#UKPHC20

AKERMAN ROAD: OVERHEATING & PHPP

Jae Cotterell & Anna Carton

AKERMAN ROAD SOCIAL HOUSING OVERHEATING and PHPP

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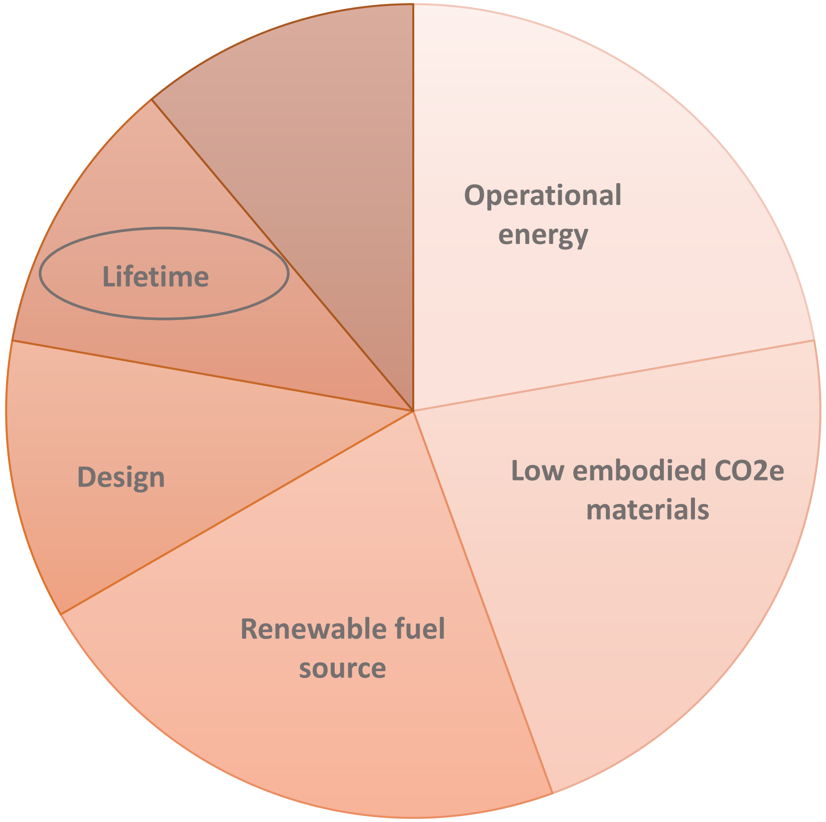
PASSIVHAUS HOMES & PH15 SYSTEM

*Winners of the **Ashden Award 2020** for UK Built Environment for PH15*

*Winner **Best Private House** 2013 Passivhaus Trust UK Awards for Totnes B&B.*

Key elements of a future proof housing solution?



‘Passivhaus’ operational energy demand

+

‘Timber’ Low Embodied CO2

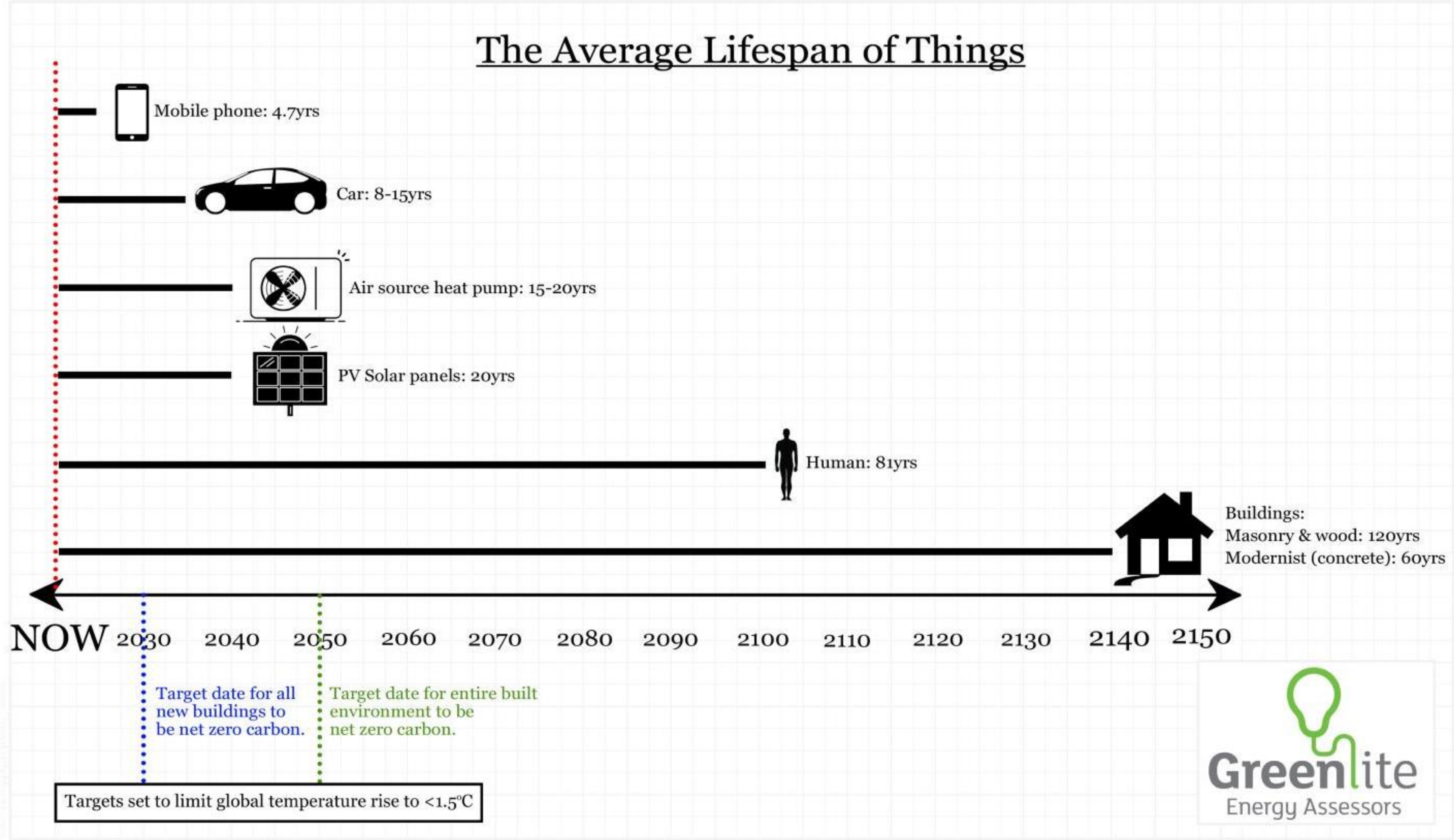
+

‘Electric’ Renewable Fuel source

+

LOW O/H RISK

Designing for low o/h risk over time?



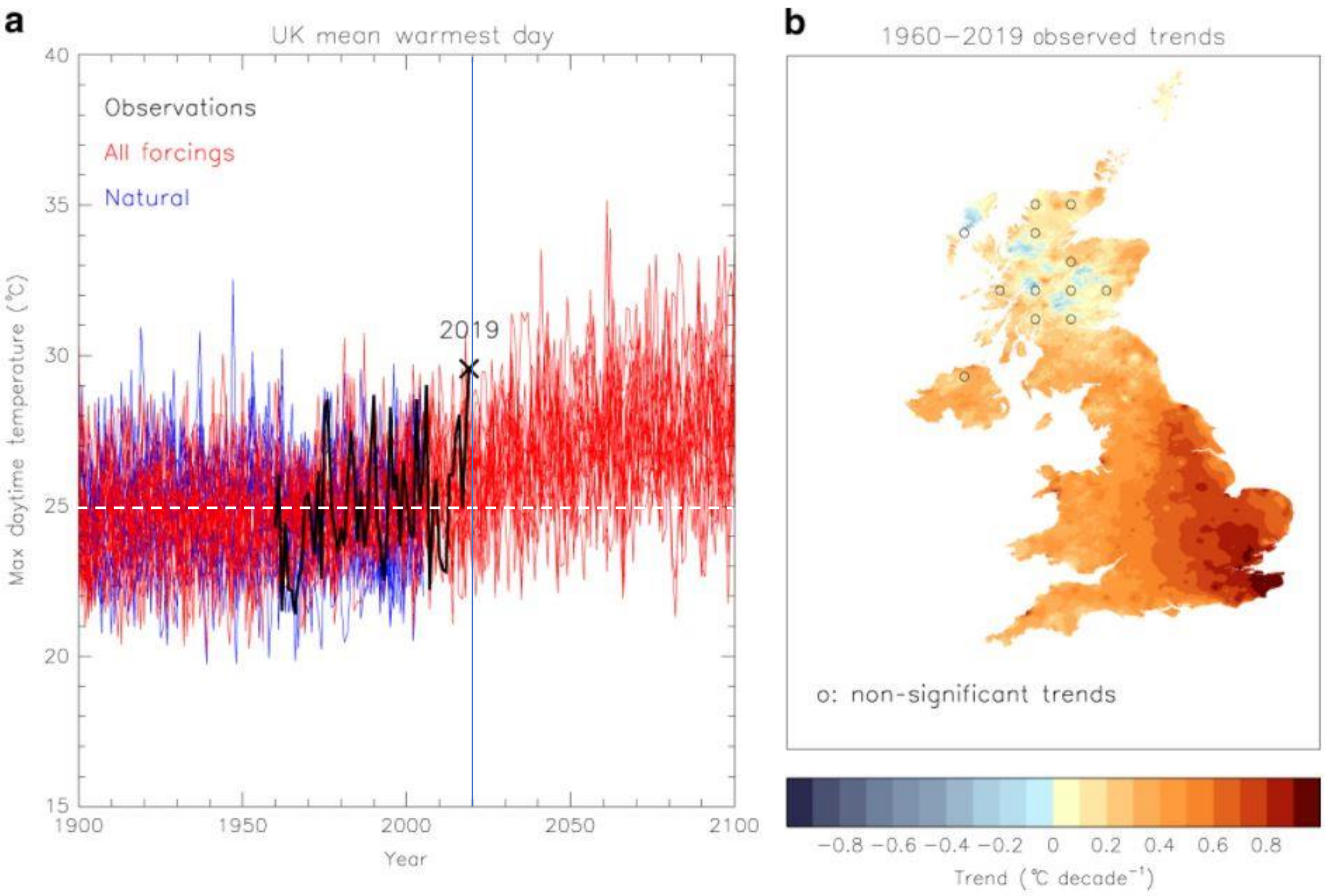
Impact of a changing climate over 80 years on o/h risk?

Future climate testing in PHPP = +1.5˚C.

Designing for low o/h risk over time?

Fig. 1: Warmest daytime temperatures (*tx01*) in the UK.

From: The increasing likelihood of temperatures above 30 to 40 °C in the United Kingdom



a Timeseries of the UK mean *tx01* from HadUK-Grid observations (black line), and simulations with 16 CMIP5 models with all climatic forcings (red lines) and natural forings only (blue lines). The observed value in 2019 is marked with a cross. Simulations of future years follow the RCP 4.5 scenario. The model data were bias-corrected to have the same mean during a reference period as the observations. **b** A map of the *tx01* trends during 1960–2019 computed with HadUK-Grid data. Circles mark areas (of ~60 × 60 km) where most grid boxes have trends not significantly different from zero (tested at the 10% level), as determined by a Mann–Kendall test.

Impact of a changing climate over 80 years on o/h risk?

+1.5˚C overall? As PHPP stress test?

South & East England - Average temperature of warmest days increased 0.5-1˚C per decade since 1960.

Christidis, N. et al (2020)

AKERMAN ROAD SOCIAL HOUSING, LAMBETH, 2015

Design by Anne Thorne Architects, delivery by 15-40 Architecture Collective (novated), Construction System PH15

Sketch by Anne Thorne Architects

PROJECT STATISTICS

TFA 371 (or 124m²/house), Form Factor 1.8, average wall/roof/floor U-value 0.1W/m2K, average whole Uwin values 0.9W/m2K. Predicted heating demand 15kWh/m² per annum. Final airtight test 0.34-0.4 ach@ 50Pa.

Offsite, pre-cut timber frame construction with natural insulations, x4 less embodied carbon than masonry equivalent construction. Medium weight construction.

PH15 Complete System Supply £54,812.00 per house or £410/m² of GIA.

OVERHEATING CHALLENGES

- **High occupancy dwellings.**
- **Central London climate.**
- **East/West Orientation.**
- **Site adjacent to busy road with the attendant noise & pollution.**
- **Conservation area setting, stringent planning requirements, inherited design with no external shading devices and larger glazing areas (21% or 28% E/W only).**
- **Delivered within a very short timeline, under a Design & Build contract.**

2015 STRESS TEST STUDY ASSUMPTIONS

No external shading devices due to conservation setting.

Much higher occupancy 35m² down to 20m² per person – 18.5 in total.

Limited use of night cooling through glazing due to noise/pollution. Boost ventilate using demand control through MVHR system.

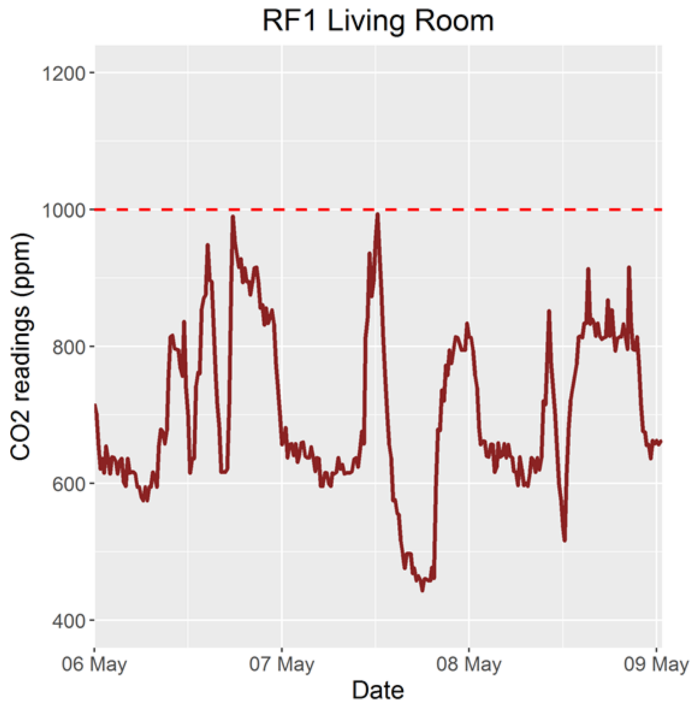
	% time over 25°				% time over 26°				% time over 27°			
Scenario all assume high occupancy density 20m² floor area per person	(1) All windows permanently shut	(2) Windows tilted open at night (50% reduction factor)	(3) Windows tilted open at night (50% reduction factor) and for 1 hour in day	(4) Windows tilted open at night (50% reduction factor) and for 2 hour in day	(1) All windows permanently shut	(2) Windows tilted open at night (50% reduction factor)	(3) Windows tilted open at night (50% reduction factor) and for 1 hour in day	(4) Windows tilted open at night (50% reduction factor) and for 2 hour in day	(1) All windows permanently shut	(2) Windows tilted open at night (50% reduction factor)	(3) Windows tilted open at night (50% reduction factor) and for 1 hour in day	(4) Windows tilted open at night (50% reduction factor) and for 2 hour in day
Low g-value glazing and MVHR with demand control	**8.9%**	2.4%	2.0%	1.7%	**4.6%**	0.1%	0.1%	0.0%	**0.8%**	0.0%	0.0%	0.0%
Low g-value glazing and standard MVHR	15.9%	4.1%	3.6%	3.1%	8.5%	0.3%	0.3%	0.2%	4.2%	0.0%	0.0%	0.0%
Standard g-value glazing (original window spec) and standard MVHR	23.1%	7.6%	6.8%	6.2%	17.1%	3.7%	3.1%	2.7%	10.1%	0.3%	0.2%	0.2%
Standard g-value glazing (original window spec) and MVHR with demand control	16.4%	5.3%	4.9%	4.5%	9.7%	1.9%	1.5%	1.2%	4.9%	0.1%	0.0%	0.0%

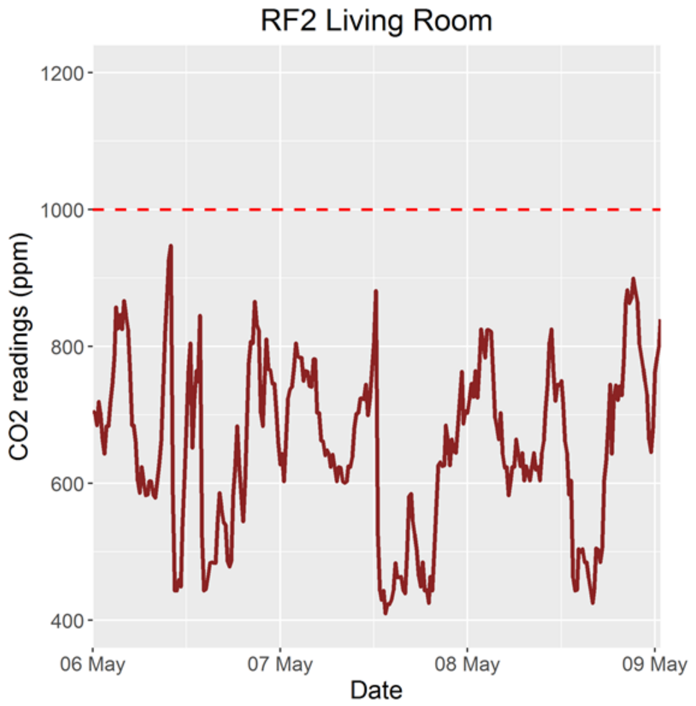
Modelled on demand control 0.65 l/h

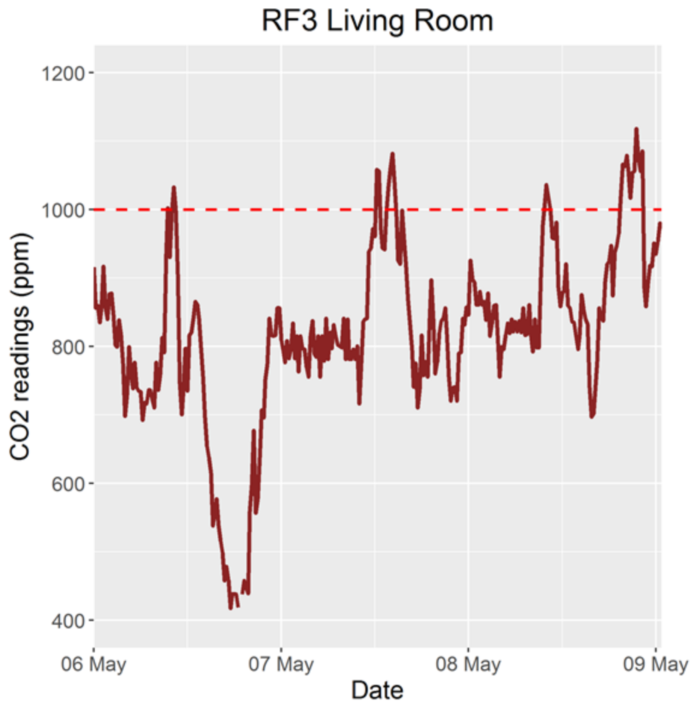
AKERMAN ROAD SOCIAL HOUSING – AIR QUALITY CO_2

Post Occupancy Monitoring by UCL

*'All residents report high satisfaction with the indoor air quality and the data supports this with consistently good levels of humidity and CO_2 – it would appear that the **MVHR system is effective in keeping the internal air fresh**. Multiple residents report improvements in respiratory health with previous issues of asthma, coughing, etc. diminished since moving in.'* From UCL STUDY

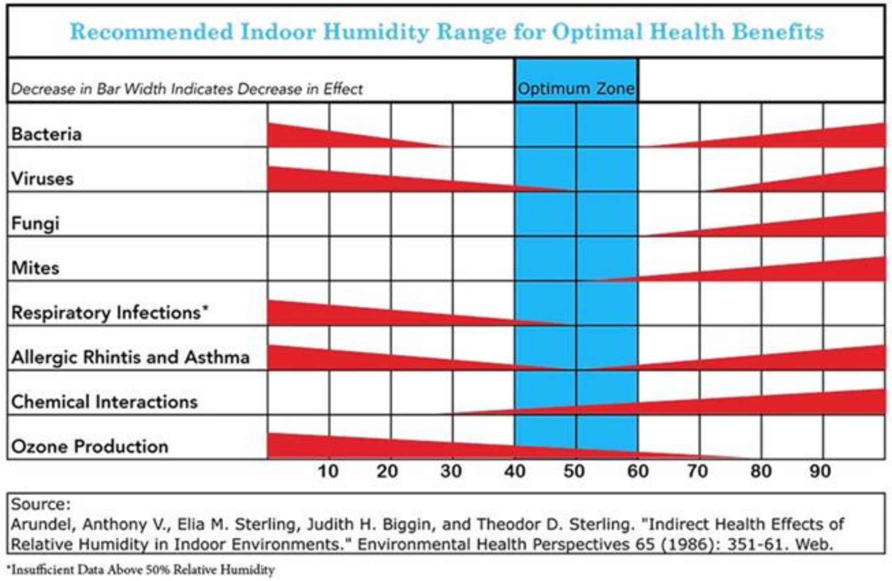




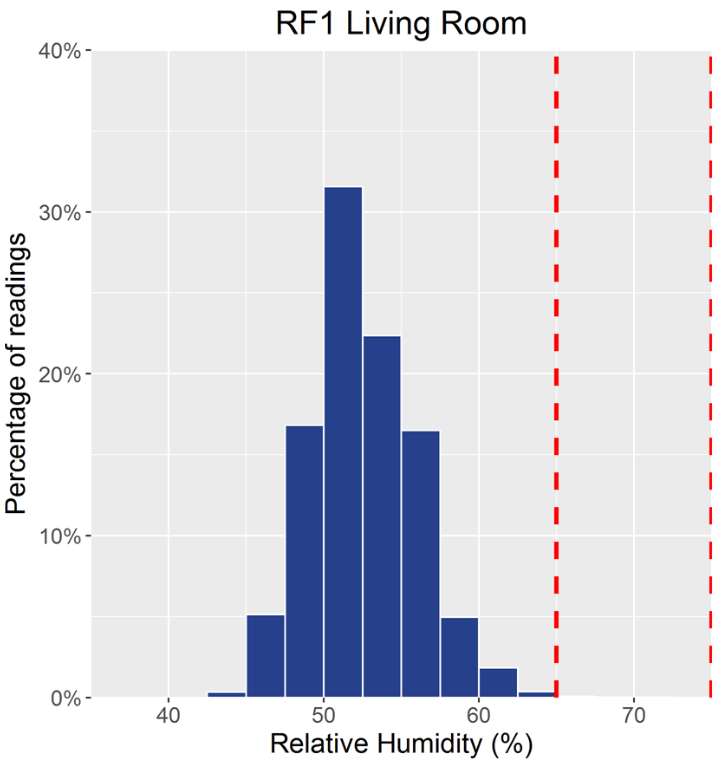


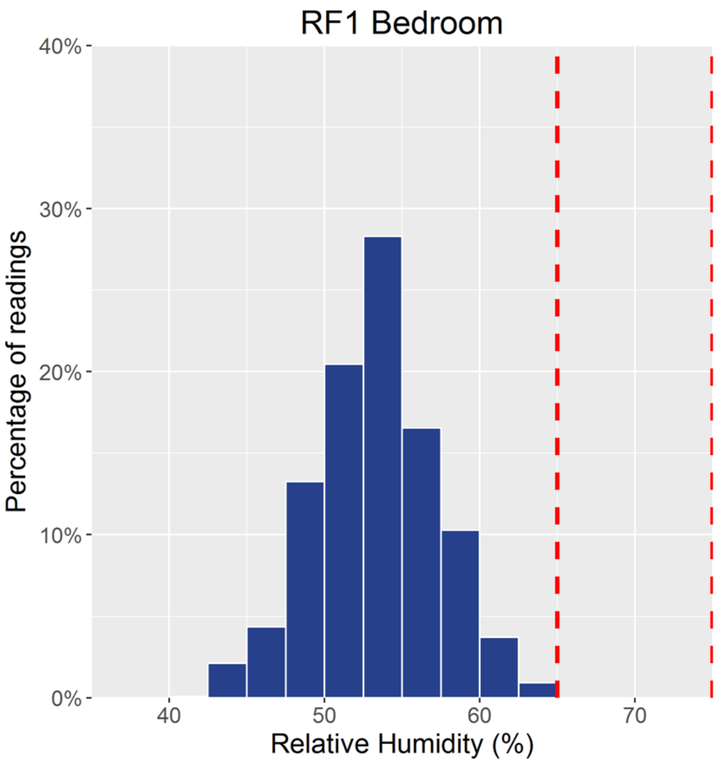
AKERMAN ROAD SOCIAL HOUSING – RELATIVE HUMIDITY

Post Occupancy Monitoring by UCL



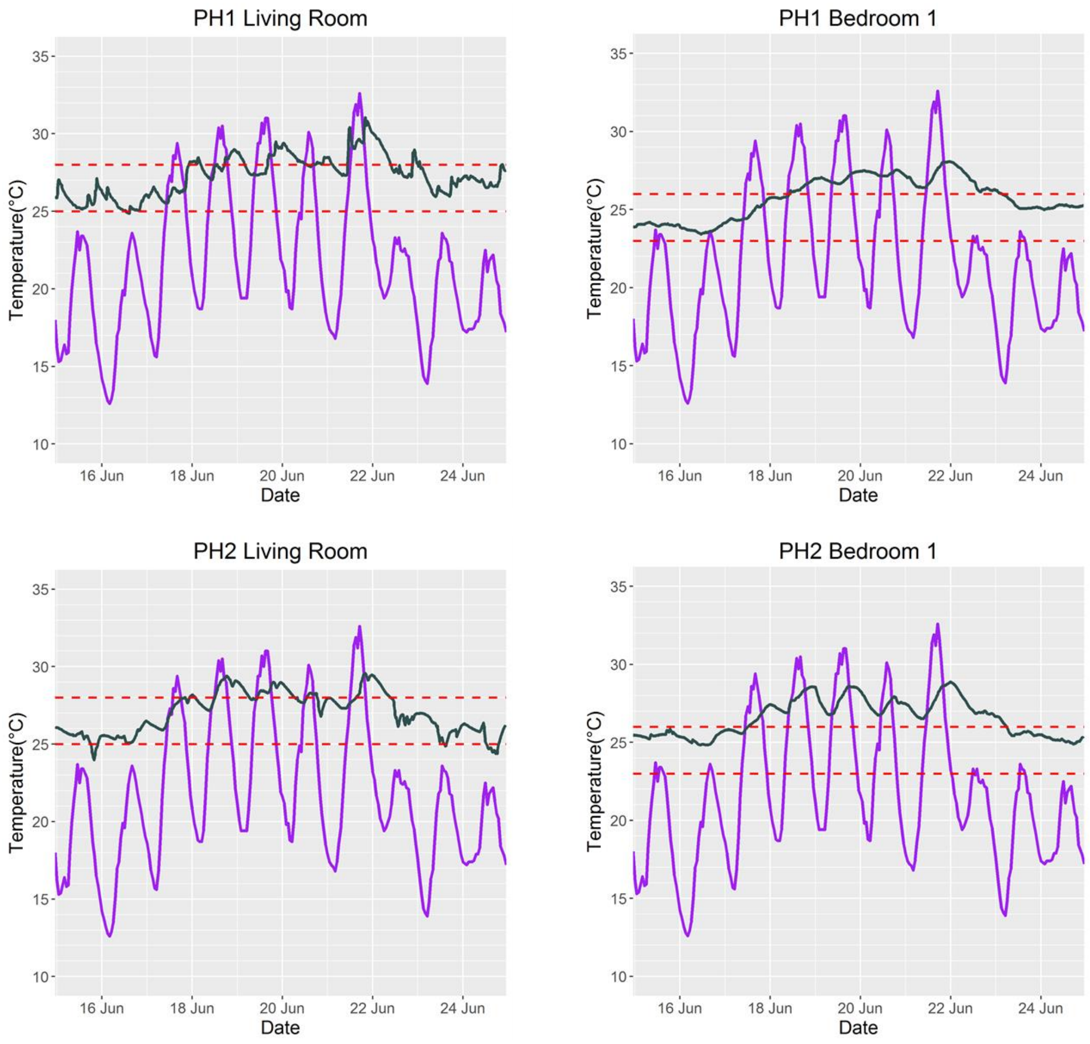
"You could hear the raspiness in her cough... she doesn't suffer from that anymore — since we've been here, she doesn't cough in the night." Passivhaus Plus Magazine





AKERMAN ROAD SOCIAL HOUSING – OVERHEATING & TEMPERATURE

Post Occupancy Monitoring by UCL



UCL STUDY OUTCOMES

Overheating over 25˚C more than PHPP model predicted.

Residents have not complained BUT when asked report very warm periods, which are uncomfortable for some. Some do use fans occasionally. One resident reports taking cold baths to cool down.

WHY THE DISCREPANCY FROM MODEL TO ACTUAL?

POST OCCUPANCY STUDY SHOWS

Day vent + night cooling through glazing not happening
security and noise issues o/h from 1.7% to 8.9%

Demand Control likely not operating as design intent
o/h rises from 8.9% to 15.9%

Occupancy even higher than modelled scenario
Two adults + five/six children each unit, >100%

Airtightness 0.4ach not 0.6ach
Exacerbates overheating

Scenario	% time over 25°				% time over 26°				% time over 27°			
all assume high occupancy density $20m^2$ floor area per person	(1) All windows permanently shut	(2) Windows tilted open at night (50% reduction factor)	(3) Windows tilted open at night (50% reduction factor) and for 1 hour in day	(4) Windows tilted open at night (50% reduction factor) and for 2 hour in day	(1) All windows permanently shut	(2) Windows tilted open at night (50% reduction factor)	(3) Windows tilted open at night (50% reduction factor) and for 1 hour in day	(4) Windows tilted open at night (50% reduction factor) and for 2 hour in day	(1) All windows permanently shut	(2) Windows tilted open at night (50% reduction factor)	(3) Windows tilted open at night (50% reduction factor) and for 1 hour in day	(4) Windows tilted open at night (50% reduction factor) and for 2 hour in day
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PHH REPORT: 'With minimal window opening overheating drops off rapidly'.

QUESTIONS to ANSWER

CHECK: Is demand control working through the MVHR System – linked to CO_2? ***Likely not and/or at too low a rate.***

CHECK: Could there be a greater contribution from DHW pipes not having been insulated? ***Yes. Could add + 2%.***

2020 New PHPP 9 Model
STRESS TESTING with NO WINDOW OPENING

Correct occupancy, lower airtightness, no mitigations (from 18 to 22 people)			
38%			
Trees (in front of 54A)	**Low G-Value** (0.38)	**MVHR** Summer boost 0.65 1/h	**Night Cooling** 0.2 1/h
33% (-5%)	30% (-8%)	29% (-9%)	25% (-13%)
Trees + Low G-value + MVHR summer boost			
18% to **9%** (boost 0.65 1/h to 0.9 1/h)			

NOTE: Changing thermal mass does not have any significant impact.

New PHPP 9 model – AIR SPEED IN THE MVHR DUCT

Ventilation boost 0.65 1/h in 75mm duct
2.6 m/s
Ventilation boost 0.9 1/h in 75mm duct
3.4 m/s – noise level associated
Ventilation rate 0.9 1/h in 90mm duct
2.5 m/s or below 1.5 m/s with two ducts

2015: duct speed rate design target **2.5 m/s** maximum
2020: duct speed rate design target **1.5 m/s** maximum

New PHPP 9 Model (MVHR boost level at lower setting)

Fixed External Shading: 2nd Floor Top Floor Windows
14% (-4%)
Fixed External Shading: 1St and 2nd Floor ALL Bedroom Windows
7% (-11%)
Internal White Blinds to front bedrooms SHADING to rear bedrooms
10%

Have very modest ventilation through glazing day and night (only from rear elevation) comes down to **8%**

CHANGE DEMAND CONTROL – CHECK DHW PIPE INSULATION – ADVISE INDOOR WHITE BLINDS

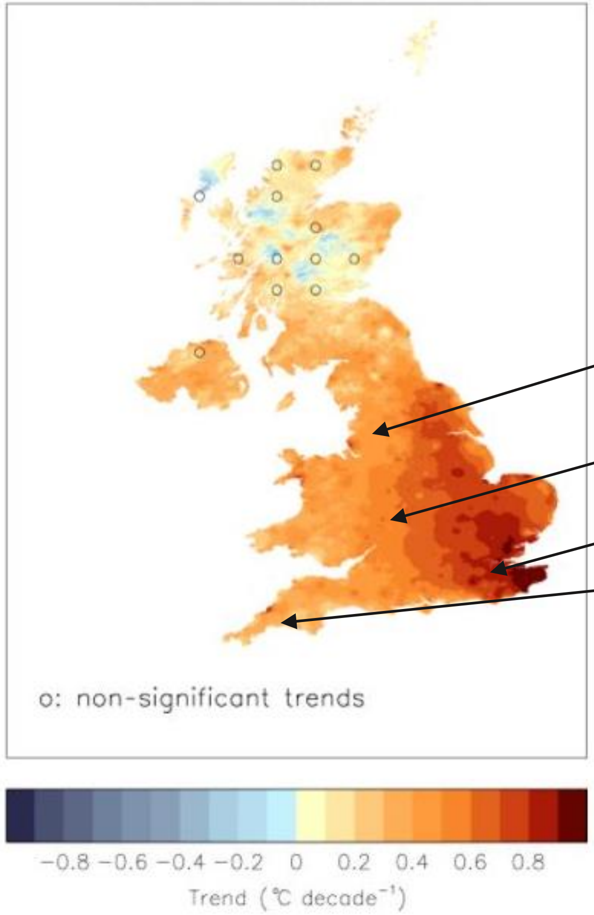
New PHPP 9 model (MVHR boost level at higher setting)

Fixed External Shading: 2nd Floor East & West Windows
6.8%
Fixed External Shading: 1St East Windows & 1st and 2nd West Windows
2.2%
Internal White Blinds to front bedrooms plus SHADE rear bedrooms
5% (noise associated)

Have modest mix of fresh air ventilation through glazing day and night (only from rear elevation, total 0.1 1/h) comes down to **3.5%**

ALTERNATIVE CURRENT CLIMATE DATA SETS UK

Low-g glass, MVHR summer boost (0.65), and internal blinds



NW England (Manchester, ALT 38m): 0%

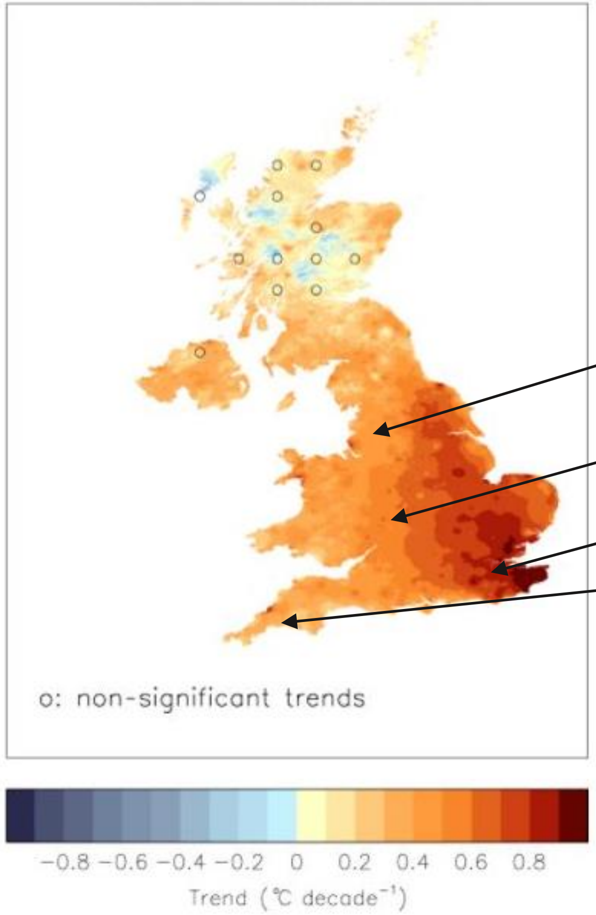
Midlands (Birmingham, ALT 140m): 0%

SE England (Gatwick, ALT 68m): 5.5%

SW England (Exeter, ALT 40m): 4.7%

ALTERNATIVE CURRENT CLIMATE DATA SETS UK

Without low-g glass and summer boost



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STRESS TEST TAKES THESE INTO LONDON CLIMATE SCENARIOS over LIFETIME of the BUILDING

CLIMATE STRESS TEST (+1.5deg.C)

2020 New PHPP 9 model STRESS TEST CLIMATE CHANGE
Trees + Low G-Value + summer boost 0.9 1/h + internal/external blinds
13% (above 25°) and 7.5% (above 26°)
Trees + Low G-Value + summer boost + external blinds to all bedrooms
10% (above 25°) and 5% (above 26°)
ADD GROUND FLOOR PERGOLA to GARDEN
8.5% (above 25°) and 2.8% (above 26°)

OPTIMAL SOLUTION

ADD MODEST **ACTIVE COOLING** TO MVHR SUPPLY IN LONDON CLIMATE WITH HIGH OCCUPANCY

(REFER ALSO to 2020 PHT ADVISORY)

KEY TAKEAWAYS for STRESS TESTING in PHPP

Do not use **night cooling of windows** to lull you into false sense of security. TURN IT OFF OR REDUCE to MAX 0.1 1/h

Do not **underestimate occupancy** – PHT suggesting at least 50% increase – in this case it was >100% than the certified PHPP model.

Use **expected airtightness** not 0.6ach.

Be aware of **DHW pipes and insulation**, if omitted it could exacerbate overheating noticeably, especially high occupancy.

Low g glass is a very useful passive control measure, usually cutting out around 15% of solar energy. Can get 0.28 g-value, would be tinted.

White internal blinds can assist where external shading is not possible.

MVHR summer ventilation boost is effective to bypass user behaviour (security, or noise issues). Size the MVHR unit accordingly and ensure good duct design to allow for this function. It will boost ventilate ONLY when external temperature is cooler than inside – which window ventilation does not ensure.

FIXED and low maintenance shading is ALWAYS IDEAL SOLUTION. Keeps heat out. Model *very cautiously* if you don't provide any.

Well designed and effective fixed shading solutions – architectural challenge for the next decade.

Thermal mass has limited benefits/beware of too much mass in a warming climate.

CONCLUSIONS

Future climate over next 80 years *will take many new PH houses into 'London' climate type scenarios*. Current location and climate data could be quite misleading.

If designing affordable homes in central London you should consider provision of **ACTIVE COOLING.**

O/H STUDIES are more important than we ever imagined (and our initial report was quite cautious), more *important and time consuming* than modelling heating demand for energy.

PH15

PASSIVHAUS STORE ◊ PASSIVHAUS HOMES ◊ PHH

Energy use will drop over time and the electric grid will continue to decarbonise BUT o/h will only ever worsen.

UK passivhaus conference 2020

A HEALTHY & GREEN FUTURE

THANK YOU

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