BUILD TEST SOLUTIONS

Too Hot to Ignore: Understanding and tackling overheating in buildings

Ben Roberts (Loughborough University)

BTS Webinar Series #12

Build Test Solutions

- **Manufacturer** of measurement equipment
- **Eliminating guesswork** in building performance, accelerating the transition to **better quality, healthier buildings**
- Pioneering, **practical** measurement technologies
- Providing accurate, **actionable** insights

BUILD TEST SOLUTIONS

Today We'll Cover

- Overheating
- Why it's getting worse
- How it can be tackled
- Q&A

BUILD TEST SOLUTIONS

BUILD TEST SOLUTIONS

Over to Ben!

Loughborough University

Too hot to ignore: Understanding and tackling overheating in buildings

Dr Ben Roberts
School of Architecture, Building and Civil Engineering
Loughborough University

School of Architecture, Building and Civil Engineering

We are one of the largest integrated centres for the built environment, advancing education and research for the changing world in the UK and globally

100% of research impact rated as ‘world-leading’ or ‘internationally excellent’

REF 2021

1st in the UK for Architecture

THE TIMES AND SUNDAY TIMES GOOD UNIVERSITY GUIDE 2026

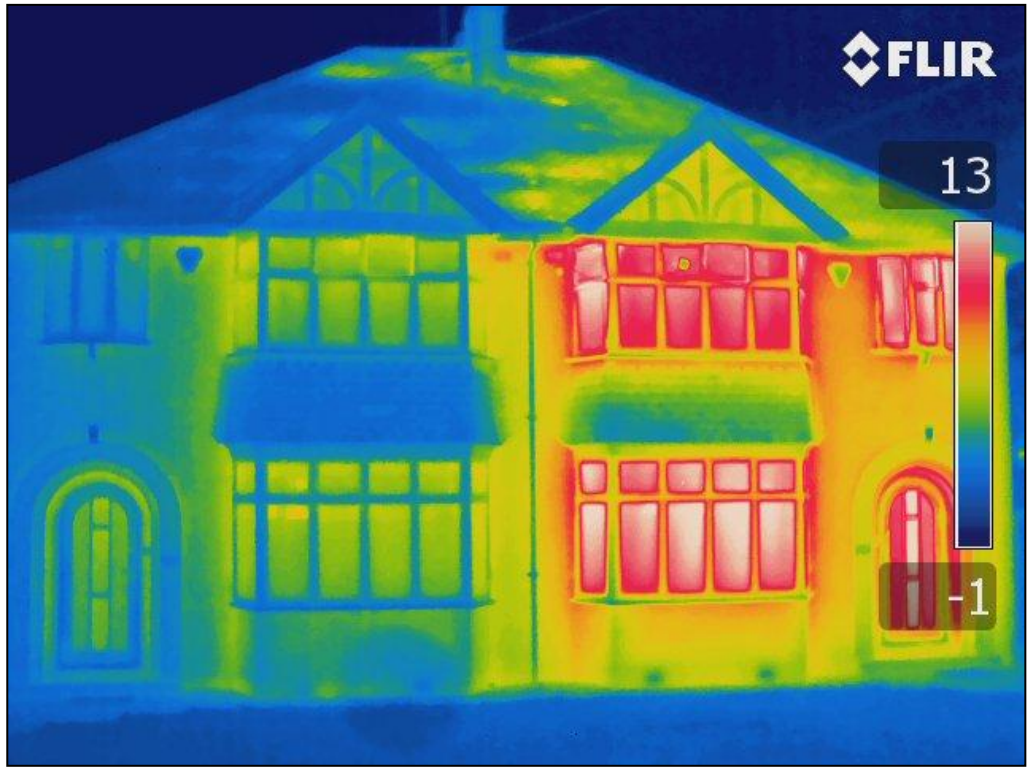
1st in the UK for Building

THE COMPLETE UNIVERSITY GUIDE 2027

Loughborough University

Research and innovation themes

1. **Low energy buildings**
   - Homes, offices, retail, and health care.
2. **Building performance evaluation**
   - Measurement, monitoring and large scale field trials.
3. **Health, wellbeing, and indoor air quality**
   - Thermal comfort, indoor air quality, overheating assessment.
4. **Smart building, communities, and cities**
   - Energy flexibility, active buildings, community energy schemes.



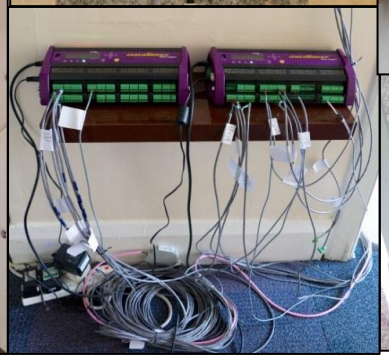
Laboratory and Test House Facilities

Building measurement and monitoring capability

In-situ measurements of building performance

- Energy and carbon emissions.
- Heat loss, ventilation and airtightness.
- Thermal comfort and Indoor Air Quality.

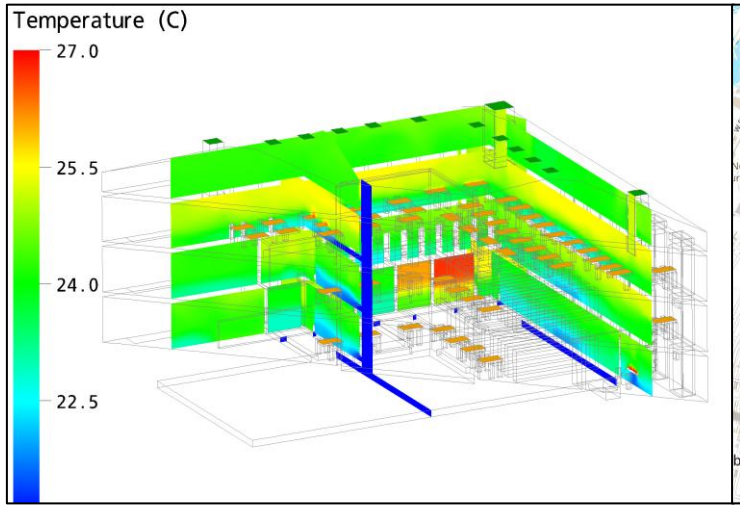


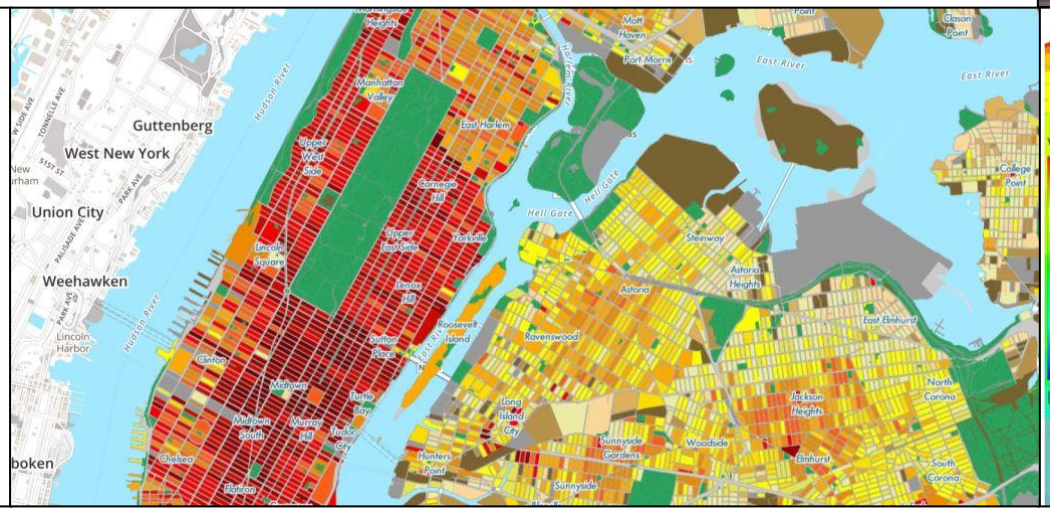



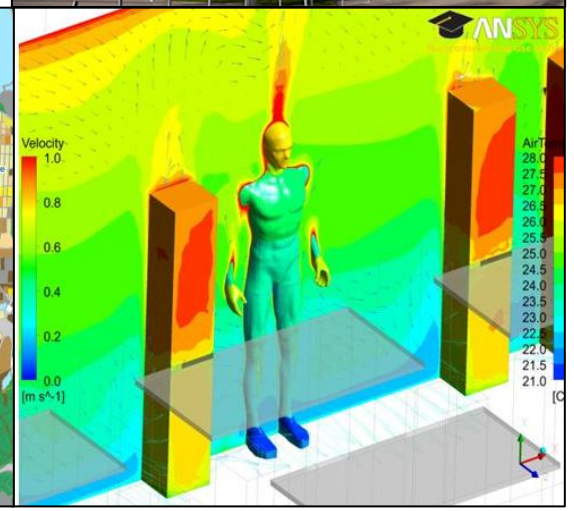


Modelling and design expertise

- Computer modelling, simulation, and optimisation
- Energy, comfort, airflow/CFD, moisture.
- Elements, buildings, and building stocks.
- Design of low energy naturally ventilated buildings.







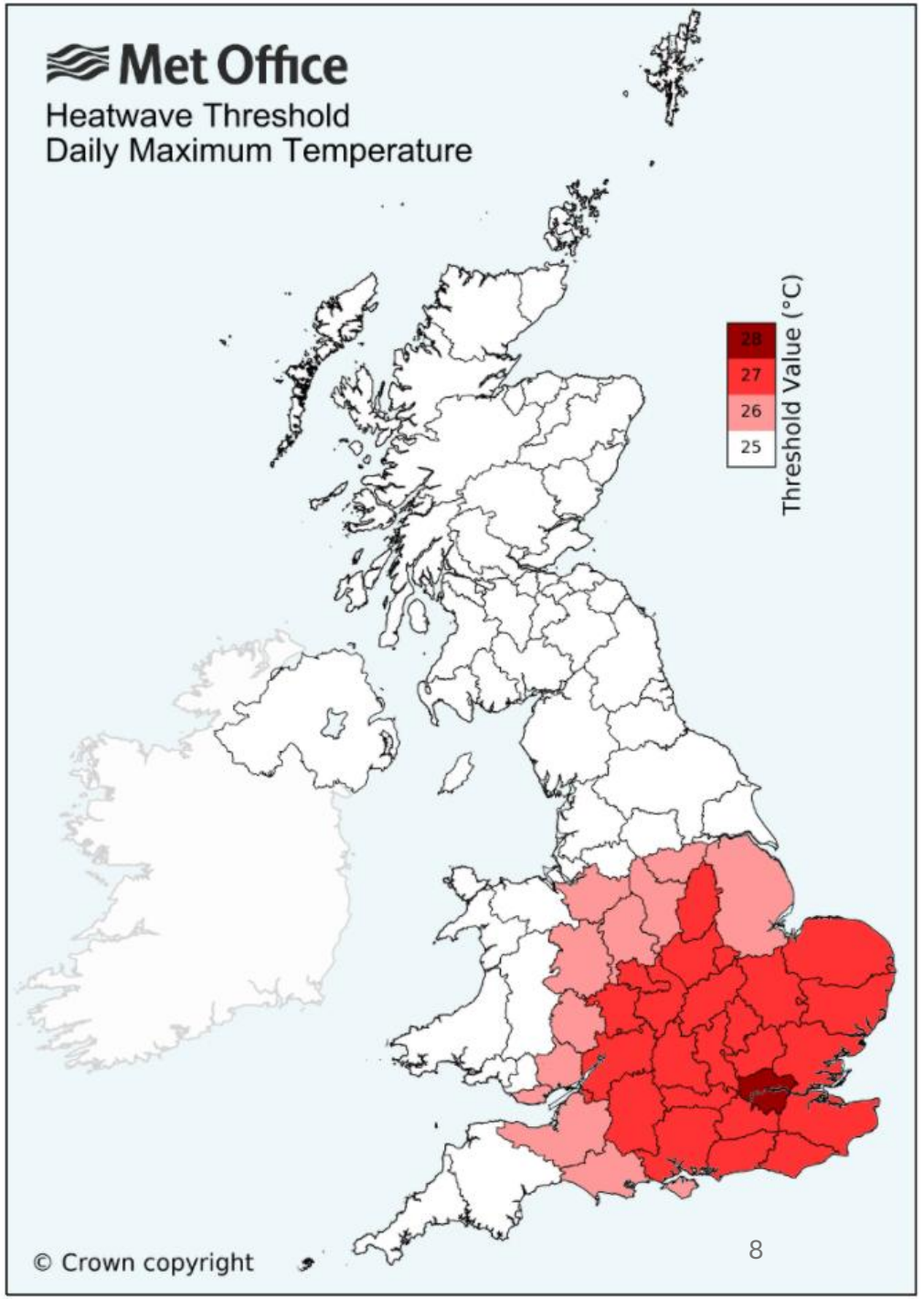
https://www.bbc.com/future/article/20190310-why-britains-rain-cant-sustain-its-thirst

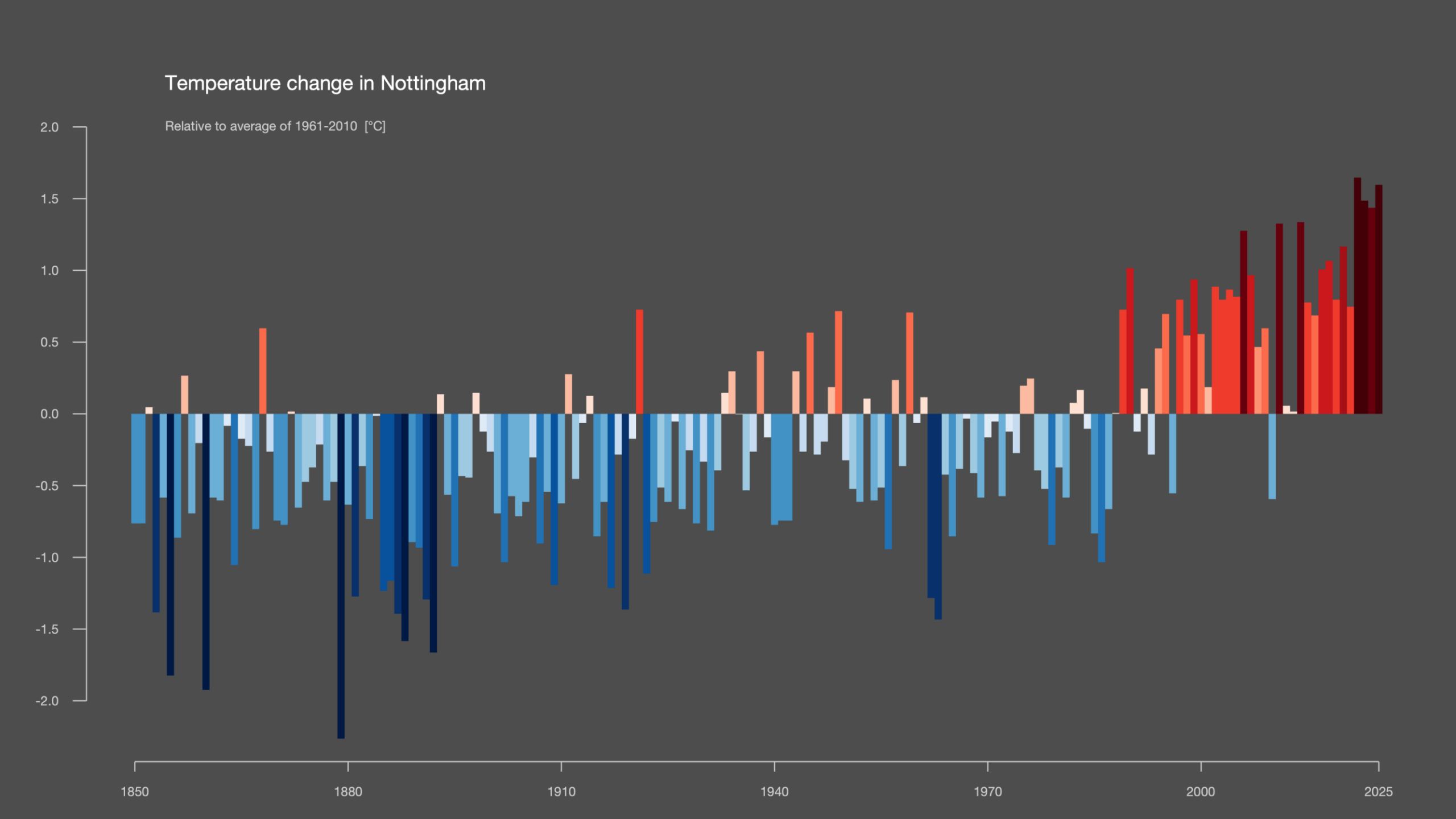
Warmest recorded temperature in UK

40.3 °C

19 July 2022

Heatwaves with greater frequency, intensity, and duration




Temperature change in Nottingham
Relative to average of 1961-2010 [°C]
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
1850
1880
1910
1940
1970
2000
2025

2025 was the

HOTTEST

and

SUNNIEST

year *ever*

(…well, since records began in 1884)

2026 so far

HOTTEST

June

ever

(in England…well, since records began in 1884)

2026 so far

> 35°C in May, June, and July

first time *ever*

(...well, since records began in 1884)

Source: Bastin J-F, Clark E, Elliott T, Hart S, van den Hoogen J, Hordijk I, et al. (2019) Understanding climate change from a global analysis of city analogues. PLoS ONE 14(7): e0217592. https://doi.org/10.1371/journal.pone.0217592

Link between homes, heat, and health

2,985

Excess heat-related deaths in summer 2022

https://www.gov.uk/government/publications/heat-mortality-monitoring-reports/heat-mortality-monitoring-report-2022

19%

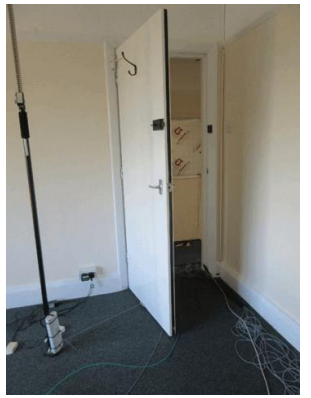
of UK bedrooms already overheat in the current climate

Lomas, K.J., Watson, S., Allinson, D., Fateh, A., Beaumont, A., Allen, J., Foster, H. and Garrett, H., 2021. Dwelling and household characteristics' influence on reported and measured summertime overheating: A glimpse of a mild climate in the 2050's. *Building and Environment*, *201*, p.107986.

How can we reduce overheating?

The “same” houses experience the same weather conditions so that we can directly compare the indoor temperatures

Synthetically occupied

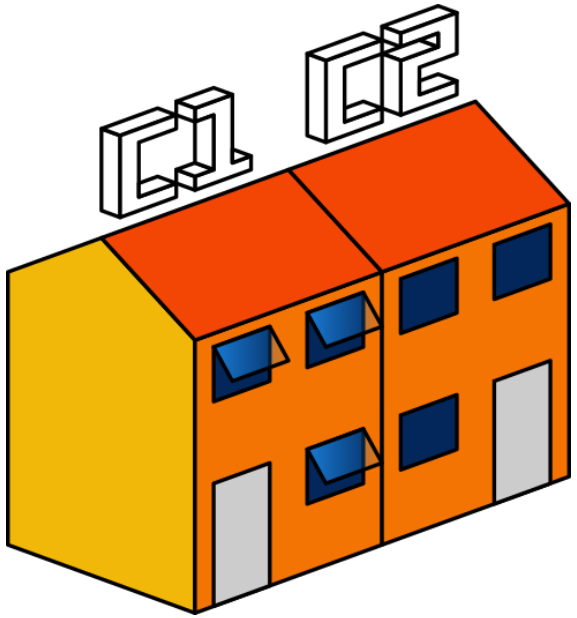


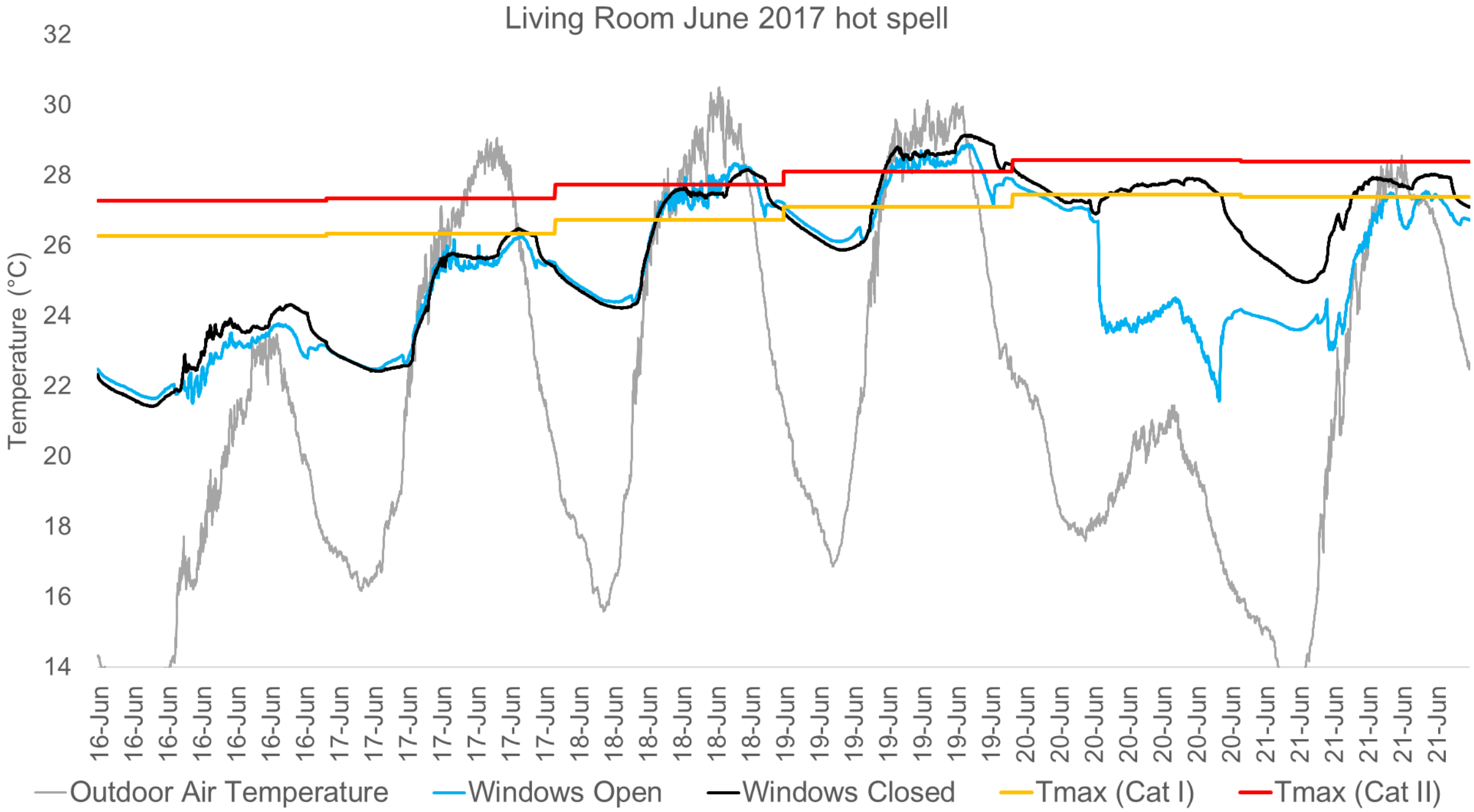
We know exactly what the occupants are doing and when – not like a real house!

Windows always closed, other house windows open when indoor temperature >22℃ and room “occupied”

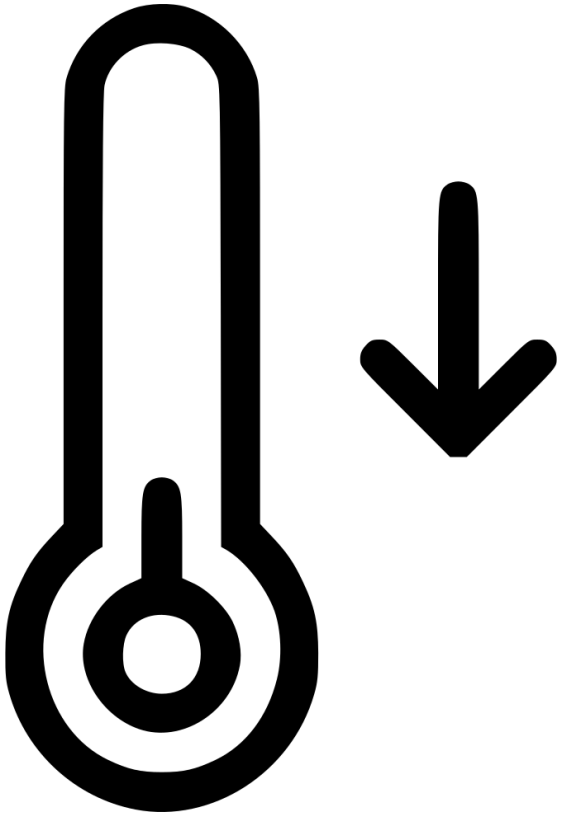
Windows open in occupied rooms when T_{in} > 22℃

Windows always closed




Living Room June 2017 hot spell
Temperature (°C)
32
30
28
26
24
22
20
18
16
14
16-Jun
17-Jun
18-Jun
19-Jun
20-Jun
21-Jun
Outdoor Air Temperature
Windows Open
Windows Closed
Tmax (Cat I)
Tmax (Cat II)

Roberts (2020). https://doi.org/10.26174/thesis.lboro.13281293.v1

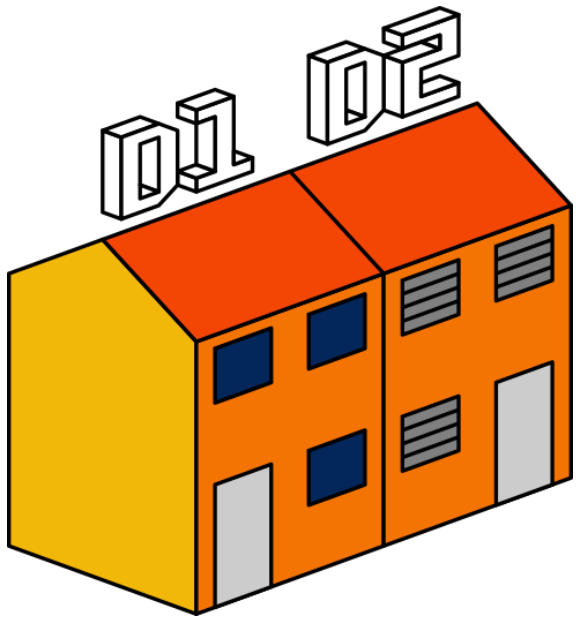


1.5°C

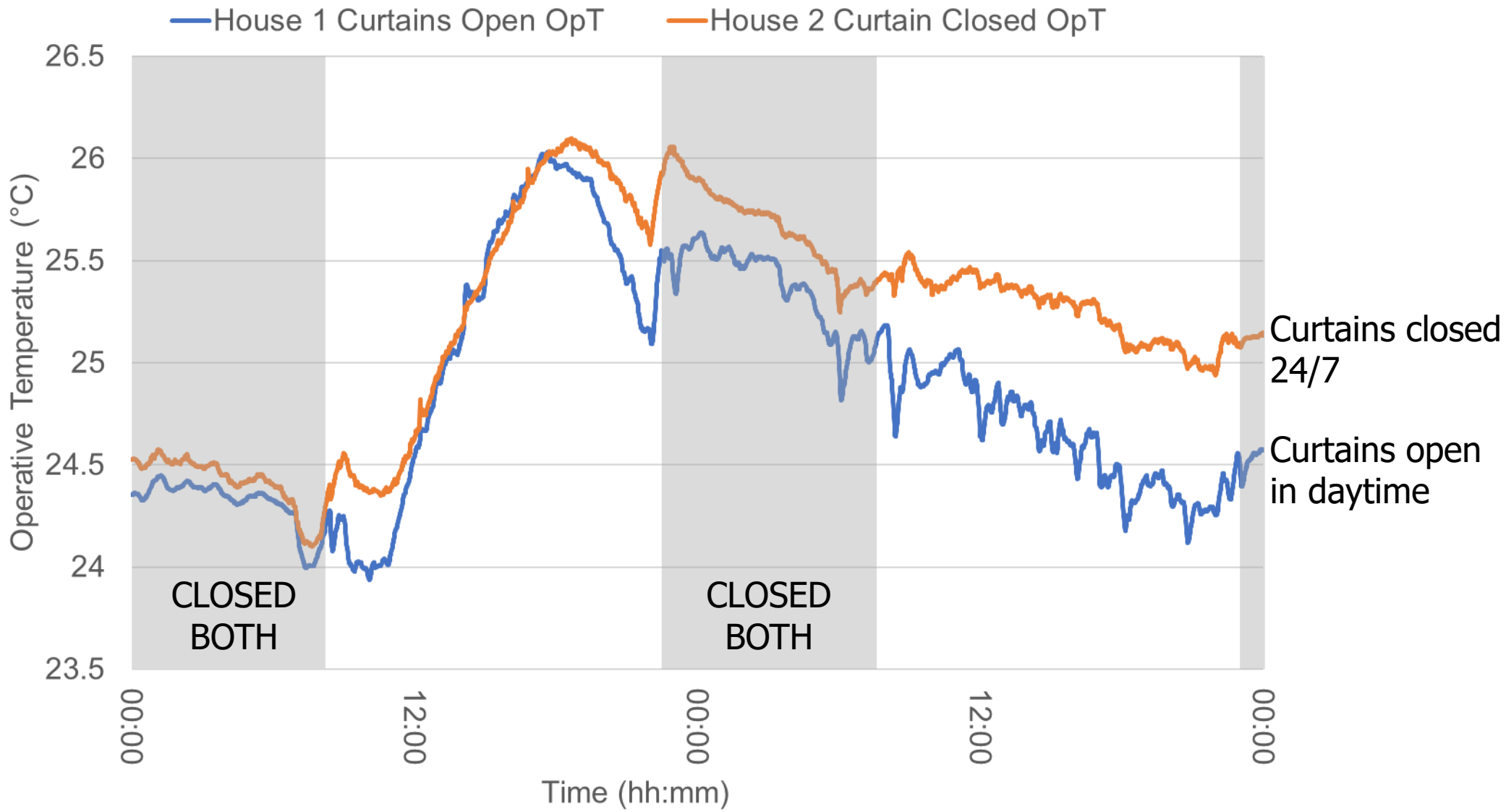
But overheating still occurred…

Mean whole-house floor area weighted average 1.5°C reduction in operative temperature by opening windows in occupied rooms when air temperature >22°C over 21 day test period

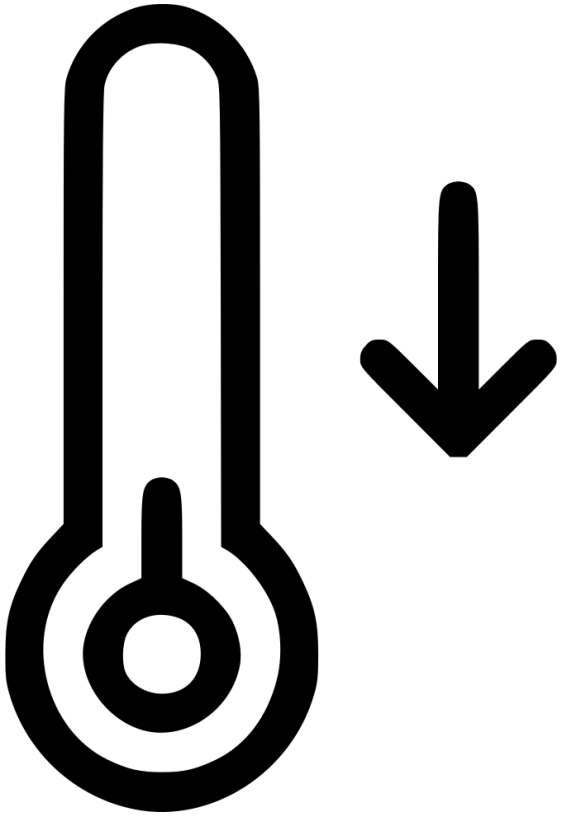
Comparing internal curtain use



A paired t-test showed north-facing bedroom operative temperatures were 0.2-0.4°C lower with **curtains open**.



Roberts (2020). https://doi.org/10.26174/thesis.lboro.13281293.v1



0°C

But reduced peak temperatures
by 1.3°C in south-facing rooms

Mean whole-house floor area weighted average 0°C reduction in operative temperature by opening windows in occupied rooms when air temperature >22°C over 21 day test period

Conclusions from experiments

- During heatwaves overheating was not prevented in either house (windows open/windows closed).
- Closing curtains restricted ventilation and made the overheating problem worse in north-facing rooms.

Is the future external shading?

Roller blinds (polyester weave fabric)

Dutch canopies)

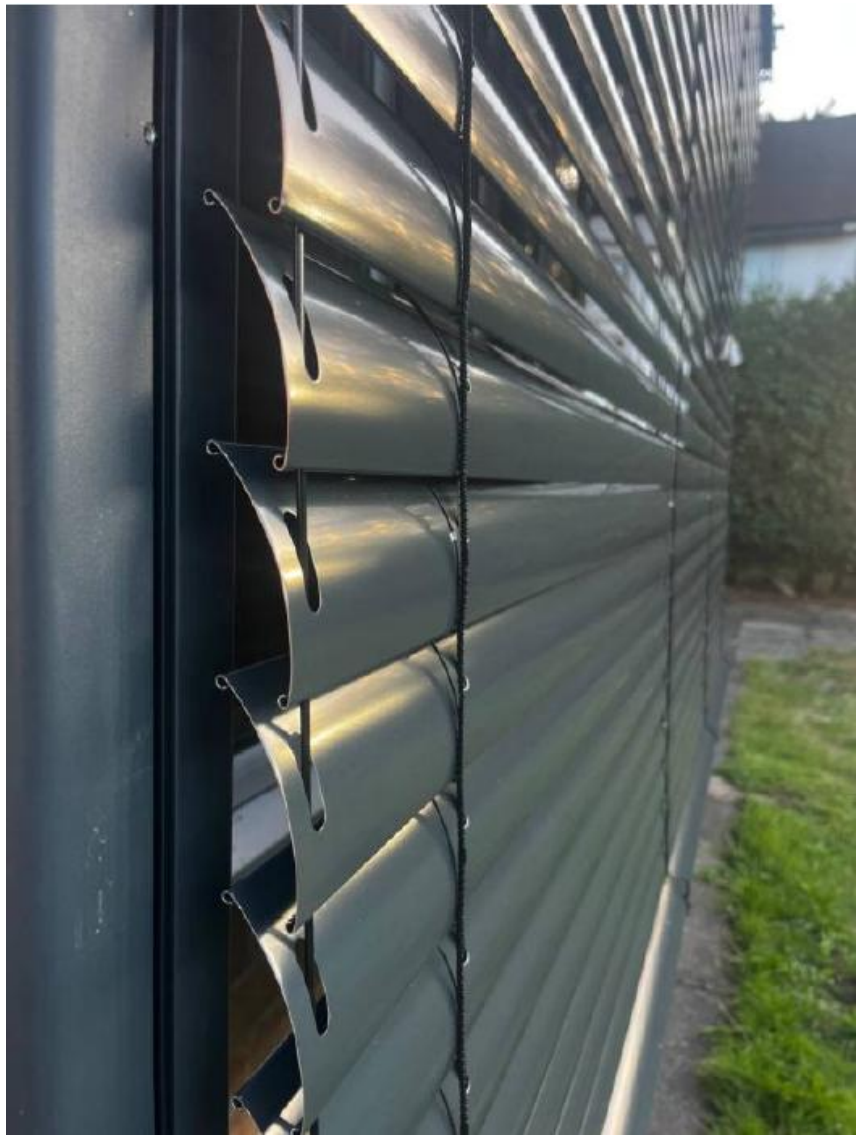
Ongoing PhD research by Niloo Todeh-Kharman sponsored by British Blind and Shutter Association

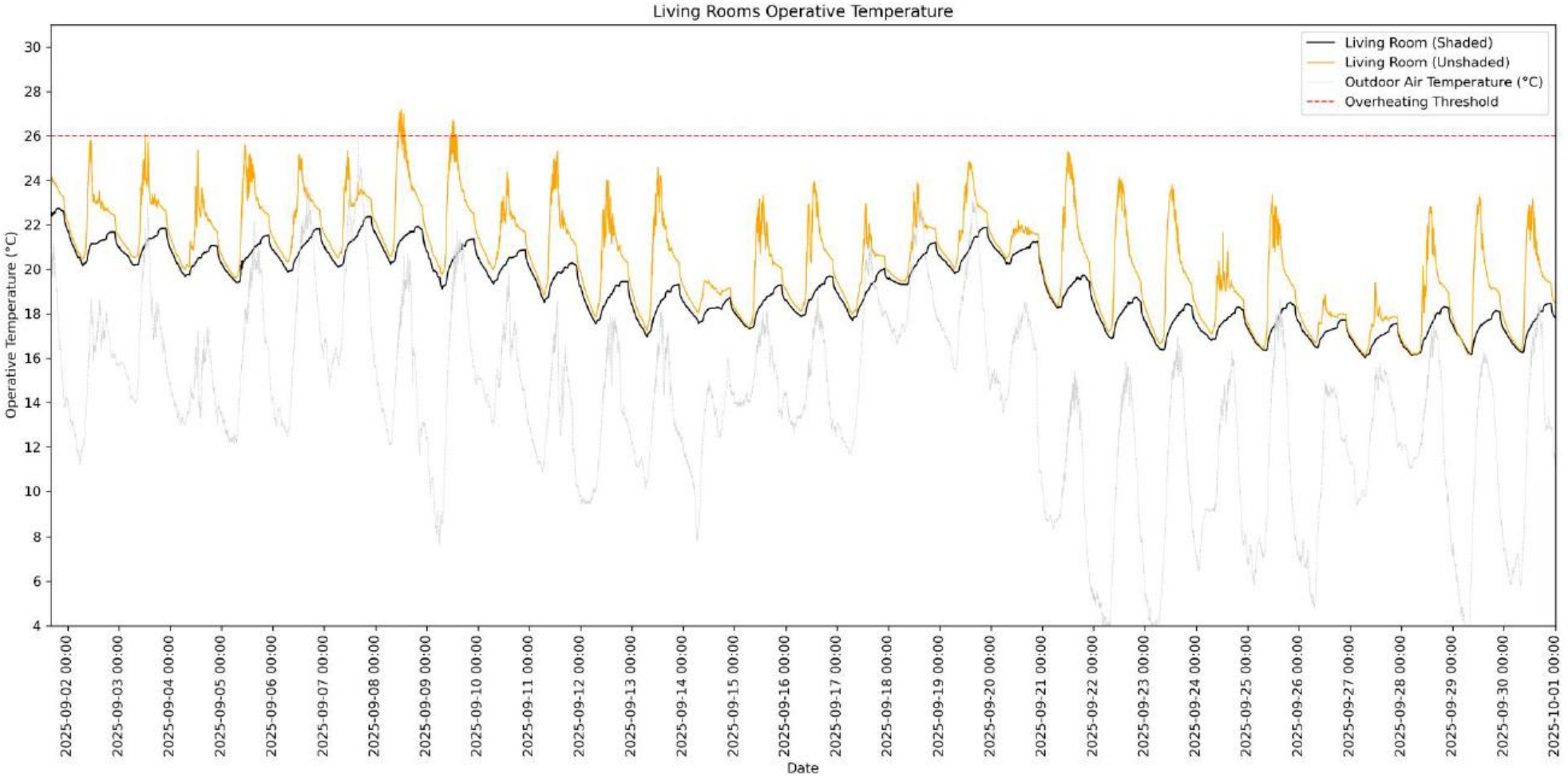
Awning

Venetian blinds (power-coated aluminium)

Venetian blinds (power-coated aluminium) – horizontal opening

Venetian blinds (power-coated aluminium)





Maximum operative temp. difference:

6.3 °C

Ongoing PhD research by Niloo Todeh-Kharman sponsored by British Blind and Shutter Association

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Experiment finds yoghurt can lower house temperature

Dr Ben Roberts said the idea for the experiment came after a conversation with Tom Greenhill

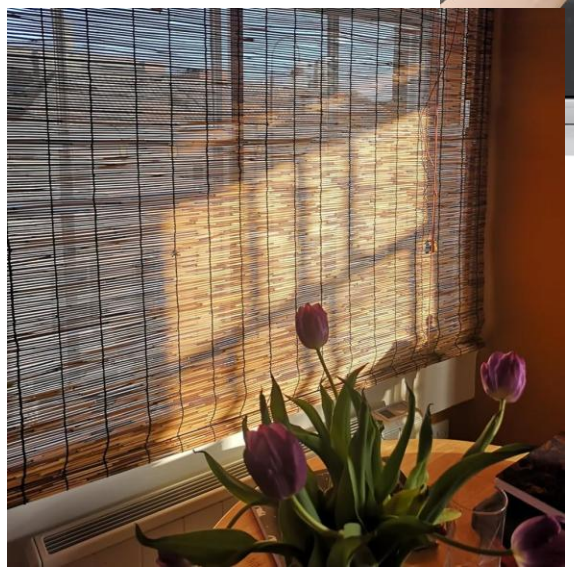
Dan Hunt, BBC News, Leicester and **Ady Dayman**, BBC News, Leicester

12 July 2025

https://www.bbc.co.uk/news/articles/cg4rg3nqq7go

Not just yoghurt – be creative (and if it works, think about permanent solutions)

https://www.heatwavetoolkit.com/solutions#shade-your-windows-with-a-temporary-covering



From measurements to models

- Pros:
  - New and existing homes
  - Relatively quick/cheap
  - Test many different adaptation measures
  - Behavioural changes
  - Archetypes to represent dwelling stock
- Cons:
  - Are inputs correct?
  - Are models reliable?
  - Is occupant behaviour correct?

ONLINE VERSION

HM Government

The Building Regulations 2010

Overheating

APPROVED DOCUMENT

Requirement O1: Overheating mitigation

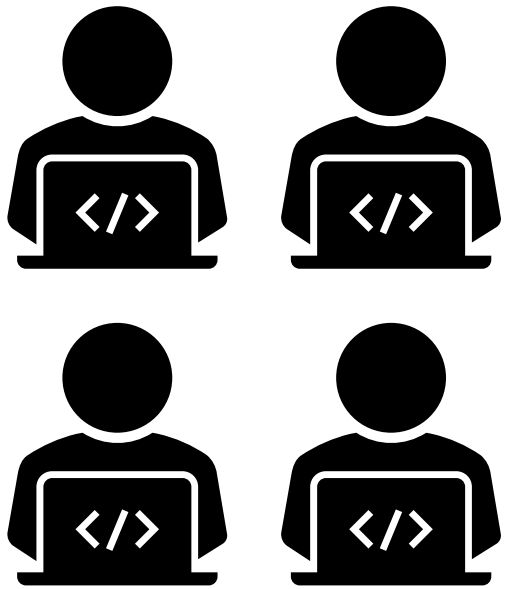
Regulations: 40B

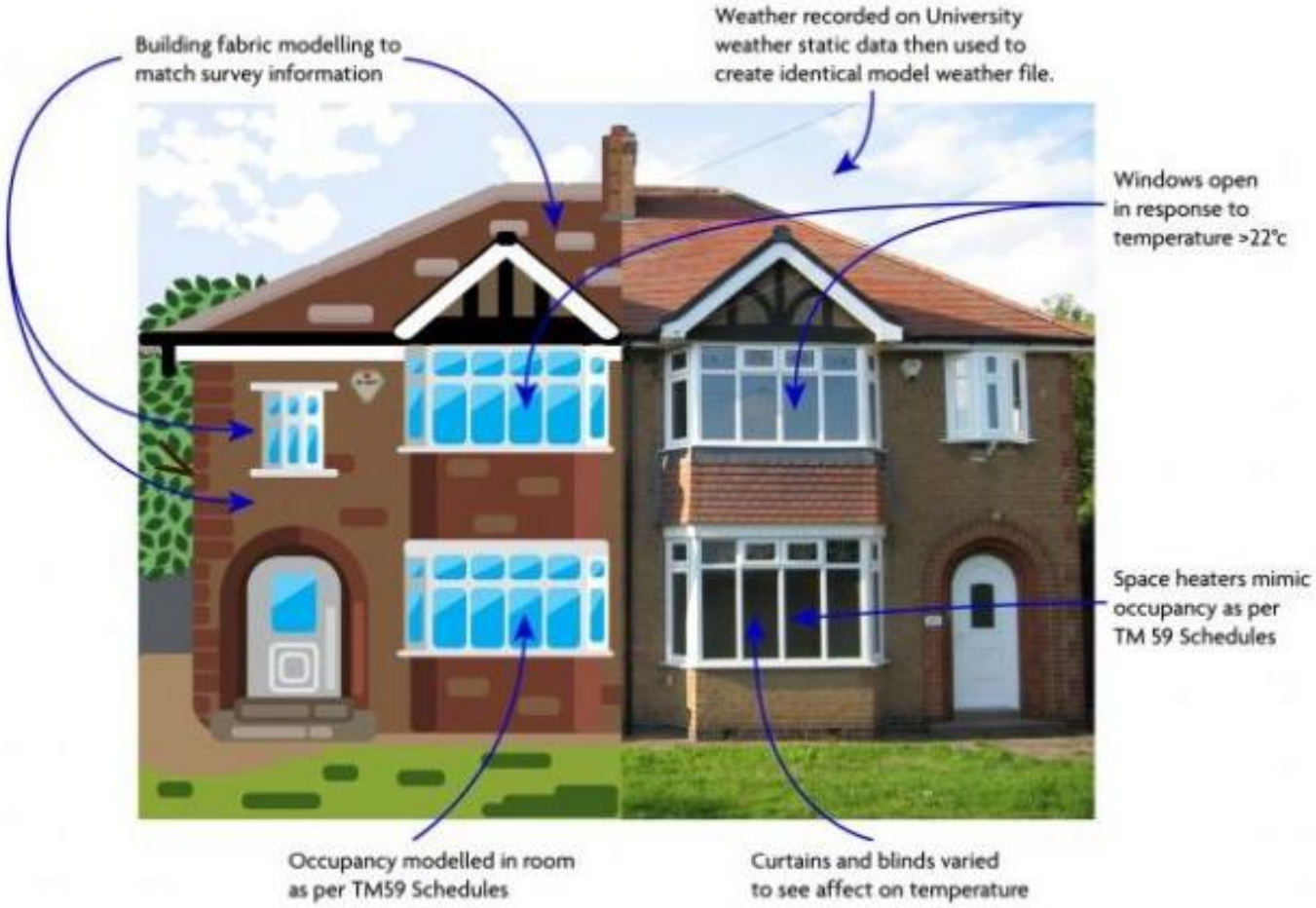
Image credit: Inkling LLP

Loughborough University Matched Pair test houses

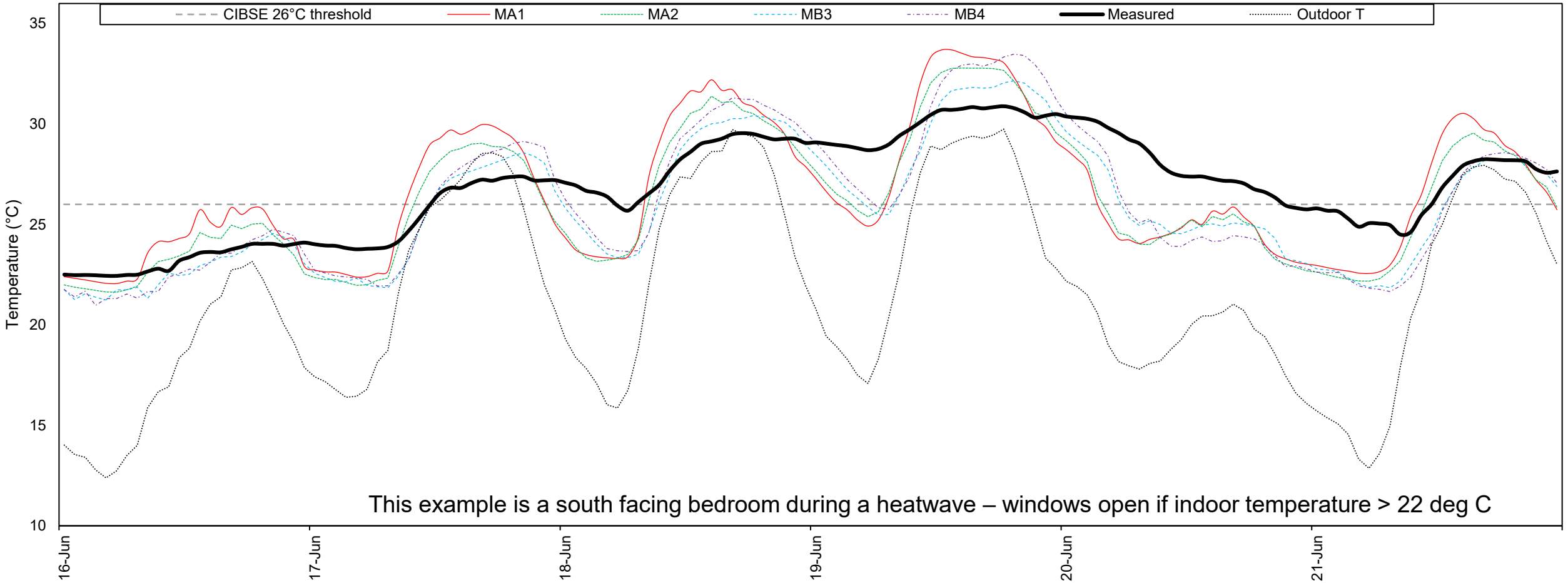
Predicting overheating with dynamic thermal models

Four highly experienced modellers





Roberts et al. (2019) *BSERT*

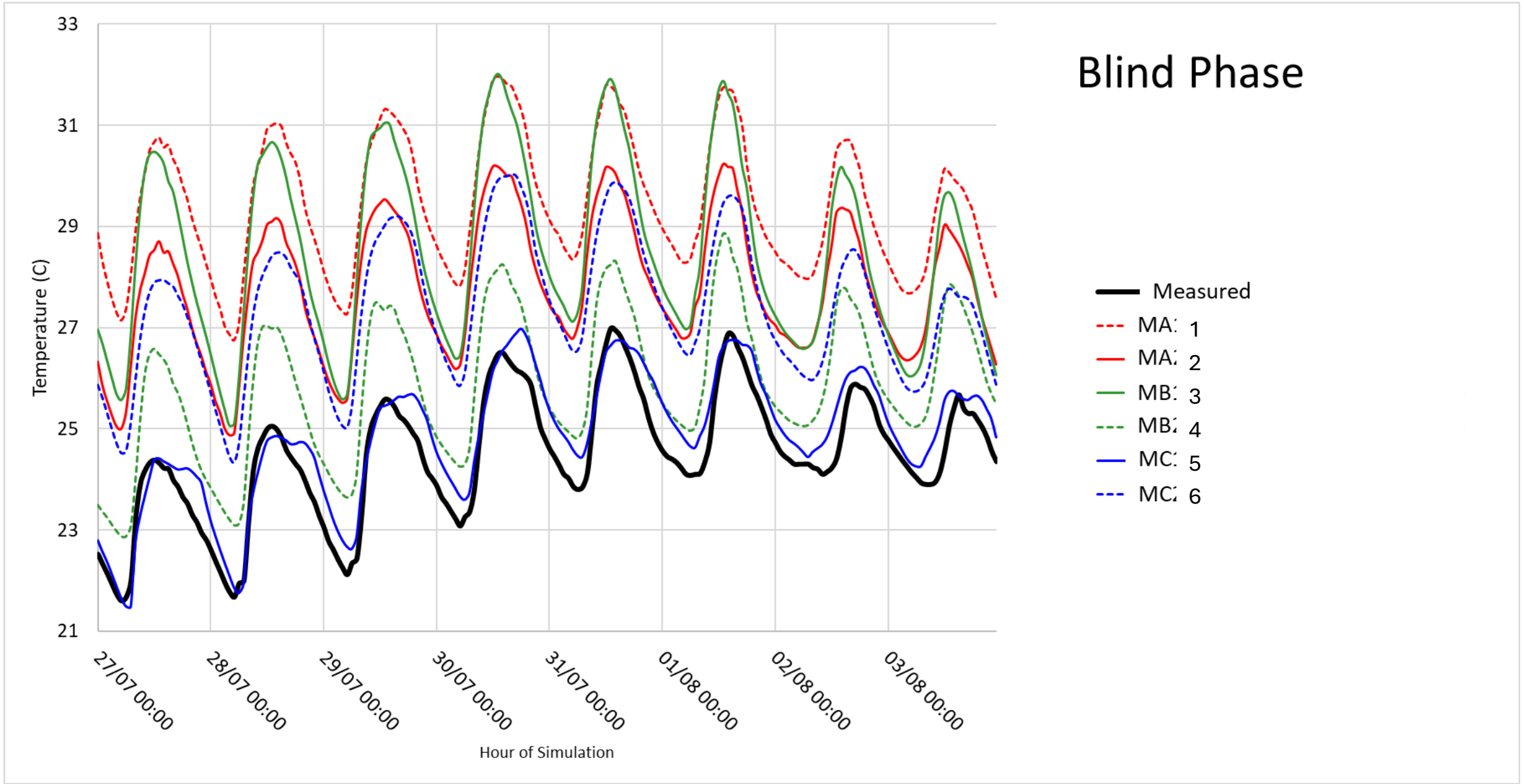


https://doi.org/10.1177/0143624419847349

London, UK

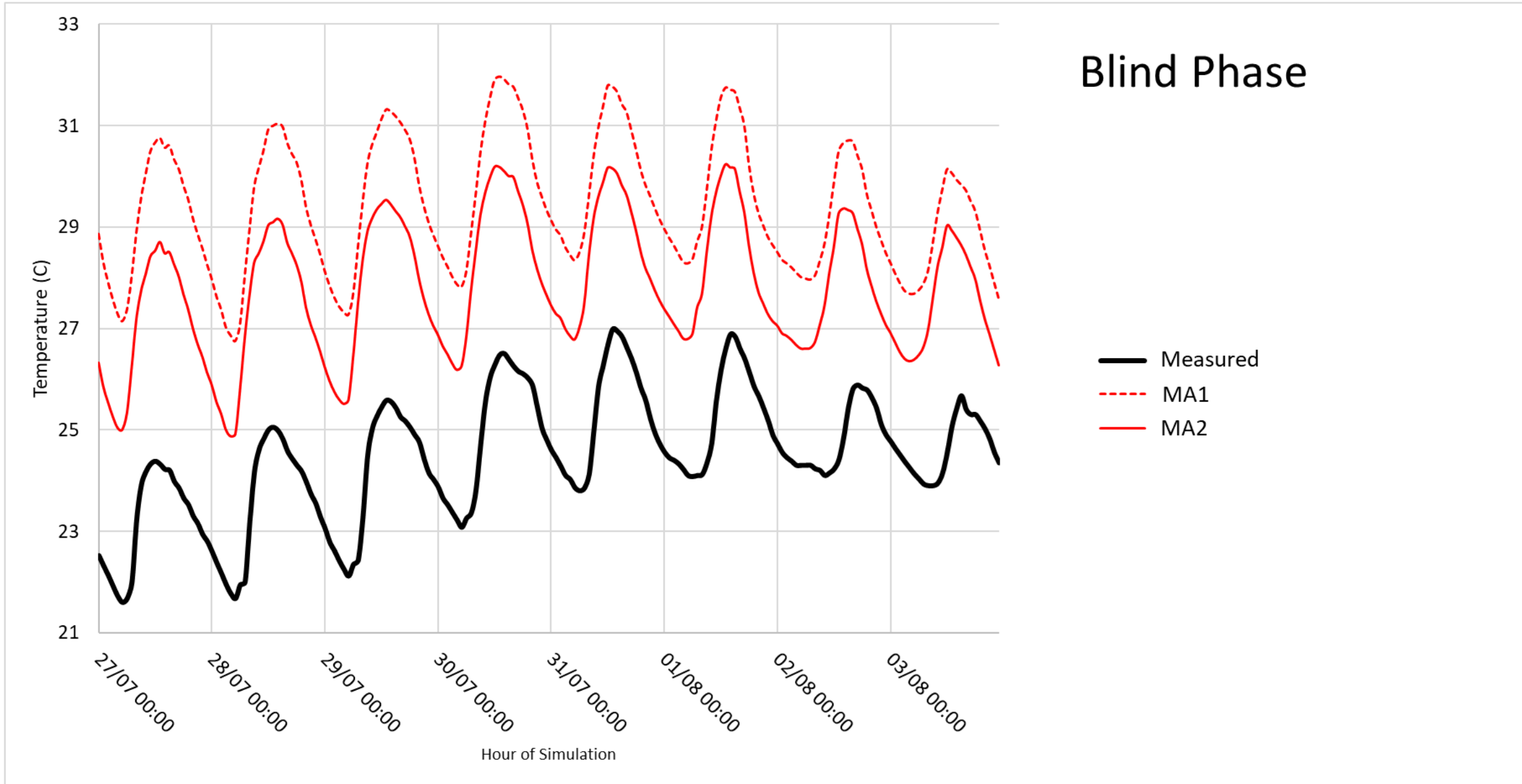
- Brand new apartment.
- Unoccupied.
- Unoccupied above and below.

Living Room - Windows **open**, mechanical ventilation off



Living Room – Software 1

Windows **open**, mechanical ventilation off



Living Room – Software 1

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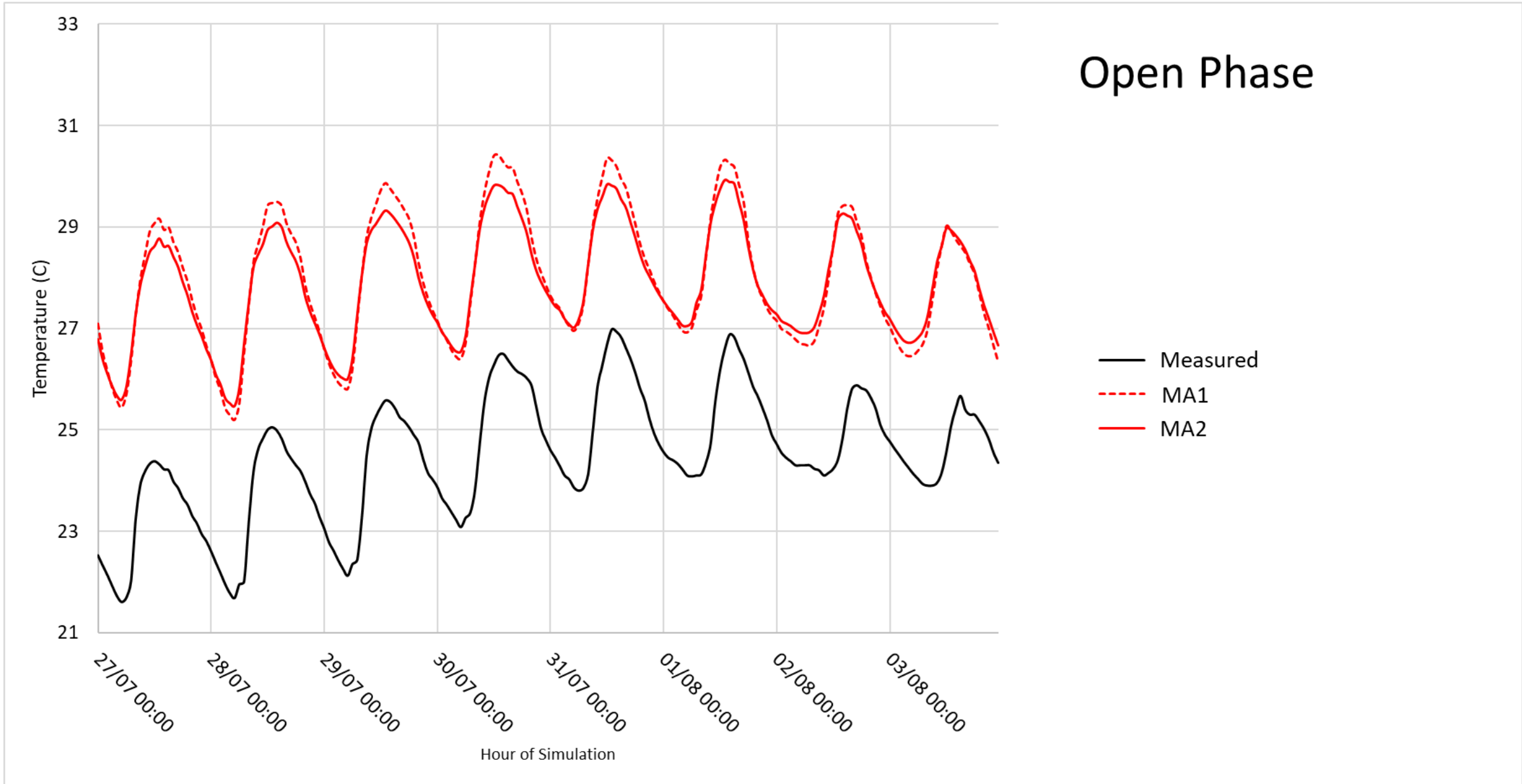
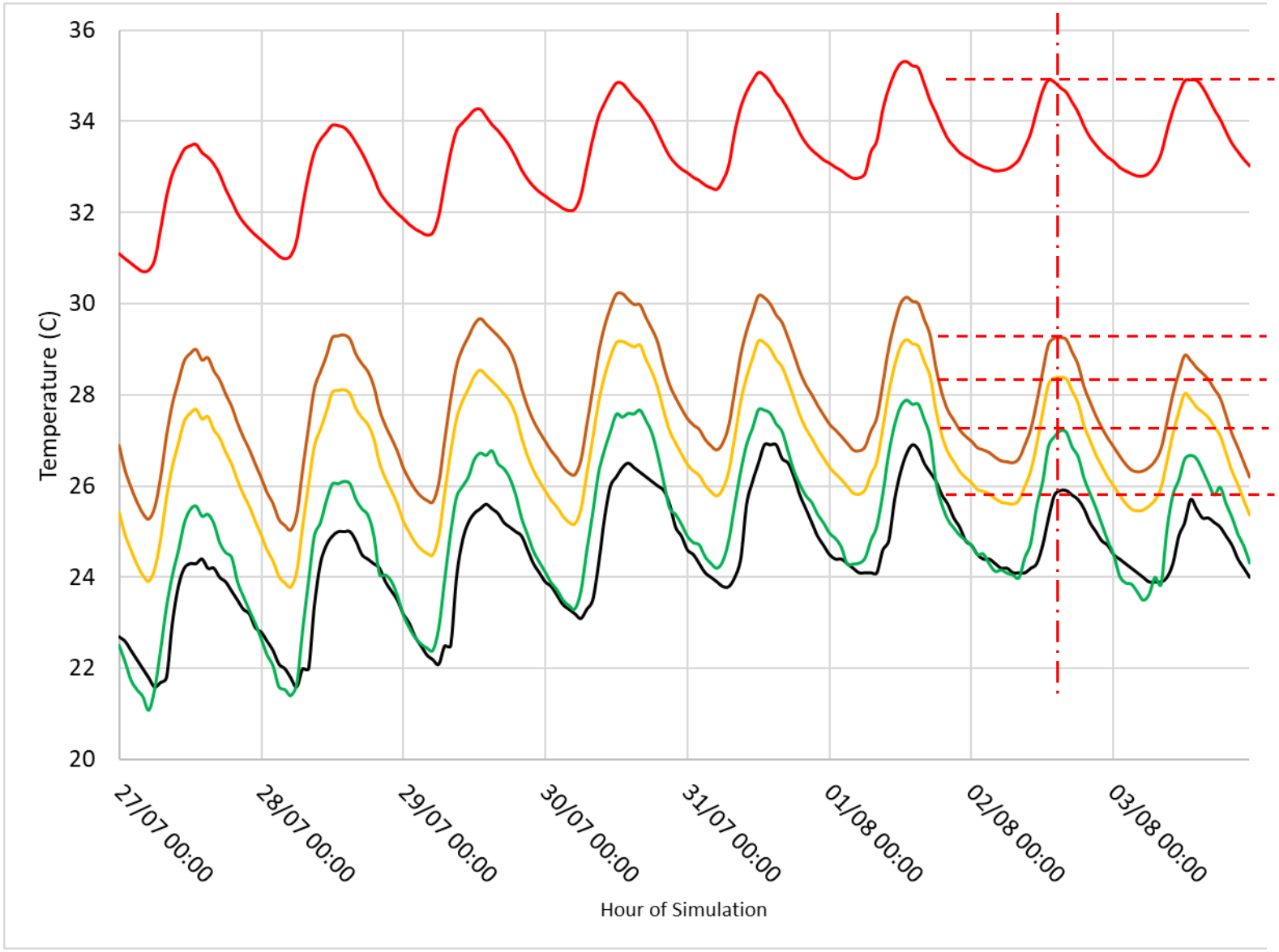


Model Progress – towards alignment



Model alignment, communal corridor, construction details

Window reveals corrected, infiltration to match tracer gas

Dynamic wind driven infiltration through windows frames

Further work – wind and solar review

- Measured
- Initial Model
- Model alignment
- Window and static infiltration correction
- Dynamic wind infiltration

Simulations – summary

- Predicting overheating is difficult in both older and new dwellings
- Input assumptions of modellers
- Issues with the model itself

What’s next?

Preventing overheating

- Keep the sun out
- Maximum ventilation at night
- Minimum ventilation in daytime
- Minimise internal gains
- Air movement?
- Air-conditioning?

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DOI: 10.5334/bc.128

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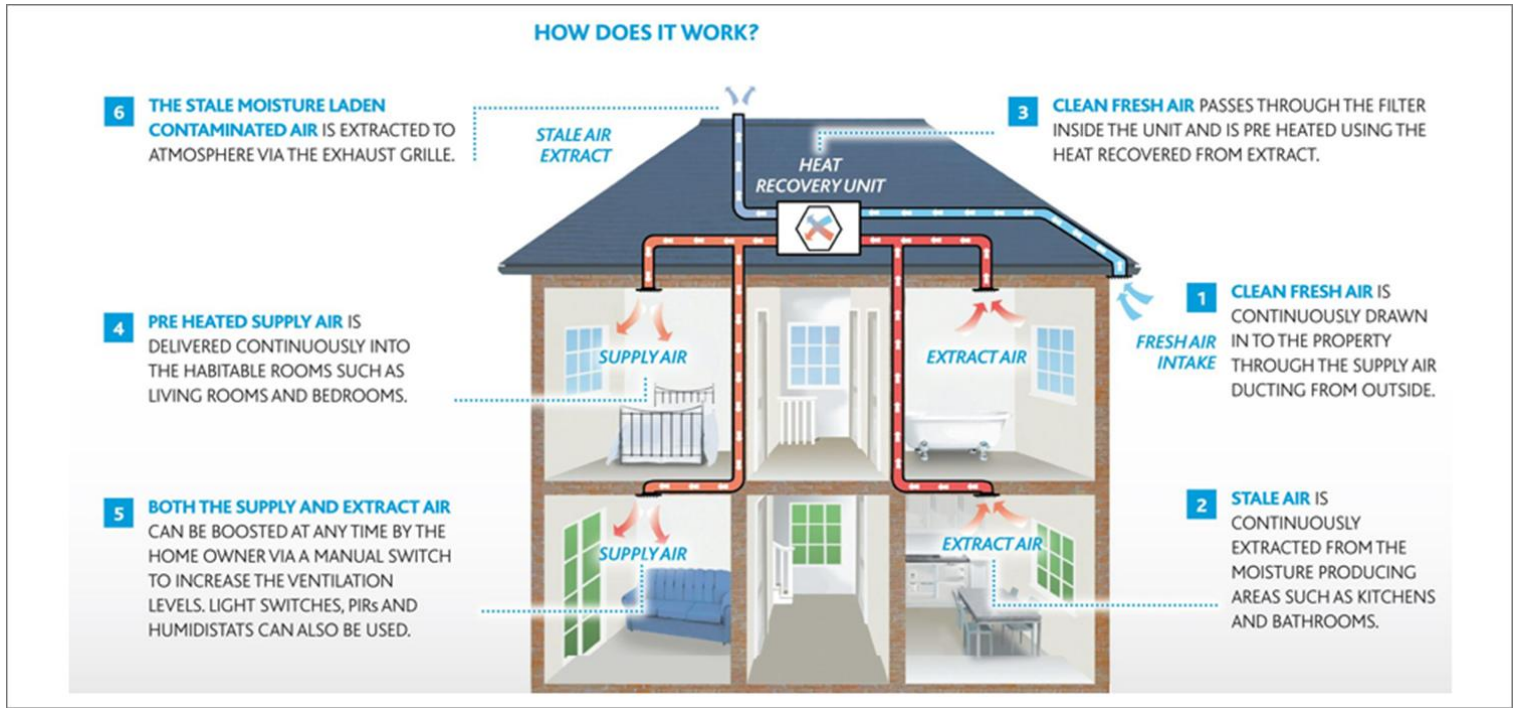

Preventing overheating

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- Minimise internal gains
- Air movement?
- Air-conditioning?

More importantly…

- Making sure that the models that predict overheating are reliable
- Next steps:
  - Investigating simplified models (PhD project nearing completion)
  - Ensuring the models accurately represent shading devices (project underway with partners)
  - More verification of the models by measuring buildings once built

Loughborough University

Contact me

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lboro.ac.uk/departments/abce/staff/ben-roberts/

Thanks to sponsors and collaborators. Any questions?

Engineering and Physical Sciences Research Council

BUILD TEST SOLUTIONS

What’s coming up next…

17 SEPTEMBER 2026

UNIVERSITY OF NOTTINGHAM

BUILD TEST SOLUTIONS

The future of building performance won't be based on promises. It'll be based on proof.

Discover how measurement is helping deliver better buildings, stronger compliance and real-world performance, today.

Conference | CPD | Networking | Exhibition

Aimed at:

Retrofit assessors
DEAs
Architects
Housing providers
Local authorities
Landlords
...and more

6 CPD hours included

Register today

Outline Conference Agenda

Policy update:	Consumer first with WHP and FHS + reflecting on the lessons of ECO and GBIS remedials
	BS40101 update by Kerry Mashford OBE, who has been involved since the outset.
Delivering the promise:	The art of the possible when using building performance measurements in the most effective ways and real-world case studies (BTS)
Heat loss:	Insight from Prof. Richard Fitton, University of Salford and the story behind Heat3D
	Update from Prof. David Allinson, Loughborough University on HTCs and CIBSE TM71
Airtightness:	From concept to Pulse 3.0 on it's 10th birthday - Christopher Wood from the University of Nottingham looks to the future of air tightness
Ventilation:	Understanding how to keep homes both healthy and comfortable whilst also airtight and efficient
Case studies:	A variety of use cases including heritage properties, integrator insights, new build performance investigations and more TBC!

…Plus panel Q&A sessions, networking and carefully curated exhibition to enhance the agenda content

Meet your speakers

Alexander Moseley,
The SEA

Richard Jack,
Build Test Solutions

Richard Fitton,
University of Salford

Chris Wood,
University of Nottingham

Kerry Mashford OBE
Interfacing

Seb Laan Lomas,
Architype

James Parker,
Clarion Housing Group

Stuart Oakes,
Stroma Built Environment

David Allinson,
Loughborough University

Confirmed Exhibitors

STROMA
BUILT ENVIRONMENT / SPECIALIST ACCESS
A PHENNA GROUP COMPANY

AMBUE

FLIR

Thermal IMAGE UK

PURRMETRIX

...with more to follow

Future Diary Dates

- **Training:**

  Level 1 Airtightness
  Pulse upskill from BlowerDoor
  U-value training
  SmartHTC user training

  A range of courses run monthly to suit all levels and requirements

- **Events:**

  BTS Conference
  Nottingham
  17th September

  Elmhurst Conference
  Cardiff
  24th September

  SAVA Expo
  Coventry
  6th October

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Thank you!

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