Health co-benefits of climate action for housing

26th February 2025

Mike Davies

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Outline

- Context
- Health co-benefits: early work
- Health Protection Research Unit (HPRU)
- Climate Change Committee (CCC)

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Context and health co-benefits

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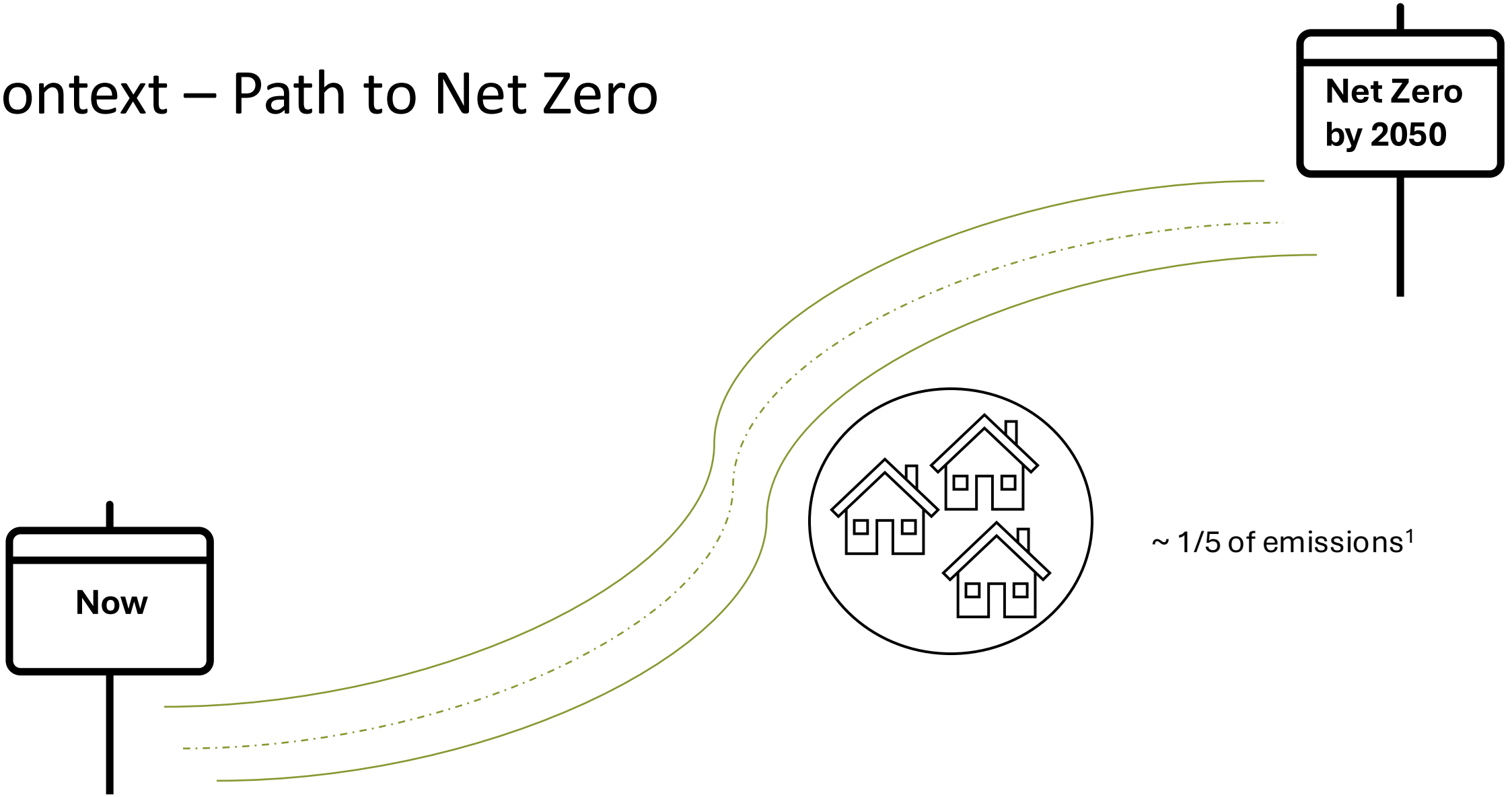
Context – Path to Net Zero



[1] DESNZ. (2024). Final UK greenhouse gas emissions national statistics: 1990 to 2022. GOV.UK. Available at: https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2022 (Accessed: 22 October 2024).

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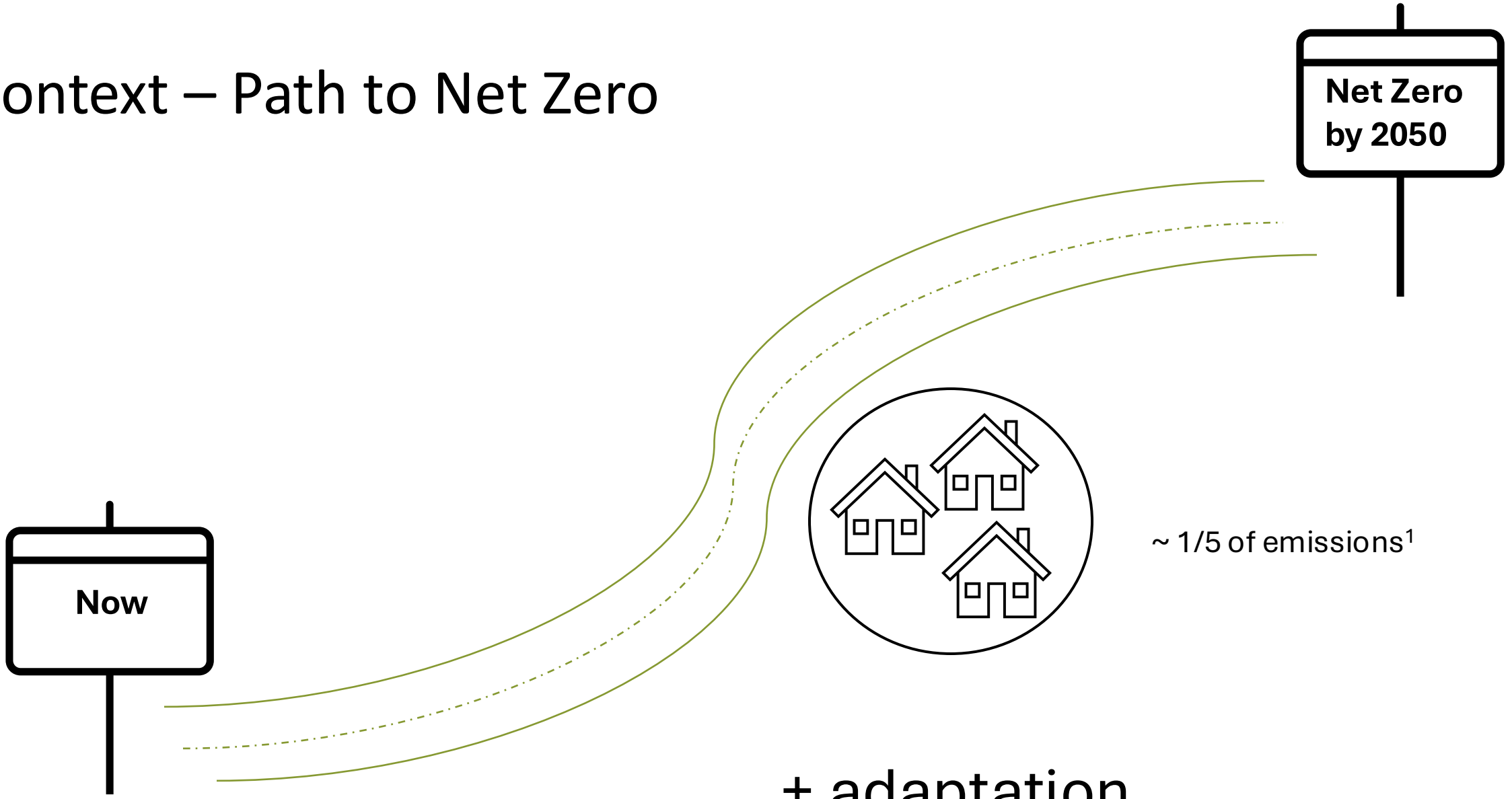

[1] DESNZ. (2024). Final UK greenhouse gas emissions national statistics: 1990 to 2022. GOV.UK. Available at: https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2022 (Accessed: 22 October 2024).

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Context

Actions to reduce emissions from the housing stock:[1]

Building Energy Efficiency

Low-carbon Heating

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Efficient Lighting & Electrical Appliances

Behaviour Change

[1] CCC. 'The Sixth Carbon Budget: The UK's Path to Net Zero'. Climate Change Committee, December 2020.

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Context – built indoor environment and health

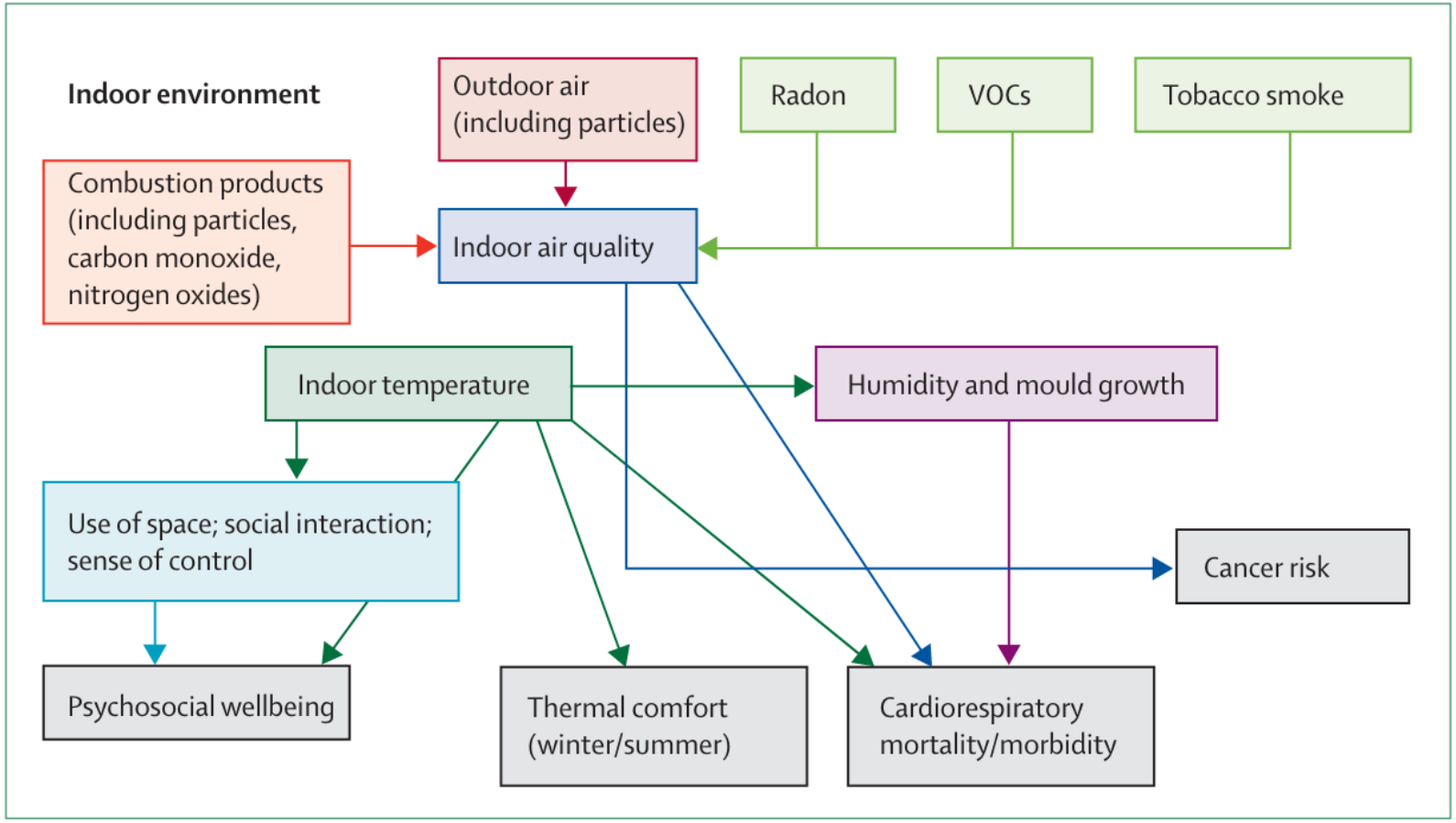
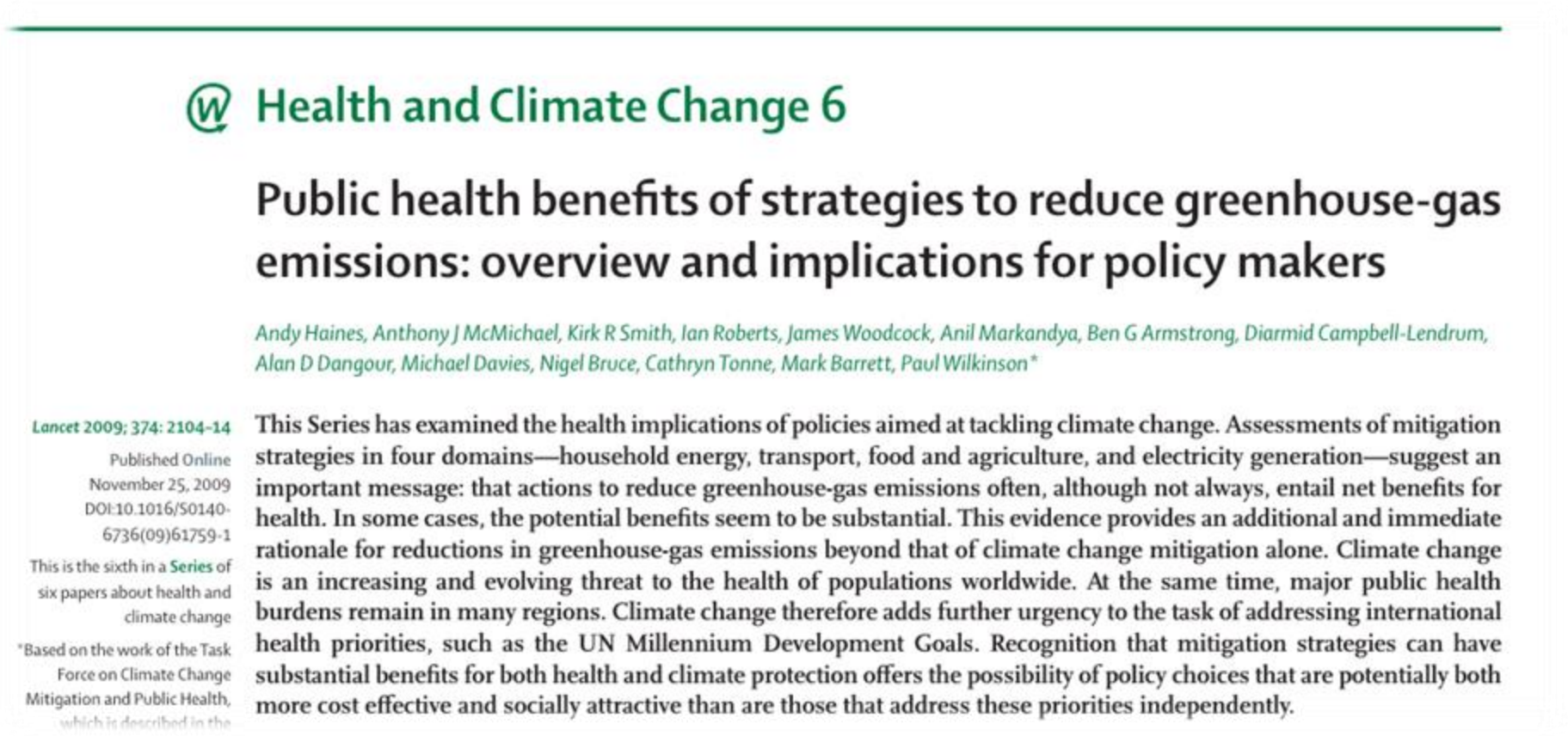


Figure 2: **Connections between the built indoor environment and health**
VOCs=volatile organic compounds.

4 Wilkinson, P., Smith, K. R., Davies, M., Adair, H., Armstrong, B. G., Barrett, M., Bruce, N., Haines, A., Hamilton, I., Oreszczyn, T., Ridley, I., Tonne, C. and Chalabi, Z. (2009). 'Public health benefits of strategies to reduce greenhouse-gas emissions: household energy'. *The Lancet*, 374 (9705), pp. 1917–1929. doi: 10.1016/S0140-6736(09)61713-X.

Health Co-benefits (early work)



Health and Climate Change 6

Public health benefits of strategies to reduce greenhouse-gas emissions: overview and implications for policy makers

*Andy Haines, Anthony J McMichael, Kirk R Smith, Ian Roberts, James Woodcock, Anil Markandya, Ben G Armstrong, Diarmid Campbell-Lendrum, Alan D Dangour, Michael Davies, Nigel Bruce, Cathryn Tonne, Mark Barrett, Paul Wilkinson**

Lancet 2009; 374: 2104–14

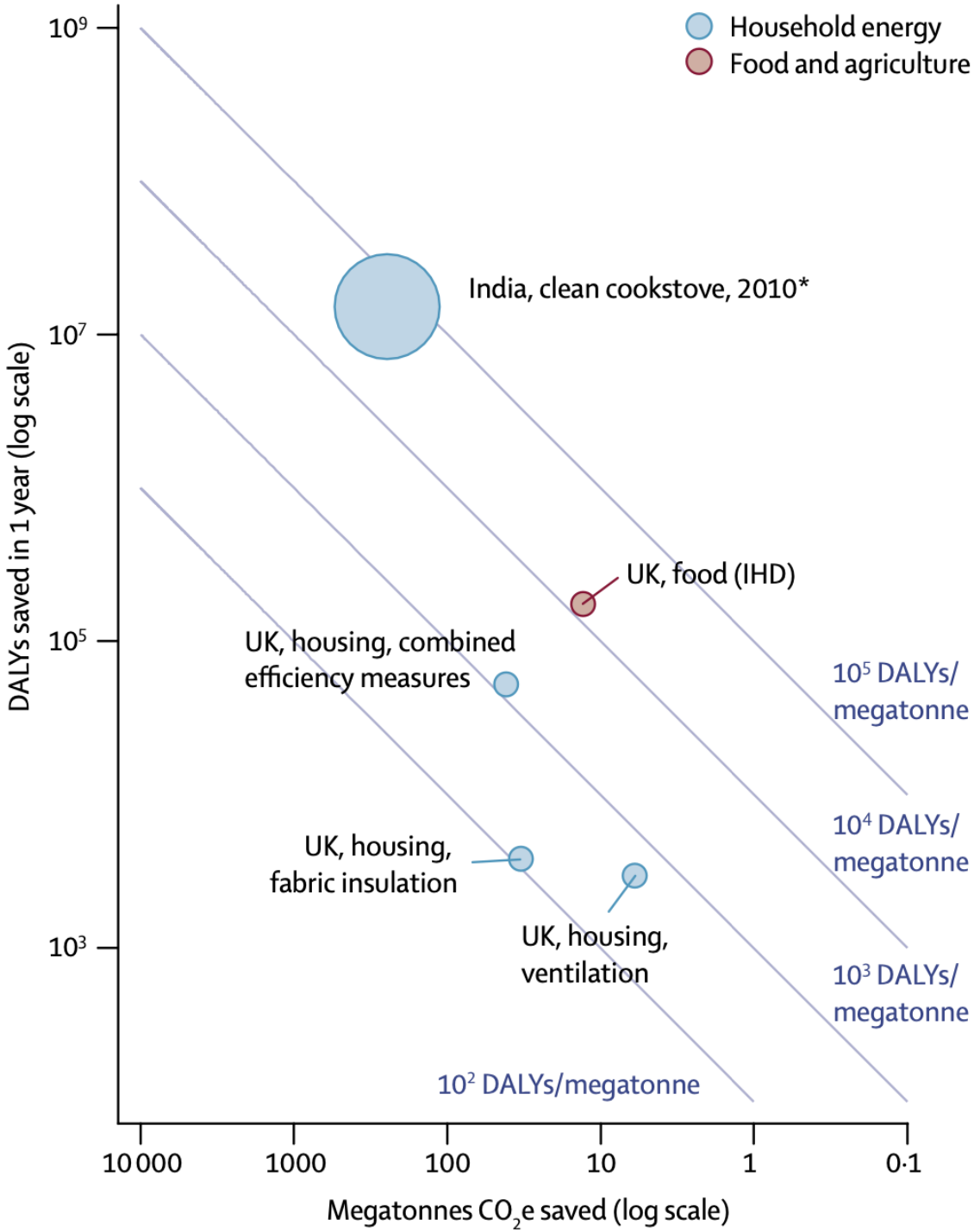
Published Online November 25, 2009 DOI:10.1016/S0140-6736(09)61759-1

This is the sixth in a Series of six papers about health and climate change

*Based on the work of the Task Force on Climate Change Mitigation and Public Health, which is described in the

This Series has examined the health implications of policies aimed at tackling climate change. Assessments of mitigation strategies in four domains—household energy, transport, food and agriculture, and electricity generation—suggest an important message: that actions to reduce greenhouse-gas emissions often, although not always, entail net benefits for health. In some cases, the potential benefits seem to be substantial. This evidence provides an additional and immediate rationale for reductions in greenhouse-gas emissions beyond that of climate change mitigation alone. Climate change is an increasing and evolving threat to the health of populations worldwide. At the same time, major public health burdens remain in many regions. Climate change therefore adds further urgency to the task of addressing international health priorities, such as the UN Millennium Development Goals. Recognition that mitigation strategies can have substantial benefits for both health and climate protection offers the possibility of policy choices that are potentially both more cost effective and socially attractive than are those that address these priorities independently.

5 Haines, A., McMichael, A. J., Smith, K. R., Roberts, I., Woodcock, J., Markandya, A., Armstrong, B. G., Campbell-Lendrum, D., Dangour, A. D., Davies, M., Bruce, N., Tonne, C., Barrett, M. and Wilkinson, P. (2009). 'Public health benefits of strategies to reduce greenhouse-gas emissions: overview and implications for policy makers'. *The Lancet*, 374(9707), pp. 2104–2114. doi: 10.1016/S0140-6736(09)61759-1.



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Health Protection Research Unit (HPRU)

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Health Protection Research Unit (HPRU)

The HPRU in Environmental Change and Health provides research to support decision-making relating to the impacts of climate change and other environmental changes that affect human health.

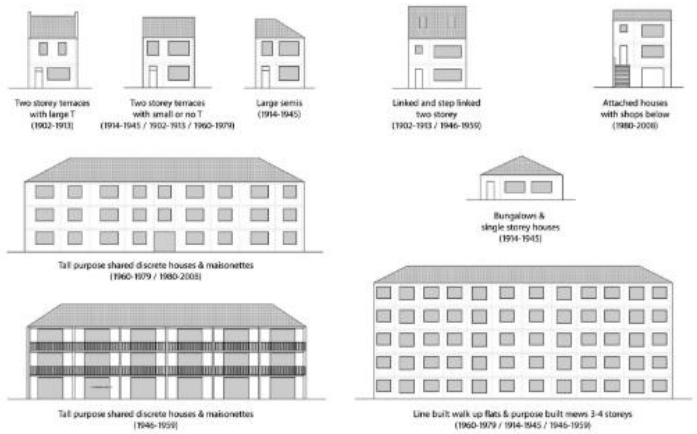
Housing/indoor environment work

Activities included:

- Development of a modelling framework to quantify impacts of home energy efficiency (HEE) measures on air pollutants (PM and NO_2)
- Indoor temperature and excess mortality during hot weather in relation to dwelling characteristics
- Indoor radon concentrations
- Position paper published in the *BMJ*. Paper argues for "systematic large-scale monitoring of indoor air quality to avoid unintended harms to health from HEE programmes"
- Health costs/benefits of strategies relating to indoor air and heat
- Expert stakeholder workshop and workshop with PLANET group
- Workshop report: https://www.lshtm.ac.uk/media/71081
- Research informed UKHSA guidance on indoor air quality, overheating, and excess winter deaths and guidance for other policymakers and industry practitioners

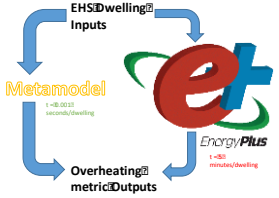
Overview: development of a modelling framework

Archetypes

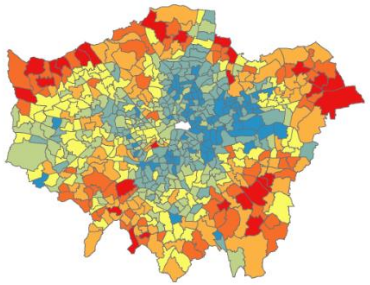


EnergyPlus

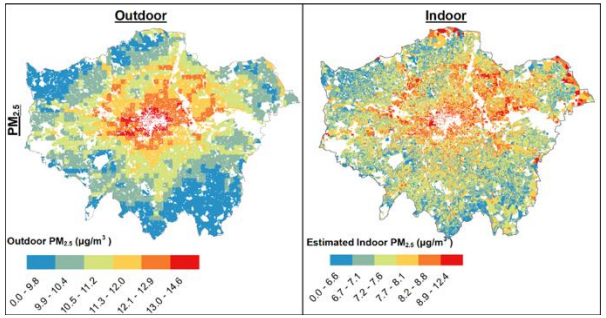
Meta-model development



Overheating model



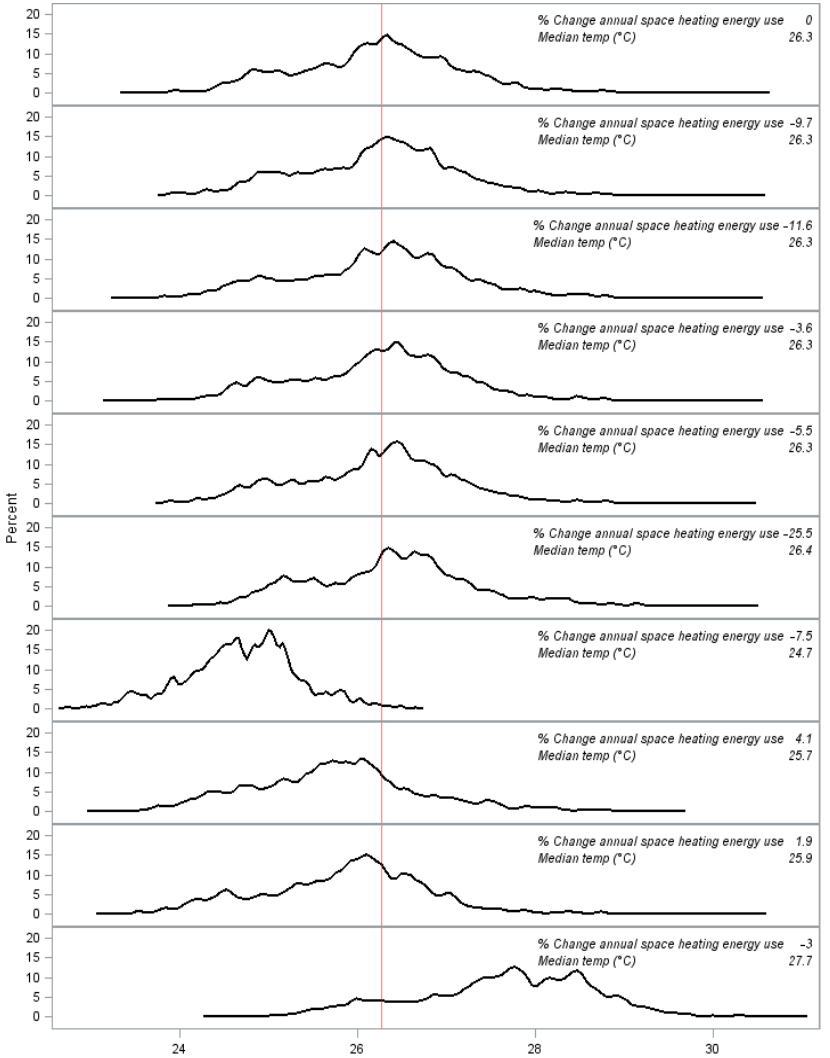
Model expanded to integrate air pollution



Indoor temperature and excess mortality during hot weather in relation to dwelling characteristics

Examples

- Evaluation of **energy efficiency retrofit** and **overheating mitigation strategies** in the **West Midlands** housing stock
- **External shutters** provided the largest reduction in heat mortality (37–43%).



Base case

Cavity wall insulation

Solid wall insulation

Floor insulation

Loft insulation

Full energy retrofit

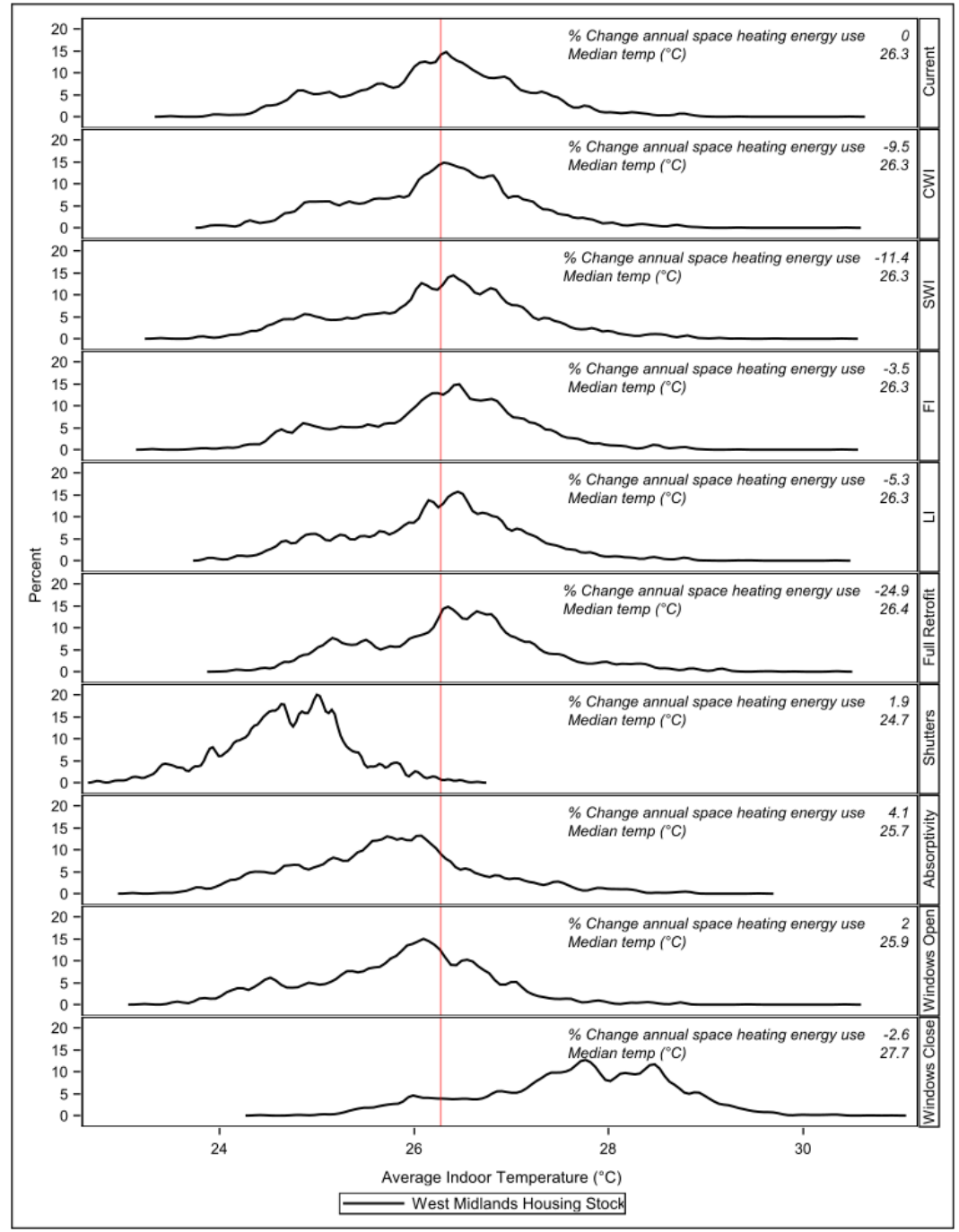
Shutters

Roof solar absorptivity

Windows open

Windows closed

Taylor et al (2018). *Estimating the influence of housing energy efficiency and overheating adaptations on heat-related mortality in the West Midlands, UK.* doi: 10.3390/atmos9050190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Median temp (°C) 26.3
Current
% Change annual space heating energy use -9.5
Median temp (°C) 26.3
CWI
% Change annual space heating energy use -11.4
Median temp (°C) 26.3
SWI
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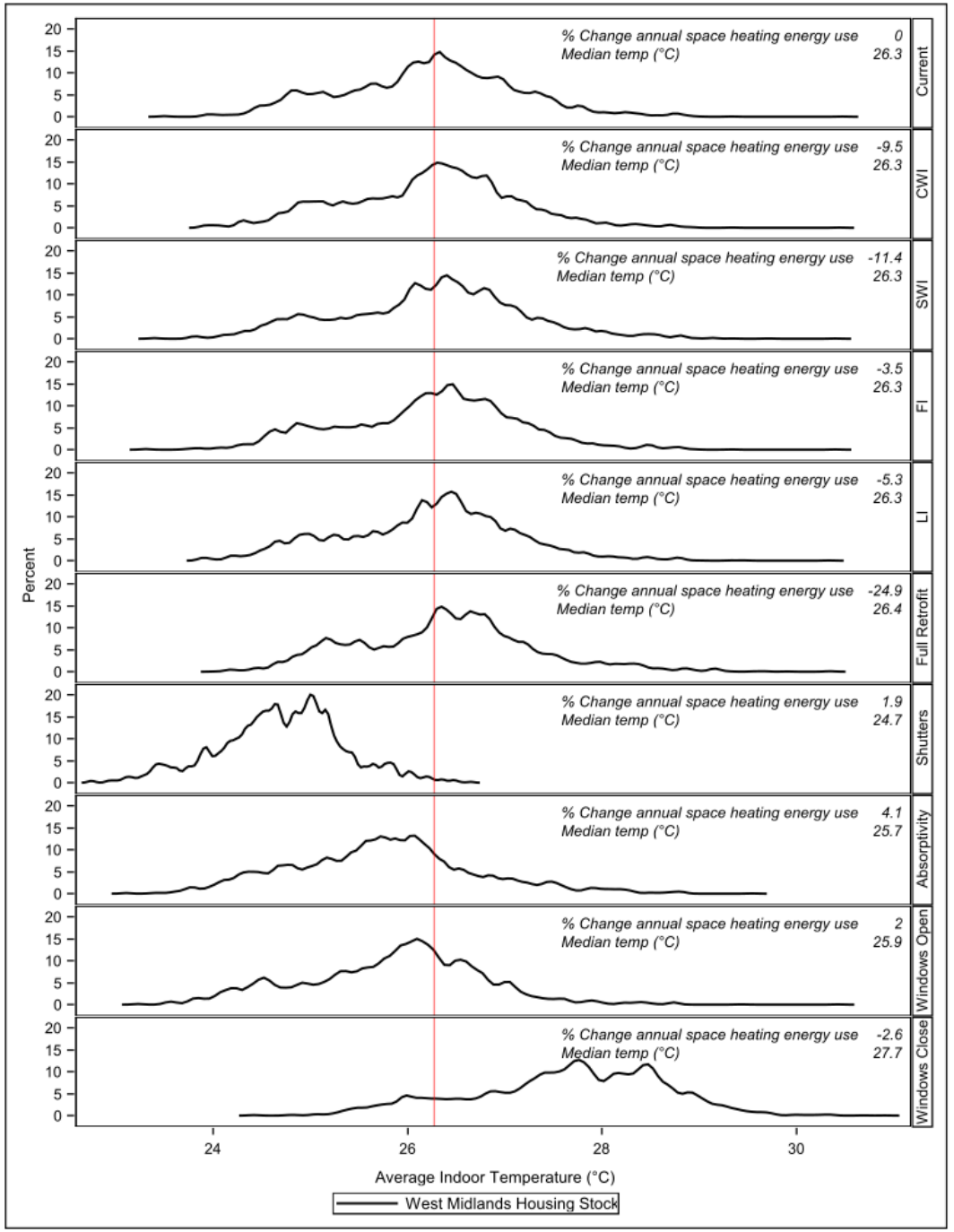
Median temp (°C) 26.3
FI
% Change annual space heating energy use -5.3
Median temp (°C) 26.3
LI
% Change annual space heating energy use -24.9
Median temp (°C) 26.4
Full Retrofit
% Change annual space heating energy use 1.9
Median temp (°C) 24.7
Shutters
% Change annual space heating energy use 4.1
Median temp (°C) 25.7
Absorptivity
% Change annual space heating energy use 2
Median temp (°C) 25.9
Windows Open
% Change annual space heating energy use -2.6
Median temp (°C) 27.7
Windows Close
Percent
0
5
10
15
20
24
26
28
30
Average Indoor Temperature (°C)
West Midlands Housing Stock

Shutters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Median temp (°C) 27.7
Windows Close
Percent
0
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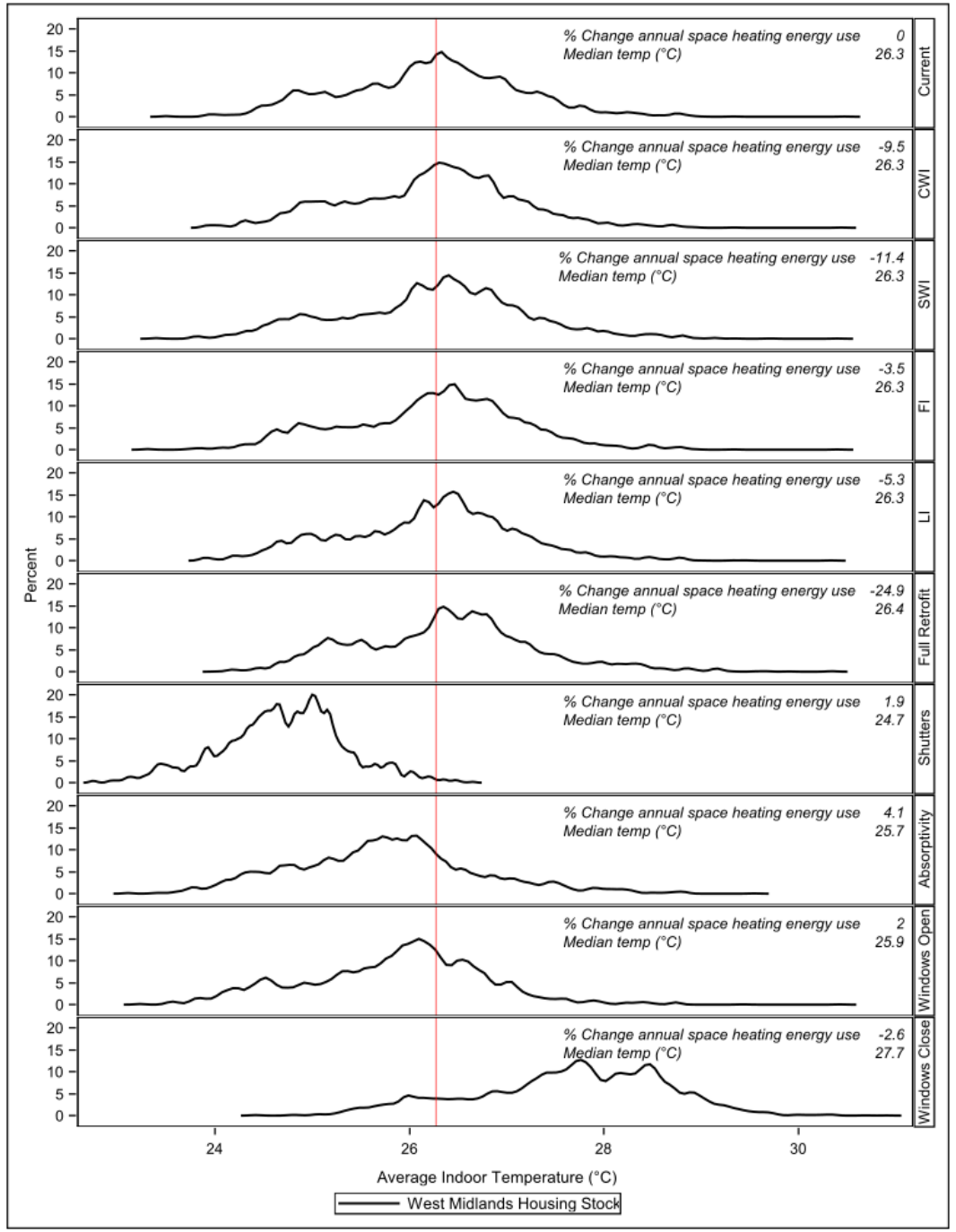
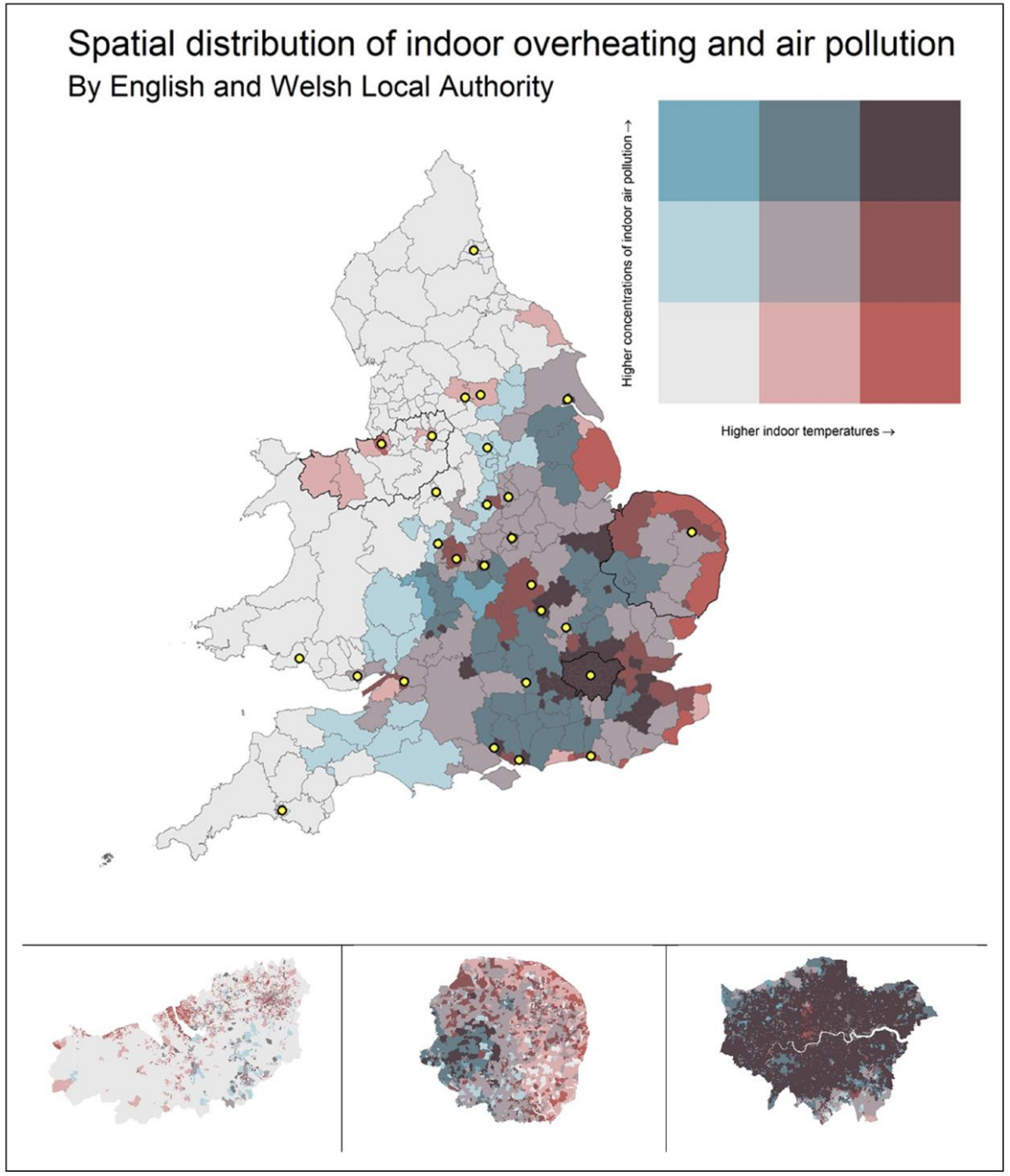
30
Average Indoor Temperature (°C)
West Midlands Housing Stock

Closed windows



Examples

A population-level framework to estimate unequal exposure to indoor heat and air pollution



Cole, R., Simpson, C. H.,Ferguson, L., Symonds, P., Taylor, J., Heaviside, C., Murage, P., Macintyre, H. L., Hajat, S., Mavrogianni, A., & Davies, M. (2024). A population-level framework to estimate unequal exposure to indoor heat and air pollution. Buildings and Cities, 5(1), pp. 562–580. DOI: https://doi.org/10.5334/bc.425

Indoor radon concentrations

Indoor radon and home energy efficiency

- Analysis of radon measurements in ~470,000 UK homes
- Positive association between energy efficiency measures and indoor radon conc.
- Double glazed had the largest association with indoor radon levels 67% higher than dwellings with no retrofit.

ORIGINAL ARTICLE | Open Access

Home energy efficiency and radon: An observational study

Phil Symonds, David Rees, Zornitza Daraktchieva, Neil McColl, Jane Bradley, Ian Hamilton, Michael Davies

Unintended Consequences

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Analysis

Home energy efficiency under net zero: time to monitor UK indoor air

BMJ 2022 ; 377 doi: https://doi.org/10.1136/bmj-2021-069435 (Published 09 May 2022)
Cite this as: *BMJ* 2022;377:e069435

Article | Related content | Metrics | Responses | Peer review

Giorgos Petrou, research fellow1,Emma Hutchinson, assistant professor2,Anna Mavrogianni, associate professor1,
James Milner, assistant professor2,Helen Macintyre, senior environmental scientist3 4,
Revati Phalkey, head of climate change and health unit3 5 6,Shih-Che Hsu, research fellow1,Phil Symonds, lecturer1,
Michael Davies, professor1,Paul Wilkinson, professor2

Author affiliations

Correspondence to: G Petrou giorgos.petrou@ucl.ac.uk

Giorgos Petrou and colleagues argue for systematic large scale monitoring of indoor air to avoid unintended harms to health from home energy efficiency programmes

8 Petrou, G., Hutchinson, E., Mavrogianni, A., Milner, J., Macintyre, H., Phalkey, R., Hsu, S.-C., Symonds, P., Davies, M. and Wilkinson, P. (2022). 'Home energy efficiency under net zero: time to monitor UK indoor air'. *BMJ*, p. e069435. doi: 10.1136/bmj-2021-069435.

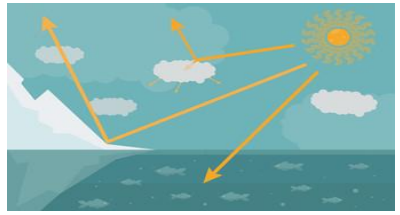
Health costs/benefits of strategies relating to indoor air and heat - care homes

Modelling work

Internal heat sources & management practices

Building fabric insulation level

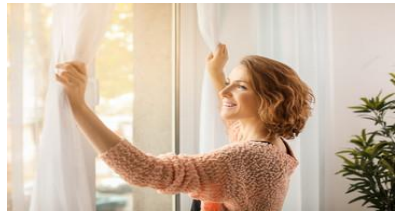
External surface albedo



Window solar protection

Thermal mass

Ventilation regimes



Green/blue infrastructure

Active cooling options

Selective application of measures

24

Results (example output)

Climate Risk Management 32 (2021) 100307

Contents lists available at ScienceDirect

Climate Risk Management

journal homepage: www.elsevier.com/locate/crm

Check for updates

Mortality benefit of building adaptations to protect care home residents against heat risks in the context of uncertainty over loss of life expectancy from heat

Andrew Ibbetson [a,1], Ai Milojevic [a], Anna Mavrogianni [c], Eleni Oikonomou [c], Nishesh Jain [c], Ioanna Tsoulou [c], Giorgos Petrou [c], Rajat Gupta [b], Michael Davies [c], Paul Wilkinson [a,*]

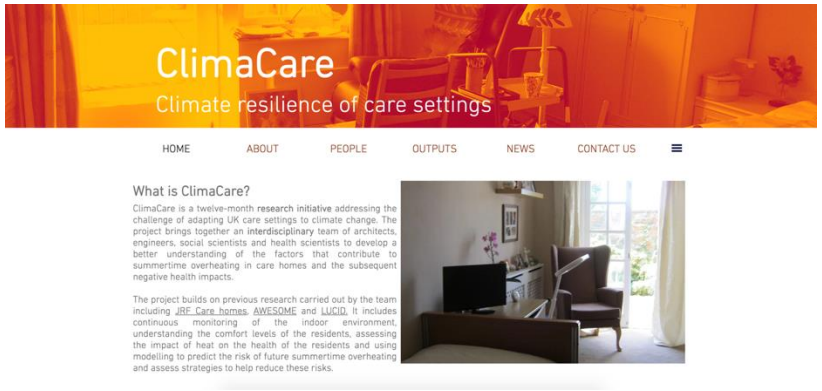
Results (example output)

- Over a 20-year time horizon and assuming an annual discount rate of 3.5%, the monetized benefit of reduced YLL would be around £90,000, £230,000 and £44,000 with the three life-expectancy assumptions.

- Although this range represents appreciable uncertainty, it appears that modest cost adaptations to heat risk may be justified in conventional cost-benefit terms even under conservative assumptions about life expectancy.

Resources

Website



climacare.org

Reports

New HPRU: ‘Climate Change and Health Security’

Healthy Indoor Environments

We will build the evidence on healthy indoor environments in a changing climate, holistically addressing indoor environmental quality.

We will develop and advance the evidence-base on the health impacts of various aspects of indoor environmental quality, including damp/mould, indoor air quality and thermal comfort, with emphasis on the co-benefits of decarbonisation and health inequalities.

UK Climate Change Committee (CCC)

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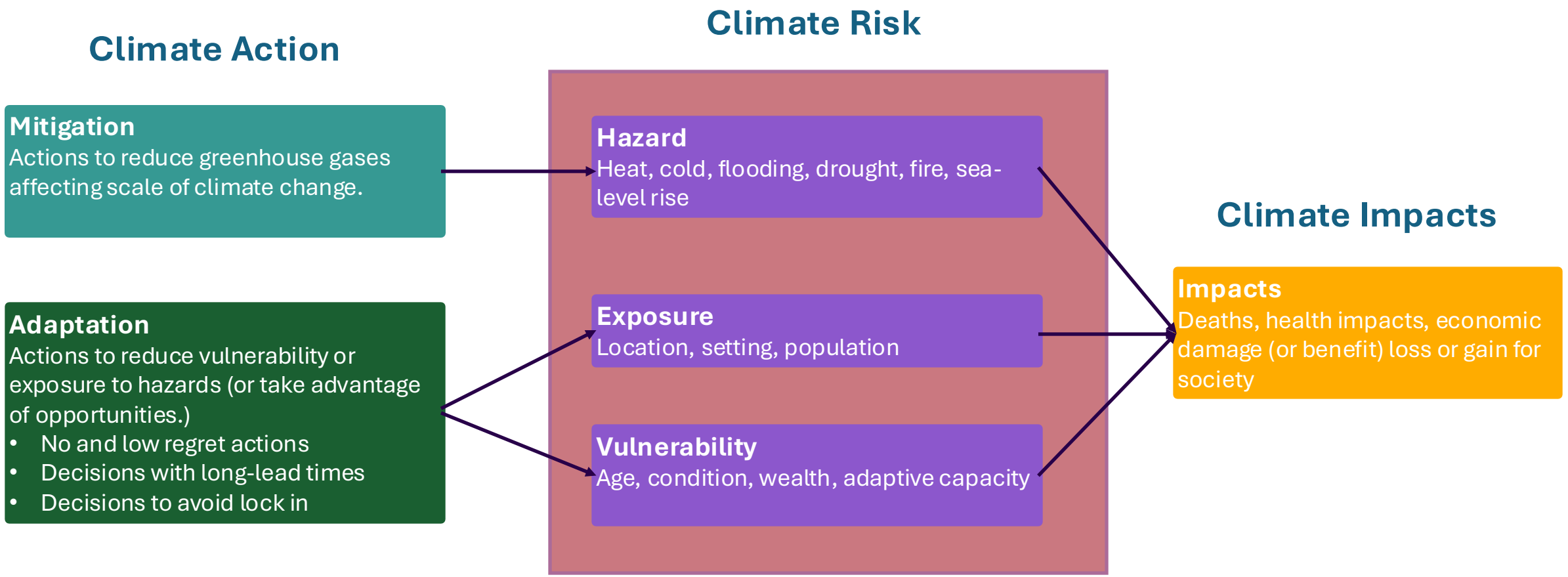
UK Climate Change Committee (UK CCC)

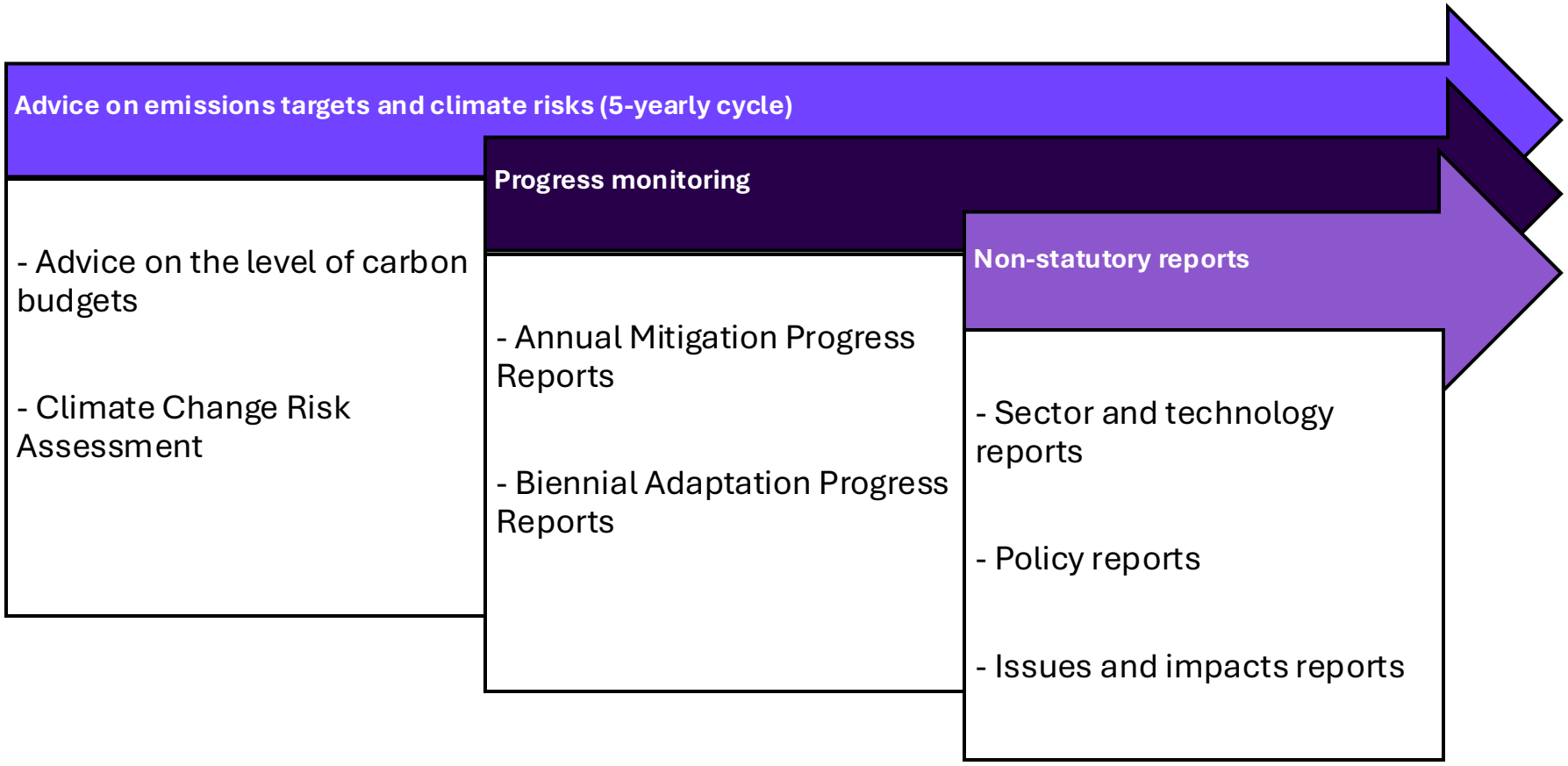
- The UK CCC is an independent, statutory body established under the UK Climate Change Act 2008

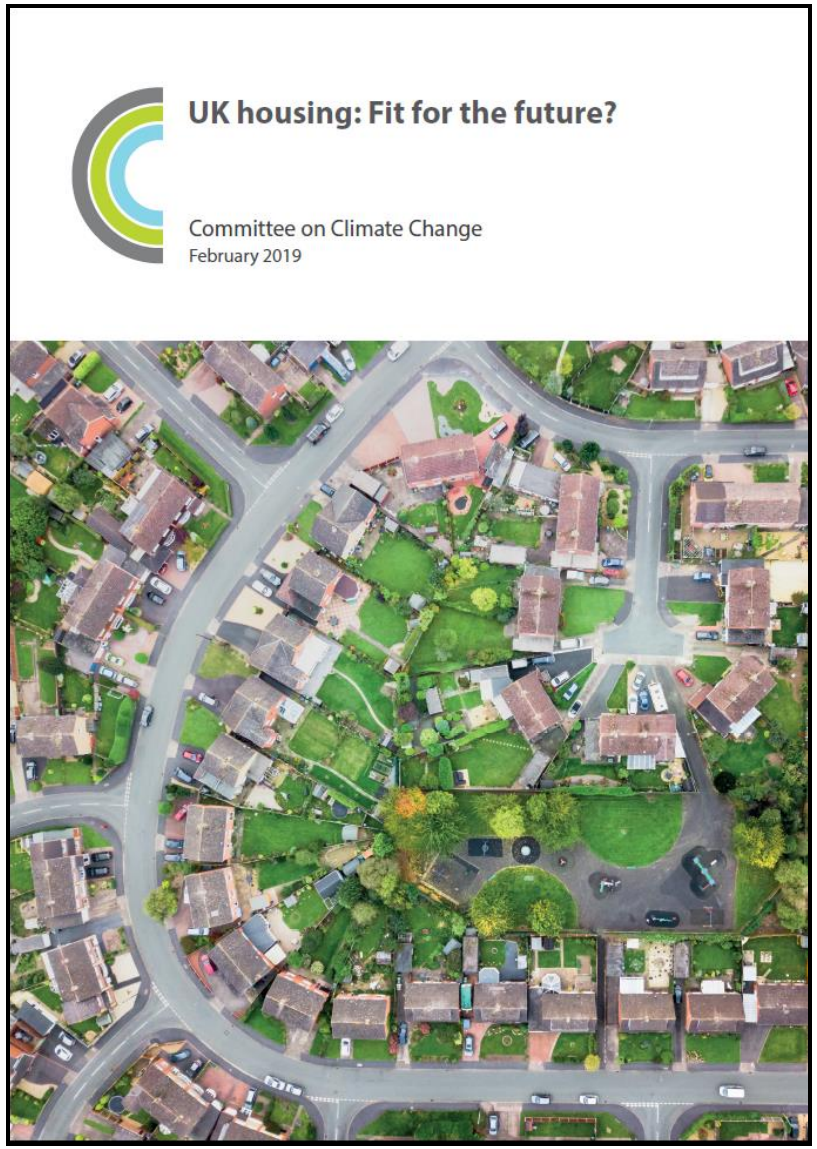
- Its purpose is to advise the UK Government on greenhouse gas emissions targets and report to Parliament on progress made in reducing emissions and preparing for climate change

We need both mitigation and adaptation action – the CCC has statutory roles for both



Target-setting, progress monitoring & informing policy





- UK wide - joint mitigation and adaptation
- Assessed state of UK housing
- Identified barriers and gaps to effective mitigation and adaptation action
- Recommended where improvements were needed - to support climate objectives *and* improve health and wellbeing

Solutions – need to be considered together in new builds and retrofit

1. Low carbon heat (heat pumps)
2. Ultra-energy efficiency, passive cooling and ventilation together
3. Whole-life carbon of homes
4. Property-level flood protection
5. Sustainable Urban Drainage
6. Urban greenspace
7. Water efficiency
8. Sustainable, low carbon transport

What does a low-carbon, sustainable home look like?

Current technology, and measures aimed at preparing for the impacts of climate change, can help new and existing homes to become low-carbon and ultra-efficient as well as adapted to flooding, heat and water scarcity.

Existing homes

Improving existing homes can help existing house-holders meet the challenges of climate change

1. **Insulation** in lofts and walls (cavity and solid)
2. **Double or triple glazing with shading** (e.g. tinted window film, blinds, curtains and trees outside)
3. **Low-carbon heating** with heat pumps or connections to district heat networks
4. **Draught proofing** of floors, windows and doors
5. **Highly energy-efficient appliances** (e.g. A^{++} and A^{+++} rating)
6. **Highly water-efficient devices** with low-flow showers and taps, insulated tanks and hot water thermostats
7. **Green space (e.g. gardens and trees)** to help reduce the risks and impacts of flooding and overheating
8. **Flood resilience and resistance** with removable air brick covers, relocated appliances (e.g. installing washing machines upstairs), treated wooden floors

24%
REDUCTION NEEDED IN DIRECT CO_2 FROM HOMES BY 2030, FROM 1990 LEVELS

15%
REDUCTION REQUIRED IN ENERGY USED FOR HEATING EXISTING BUILDINGS BY 2030 THROUGH EFFICIENCY IMPROVEMENTS[1]

New build homes

New build homes can and should meet even more ambitious standards in some areas

- **A** **High levels of airtightness**
- **B** **More fresh air** with mechanical ventilation and heat recovery, and passive cooling measures such as openable windows
- **C** **Triple glazed windows and external shading** especially on south and west faces
- **D** **Low-carbon heating** and no new homes on the gas grid by 2025 at the latest
- **E** **Water management and cooling** more ambitious water efficiency standards, green roofs and reflective walls
- **F** **Flood resilience and resistance** e.g. raised electricals, concrete floors and greening your garden
- **G** **Construction and site planning** timber frames, sustainable transport options (such as cycling)

The need for action noted in 5 key themes

- Enforcing standards, ensuring compliance with those standards and closing the 'performance gap’
- Delivering a step-change in construction skills
- Retrofitting existing homes so they are low-carbon and resilient to a changing climate.
- Ensuring new homes are low-carbon, energy efficient and climate resilient
- Addressing urgent funding needs

CCC ‘Monitoring Maps’

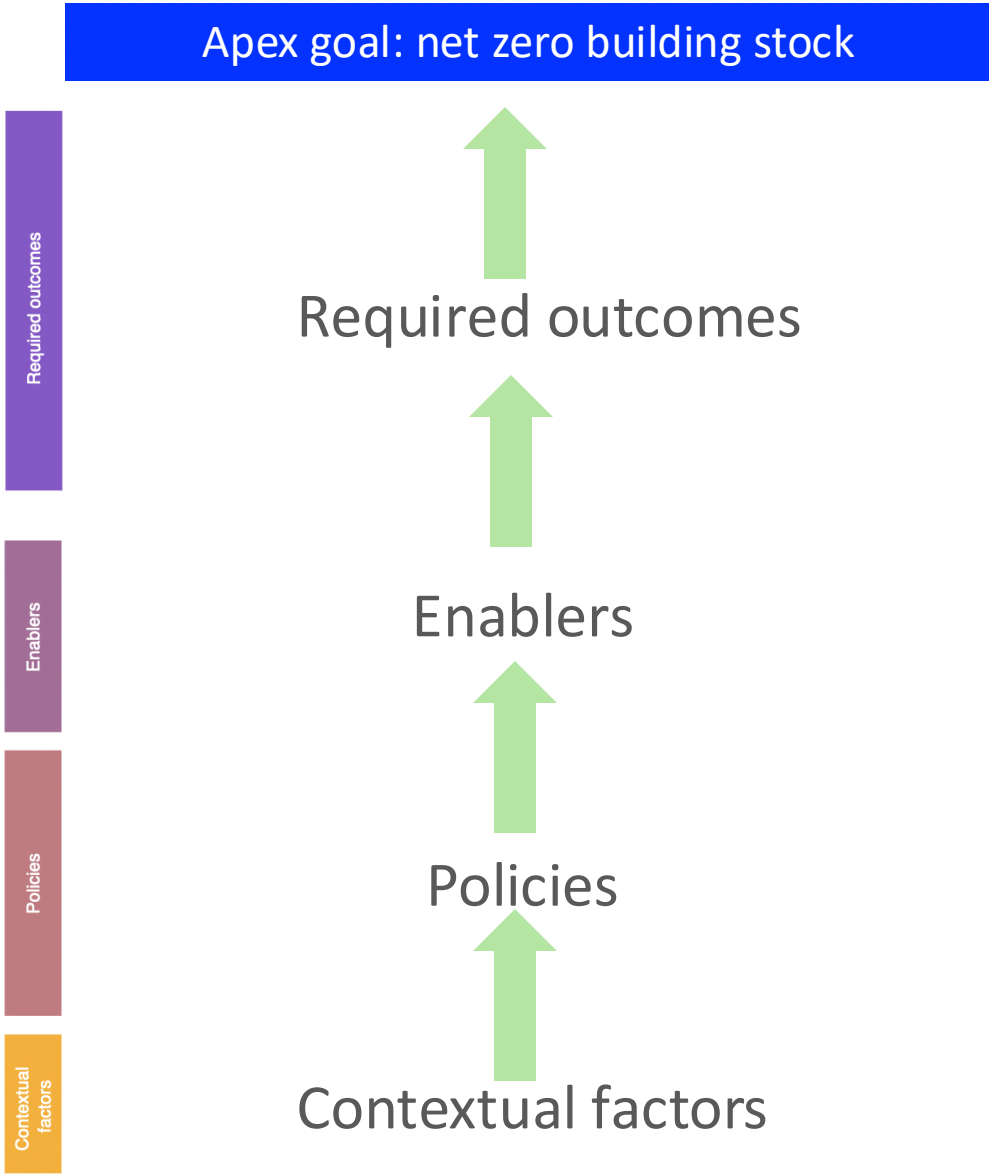
- For the major sectors, the CCC has mapped the relationships and interdependencies between the policies, enablers and outcomes required to meet the UK’s climate targets (adaptation and mitigation)
- These monitoring maps demonstrate the CCC’s ‘theory of change’ for each sector
- Importantly, health is not yet integrated into the mitigation monitoring maps
- Integrated analyses across all sectors are required

CCC monitoring maps

Levels:

- **Apex goal:** Ultimate objective
- **Required outcomes:** the delivery of specific measures to deliver apex goal
- **Enablers:** Factors that are necessary to deliver the outcomes
- **Policies:** Requirements from policy to support achieving outcomes
- **Contextual factors**

Figure 3.1 Monitoring map for buildings



Source: CCC analysis.
Notes: We use the following acronyms: EPC – Energy Performance Certificates. H2-ready boilers – hydrogen-ready boilers. LAEP – local area energy planning. DAs – Devolved Administrations. LAs – Local Authorities. PRS – private rented sector. HPs – heat pumps. EE – energy efficiency.

CCC monitoring maps

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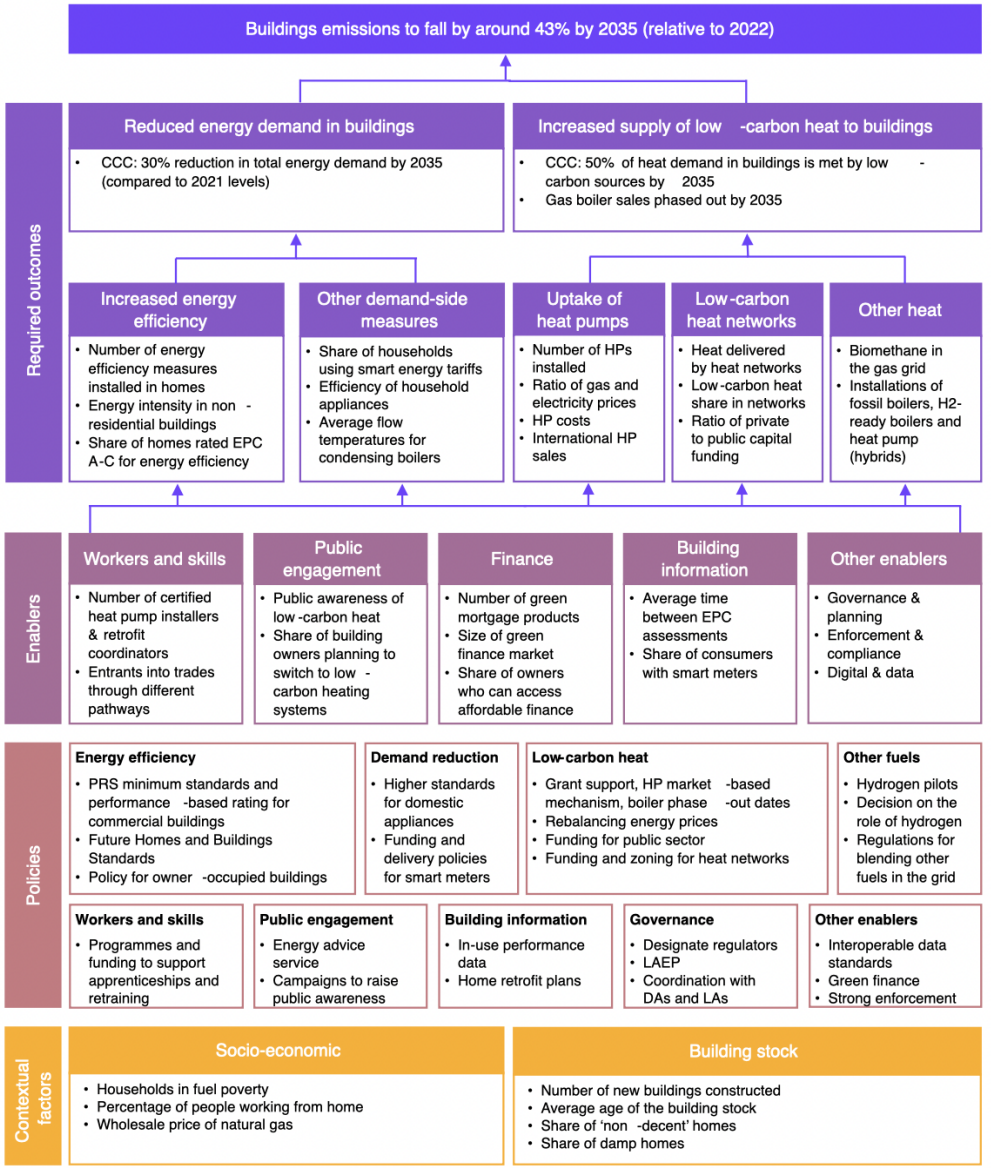

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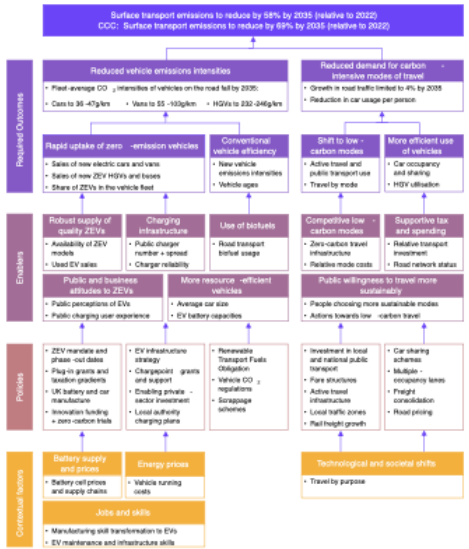
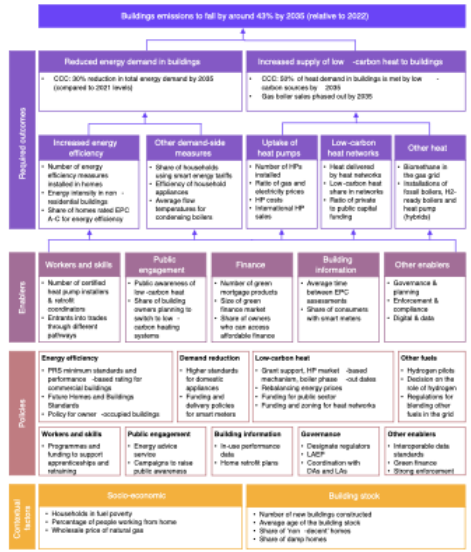
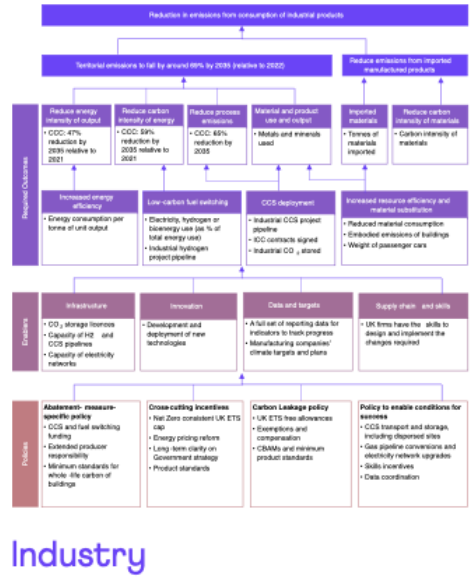


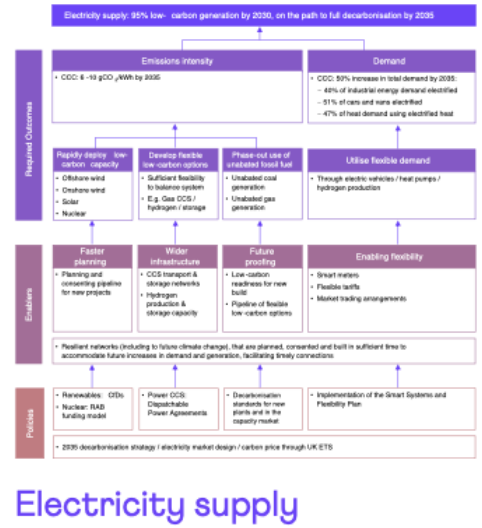
Surface transport



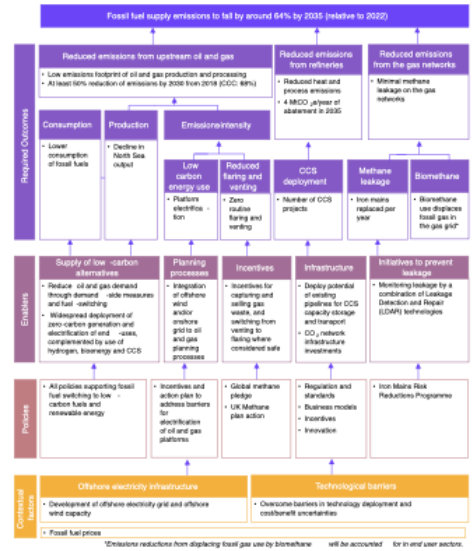
Buildings



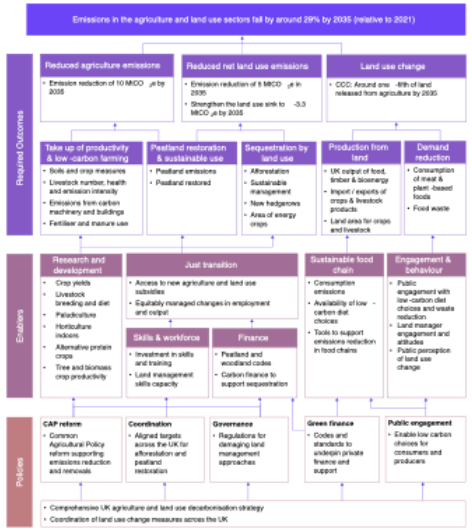
Industry



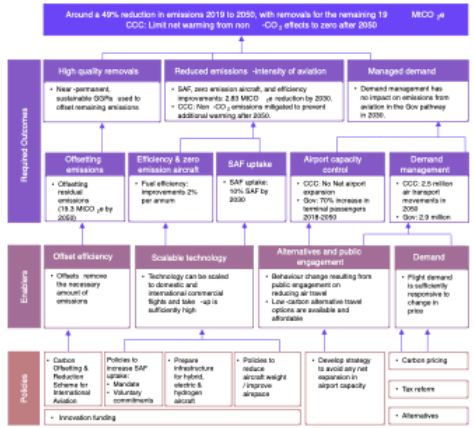
Electricity supply



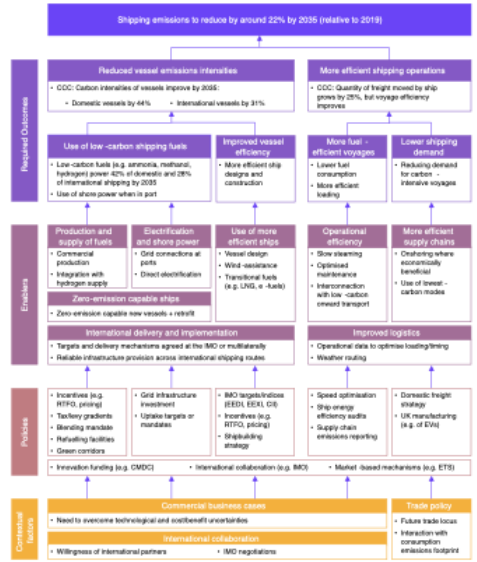
Fuel supply



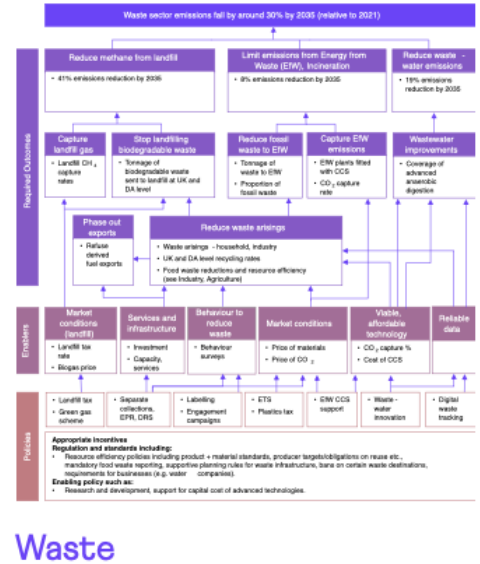
Agriculture and land use



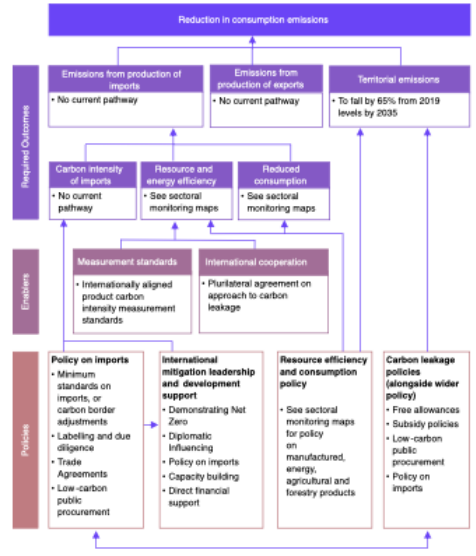
Aviation



Shipping



Waste



Trade & consumption emissions

'*Policy and Implementation for Climate & Health Equity*' (PAICE)

Our Wellcome Trust funded PAICE project is working with the UK CCC to:

- integrate health into the monitoring maps
- integrating all the sectoral maps (inc. adaptation maps) via a 'systems thinking' approach
- translate the maps from national to local level – working with the Greater London Authority for example

Summary

1. Substantial co-benefits from Net Zero actions in housing
2. Need also to consider unintended consequences
3. Synergies between mitigation and adaptation
4. Cross-sectoral, transdisciplinary, systems thinking approach

End

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