Overheating Risk Under Future Climate Scenarios: Climate Change Adaptation for Schools

Dr Tim Taylor

Principal Engineer, Cundall (from 26 July)

Email: dr.timothy.taylor@gmail.com

LCAW Schools Summit: Climate Resilient Schools

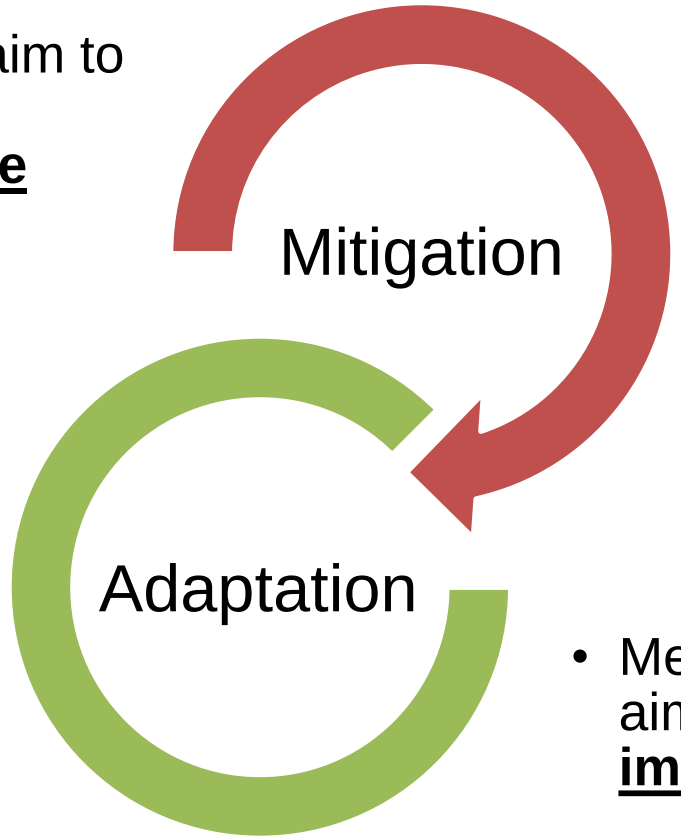
29/06/2021

Agenda

1. Climate change adaptation: UK Government policy overview
2. UK climate projections and summertime temperatures
3. CIBSE School Design Group overheating risk study – key findings
4. School Rebuilding Programme: new sustainability standards
5. Opportunities for adaptation in new and existing schools

How can we embed capacity for *adaptation* when implementing measures for climate change *mitigation*?

- Measures or strategies that aim to limit or prevent emissions of greenhouse gases that **cause** climate change



- Measures or strategies that aim to limit the negative **impacts** of climate change

3

Climate Change Policy: Buildings and Infrastructure

UK Climate Change Act	Building Regulations	Climate Change Risk Assessment (CCRA)	National Adaptation Programme (NAP)
BEIS	MHCLG	Committee on Climate Change	DEFRA

Future Climate Projections

UK Climate Projections (UKCP) were updated in 2018

- **Updated methodology:** UKCP18 uses “Representative Concentration Pathways” (RCPs) instead of the emissions scenarios developed for UKCP09
- The UKCP18 methodology produces broader ranges in comparison to UKCP09 to "give a fuller picture of plausible changes that reduces the risk of overconfident decision-making“
- **Uncertainties in emissions pathways and uncertainty in climate response** have a comparable impact on the range of outcomes

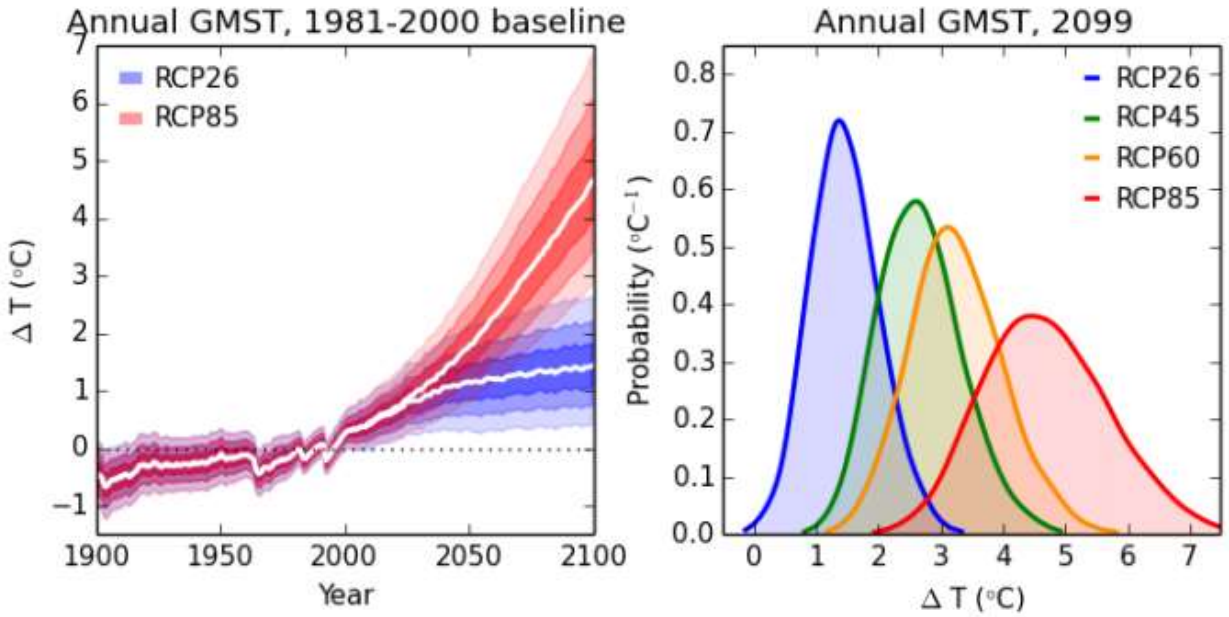


Figure 2.8. Comparison of probabilistic projections of annual GMST (°C) from Strand 1, for different emissions scenarios. Left panel (red shading) shows the 5, 10, 25, 75, 90 and 95% probability levels of the time-evolving distributions under historical changes in radiative forcing to 2005, and future responses to the RCP8.5 scenario from 2006-2100. Blue shading shows the same probability levels for the 21st century response to RCP2.6. The white lines show the medians of the relevant probability distributions. Anomalies are calculated relative to the 1981-2000 baseline. Right panel shows probability distributions of change for 2099, for the RCP2.6, 4.5, 6.0 and 8.5 scenarios.

Image source: Met Office UKCP18 Land Projections: Science Report November 2018
https://www.metoffice.gov.uk/pub/data/weather/uk/ukcp18/science-reports/UKCP18-Land-report.pdf

UKCP18 analysis of 2°C and 4°C global warming

Impact of 2°C global warming on the UK

- Median warming will be at least 1 to 2°C throughout the year across the whole of the UK
- **Summer temperatures in the SE of England may increase another 3 to 4°C** (relative to 1981-2000 baseline)
- Winter cool days will warm by 1 to 1.5°C across the country, whilst temperatures on warmer winter days increase by less than 1°C

Impact of 4°C global warming on the UK

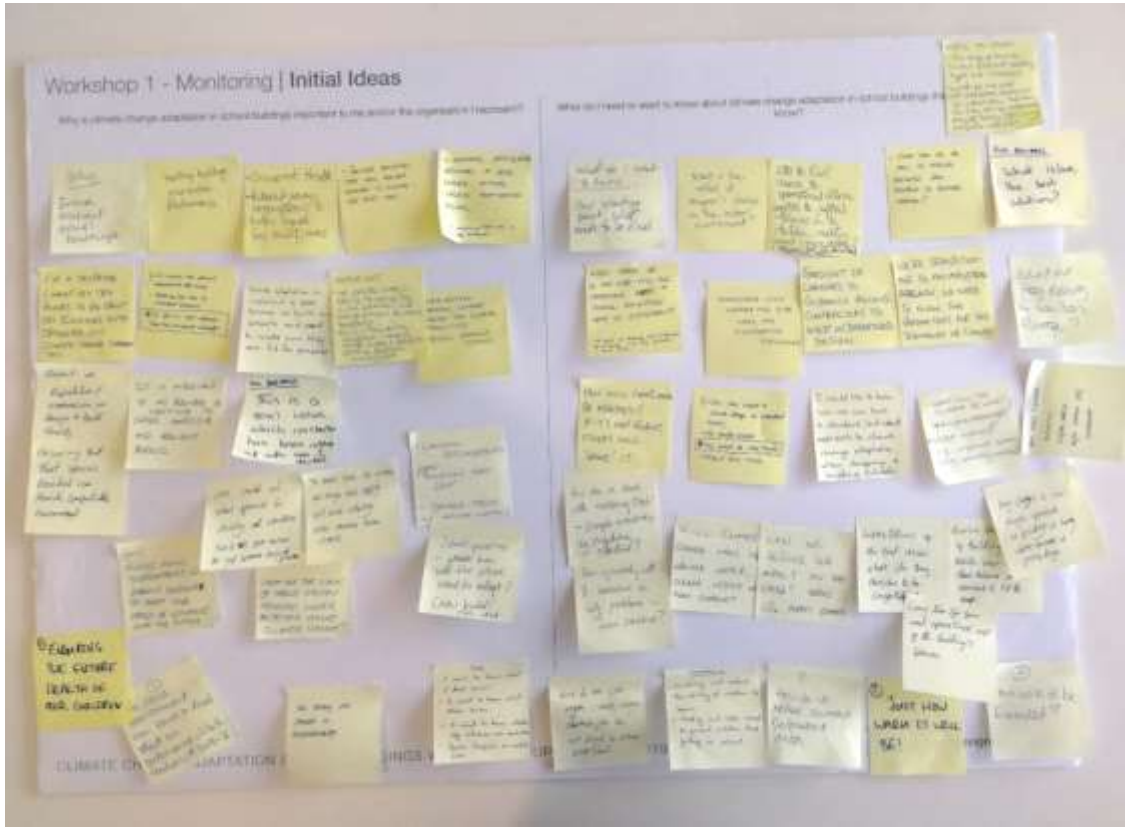
- **Summer temperatures rise by another 4 to 5°C in the south of England and 3 to 4°C elsewhere**
- Hot summer days warm by 4.5 to 5°C across much of Southern England, possibly exceeding 5°C in some places (relative to 1981-2000 baseline)
- Cool winter days warm by 2.5 to 3°C across the country
- Warm winter days warm by 2.5 to 3°C in England but by 2 to 2.5°C in Wales and Scotland

Source: UKCP18 Factsheet: Derived projections
https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-fact-sheet-derived-projections.pdf

CIBSE School Design Group

In 2019 the CIBSE School Design Group convened a Climate Change Adaptation working group to share knowledge and promote good practice in adapting school buildings to future climate.

The work of the group aimed to engage industry-wide stakeholders to develop a balanced and collaborative range of recommendations.



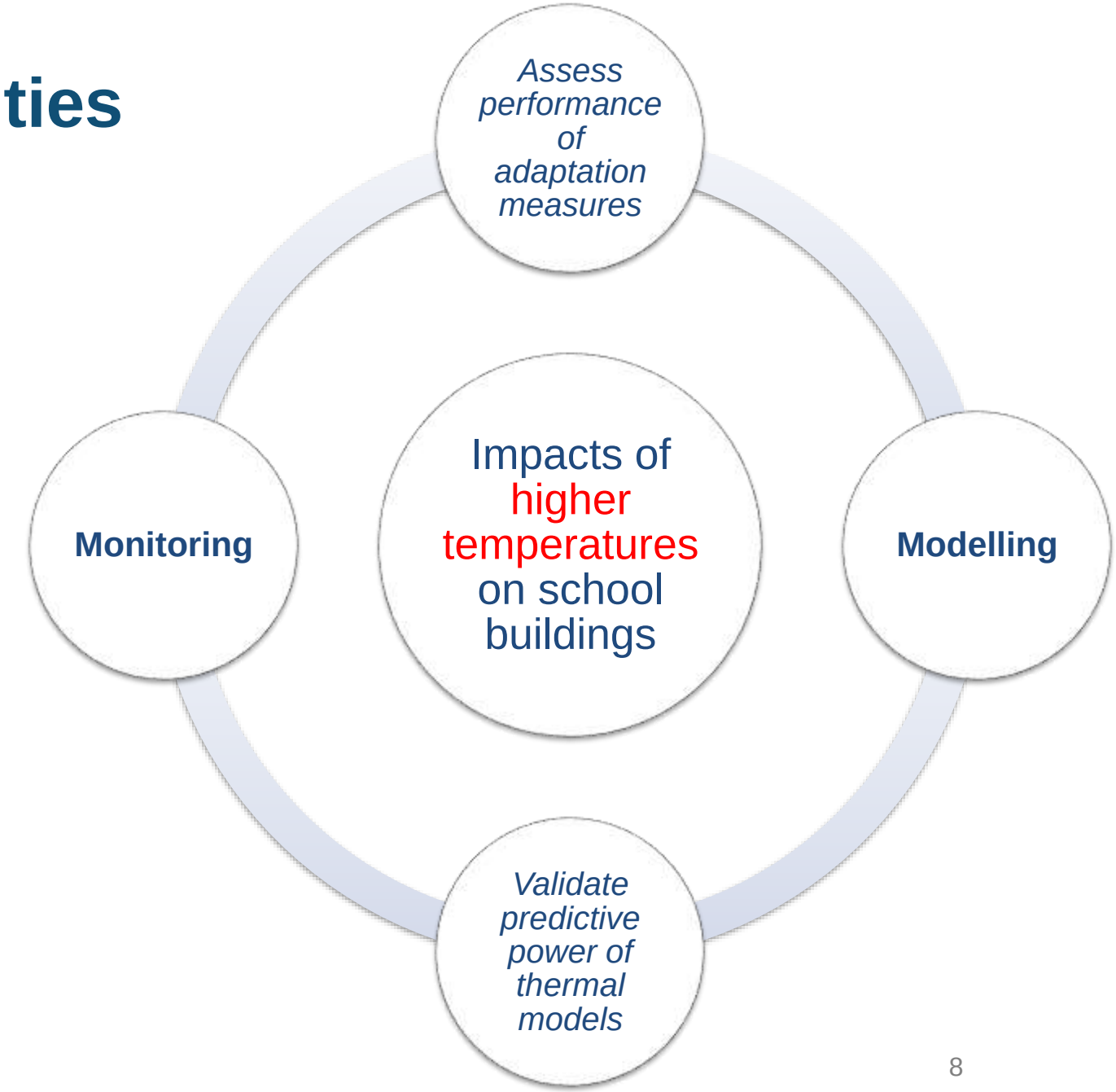
Working Group Activities

Modelling workstream

Testing performance of recent school designs under future climate scenarios

Monitoring workstream

Gathering data on how school buildings are performing under current climate conditions



Future Climate Modelling Brief

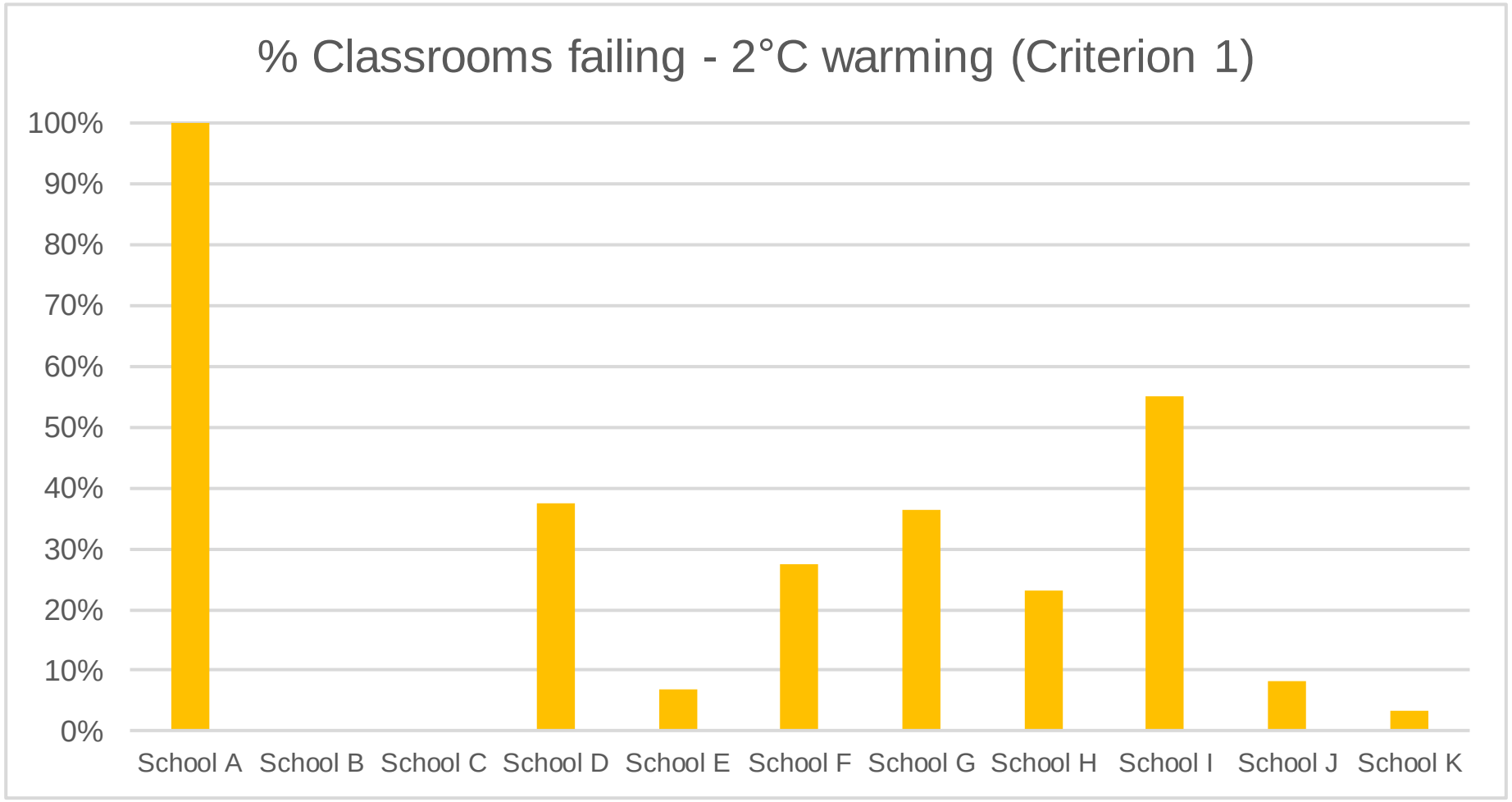
- Modelling based on BB101 overheating risk assessment methodology
- Data collected on schools designed to the most recent standards (i.e. to the requirements of the Facilities Output Specification 2013 or later)
- Spreadsheet pro-forma circulated to consultants and contractors engaged on DfE procurement frameworks
- Results anonymised and checked
- 11 schools included in dataset

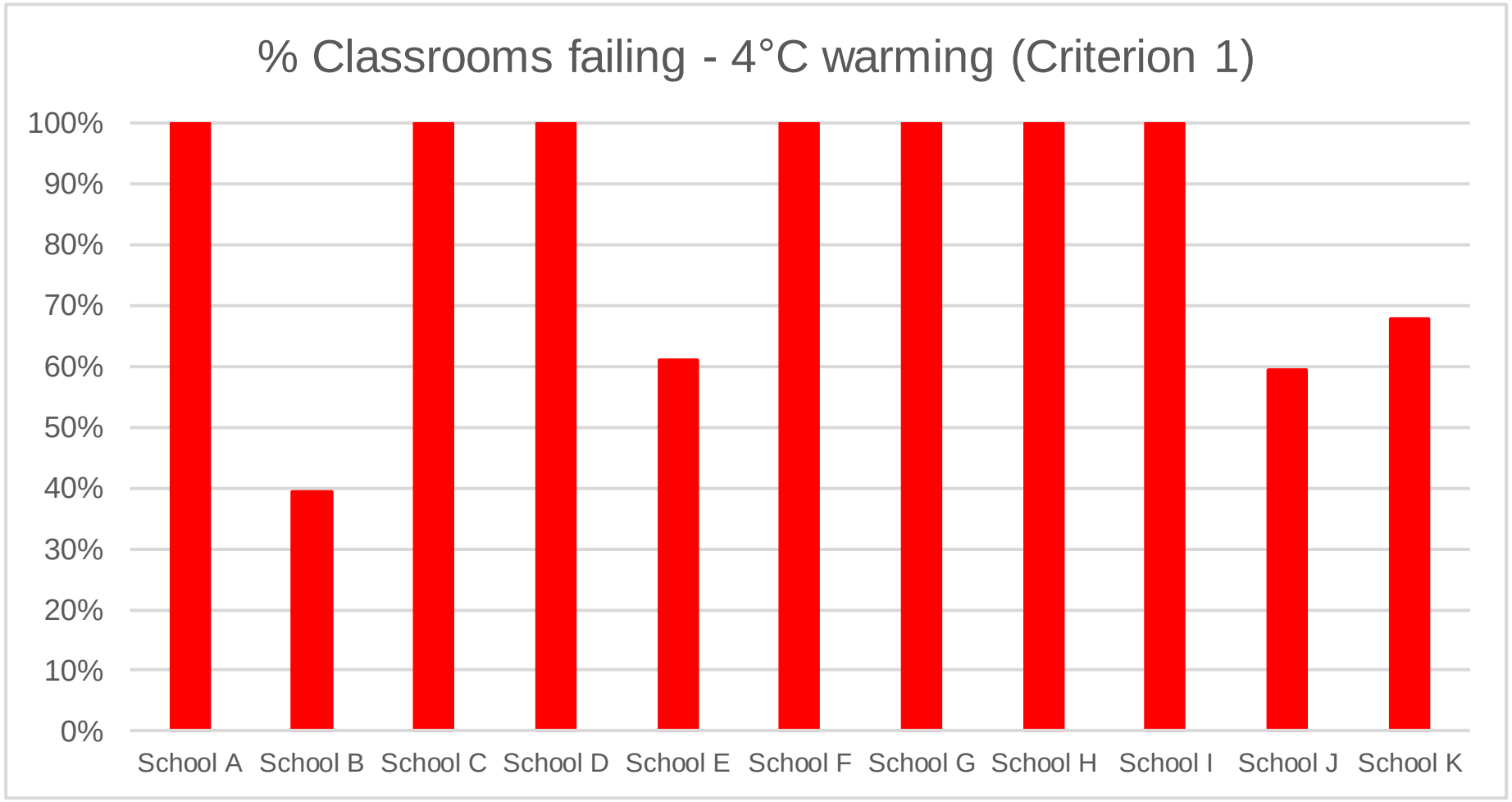
9

School Characteristics

- Majority are new-build secondary schools, with one primary school and a SEN/special school. Generally located in urban or suburban contexts.
- Locations represented by four different CIBSE weather files: Birmingham, Norwich, Leeds and London (London Weather Centre).
- Floor area of the schools ranged from 1,370m^2 to 9,480m^2. Mix of building form typologies, from simple rectangular plan to “superblock”.
- Glazing proportion for standard classrooms ranged from 25% to 52%.
- Majority of schools used a hybrid, single-sided ventilation strategy. Most have thermal mass. All incorporated some form of night-purge strategy.

10


% Classrooms failing - 2°C warming (Criterion 1)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
School A
School B
School C
School D
School E
School F
School G
School H
School I
School J
School K


% Classrooms failing - 4°C warming (Criterion 1)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
School A
School B
School C
School D
School E
School F
School G
School H
School I
School J
School K

Findings

- Some incidences of classrooms failing the BB101 overheating risk assessment with 2°C global warming. Majority of classrooms are failing the BB101 overheating risk assessment with 4°C global warming.
- Variation in results partly attributable to location and environmental design strategy.
- Some design strategies may have greater resilience than others e.g. cross-ventilation vs. single-sided ventilation.
- Differences in modelling methodologies:
  - *Ventilation openings and systems*
  - *Use of internal blinds*
- Modelling needs to reflect school user and management behaviours.

School Rebuilding Programme (SRP)

- A 10-year rebuilding and refurbishment programme for schools and sixth form colleges in England
- First phase with a value of £1bn begins this year
- New sustainability standards incorporated in the S21 specification

- **“All new school buildings in England must be net zero carbon in operation as part of the S21 output specification… Other changes include a greater emphasis on ventilation, outdoor learning spaces and use of landscape as part of climate change mitigation.”**

“What the School Rebuilding Programme means for architects” RIBA Journal, 14 May 2021

Strategy	Measure type	Adaptation Measure
Reduce internal heat gains	Low energy equipment	Energy efficient lighting
		Energy efficient IT equipment
	Occupancy regime	Reduce occupancy density
		Occupancy scheduling to reduce heat exposure
Remove excess heat	Increase ventilation rate	Natural ventilation (e.g. openable windows, louvres, wind catchers)
		Mechanical ventilation
	Reduce temperature of ventilation supply air	Evaporative cooling
		Ground coupling e.g. earth tubes
Reduce operative temperature	Increase air movement	Ceiling fans
	Thermal storage	Exposed thermal mass with night purge cooling
Reduce exposure (external heat gains)	Building fabric	Thermal insulation
		Green roof / cool roof (high albedo)
	Glazing	Low g-value glazing or solar film retrofit
	Solar shading	External shading elements (moveable/fixed) e.g. brise soleil
		Tree planting
		Building massing and orientation
	Landscaping/surface treatment	Green surfaces and water features

"Continuing to design for yesterday's climate is exposing our buildings and their occupants to significant risks. ***Hot summers and heat waves, as well as floods and drought, are expected to become more common with climate change. In many cases simple, low cost design changes can make all the difference*** *- creating better spaces in which to live and work, able to safeguard peoples' health and productivity, and cope more readily with weather extremes."*

- **Daniel Johns, Head of Adaptation, Committee on Climate Change**

Thank you

dr.timothy.taylor@gmail.com