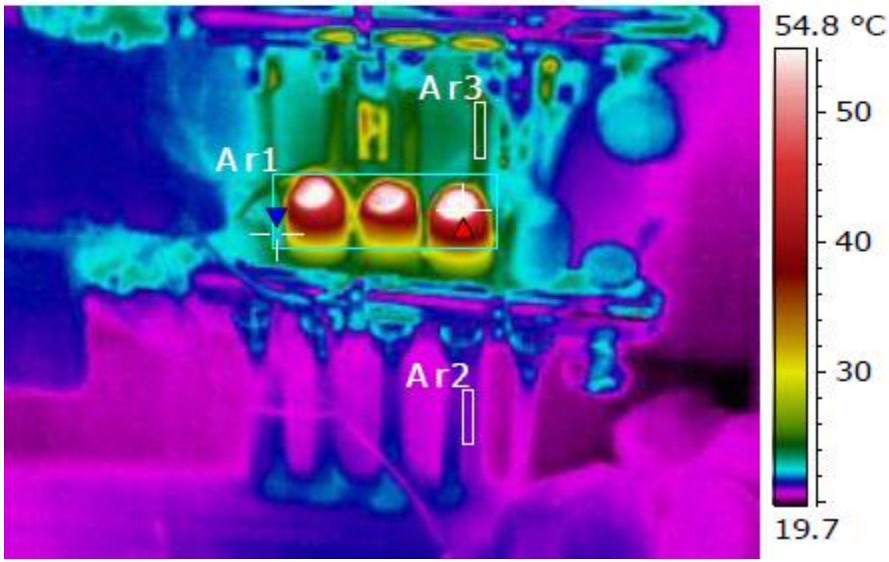
4. How do air tightness values that exceed the maximum optimum of 3 $m^3/h.m^2$, at 4.8 $m^3/h.m^2$ (houses) affect the use of the EASHPs.

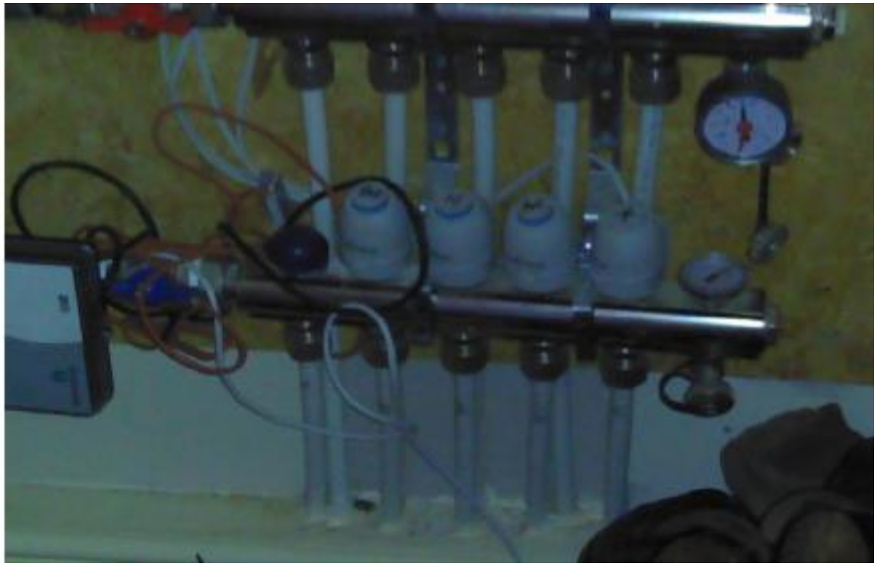
5. UW wishes to understand whether it needs to fundamentally overhaul its design, procurement, commissioning and hand-over strategies; by stipulating more exacting design, construction, commissioning and operational standards.

Litttewood et al, (2014, 2016)

Systems Review: Underfloor Heating Controls & Heat Pump Controls

House





Flat

House

Litttewood et al,
(2014, 2016)

Systems Review: Thermostats

Flat Room Thermostat

House Room thermostat

Both dwellings are similar as far as the local room controls are concerned. The thermostats in House . were set to maximum (30°C).

Flat Hall (main) Thermostat

House Hall (main) Thermostat

Litttewood et al, (2016)

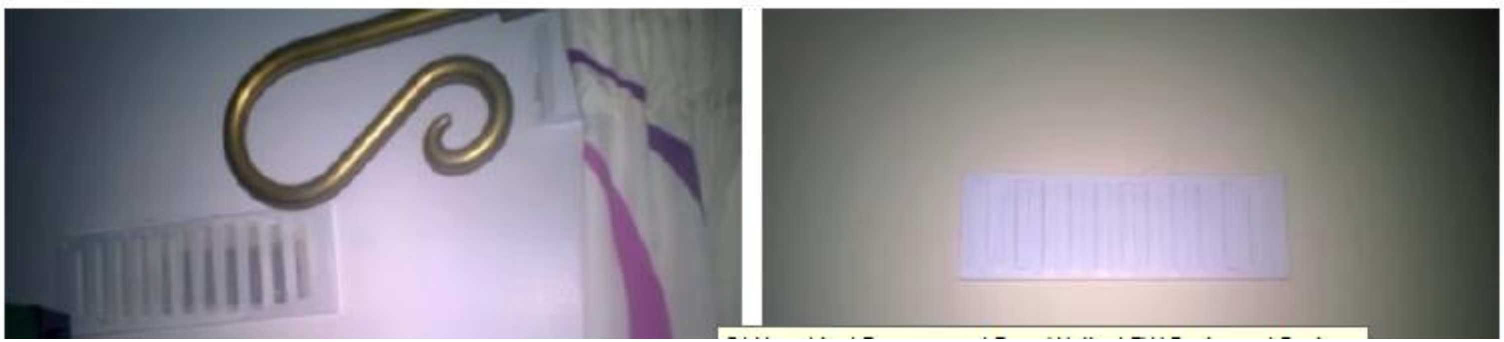
Occupant interaction with extract ventilation & filters




Litttewood et al, (2014, 2016)

Occupant interaction with supply ventilation

Air make-up (to replace the air extracted by the NIBE system) is via wall transfer grilles in each property. These are located in each of the non-wet rooms, i.e. living rooms and bedrooms. This type of air inlet and the installed capacity is appropriate for this type of ventilation system. As often found, however, is the tendency for occupants to close these (Figure 2.6), either due to perceived heat loss, or discomfort from draughts, or both. Two out of the three air inlets in House 4 were found to be closed, and two out of two air inlets in Flat 6A were found to be closed. This finding is symptomatic of poor user guidance and understanding and it is recommended that guidance is made available as detailed earlier in this report.



Litttewood et al,
(2014, 2016)

Some key Findings Monitoring vs SAP – Heating: Flat & House

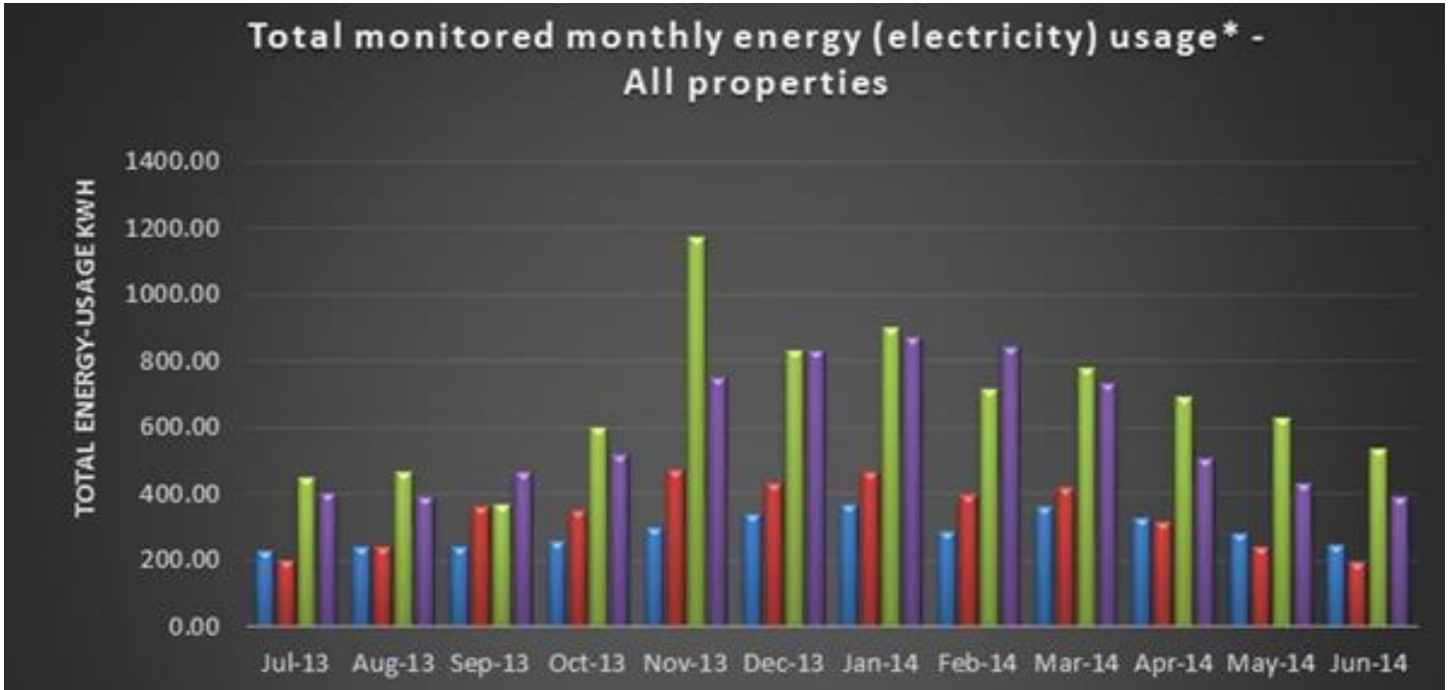
Energy	2010-SAP	2014-SAP	Monitored data	% monitored value of SAP value	
Total Heating Energy Usage (kWh/yr)*	2051.63	2307.25	1628.50	79.37	70.58
S/Heating Energy Outputs (kWh/yr)	1387.70	3149.83	1244.00#	89.64	60.51
H/W Heating Energy Outputs (kWh/yr)	2111.63	1533.46	342.00#	16.20	22.30

Energy	2010-SAP	2014-SAP	Monitored data	% monitored value of SAP value	
Total Heating Energy Usage (kWh/yr)*	2858.93	3376.83	4009.80	140.26	118.74
S/Heating Energy Outputs (kWh/yr)	2417.51	6463.01	2046.00#	84.63	31.65
H/W Heating Energy Outputs (kWh/yr)	2608.35	1855.38	2558.00#	98.07	137.87

*heating values includes energy usages for heat pump, immersion and, pumps, fans and controls.
#monitored heating, space and hot water, energy outputs (NOT USAGE).

(Littlewood & Smallwood, 2015)

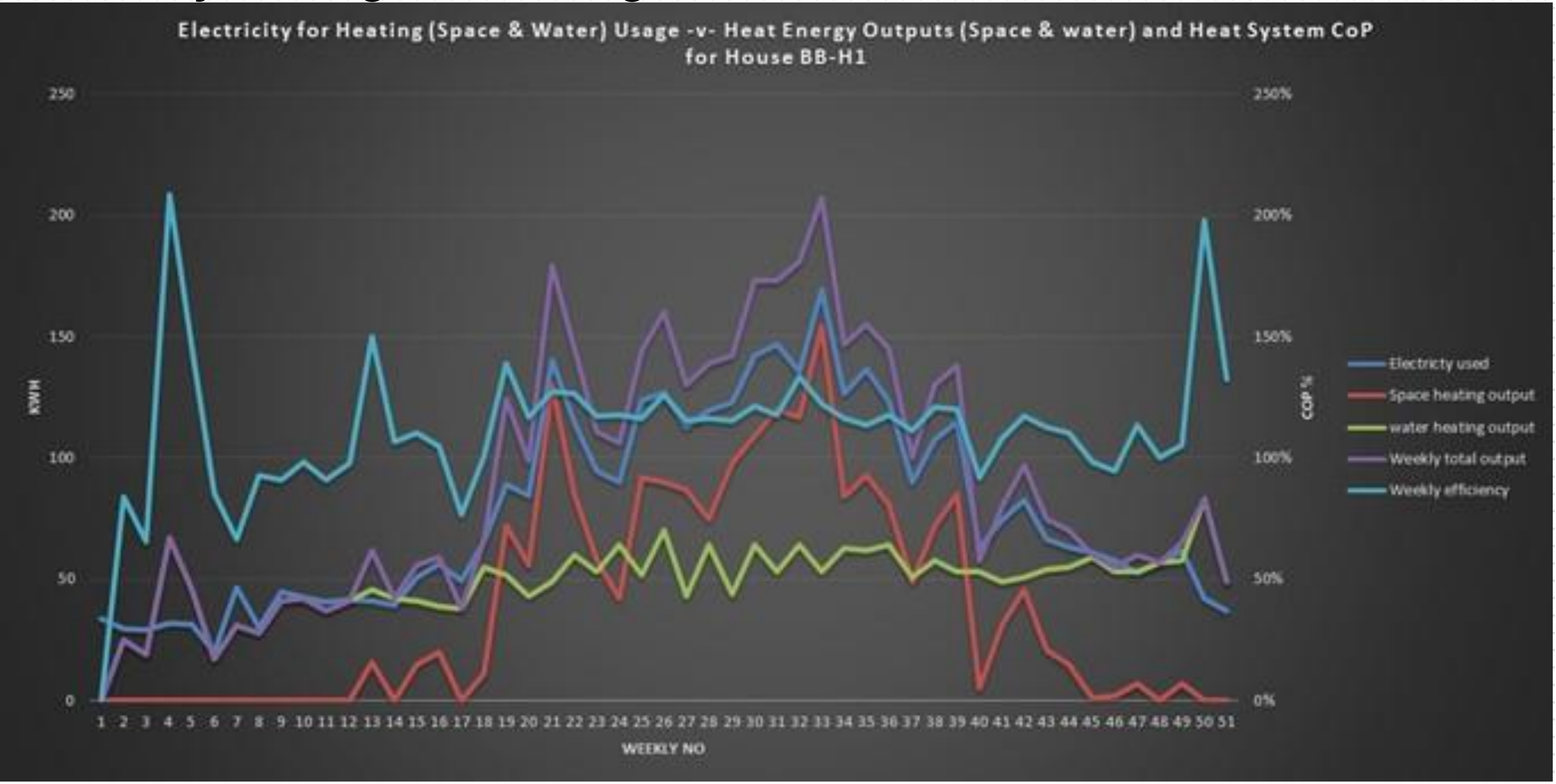
Some key Findings Monitoring – Energy Usages all dwellings



	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14
TF/C-F1 kWh	225.48	236.24	239.63	254.30	295.20	337.40	365.20	287.10	358.80	325.40	280.20	242.00
TF/C-F1a kWh	198.50	240.50	362.42	349.64	468.56	432.11	464.47	392.84	416.00	314.58	237.11	194.13
BB-H1a kWh	447.95	464.90	363.92	597.00	1173.57	831.61	899.65	711.68	778.62	687.96	624.54	535.51
BB-H1 kWh	400.40	389.70	463.10	516.80	748.50	831.40	872.40	842.50	732.60	506.50	428.00	387.10

Occupancy patterns are linked to higher energy usage as are greater exposed facades

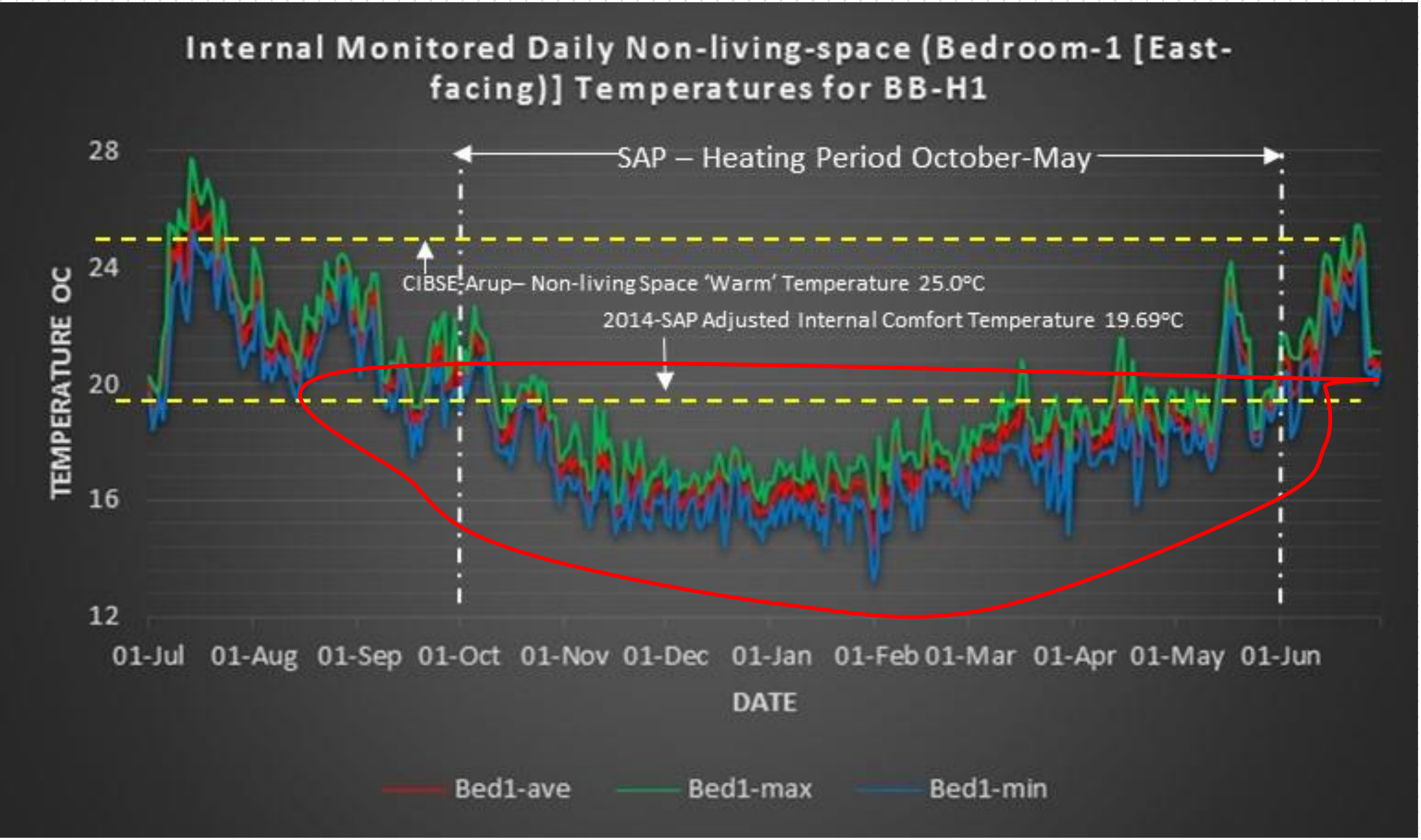
Some key Findings Monitoring – EASHP COP: House



The Derived CoP values are unusual. Notable, the maximum Derived CoPs occur in the SAP non-heating period; July to September, before the first heating period begins.

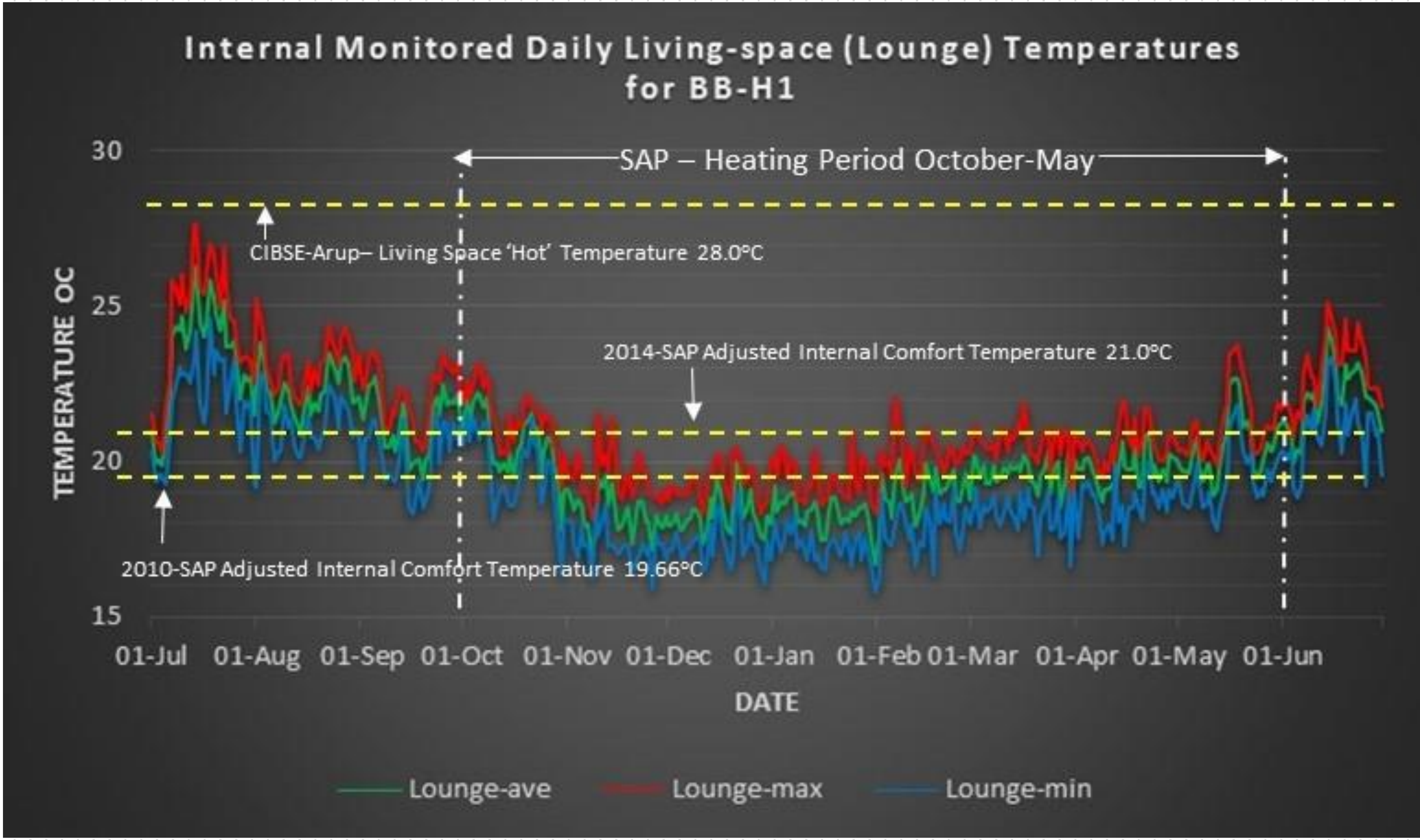
NIBE SYSTEM	NIBE-Published CoP	Derived CoP Maximum (Difference)	Derived CoP Minimum (Difference)
Fighter 360P	3.40	2.09 (-1.31)	0.655 (-2.75)

Environmental Conditions Review: Monitored Data



Underheating/Overheating - cause may not be the M&E, occupants could be the fabric

Some key Findings Monitoring – Environmental Conditions House



Underheating/Overheating - cause may not be the M&E, occupants could be the fabric

Some key Findings from the System Inspection & occupant Interaction

- The EASHP heating-curve 'set-point' for both dwellings was set to the manufacture's settings for radiators not under-floor heat output sources.

- In the house, the 'selected' heating-curve and heat-supply output was set for climates akin to Sweden with external temperatures of -20C and the Swedish language.

- Ceiling terminals for extracting air from some rooms: inspected as altered and also dust, grease and particulate matter was found to be blocking the ducting, both.

- Monitored data indicates that overall the flat never sustains the SAP-Adjusted internal comfort temperature suggesting little heat is recovered through the ceiling ducts & underfloor heating was faulty.

- Both house and flat: overall air flow, (m^3/h^{-1}), is 35% higher & 26% lower in house/flat than the manufacture's recommendations: affecting indoor air quality, heating demands and heat recovery.

- Both house and flat: occupants 'fail' to understand the 'nuances of the installed EASHPs/under-floor heating, operated as 'turn-on/off' & timed – even after repeated instructions during handover, and the BPE project. Filter cleaning problem.

Heating, Thermostats, Occupants or Fabric causing inadequate performanc

	As Built Air Permeability - 2010	Air Permeability 2014 Test Result	Difference
Flat	2.9 $m^3/(h.m^2)@50Pa$	3.72 $m^3/(h.m^2)@50Pa$	+0.82 $m^3/(h.m^2)@50Pa$
House	4.8 $m^3/(h.m^2)@50Pa$	8.8 $m^3/(h.m^2)@50Pa$	+4.00 $m^3/(h.m^2)@50Pa$

Litttewood & Smallwood (2015)

Some Key conclusions from Abertridwr

The incorrect testing/commissioning of the installed heating and ventilation systems means that, regardless of other external factors, the installed EASHP-systems cannot operate to the manufacture's efficiencies.

So difficult to draw conclusions of the effectiveness of the installed technologies in reducing energy consumption, associated emissions and operating costs.

This BPE study highlights the existence of a 'knowledge gap' within the end-users, occupants have developed behaviour strategies in the provision of their internal comfort levels and environmental conditions using the installed heating and ventilation.

Certain actions have a significant detrimental effect which further exasperate the effectiveness of the installed systems and are also reflective of the barrier between users and new technologies in that there 'appears' to be evidence that older technologies; central heating and extractor fans for example, provide a greater feeling of control of the end-user internal environments.

Key Messages

It appears that the Design and Build and complete package deals, where the contractor retains the majority of the control until handover, may not be suitable for innovative developments using non-standard design, construction and systems.

The local authority building control must be active in checking construction compliance on site throughout the process until handover, to ensure responsible and true certification. In addition, the NHBC should also take an active part in this process to ensure that construction and installation meets design intents.

The 'Performance Gap' does not stop post-construction; the processes of an informed handover to future occupants and a robust maintenance management programme is need to ensure that the properties are used and maintained as to the original design intents if energy-efficiency and low-costs benefits are to be continually realized.

Building performance in the life-time of a property is ultimately dependent upon the occupier's ability and willingness to use the building and systems to the original design intents and not rely on others to manage this on their behalf.

The BPE study further highlights the current serious questions within sustainable construction as to applicability/enforceability of the current raft of regulations, policies and standards so that design intents are translated into actual long-term usable benefits.

Lessons embedded at United Welsh

During the BPE project, a dedicated staff member was employed within the development team for managing handover of projects to tenants;

Post BPE study, a new development inspector (clerk of works) was employed to specifically focus upon construction performance during the build stage, with both architectural design and construction experience

SCMR Ltd retained post BPE to offer guidance on compliance testing: air test observations, conducting independent air tests, thermography tests, and whole dwelling smoke tests.

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LITTLEWOOD, J. R. DAVIES, G, J. SMALLWOOD, I. 2014. Energy and Environmental Performance of the Abertridwr Community – First Winter Season. *Energy Procedia*, Volume 62, December, Pages 532–542.

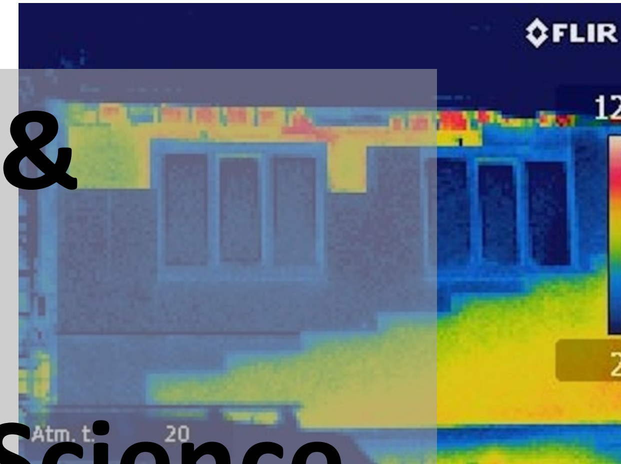
LITTLEWOOD, J. R. SMALLWOOD, I. 2015. Testing Building Fabric Performance and the Impacts Upon Occupant Safety, Energy Use and Carbon Inefficiencies in Dwellings. *Energy Procedia*, Volume 83, December, Pages 454-463.

LITTLEWOOD, J. R. SMALLWOOD, I. 2016. Annual Energy and Environmental Performance of the Abertridwr Community. *Energy Procedia*, Volume TBc, December, Pages Tbc.

THANK YOU FOR YOUR ATTENTION

ANY QUESTIONS

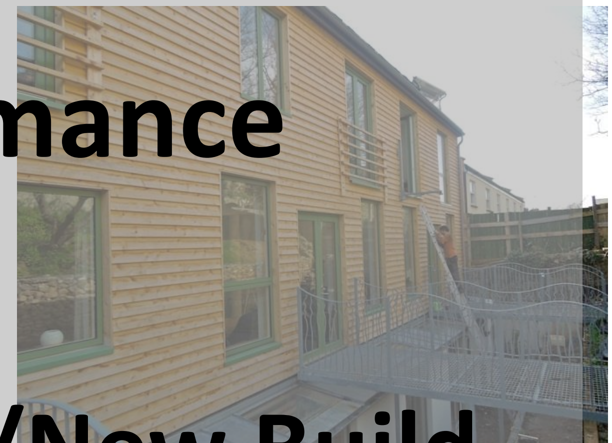

The Main Place
Coleford Community Centre
The Main Place
The Library
Building Performance Evaluation
Piers Sadler
PIERS SADLER CONSULTING



- **Passivhaus Design & Consultancy**
- **Building Energy & Science**
- **Building Performance**

Including

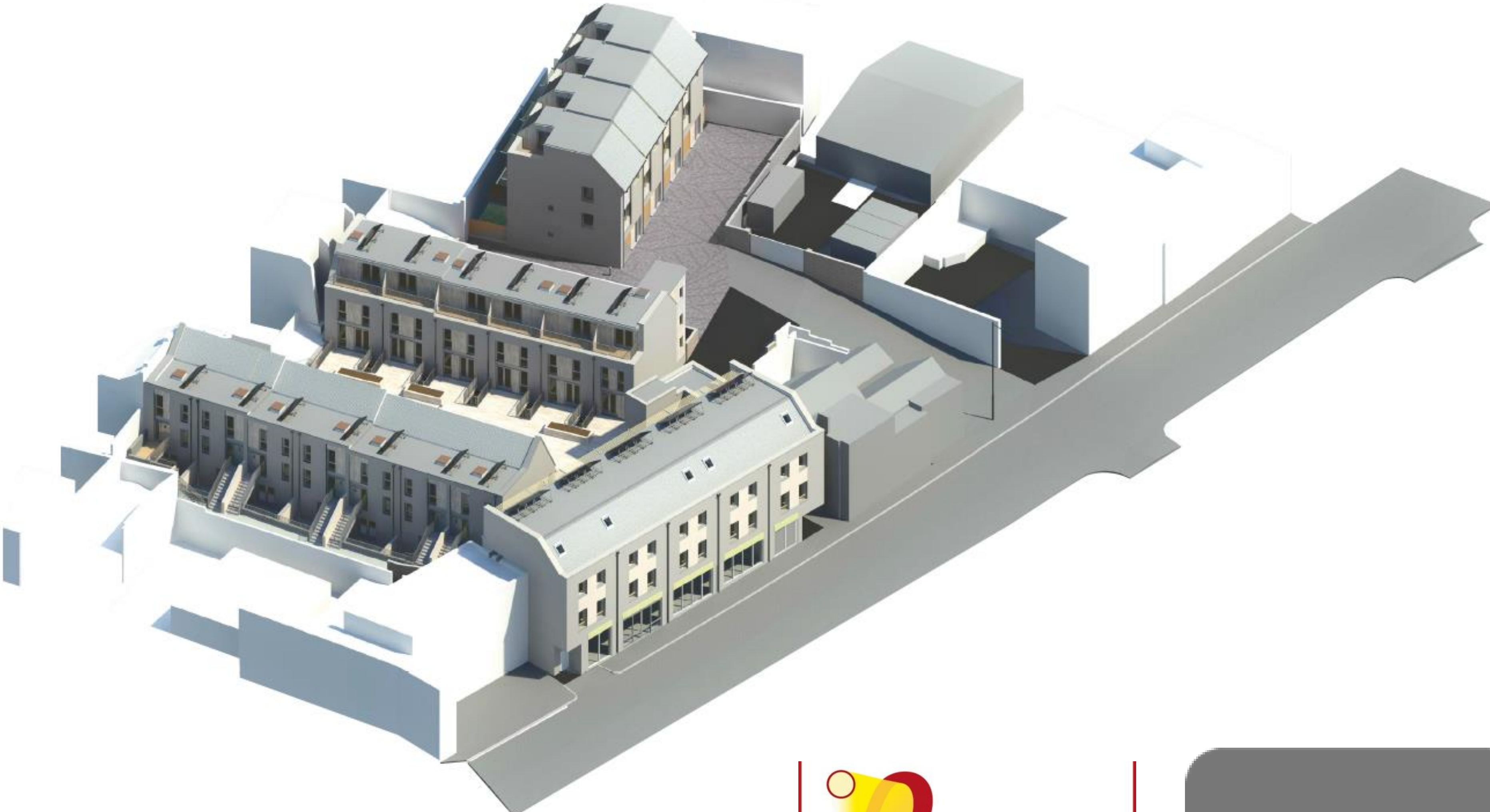
- **Refurbishment/New Build**
- **Domestic/Non-Domestic**



www.piers-sadler.co.uk

DESIGNER
CERTIFIED PASSIVE HOUSE DESIGNER

PIERS SADLER CONSULTING



DESIGNER

CERTIFIED
PASSIVE HOUSE
DESIGNER

PIERS
SADLER
CONSULTING

Building Performance Evaluation
The Main Place

- Client: Innovate UK
- Lead Consultant: Quattro Design Architects
- Sub-Consultant: Piers Sadler Consulting
- Sponsorship: Gloucestershire County Council
- Support (Dissemination): Constructing Excellence
- Duration: July 2012-October 2014

Quattro Design Architects collaborative culture sustainable buildings

Innovate UK Technology Strategy Board

PIERS SADLER CONSULTING

CONSTRUCTING EXCELLENCE in the built environment

Gloucestershire COUNTY COUNCIL

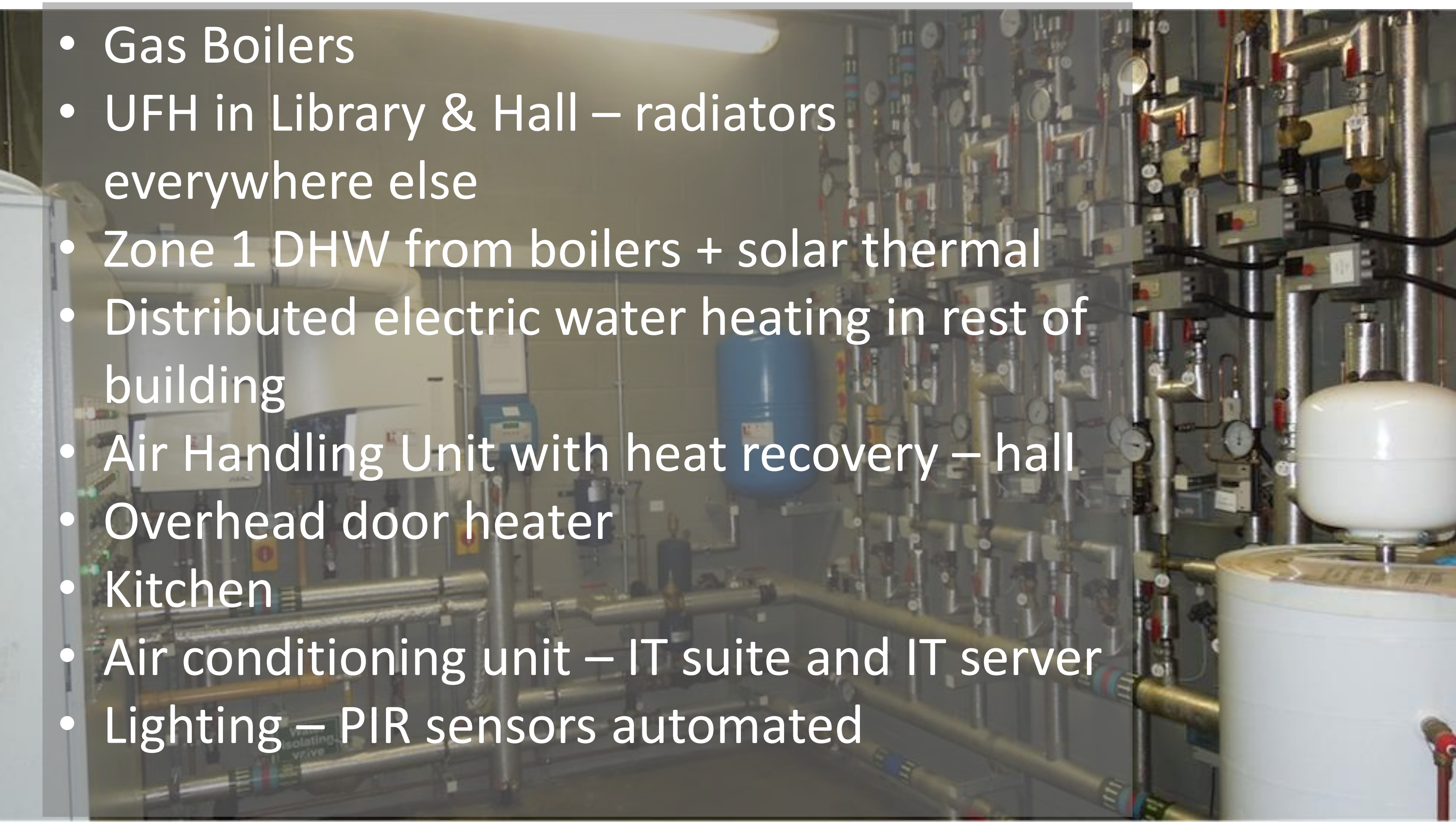
Project Background

- Kier Construction - Design and Build Contract
- Occupied from February 2010
- Four user groups – CAP, Library, Youth and Learning and Disability Services, shared hall and catering

Handover

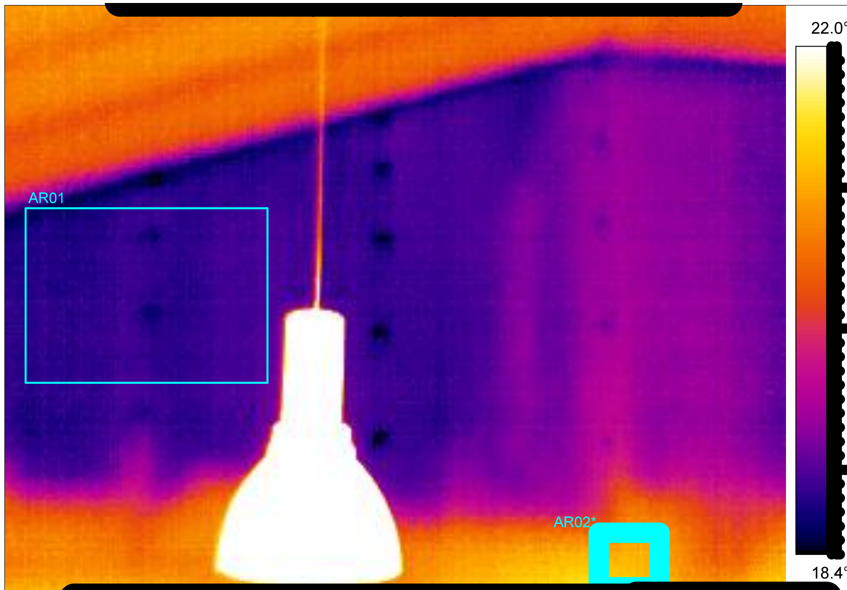
- Training (DVD)
- Documentation (BREEAM points)
- Defects:
  - Door security
  - Heating pipes (plant room)
  - Mikrofill – pressure maintenance system
  - Water boilers
  - Meters
  - Cracks

Systems



- Gas Boilers
- UFH in Library & Hall – radiators everywhere else
- Zone 1 DHW from boilers + solar thermal
- Distributed electric water heating in rest of building
- Air Handling Unit with heat recovery – hall
- Overhead door heater
- Kitchen
- Air conditioning unit – IT suite and IT server
- Lighting – PIR sensors automated

Thermographic Survey



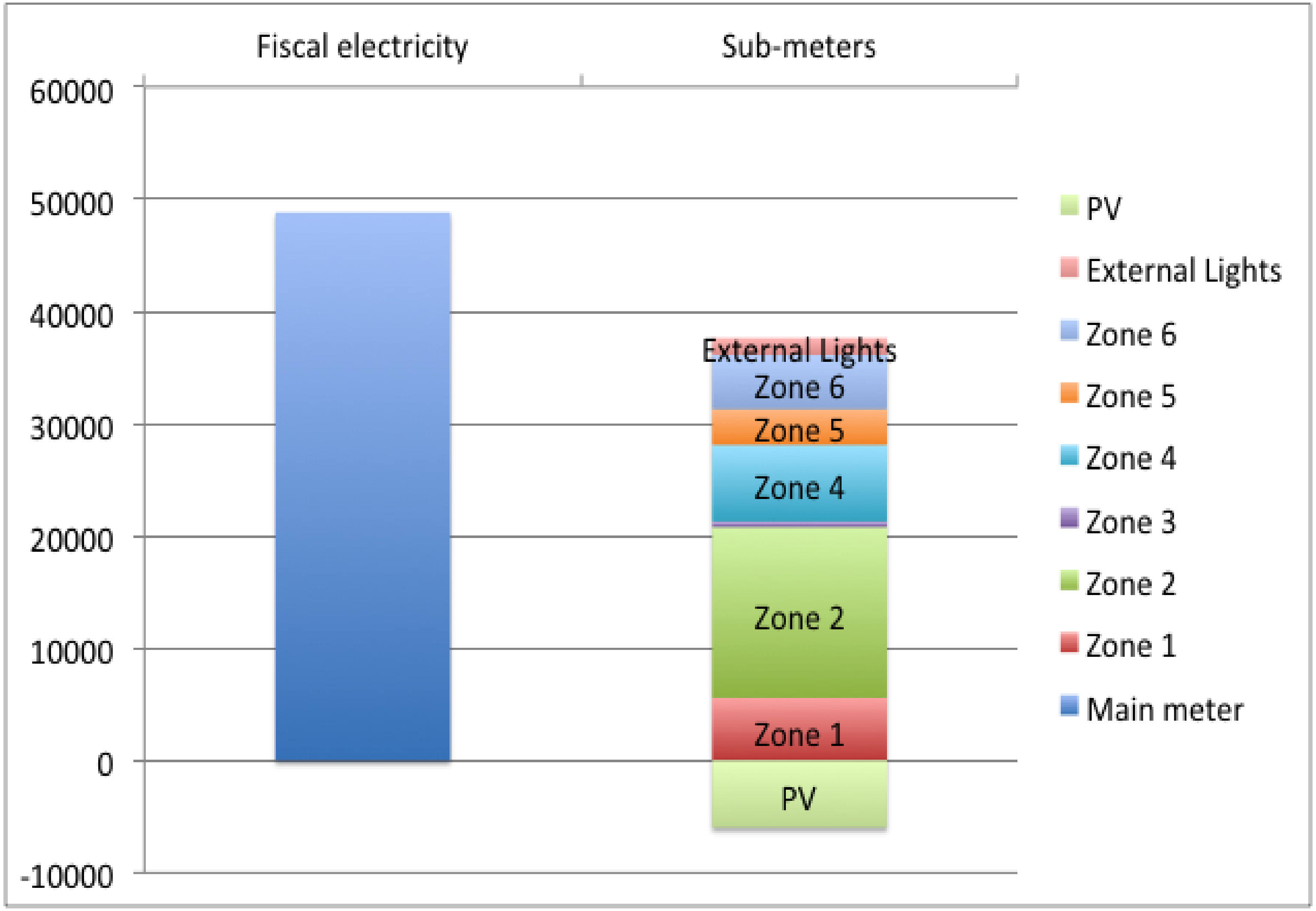
Metering and BMS

- 6 zones all sub-metered for electricity and heat

BUT

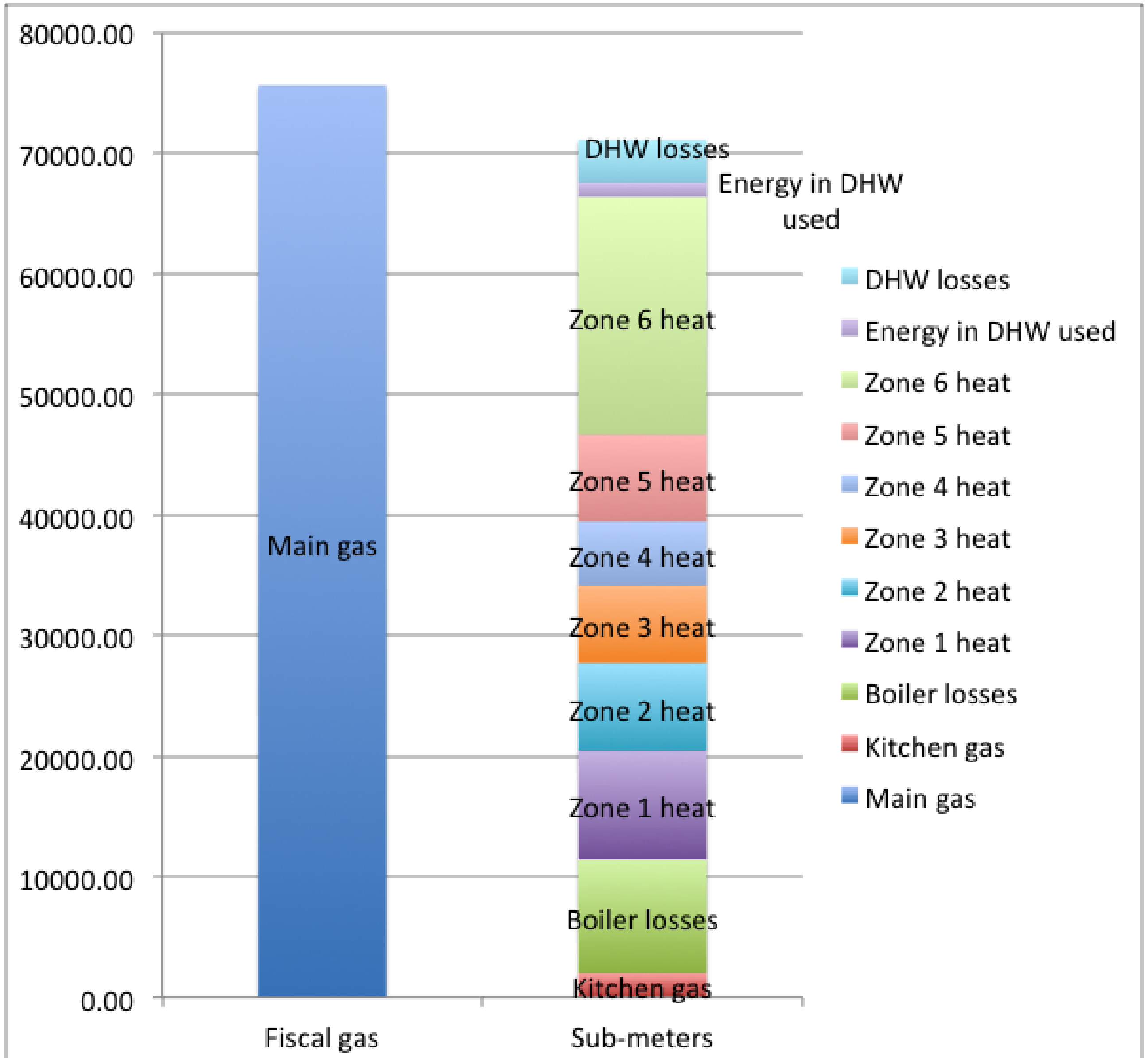
- Electrical sub-meters not properly commissioned
- Gas meters not properly calibrated
- Heat sub-meters not capable of communicating with BMS
- BMS not correctly reading electrical meter pulses

Electricity Metering - Reconciliation



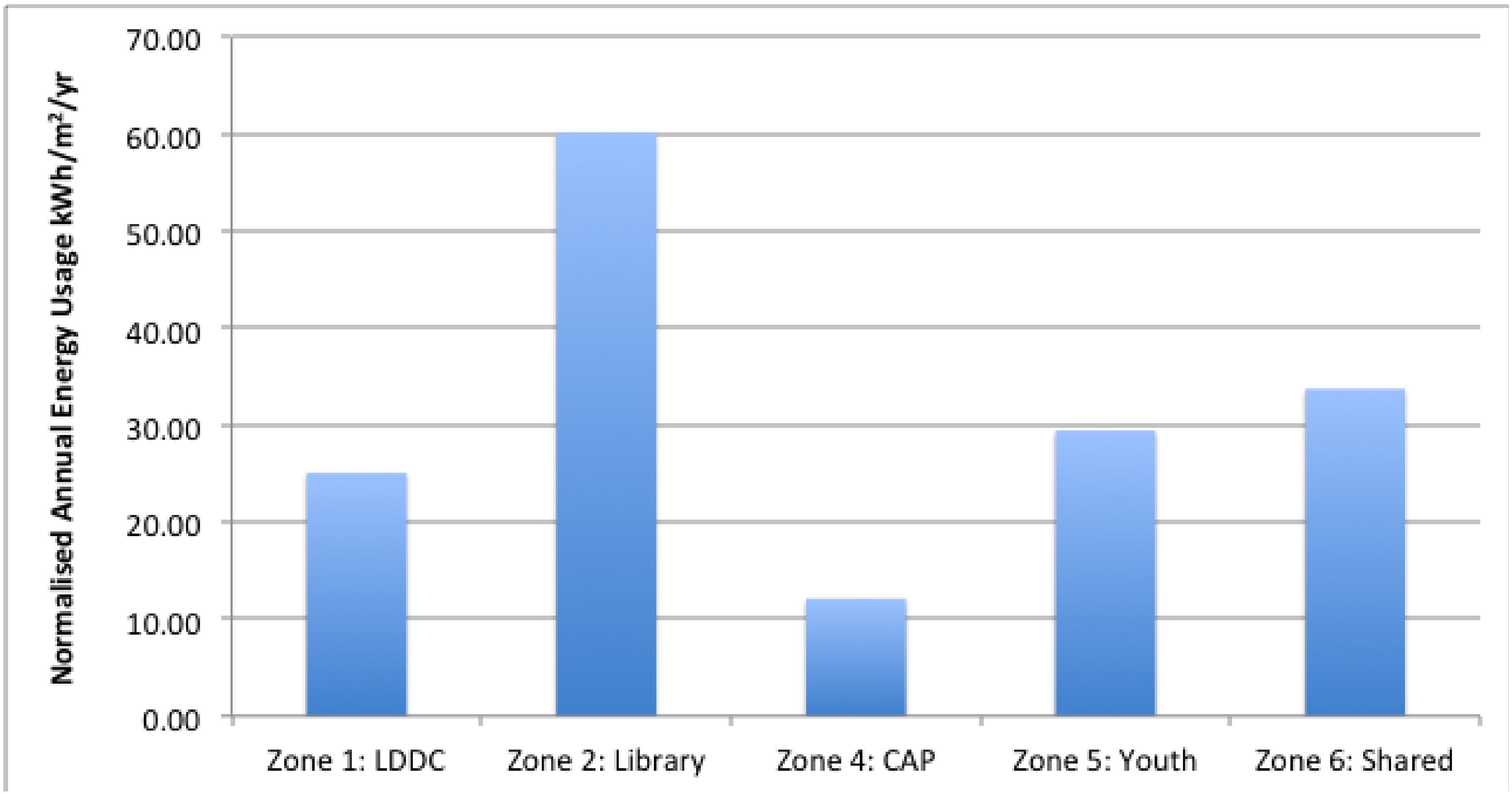
77% electricity usage accounted for:
Plant room, pumps, fans and controls not sub-metered

Gas/Heat Metering - Reconciliation

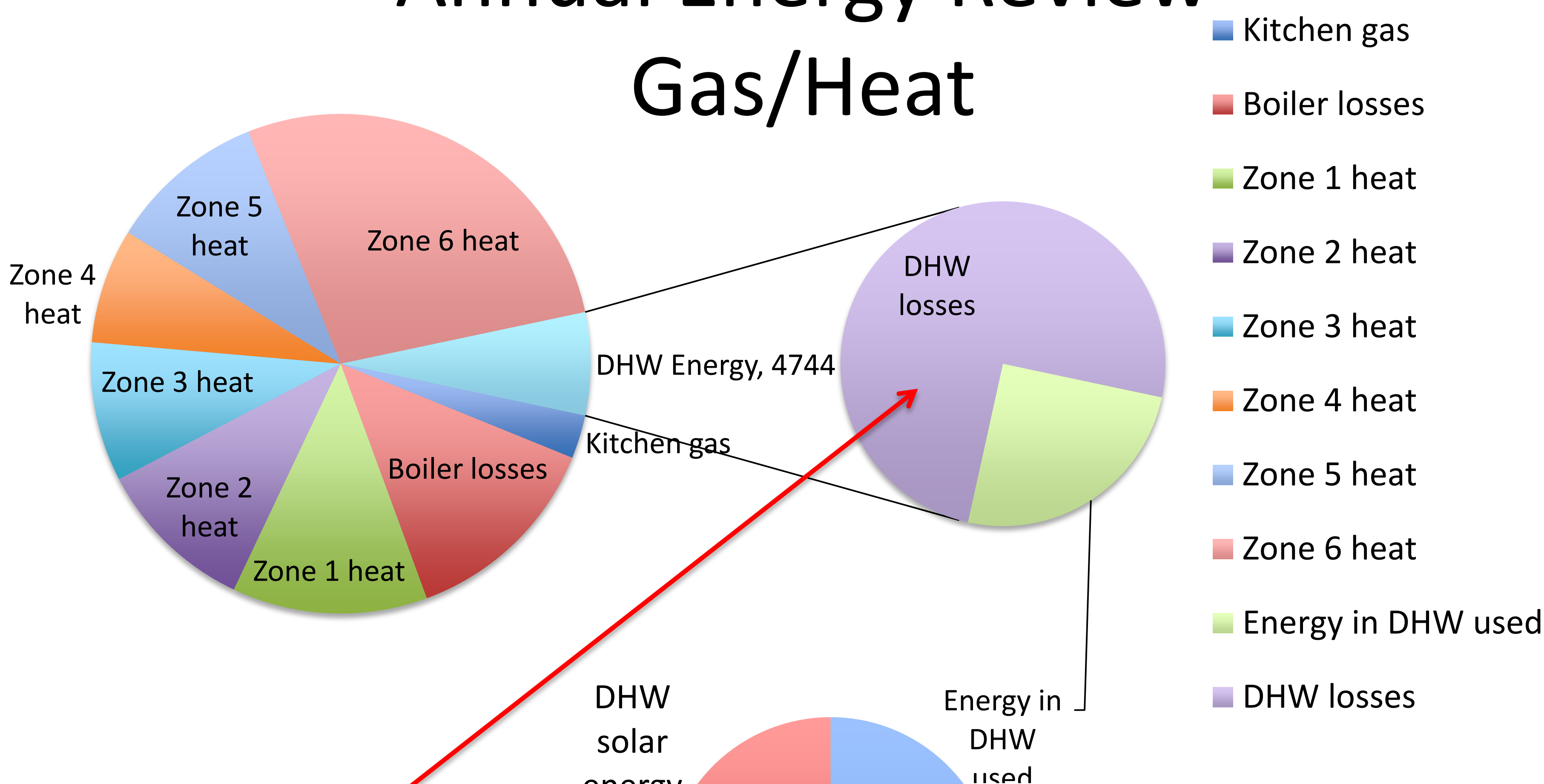


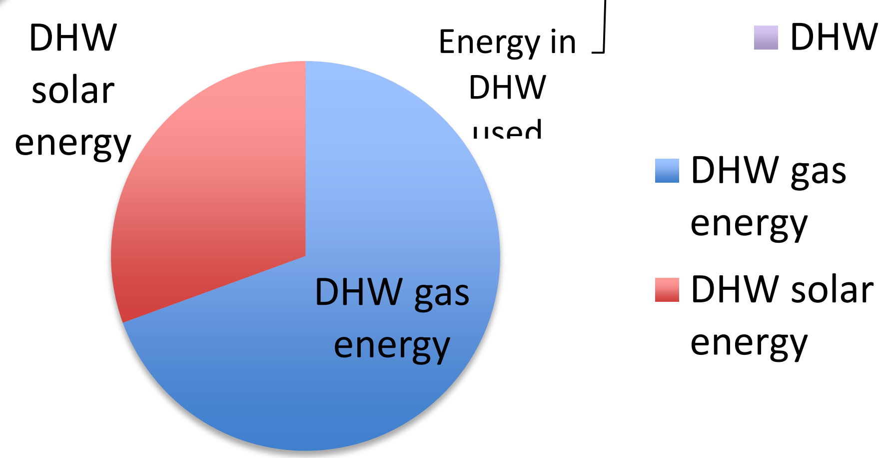
92% of gas energy accounted for

Annual Energy Review
Electricity



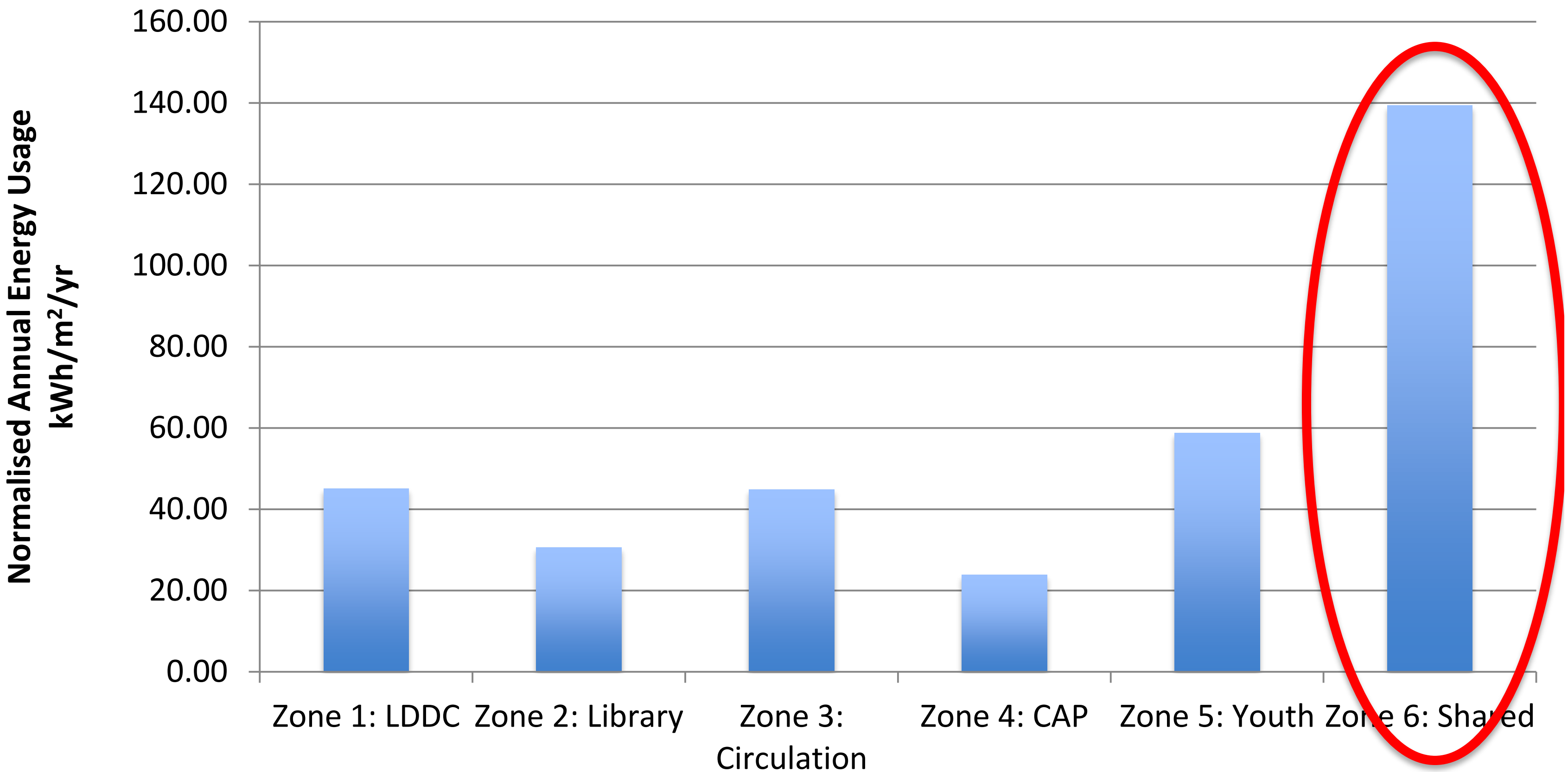
Annual Energy Review
Gas/Heat





£220/yr lost due to hot water system inefficiency
Losses are because system is currently over-sized for the use it gets at about 50l hot water/day

Annual Energy Review
Gas/Heat

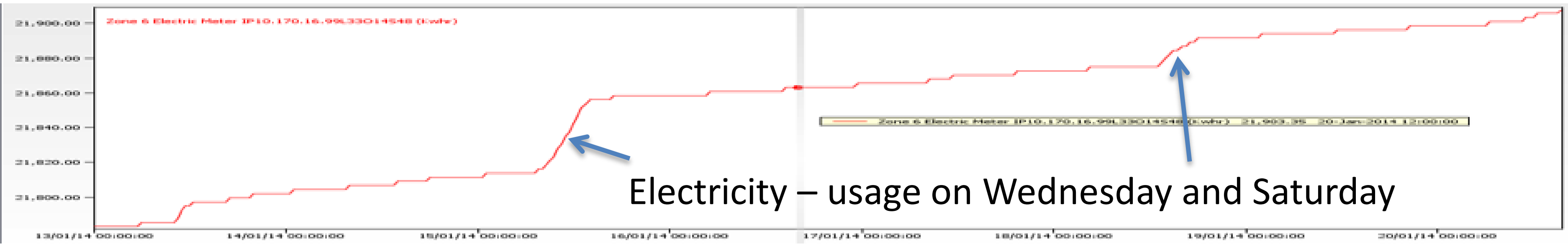


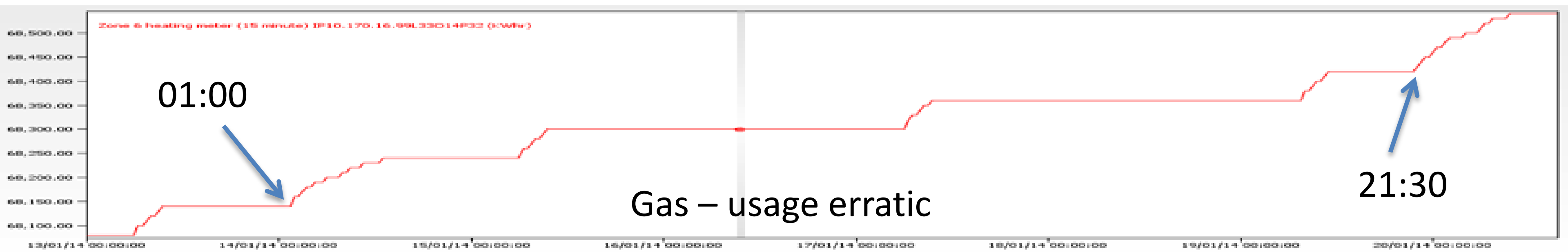
~£1500/yr to heat the hall

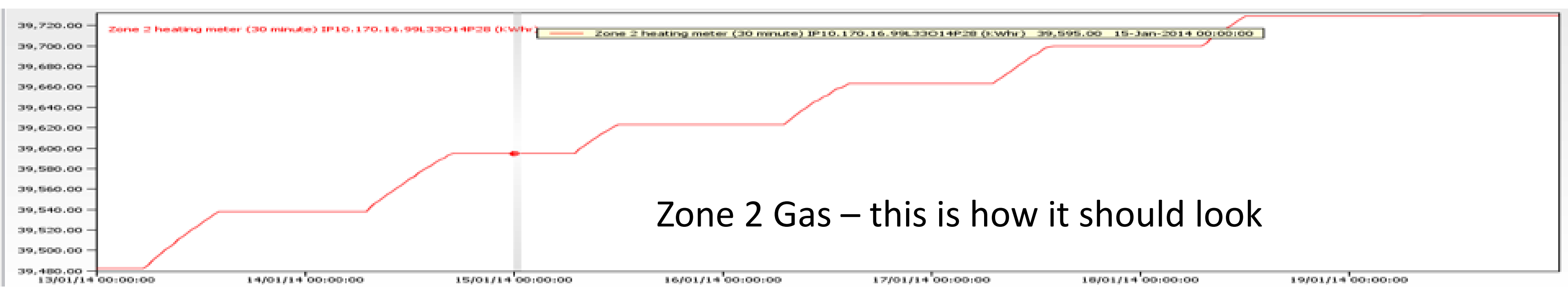
~£500/yr youth heating

Issues Arising and Interventions

Zone 6 Heating







Issues Arising and Interventions

Air Handling Unit

Issues Arising and Interventions

Air handling unit heater & frost protection

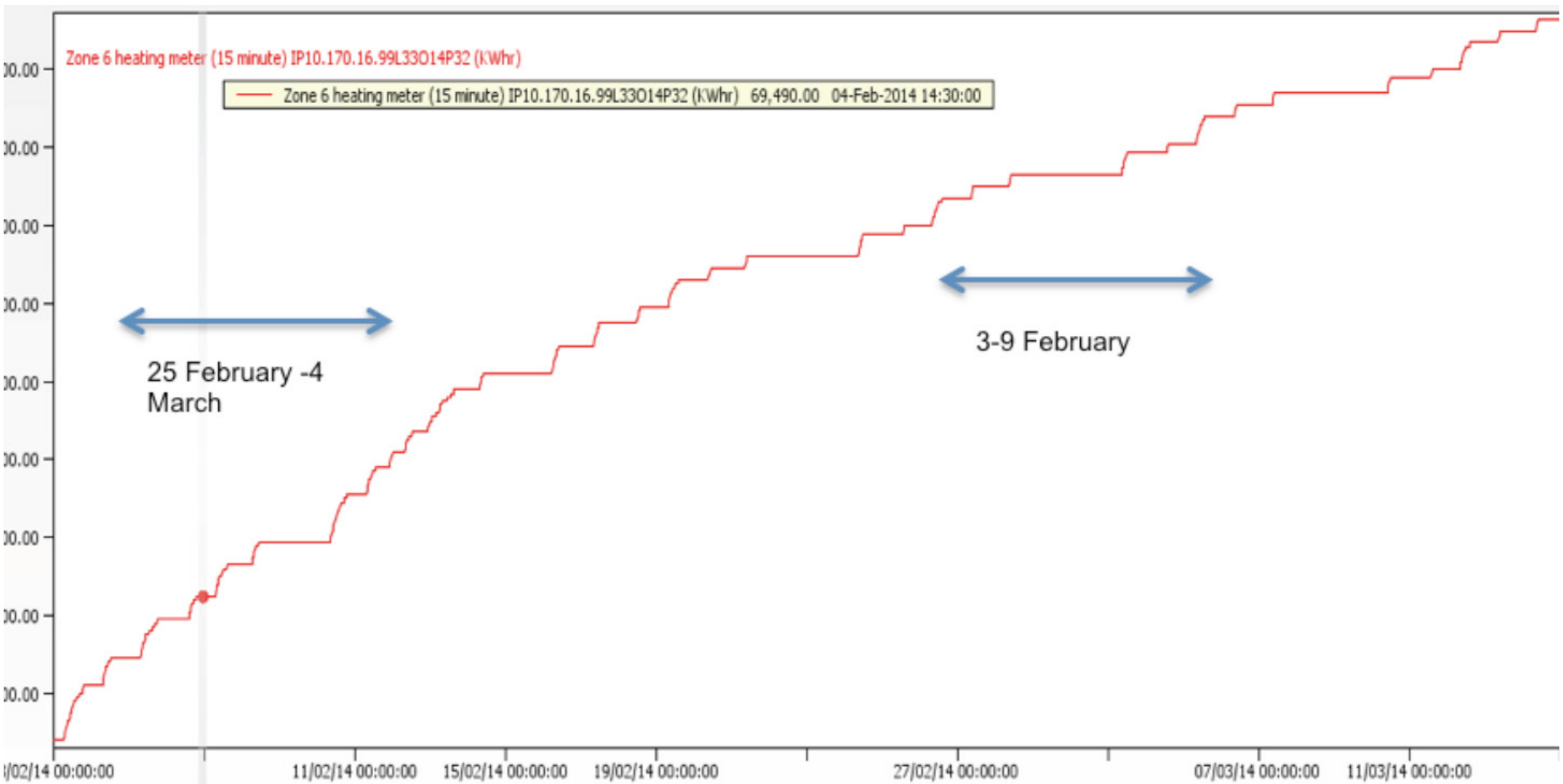
Options:

Drain system, remove heater, re-route circuit (£2600)

Change frost protection settings (within project cost)

Issues Arising and Interventions

Changes to frost protection

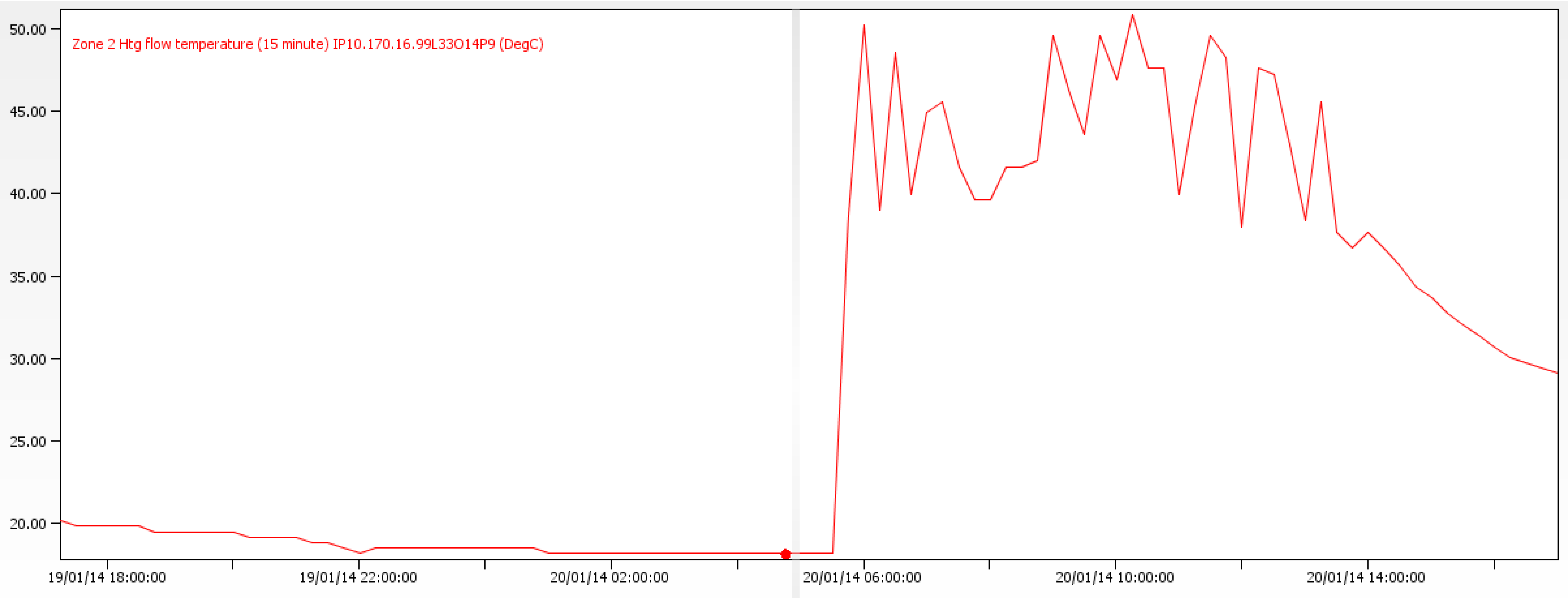


Extrapolated to the year 9000kWh or ~£250

Issues Arising and Interventions

Zone 2 - Library Heating

– UFH & radiators on same circuit
– Radiators running at ~50°C

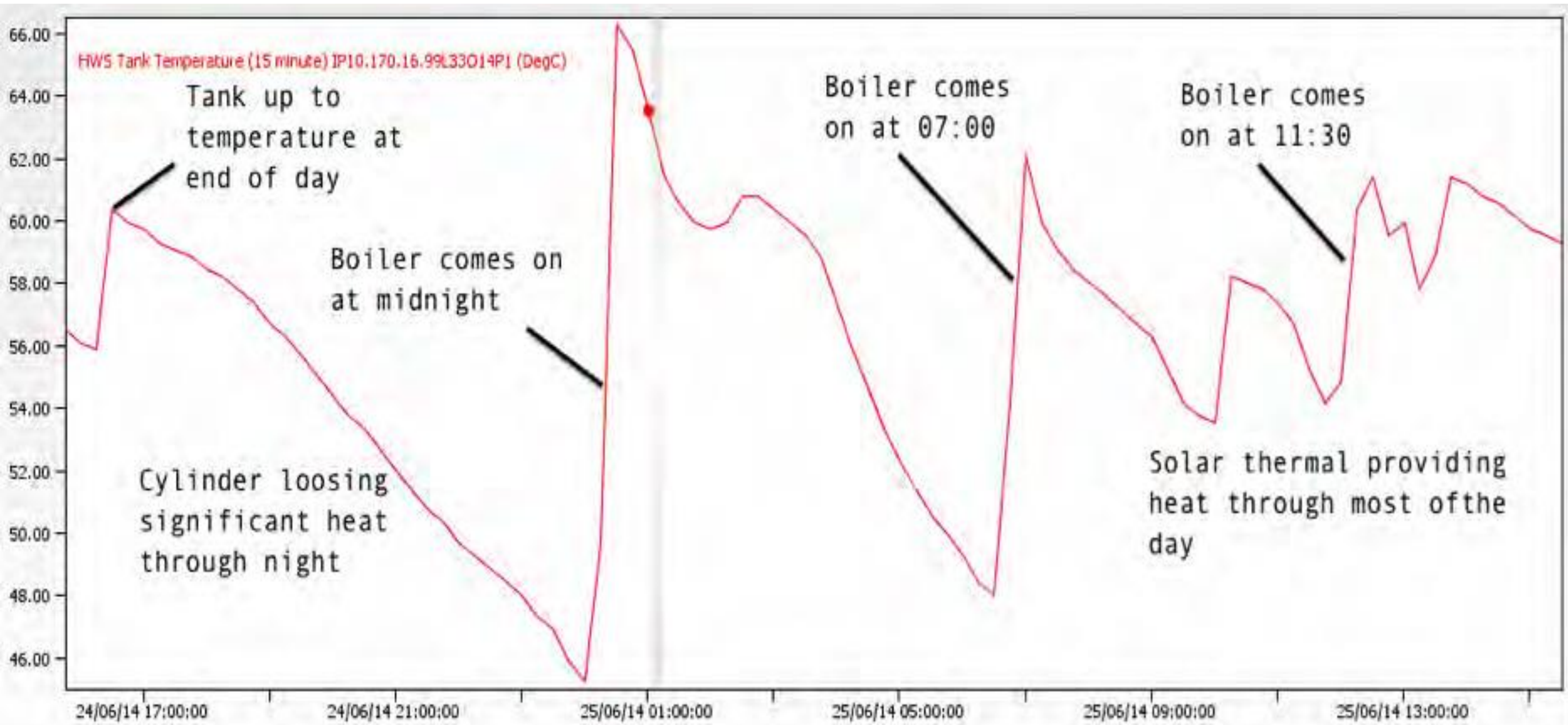


Issues Arising and Interventions

Zone 2 electric heaters

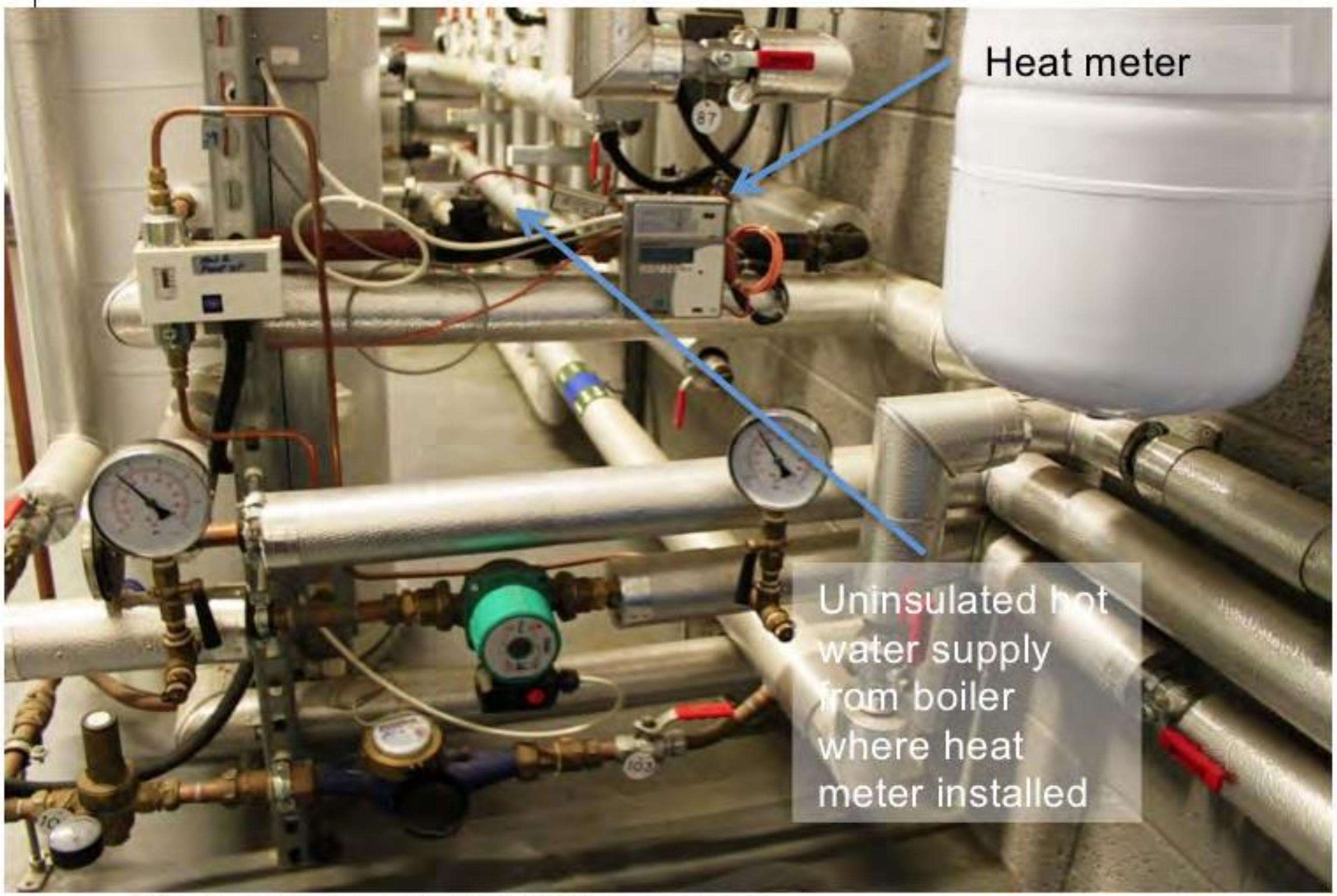
- ~£189/yr additional cost of electricity for fans
- £3200 to install thermostat on UFH manifold and reprogramme BMS to provide 70^{o}C water to radiators (not done)

Issues Arising and Interventions



Issues Arising and Interventions

Zone 1 Domestic hot water (DHW)
& solar thermal



Note also numerous uninsulated valves and gauges

Issues Arising and Interventions

Distributed electric water heaters

- Zone 3 Hot Water – needs to be left on 24/7 for cleaners
- Some water heaters inaccessible so can't be controlled

Issues Arising and Interventions

Lighting

- Youth and CAP offices
- Hall cupboards, gallery, youth activity area – PIR adjustments (£8/yr)
- Youth ‘lounge’ (resolved)

Interventions and Improvements Behaviour

- Operations and behaviour:
  - Water heaters turned off at night
  - TRVs turned down in Zone 5
  - Kettle used in favour of water boiler Zone 1
  - IT suite air con turned off in winter
- Building User Guide and Labelling

Building User Guide

IT Suite Controls

Simple ON/Off Controls and Temperature Set Point

Use only on hot days – a 20 or 21°C set point should be sufficient

IT Server Room – remote controller fixed in place by Velcro

Programmable controls – basic features only required

IT Server room – use in Cooling Mode only with continuous operation and a temperature set point of 25°C

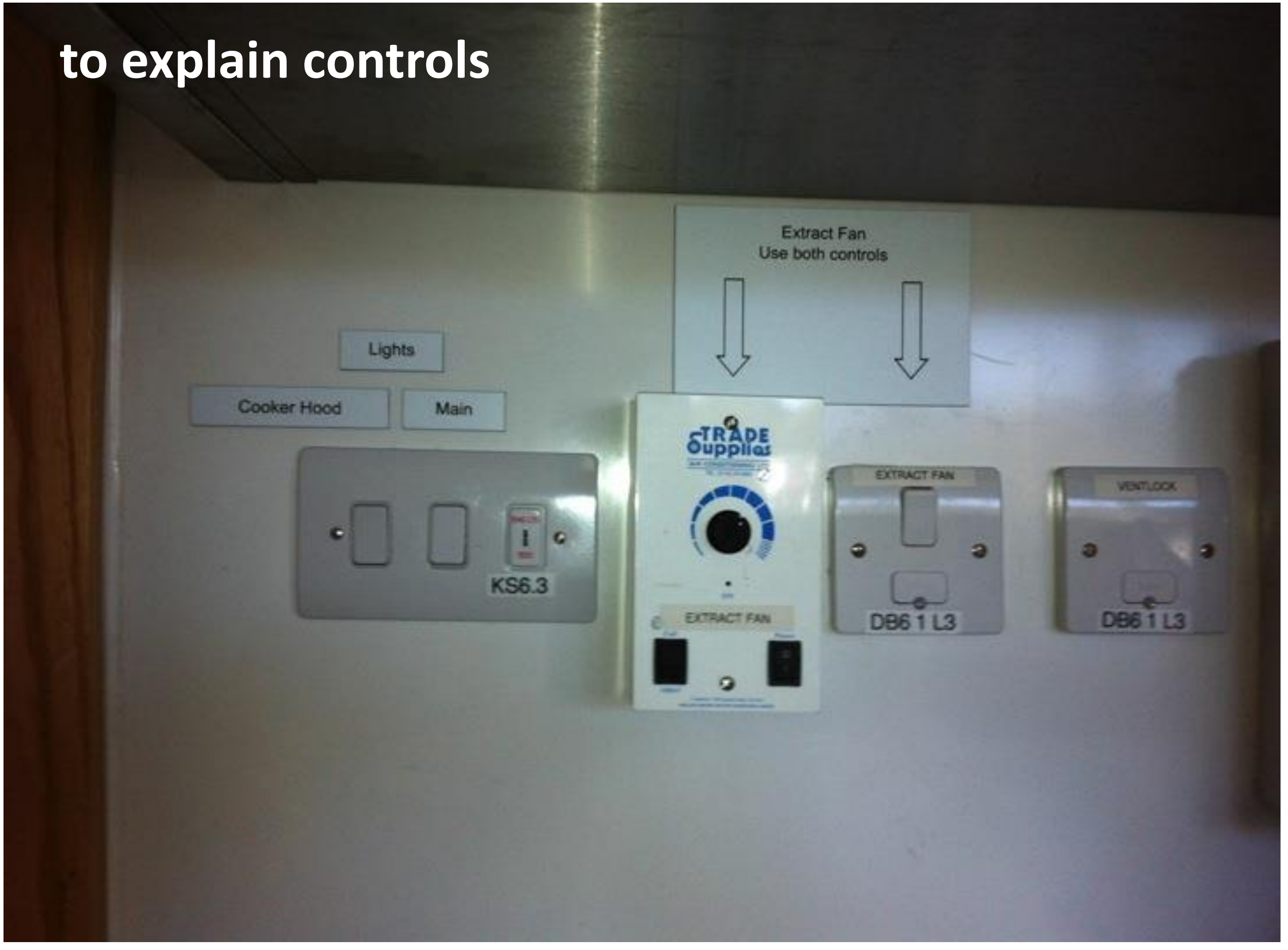
Labelling

HYDRO BOILER
switch off each evening
Boiler
DB1 2 L1
DB
FRIDGE
DO
NOT
TURN
OFF
PLEASE

Labelling…

to encourage energy saving behaviour

Labelling...

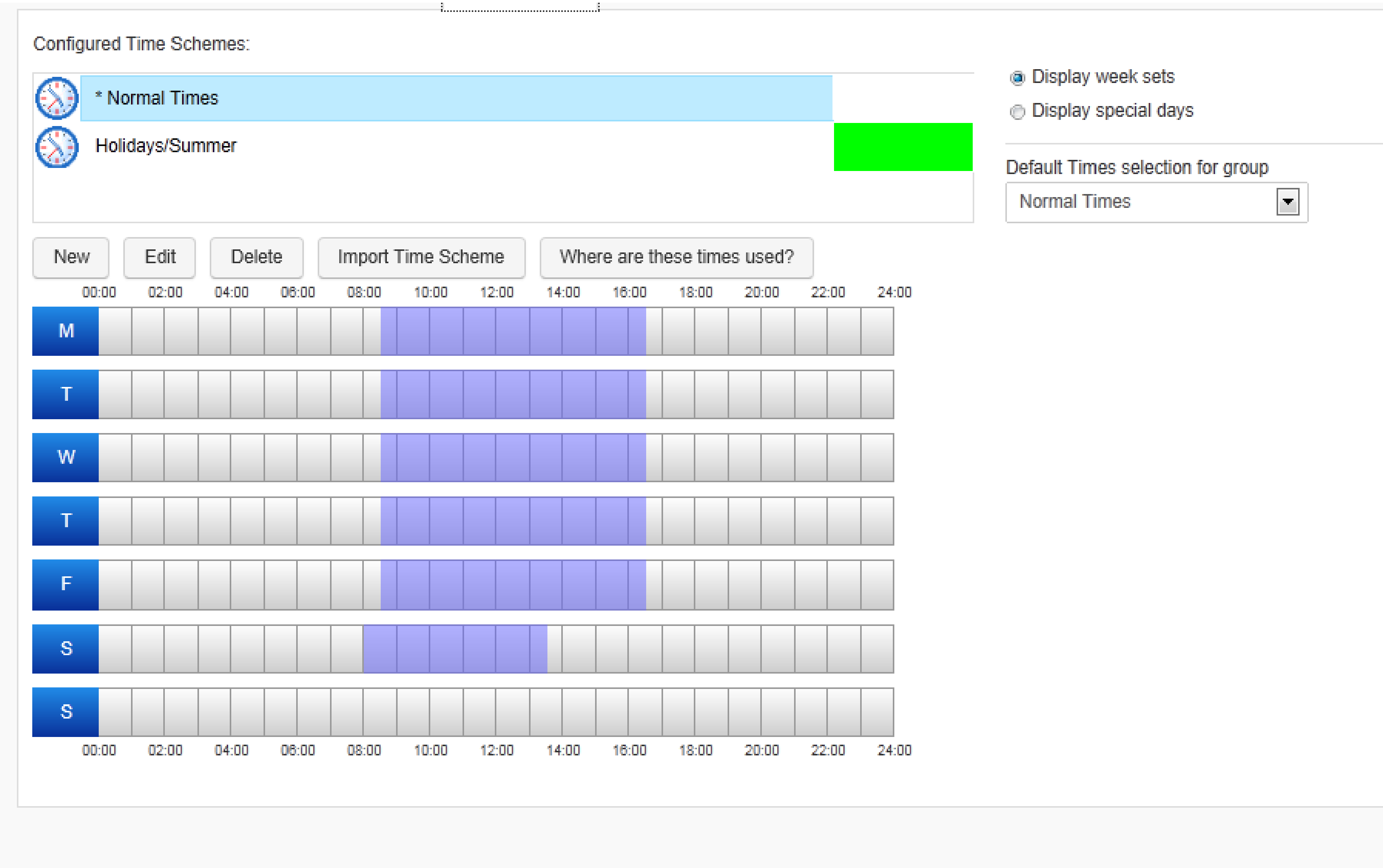


to explain controls
Extract Fan
Use both controls
Lights
Cooker Hood
Main
KS6.3
EXTRACT FAN
EXTRACT FAN
VENTLOCK
DB6 1 L3
DB6 1 L3

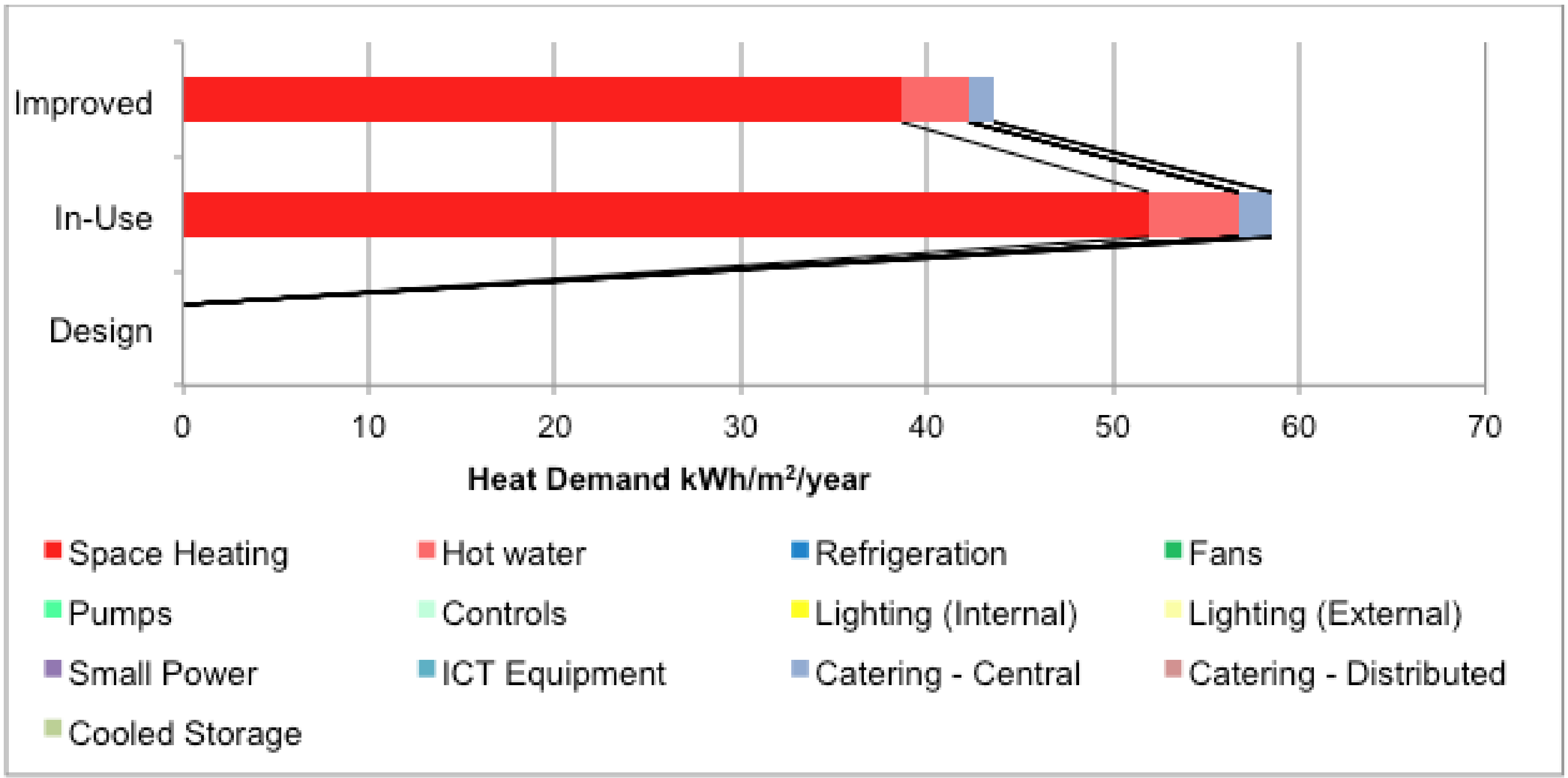
Other issues

- Computers 24/7/365
- BMS Zone pumps running in summer
- Temperature set points eg circulation area set to $21^{\circ}C$
- BMS access – ensuring users can change their settings in accordance with usage

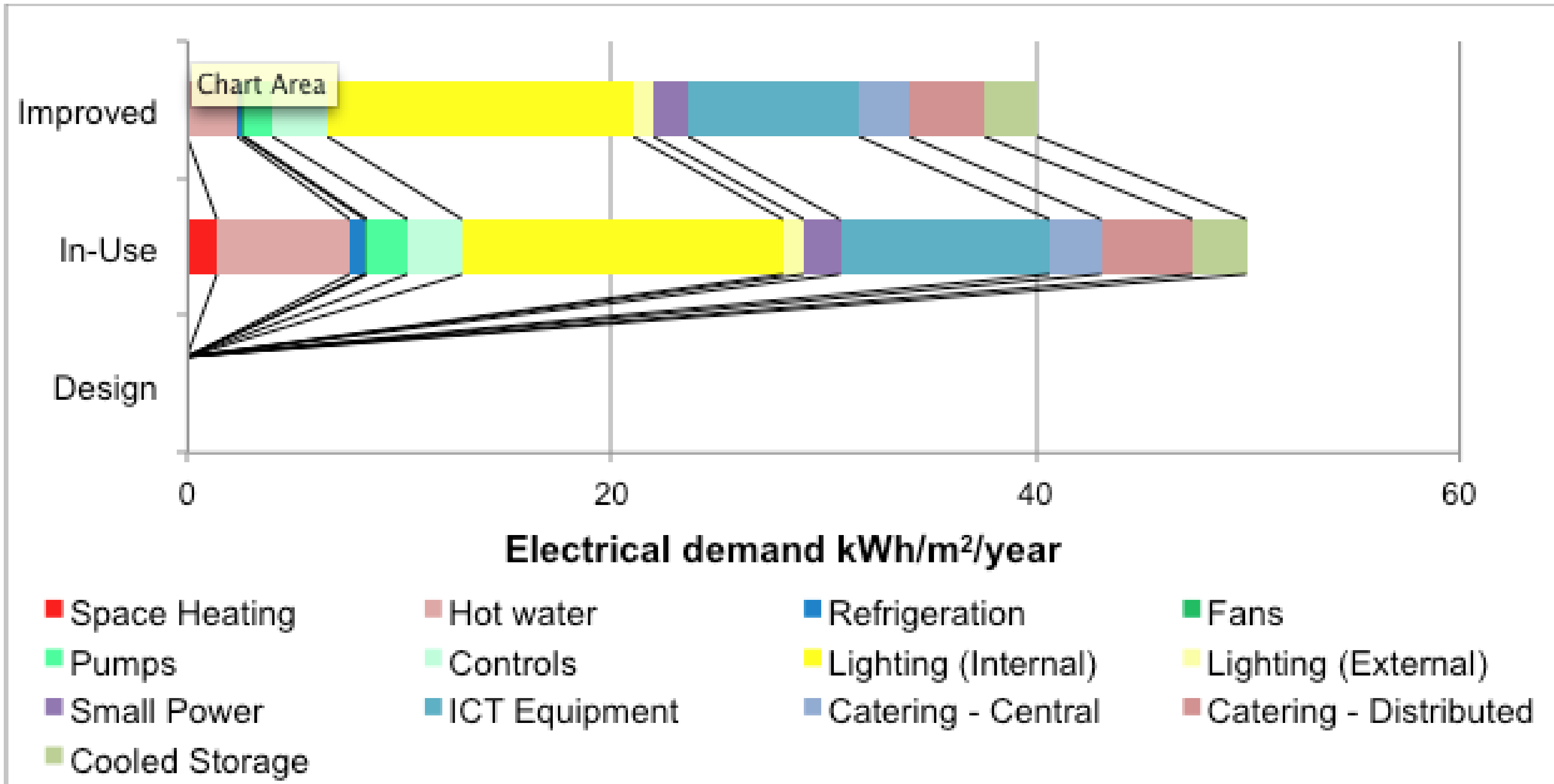
Summer time settings



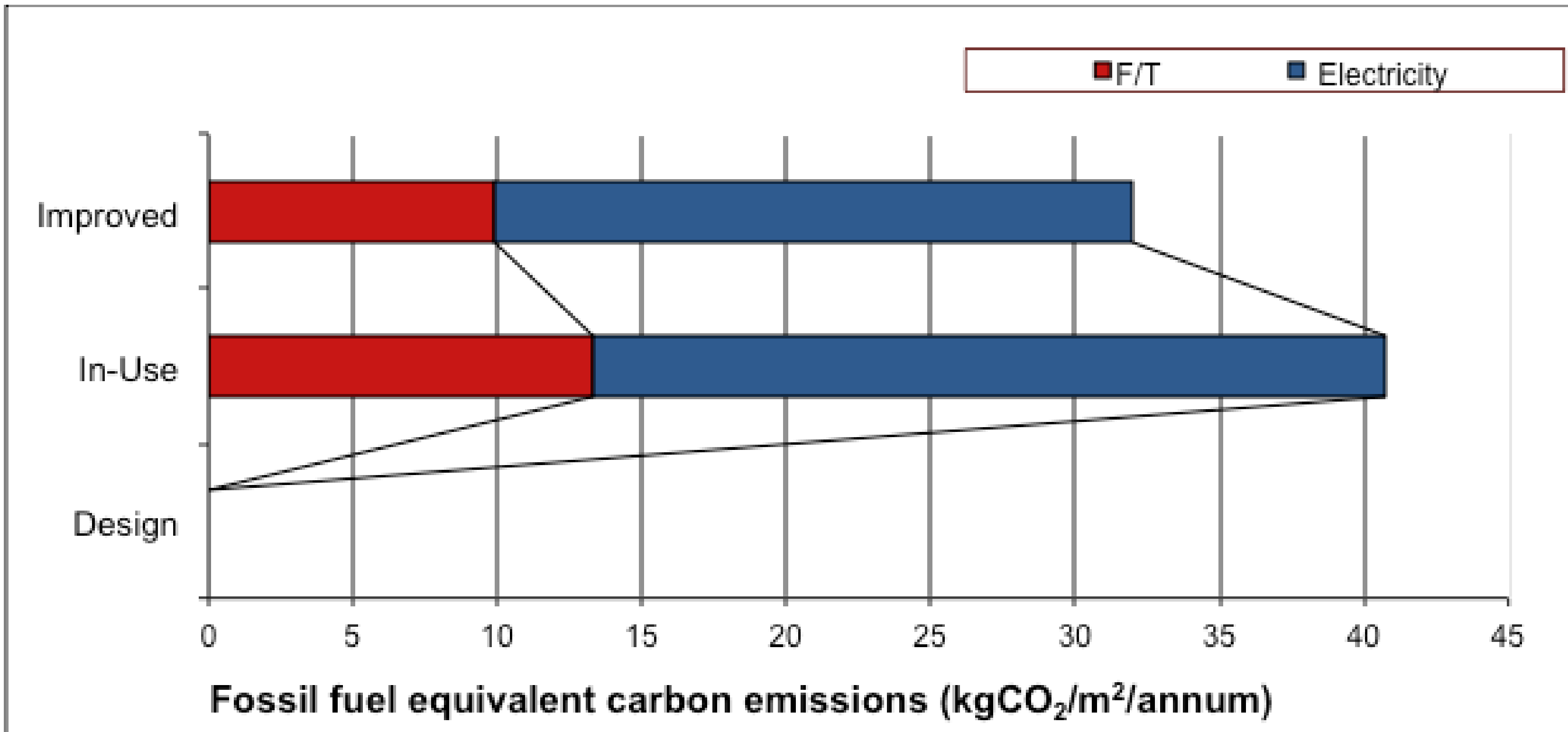
Projected Improvements Thermal



Projected Improvements Electrical



Projected Improvements Emissions



Conclusions

- Building handover lacks a user focus
- Buildings metering not fit for purpose
- Influence of BREEAM credits –meters, documentation, solar thermal – present but not useful
- Effort spent at commissioning and handover has potential payback throughout the life of the building
- No and low cost opportunities to save energy and cost across the building stock

Thank you

Questions/Discussion

Q&A