Purpose of CLR is to increase understanding of & confidence in retrofit

- Improving understanding of existing buildings - types, constructions & building physics, before/after
- Increase confidence in retrofit to improve comfort levels, reduce running costs & GHG emissions (is ‘materials agnostic’ except wrt moisture – building physics dictates appropriate use)
- Help close the performance gap
- Reduce risks to building structure and occupants health
- Promote more robust retrofit strategies
- Develop ambitious but pragmatic thermal performance targets
- Promote whole building approach considering the hygrothermal performance of the building fabric + synergy of ventilation, heating/cooling

By:

- Using and making accessible high quality existing knowledge & expertise
- Providing accessible & affordable training,
- Creating a certification scheme to certify retrofits projects,
- Encouraging members to monitor retrofit projects and share results
- Encouraging investment in R&D by industry and government where required
- Working with other organisations where possible (UCL is a partner)

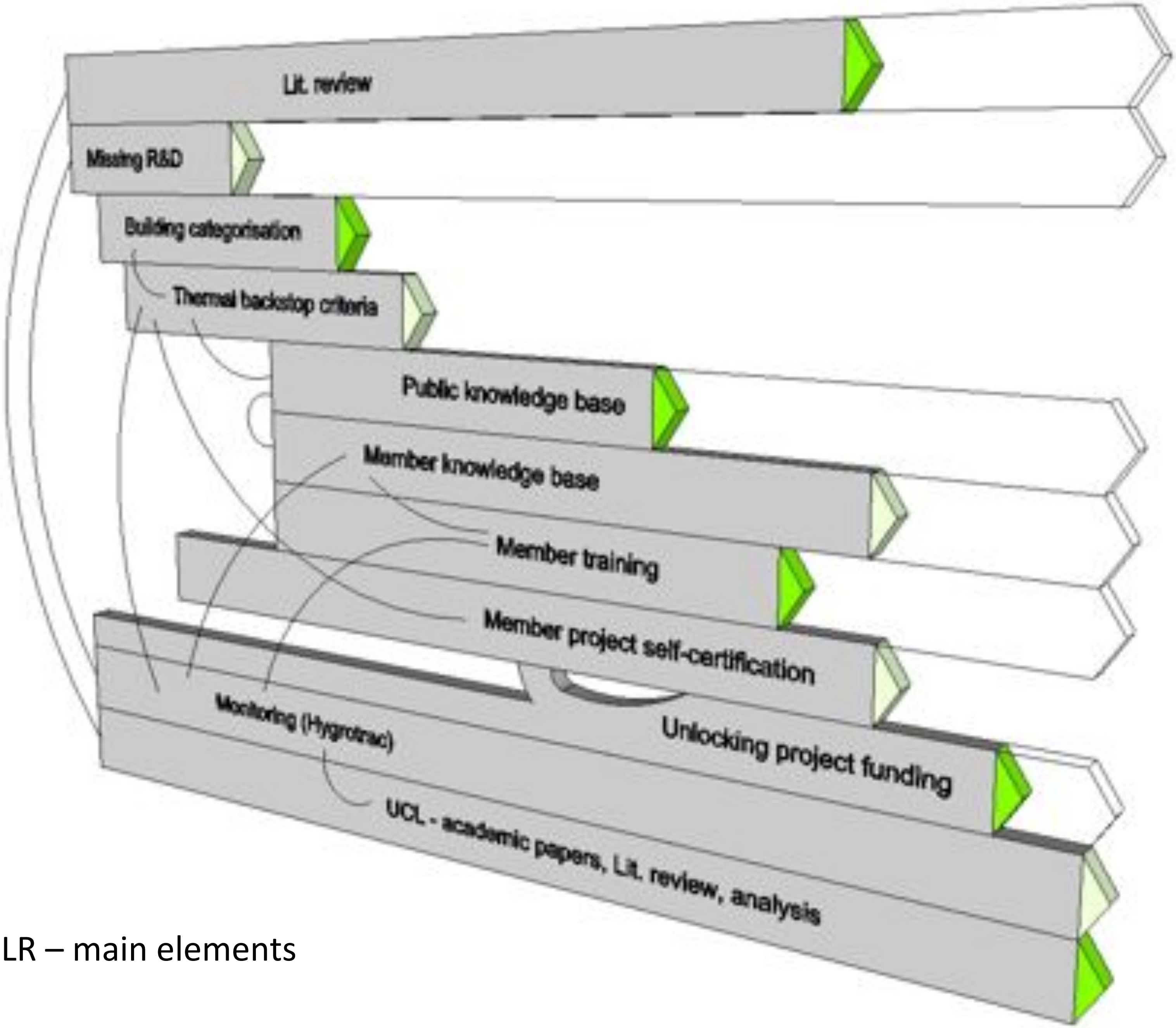
Birmingham Science Park Aston running a programme of 30 climate change practitioners onto European-funded exchange programme. ***AECB now offers placements.***

http://www.innovationbham.com/news/birmingham-science-park-aston-enrolls-30-climate-change-practitioners-onto-european-funded-exchange-programme/

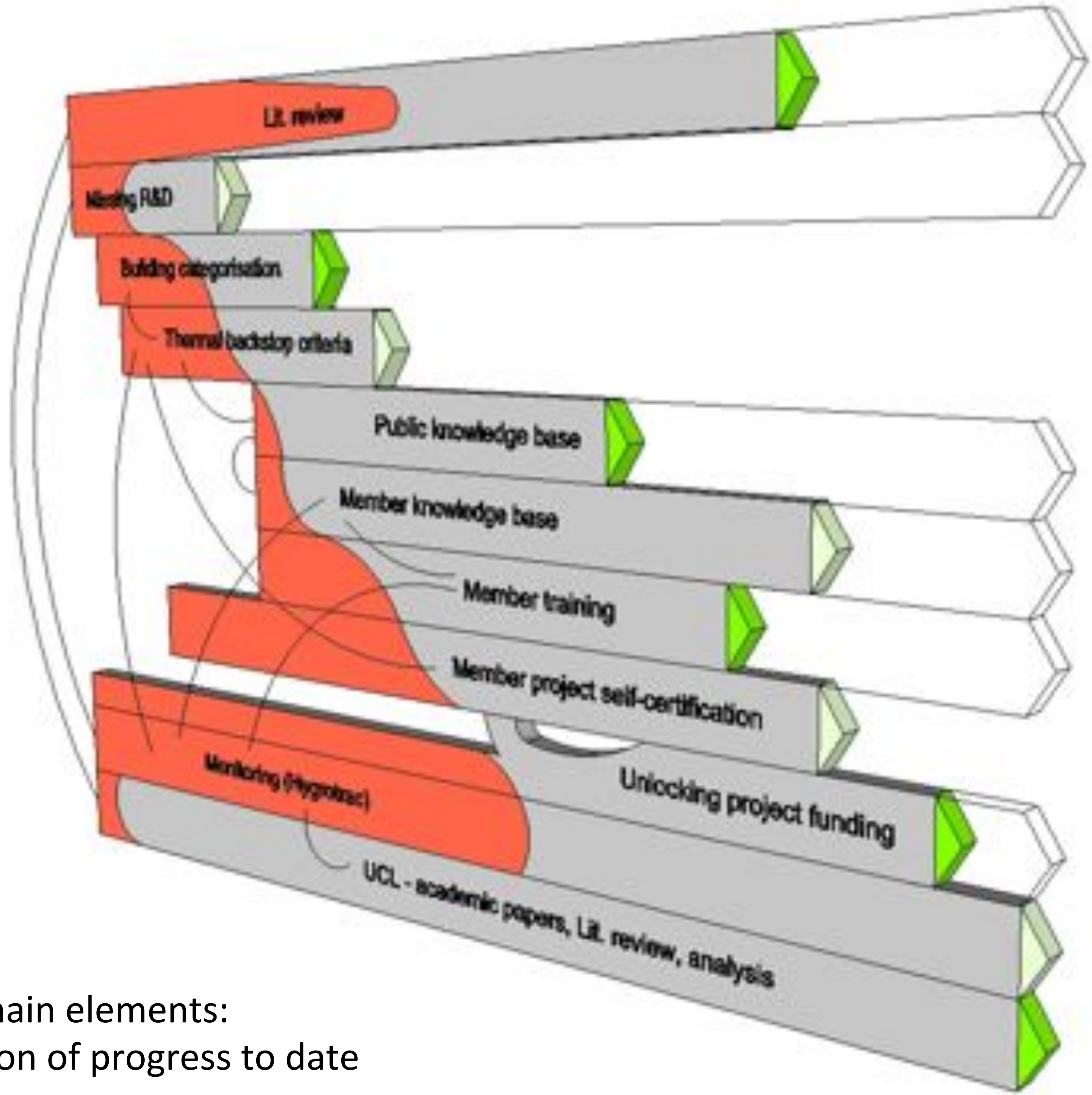
Pioneers into Practice (PiP) exchange programme: AECB placement, May 2013.

Tim Martel

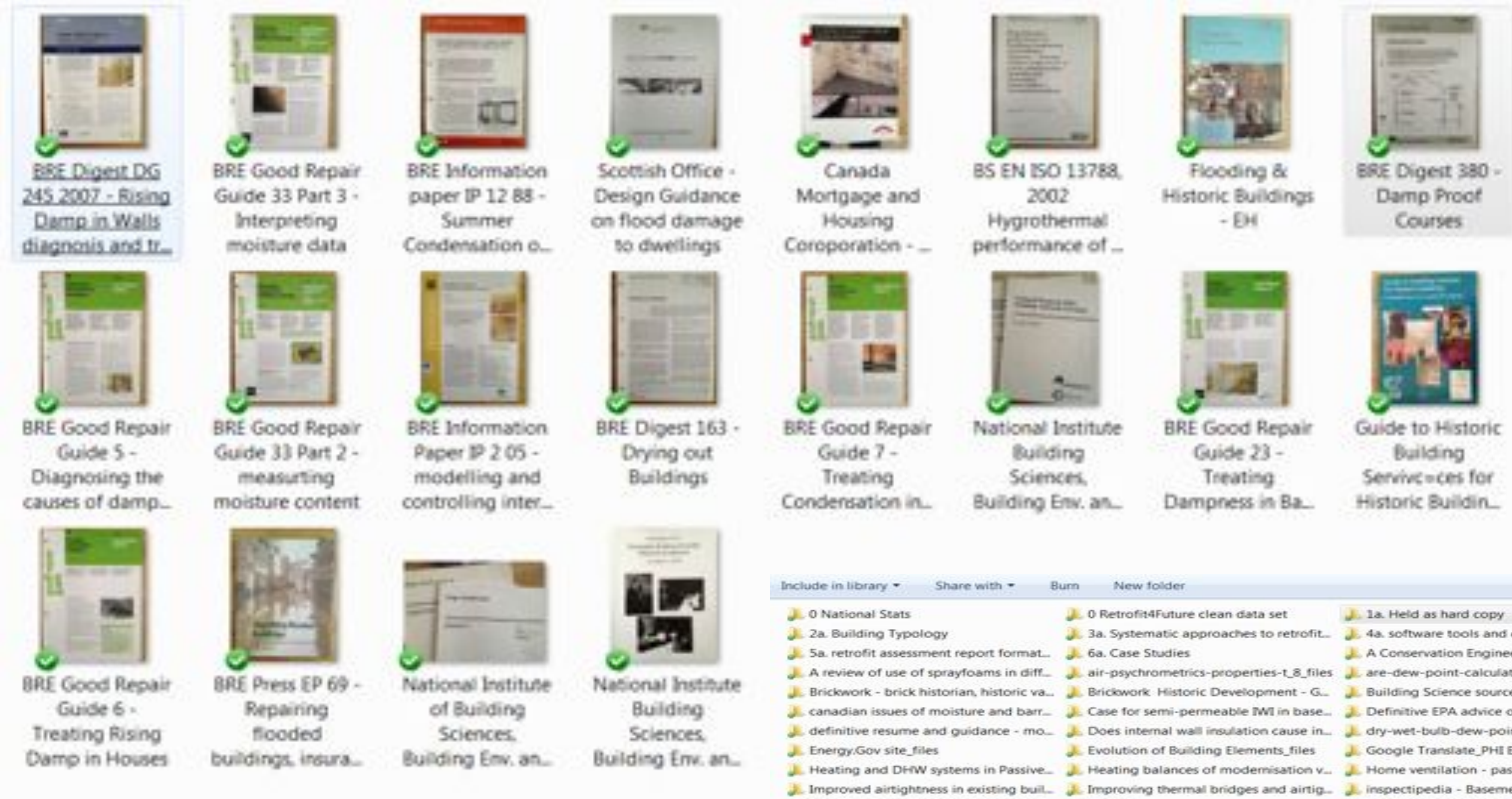
43, graduated 2 years ago with 1st Class Hons in Architectural Technology. Dissertation was on "Orientation and Spacing of Passivhaus Developments" which used PHPP to find a matrix of solutions for Passivhauses meeting 2 UK daylighting requirements. Took the Passivhaus Designer course with the BRE, passing the exam in Dec 2011. In 2012 worked for a year with Peter Warm organizing their CarbonLite courses and carried out some PHPP certification work. Currently working with AECB on helping develop its CarbonLite retrofit programme. AECB hosted Tim on his PiP placement, PHI are the exchange partner (1 month in Nov 2013).

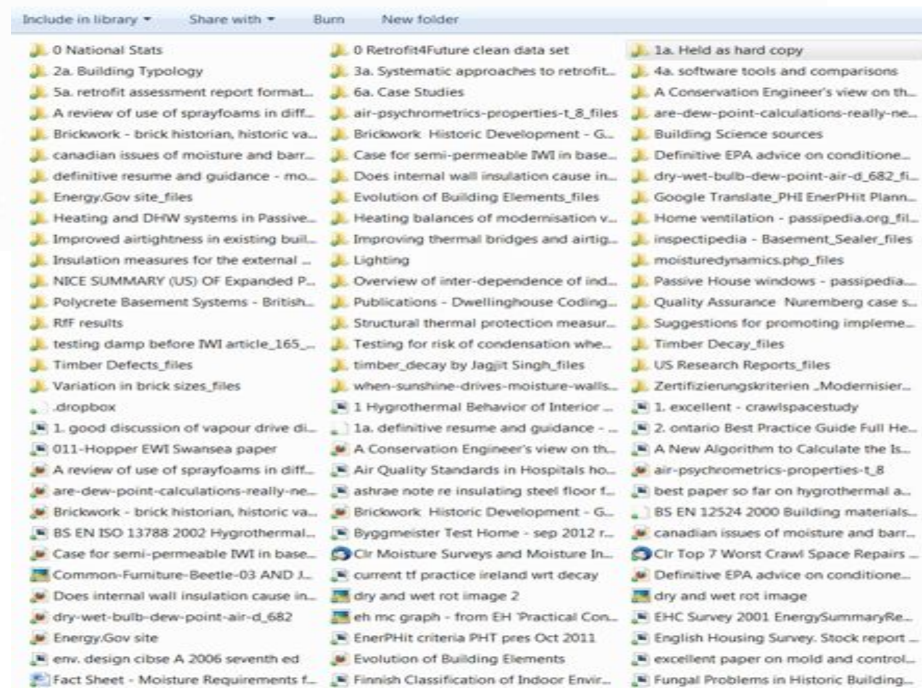


CLR – main elements



CLR – main elements:
indication of progress to date


BRE Digest DG 245 2007 - Rising Damp in Walls diagnosis and tr...
BRE Good Repair Guide 33 Part 3 - Interpreting moisture data
BRE Information paper IP 12 88 - Summer Condensation o...
Scottish Office - Design Guidance on flood damage to dwellings
Canada Mortgage and Housing Coroporation - ...
BS EN ISO 13788, 2002 Hygrothermal performance of ...
Flooding & Historic Buildings - EH
BRE Digest 380 - Damp Proof Courses
BRE Good Repair Guide 5 - Diagnosing the causes of damp...
BRE Good Repair Guide 33 Part 2 - measurting moisture content
BRE Information Paper IP 2 05 - modelling and controlling inter...
BRE Digest 163 - Drying out Buildings
BRE Good Repair Guide 7 - Treating Condensation in...
National Institute Building Sciences, Building Env. an...
BRE Good Repair Guide 23 - Treating Dampness in Ba...
Guide to Historic Building Servicces for Historic Buildin...
BRE Good Repair Guide 6 - Treating Rising Damp in Houses
BRE Press EP 69 - Repairing flooded buildings, insura...
National Institute of Building Sciences, Building Env. an...
National Institute Building Sciences, Building Env. an...


Include in library
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New folder
0 National Stats
2a. Building Typology
5a. retrofit assessment report format...
A review of use of sprayfoams in diff...
Brickwork - brick historian, historic va...
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Heating and DHW systems in Passive...
Improved airtightness in existing buil...
Insulation measures for the external ...
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Polycrete Basement Systems - British...
RfF results
testing damp before IWI article_165_...
Timber Defects_files
Variation in brick sizes_files
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1. good discussion of vapour drive di...
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A review of use of sprayfoams in diff...
are-dew-point-calculations-really-ne...
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Case for semi-permeable IWI in base...
Common-Furniture-Beetle-03 AND J...
Does internal wall insulation cause in...
dry-wet-bulb-dew-point-air-d_682
Energy.Gov site
env. design cibse A 2006 seventh ed
Fact Sheet - Moisture Requirements f...
0 Retrofit4Future clean data set
3a. Systematic approaches to retrofit...
6a. Case Studies
air-psychrometrics-properties-t_8_files
Brickwork Historic Development - G...
Case for semi-permeable IWI in base...
Does internal wall insulation cause in...
Evolution of Building Elements_files
Heating balances of modernisation v...
Improving thermal bridges and airtig...
Lighting
Overview of inter-dependence of ind...
Publications - Dwellinghouse Coding...
Structural thermal protection measur...
Testing for risk of condensation whe...
timber_decay by Jagjit Singh_files
when-sunshine-drives-moisture-walls...
1 Hygrothermal Behavior of Interior ...
1a. definitive resume and guidance - ...
A Conservation Engineer's view on th...
Air Quality Standards in Hospitals ho...
ashrae note re insulating steel floor f...
Brickwork Historic Development - G...
Byggmeister Test Home - sep 2012 r...
Clr Moisture Surveys and Moisture In...
current tf practice ireland wrt decay
dry and wet rot image 2
eh mc graph - from EH 'Practical Con...
EnerPHit criteria PHT pres Oct 2011
Evolution of Building Elements
Finnish Classification of Indoor Envir...
1a. Held as hard copy
4a. software tools and comparisons
A Conservation Engineer's view on th...
are-dew-point-calculations-really-ne...
Building Science sources
Definitive EPA advice on conditione...
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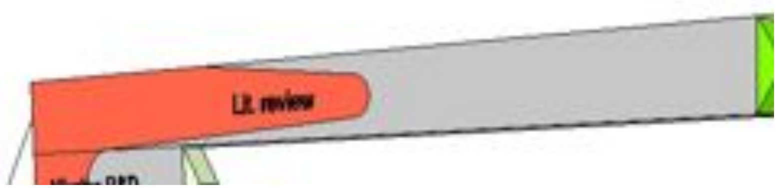
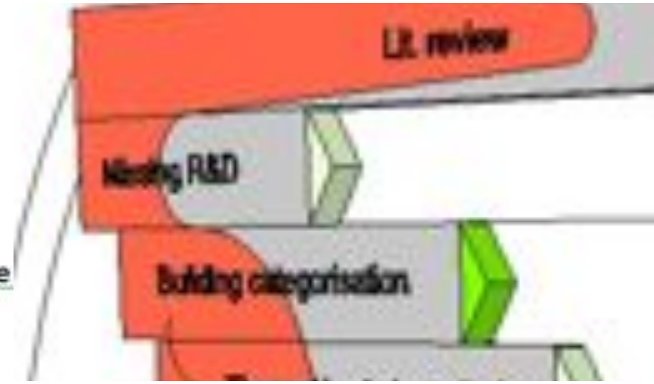
Home ventilation - passipedia.org_fil...
inspectipedia - Basement_Sealer_files
moisturedynamics.php_files
Passive House windows - passipedia...
Quality Assurance Nuremberg case s...
Suggestions for promoting impleme...
Timber Decay_files
US Research Reports_files
Zertifizierungskriterien „Modernisier...
1. excellent - crawlspacestudy
2. ontario Best Practice Guide Full He...
A New Algorithm to Calculate the Is...
air-psychrometrics-properties-t_8
best paper so far on hygrothermal a...
BS EN 12524 2000 Building materials...
canadian issues of moisture and barr...
Clr Top 7 Worst Crawl Space Repairs ...
Definitive EPA advice on conditione...
dry and wet rot image
EHC Survey 2001 EnergySummaryRe...
English Housing Survey. Stock report ...
excellent paper on mold and control...
Fungal Problems in Historic Building...


Lit. review

DECC small funds bid



AECB believes that the UK lacks sufficient knowledge to underpin a thorough retrofit program. Work packages 1 to 6 below are an important part of improving the knowledge base.

Topics to be studied:

1. **Ventilation**
2. **Heating Controls**
3. **Measured Moisture Problems**
4. **External Wall Constructions**

(a) Pre-1930s cavity-walled dwellings misidentified as solid walls
(b) Modern brick-clad timber-frame walls misidentified as cavity walls
(c) Hardwood-frame pre-1850 dwellings misidentified as solid walls.

5. **Non-Standard Heat-Saving Measures**
6. **Air Leakage Control**

It could use the local AECB network to help do this, led by a core AECB / DECC team. It could liaise with English Heritage, STBA, SPAB, local experts in Hfds. (Barrie Morgan, Marches Conservation Services), Glos., Worcs., Oxon. (Richard Oxley, Oxley Conservation Services Ltd.), Gwynedd (Voelcker Architects), other counties. Also with RICS.

DECC may wish to consider whether any work supported should relate to England and Wales only or to Great Britain. There are significant regional and national differences in building construction, also in Building Regulations.

Non-Domestic

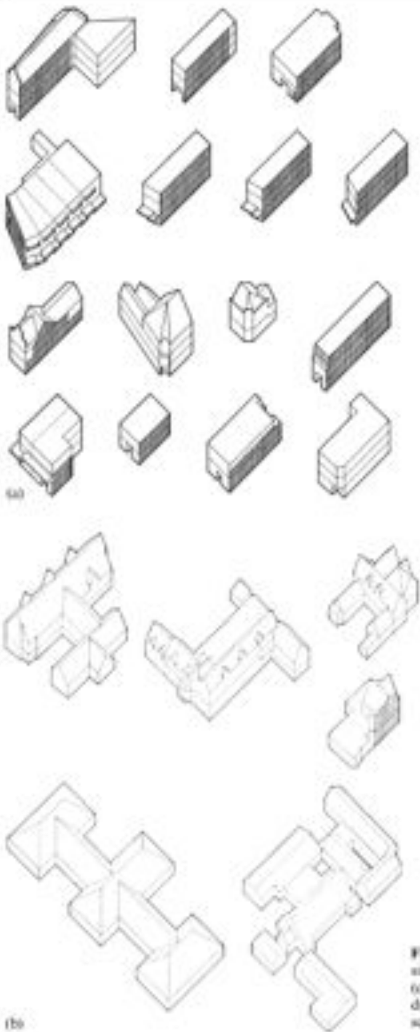


Figure 1. Examples of (a) medium-sized shops, (b) schools, and (c) industrial sheds in Swindon, drawn in axonometric views at a scale of approximately 1:1500.

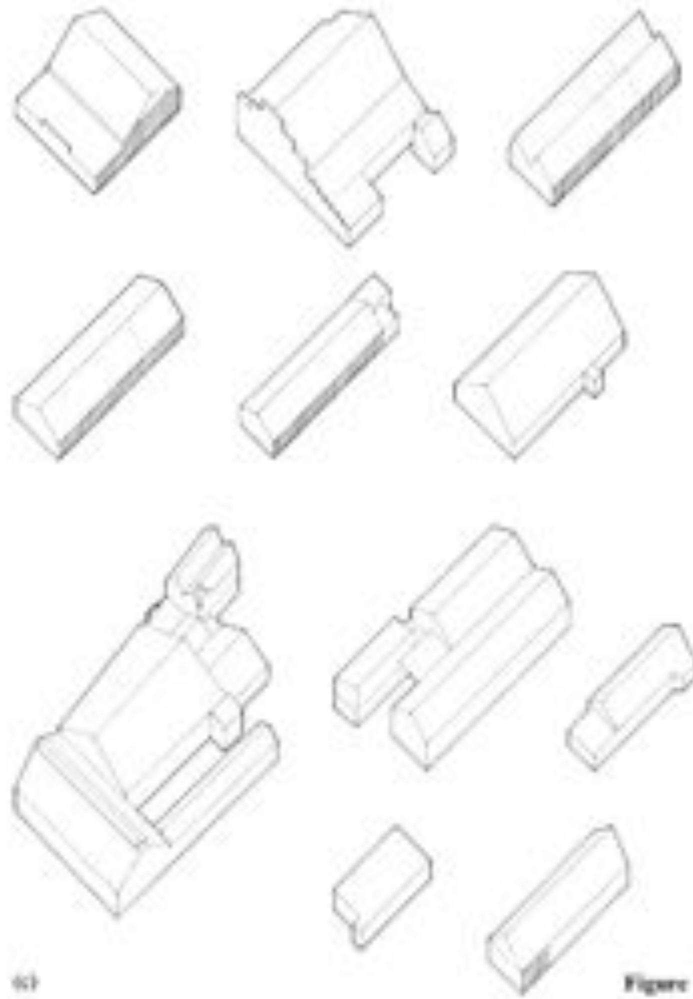


Figure 1 (continued).

Some simplifying strategies

Three strategies have been adopted to simplify the representation of built form, for the purposes of developing a comprehensive classification. First, all minor details of form—any surface articulation, attached orders, small porticoes and balconies, small

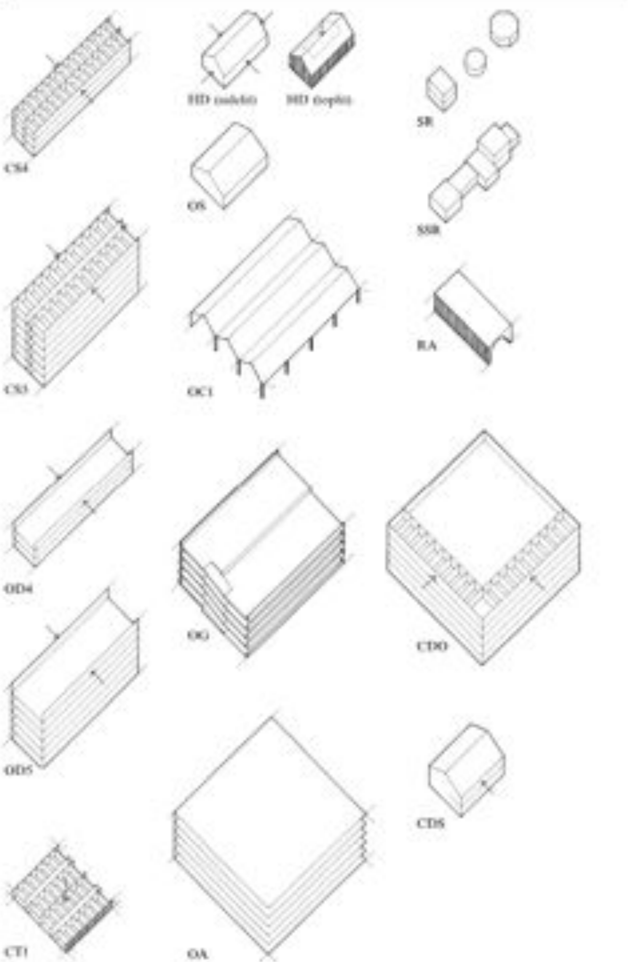


Figure 12. Diagrams of principal forms (see table 1 for key). Arrows show the directions of daylighting. (No diagram is shown for HA, 'artificially lit hall', which is equivalent to HD in form.)

Table 2. Parasite form types.

AC	Attached open-sided canopy
AG	Attached glasshouse or conservatory
AI	Monopitch aisle
AR	Covered street or arcade
AT	Atrium
BA	Basement
BL	Large balcony
CB	Circulation bridge
CL	Covered enclosed ground-level circulation link
CT	Attached circulation tower
EX	Small single-storey extension
OR	Occupied pitched roof or attic
PC	Porte cochere
PR	Roof-level plant room

possible, use of these codes has been avoided. They have only been necessary where buildings had already been broken down geometrically into floor polygons in the Smallworld GIS in ways which were not compatible with the simple built form categories.

Table 2 lists all the parasite forms in the classification, and figure 13 gives illustrations. Note that atria and covered streets or arcades (as found typically in shopping centres) have been treated as parasites rather than as open-plan space because of their special structural and glazing characteristics and the fact that they would never exist as independent entities. The decision was taken initially to treat basements (other than basement car parks) and occupied pitched roofs or attics as parasites, rather than include them with the principal built forms. In subsequent analysis, however, this decision has been reversed (see Steadman et al, 2000b).

A few additional codes are provided for other subsidiary forms, comparable with parasites, but which are not actually attached to their 'hosts'. Some of these are specialised structures or large machines, for example training towers for firefighting practice, car washes, and bus washes. Outdoor swimming pools have been coded, despite their not being 'buildings', because of their use of energy.

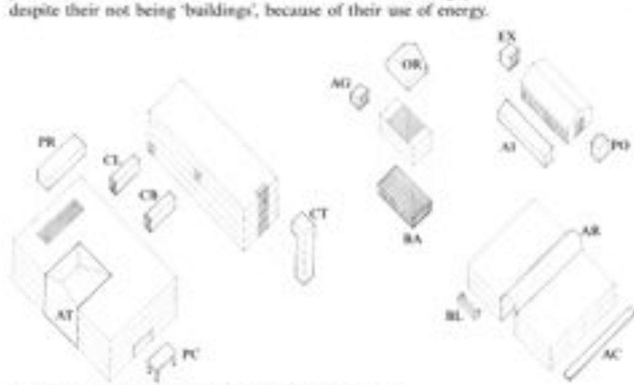


Figure 13. Diagrams of parasite forms (see table 2 for key).

‘Domestic’ (i.e., also representative of some Non-Dom)

Type

Standard Dwellings	
Det Bungalow	
SemiDet Bungalow	
Small Det House	
Period End Terr	
Small SemiDet	
Modern End Terr	
Large SemiDet	
Large Det House	
Period Mid Terr	
Modern Mid Terr	
2 Bed Flat 1	
Modern 3 storey town house	
Old 3 storey town house	

Wall construction

[note: beware current assumptions
involve for example, thermal imagin
More info at CLR Technical Resources

Main Building Types – by wall construction

Code	Age	Thickn (mm)	Material	Cavity	Description
Masonry Cav1		350	masonry		Solid masonry wall - thick, 350 mm b
Masonry Cav2		215	masonry		Solid masonry wall - thin, 215mm bri
Masonry Cav3	c1900+		masonry	✓	Cavity Walled c. 1900 onwards, early
Masonry Cav4	1950+		masonry	✓	Cavity Walled 'Modern' later 20th C,
Timber1			hardwood		Historic hardwood-frame, post and b
Timber2			hardwood		Historic hardwood-frame, post and b
Timber3			hardwood		Historic hardwood-frame, post and b
Timber4			softwood		Historic softwood, Timber Frame, ra
Timber5			softwood		Late 20th C Soft Wood Timber Frame,
Timber6			timber		Modern soft wood timber frame - bri
Masonry Solid1	1925-45	200	Poured In-Situ	✓	Laing Easi-Form. 8" thick solid no-fin with 2" cavity, usually finished extern of 3" thickness separated by a 2" cav
Masonry Solid2		225	Poured In-Situ		Mowlem Solid wall types 225mm th
Masonry Solid3	1952-81		Poured In-Situ	✓	Mowlem Cavity wall types. A cast in mass concrete for the inner blockwor
Masonry Solid4	1940s-60s	200-300	Poured In-Situ		Wimpey No-Fines in situ cast no-fines thickness, after 1964 walls were com DPC level the external walls maybe of walls maybe tile faced or weather bo door and window openings.
Masonry Solid5			Precast Reinf Conc		Airey. Post and panel construction. S cast concrete shiplap panels secured
Masonry Solid6			Precast Reinf Conc	✓	Boot. External walls trained in concre panels, plastered internally and rough

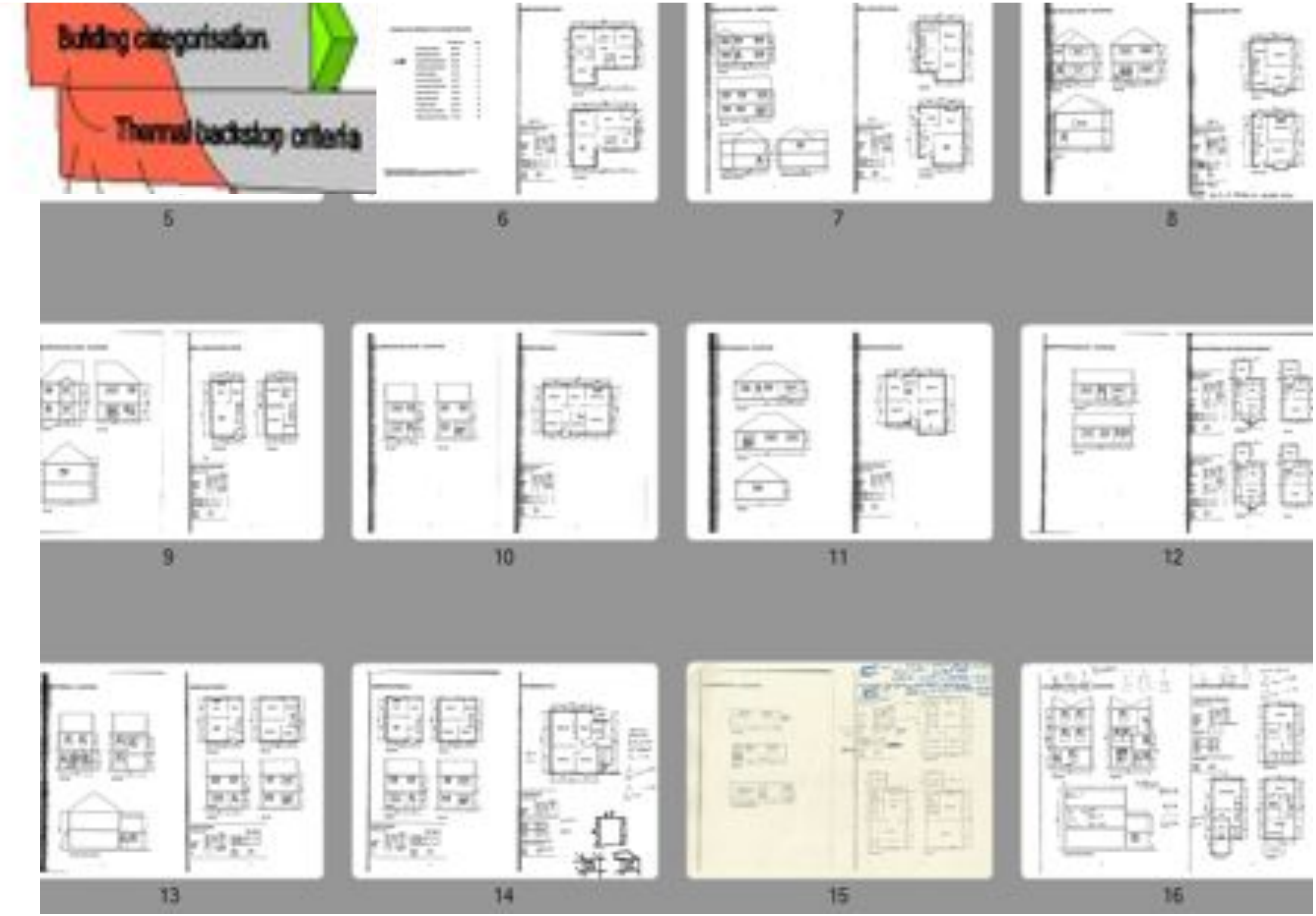
Typical sub sets –building systems

From
http://www.hiresources.co.uk/NT-AllType.asp

Type	Picture	Name and Description
Poured In-Situ		**Laing Easi-Form** 8" thick solid no-fines clinker concrete walls in the period 1919 to 1928. 1925 to 1945 cast in situ cavity walls, 3" thick inner and outer leaves with 2" cavity, usually finished externally with stone dashed render coat. Post 1945 (the majority of houses) cast in situ concrete walls, inner and outer leaves of 3" thickness separated by a 2" cavity, reinforcement in both skins located in 4 horizontal bands above and below window openings. Common Identifying Features Line of wall lift evident in horizontal line within roof space, in roof space internal face of walls aggregate not so coarse as Wimpey No-Fines construction. Ventilation through external walls rectangular in many examples of this construction.
Poured In-Situ		**Mowlem** Solid cavity wall types. A cast in situ concrete form of construction, first used in 1952 but mainly in the period 1962 to 1981. Construction substitutes mass concrete for the inner blockwork walls of traditional housing. Solid wall types 225mm thick cast in lightweight concrete, rendered externally. Cavity wall types with an 'inner leaf of 100-125mm thick concrete. Common Identifying Features None known.
Poured In-Situ		**Wimpey No-Fines** Construction Is in situ cast no-fines concrete. Before 1951 external walls were commonly 12" thickness, 1951 to 1964 external walls were commonly 10" thickness, after 1964 walls were commonly 8" thickness. Gable walls maybe clad with a masonry outer leaf tied to the cast in situ concrete with wall ties. Up to DPC level the external walls maybe of masonry construction. Post 1964 examples of this construction can be dry lined internally and some external surfaces of walls maybe tile faced or weather boarded. Reinforcement commonly incorporated at eaves level and at a level to tie in with reinforcement over ground floor door and window openings. Common Identifying Features Measurement of the external walls at some 12" thickness, coarse aggregate evident to wall face concrete mix in roof space. Ventilation through external walls circular in many examples of this construction.
Precast Reinf Conc		**Airey** Construction Post and panel construction. Storey height pre-cast concrete posts at 18" centres Incorporating steel tube reinforcement. External cladding 3' x 9" pre-cast concrete shiplap panels secured to posts by copper wire fixings, panel rendered in some cases. Common Identifying Features 'Shiplap' cladding panels, tile hung gable ends Additional image(s): click here, click here, click here
Precast Reinf Conc		**Boot**

House Types | Type by Wall | Type by System

BRE – standard dwelling types for energy modelling



Type	A/V	Form Factor
Det Bungalow	1.13	3.9
SemiDet Bungalow	1.07	3.6
Small Det House	0.89	2.9
Period End Terr	0.85	2.7
Small SemiDet	0.80	2.5
Modern End Terr	0.79	2.6
Large SemiDet	0.78	2.5
Large Det House	0.76	2.5
Period Mid Terr	0.64	2.0
Modern Mid Terr	0.63	2.0
Low rise block 2 Bed Flat [1]	0.53	1.7
Modern 3 storey town house	0.52	1.6
Old 3 storey town house	0.46	1.6

Thinking ahead about CLR building certification – and need for thermal backstop target / criteria:

Certification – does not ask for PHPP!

Thinking that due to 'unforseens' & variations cf to the 'classic type' that the space heat requirement should be a target only. However a whole house approach would still be required – evidence based checklist

CLR programme requires a backstop whole house target (later non-dom?) that ensures no project can be certified unless it adopts a minimum level of thermal performance.

The target needs to recognise that for many properties certain elements may not be upgradeable for reasons of disruption, costs and given this may not represent a worthwhile investment for the increase in comfort or energy savings resulting. For similar reasons the use of MVHR may also be more appropriately replaced with whole house MEV as part of this approach.

Previous work under the LEAF project by Simmonds.Mills/David Olivier/Alan Pither and other work by David Olivier using PHPP indicate that a realistic space heat demand of around 100kWh/m2.yr could be achieved at reasonable cost and effort. However the building stock contains a number of different house types and construction types:

- Application of any thermal standard will be more difficult/expensive:
  - for some construction types compared to others
  - For buildings with different heat loss areas: volume ratios (S:V ratio)

The minimum CLR standard could be expressed simply as 1) a max. space heat demand that all house types must achieve on CLR retrofit to be certifiable OR 2) a typical max. heat demand with variations for each house type based on the S:V ratios (high S:V types have a higher heat demand allowance).

1) Means that high S:V ratio homes may be more expensive to retrofit under CLR (e.g. small bungalows), there is an element of social inequity in this approach, unless funding mechanisms counter this. CLR Partner funding mechanisms could potentially take this into

…also 12 – 24 months fuel use must be agreed to and added to LEBD

Comparing to AECB Silver (currently Silver is AECB self assessment standard so is a useful format to start from)

Energy Performance

- Specific heat demand according to PHPP ≤40kWh/(m^2.a)
- Specific primary energy demand according to PHPP ≤120kWh/(m^2.a)
- Air leakage (n50) ≤1.5 h^{-1} if balanced ventilation with heat recovery used or ≤3 h^{-1} if mechanical extract ventilation is used[3].

Thermal Bridges

The Passivhaus approach of designing out thermal bridges and using external dimensions simplifies modelling and guards against problems such as mould and condensation. For these reasons it is recommended that where possible designs are thermal bridge free according to the Passivhaus definition. Where it is not practical or economical to achieve a thermal bridge free junction, the additional heat loss must be determined. If no calculation is submitted, then the decision as to whether a detail is thermal bridge free may be queried at the AECB's discretion.

Very important to factor in thermal bridges: heat loss, mold growth, surface temperatures. These are areas where moisture related problems often exist and these should be *improved* not *retained* or *made worse* by retrofit measures.

AECB Silver Standard criteria

The AECB Silver Standard can be said to be achieved where a building that is designed and modelled using PHPP[1] in accordance with current Passivhaus methodology meets the following requirements:

Parameter	Target	Notes
Delivered Heat and cooling	≤ 40kWh/(m².a)	According to PHPP and Passivhaus methodology.
Primary Energy demand	120 Wh/(m².a)	ditto
Air tightness (n50)	$\leq 1.5\ h^{-1}$ ($\leq 3\ h^{-1}$)	With MVHR (with MEV)[2]
Thermal Bridges[3]	$Psi_{external}$ <0.01 W/m	Calculated if > 0.01 W/m
Summer overheating	<10%	<5% recommended

100? A:V variation?

Yes – if energy modelling carried out. Submit PHPP

Target + fuel use measured

Target + test

Must provide evidence bridges treated

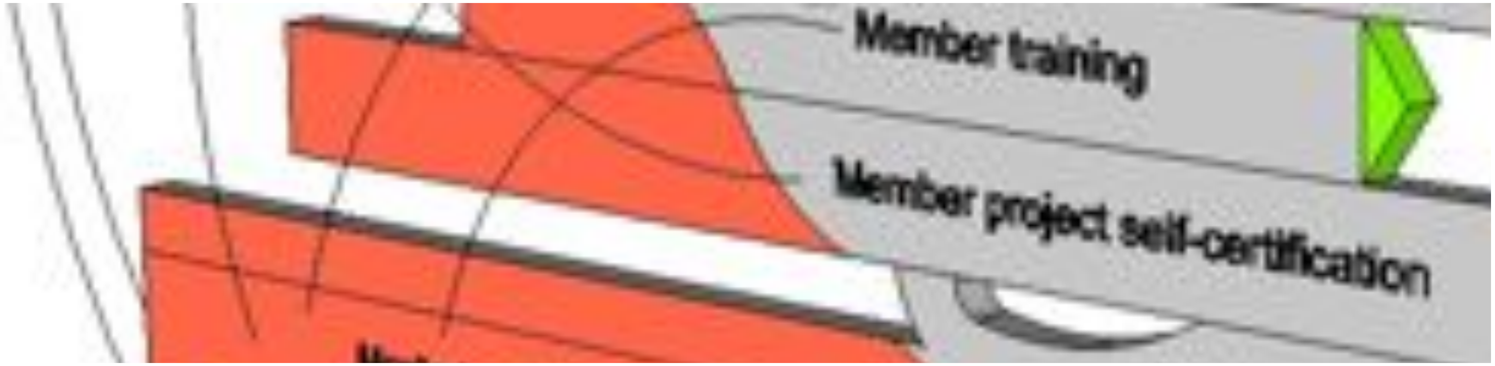
Target + evidence

1 The Passive House Planning Package.

2 Note it may not be possible to meet the heat demand target without MVHR for some buildings.

3 Standard Passivhaus methodology is used. If no calculation is submitted, then the decision as to whether a detail is thermal bridge free may be queried at the discretion of the AECB.

Primary energy target (domestic)?



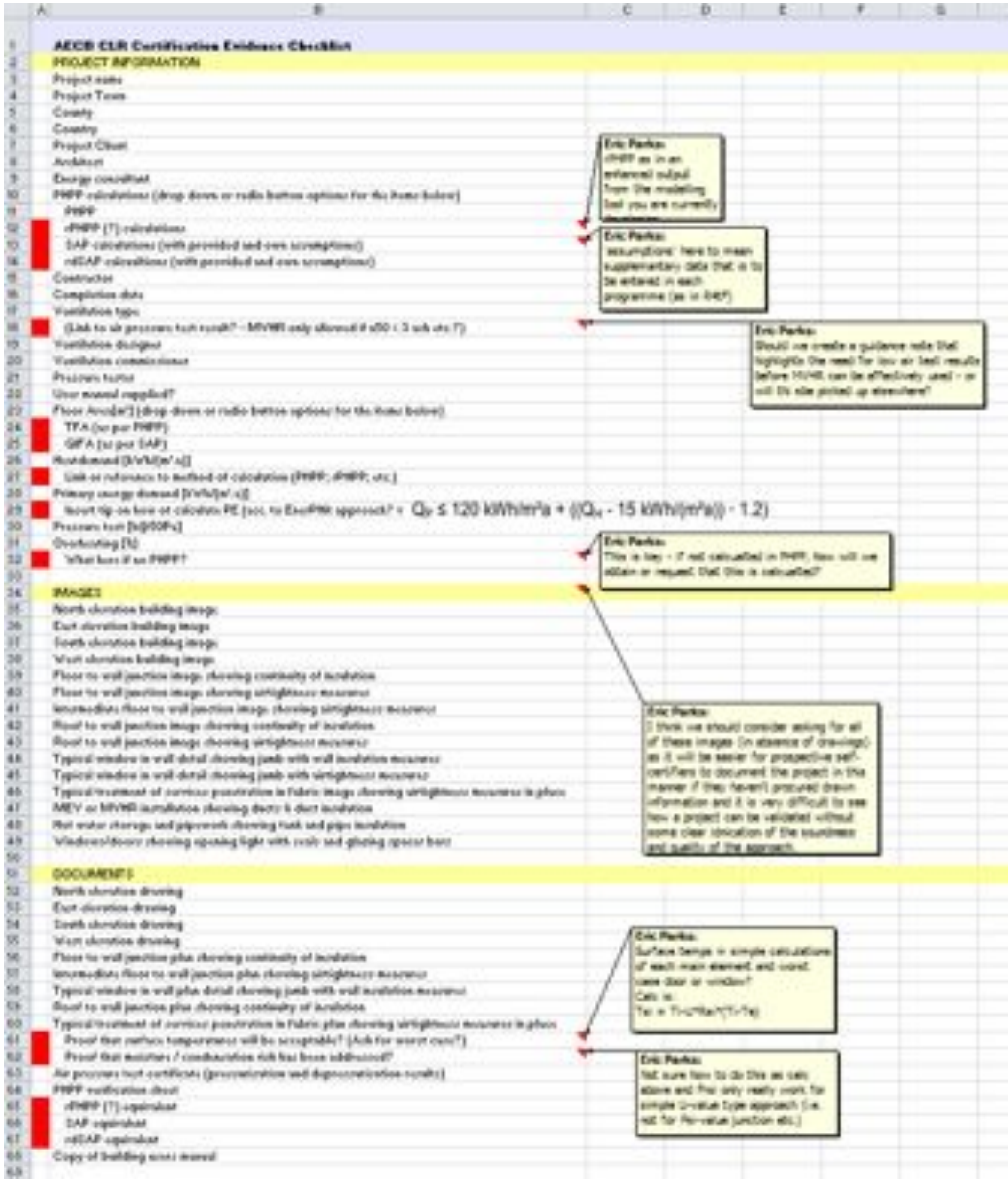
Supporting evidence requirements

	Drawing & Photographic Record	Drawi
1	All elevations of completed building	One elevation be included
2	Floor to wall junction – continuity of insulation visible	✔
3	Floor to wall junction – airtightness measures visible	
4	Intermediate floor to wall junction – airtightness measures visible	✔
5	Roof to wall junction - continuity of insulation visible	✔
6	Roof to wall junction - airtightness measures visible	

Supporting evidence requirements

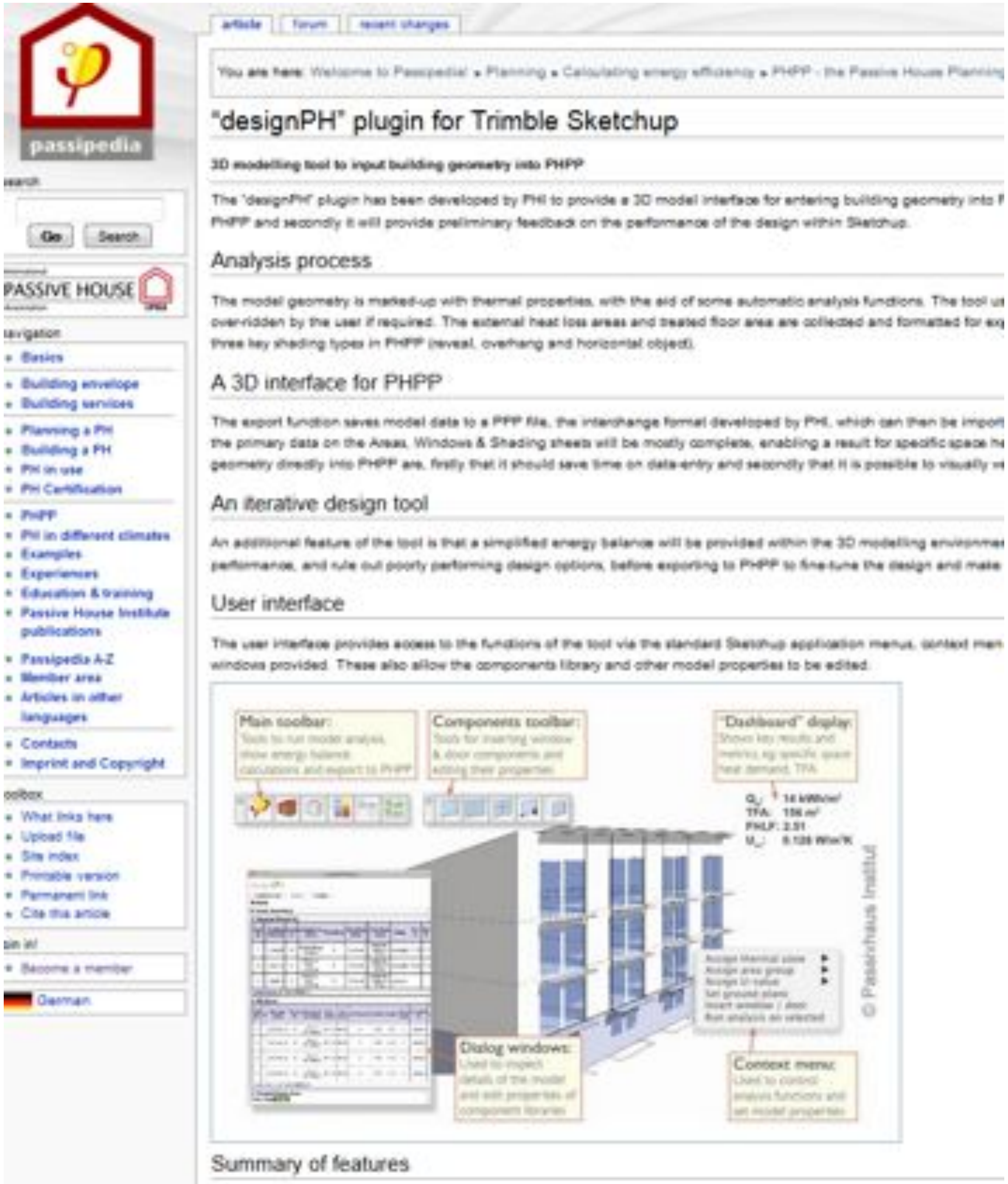
	Drawing & Photographic Record	Drawings. Pdf A4 format	Photographs jpeg format.
1	All elevations of completed building	One elevation per page. Scale bar to be included	one photo for each elevation
2	Floor to wall junction – continuity of insulation visible	✓	✓
3	Floor to wall junction – airtightness measures visible		✓
4	Intermediate floor to wall junction – airtightness measures visible	✓	✓
5	Roof to wall junction - continuity of insulation visible	✓	✓
6	Roof to wall junction - airtightness measures visible		✓
7	Typical window in wall detail – jamb with wall insulation measures visible	✓	✓
8	Typical window in wall detail – jamb with airtightness measures visible		✓
9	Typical treatment of services penetration in fabric – with airtightness measures in place	✓	✓
10	Typical MEV or MVHR installation showing ducts & duct insulation		✓
11	Hotwater storage and pipework – showing tank and pipe insulation		
12	Windows/doors – showing opening light with seals and glazing spacer bars		
Other			
13	Air pressure test certificate (pressurisation and depressurisation results)	✓	
14	PHPP verification sheet as pdf	✓	
15	Copy of building users manual	✓	

Unlikely that full drawings will be usually available, nor full PHPP…. Potential for [Form Factor] + [Prescriptive U value + minimum no. of measures approach]?



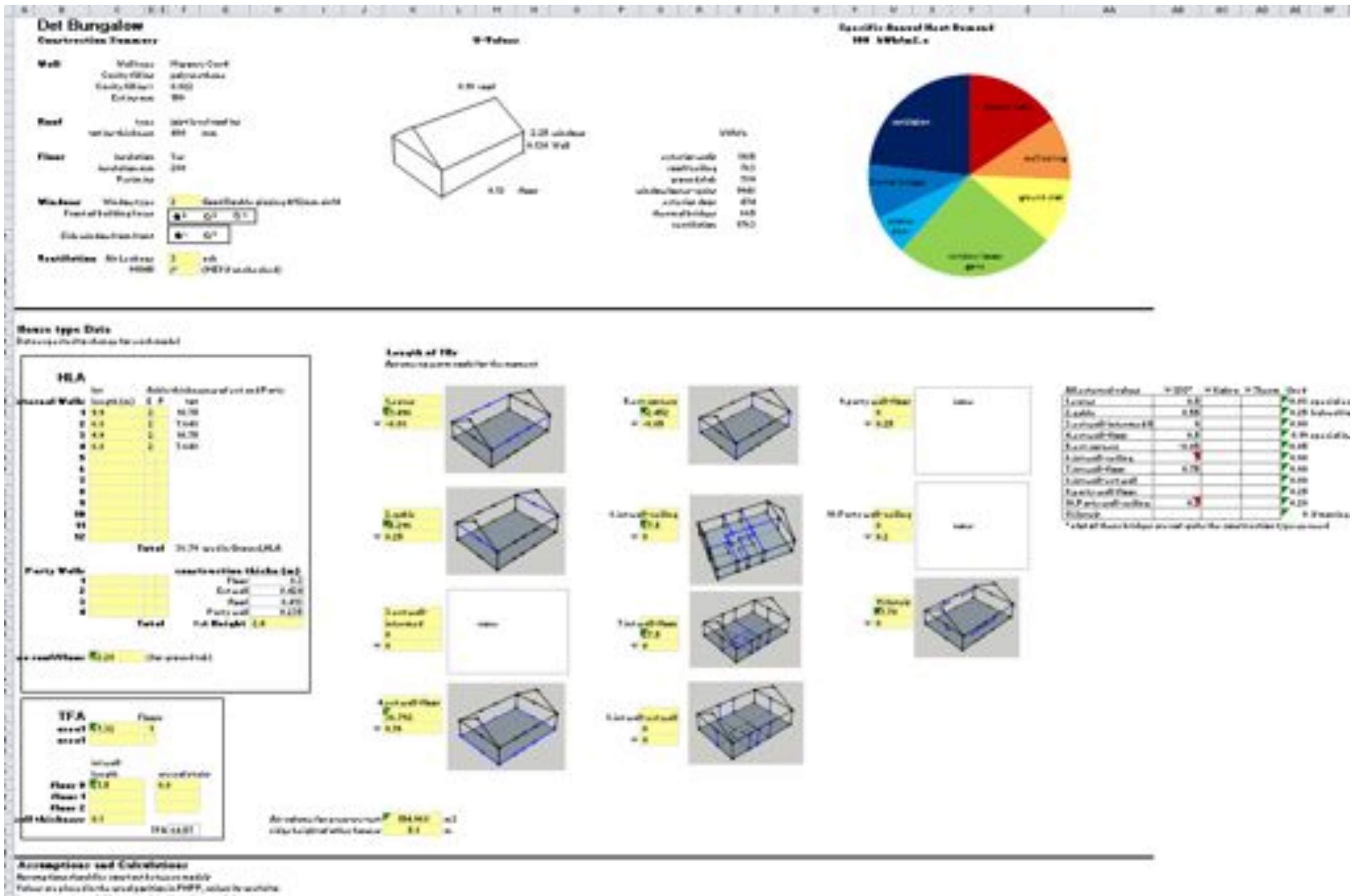
AECB CLR Certification Evidence Checklist

1	**AECB CLR Certification Evidence Checklist**	
2	**PROJECT INFORMATION**	
3	Project name	
4	Project Team	
5	County	
6	Country	
7	Project Client	
8	Architect	
9	Energy consultant	
10	PHPP calculations (drop down or radio button options for the items below)	
11	PHPP	
12	ePHPP (?) calculations	Eric Parks: ePHPP as in an enhanced output from the modelling tool you are currently [illegible]
13	SAP calculations (with provided and own assumptions)	Eric Parks: 'assumptions' here to mean supplementary data that is to be entered in each programme (as in PHPP)
14	rdSAP calculations (with provided and own assumptions)	
15	Contractor	
16	Completion date	
17	Ventilation type	
18	(Link to air pressure test result? - MVHR only allowed if n50 < 3 ach etc.?)	Eric Parks: Should we create a guidance note that highlights the need for low air test results before MVHR can be effectively used - or will this be picked up elsewhere?
19	Ventilation designer	
20	Ventilation commissioner	
21	Pressure tester	
22	User manual supplied?	
23	Floor Area [m²] (drop down or radio button options for the items below)	
24	TFA (as per PHPP)	
25	GIFA (as per SAP)	
26	Heat demand [kWh/(m².a)]	
27	Link or reference to method of calculation (PHPP; ePHPP; etc.)	
28	Primary energy demand [kWh/(m².a)]	
29	Insert tip on how to calculate PE (acc. to EnerPHit approach? = $Q_P \leq 120$ kWh/m²a + ((Q_H - 15 kWh/(m²a)) · 1.2)	
30	Pressure test [h@50Pa]	
31	Overheating [%]	
32	What here if no PHPP?	Eric Parks: This is key - if not calculated in PHPP, how will we obtain or request that this is calculated?
33		
34	**IMAGES**	Eric Parks: I think we should consider asking for all of these images (in absence of drawings) as it will be easier for prospective self-certifiers to document the project in this manner if they haven't procured drawn information and it is very difficult to see how a project can be validated without some clear indication of the soundness and quality of the approach.
35	North elevation building image	
36	East elevation building image	
37	South elevation building image	
38	West elevation building image	
39	Floor to wall junction image showing continuity of insulation	
40	Floor to wall junction image showing airtightness measures	
41	Intermediate floor to wall junction image showing airtightness measures	
42	Roof to wall junction image showing continuity of insulation	
43	Roof to wall junction image showing airtightness measures	
44	Typical window in wall detail showing jamb with wall insulation measures	
45	Typical window in wall detail showing jamb with airtightness measures	
46	Typical treatment of services penetration in fabric image showing airtightness measures in place	
47	MEV or MVHR installation showing ducts & duct insulation	
48	Hot water storage and pipework showing tank and pipe insulation	
49	Windows/doors showing opening light with seals and glazing spacer bars	
50		
51	**DOCUMENTS**	
52	North elevation drawing	
53	East elevation drawing	
54	South elevation drawing	
55	West elevation drawing	
56	Floor to wall junction plan showing continuity of insulation	
57	Intermediate floor to wall junction plan showing airtightness measures	
58	Typical window in wall plan detail showing jamb with wall insulation measures	
59	Roof to wall junction plan showing continuity of insulation	
60	Typical treatment of services penetration in fabric plan showing airtightness measures in place	
61	Proof that surface temperatures will be acceptable? (Ask for worst case?)	Eric Parks: Surface temps in simple calculations of each main element and worst case door or window? Calc is: Tsi = Ti-U*Rsi*(Ti-Te)
62	Proof that moisture / condensation risk has been addressed?	Eric Parks: Not sure how to do this as calc above and this only really work for simple U-value type approach (i.e. not for Psi-value junction etc.)
63	Air pressure test certificate (pressurisation and depressurisation results)	
64	PHPP verification sheet	
65	ePHPP (?) equivalent	
66	SAP equivalent	
67	rdSAP equivalent	
68	Copy of building users manual	
69		

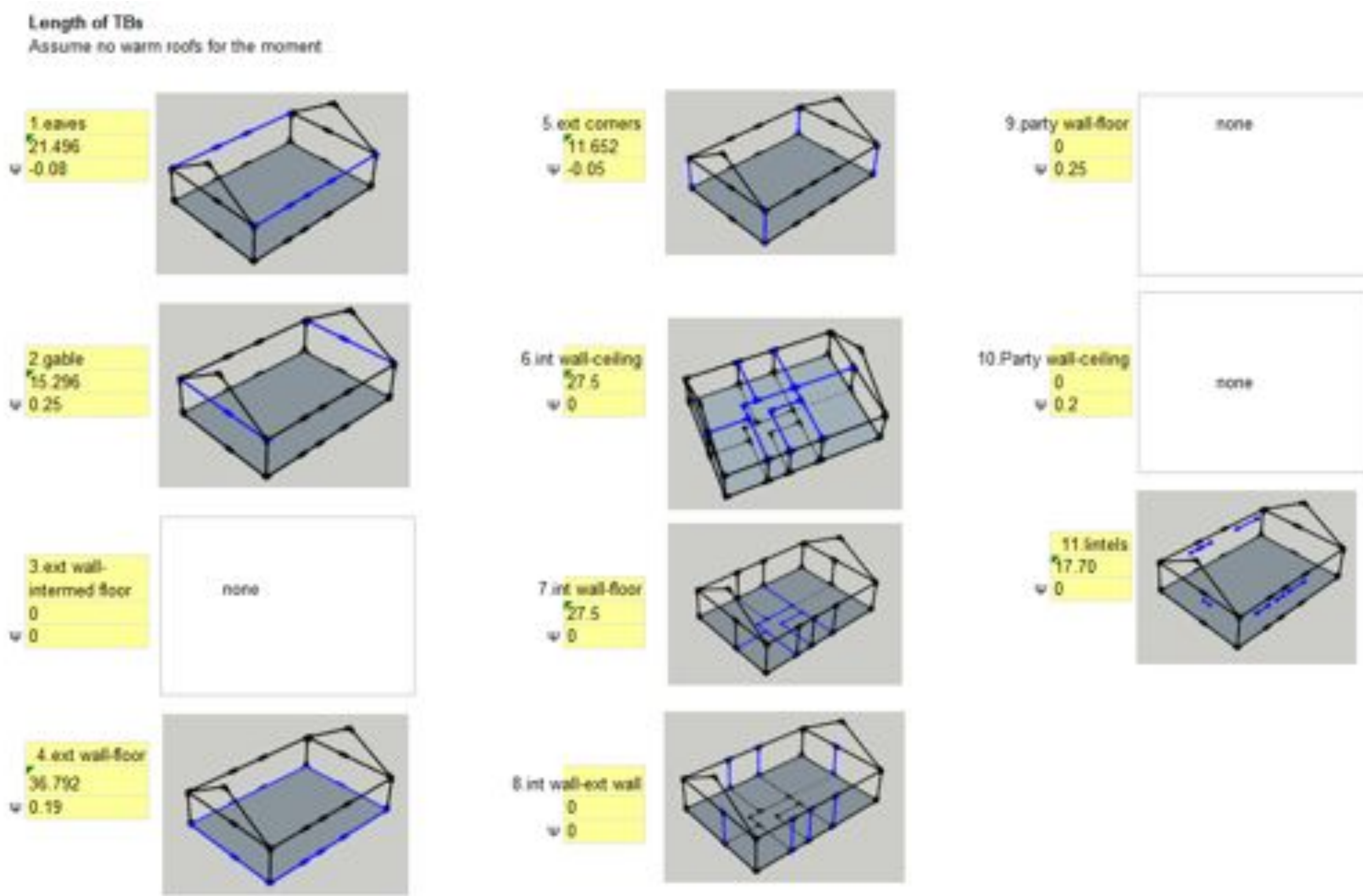


Considered for CLR modelling purposes – decided to use PHPP for transparency of process

PHPP – with retrofit sheet added – partly for data entry – partly for recording and reporting



Keeping track of thermal bridges



Assumptions and Calculations

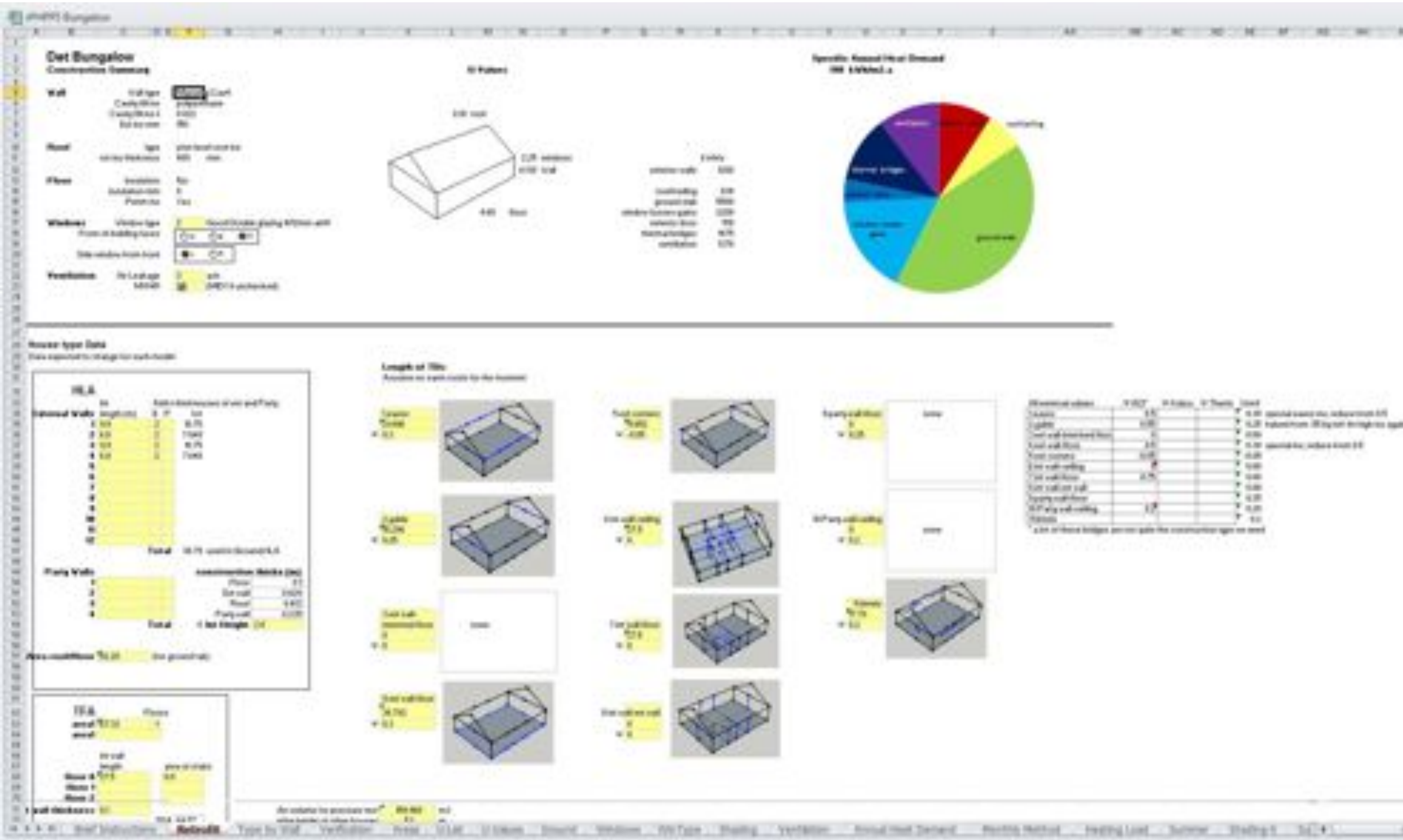
Assumptions should be constant between models
Values are placed in the usual position in PHPP, unless its useful to have a separate variable to calculate the value needed

Assumptions

Climate	GB - Manchester			
Verification	Monthly Method			
	Internal Temp (drafts, cold radiant)		20	C
U-list	Cavity insulation is high performance if lined k=0.021			
Areas	Ψ 1.eaves		-0.08	W/mK
	Ψ 2.gable		0.25	W/mK
	Ψ 3.ext wall-intermed floor		0.00	W/mK
	Ψ 4.ext wall-floor		0.19	W/mK
	Ψ 5.ext corners		-0.05	W/mK
	Ψ 6.int wall-ceiling		0.00	W/mK
	Ψ 7.int wall-floor		0.00	W/mK
	Ψ 8.int wall-ext wall		0.00	W/mK
	Ψ 9.party wall-floor		0.25	W/mK
	Ψ 10.Party wall-ceiling		0.20	W/mK
	Ψ 11.lintels		0.00	W/mK
	Ψ		0.00	W/mK
Ground	perimeter from F49 on this tab			
	area from C59 on this tab			
	slab on grade perim length		1.20	m
	slab on grade perim ins thickness		0.10	m
	slab on grade perim ins U		0.021	W/mK
	slab on grade perim ins orient		FALSE	
	Suspended floor Uvalue crawl space		0	W/(m²K)
	Suspended floor height crawlspace wall		0	m
	Suspended floor Uvalue crawl space wall		0	W/(m²K)
	Suspended floor area of vent openings		0	m²
Wintype	glazing1	Old Double glazing 4/12mm air/4		
	glazing2	Good Double glazing 4/12mm air/4		
	glazing3	Triple Low-E 0.69 N 52 - GUARDIAN Flachglas		
	frame1	Plastic until 98		
	frame2	Good double glazed, Plastic until 98		
	frame3	Passive House frame, good thermal quality		
Shading	Assume 75% is typical, i.e. PHPP default			
Ventilation	Wind coeff e: Moderate screening, sev sides exp		0.07	
	Wind Protection Coefficient, f		15	
	Air Change Rate at Press. Test		3	
	Length ambient air duct		2	m
	Length extract air duct		1	m
	nominal width of supply/extract ducts		150	mm
	thickness of insulation on supply/extract ducts		25	mm
	reflective coating of supply/extract ducts		no	
	Thermal conductivity of of supply/extract duct ins		0.040	W/mK

Assumptions and calculation procedures recorded clearly for easier peer review

Modelling the building types & 'worst case' wall & floor constructions – after application of 'typical' retrofit measures. Sensitivity testing of effects of weather data, orientation, internal temperature, thermal bridges, ventilation system, window types, hard to treat elements etc.

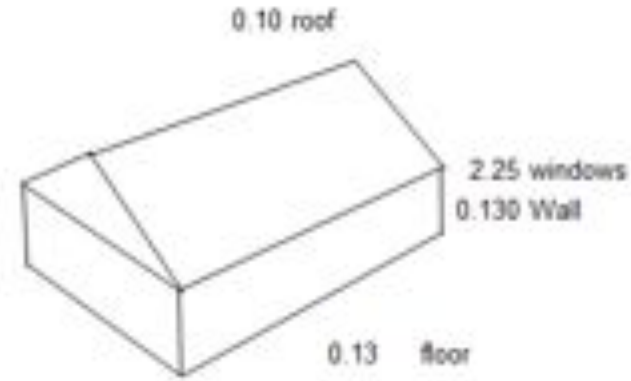


Det Bungalow

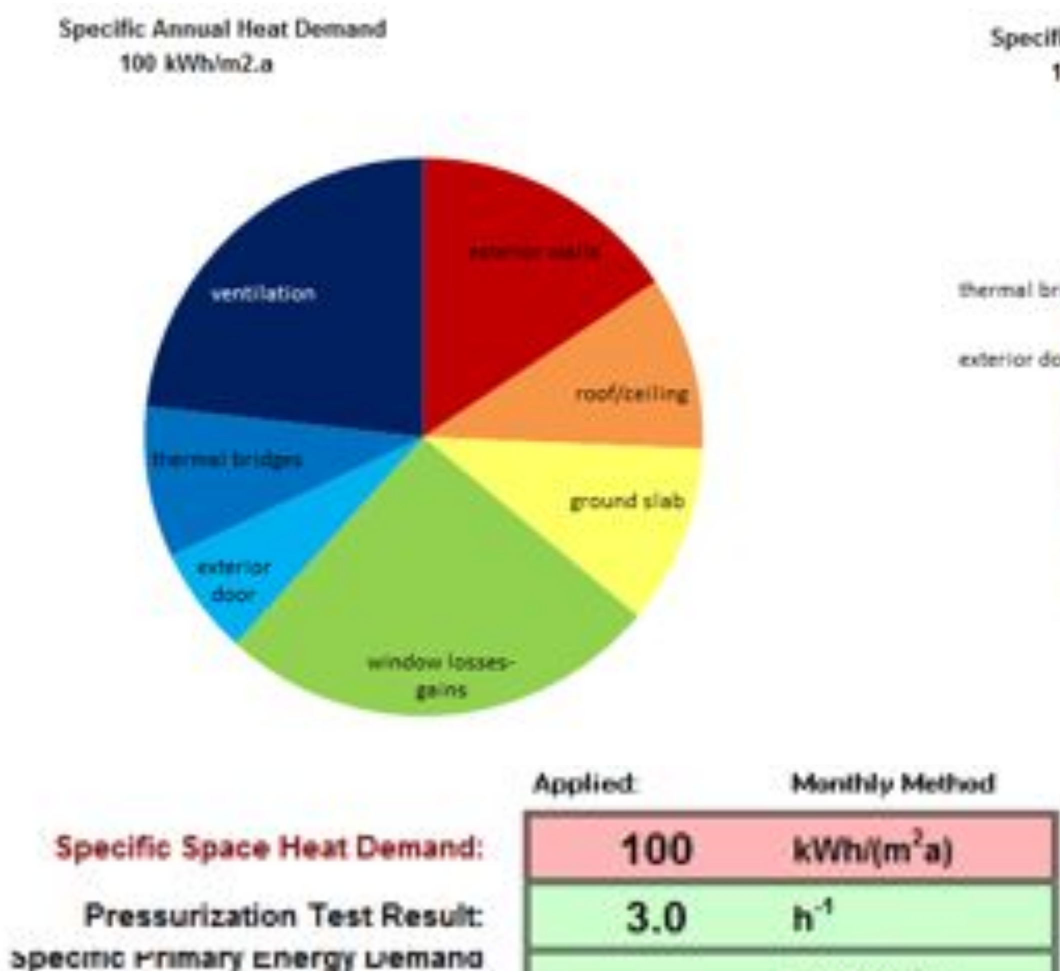
Construction Summary

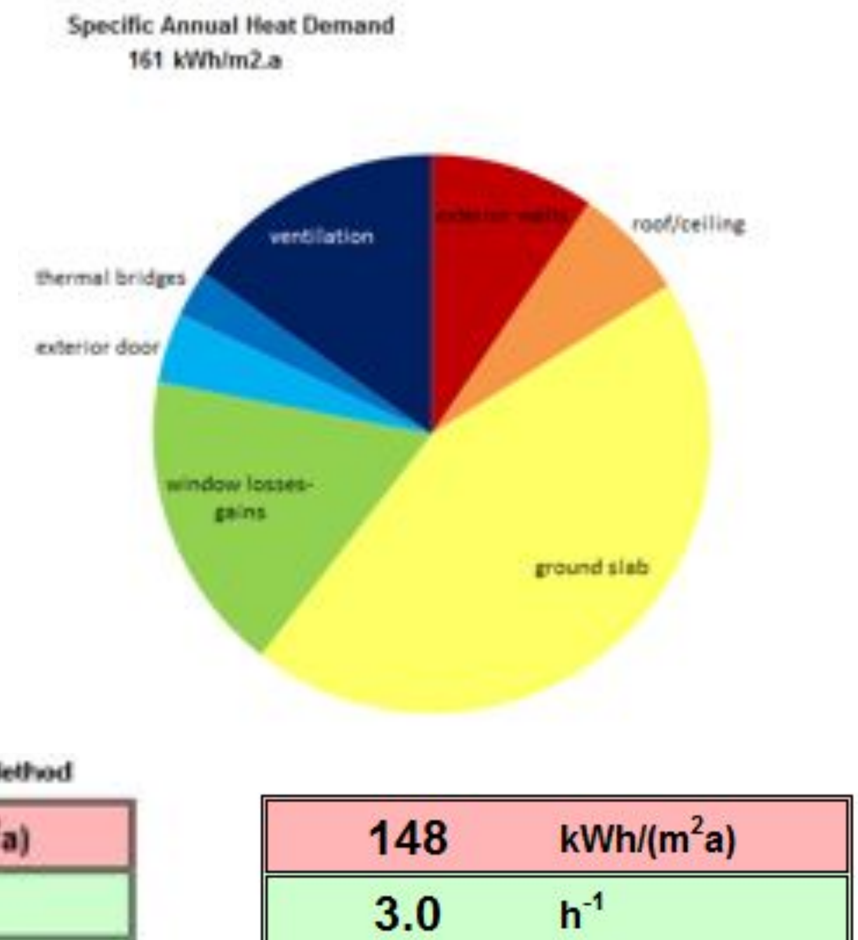
U-Values

Wall	Wall type	Masonry Cav4	
	Cavity fill ins	polyurethane	
	Cavity fill ins λ	0.022	
	Ext ins mm	150	
Roof	type	joist level roof ins	
	tot ins thickness	400	mm
Floor	insulation	Yes	
	insulation mm	200	
	Perim ins		
Windows	Window type	2	Good Double glazing 4/12mm air/4
	Front of building faces	● S ○ E ○ N	
	Side window from front	● L ○ R	
Ventilation	Air Leakage	3	ach
	MVHR	☐	(MEV if unchecked)



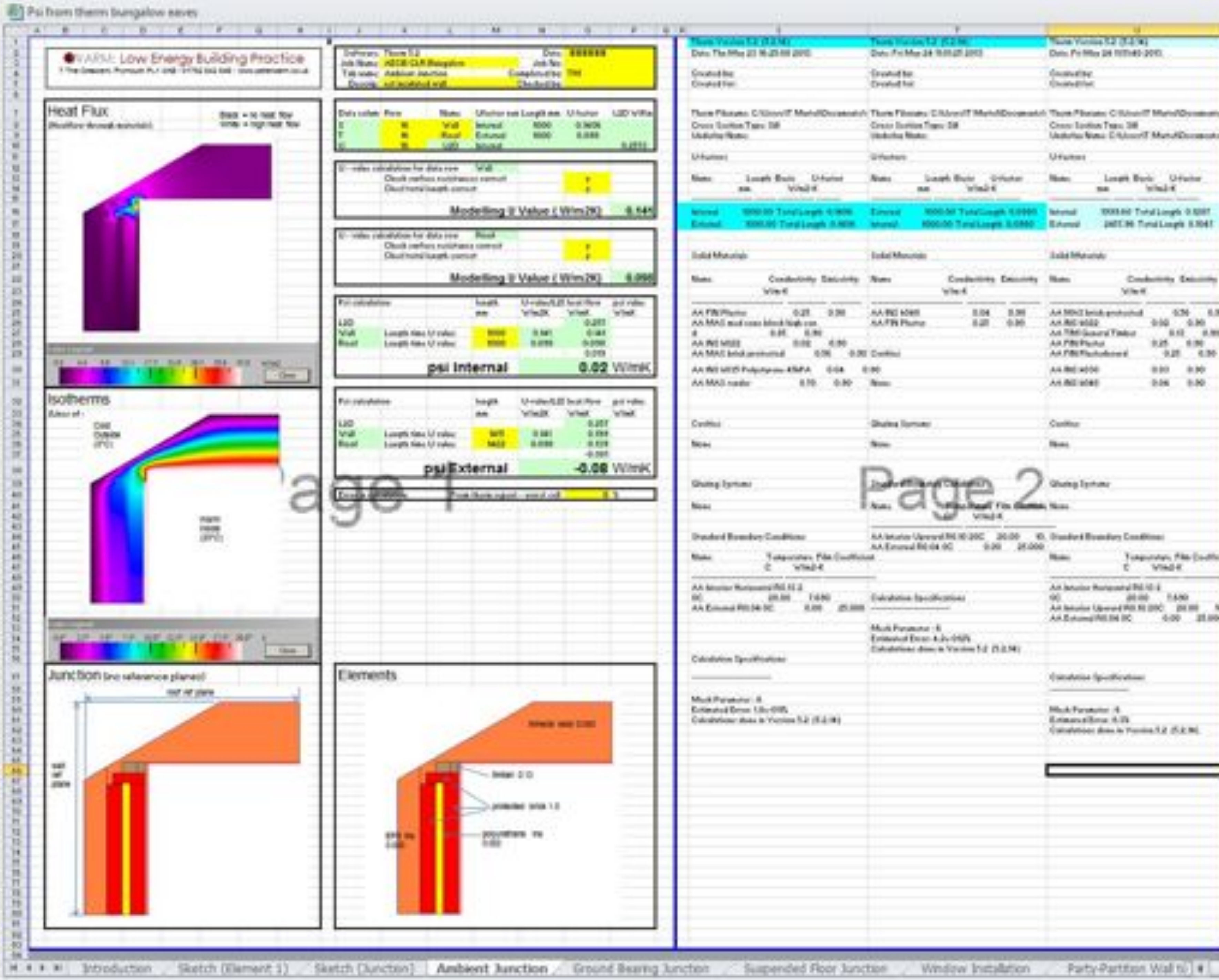
Quick feedback via retrofit sheet





Good double glazing
CWI & EWI
Renew floor to add insulation
MEV + 3 ac/hr
Loft insulation

Good double glazing
CWI & EWI
Perimeter insulation & carpet
MEV + 3 ac/hr
Loft insulation


Psi from therm bungalow eaves
WARM: Low Energy Building Practice
Heat Flux
Modelling U Value (W/m2K)
Modelling U Value (W/m2K)
psi Internal 0.02 W/mK
psi External -0.08 W/mK
Isotherms
Page 1
Page 2
Junction (no reference planes)
Elements
Introduction
Sketch (Element 1)
Sketch (Junction)
Ambient Junction
Ground Bearing Junction
Suspended Floor Junction
Window Installation
Party-Partition Wall to

ific Demands with Reference to the Treated Floor Area

Treated Floor Area:	73.2 m²			
	Applied:	#N/A	PH Certificate:	uirement fulfilled?
Specific Space Heat Demand:	95	kWh/(m²a)	15 kWh/(m²a)	No
Pressurization Test Result:	3.0	h^{-1}	0.6 h^{-1}	No
Specific Primary Energy Demand (DHW, Heating, Auxiliary and Household Electricity):	274	kWh/(m²a)	120 kWh/(m²a)	No
Specific Primary Energy Demand (DHW, Heating and Auxiliary Electricity):	137	kWh/(m²a)		
Specific Primary Energy Demand Energy conservation by solar-generated electricity:	0	kWh/(m²a)		
Heating Load:				
Frequency of Overheating:				
Specific Useful Cooling Energy Demand:				
Cooling Load:				

Street:				
stcode/City:				
Construction:	1950s			
elling Units:	1		Interior Temperature:	22.0
l Volume V_e:	175.7 m³		Internal Heat Gains:	2.1
Occupants:	2.1			

he Treated Floor Area

l Floor Area:	73.2 m²		
	Applied:	#N/A	PH Certificate:
t Demand:	122	kWh/(m²a)	15 kWh/(m²a)
est Result:	3.0	h^{-1}	0.6 h^{-1}
y Demand l Household Electricity:	302	kWh/(m²a)	120 kWh/(m²a)
y Demand			

AECB CEO									
Site Name			Gateway(s)	Created	Last Activity			Status	Claim/Job
Arboreal - IWI			1	5/22/2013	7/9/2013 3:31:18 PM			A	
Sensors	Gateways	Report	WME Report	Downloads	Users	RDC	Rooms	0 Alarms	Edit
Hereford			1	11/19/2012	7/9/2013 3:31:21 PM			A	
Sensors	Gateways	Report	WME Report	Downloads	Users	RDC	Rooms	0 Alarms	Edit
Pioneering Places Project - EWI			1	4/25/2013	7/9/2013 8:19:17 AM			A	
Sensors	Gateways	Report	WME Report	Downloads	Users	RDC	Rooms	0 Alarms	Edit
Pioneering Places Project - IWI			1	5/7/2013	7/9/2013 3:31:02 PM			A	
Sensors	Gateways	Report	WME Report	Downloads	Users	RDC	Rooms	0 Alarms	Edit
Salford			1	12/18/2012	7/9/2013 3:27:58 PM			A	
Sensors	Gateways	Report	WME Report	Downloads	Users	RDC	Rooms	0 Alarms	Edit
Canon Pyon			1	5/30/2012	5/31/2013 8:57:14 AM			I *	
Sensors	Gateways	Report	WME Report	Downloads	Users	RDC	Rooms	1 Alarms	Edit
DECC IWI Project - dwelling A-1			1	5/24/2013	7/2/2013 3:28:41 PM			I	
Sensors	Gateways	Report	WME Report	Downloads	Users	RDC	Rooms	0 Alarms	Edit
Stirley Barn			1	2/28/2013	3/21/2013 5:07:37 PM			I	
Sensors	Gateways	Report	WME Report	Downloads	Users	RDC	Rooms	0 Alarms	Edit

Sensors for Salford

Show : All Only Alarming Only Active

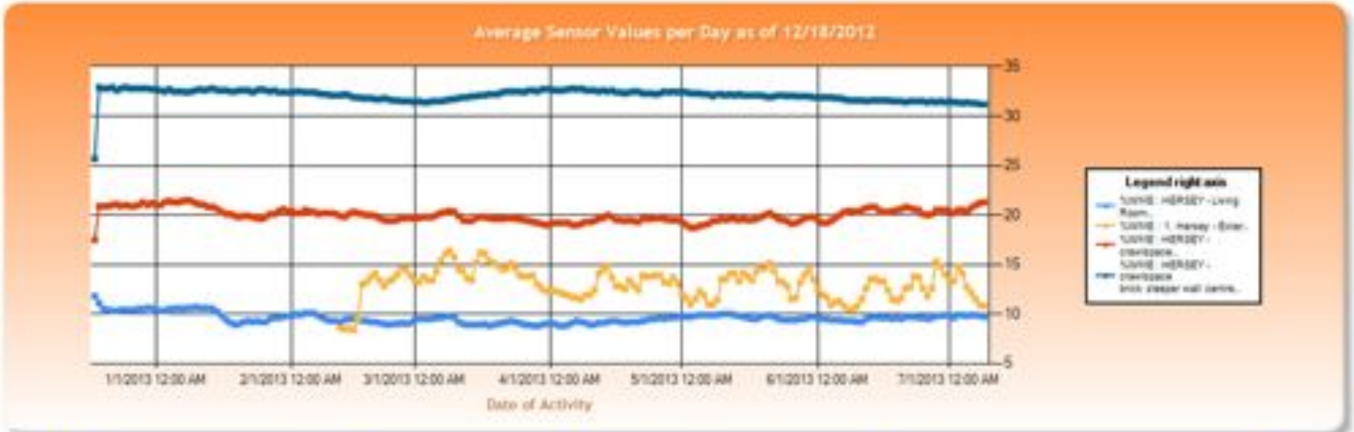
Delete Checked Sensors

Sensor Type 1 - T, RH and Wood Moisture										
Sensor Id	Description	Last Activity	Sts	T(°C)	%RH	AH(g/kg)	DP(°C)	%WME	Vbatt(Vdc)	
16950112	1. Hersey - External	13-07-09 15:13:08	A	29.2	49.7	12.7	17.7	10.4	3.4	
16950208	HERSEY - crawlspace adj dining table	13-07-09 15:07:50	A	17.1	95.0	11.6	16.4	21.4	3.2	
16950173	HERSEY - crawlspace below LHS LR Chimney	13-07-09 14:43:48	A	16.2	106.6	12.3	17.1	27.1	3.2	
16950155	HERSEY - crawlspace below LR cupd	13-07-09 15:02:26	A	17.4	99.4	12.4	17.4	24.4	3.2	
16950099	HERSEY - crawlspace below RHS LR chimney	13-07-09 15:27:06	A	16.2	100.9	11.6	16.4	20.5	3.2	
1695015D	HERSEY - crawlspace between kitchen & hatch	13-07-09 15:09:32	A	16.2	100.0	11.6	16.3	24.1	3.2	
169500EA	HERSEY - crawlspace brick sleeper wall centre LR	13-07-09 15:27:34	A	15.3	96.6	10.5	14.9	31.1	3.3	
169500D1	HERSEY - Living Room ambient	13-07-09 15:07:10	A	24.3	59.6	11.8	16.6	9.6	3.1	
16950068	HERSEY - Living room cupbd floor	13-07-09 15:06:44	A	25.3	57.8	11.7	16.5	9.7	3.2	

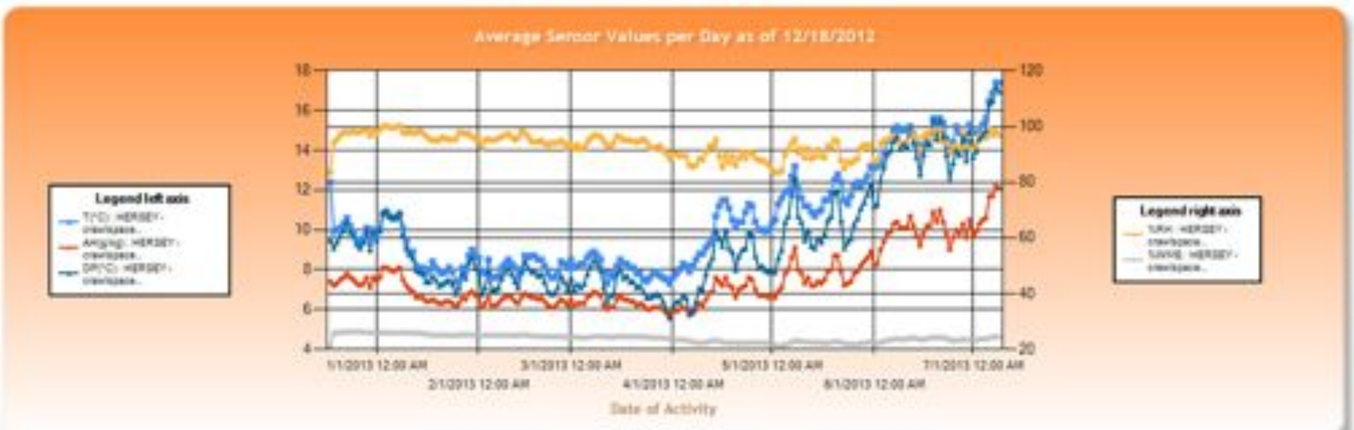
Company: AECB CEO **Site:** Salford **Time Zone:** GMT Daylight Time

Time Span: Last Hour | Last Day | Last Week | Last Month | Last 3 Months | Last 6 Months | Last Year | All Readings

Time Interval: All (daily avg) **Start Date:** 12/18/2012 00 : 00 Show values Enable Recenter Enable Tool Tips Refresh

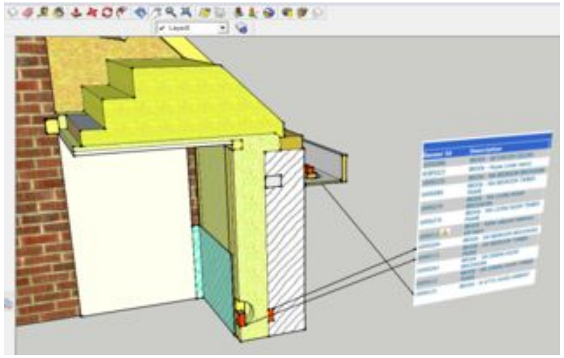


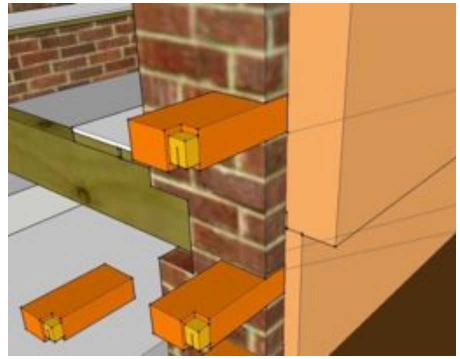
	%WME : HERSEY - Living Room ambient	%WME : 1. Hersey - External	%WME : HERSEY - crawlspace adj dining table	%WME : HERSEY - crawlspace brick sleeper wall centre LR
min	8.8	8.4	17.5	25.7
max	11.8	16.4	21.5	32.9

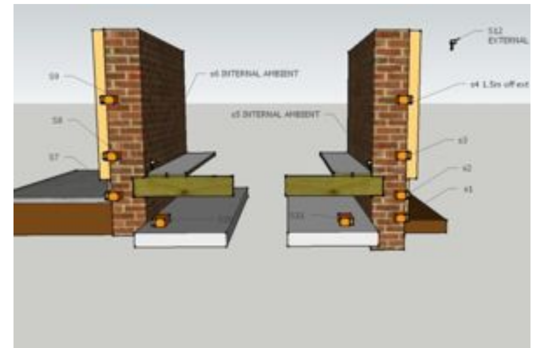


Sensors | Gateways | Report | WME Report | Downloads | Users | RDC | Rooms | 1 Alarms | Edit

AECB Hygrotrac project – making the most of the data for educational purposes within the CLR > simple CLR sketchup/spreadsheet based tool for interactively looking at vapour drive & moisture content. Tool and case study material for training and knowledge base illustrations.

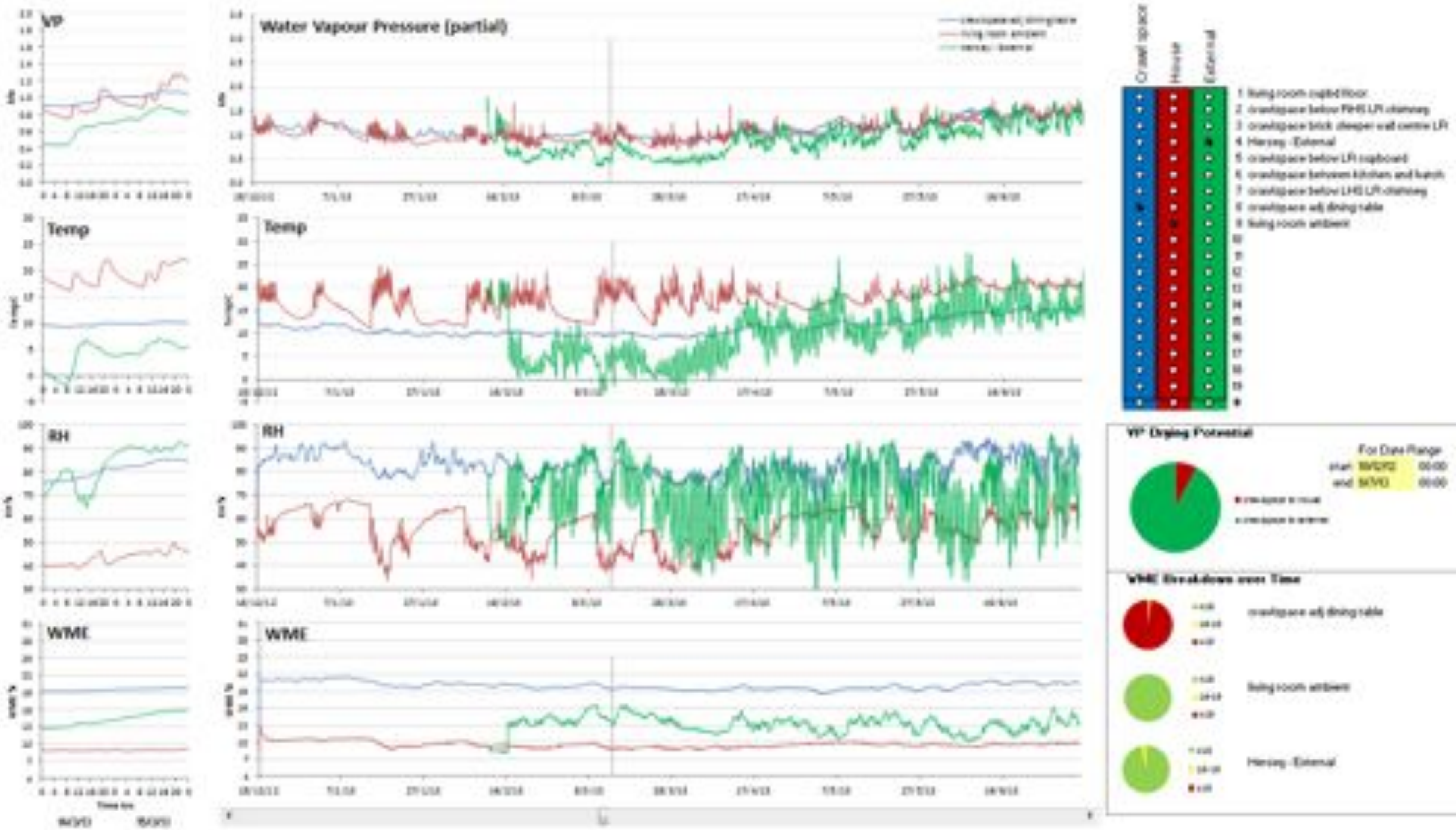


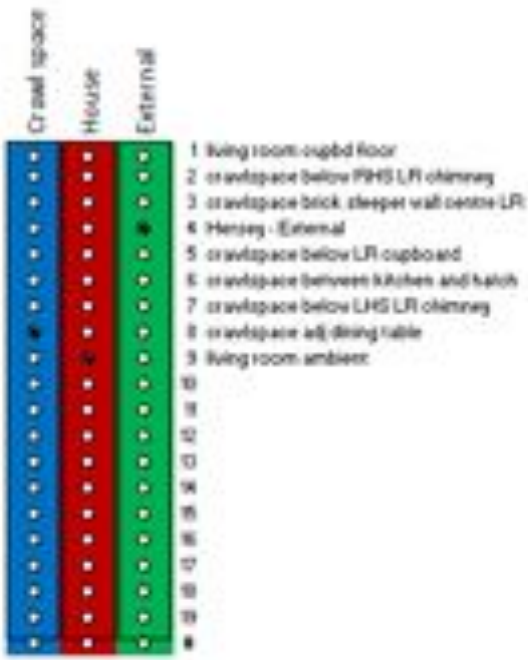




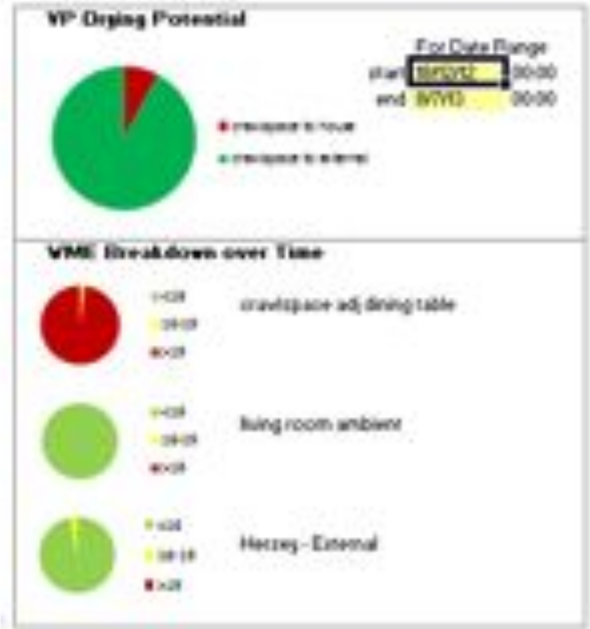

Average Sensor Values per Day as of 2/12/2013
Legend left axis
AH(g/kg) : 1. Hersey - Exte...
AH(g/kg) : HERSEY - crawlspace...
AH(g/kg) : HERSEY - Living Room ambient
12
10
8
6
4
2
0
2/24/2013 12:00 AM
3/10/2013 12:00 AM
3/24/2013 12:00 AM
4/7/2013 12:00 AM
4/21/2013 12:00 AM
5/5/2013 12:00 AM
5/19/2013 12:00 AM
6/2/2013 12:00 AM
6/16/2013 12:00 AM
6/30/2013 12:00 AM
Date of Activity

Using the hygrotrac data for project owner and CLR

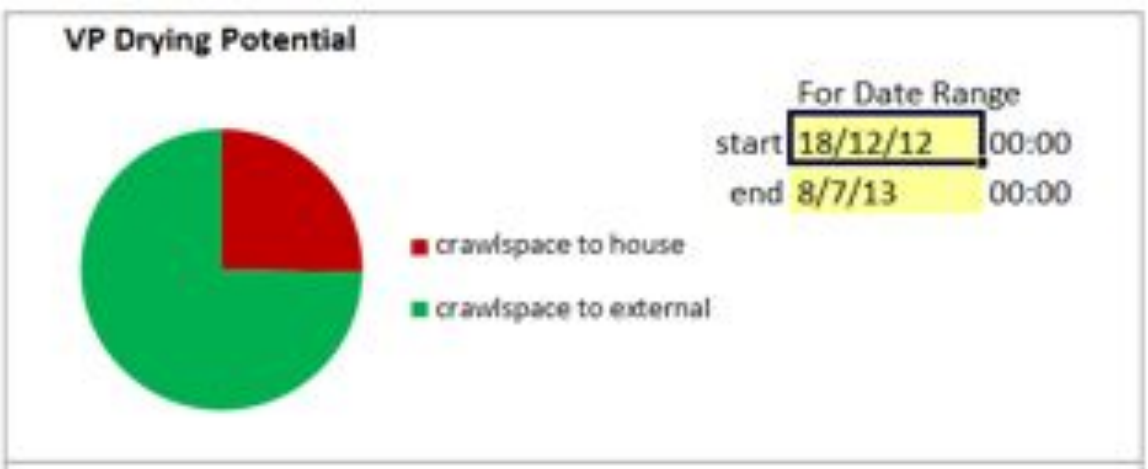




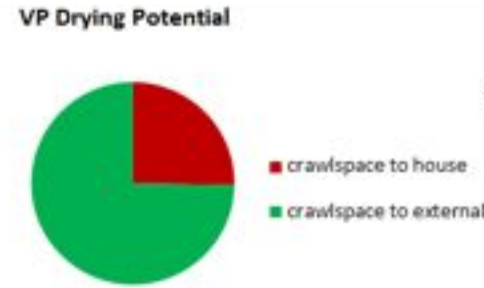
Crawl space
House
External
1 living room cupbd floor
2 crawlspace below RHS LR chimney
3 crawlspace brick sleeper wall centre LR
5 crawlspace below LR cupboard
6 crawlspace between kitchen and hatch
7 crawlspace below LHS LR chimney
8 crawlspace adj dining table
9 living room ambient



VP Drying Potential
For Date Range
start
00:00
end
00:00
VME Breakdown over Time
crawlspace adj dining table
living room ambient



VP Drying Potential
For Date Range
start 18/12/12 00:00
end 8/7/13 00:00
crawlspace to house
crawlspace to external

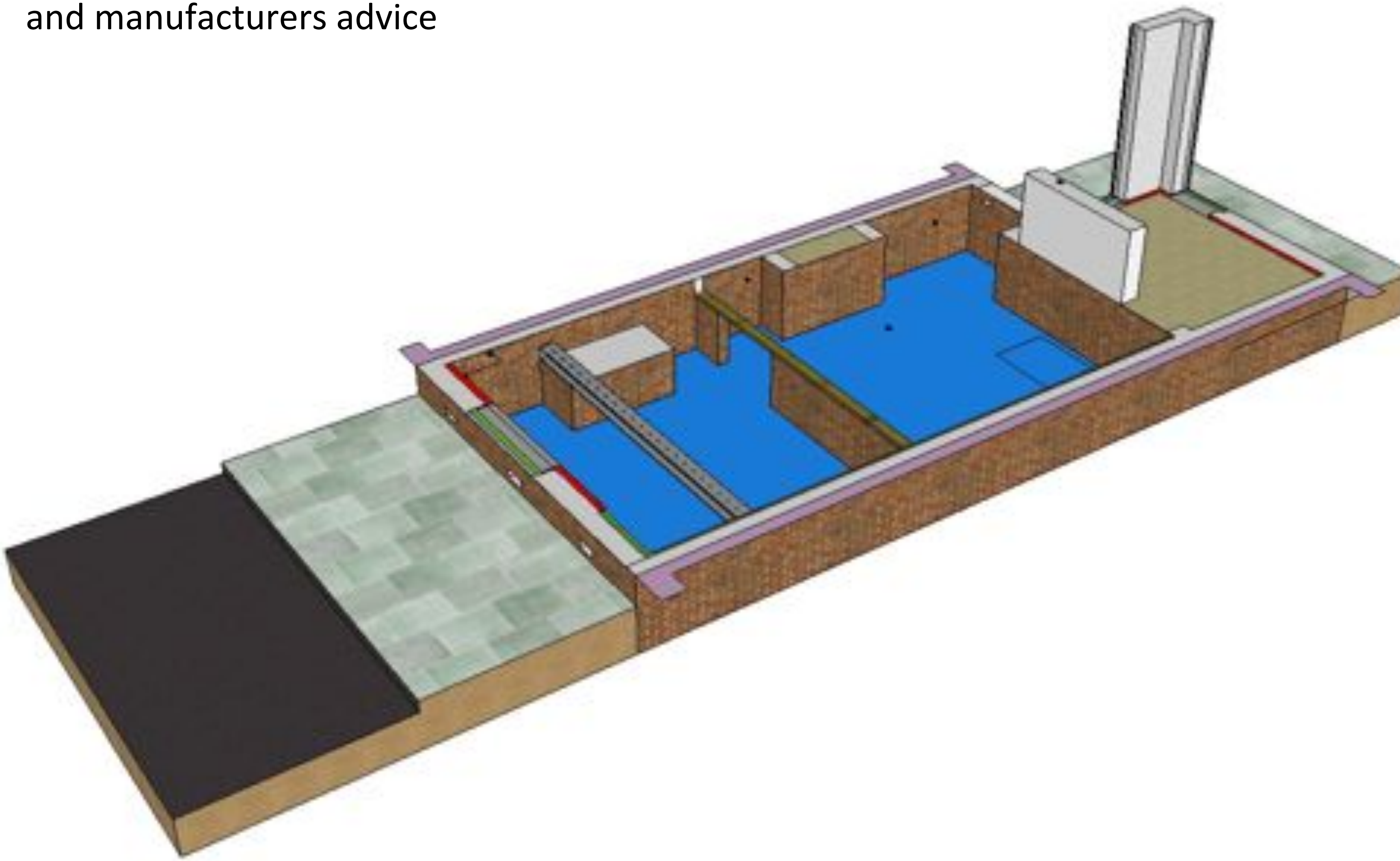


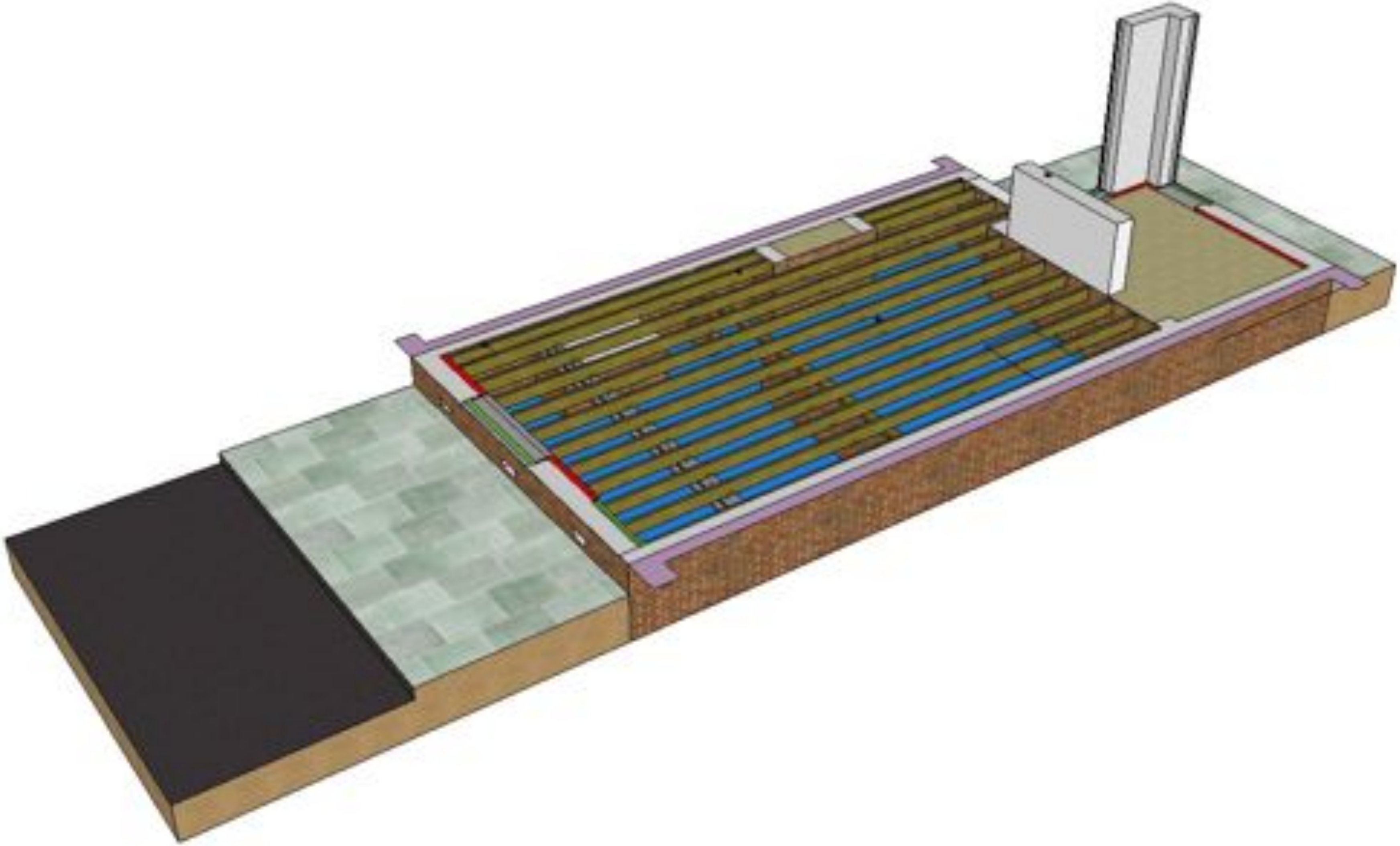
DRYING POTENTIAL PIE CHART: In this example the chart shows that, overall, the drying potential is 4 x greater to the external than to the house over that period. However, there could be short times in that period when the drying potential is only to the house, only to external or in the other direction (from the house to the crawlspace). You would be able to see these periods by inspecting the main and subgraphs.

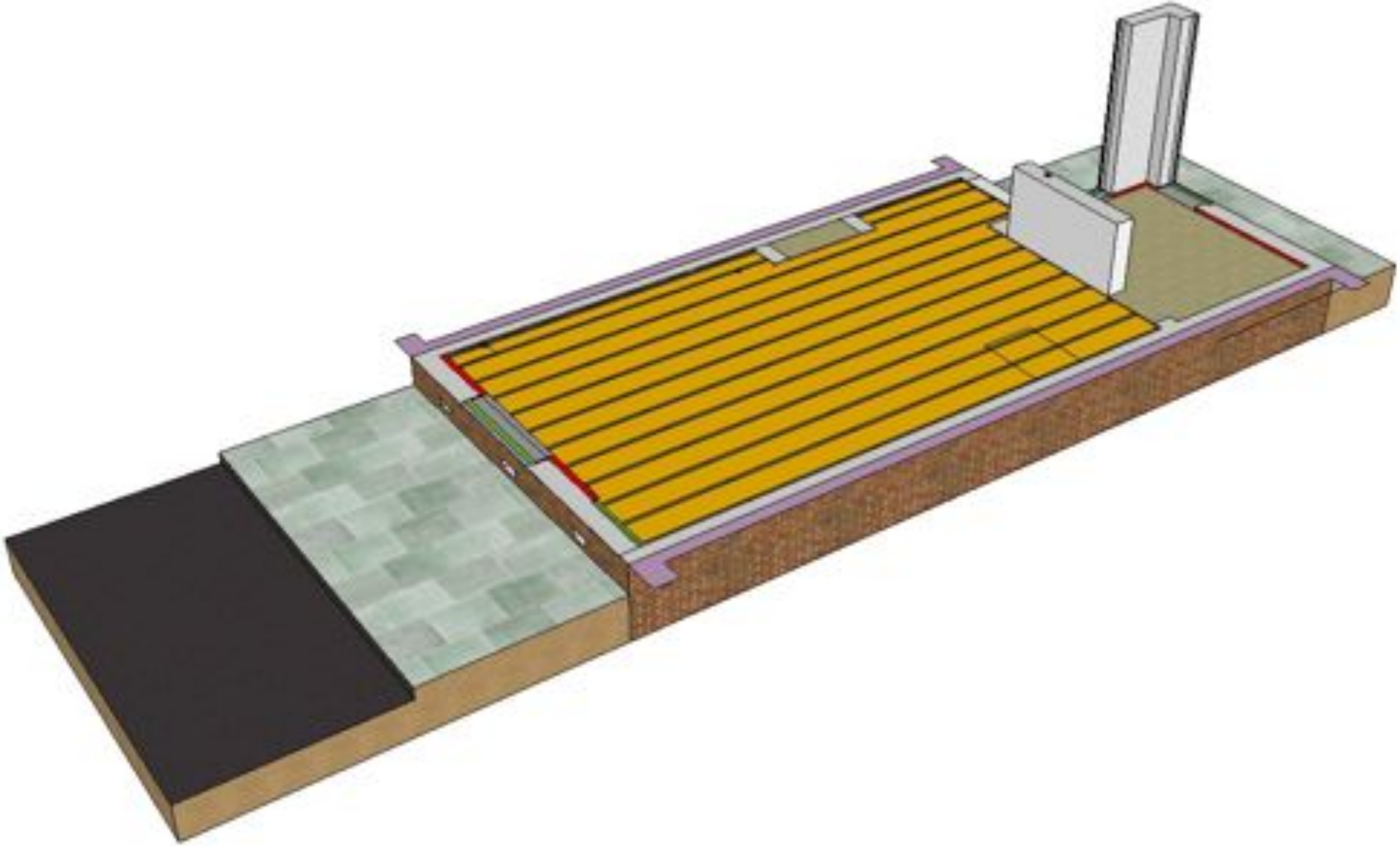
Overall this graph illustrates what direction should help dry out the crawlspace most - it helps with strategic approach. It suggests the best theoretical path for drying.   Currently the spreadsheet doesn't take into account vapour resistance of the materials, or in the case of drying to outside, the vapour resistance of the mechanism, i.e. air bricks / natural / assisted crawlspace ventilation). The chart is purely relative, it doesn't suggest anything about the size of the effect, it cant yet answer "how long would it take to dry". It could even be that both directions are too small to be useful, but you should be able to see that from the main graph.

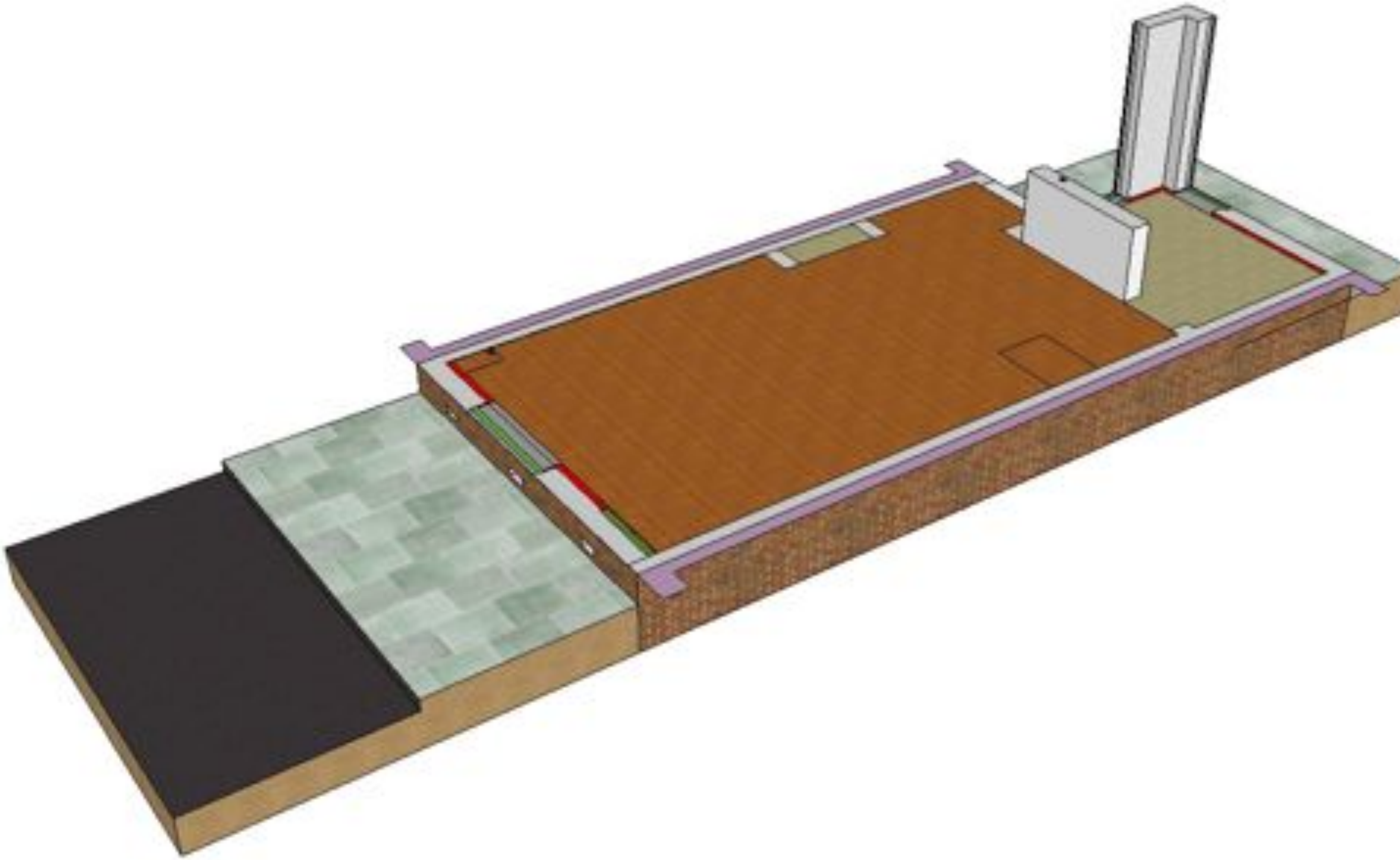
Future development could be to add the effect of the vapour resistance of materials (we already have a spreadsheet that can do that, this could be merged in). This might usefully indicate risks arising within each potential 'drying pathway' e.g., focusing attention on constructions and materials within assemblies across which a water vapour pressure gradient exists. This excercise is focused on understanding environmental monitoring results of pre- or retrofitted constructions. WUFI in contrast is a predictive tool and requires a high level of expertise & skills and materials and building experience.

A simple (?) case study of a completed retrofit – looking at the insulation and airtightness of suspended timber floor which followed 'best practice guidance' and manufacturers advice

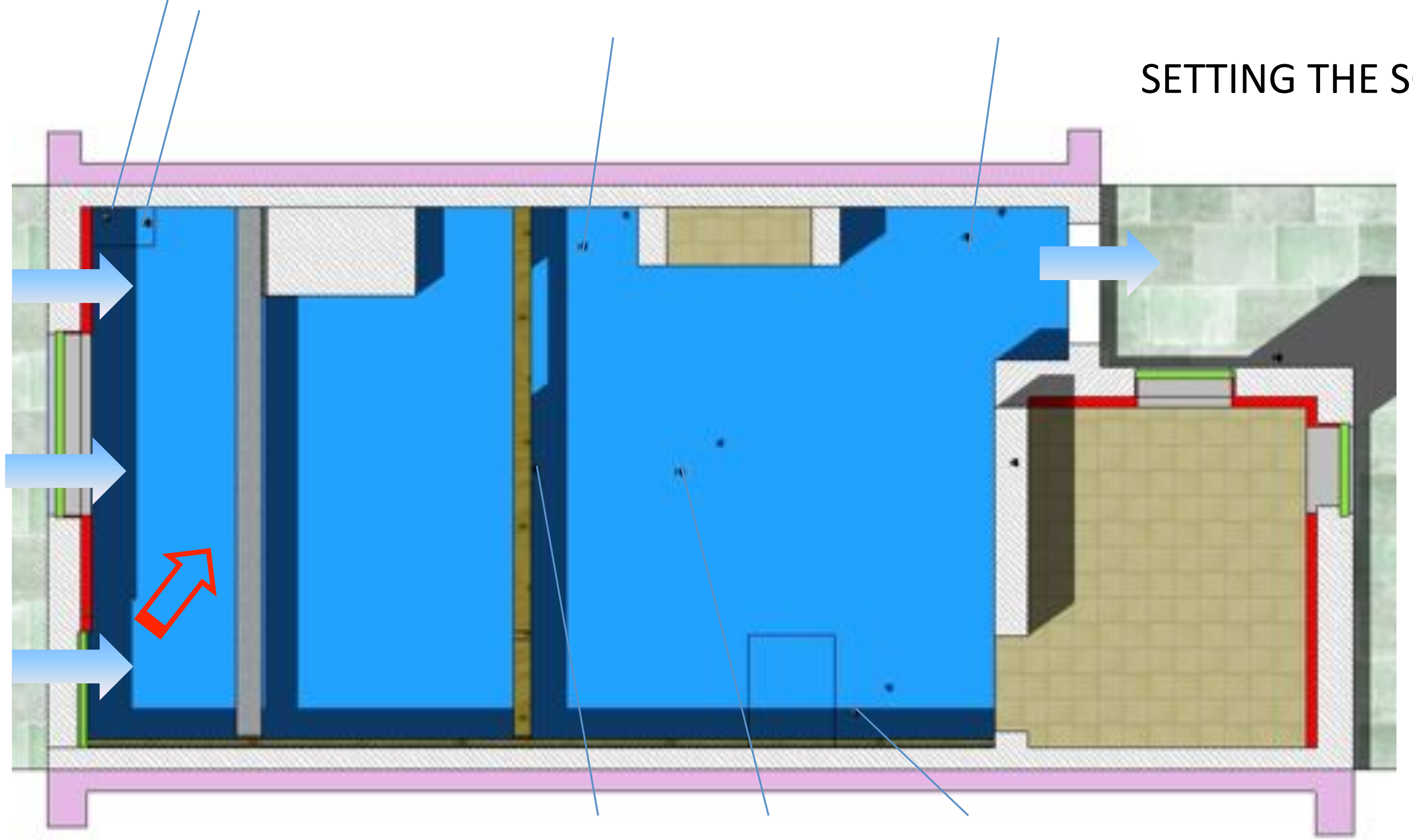








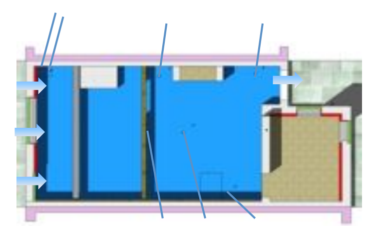
SETTING THE SCENE



Now (below), but before?

	%WME : HERSEY - crawlspace below LR cupd
min	21
max	26.3

	%RH : crawlspace adj dining table	%RH : crawlspace below LHS LR Chimney	%RH : crawlspace below LR cupd	%RH : crawlspace below RHS LR chimney	%RH : crawlspace between kitchen & hatch	%RH : crawlspace brick sleeper wall centre LR	%RH : External	%RH : Living Room ambient	%RH : Living room cupbd floor
min	74.1	79.9	83.5	78.9	71.7	78.5	48	37.6	44.9
max	94.6	106.7	100.3	101.1	100.8	100	93.9	68.1	62.8

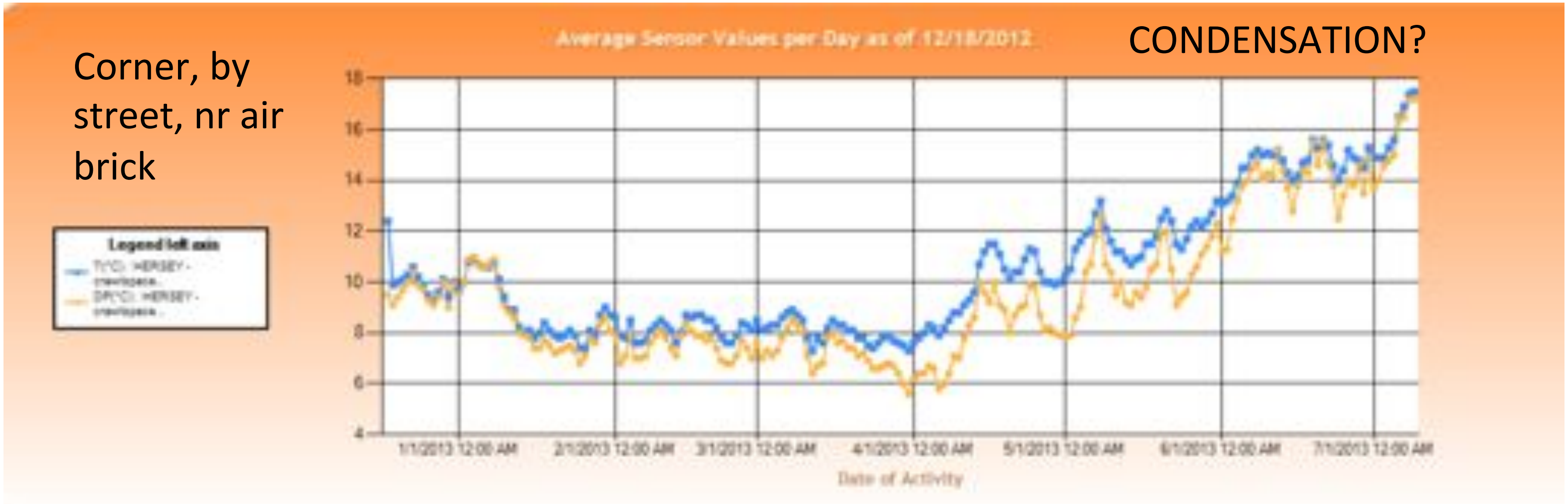


<u>High RH in crawlspace – where is it coming from?</u>

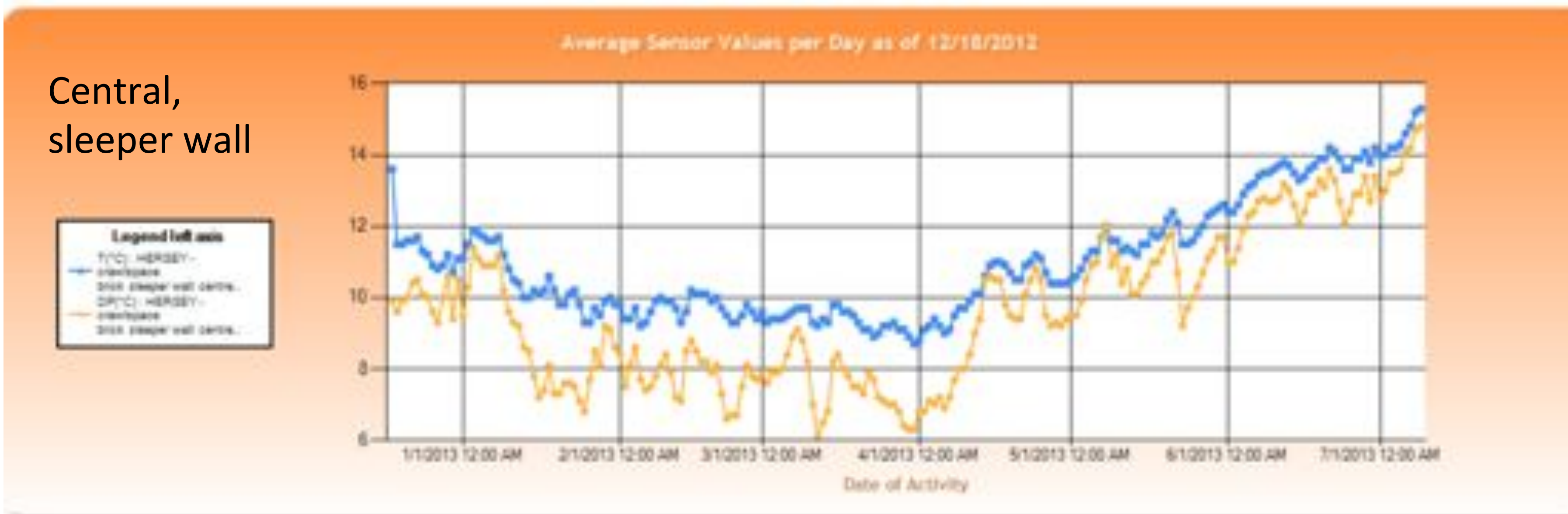
1. Ground evaporation? Plastic (non sealed edges tho').
2. Soil gas (high RH of infiltrating gas)?
2. External air is high RH? External RH is generally lower all year.
3. Condensation from warmer moist air condensing on cold areas of brick work – yes, some. How much? No doubt hygroscopic salts add to mc of the brickwork by absorbing moisture from the ventilation air.
4. Rising damp (+ high water table) – a powerful mechanism to transport and supply moisture into a void via capillary action and evaporation. Height increased by hygroscopic salts and limited evaporation.

CONDENSATION?

Corner, by street, nr air brick



Central, sleeper wall

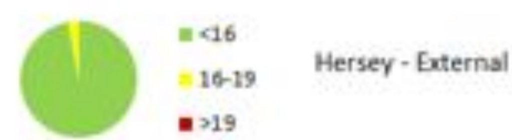


ABOVE: WME (%) OF CENTRAL BRICK SLEEPER WALL (HONEYCOMB)

	%RH : HERSEY - crawlspace brick sleeper wall centre LR	%RH : 1. Hersey - External
min	78.5	48
max	100	93.9

Safe timber is in the room:
warm, dry, well mixed air, adequate air flow for the moisture load.

	%WME : HERSEY - crawlspace brick sleeper wall centre LR	%WME : 1. Hersey - External	%WME : HERSEY - crawlspace adj dining table	%WME : HERSEY - crawlspace below LHS LR Chimney	%WME : HERSEY - crawlspace below LR cupd	%WME : HERSEY - crawlspace below RHS LR chimney	%WME : HERSEY - crawlspace between kitchen & hatch	%WME : HERSEY - Living Room ambient	%WME : HERSEY - Living room cupbd floor
min	25.7	8.4	17.5	21	21	15.9	17.2	8.8	9.5
max	32.9	16.4	21.5	27.5	26.3	20.5	24.1	11.8	10



Timber joists are at risk.

'Sharp Front' Model of rising damp

$$H = S\left[\frac{b}{2\,e\alpha}\right]^{1/2}$$

H = height of the rising damp front

S = Sorptivity (the suction of water into the mortar)

b = wall thickness

e = rate of evaporation per unit area of the wetted surface

α = moisture content of the wetted region i.e. the volume of water per unit volume material.

From the model it is possible to calculate some interesting quantities. For a solid masonry wall constructed of stone with a sorptivity of 1.0 mm $\text{min}^{-0.5}$, at a wall thickness of 150 mm the steady-state height of rise is 0.61 metres. If the wall thickness is increased to 300 mm, the height of rise increases to 0.87 m. This is because there is proportionally less evaporation to capillary suction in a thicker wall.

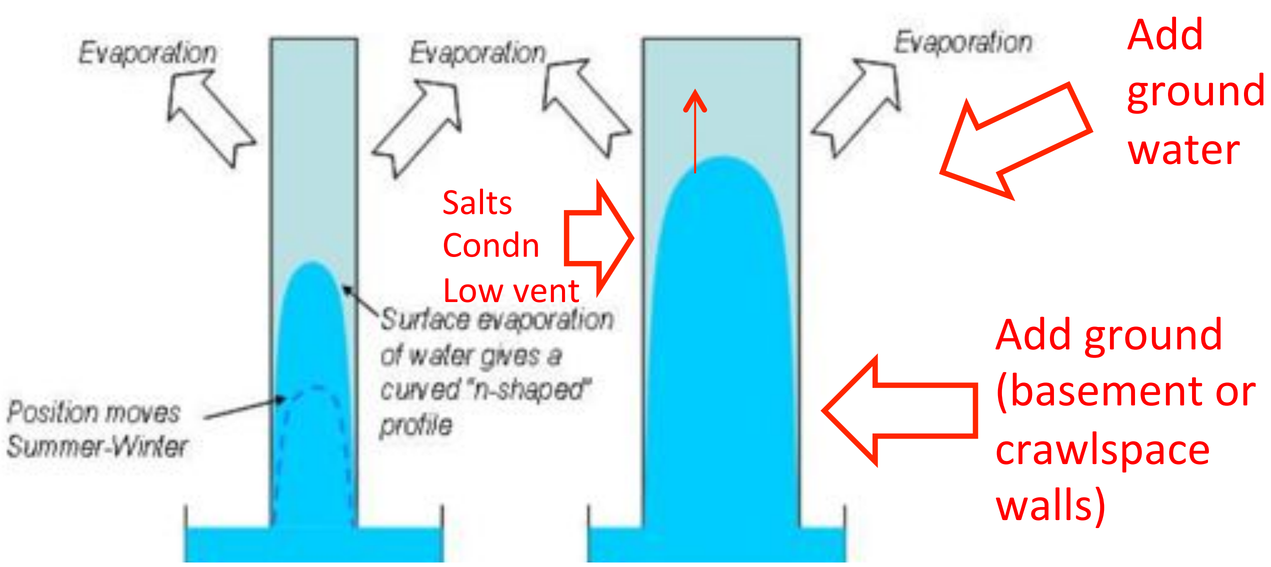
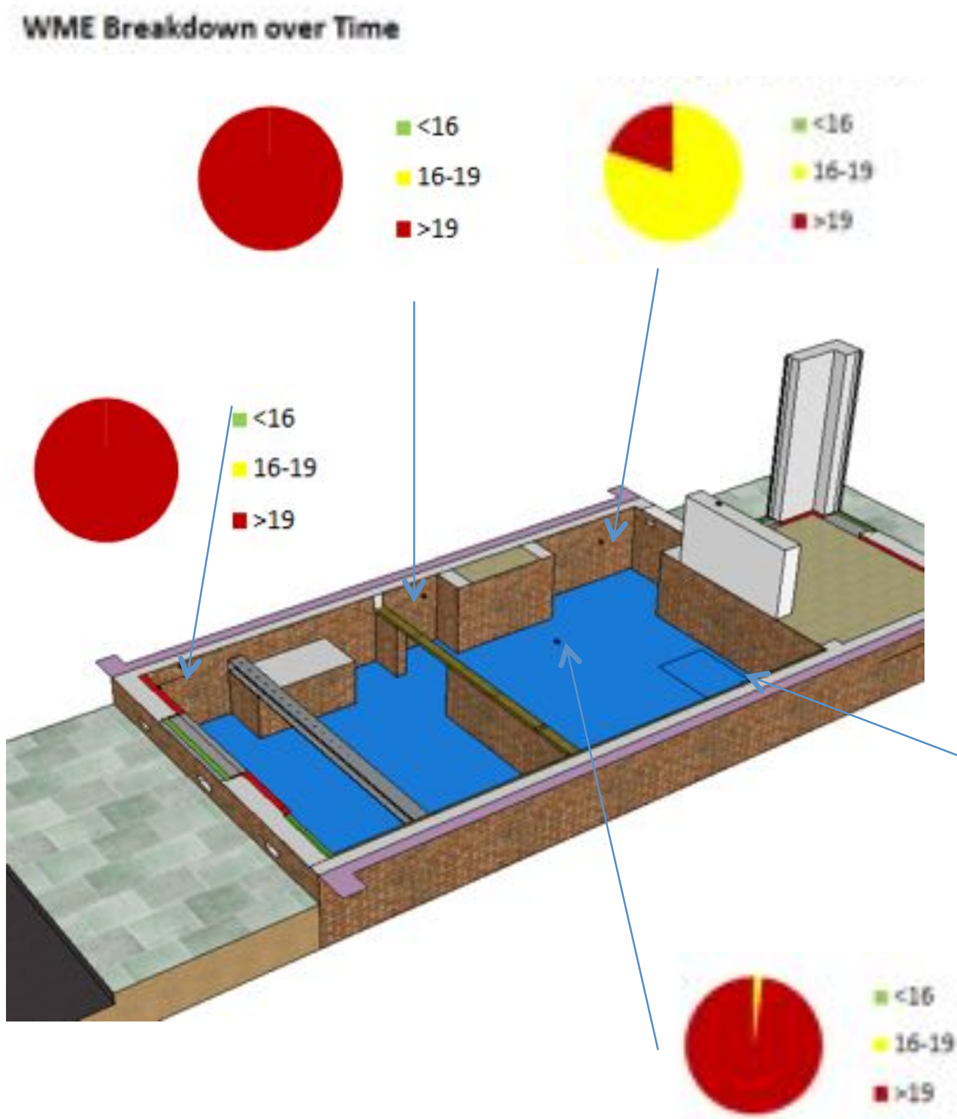


Figure 1: Schematic of equilibrium between capillarity and surface evaporation

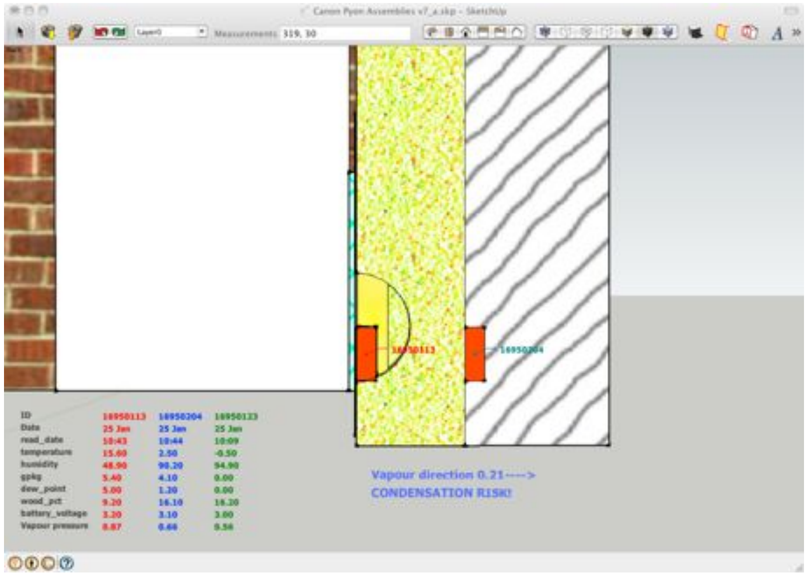


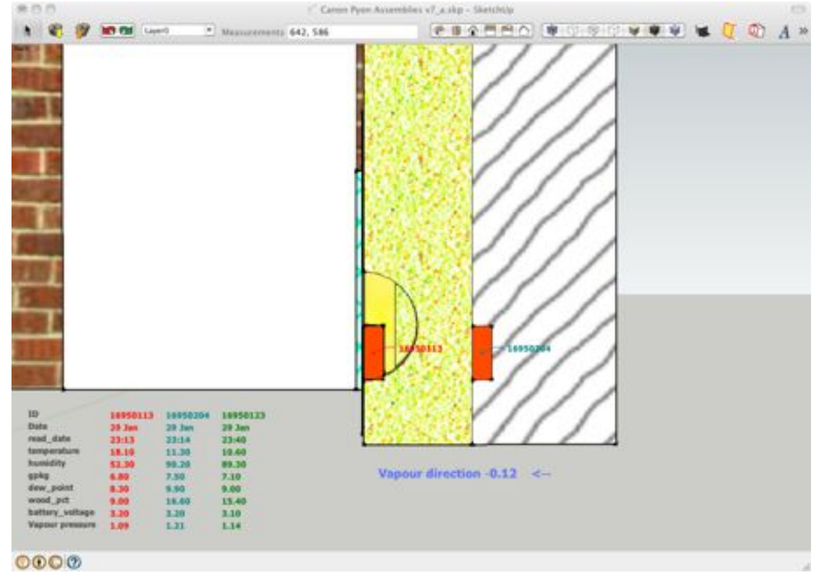
<u>Saturated brickwork</u>, from combined effects of rising damp, condensation, hygroscopic salts

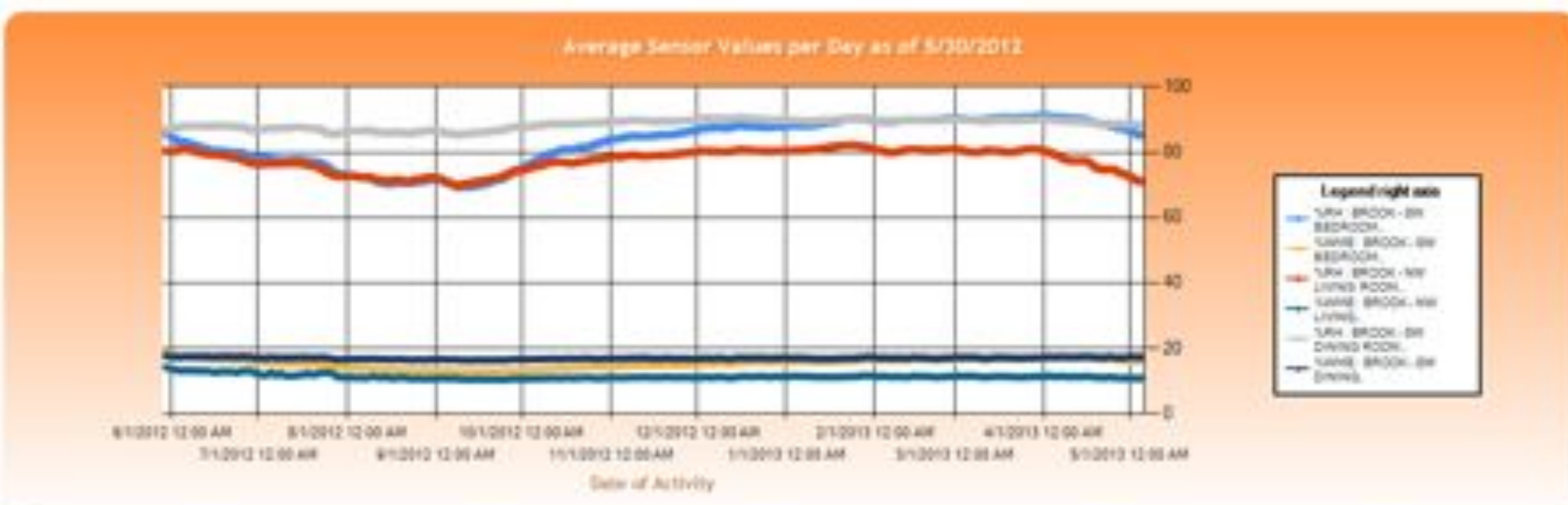
Pie charts showing moisture content of timber joists over time (% WME)

POST WORKSHOP ADDITION:

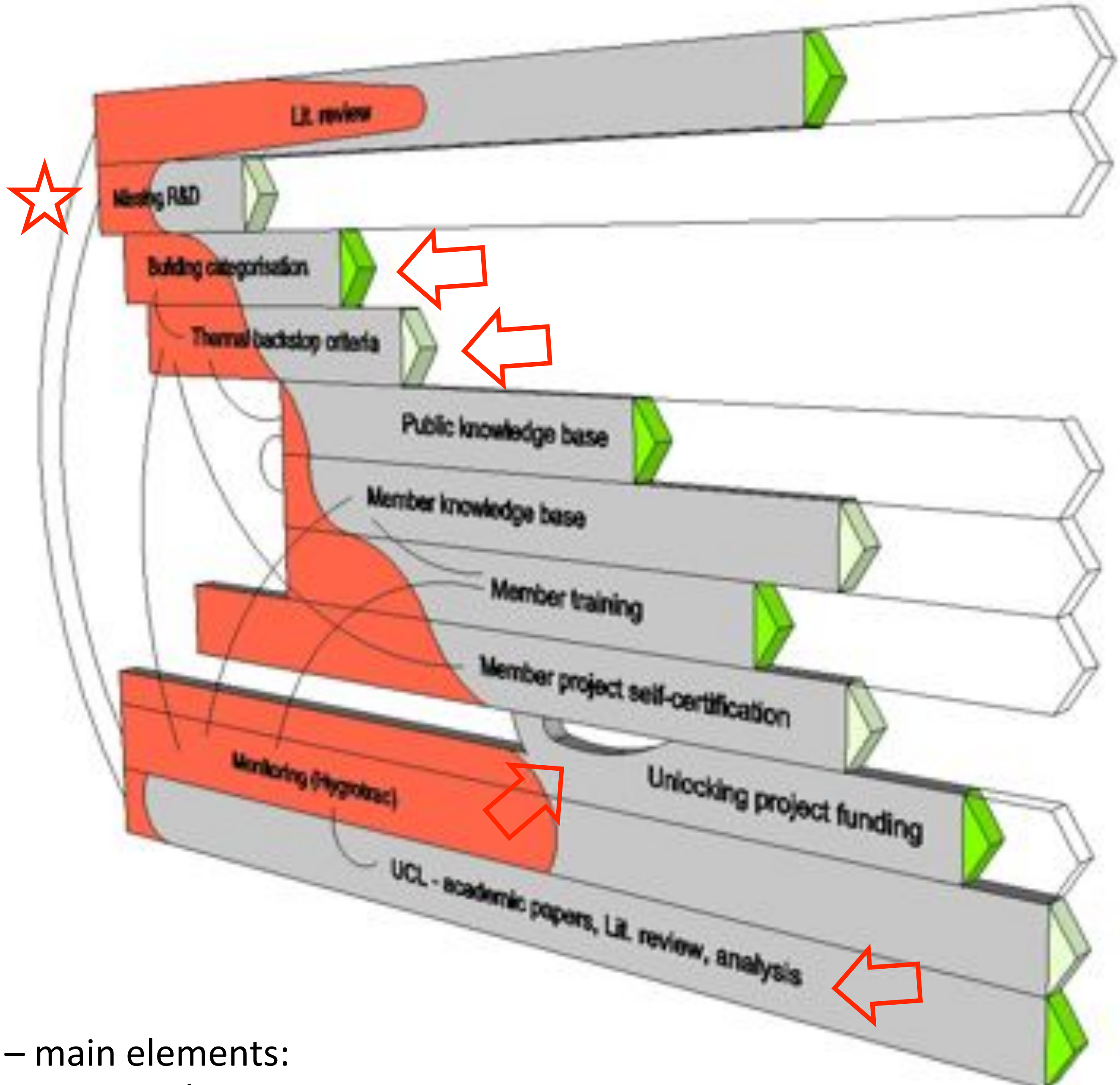
- Inward vapour drive does happen frequently & strongly with wet & warm weather (inner face of wall as shown by higher VP/AH outside cf inside)
- Half the year walls surface dries outward and half the year inward
- Inward drying events coincide with higher levels of RH, strongest inward drying events coincide with higher T (wet/sunny periods)
- Periods typically week long events
- Untreated wall dries outwards 64% time
- Treated wall dries outwards 68% of the time
- The wall treated with brickcream produces a maximum reduction in RH within the TF section of the wall of 10% cf to the untreated wall
- The wall treated with brickcream produces a maximum reduction in wme of the Tf elements of -2% cf to the untreated wall
- 88% of the time the timber elements in the untreated walls are less than 15% wme, 12% of the time they are between 15-18%
- For the inner section of brickwork in the untreated wall: 71% of the time the wme is 15-18%, 15% of the time it is 18-20% and 14% of the time it is above 20%. The period the wall at this point was the wettest coincided with the house being unoccupied and unheated (new year). The same time the following year after application of the brick cream to one wall, the walls were both drier, with the wme of the treated wall being below 15% and the untreated wall c. 17%







	%RH : BROOK - SW BEDROOM BRICKWORK	%WME : BROOK - SW BEDROOM BRICKWORK	%RH : BROOK - NW LIVING ROOM BRICKWORK	%WME : BROOK - NW LIVING ROOM BRICKWORK	%RH : BROOK - SW DINING ROOM BRICKWORK	%WME : BROOK - SW DINING ROOM BRICKWORK
min	69.2	12.9	69.7	10.3	85.4	16.2
max	91.1	18.6	82.2	14.1	90.7	17.5



CLR – main elements:
External input / peer review via
a) Consultants b) UCL c) Partner / other orgs d) technical panel (CLR, PHT etc.) - TBC