Cooling Systems

Innovate UK

Department for Energy Security & Net Zero

Sustainable Cooling and the Global Cooling Pledge

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Department for Energy Security & Net Zero

Today's cooling journey

1. Cooling – it's a hot topic!
2. Researching the "cold case" for cooling and emissions
3. The Global Cooling Pledge and the Cooling Outlook Document

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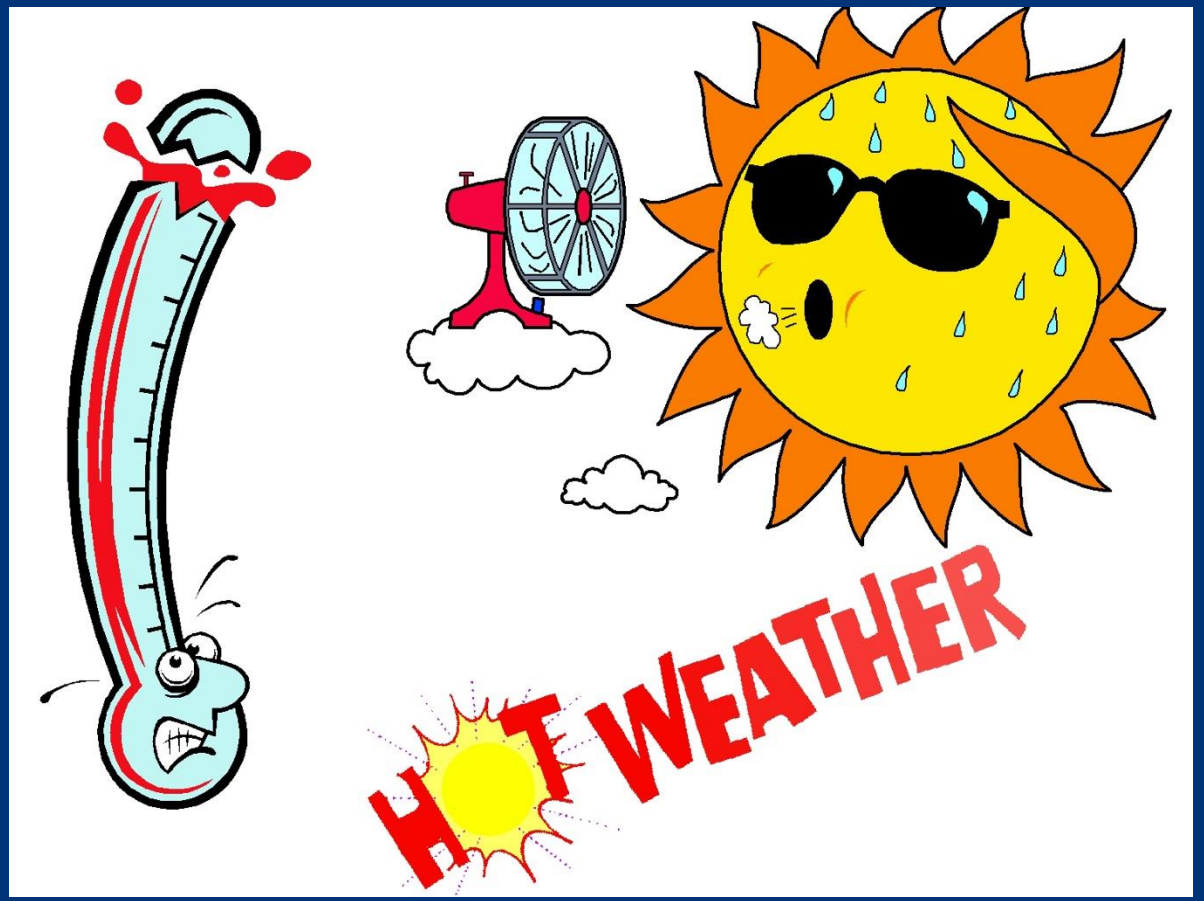
2. Cooling – it's a hot topic!

Why cooling matters



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Why Cooling Matters Worldwide

50% food waste in developing world

13% of global population malnourished

3 billion use fossil fuel for cooking and heating

90% urban dwellers breathing unsafe air

4.2 million deaths due to air pollution

250,000 climate deaths by **2050**

2024 was the warmest on record

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Why Cooling Matters to the UK

IPCC - likely to exceed 1.5C in the near term and the Climate Change Committee is assessing climate risks for 4C of warming. We will need to adapt.

>80% of the UK's 2050 **building stock** exists but **not built for our future climate**. Homes and workplaces are at risk of overheating and damage from extreme weather.

We are already seeing impacts of failing to adapt – In the UK in 2022 extreme heat led to 5017 excess deaths amongst over-70s.


Heatwave last summer killed 61,000 people in Europe, research finds

Hottest summer on record - fuelled by climate crisis - brought unusually high mortality rates, statistics show

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Why Cooling Matters to the UK

Cooling is essential to applications beyond comfort.

Cooling and refrigeration has essential uses in hospitals, preserving food and medicines, industrial processes, data centres, etc.

Many of these are critical facilities.

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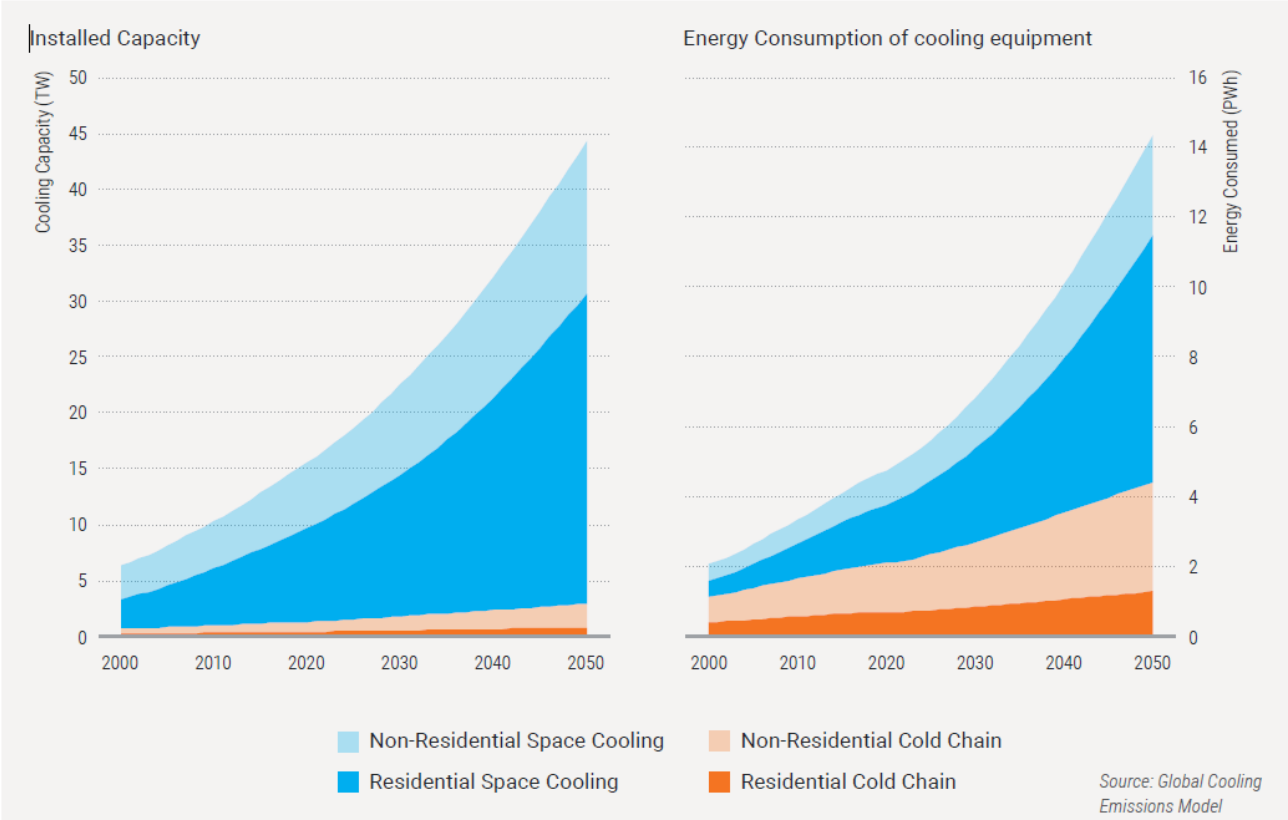
Why Cooling Matters to the UK

- As temperatures increase, cooling & refrigeration demand will increase.
- Without action to promote sustainable cooling and adaptation this could threaten energy security and net zero.
- Some applications predicted to grow 50x
  - 100GT CO2e to 2050
  - 0.5°C of warming



Source; UNEP, Global Cooling Watch 2023

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Cooling demand is expected to increase in the future

29 cooling degree days Gatwick on average per annum – last 20 years

46 cooling degree days Gatwick on average per annum – 2016-20

52 cooling degree days Rouen on average per year – last 20 years

Or the climate moved 50km south each year

London Predictions 80CDD 2025 and 125CDD in 2035

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What could warmer climates look like for us

Graeme Maidment
London, UK

Melanie Jans-Singh
Pau, France

André Neto-Bradley
Porto, Portugal

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2. Researching the “cold case”

Developing technical evidence for policy

Building the evidence base

DESNZ research

Cooling in the UK

CSN0W- National Cooling Estimate

CSN0W- Overheating in homes

Global Cooling Pledge for COP28

2021 2022 2023 2024 2025

Global Cooling Prize

Third National Adaption Programme (NAP3)

Global Cooling Watch 2023

External projects

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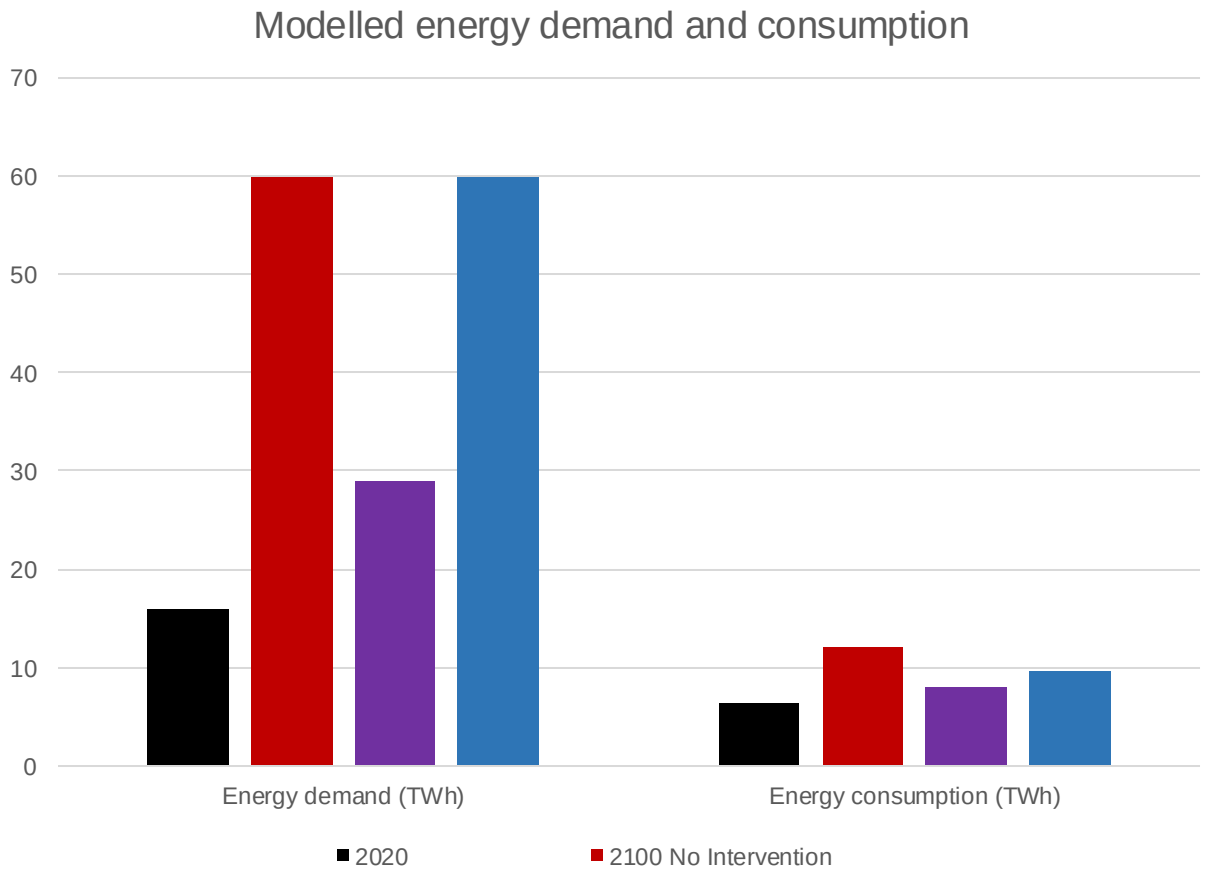
Cooling in the UK



With 4°C of climate change (high emissions scenario)

Annual demand increases by 4 and consumption by 2.

The capital cost by 2050:
~£60bn no intervention
~£30bn passive first
~£75bn efficient technologies

Residential increases to 75-85% of cooling demand.

Cooling energy consumption corresponds to energy demand divided by the seasonal energy efficiency ratio for the different scenarios for the UK building stock. Note that these are modelled results based on building archetypes and do not represent actual metered energy demand.

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Find out more:
https://www.gov.uk/government/publications/cooling-in-the-uk

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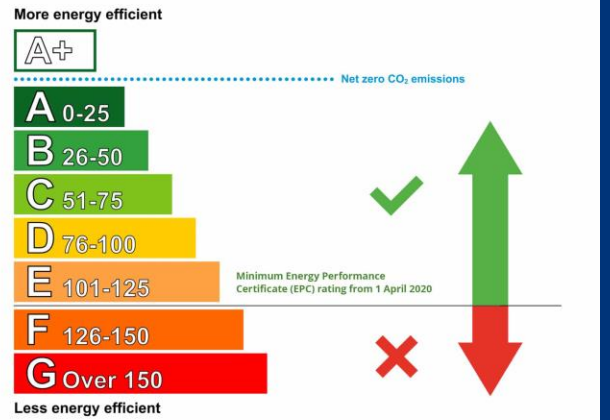
Research to mitigate at component level
The 5x challenge

Global Cooling Prize



Find out more:
https://globalcoolingprize.org/

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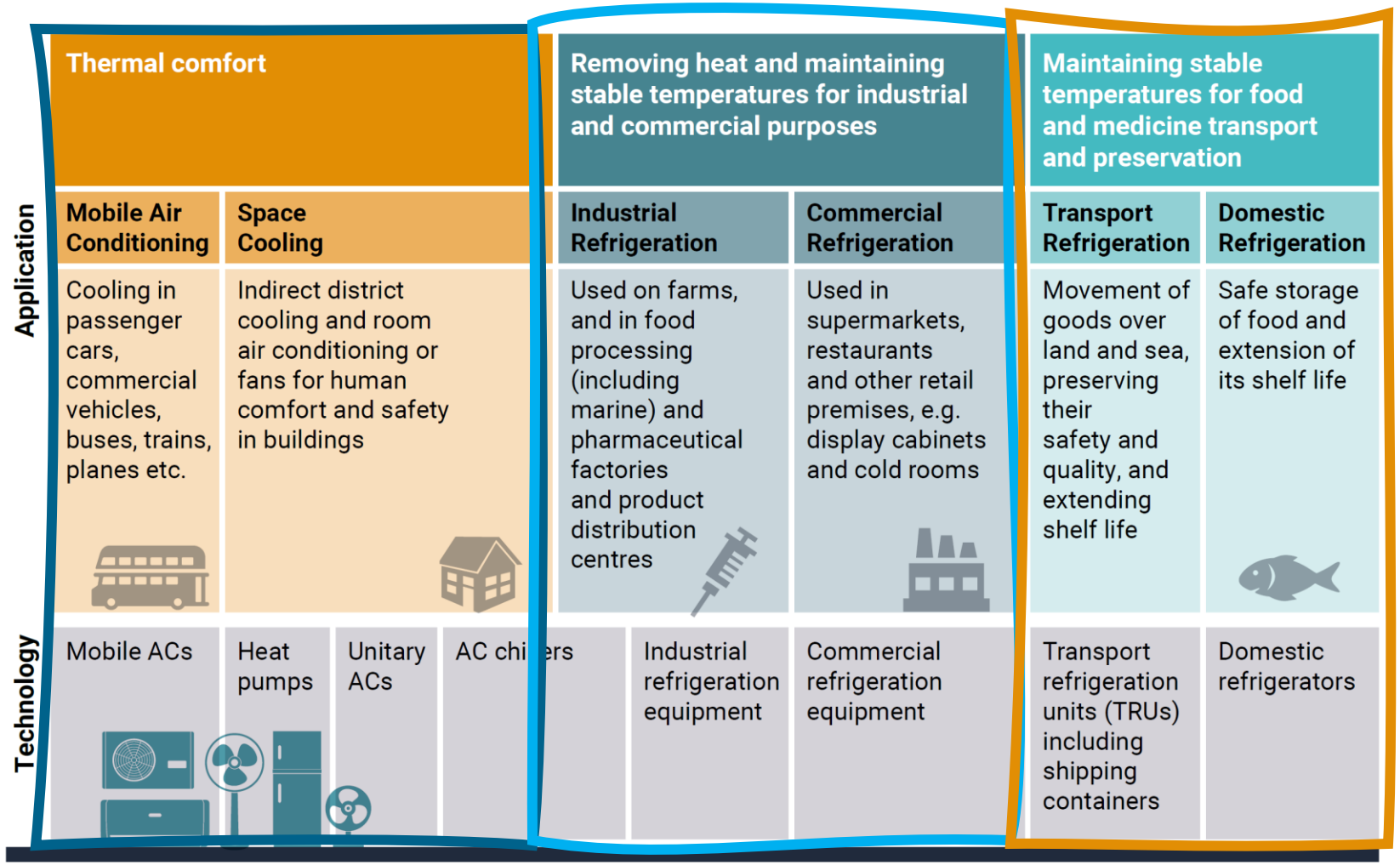
Developing the evidence base for the cooling sector



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Transport Industrial and Commercial Refrigeration (TICR)

TICR aims to **support decarbonisation**, promote **innovation strategies** and inform **government**

GHG emissions from refrigeration

Benchmarks

Roadmaps

Resources

Policy opportunities

Find out more:
https://netzerorefrigeration.uk/

Transport Industrial and Commercial Refrigeration (TICR)

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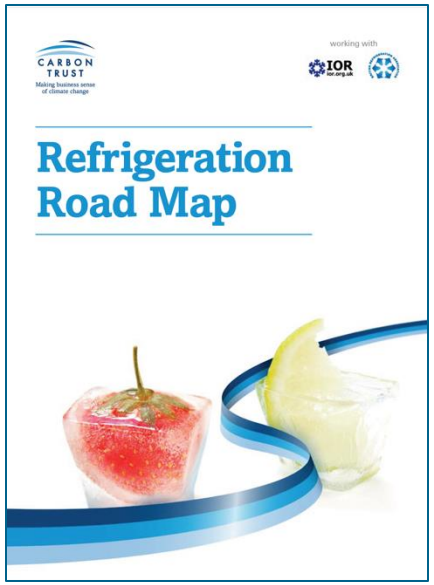

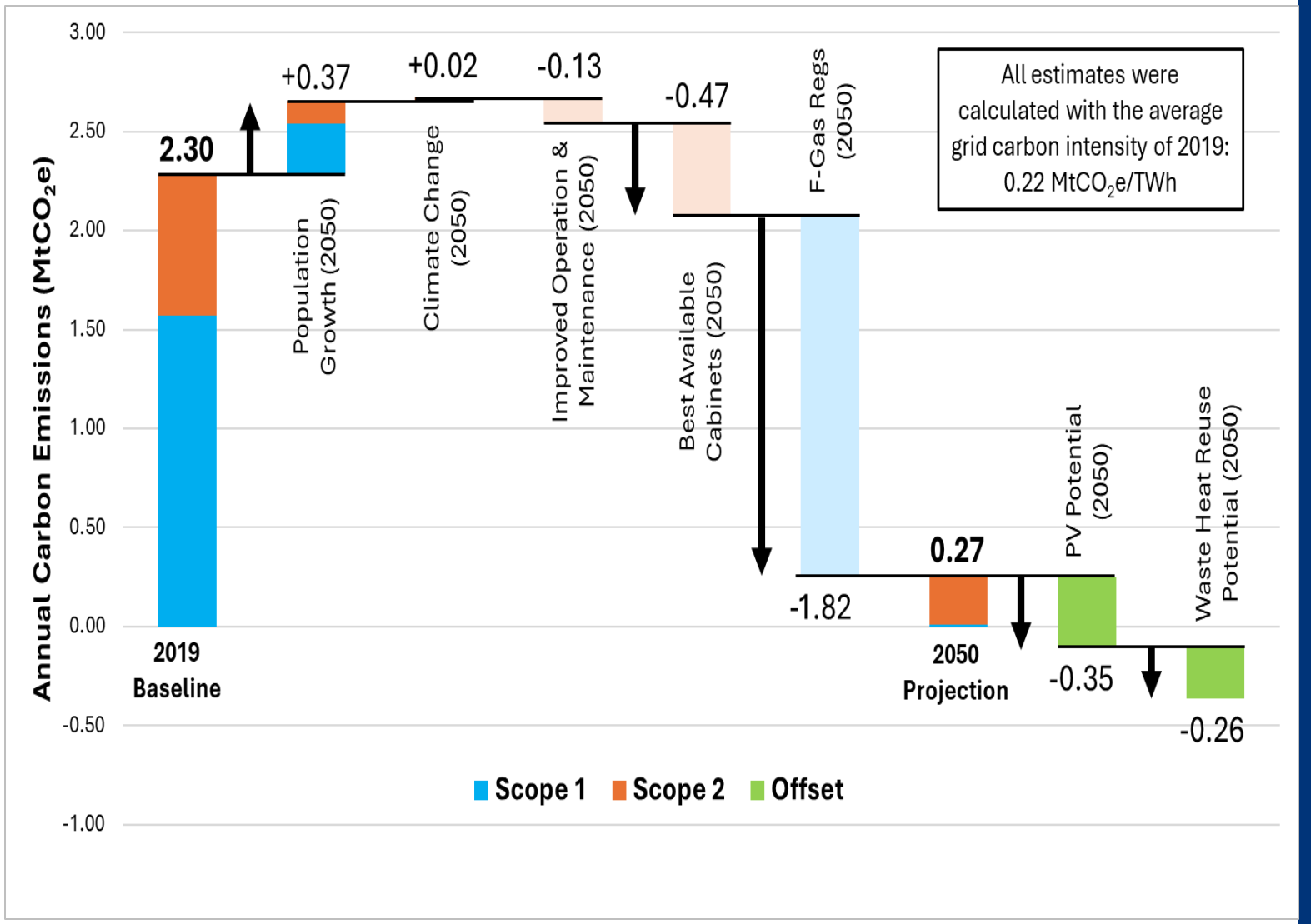

Retail refrigeration - **Emissions** reduction potential.

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Developing the evidence base on the sector – CSN0W and TICR

We have been carrying out research to better understand emissions and energy consumption attributable to cooling & refrigeration in the UK.

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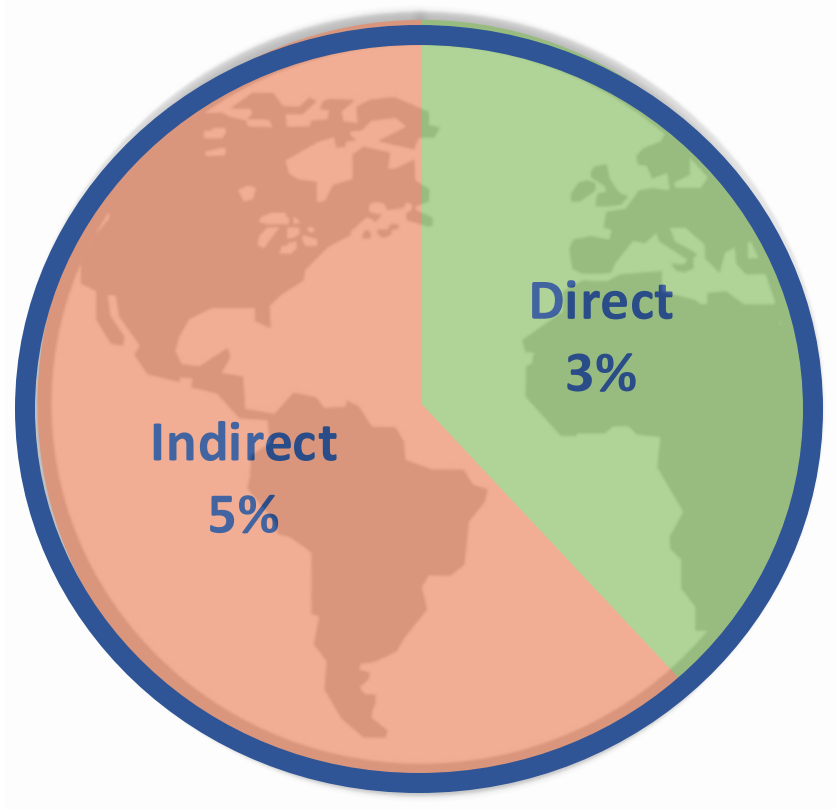
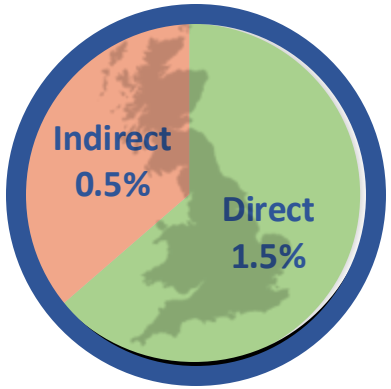
Developing the evidence base on the sector



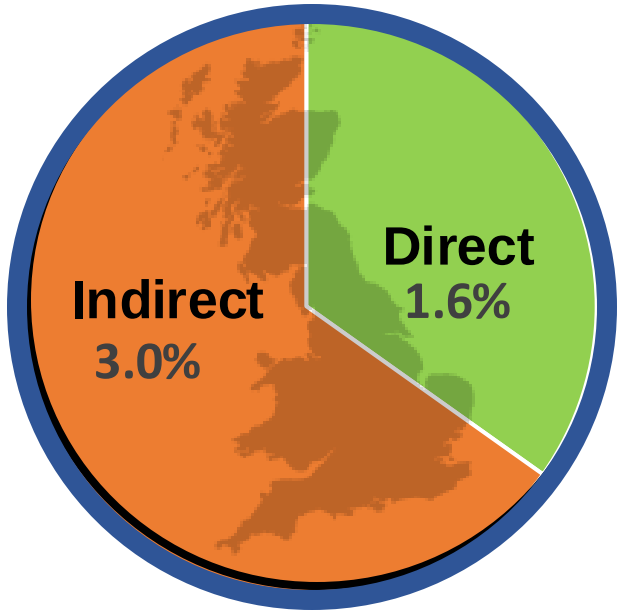
Global Emissions reported in 2022



UK Emissions estimated in 2022

Across all sectors

c5%



Emerging data from our recent study

https://www.gov.uk/government/statistics/digest-of-uk-energy-statistics-dukes-2022

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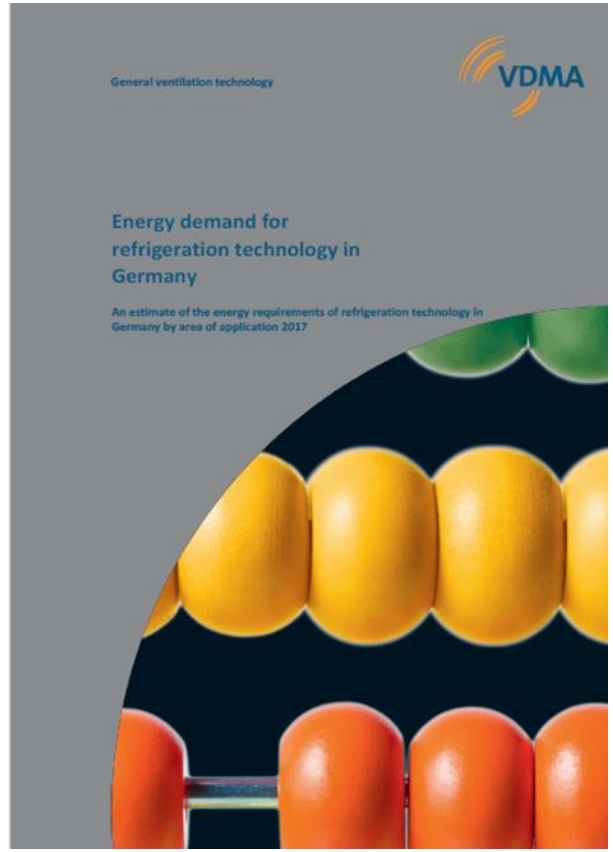
Developing the evidence base on the sector – emerging findings

	UK in 2021 (GWh)	German in 2017 (GWh)
Residential	15573	17743
Supermarket	3277	8502
Food production	2853	7097
Commercial refrigeration	3709	5154
Transport refrigeration	5188	1650
AC homes, buildings and vehicles including DCs	26132	22969
Industrial	877	12276
Medicine		1412
Cold stores	2308	1475
Others sport/ defence		972
Total	59917	79250
per capita (kWh)	789	790
% total electricity	16%	13%



VMDA, Energy demand for refrigeration technology in Germany, 2017

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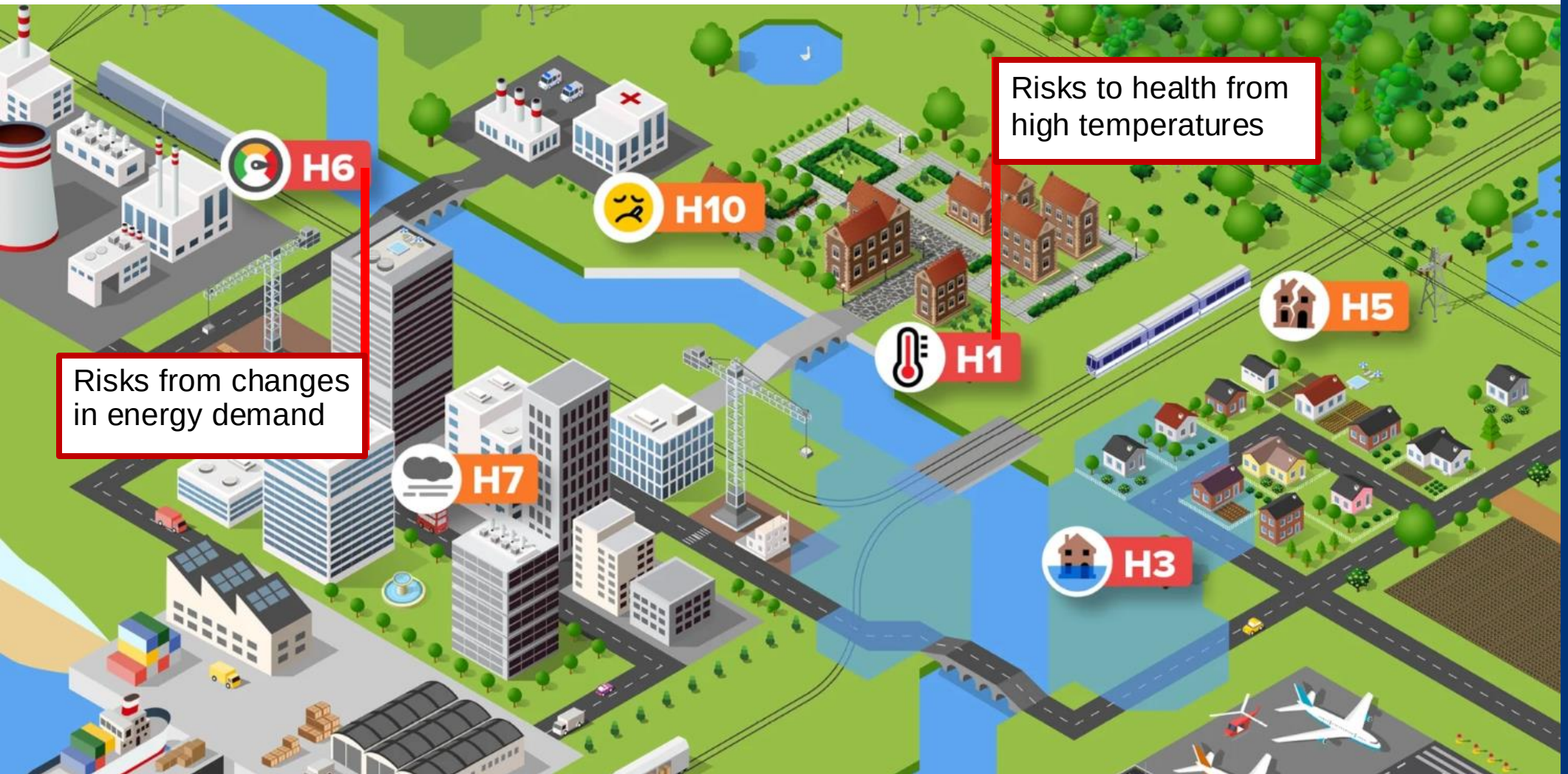
Adaptation to Extreme Heat



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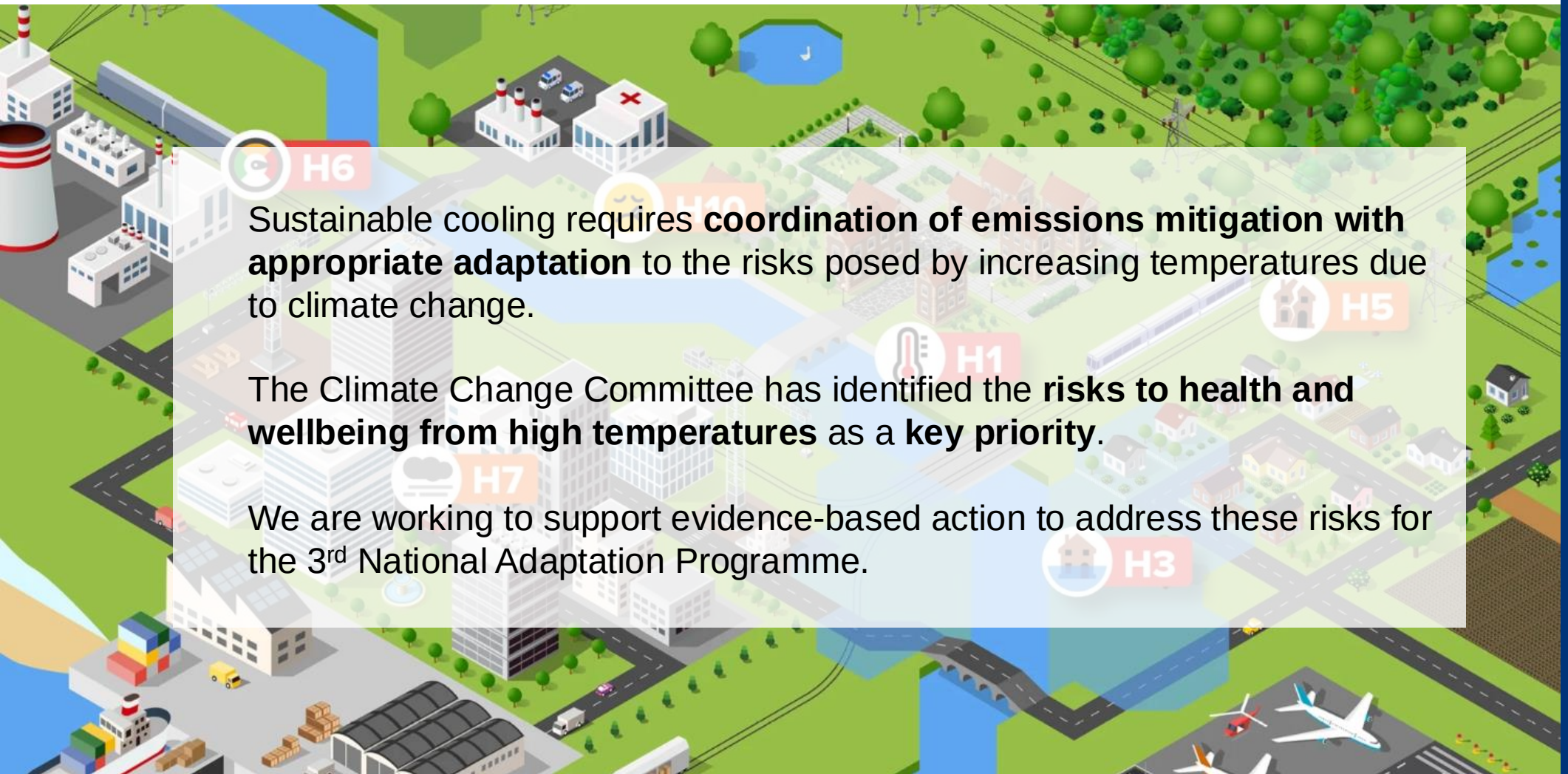
Adaptation to Extreme Heat



Sustainable cooling requires **coordination of emissions mitigation with appropriate adaptation** to the risks posed by increasing temperatures due to climate change.

The Climate Change Committee has identified the **risks to health and wellbeing from high temperatures** as a **key priority**.

We are working to support evidence-based action to address these risks for the 3rd National Adaptation Programme.

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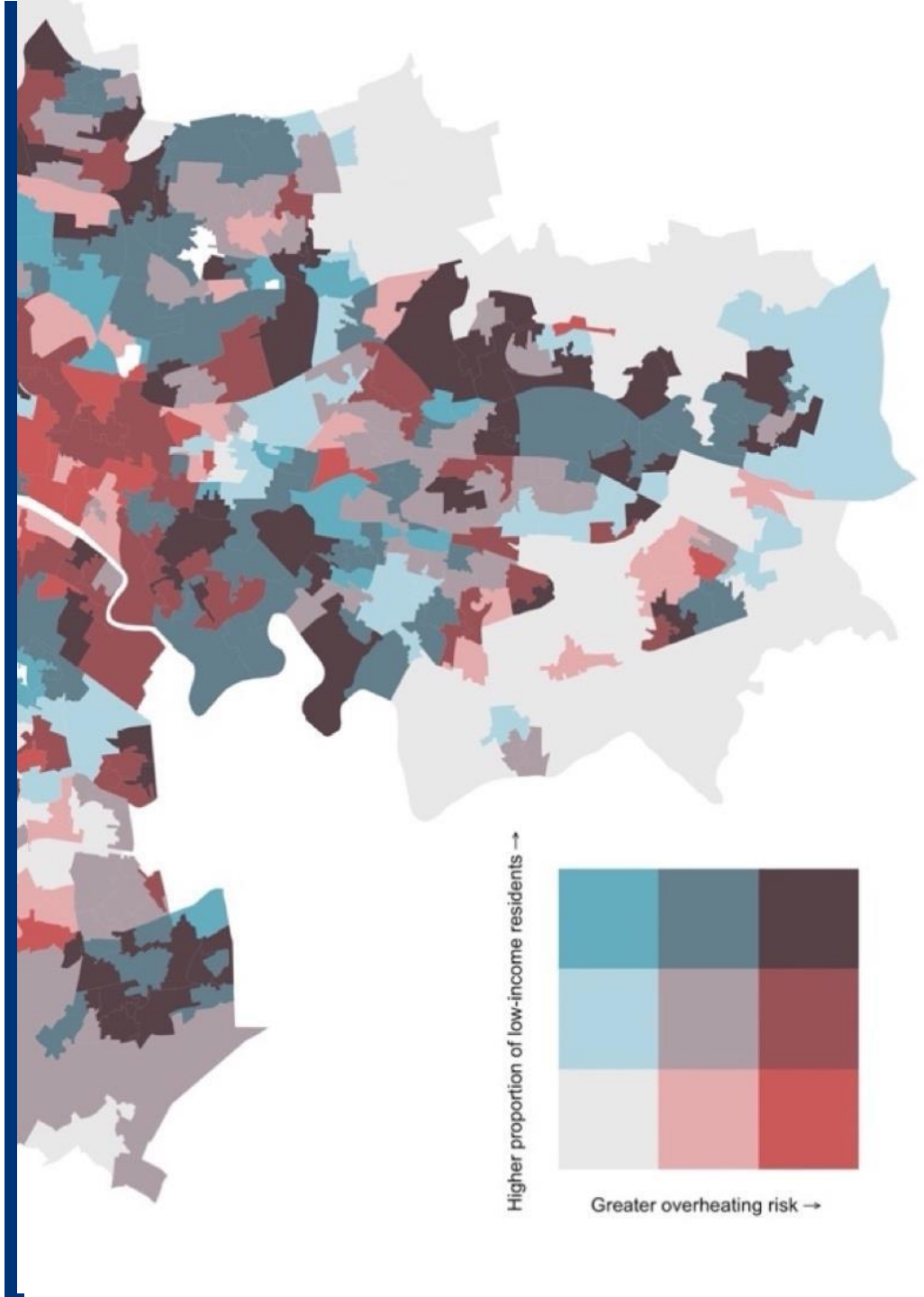
Adaptation to Extreme Heat

In NAP3 the **Government is building the evidence base** to support informed action.

Existing research provides a good high-level understanding, but **more granular evidence is needed** including on cost-effectiveness, deliverability, and trade-offs of different solutions.

We need to make sure that our thinking on climate change **mitigation and adaptation are linked up**, to avoid maladaptation, and added cost and carbon emission down the line.



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3. The Global Cooling Pledge

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Background & Rationale for a Global Pledge

Cooling and cooling emissions are often not explicitly accounted for, and do not neatly fall under a single policy area. With demand for cooling expected to increase there is an urgent need to ensure this is met sustainably.

The Global Cooling Pledge was an initiative of the COP 28 Presidency, with the objective of building an international commitment to pursuing sustainable cooling.

The UK played a leading role in the development of the pledge working alongside international partners.

COP28 UAE

UN environment programme

Cool Coalition

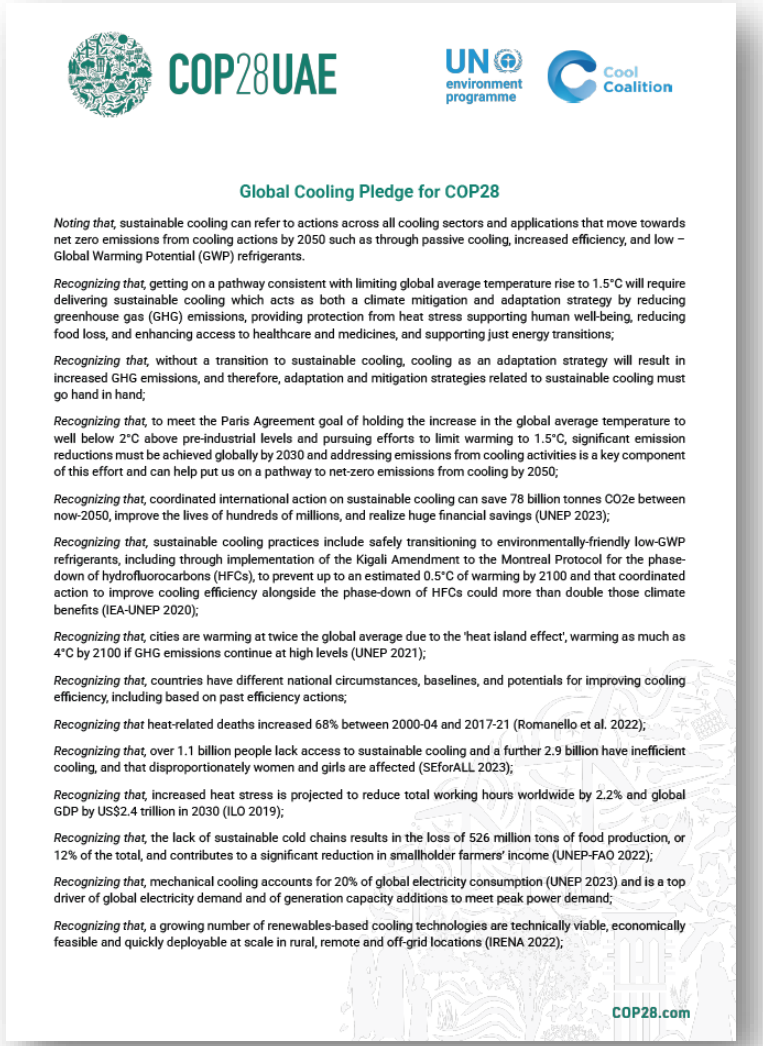
Department for Energy Security & Net Zero

The Global Cooling Pledge Commitments

The Global Cooling Pledge is made up of 16 commitments including a focus on:

- Pursuit of greater energy efficiency of cooling equipment;
- Phasing out of high-GWP refrigerants;
- Developing and implementing building codes that address risk of overheating;
- Collaborating internationally to deliver innovation in cooling.

The Global Cooling Pledge has been **signed by over 70 countries** since being launched at COP 28 in December.



COP28UAE

UN environment programme

Cool Coalition

Global Cooling Pledge for COP28

Noting that, sustainable cooling can refer to actions across all cooling sectors and applications that move towards net zero emissions from cooling actions by 2050 such as through passive cooling, increased efficiency, and low – Global Warming Potential (GWP) refrigerants.

Recognizing that, getting on a pathway consistent with limiting global average temperature rise to 1.5°C will require delivering sustainable cooling which acts as both a climate mitigation and adaptation strategy by reducing greenhouse gas (GHG) emissions, providing protection from heat stress supporting human well-being, reducing food loss, and enhancing access to healthcare and medicines, and supporting just energy transitions;

Recognizing that, without a transition to sustainable cooling, cooling as an adaptation strategy will result in increased GHG emissions, and therefore, adaptation and mitigation strategies related to sustainable cooling must go hand in hand;

Recognizing that, to meet the Paris Agreement goal of holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit warming to 1.5°C, significant emission reductions must be achieved globally by 2030 and addressing emissions from cooling activities is a key component of this effort and can help put us on a pathway to net-zero emissions from cooling by 2050;

Recognizing that, coordinated international action on sustainable cooling can save 78 billion tonnes CO2e between now-2050, improve the lives of hundreds of millions, and realize huge financial savings (UNEP 2023);

Recognizing that, sustainable cooling practices include safely transitioning to environmentally-friendly low-GWP refrigerants, including through implementation of the Kigali Amendment to the Montreal Protocol for the phase-down of hydrofluorocarbons (HFCs), to prevent up to an estimated 0.5°C of warming by 2100 and that coordinated action to improve cooling efficiency alongside the phase-down of HFCs could more than double those climate benefits (IEA-UNEP 2020);

Recognizing that, cities are warming at twice the global average due to the 'heat island effect', warming as much as 4°C by 2100 if GHG emissions continue at high levels (UNEP 2021);

Recognizing that, countries have different national circumstances, baselines, and potentials for improving cooling efficiency, including based on past efficiency actions;

Recognizing that heat-related deaths increased 68% between 2000-04 and 2017-21 (Romanello et al. 2022);

Recognizing that, over 1.1 billion people lack access to sustainable cooling and a further 2.9 billion have inefficient cooling, and that disproportionately women and girls are affected (SEforALL 2023);

Recognizing that, increased heat stress is projected to reduce total working hours worldwide by 2.2% and global GDP by US$2.4 trillion in 2030 (ILO 2019);

Recognizing that, the lack of sustainable cold chains results in the loss of 526 million tons of food production, or 12% of the total, and contributes to a significant reduction in smallholder farmers' income (UNEP-FAO 2022);

Recognizing that, mechanical cooling accounts for 20% of global electricity consumption (UNEP 2023) and is a top driver of global electricity demand and of generation capacity additions to meet peak power demand;

Recognizing that, a growing number of renewables-based cooling technologies are technically viable, economically feasible and quickly deployable at scale in rural, remote and off-grid locations (IRENA 2022);

COP28.com

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UK international leadership on cooling

A UK Cooling Outlook

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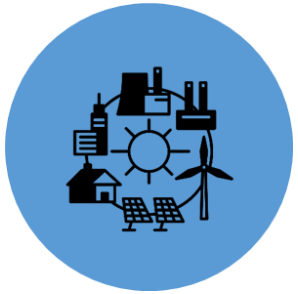
One of the commitments of the Global Cooling Pledge requires producing a document providing a strategic overview of cooling in the UK.

We will need to work with stakeholders to bring together our existing evidence and data on the sector.

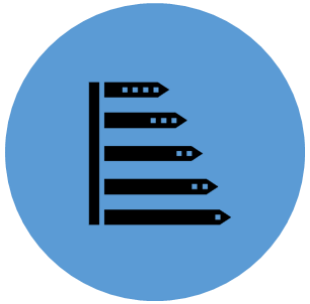
This unified cooling outlook will provide an opportunity to identify gaps and opportunities for sustainable cooling.

F-Gases/ embodied

Adaptation



Decarbonised electricity



Energy Efficiency

Evidence driven sector by sector approach

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4. Cool opportunities to work together

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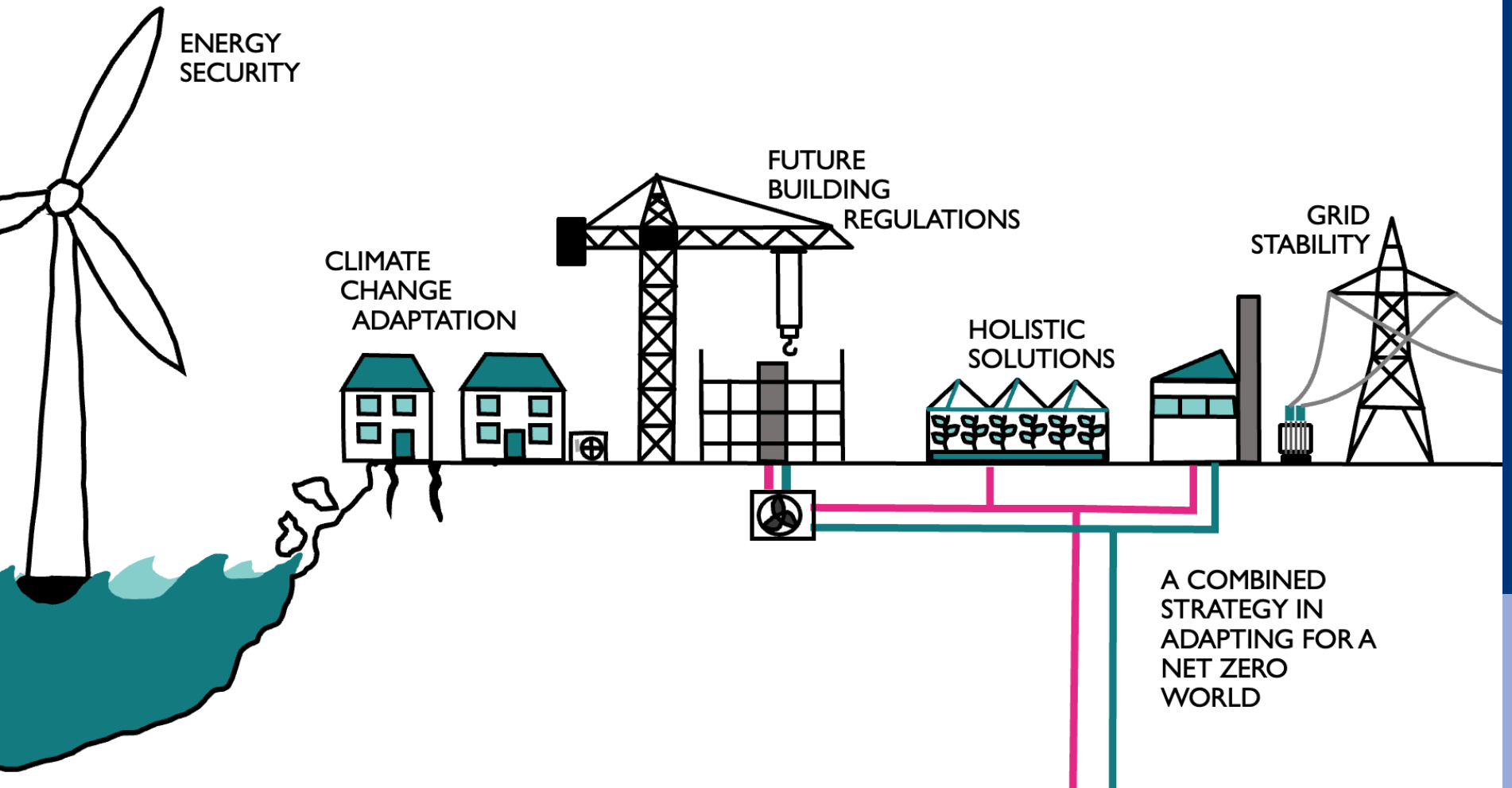
From Retrofit to Future Fit.



The Energy Research Team aims to provide evidence to underpin policy making. We focus on:

- Adaptation and resilience of our building stock and energy system
- Demand reduction and energy security
- Building retrofit opportunities
- Hard to abate sectors *(e.g. industrial sectors or conservation areas)*
- Embodied energy, carbon and life cycle assessment

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Thank you

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Challenges for cooling in industry

Resilience of the UK's cold supply chain to rising and extreme temperatures

Judith Evans, LSBU

The world is getting hotter

- Worldwide seasonal ambient temperatures are rising, and heatwaves are becoming more frequent, prolonged and severe
- Current policy commitments will result in a global mean temperature of 2.6°C-2.8 °C warmer by the end of the century compared to pre-industrial levels[1]
- Cold chains are vital to the UK's food security and health
- CCC previously identified that insufficient/limited policies and plans plus insufficient progress or unable to evaluate issues related to food security[2]
- It is essential that the UK's cold chains are well adapted and resilient to higher temperatures, as well as other aspects of climate change that will impact their operation and integrity

[1] *https://url6.mailanyone.net/scanner?m=1tIRHe-0000000028r-2QbS&d=4%7Cmail%2F90%2F1740137400%2F1tIRHe-0000000028r-2QbS%7Cin6j%7C57e1b682%7C10937368%7C14344598%7C67B8648A133508BA86F0AC49C846B506&o=%2Fphtn%3A%2Futsrcep%2F.ogccnsem-iosiso-gateprpr%2Fs&s=TEOnf6ifFTmJyROWzL_AQIJkK7Y*

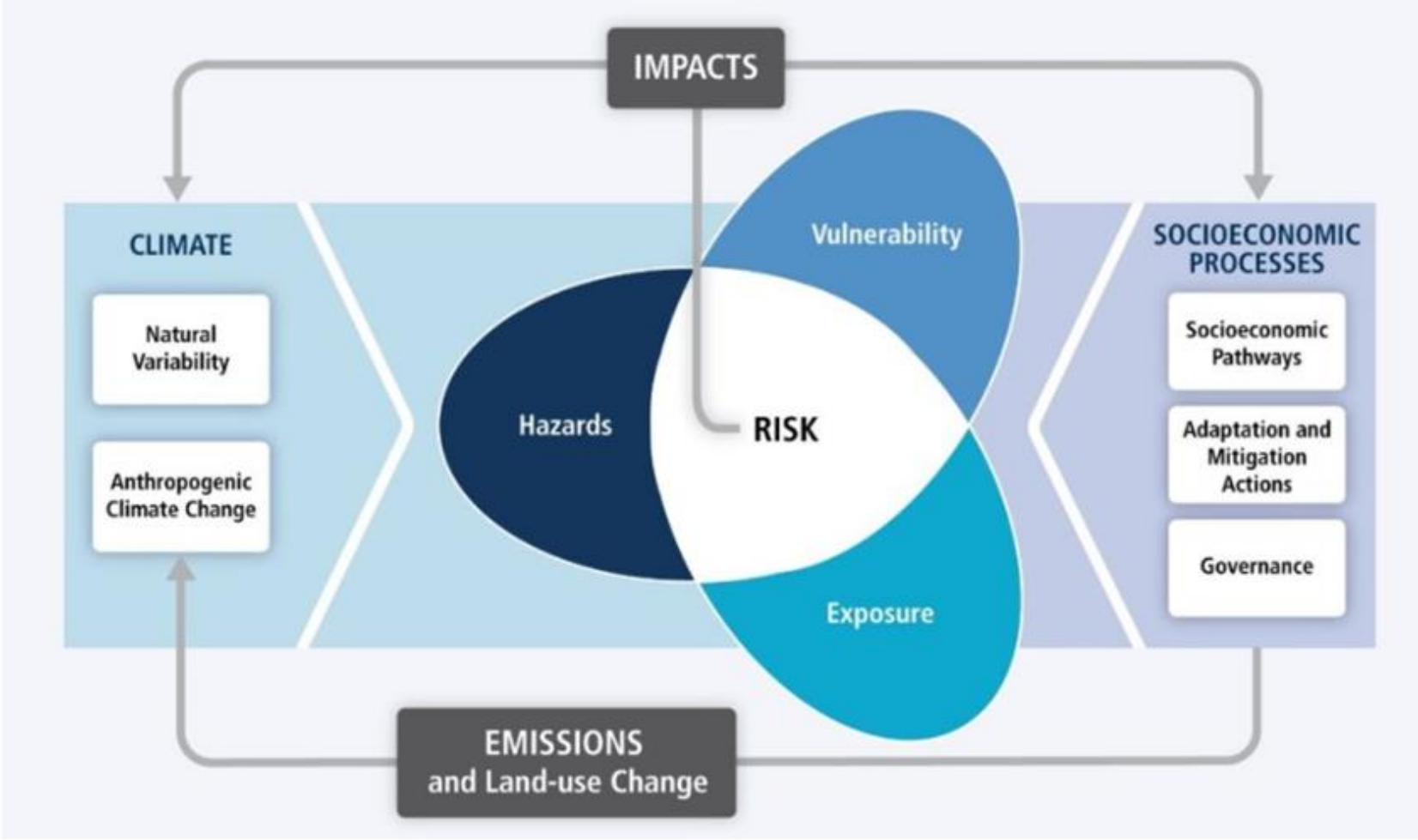
[2] *Progress in adapting to climate change. 2023 Report to Parliament. Climate Change Committee, March 2023*

Background

CCC project:

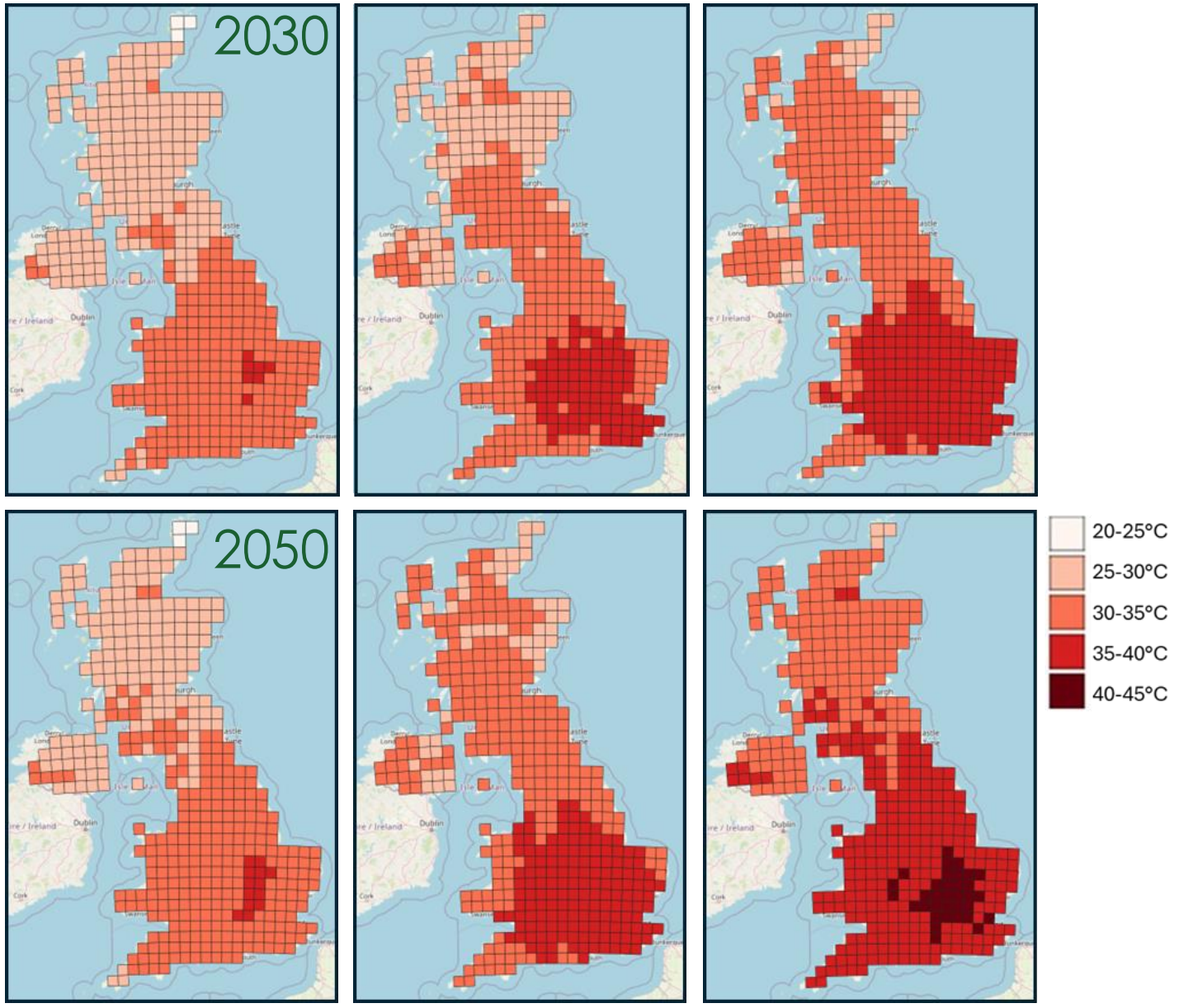
- Scoping study to assess the resilience of the UK's cold supply chain to rising and extreme temperatures
- Food, pharmaceuticals
- Understand the potential impacts on different actors/communities
  - Exposure
  - Hazards
  - Risks and impacts
  - Vulnerability, resilience
- Heat effects only

For CCRA4 (2027)

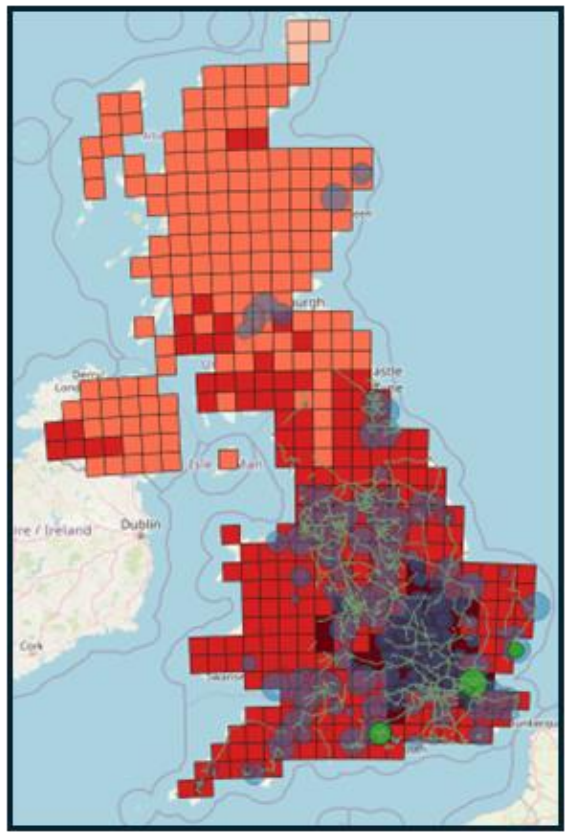


Exposure to increasing/high temperatures

- Maximum air temperature
- @1.5 m
- June, July, Aug
- 20-year return period
- RCP 8.5



Hazards: co-location of food chain facilities



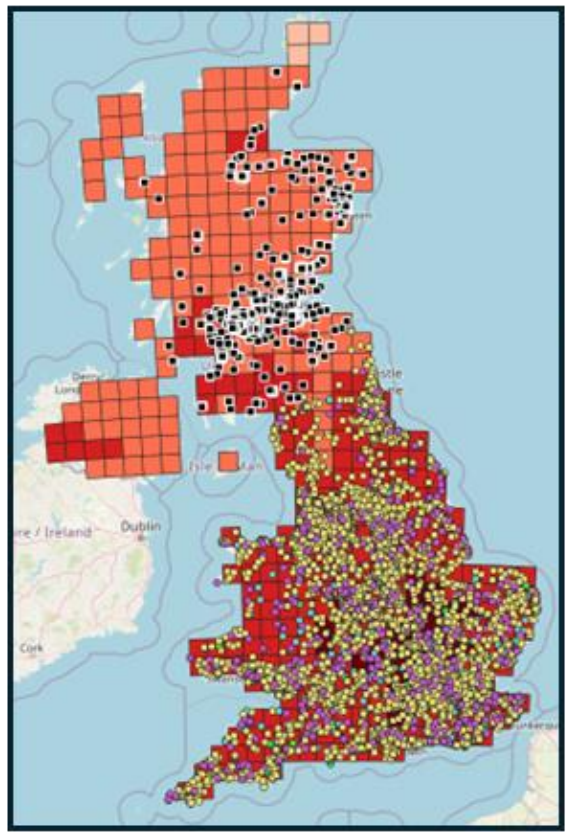
0-2,871
2,871-7,094
7,094-12,625
12,625-25,276
25,276-124,700

Cold store floor area (m^2)

4,119-6,460
6,460-21,653
21,653-55,299
55,299-71,946
71,946-174,181

Ports (number of individual product laden refrigerated shipping containers entering)

Roads, ports cold stores



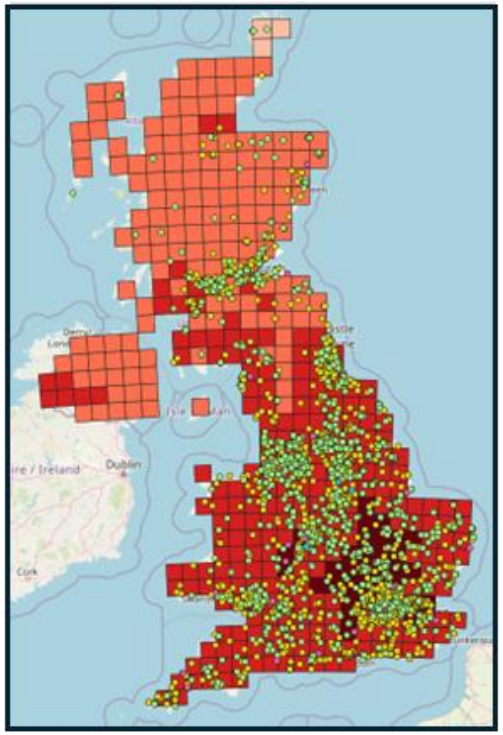
Convenience stores
Food stores
Hypermarket/superstores (over 2,500 m^2)
Large food stores (750-2,500 m^2)
Large shops (750-1,850 m^2)
Large shops (over 1,850 m^2)
Retail warehouses and food stores
Shops
Big retailers - Scotland

Retail

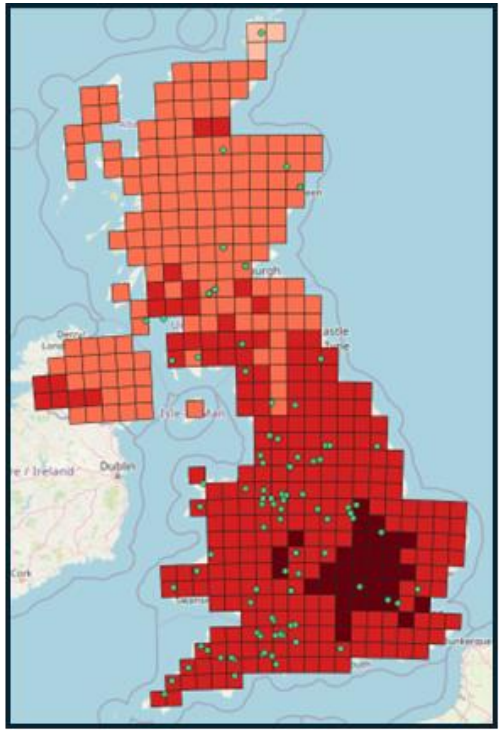
2050
20-year return period
RCP 8.5
90th percentile

Major road arteries, cold stores and retail outlets in warmest areas

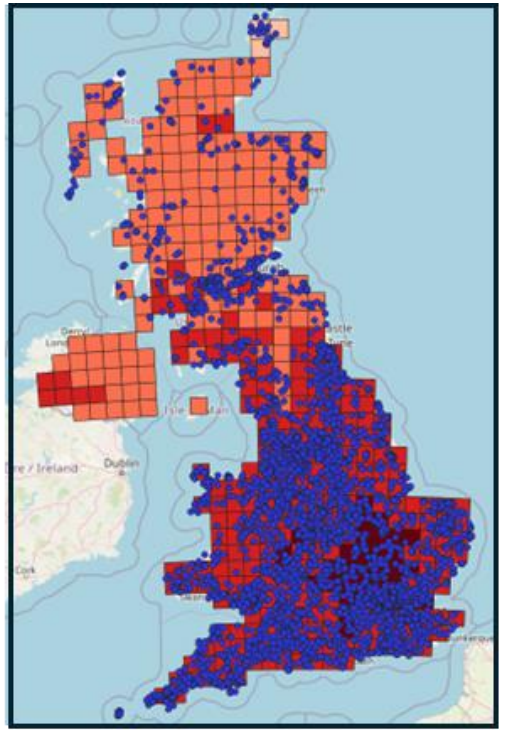
Hazards: co-location of food chain facilities



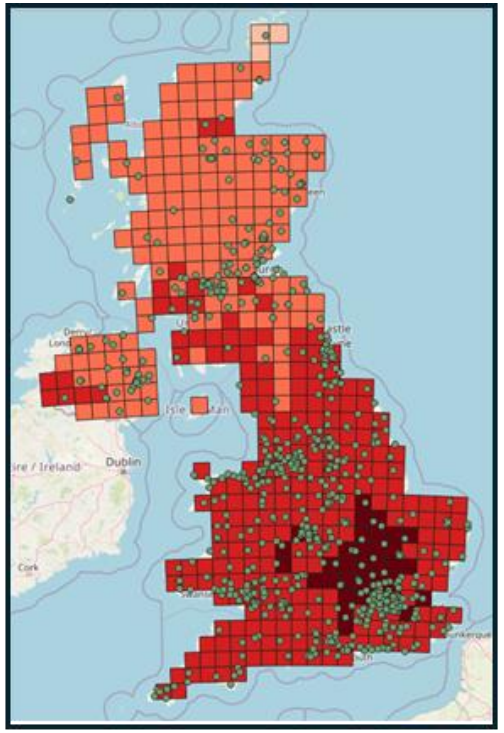
Food manufacture (bakers, brewing, egg processing and food and drink)



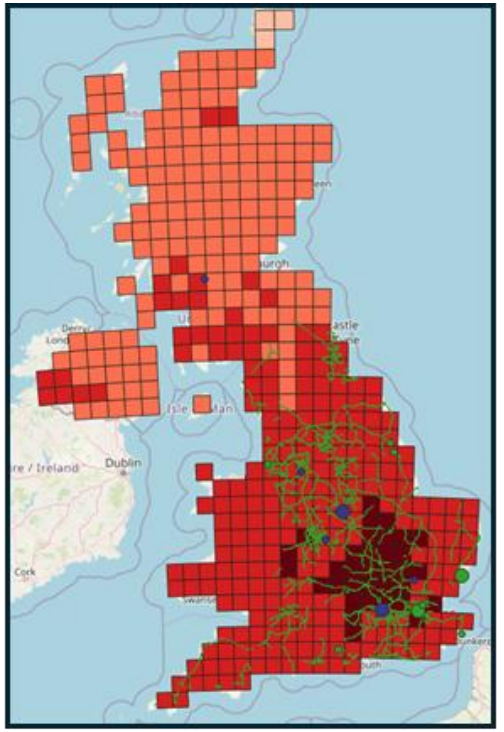
Food manufacture (dairy)



Food manufacture (poultry)



Hospitals



Pharmaceutical ports

Air large

Water large

Major facilities often in warmest areas

2050

20-year return period

RCP 8.5

90th percentile

Vulnerability – plant design

Current plant designed for ~32°C (some 25/26°C)

New plant 35°C

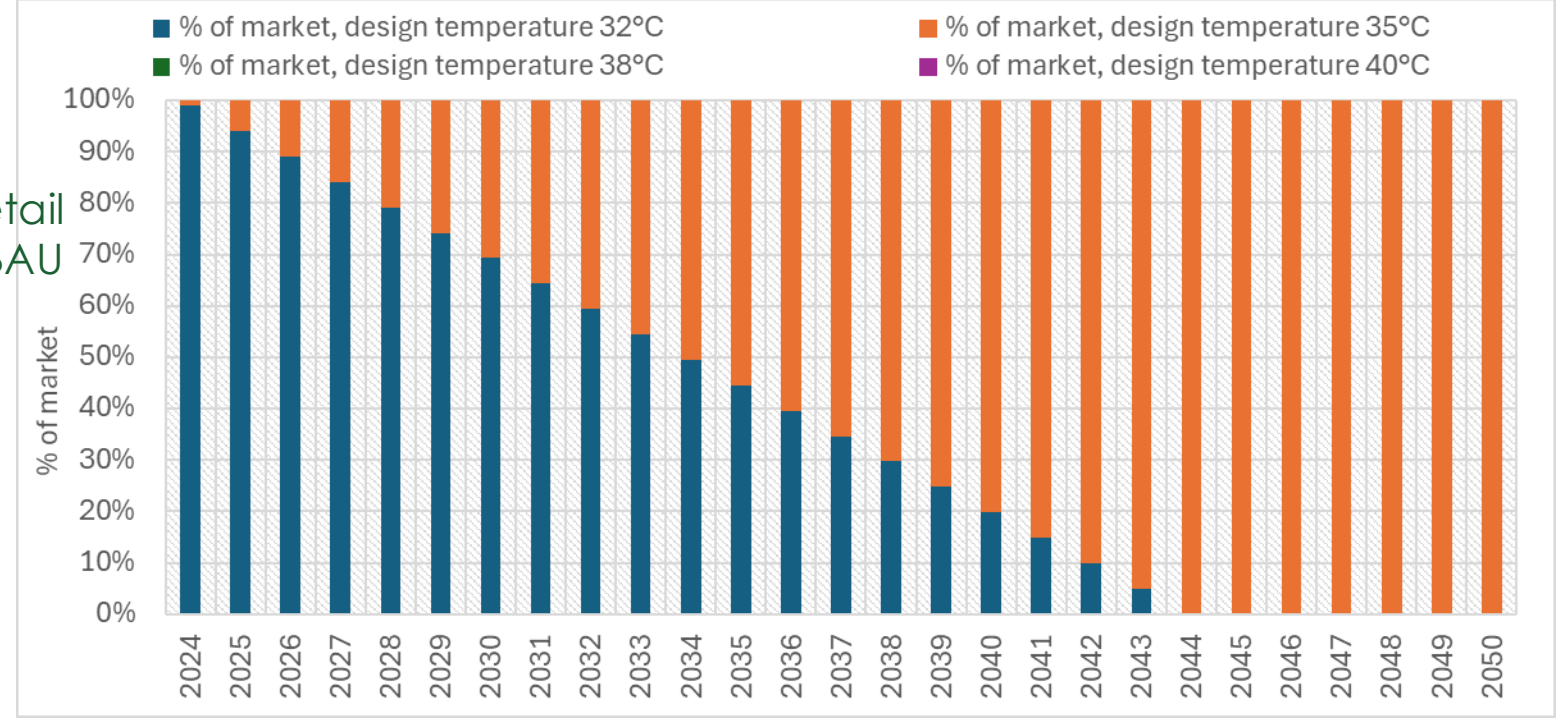
However, plant in operation for 20-50/60 years

Even with rapid replacement, large % of plant will still be designed for <40°C in 2050

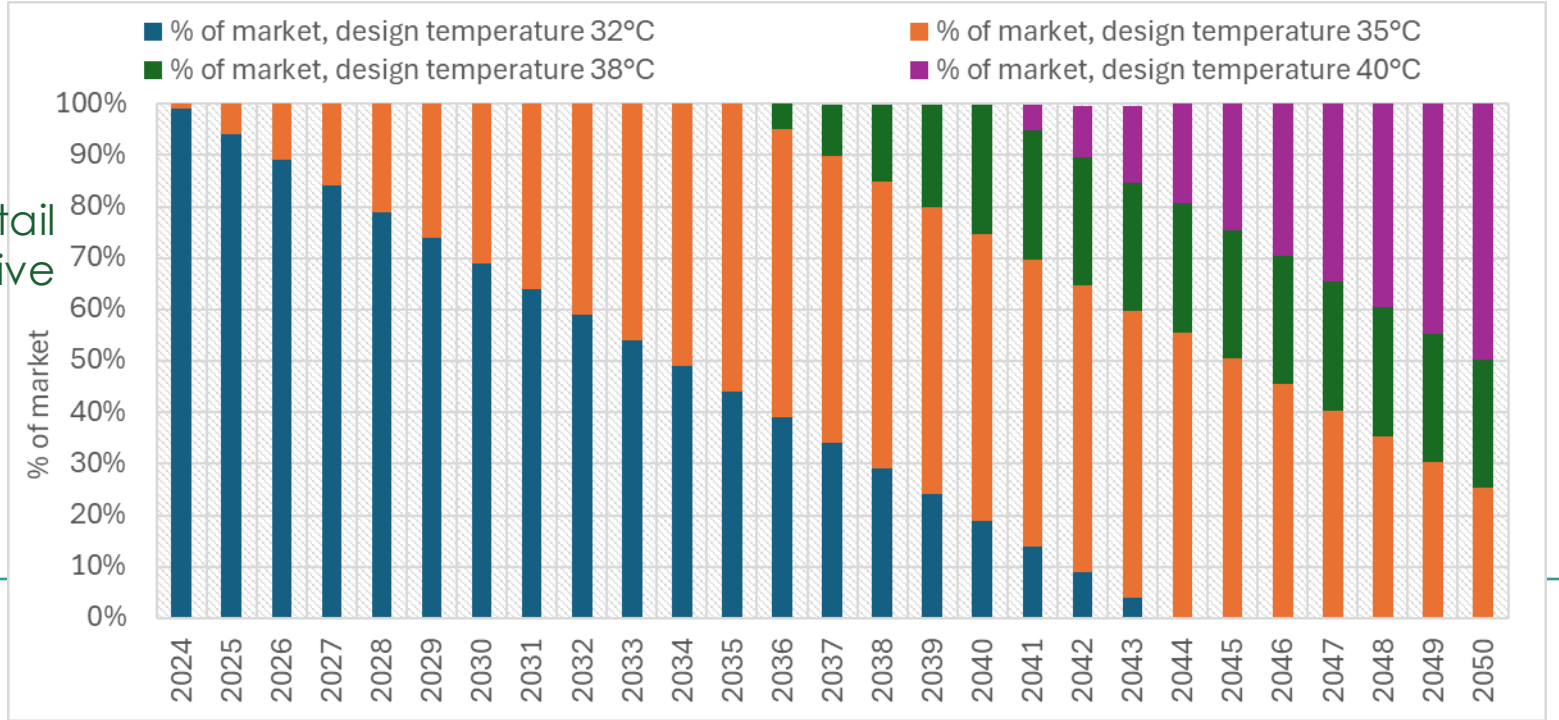
Lock-in

Potential significant vulnerability

Retail BAU



Retail Adaptive

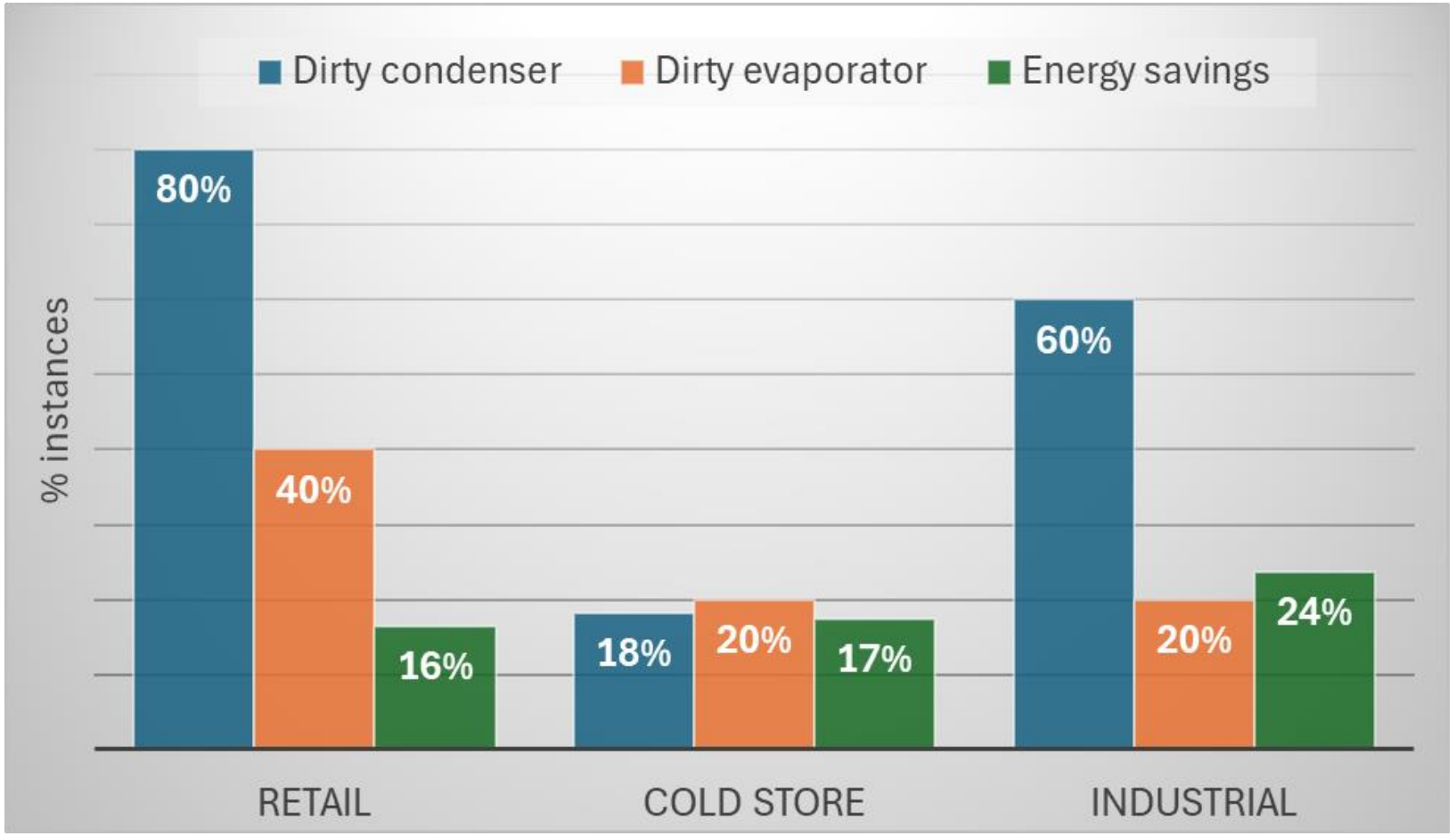


Vulnerability – plant maintenance

Significant issues with condensers

Substantial energy savings achievable

Nothing seems to have changed over last 10-15 years



Vulnerability – other areas

- Transfer between refrigeration plant/sectors
- Bottlenecks at borders
- Electrification of vehicles
- Just in time delivery
- Home delivery (small vehicles)
- Consumer handling
- Lack of skilled maintenance engineers, training
- Low margins – low investment
- Adaptive maturity, reactive not active
- Lack of codes, standards dealing with climate change
  - Regulation does not currently include adaptation except Environmental Permitting
- Lack of time-temperature climate models

Resilience

- Supermarket sensitivity to food customer satisfaction and safety biggest protection to public health in food cold chain
  - Supply chain businesses foods, absorb the pain
- Similar for the pharmaceutical supply chain
  - Potential health impact of shortages in pharmaceutical supply may be more significant for public health than food
- Currently number of drivers of pharmaceutical shortages, not climate related
  - Enables supply chain to absorb shortages and sustain critical patient need where climate impacts occur

Resilience

Adaption strategies:

- Load shedding/reducing load on plant
- Load shifting
- Adiabatic/evaporative condensers
- Increasing plant capacity
- Thermal storage/energy storage
- Packaging
- More ambient/canned/frozen food
- Enhanced maintenance, digital twins, AI

Impacts

- Operational issues
  - Refrigeration equipment stressed, potential failure
  - Increased food/pharma loss/waste
  - Support and maintenance unavailable
- Human health
  - Food quality/safety
  - Cost of products increase
  - Food/medicines not available, shortages of preferred foods but substitutes are likely to be available, extremes panic buying
  - Health – poorer clinical outcomes
- Business
  - Business disruptions (large company's, SMEs), reduced income
  - Insurance premiums increase
  - Workforce unable to perform (workplace H&S)
  - Potential closure of businesses
- Often compounded impacts

Thanks

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