



UK-IEG Conference 2019

***Guidance and criteria for
healthy & comfortable environments:
Update from CIBSE and the Good Homes Alliance***

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27th June 2019**

Currently in editing – expected in 2019

Impact of built environment

Environmental factors

Thermal conditions

Humidity

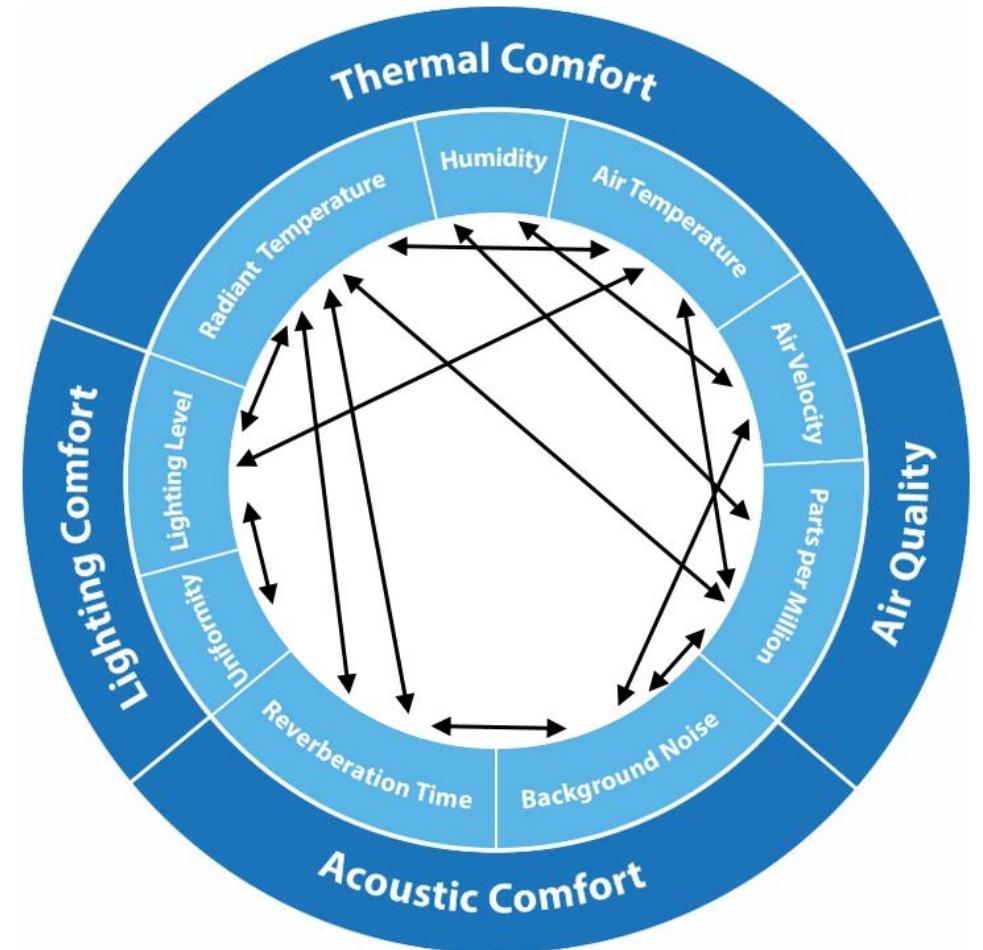
Air quality

Light

Water

Electrical & electromagnetic fields

Acoustics



Supportive Environment

Health, Comfort,
Cognitive performance

Health & Safety

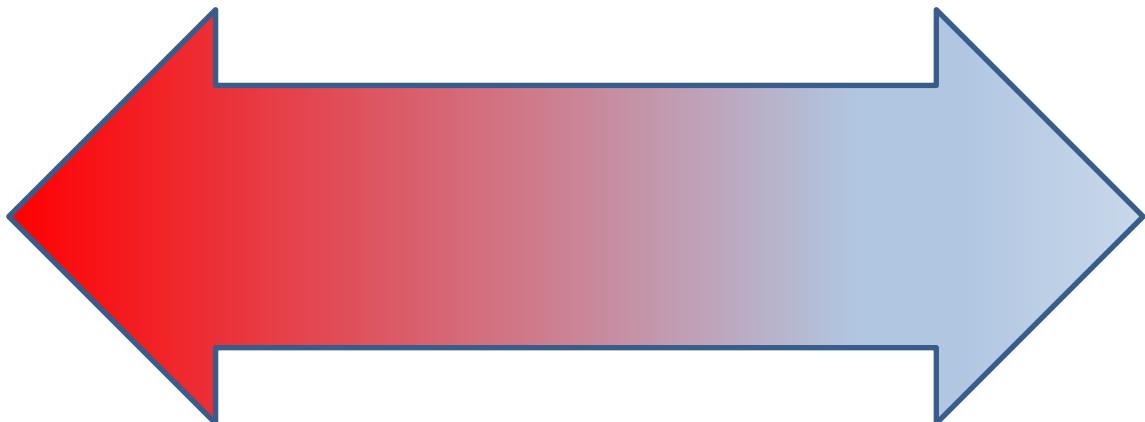
Hazards

Security

Beauty

Happiness

Belonging



...

Approach



WHY

Effects on **health, comfort, cognitive performance**

WHAT

Health & comfort **performance criteria** in buildings

HOW

Guidance, from early stages to O&M and monitoring

EMERGING THEMES

Debate, innovation, R&D

Why – Health



Public Health
England

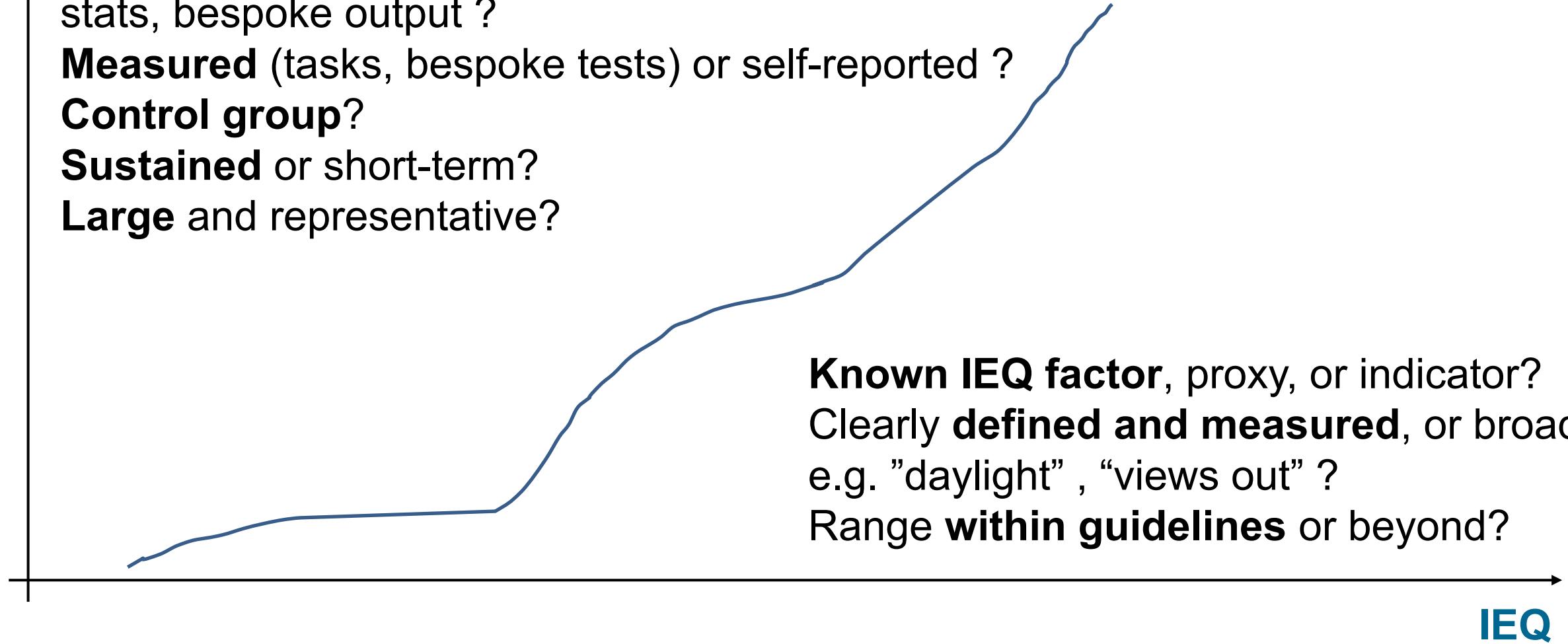


Why - IEQ & Cognitive Performance

IEQ and Cognitive Performance

“PERFORMANCE”

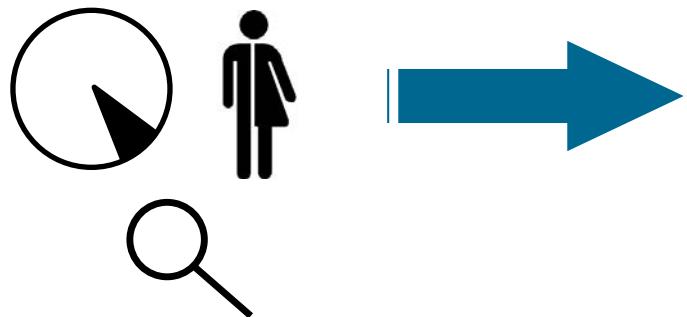
↑ Individual or Organisation performance e.g. HR stats, bespoke output ?
Measured (tasks, bespoke tests) or self-reported ?
Control group?
Sustained or short-term?
Large and representative?



IEQ and Cognitive Performance

Oseland and Burton, 2012

“30% improvement”



“1.1%-3.5% improvement”



Table 2: Weighted effect for single factor studies

Factor	Count	Unweighted mean	Weighted effect		
			Mean	Lower quartile	Upper quartile
Lighting (L)	17	9.5	1.1	0.1	2.0
Noise (N)	10	27.8	1.4	0.2	1.7
Temperature (T)	16	17.0	1.2	0.0	1.9
Ventilation (V)	16	9.0	1.4	0.2	1.7
Control (F)	10	8.0	1.2	0.3	2.1
Furniture (F)	8	15.7	2.1	1.0	2.1
Space (S)	3	24.1	3.5	1.7	4.4
Average/Total	80	15.9	1.7	0.1	2.0

What - IEQ criteria

What is "Good IEQ"? Metrics & Language



Thermal comfort: PMV/PPD, adaptive comfort etc

Light: visual effects ok, non-visual much debated

Air quality: Very often, reliance on proxys:

- **User perception** e.g. “stuffy” ➤ Unreliable e.g. carbon monoxide
- **Human outcomes** e.g. “productive” ➤ How to assess ?
- **Design measures** e.g. ventilation rates ➤ IAQ outcome ? e.g. outdoor pollution
- **Indicators** e.g. TVOC, CO₂ ➤ OK only to an extent & if known pollutants

Perceptions & satisfaction



Health-based metrics

Design measures



Desired IEQ outcomes

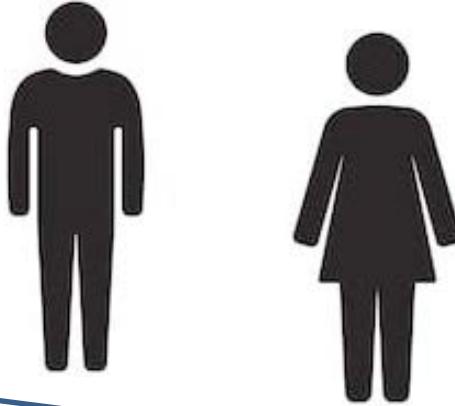
Indicators (e.g. TVOCs)



Pollutants (e.g. formaldehyde)



Caveats



IEQ guidelines confidence & details

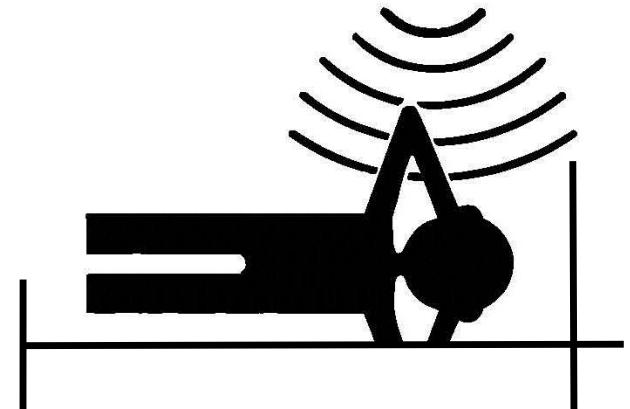
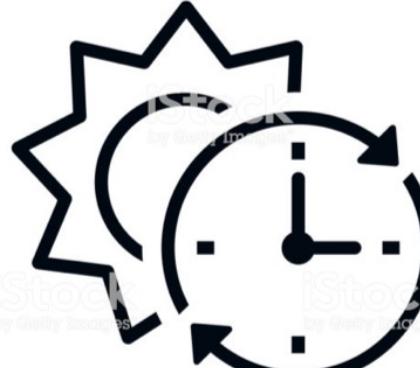
Allergies, asthma and “hyper-sensitivities”:

Medical condition? Canaries ? Something else e.g. personal context, fear of “technology” beyond our control?

Caveats



:



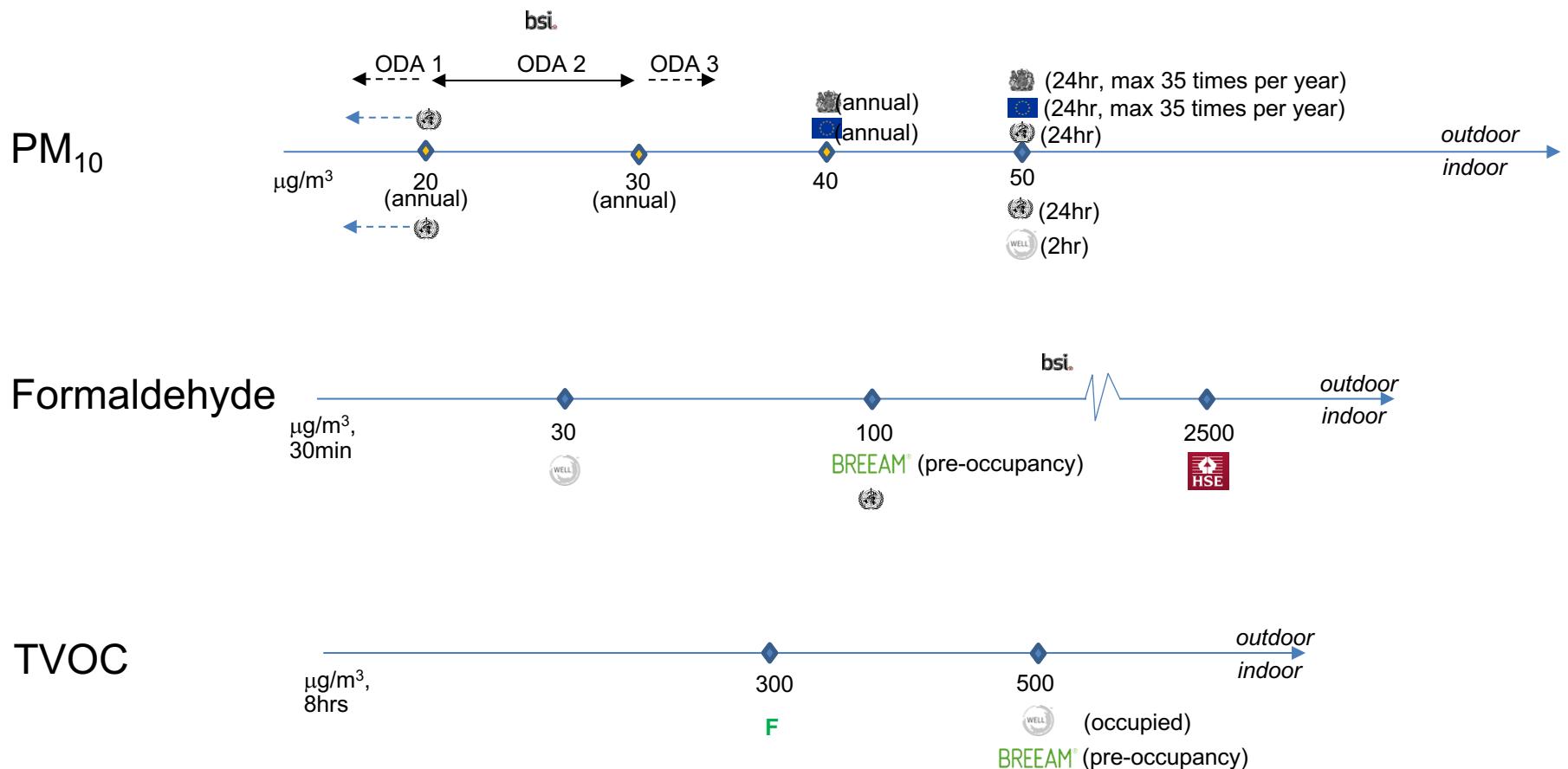
Air pollutants:

- Cocktails?
- Multiple exposure?
- Emerging ones from consumer products ?

Exposure to **multiple stressors** e.g. noise + heat, noise + air pollution

How - Guidance

IAQ Criteria – Examples



>> Guidance on most likely to require attention from designers, from indoor and outdoor sources

- ◆ Annual average
- ◆ Short-term average
- WHO guideline
- WHO recommends further progressive improvements
- EU ambient air objective
- UK ambient air objective
- HSE occupational limit (2018)
- F Building Regulations Approved Document F performance criterion
- BSI Limits of Outdoor Air (ODA) classes in BS EN 16798-3:2017
- BREEAM® BREEAM 2018 credit
- WELL v1 credit

Hierarchical Approach – Example of IAQ

Site assessment

Source control

Internal & external, to indoor & outdoor
Early decisions incl. building layout



Ventilation

Strategy
Rates

Filtration & purification: ISO 16890:2016
(PM); ISO 10121-2:2013 (gases – rare)

Construction, checks, commissioning

Benefits to users AND site workers

MVHR

Details! e.g. ductwork cleaning

O&M, incl cleaning and products



© ZCH, 2016

© Craig Booth, Ductwork Cleaning

IAQ R&D - Monitoring

Consumer awareness
+ contractual / regulatory performance
>> Liability & opportunity

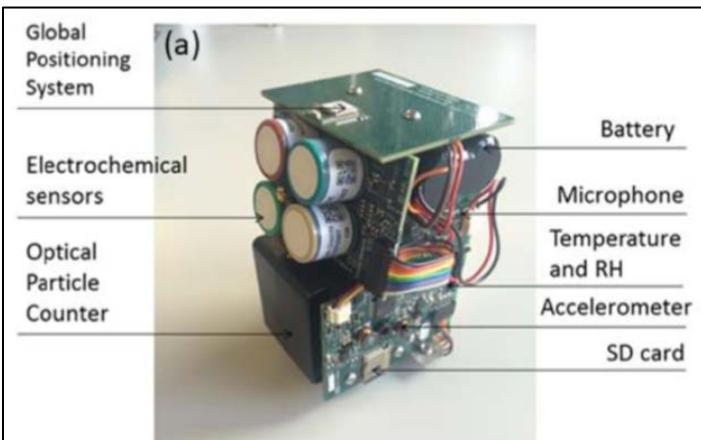
What data, what for, who for

Accuracy, contractual obligation:

- Equipment calibrated by accredited lab e.g. UKAS 17025
- Standard tests and procedures e.g. BS/EN/ISO 16000 suite

Trends and awareness: more flexibility

CIBSE Air Quality working group



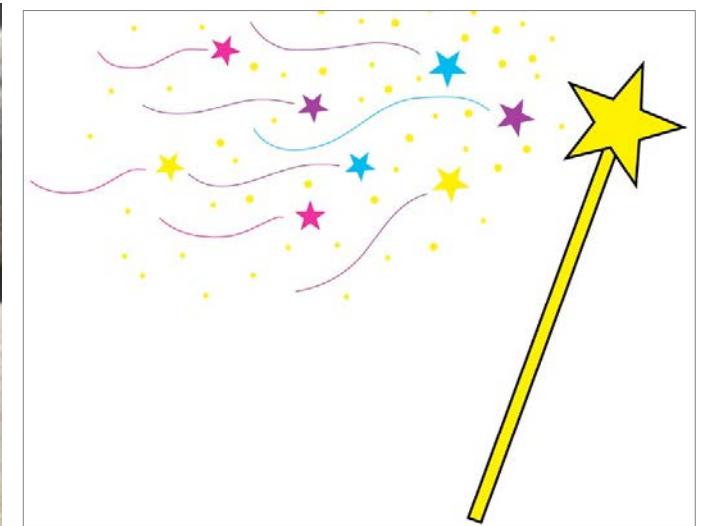
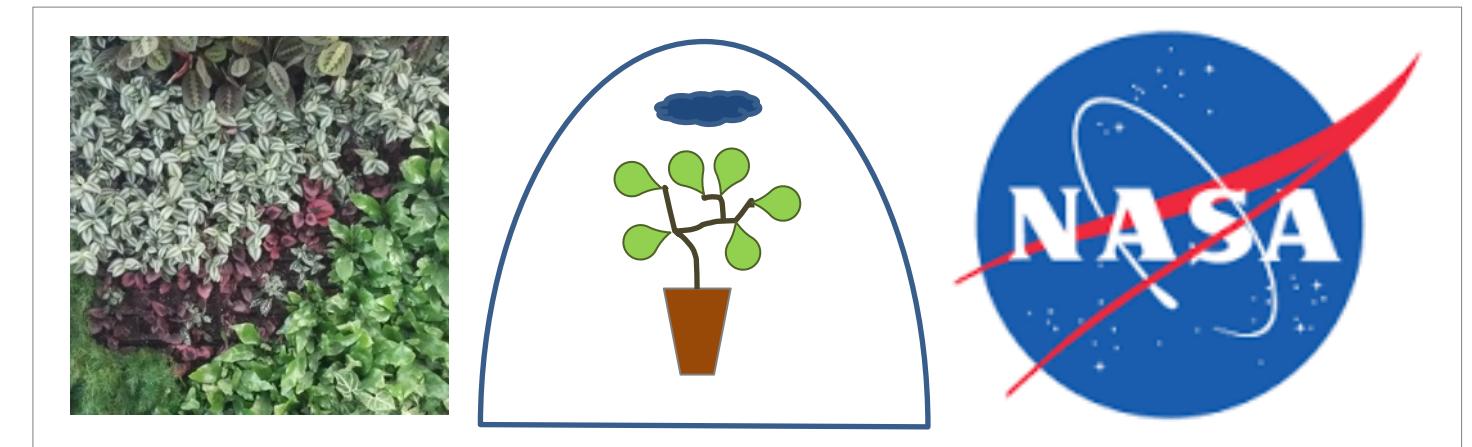
NOx and other gas filters,
beyond special applications

“Purifying”, “absorbing” products

>> By-products?

>> Scale?

>> Timescale?

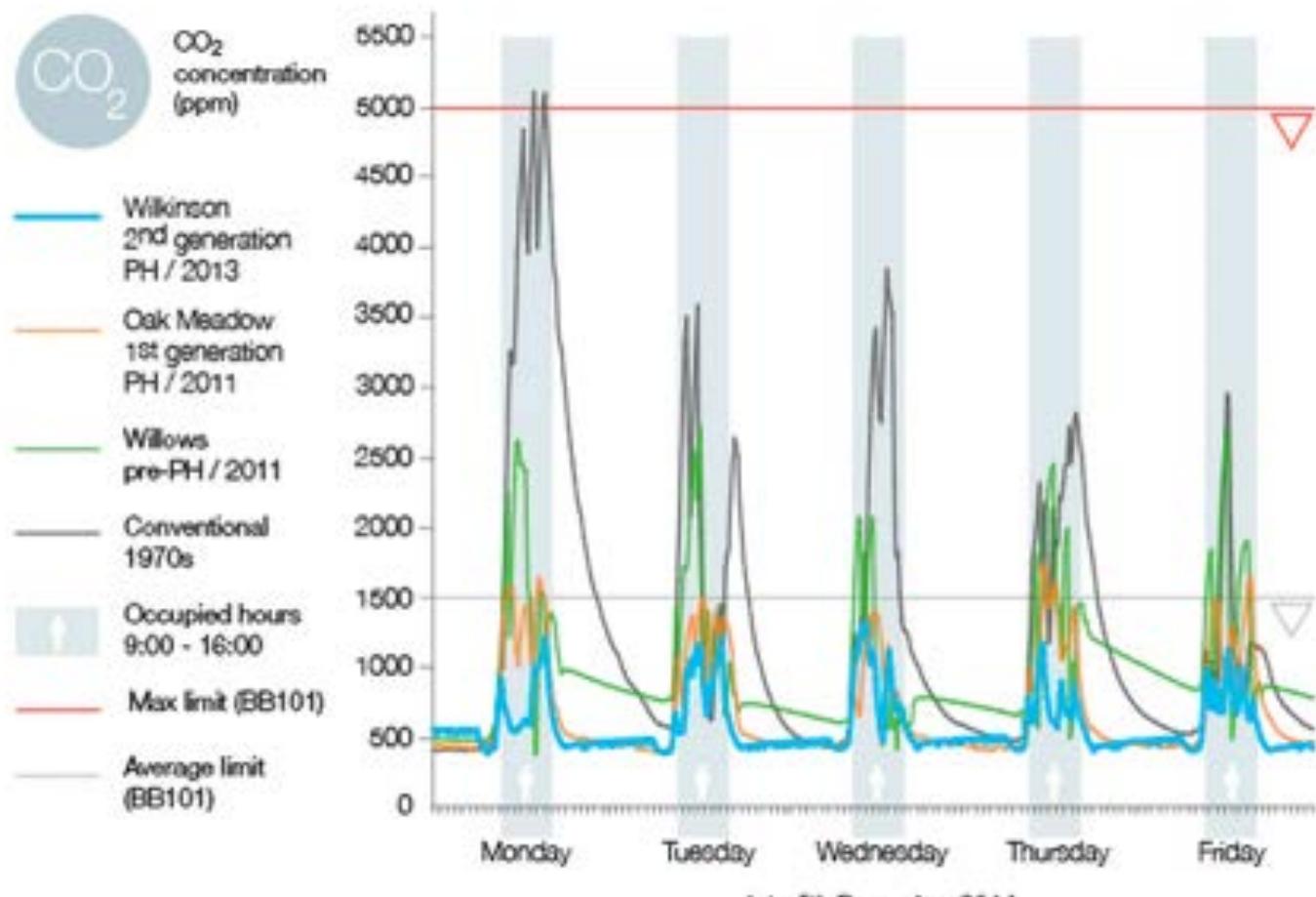


IAQ R&D - CO₂: indicator or pollutant?

CO₂ only harmful at high levels

- WHO : n/a
- COSHH: 5,000ppm - 8hrs
15,000ppm - 15min

- Normally seen as indicator of ventilation effectiveness against indoor (human) pollutants
- Energy efficiency – e.g. CO₂ controlled ventilation



IAQ R&D - CO₂: indicator or pollutant?

Allen and al, 2016

- 24 participants, 6 days, office lab
- CO₂ varied independently from fresh air rates
- “Decision making” cognitive tests

- CO₂ seems to have effect on its own at lower levels than usually assumed
- Maybe some performance gains in the margin, BUT ...
- Commissioning, O&M and monitoring !

At 400ppm outdoors:

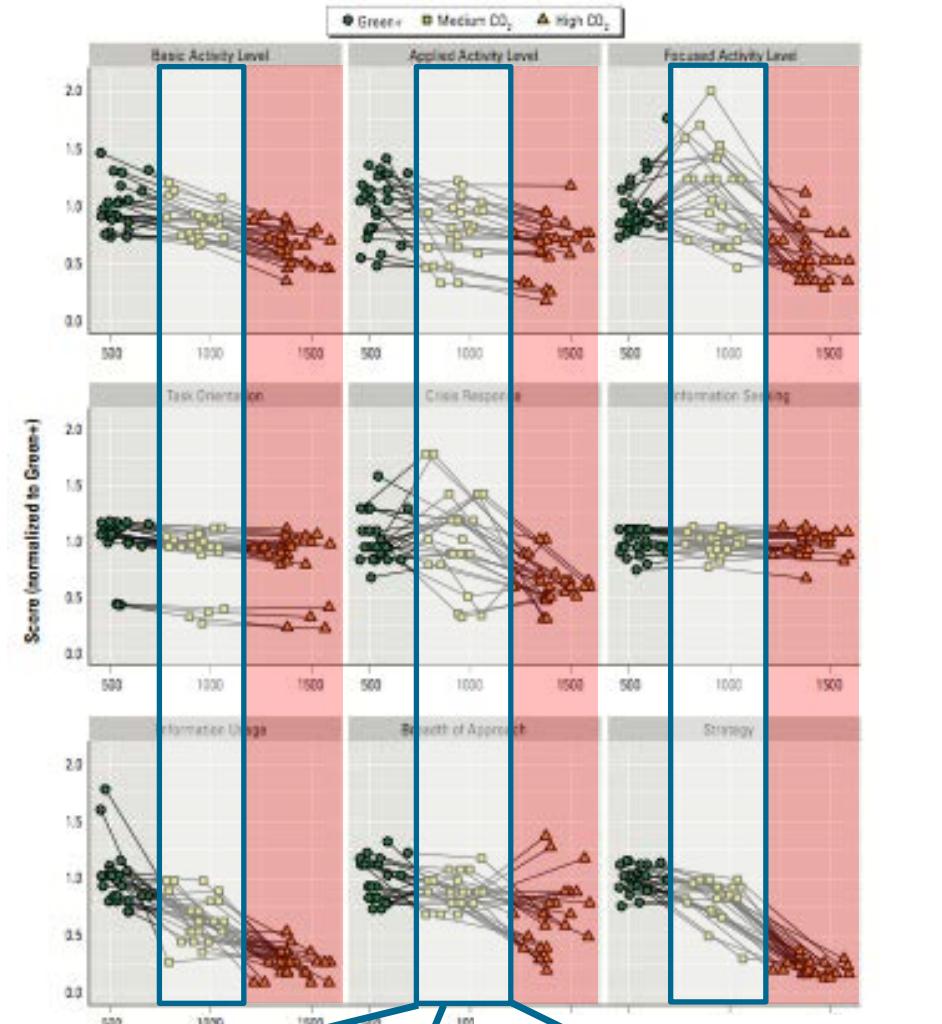
“high/medium” quality

750 – 900ppm
15251:2007

WELL

800ppm
16798-1:2019

“high/medium” quality

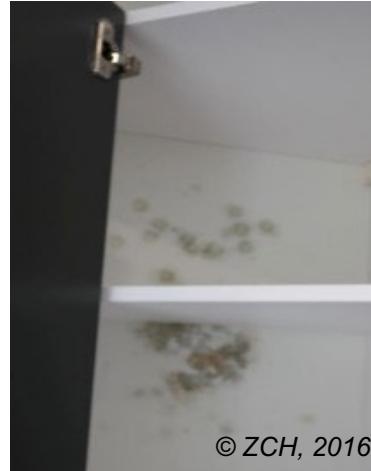


Humidity

Mould and allergens e.g. House Dust Mites

Higher T & RH

- Summer discomfort
- Risk of death at extremes, mostly in Asia; climate change!!



Unintended consequence of high ventilation rates: dry air, winter discomfort e.g. offices

No WHO criterion: ventilation, surface T

- 40-60% RH in dwellings and air-conditioned buildings, 40-70% elsewhere
- Good construction & operation



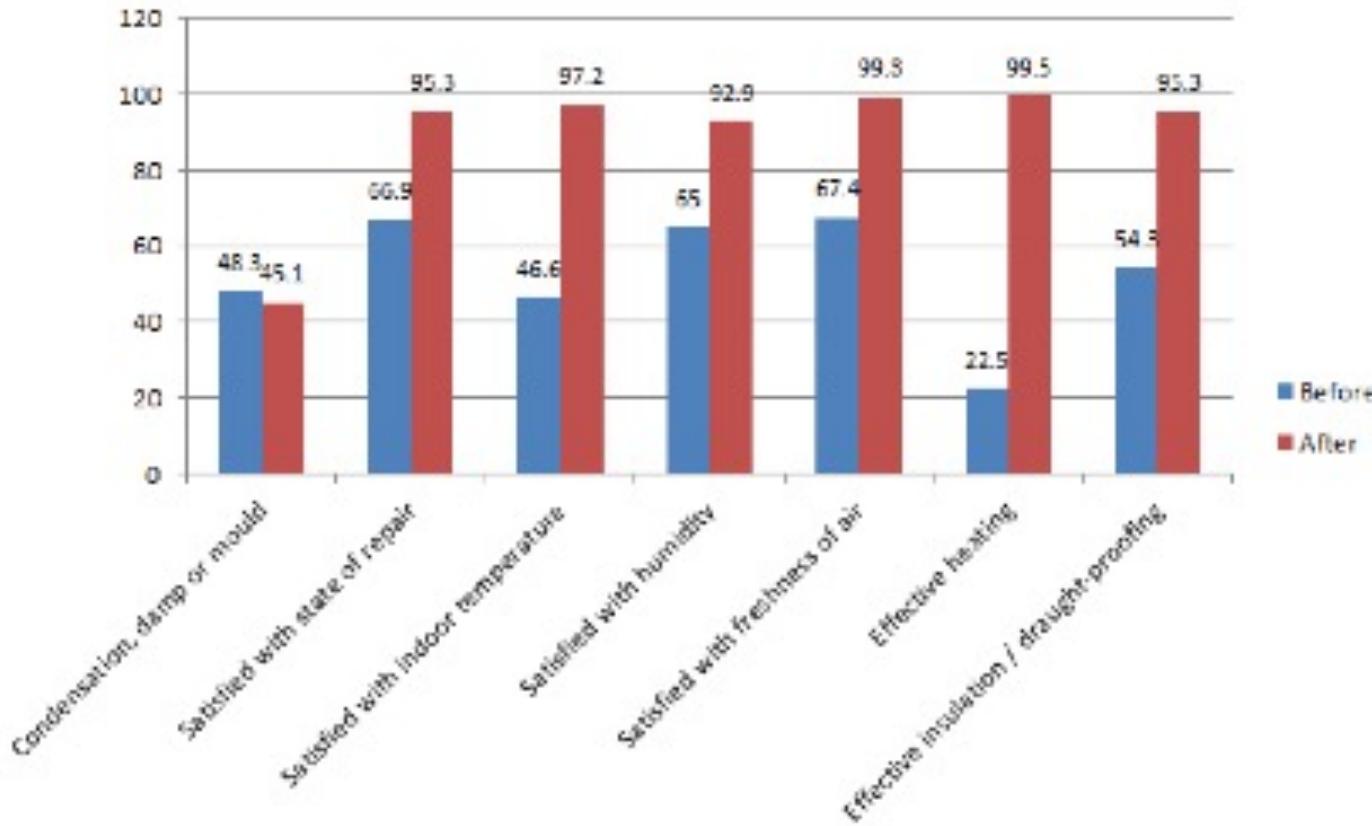
Residential retrofit

Airtightness and ventilation; interstitial condensation; cold bridges ...

- >> Need for holistic approach
- >> PAS 2030 & 2035
- >> Need for joint monitoring of energy, costs, health, comfort, building fabric

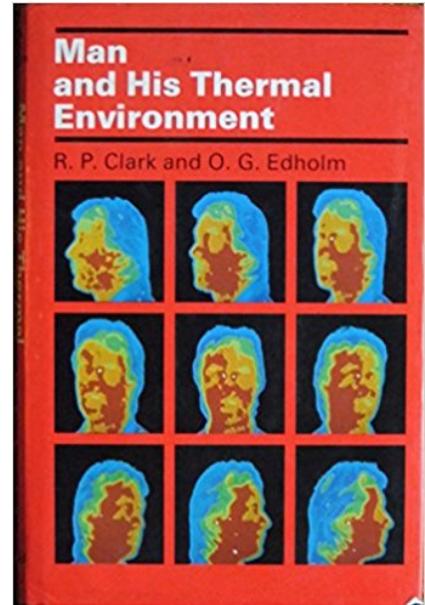


Warm Homes Oldham
Example of joint health & housing initiative



Ref.: Sheffield University / Oldham Council

Thermal Conditions – Criteria



Winter deaths (incl. flu) and health inequalities >> Retrofit >> Air quality and humidity
Overheating risk and awareness rising; public health **campaigns** help
Health-based criteria? >> Limits of comfort, CIBSE TM59 & TM52
Adaptive and PMV/PPD approaches, operative temperature
Choice

Thermal Conditions – Guidance



Passive solutions first: energy / carbon, resilience, comfort

Links to AQ e.g. Chilled ceilings >> Mixing

Controls linked to air T: disconnect user – designer / FM >> R&D opportunity!

Overheating in residences >> Noise

Light - Criteria

Light as **radiation**

Visual aspects – lux, rendering, views etc

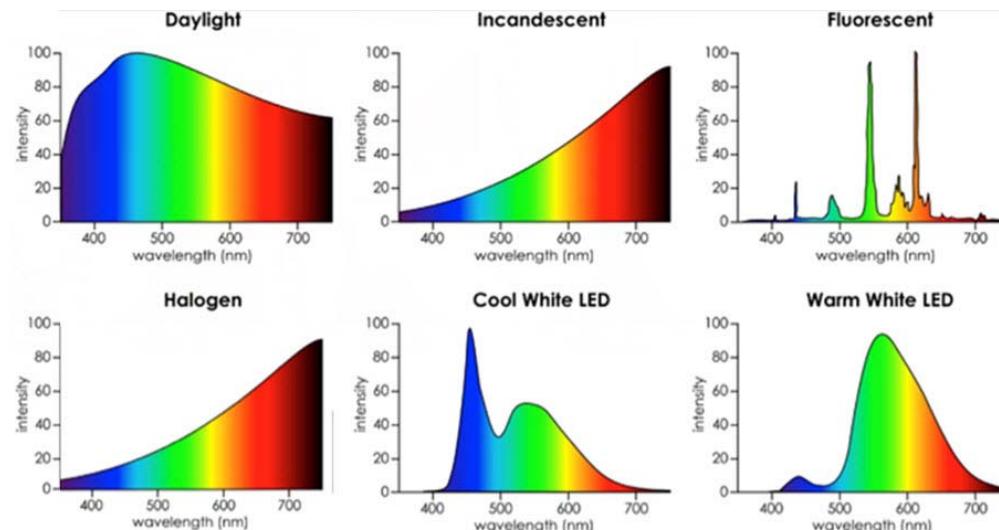
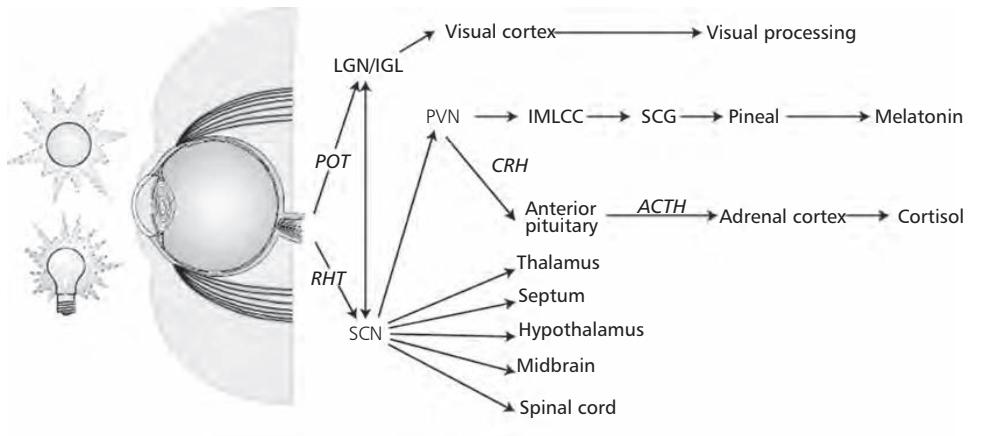
Non-visual effects: ipRGCs receptors, 2002

“Circadian”, “human-centric” lighting = ??

- ✓ Importance of spectrum
- ? Metric: WELL “melanopic lux” is one of many
- ? Level
- ! Time dependent

Rapid and wide adoption of LED

- **Daylight and views out**
- ? **Metric for glare from natural light**



Light – Guidance

Daylight



Glare control

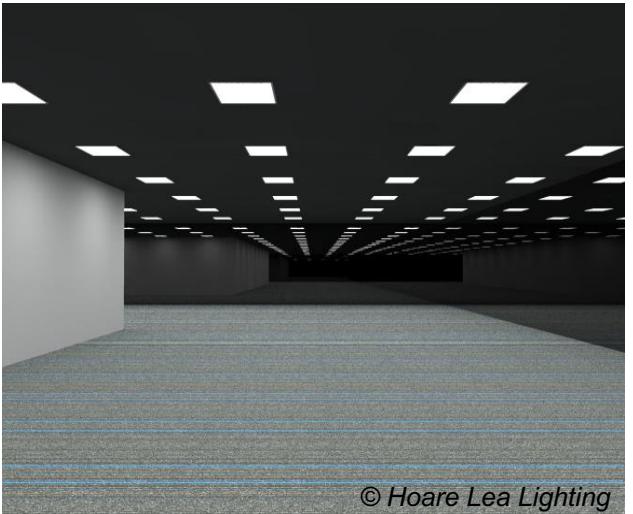


Location and amount of glazing

Coordination: finishes, furniture layout, position of light sensors

Good quality fittings and controls – e.g. LED drivers: beware **flicker**

User control, task lighting



Acoustics

Overheating in residences

Smarter **open-plan office layouts**
for different needs

Ventilation design, installation &
maintenance >> air quality

R&D

Acoustic criteria for **sleep**

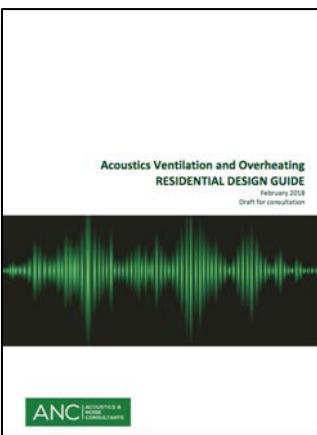
Balancing **heat and noise** >>

Collaboration with ANC and IOA

Acoustically attenuated openings

Soundscapes

Virtual reality



Electro-Magnetic Fields: Guidelines vs Measured Exposure

Low-frequency:



Earth's field:
50 microT

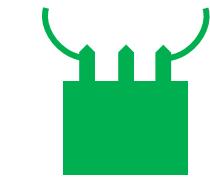


Occupational & power lines:
9 kV/m + protection
360 microT

A few kV/m
A few 10s microT

General exposure:
5 kV/m
100 microT

Close to appliances & wiring:
A few 100s V/m
A few 10s microT



Substations:
No / negligible electric field
A few microT



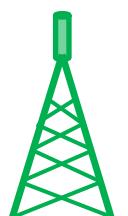
Typical UK homes:
1-20V/m
0.01-0.2 microT

High-frequency:



Mobile phones:
(vs Head & Trunk SAR)

- Has been found on occasions above guidelines when held close to the head for phone calls, especially when used by children
- **Children:** limit exposure & long calls
- **Adults should have a choice**
- **Select device with low SAR**
- Observe separation distances from head & body recommended in product literature



Mobile phone base stations,
outside exclusion zones :
0.002-2% of guideline (*whole-body SAR*)



Wifi, microwave ovens,
smart meters
Exposures much lower
than guidelines and than
from mobile phones

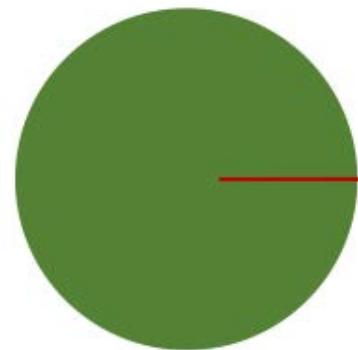
Pollution, flooding, climate change

UK limits \leq WHO guidelines

Public supplies: 99.96% tested compliance (+ incidents)

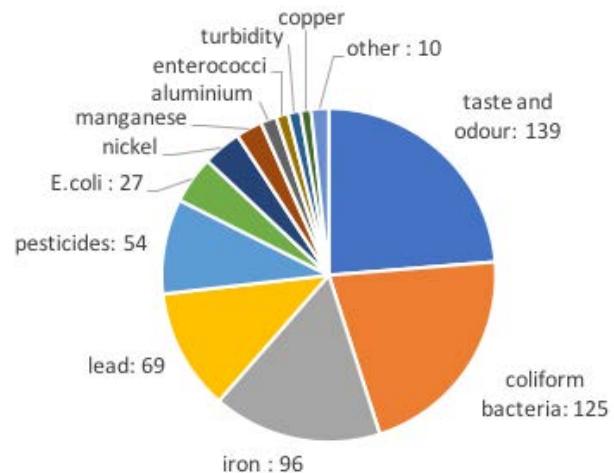
Beware on-site filters and purification that are not WRAS-approved

387,730 tests
incl. 39 parameters
(standards or indicators)



failures in
at least 1
standard or
indicator:
1,132

586 failures in standard





Good Homes Alliance

*non-CIBSE work
with Susie Diamond, Inkling*

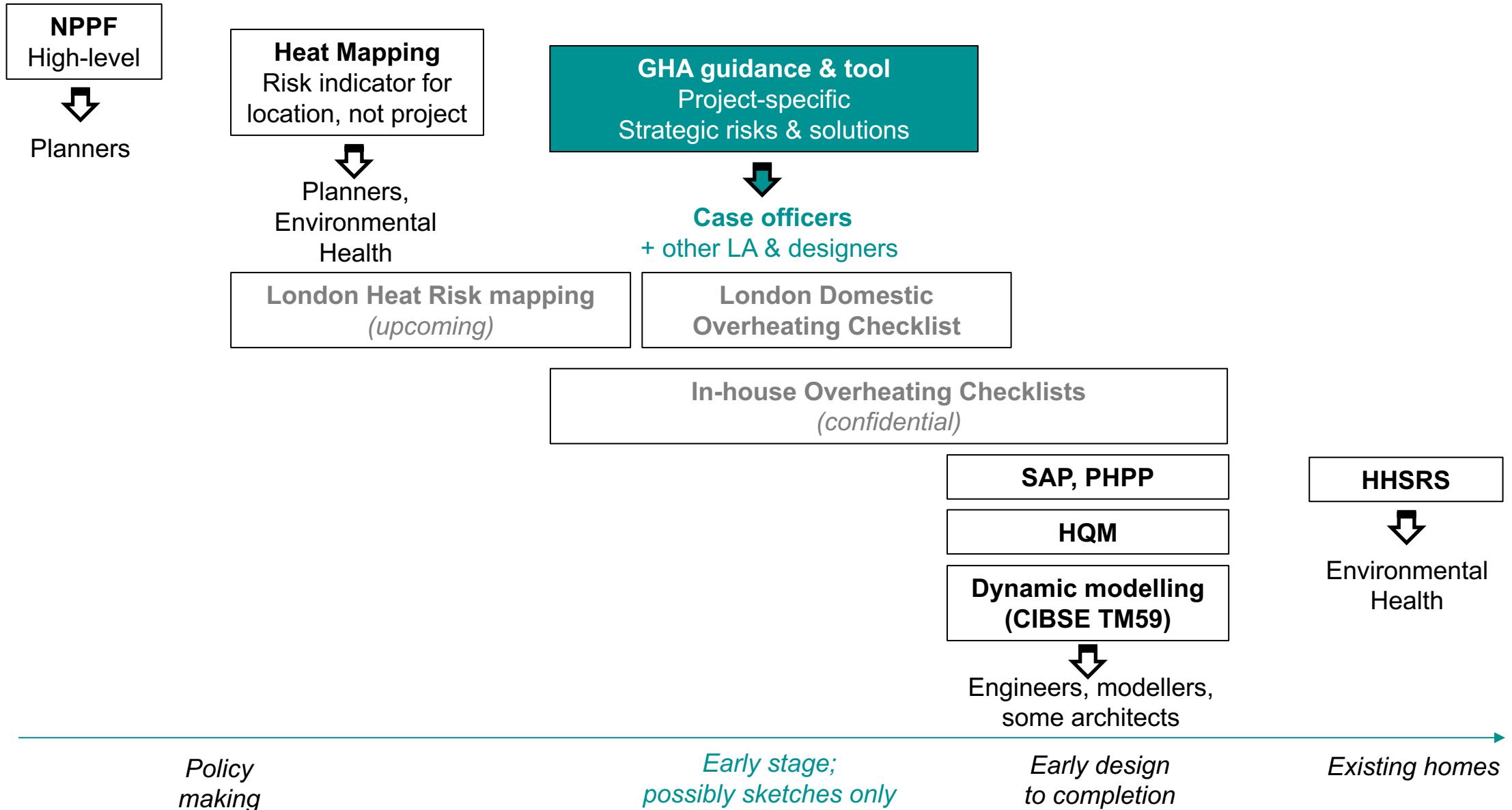


Objectives



*Better support **local authorities** and project teams in
the **evaluation of overheating risk** in new residential planning
applications,
and raise awareness of possible **design solutions***

Target Audience

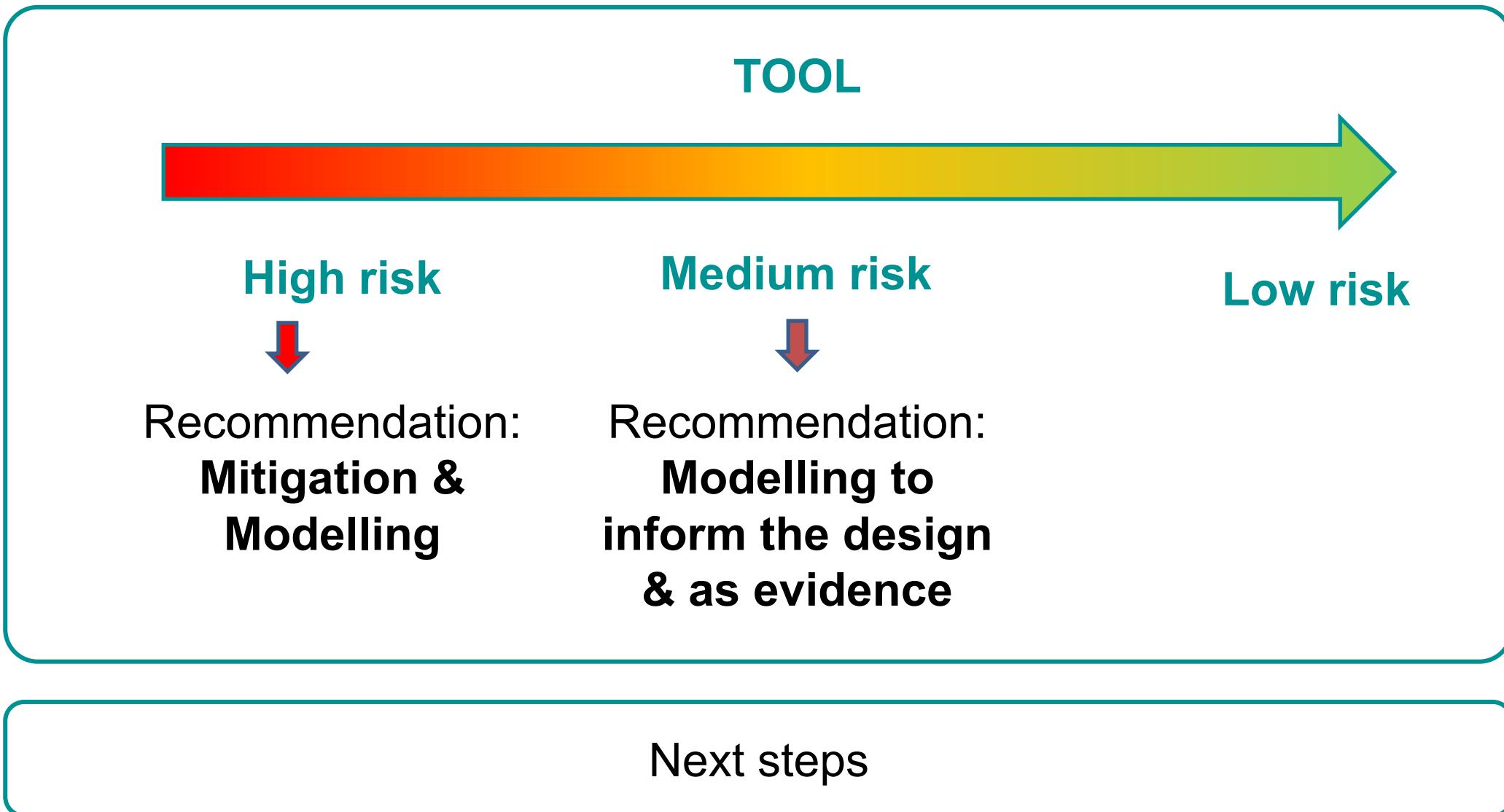


Scope

	Site context green, UHI ...	Noise, security	Occupancy risk profiles	Design options	Community heating	Future climate
SAP	✗	≈	✗	≈	≈	✗
HQM	✓	✓	✗	≈ (principles)	✓	✗
PHPP	✗	≈	≈	✓	✓	✗
TM59	✗	≈	≈	✓	≈	≈
GHA tool	✓	✓	✗	≈ (principles)	✓	✗

- Early stage
- Accounting for site context

GHA tool as “first filter”



EARLY STAGE OVERHEATING RISK TOOL

Version 1.0, May 2019
This tool provides guidance on how to assess overheating risk in residential schemes at the early stages of design. It is specifically a pre-detail design assessment intended to help identify factors that could contribute to or mitigate the likelihood of overheating.

The questions can be answered for an overall scheme or for individual units. Score zero wherever the question does not apply. Additional information is provided in the accompanying guidance, with examples of scoring and advice on next steps.

Download accompanying guidance at www.goodhomes.org.uk/overheatingscore.

KEY FACTORS INCREASING THE LIKELIHOOD OF OVERHEATING		KEY FACTORS REDUCING THE LIKELIHOOD OF OVERHEATING	
Geographical and local context			
#1 Where is the scheme in the UK?	South east 4 Northern England, Scotland & NI 0 Rest of England and Wales 2	#8 Do the site surroundings feature significant blue/green infrastructure?	Proximity to green spaces and large water bodies has beneficial effects on local temperatures; as guidance, this would require at least 50% of surroundings within a 100m radius to be blue/green, or a rural context 1
#2 Is the site likely to see an Urban Heat Island effect?	Central London (see guidance) 3 Gtr London, Manchester, B'ham 2 Other cities, towns & dense suburban areas 1		
Site characteristics			
#3 Does the site have barriers to windows opening?	Day - reasons to keep all windows closed 8 Day - barriers some of the time, or for some windows e.g. on quiet side 4 Night - reasons to keep all windows closed 8 Night - bedroom windows OK to open, but other windows are likely to stay closed 4	#9 Are immediate surrounding surfaces in majority pale in colour, or blue/green?	Lighter surfaces reflect more heat and absorb less so their temperatures remain lower; consider horizontal and vertical surfaces within 10m of the scheme 1
#4 Are the dwellings flats?	Flats often combine a number of factors contributing to overheating risk e.g. dwelling size, gains from surrounding areas; other dense and enclosed dwellings may be similarly affected - see guidance for examples 3	#10 Do the site have existing tall trees or buildings in solar-exposed glazed areas?	The site have existing tall trees or buildings in solar-exposed glazed areas? south and west facing areas can reduce also reduce daylight levels 1
#5 Does the scheme have community heating?	i.e. with hot pipework operating during summer, especially in internal areas, leading to heat gains and higher temperatures 3	#11 Do dwellings have high exposed thermal mass for secure and quiet night ventilation?	Dwellings have high exposed thermal mass for secure and quiet night ventilation? Mass can help slow down temperature rises, but it also cause properties to be slower to cool, so needs to be used with care - see guidance 1
Scheme characteristics and dwelling type			
#6 What is the estimated average glazing ratio for the dwellings?	>85% 12 >60% 7 >35% 4	#12 Do floor-to-ceiling heights allow ceiling fans, now or in the future?	>2.8m and fan installed 2 > 2.8m 1
#7 Are the dwellings single aspect?	Single-aspect 3 Dual aspect 0	#13 Is there useful external shading?	Full Part >85% 6 3 >50% 4 2 >35% 2 1
Solar heat gains and ventilation			
#8 Are windows & openings supported by effective ventilation?	Larger, effective and secure openings will help dissipate heat - see guidance 3	#14 Do windows & openings support effective ventilation?	Part F +50% +100% Single-aspect minimum required 3 4 Dual aspect 2 3
TOTAL SCORE <input type="text"/> = Sum of contributing factors: <input type="text"/> minus Sum of mitigating factors: <input type="text"/>			
High 12		Medium 8	
Low			
score >12: Incorporate design changes to reduce risk factors and increase mitigation factors AND Carry out a detailed assessment (e.g. dynamic modelling against CIBSE TM59)		score between 8 and 12: Seek design changes to reduce risk factors and/or increase mitigation factors AND Carry out a detailed assessment (e.g. dynamic modelling against CIBSE TM59)	
score <8: Ensure the mitigating measures are retained, and that risk factors do not increase (e.g. in planning conditions)			

FINAL DRAFT

Heat gains

Solar gains
Local microclimate
Site surroundings



Capacity to dissipate heat

Ventilation potential
Site surroundings

LAUNCH 16th July 2019

R&D: Where Approximations & Best Guesses Were Required

Urban Heat Island

Micro climates

Effects of **peak vs cumulative** solar gains

Thermal mass operation and benefits in practice



Conclusions

Regulations Wish List: Filling the Gaps



Overheating

Indoor air quality (not just ventilation)

Whole-house approach to retrofit – Part L1B, L2B,
Part F, overheating

Better consideration of **micro-climates and site context** in planning and/or building regulations

Towards **outcomes**:

- >> Operational building performance
- >> Long-term health impact assessments



<https://www.cibse.org/news-and-policy/>

Recommendations

More focus on **building performance outcomes**

Hierarchical approach, centered on the **precautionary principle**

Source control

Site assessment

Benchmarking & targets

O&M, monitoring and evaluation

Evolving knowledge and solutions

Thank you

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