The Future of Net Zero Policies on air pollution in the UK

The Health and Equity Impacts of Climate Change Mitigation measures on indoor and outdoor air pollution exposure (HEICCAM)

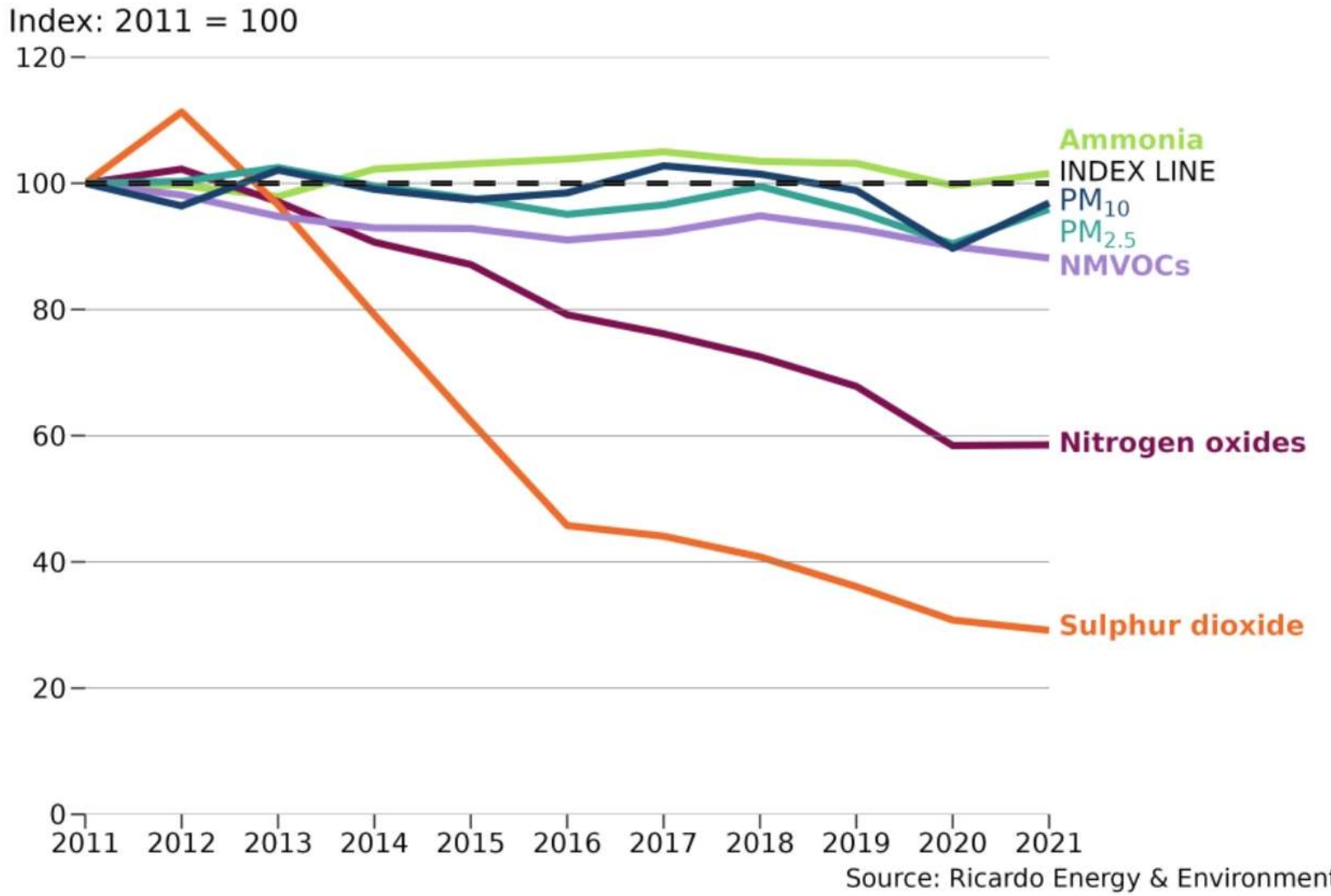
Ruth Doherty, University of Edinburgh
And the HEICCAM network

The future of Net Zero policies on air pollution in the UK

- The impact of Net Zero policies on UK air quality: complicated
- Two aspects we've considered in HEICCAM
- How do future emission pathways, that lead to Net Zero, impact outdoor air quality over the UK?
- How do Net Zero policies for the UK housing sector impact indoor air quality?
- Challenges: Interactions occur within and between chemical environments and exposures are modified e.g., occupant behavior affects ventilation
- Need to consider holistic (multiple sectors/actions) impacts of Net Zero policies on air pollution across the outdoor-indoor continuum?

Outdoor air pollution- recent UK emission changes

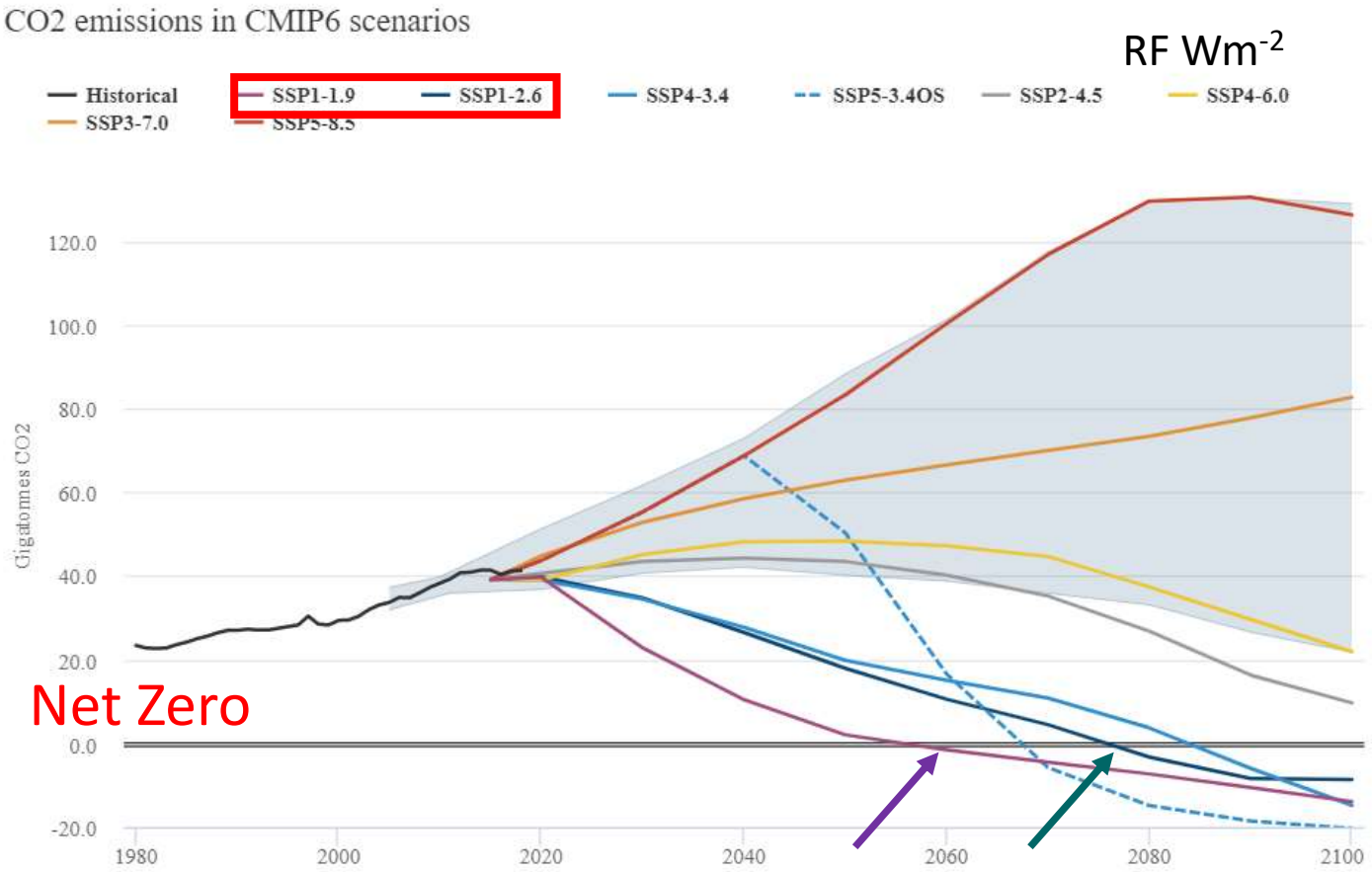
- Trends over the last decade in annual emissions of air pollutants and air pollutant precursors



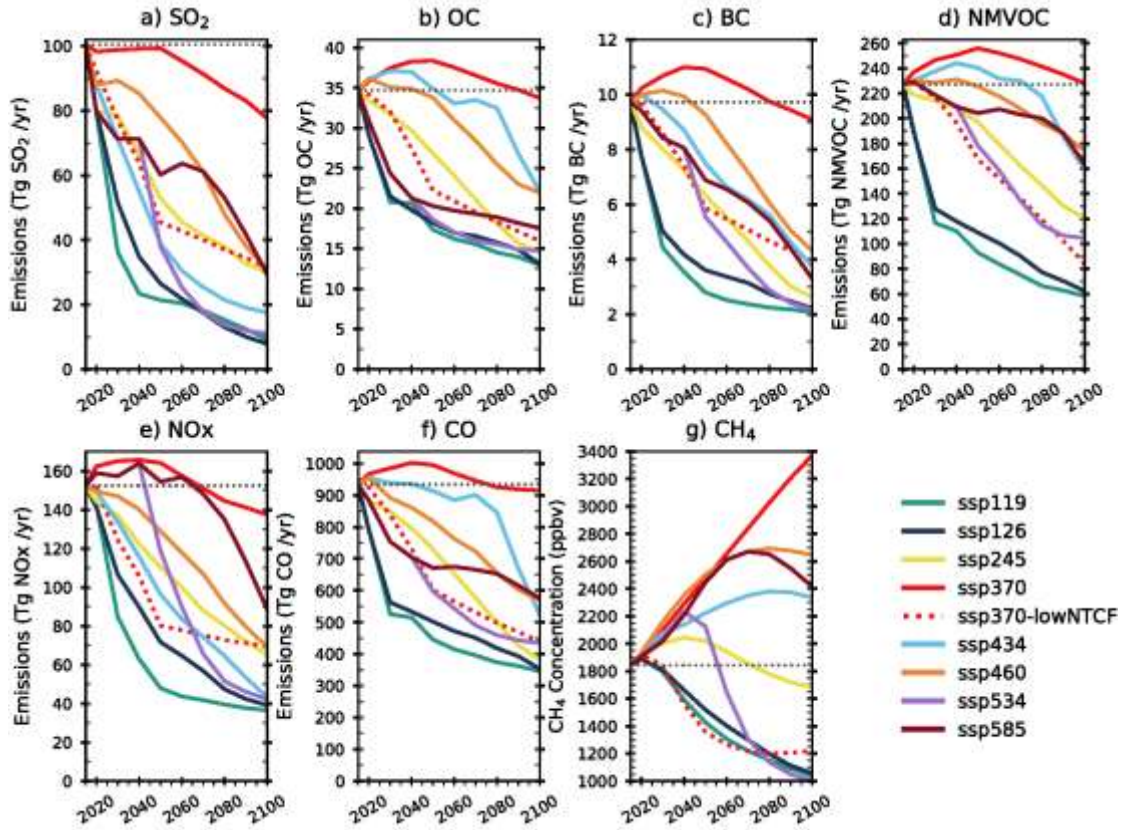
https://www.gov.uk/government/statistics/emissions-of-air-pollutants/emissions-of-air-pollutants-in-the-uk-summary
DEFRA, 2023.

Clean Air Programme

Shared Socioeconomic Pathways (SSPs)- global



Turnock et al. 2020

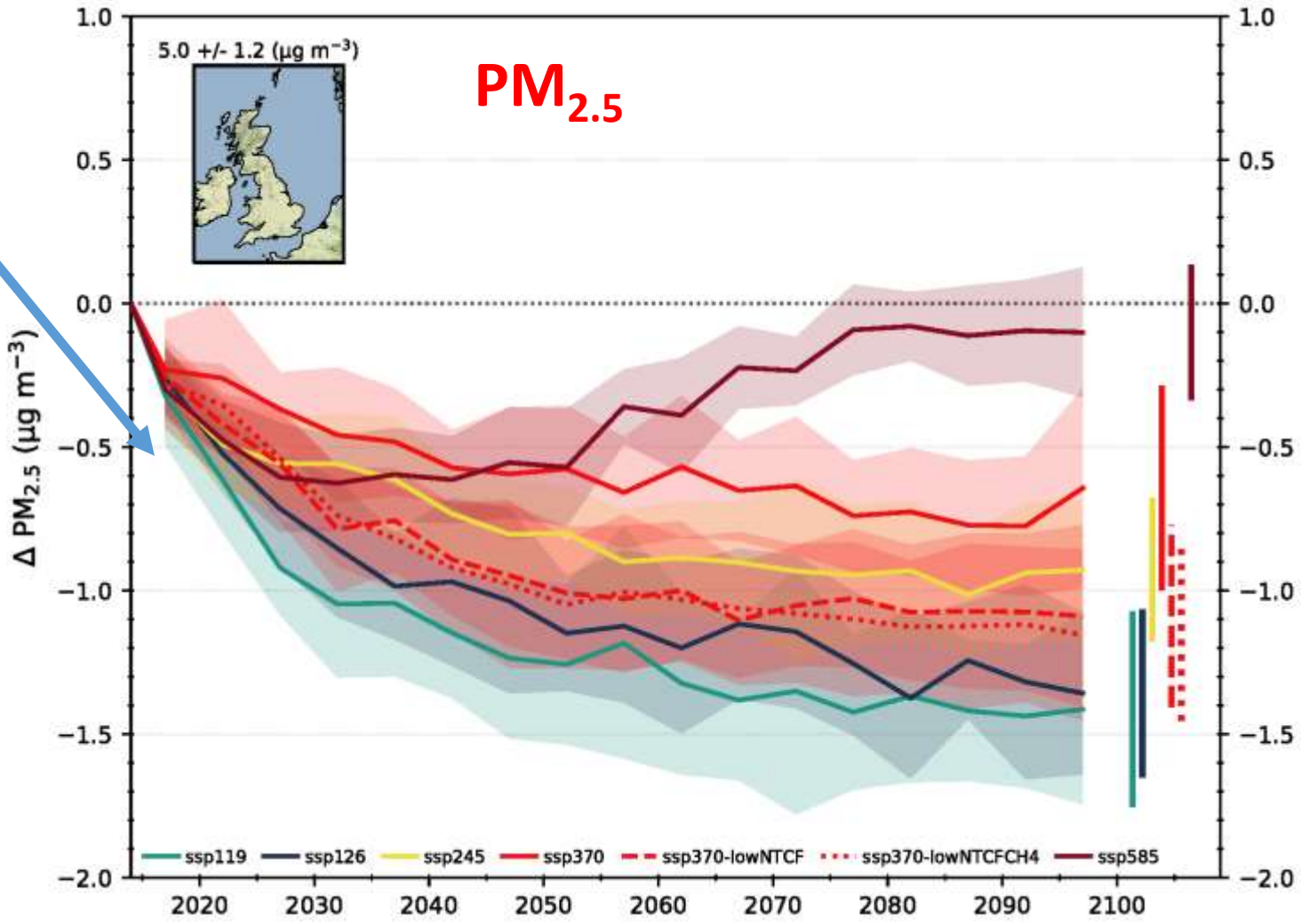


https://www.carbonbrief.org/cmip6-the-next-generation-of-climate-models-explained

Net Zero scenarios show a reduction in global emissions of air pollutant precursors

Future outdoor air pollution for the UK

- Outdoor $PM_{2.5}$ levels in the UK reduce under Net Zero scenarios
- Regional O_3 and NO_2 concentrations reduce under Net Zero SSPs
- Urban O_3 may increase where urban NO_2 decreases
- SSPs are uncertain, some road map is needed to achieve these
- A key question: Can the UK achieve 2021 WHO air quality guidelines?



Results are based on multiple CMIP6 models for each scenario (shading shows diversity in model response)

Effect of net zero policies and climate change on air quality: Royal Society 2021

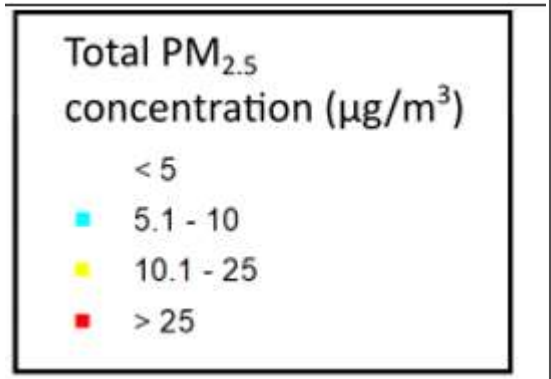
Implications of New WHO air quality guidelines

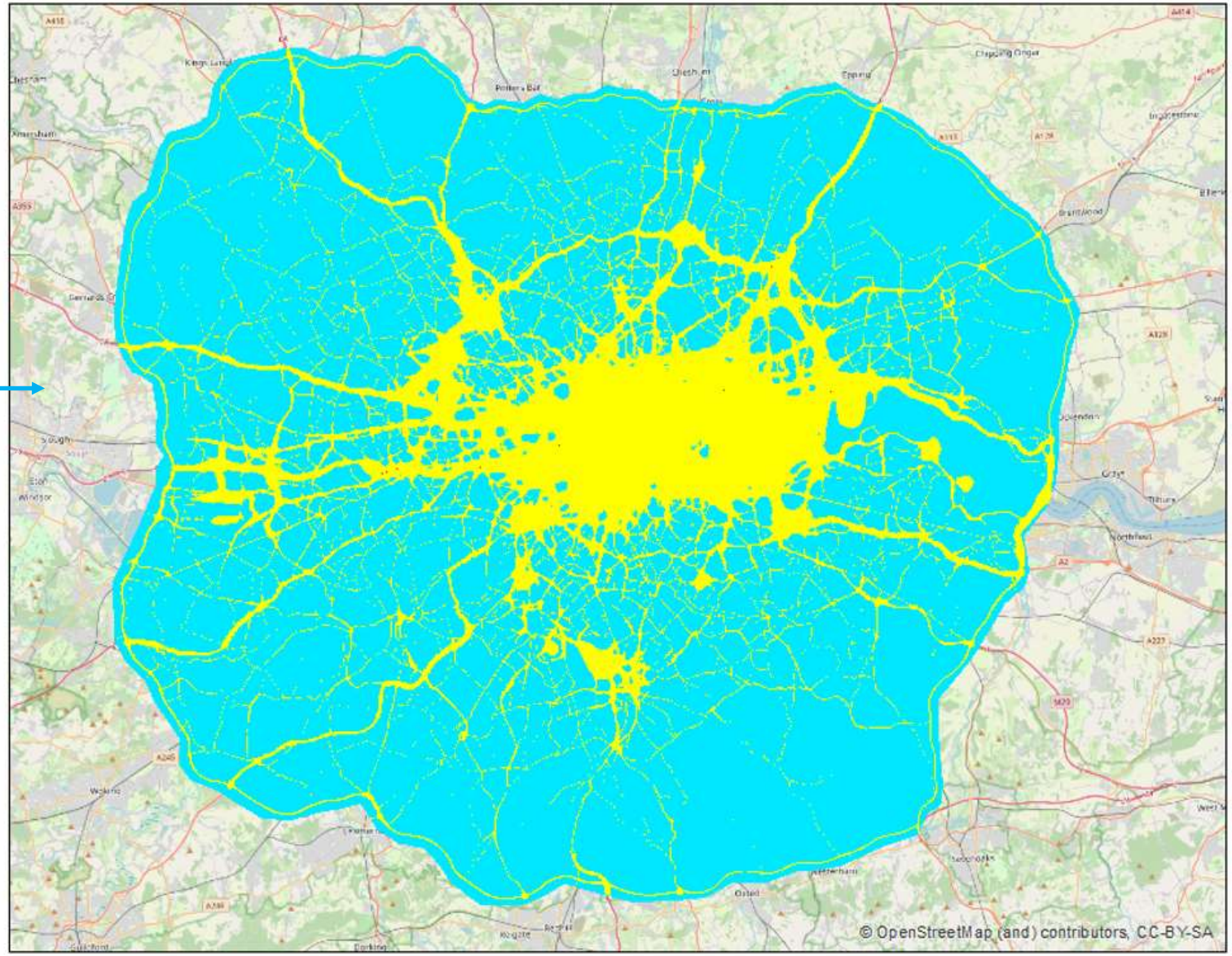
- New 2021 WHO guidelines challenging especially for $PM_{2.5}$ (annual-mean $<5\mu gm^{-3}$)
- Nowhere in London below limit for 2019!

2019

(Streetscale)

Courtesy of CERC





Net Zero measures: carbon budgets for the UK:

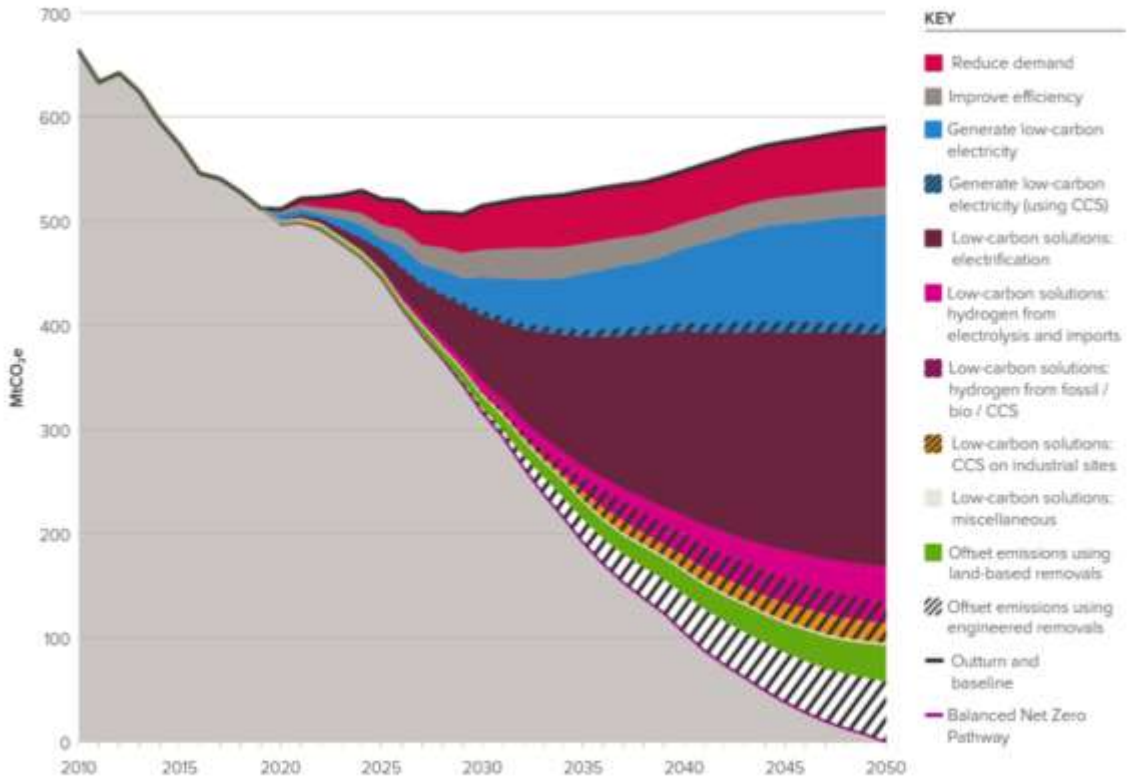
- UK Climate Change Act: Net Zero GHG emissions by 2050
- CCC- Sixth Carbon Budget: 5 pathways
- Balanced Pathway: improve efficiency; electrification of home heating (heat pumps)

Sector	Balanced Pathway
Housing	**Household fuel use** • 87% increase in electricity demand by 2050 • Gas, petrol, solid fuels phased out, some bioenergy and hydrogen
	Home energy efficiency • 65% retrofitted by 2030 • 100% retrofitted by 2050 (>99% by 2047)

But, careful not to reduce ventilation

FIGURE 8

Balanced Pathway for reductions in UK greenhouse gases to reach net-zero in 2050

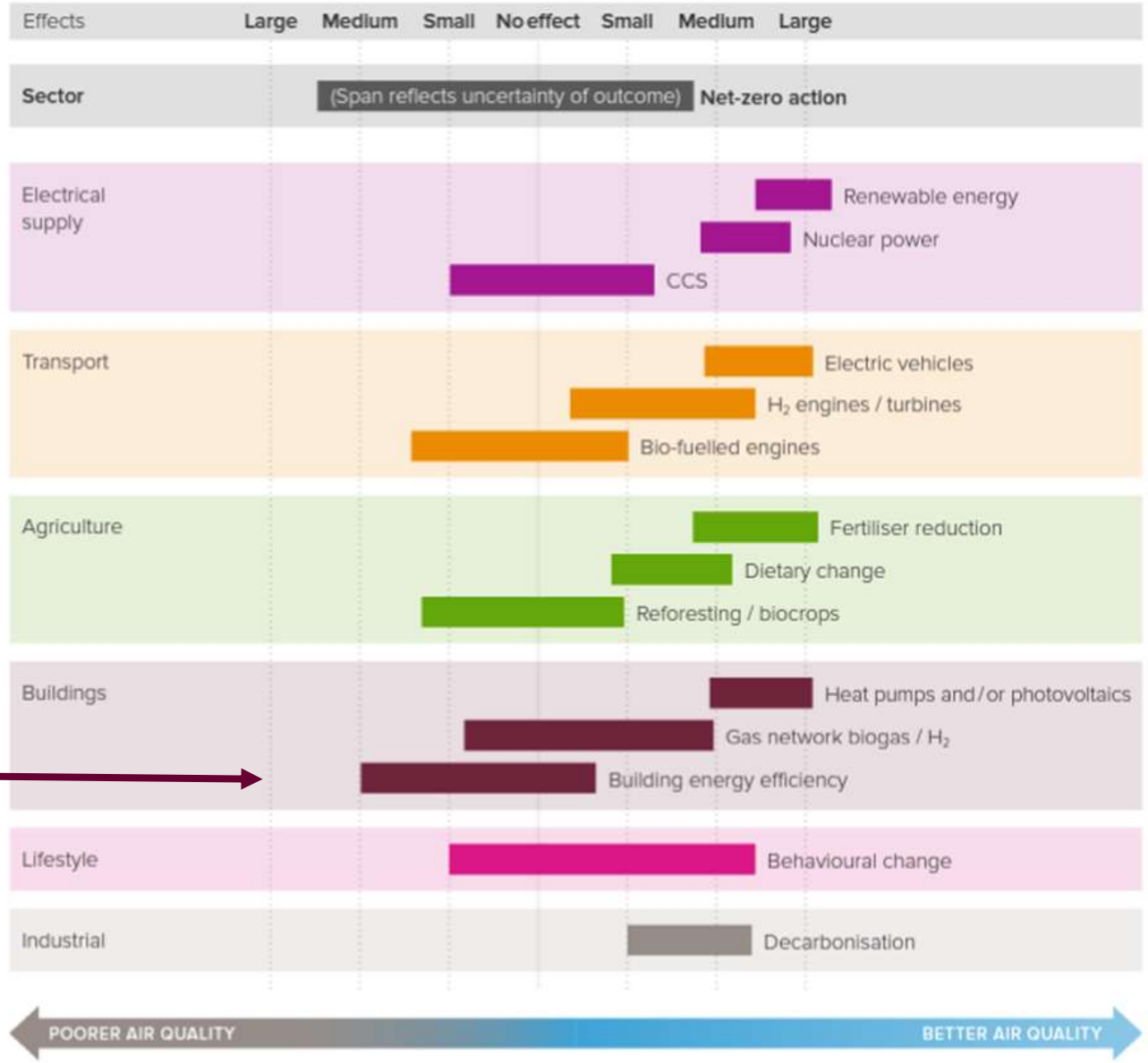


Source: Figure adapted from CCC 2020, with further breakdown on CCS provided by the CCC.

Royal Society 2021

Net Zero measures on UK outdoor/indoor air quality

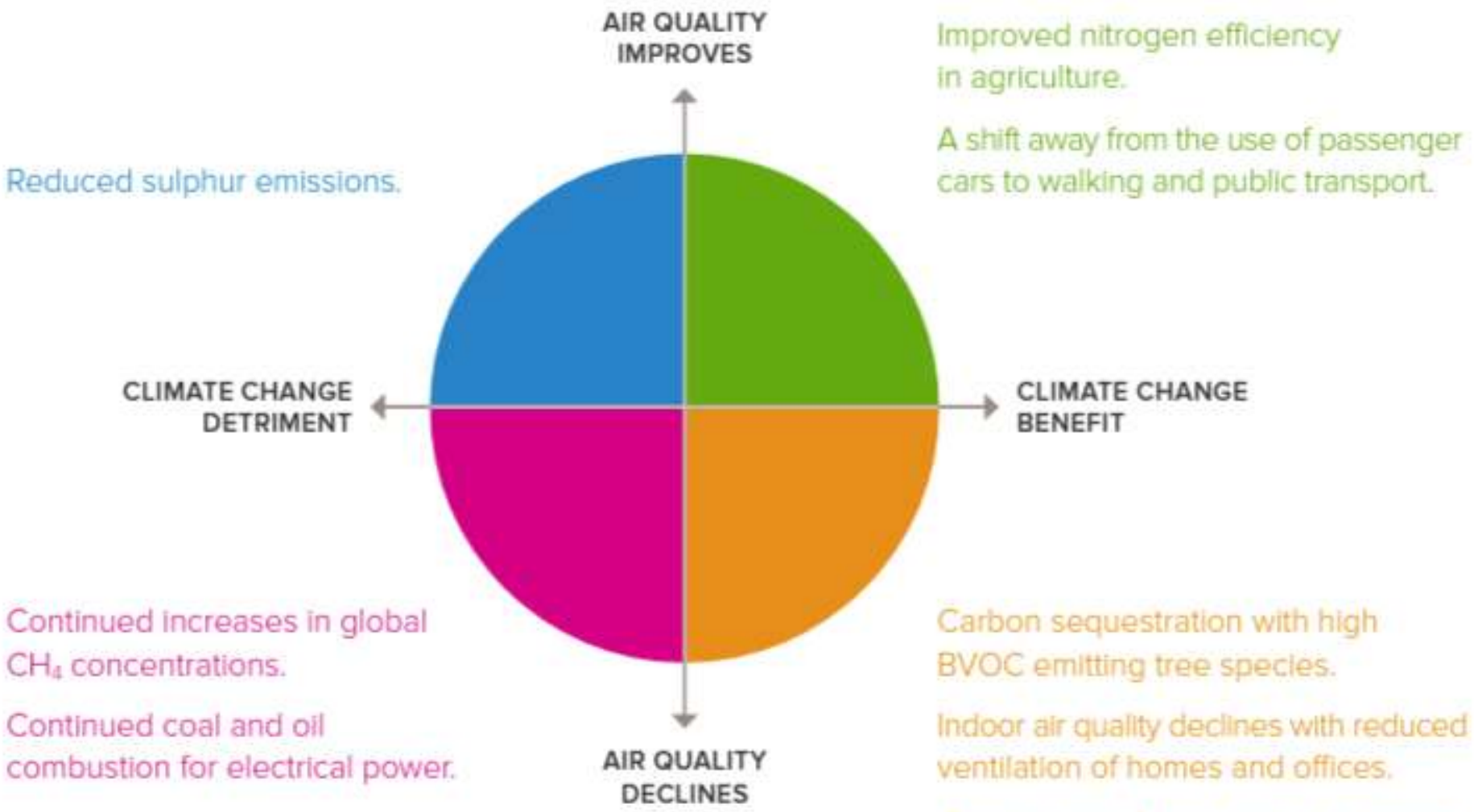
- What will Net Zero mean for air quality?
- Many measures could improve air quality ☺
- Some activities e.g. in the transport sector more biofuel crops could lead to poorer ambient air quality
- In the housing sector –home energy efficiency → reduced ventilation will lead to poorer indoor air quality



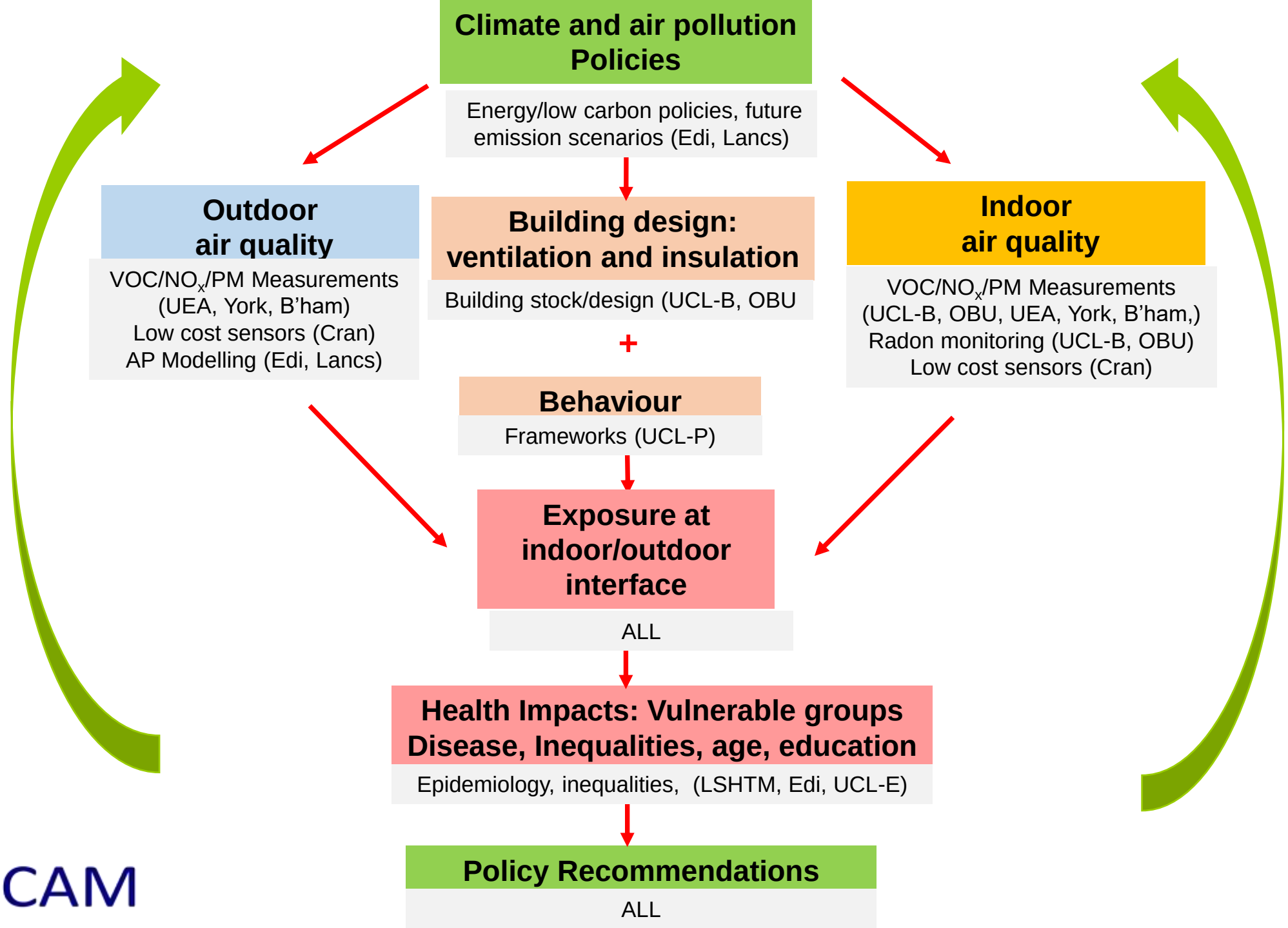
Effect of net zero policies and climate change on air quality: Royal Society 2021

Effects of Net zero policies on air quality and climate change: maximising co-benefits -Royal Society 2021

- The opportunity for co-benefits
- Next slides focus on housing sector and its challenges



Royal Society 2021


Climate and air pollution Policies
Energy/low carbon policies, future emission scenarios (Edi, Lancs)
Outdoor air quality
VOC/NOx/PM Measurements (UEA, York, B'ham)
Low cost sensors (Cran)
AP Modelling (Edi, Lancs)
Building design: ventilation and insulation
Building stock/design (UCL-B, OBU
+
Behaviour
Frameworks (UCL-P)
Indoor air quality
VOC/NOx/PM Measurements (UCL-B, OBU, UEA, York, B'ham,)
Radon monitoring (UCL-B, OBU)
Low cost sensors (Cran)
Exposure at indoor/outdoor interface
ALL
Health Impacts: Vulnerable groups Disease, Inequalities, age, education
Epidemiology, inequalities, (LSHTM, Edi, UCL-E)
Policy Recommendations
ALL

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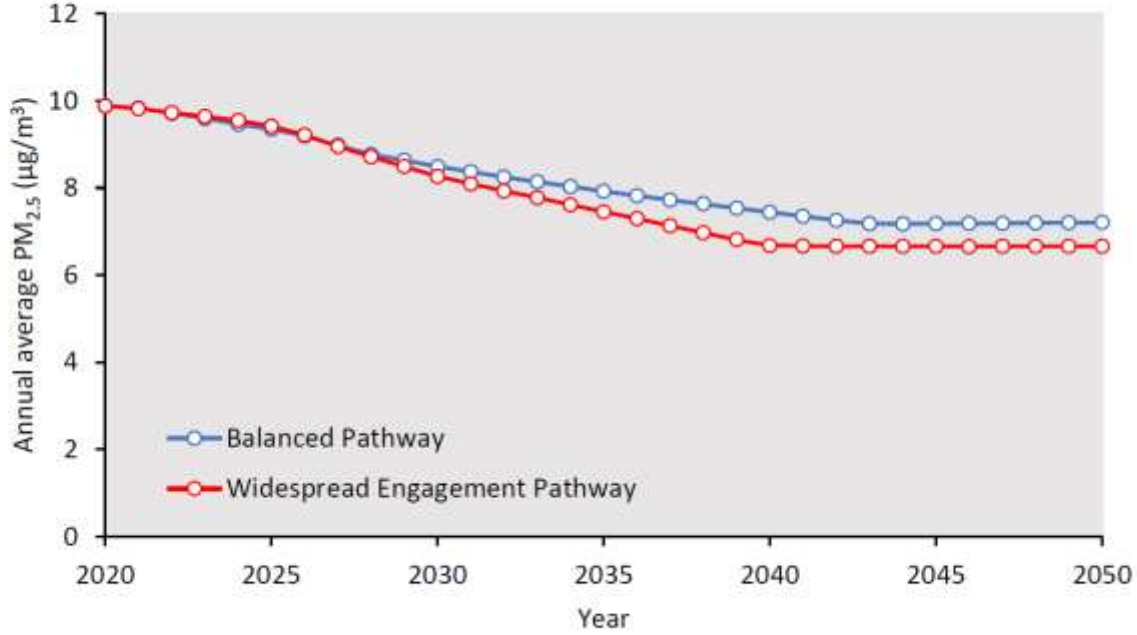
Impacts of CCC 6th carbon budget actions on air pollution

Ambient air pollution: annual average $PM_{2.5}$



Housing-indoor sources: annual average $PM_{2.5}$

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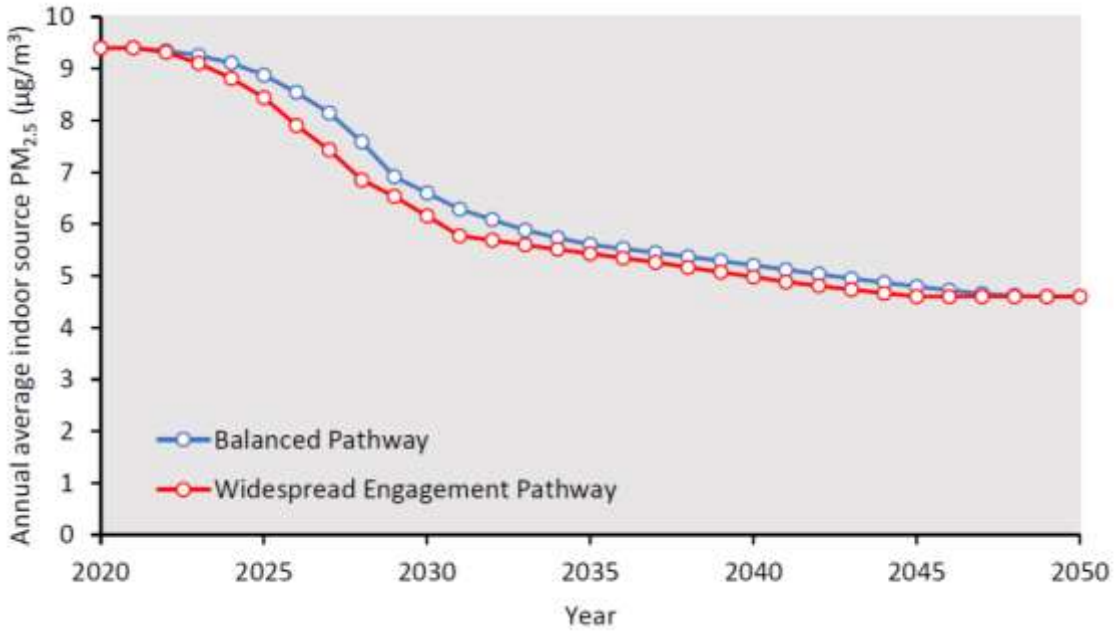
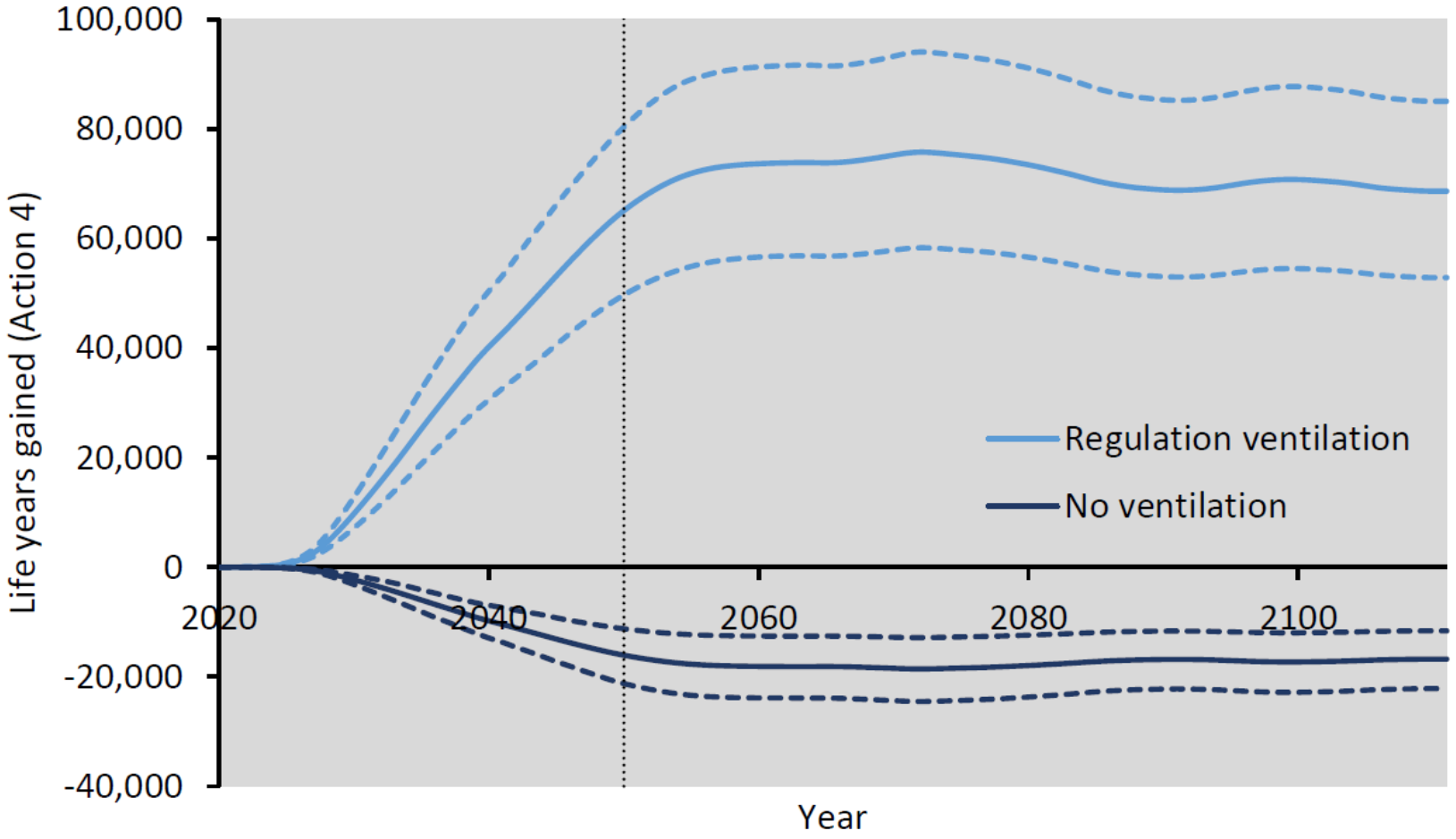


- Two contrasting CCC pathways to Net Zero: balanced pathway, widespread engagement pathway
- Actions modelled are switching to: low GHG fuels for electricity generation; low GHG fuels for transport; low GHG fuels for home energy, increased home energy efficiency (with ventilation regulations met), increased active travel, reduced meat and dairy consumption
- Annual average $PM_{2.5}$ levels both outdoors and from indoor sources are important and reduce considerably (closer to WHO 2021 guidelines)

Milner et al. Lancet planetary health,2023

Anna Mavrogianni
James Milner

- Considering ventilation:
- If regulations for ventilation are met: 70,000 annual life years gained
- But without adequate compensatory home ventilation 20,000 annual life years lost
- Failure to provide adequate ventilation may worsen indoor air quality



Milner et al. Lancet planetary health,2023

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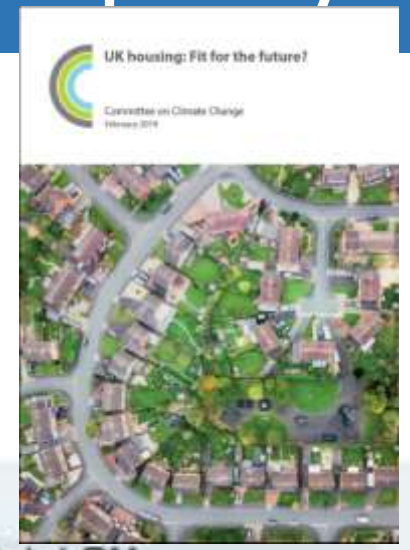
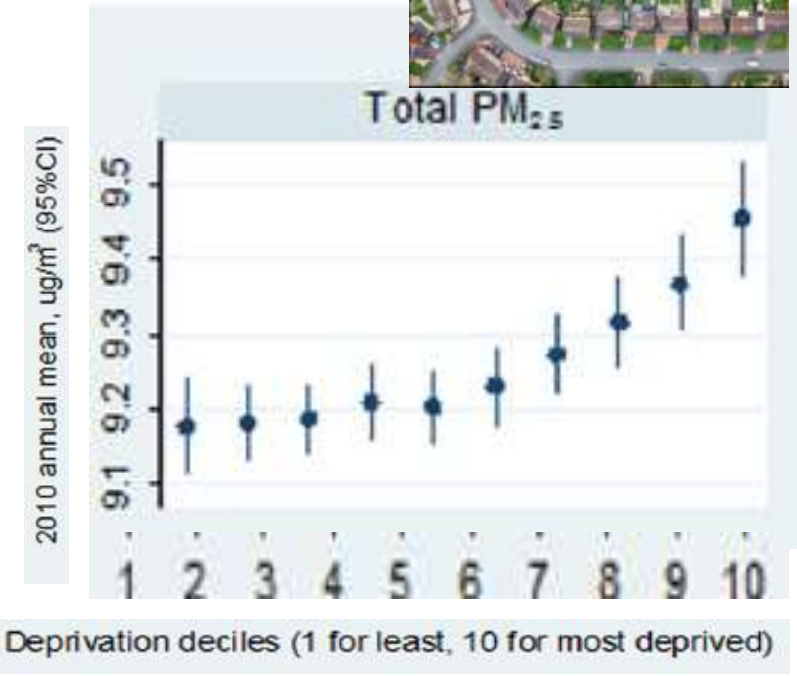
Opportunities/challenges of Net Zero policies for air quality

- Mostly good news on the outdoor air pollution front but much uncertainty; co-benefits for air quality and climate change
- Indoor air quality: even more uncertainty including a lack of measurement data; Net Zero measures have some co-benefits (e.g. switching fuel type); the potential for increased airtightness → reducing ventilation → key concern
- Under CCC scenarios outdoor and indoor air pollution levels for annual-mean $PM_{2.5}$ decrease→ nearer to new WHO guidelines
- The scale of the problem: CCC (2019): UK homes are not fit for the future: 80% of the existing 28 million homes will be around in 2050. Net Zero housing targets require large-scale home energy retrofits
- Limited empirical data on the effect of home energy efficiency interventions on air exchange and indoor air quality
- Need to understand impacts for health and health inequalities to avoid worsening differential exposure





Patterns of ambient PM2.5 concentrations in Englan by decile of socioeconomic deprivation (Milojevic et Environ Health 2017)

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