Climate Change Adaptation

Understanding the Risks

Hershil Patel, Head of Energy, Department for Education

Dr Tim Taylor, Consultant (part-time secondment at DfE)

Workshop at SPACES Study Day 2019 – Education

20/06/2019

Department
for Education

Workshop Agenda

1. Mitigation and adaptation
2. Emerging findings of building in-use surveys
3. Overview of DfE standards and guidance
4. Climate change: latest science and impacts on the built environment
5. CIBSE Schools Climate Change Adaptation Working Group
6. Steps to climate-resilient schools
7. Q&A

Department
for Education

Mitigation versus Adaptation

Mitigation

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

Adaptation

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

Department for Education

Climate Change Policy: Buildings and Infrastructure

UK Climate Change Act 2008	Building Regulations	Climate Change Risk Assessment (CCRA)	National Adaptation Programme (NAP)
BEIS	MHCLG	Committee on Climate Change	DEFRA

Department for Education

Building In-Use Surveys

Emerging Findings & DfE Standards and Guidance Update

Department
for Education

Building In-use Surveys

- **Why -** We are entrusted with billions of pounds of public money. We must continue to ask how this money can be spent most effectively.
- **What -** Functionality, Health and Safety , Standardisation, Future proofing, Minimum Life Expectancy & Sustainable Design
- **Where -** 70 school buildings across major capital programmes
- **When -** Buildings open 2-3 years on average
- **Who –** Technical and Non-Technical end users

Department
for Education

Summer Temperatures and Ventilation

- **Circa 50%** of respondents are uncomfortable or very uncomfortable with **temperatures** or **ventilation** in summer

In the free text -

- **56%** of comments mentioned temperature or ventilation, noting;
  - Did not know how to control temperature/ventilation
  - Struggled with central controls and wanted local controls

Summer Temperatures and Ventilation

- **44%** disagree or strongly disagree that "In summer the classrooms are comfortable"
- **34%** disagree or strongly disagree that "The comfort level in the classroom is easy to control"

- **31%** of respondents agreed or strongly agreed that "The non-technical building user guide for non- technical staff is effective"
- **17%** noted that they had not received or were not aware of such a user guide

Monitored Data

Performance in Use Data (Overheated Rooms)

- **Data Source** – Data provided to iSERV (K2n Platform)
- **Notes** – Analysis excludes review of
  - operation strategy and user behaviour
  - any maintenance carried out
  - system specification
  - the severity of overheating

Department for Education

CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD

K2n
W: www.k2nenergy.com
E: info@k2nenergy.com

BB101 Performance In-Use Criteria

- It shall be possible to demonstrate within spaces……

that are occupied for more than **30 minutes** at a time that,

→ **during** the school day,

→ the average **internal air temperature** does not exceed the **average external air temperature** measured over an occupied day **by more than 5ºC;**

↓

both temperatures being averaged over the time period when the external air **temperature is 20ºC, or higher**

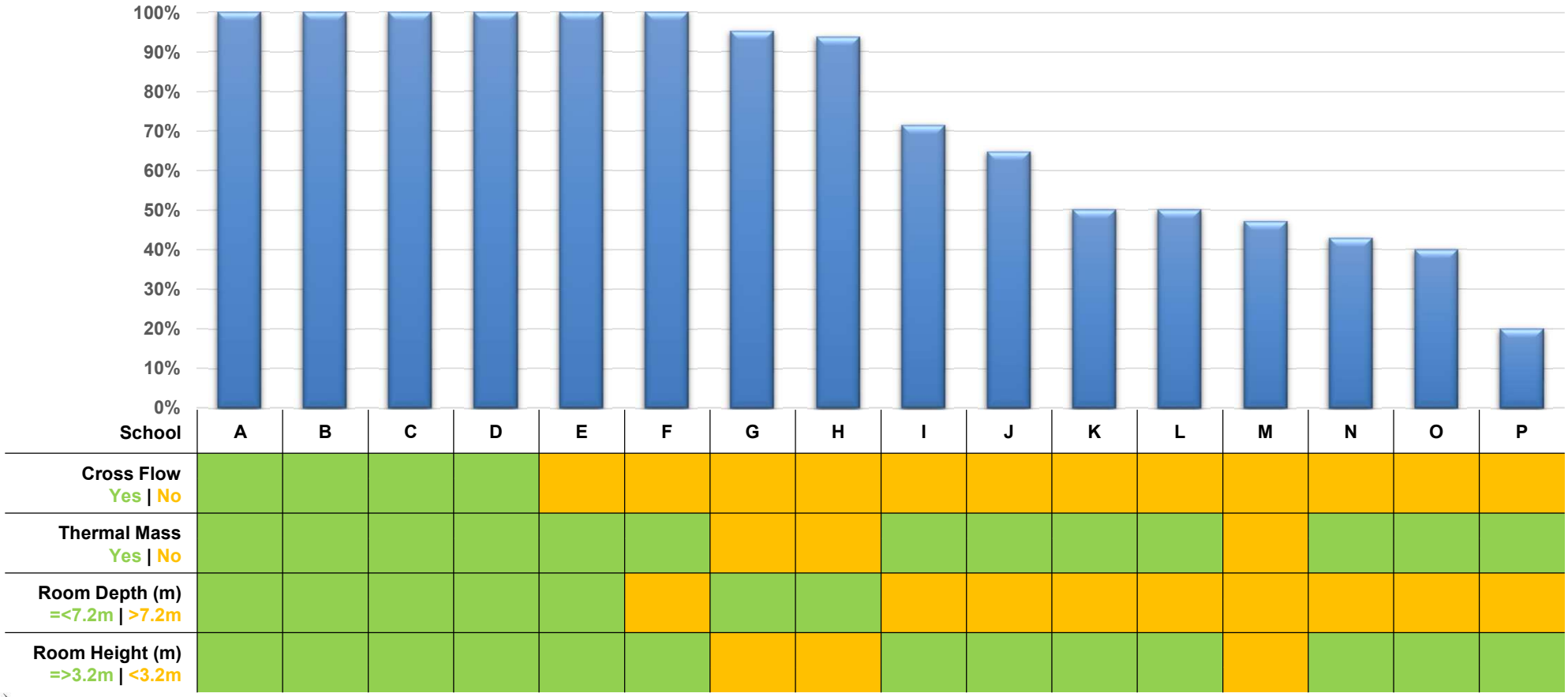
→ except when the **diurnal temperature range is less than 4ºC**.

The buildings shall be able to achieve temperatures within the acceptable range when windows, fans and ventilation systems are operated to reduce summertime temperatures, and the space has the intended number of occupants, numbers and types of computers, data projectors and other ICT equipment.

Department for Education

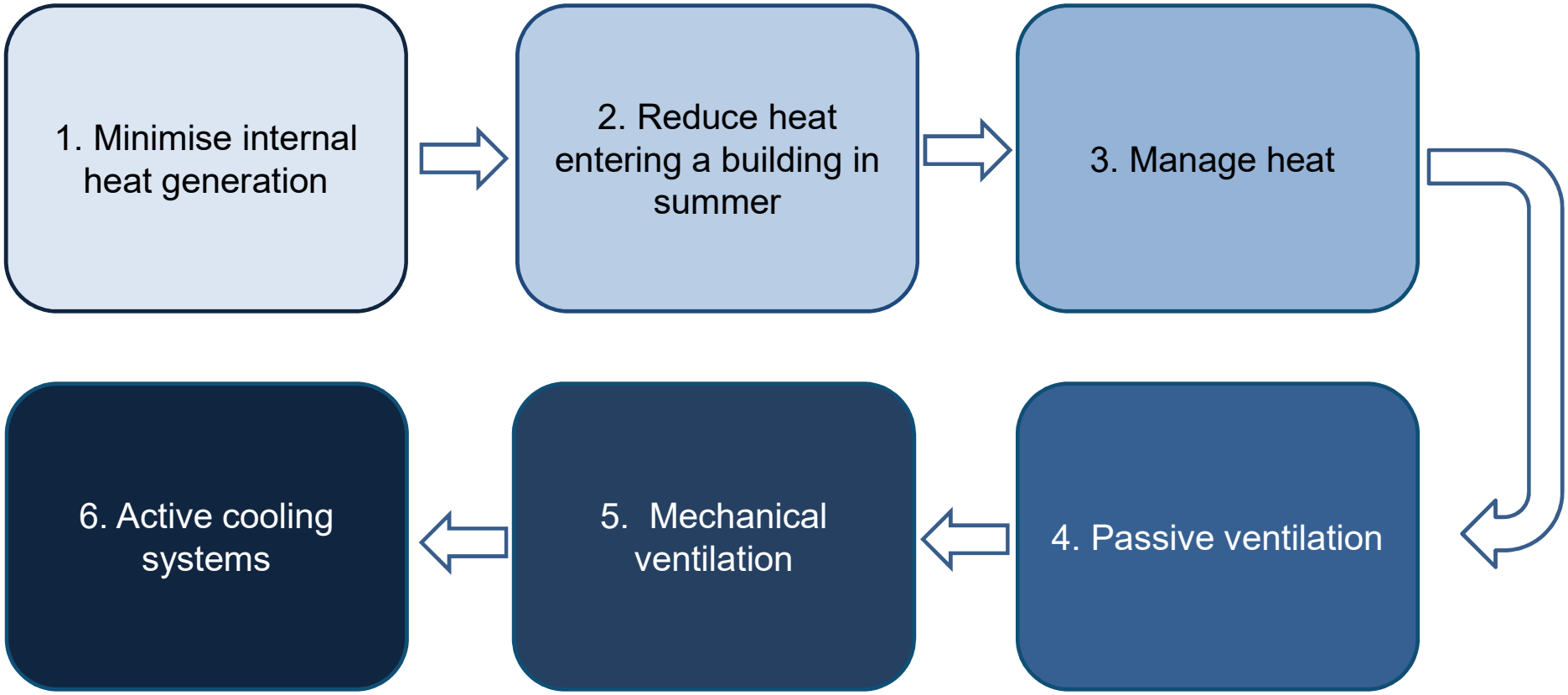
BB101 (2018) – Section 7.7.1

% of Occupied Rooms NOT Overheating



Department for Education

Cooling Hierarchy



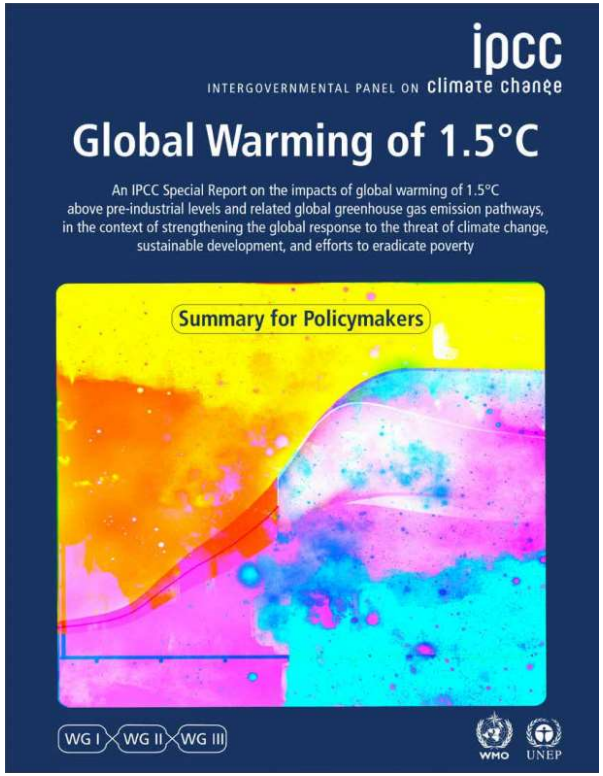
Department for Education

Climate Change

Latest science and impacts on the built environment

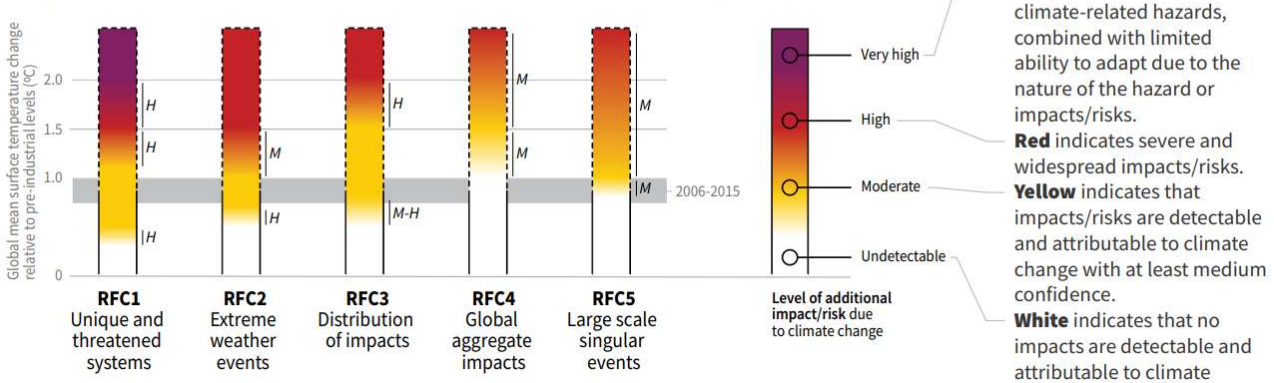
Department
for Education

IPCC 1.5 Degrees Special Report



Five Reasons For Concern (RFCs) illustrate the impacts and risks of different levels of global warming for people, economies and ecosystems across sectors and regions.

Impacts and risks associated with the Reasons for Concern (RFCs)



Purple indicates very high risks of severe impacts/risks and the presence of significant irreversibility or the persistence of climate-related hazards, combined with limited ability to adapt due to the nature of the hazard or impacts/risks.
Red indicates severe and widespread impacts/risks.
Yellow indicates that impacts/risks are detectable and attributable to climate change with at least medium confidence.
White indicates that no impacts are detectable and attributable to climate change.

Image source: IPCC Special Report Global Warming of 1.5°C – Summary for Policymakers
https://www.ipcc.ch/sr15/

News story

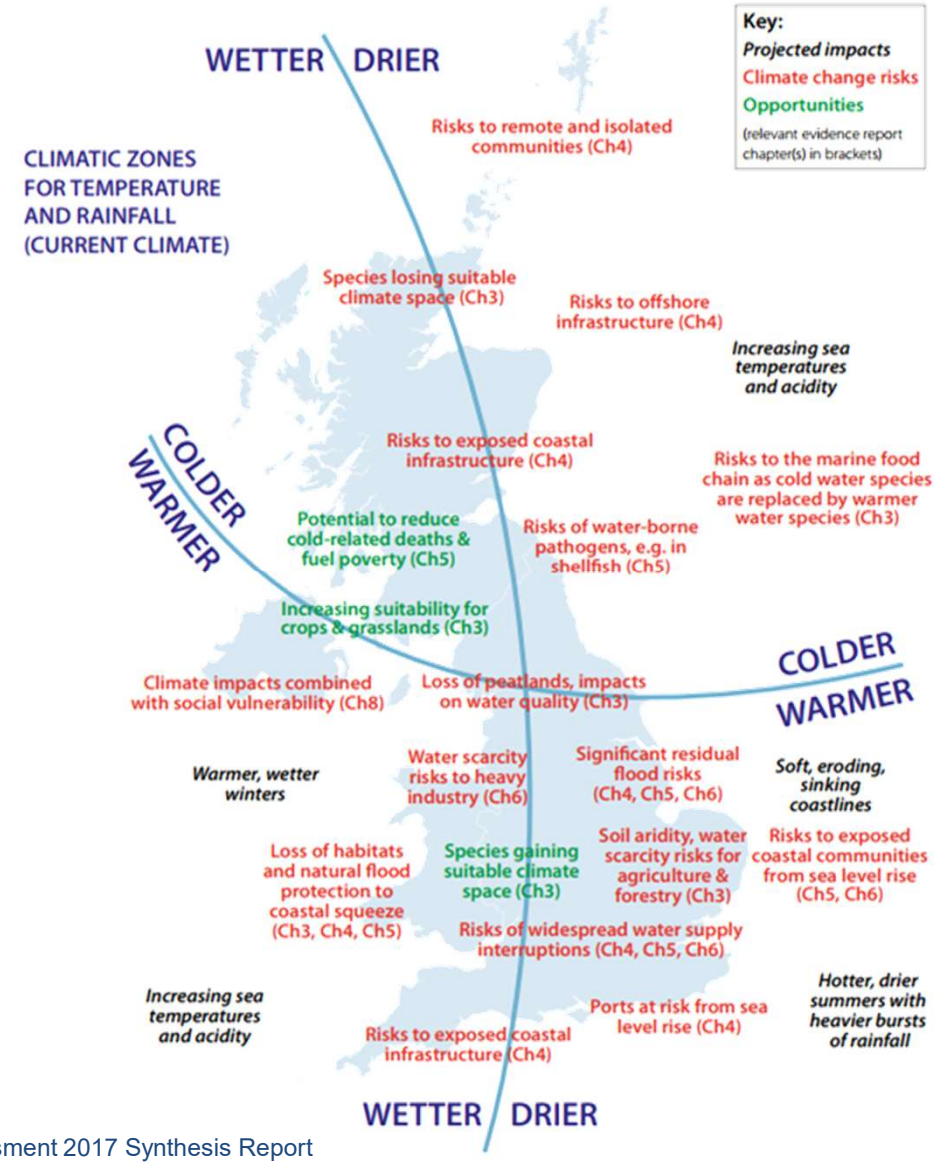
Government announcement to end UK's contribution to climate change

Department for Education

The Challenge

"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**



Department for Education

Image source: UK Climate Change Risk Assessment 2017 Synthesis Report
https://www.theccc.org.uk/wp-content/uploads/2016/07/UK-CCRA-2017-Synthesis-Report-Committee-on-Climate-Change.pdf

Impacts on the Built Environment

- The risks of climate change to the built environment include:
  - Risks to comfort, energy use and health and wellbeing;
  - Risks that affect construction; and
  - Risks in managing water.
- Can we map the level of risk across the school building stock in order to inform future capital investment programmes?

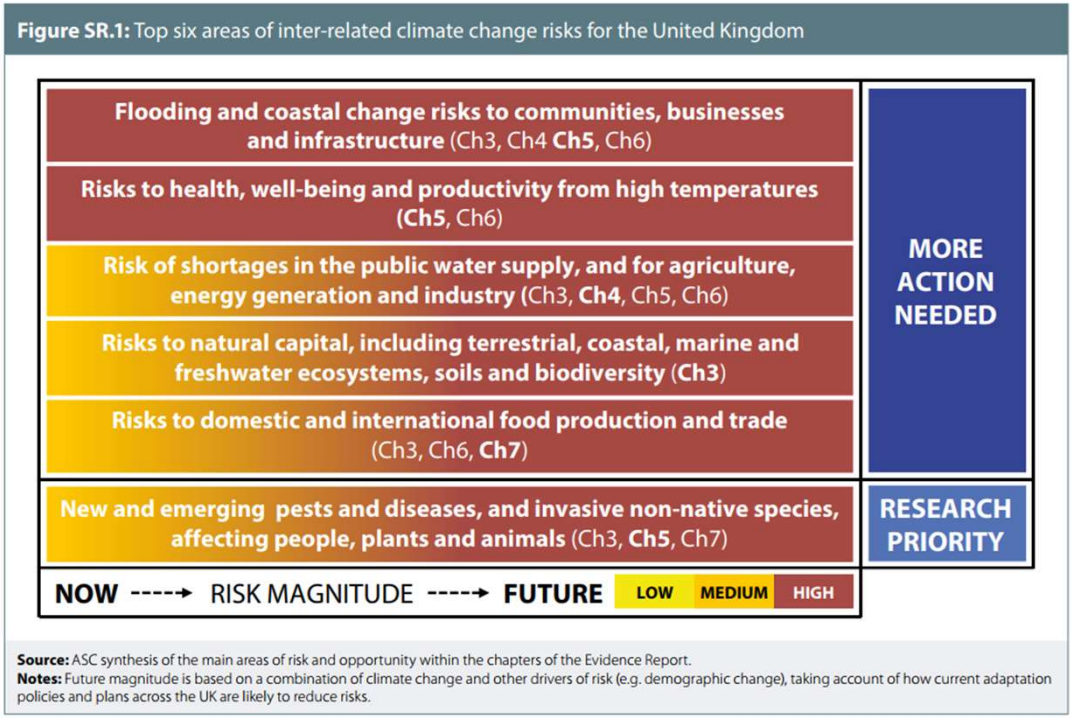


Image source: UK Climate Change Risk Assessment 2017 Synthesis Report https://www.theccc.org.uk/wp-content/uploads/2016/07/UK-CCRA-2017-Synthesis-Report-Committee-on-Climate-Change.pdf

Department for Education

UK 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

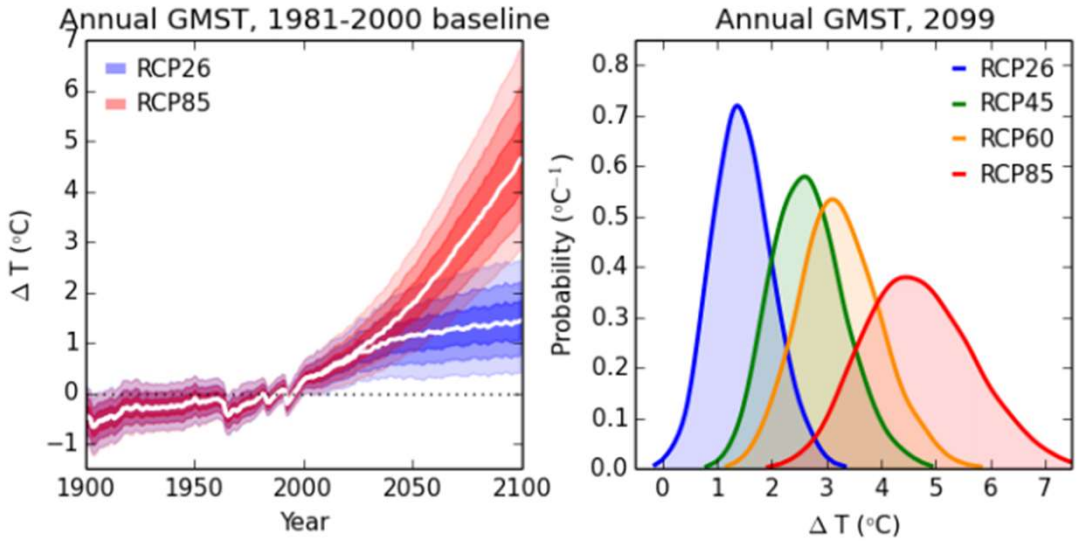
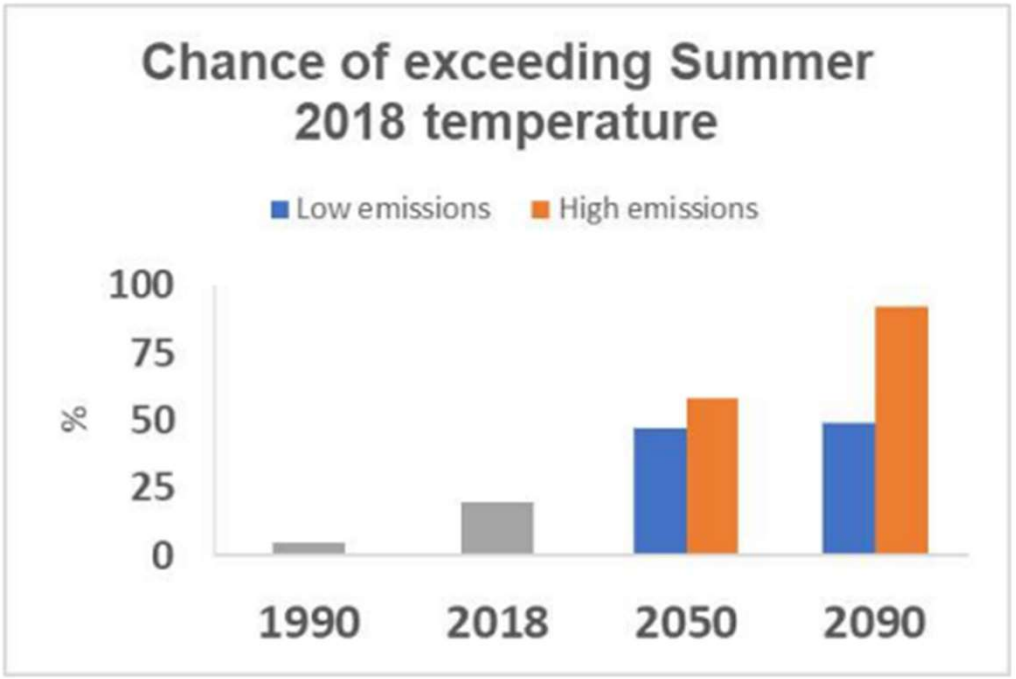


Figure 2.8. Comparison of probabilistic projections of annual GMST (°C) from Strand 1, for different emissions scenarios. Left panel (red shading) shows the 5, 10, 25, 75, 90 and 95% probability levels of the time-evolving distributions under historical changes in radiative forcing to 2005, and future 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

2018 summer heatwave – the norm by 2050?

- Chance of such hot summers low in the baseline period (<10%)
- By mid-century the chance of hot summers will be of the order of 50%
- Beyond 2050 the chance of a warmer summer more strongly depends on emission scenario



Department for Education

Source: UKCP18 National Climate Projections Overview Slidepack
https://www.metoffice.gov.uk/binaries/content/assets/mohippo/pdf/ukcp18/ukcp18-overview-slidepack.ff-compressed.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

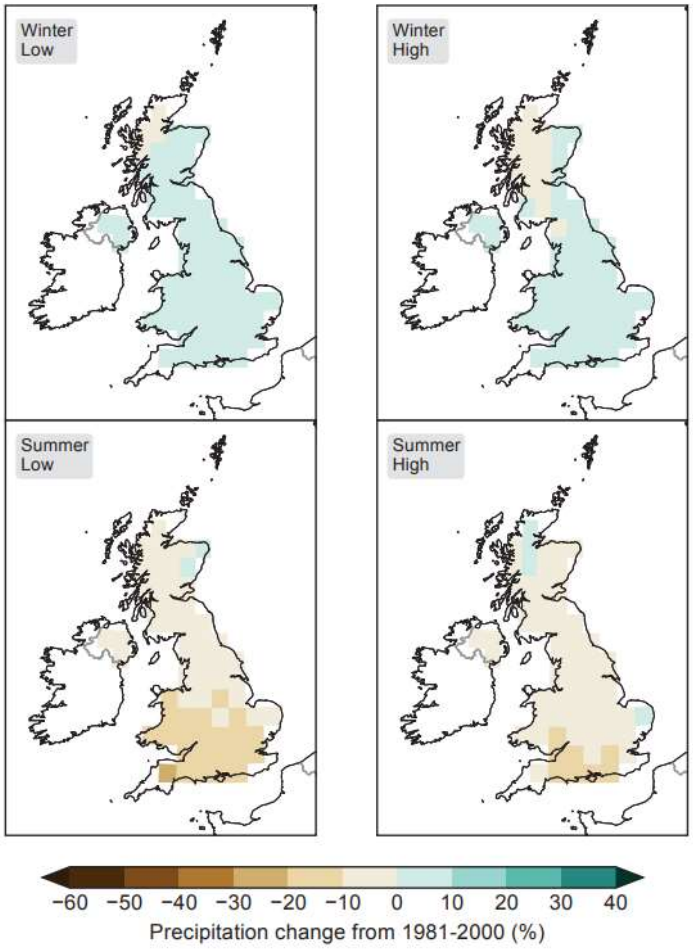
- **Summer temperatures rise by another 4 to 5°C in the south of England and 3 to 4°C elsewhere**
- Hot summer days warm by 4.5 to 5°C across much of Southern England, possibly exceeding 5°C in some places (relative to 1981-2000 baseline)
- Cool winter days warm by 2.5 to 3°C across the country
- Warm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

Department for Education

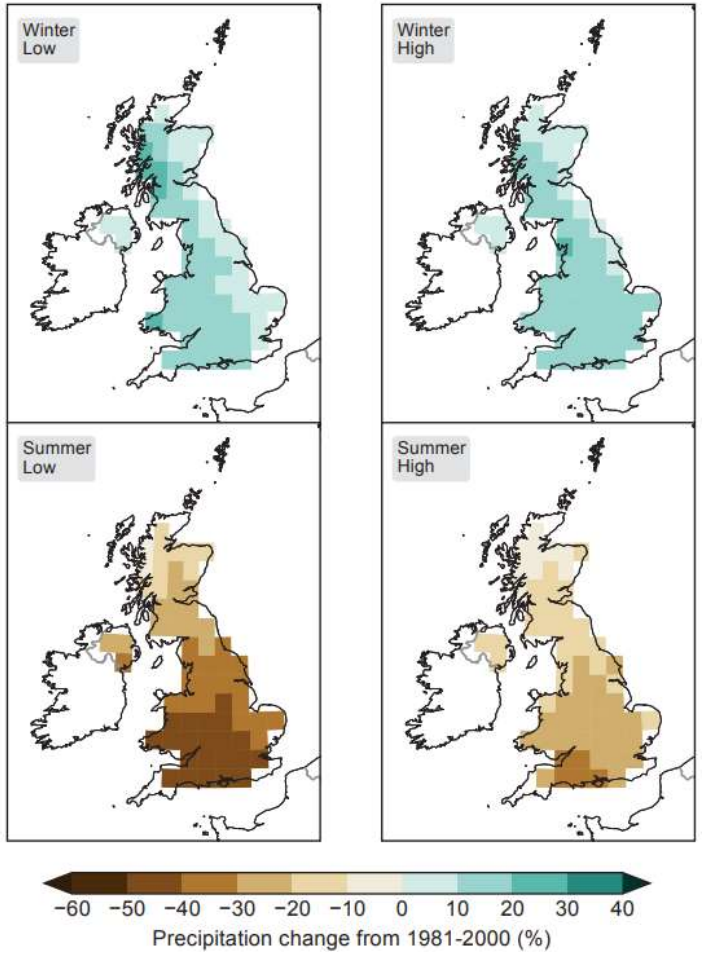
Source: UKCP18 Factsheet: Derived projections
https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-fact-sheet-derived-projections.pdf

UKCP18 Headlines - Precipitation

Projected change in daily precipitation for time when global warming reaches 2 °C above pre-industrial levels



Projected change in daily precipitation for time when global warming reaches 4 °C above pre-industrial levels



Source: UKCP18 Derived Projections of Future Climate over the UK
https://www.metoffice.gov.uk/pub/data/weather/uk/ukcp18/science-reports/UKCP18-Derived-Projections-of-Future-Climate-over-the-UK.pdf

Department for Education

CIBSE School Design Group

Climate Change Adaptation Working Group

Department
for Education

Aim and Objectives

The CIBSE School Design Group has 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 aims to engage industry-wide stakeholders to develop a balanced and collaborative range of recommendations.

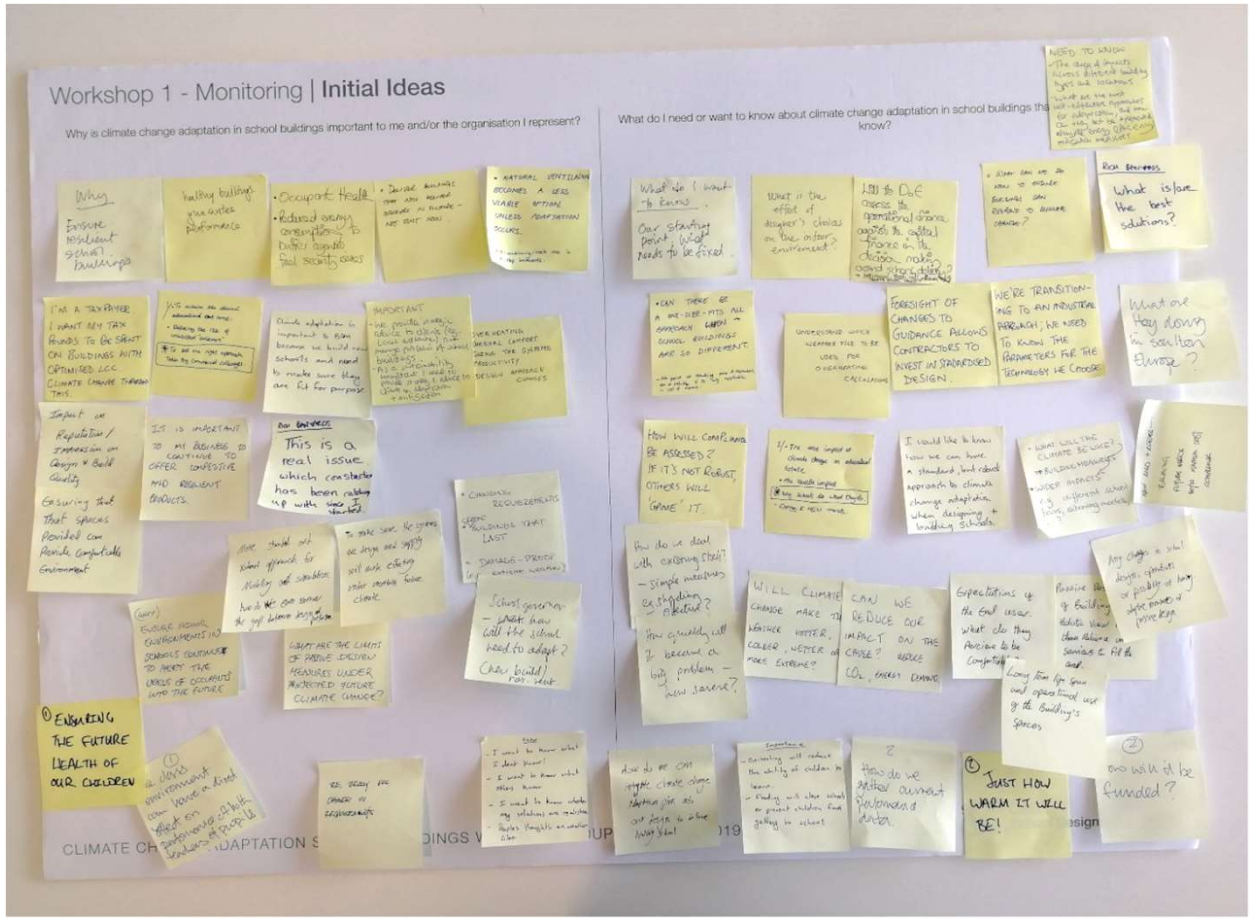
In the first phase of work, the group aims to review the latest understanding of the changes predicted to occur in the UK climate this century, with a focus on the impacts of higher summer temperatures. The predicted impacts are to be examined with reference to the results of:

- Thermal modelling of new and existing schools (referred to as the “modelling” workstream);
- Feedback obtained from building performance evaluation studies of in-service performance (referred to as the “monitoring” workstream).

The group aims to report back on its interim findings in November 2019. This work will support the DfE in its response to the National Adaptation Programme for the UK Government.

Kick-off Workshop

- **Workshop held at DfE offices in Cambridge in April 2019**
- **Explored evidence needed and actions to be taken by group**



Department for Education

Key Points from the Workshop

- **The industry needs to do more to understand how schools are currently performing** in order to predict their performance under future climate scenarios.
- There are a **range of barriers to wider practice of building performance evaluation**. The working group aims to share experience of making it work in practice, including **effective engagement with building users**.
- The **existing school building stock represents the biggest challenge** for both climate change mitigation and adaptation. However, the working group is also an opportunity to reflect on the performance of schools designed to current standards.

Key Points from the Workshop

- Dynamic thermal modelling is the basis of current design standards for schools. The group aims to provide further guidance on the selection of weather files and QA procedures to encourage consistency in modelling approaches. **Schools designed to recent standards are to be modelled to test their performance under longer-term climate change scenarios.**
- **The group aims to collate case studies of Building Performance Evaluation studies previously completed in schools**, including performance during the hot weather experienced in 2017 and 2018, and share lessons learned from the process.

Steps to Climate-Resilient Schools

Managing the Risks of an Uncertain Future

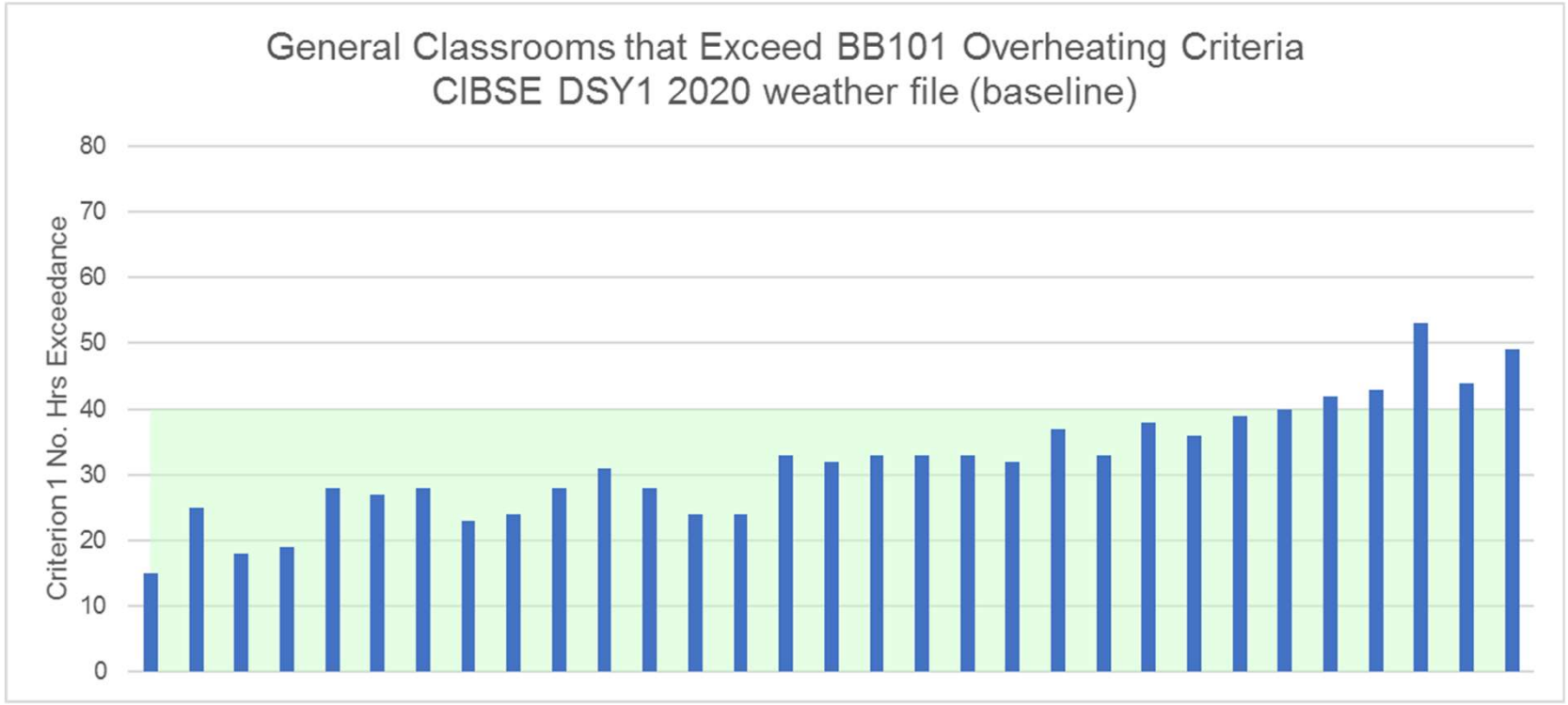
Department
for Education

BB101 Overheating Risk Assessment Methodology

- Criterion 1 of CIBSE TM52 is used as the minimum requirement for demonstrating compliance with BB101 (threshold of 40 hours exceedance)
- CIBSE DSY1 2020 50% weather file (high emissions)
- Occupied throughout summer period, 09:00 to 16:00, Monday-Friday
- No internal gains in teaching spaces during the lunch period 12:00 to 13:00

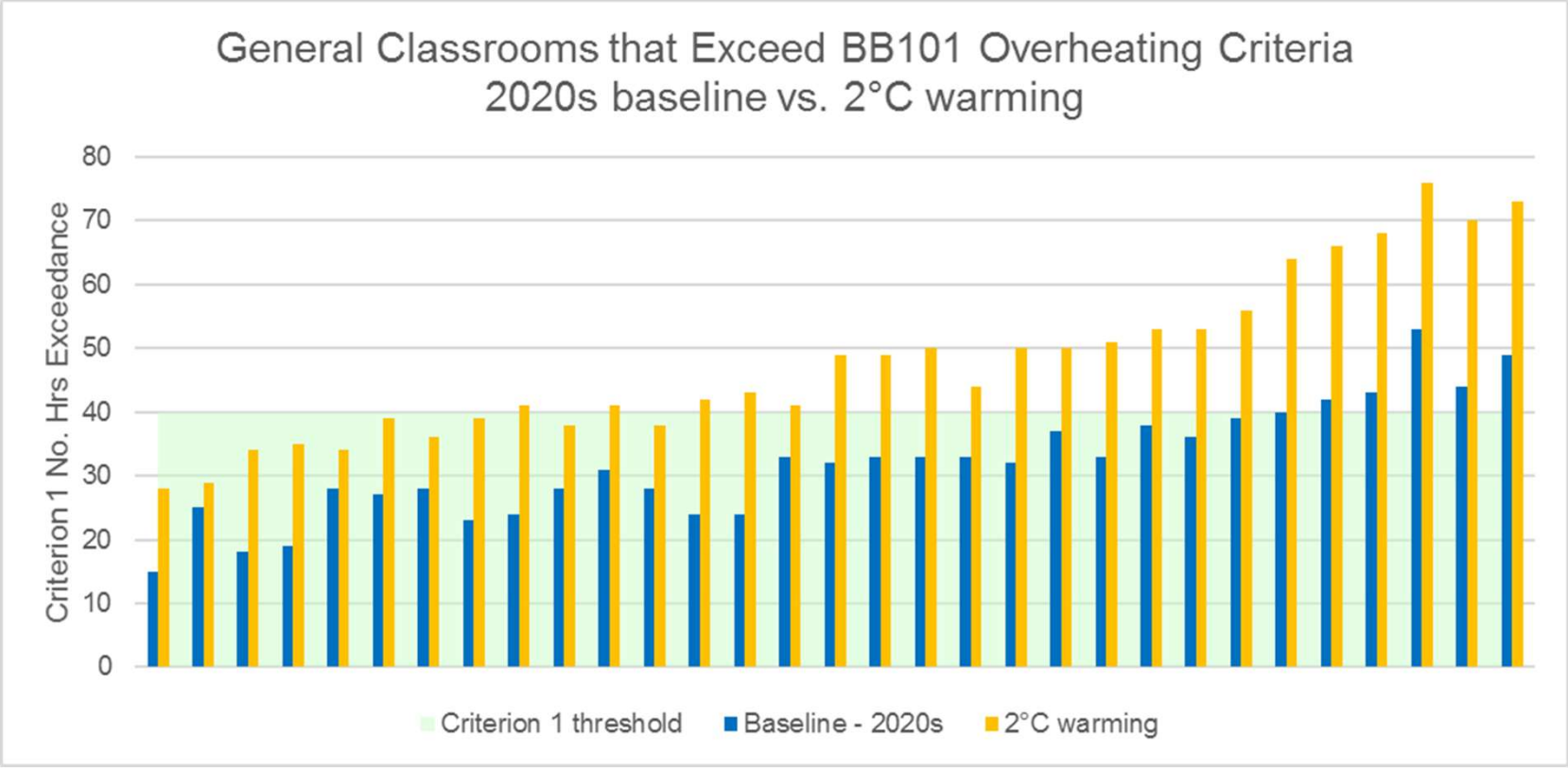
Primary School
Equipment: 5W/m^2
Lighting: 7.2W/m^2
People: 60W (pupil), 70W (teacher)
Secondary School
Equipment: 10W/m^2
Lighting: 7.2W/m^2
People: 70W/person

Example Results – Current BB101 Standards



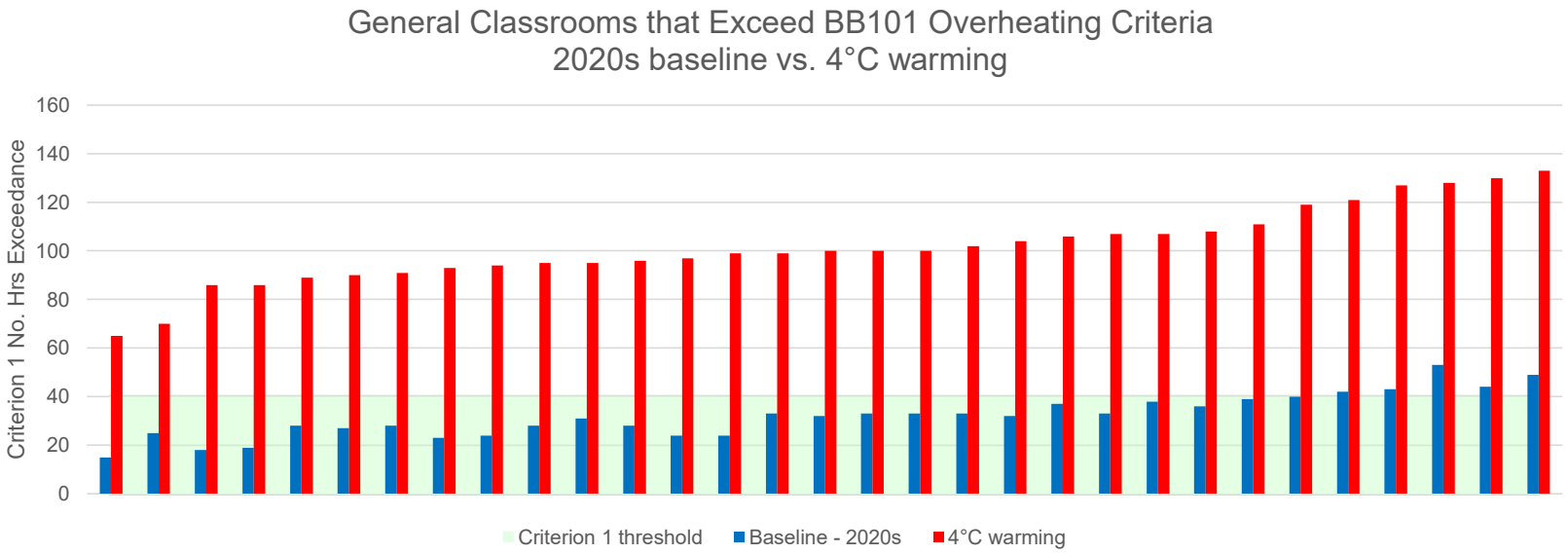
Department
for Education

Example Results – 2°C Warming



Department
for Education

Example Results – 4°C Warming



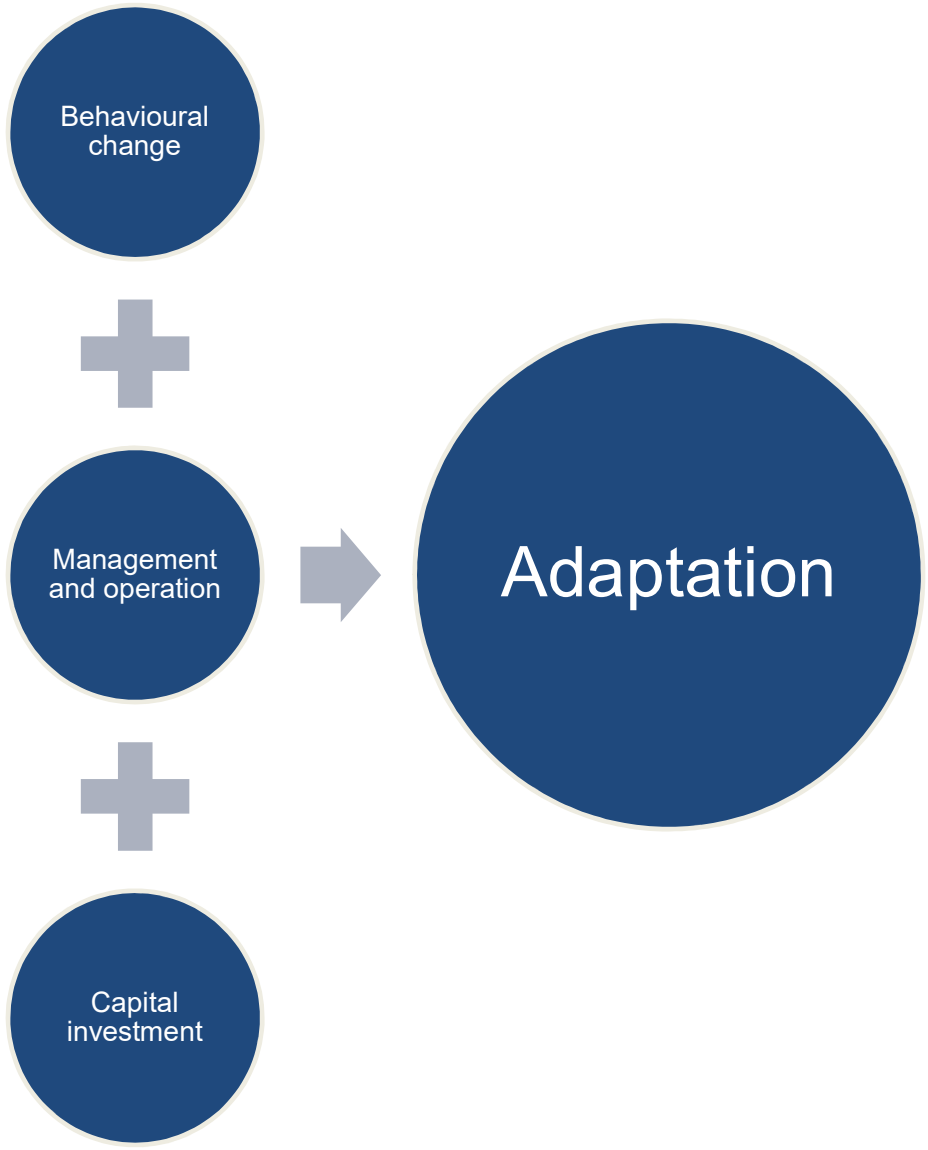
Department for Education

Adaptive Capacity

"The ability or potential of a building, its operation and occupants to adjust to future climate change hazards while retaining the same basic structure and ways of functioning. It is the term used to describe a building's resilience to changes in climate."

Definition from Innovate UK (2014) "The business case for adapting buildings to climate change" report

Adaptive capacity and adaptation measures can together form a strategy for adaptation.



Department for Education

Key Questions

- How resilient are new schools designed to current standards to the predicted longer-term changes in UK climate?
- How well do current methodologies predict the risk of overheating?
- Which parts of the existing school building stock are most at risk from higher summer temperatures?
- How well are existing schools currently managing during heatwave events?
- What are the most cost-effective approaches for adaptation in schools?

For the full collection of the Output Specification, see

www.gov.uk/guidance/school-design-and-construction

Please contact the DfE Capital Design Team for design and technical advice and with your design and technical queries on the design standards

DesignStandards.ESFACAPITAL@education.gov.uk

Thank you

DfE Design Team

Technical Support

Department for Education