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Health co-benefits of Net Zero

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UK Net Zero co-benefits

Our approach

1. Incorporate all emissions in the air pollution model from Europe to UK roads for existing policy – business as usual (BAU)

2. Predict into the future – 2030/40 BAU

3. Replace with the BNZP transport, active travel and building scenario data

4. Predict into the future - – 2030/40 and 50 BNZP

5. Compare 4 and 2 to obtain the impacts of Net Zero policy on $PM_{2.5}$, NO_2 and O_3

6. Appy these changes in air pollution to calculate inequalities, health impacts, indoor exposure and cost benefit analysis

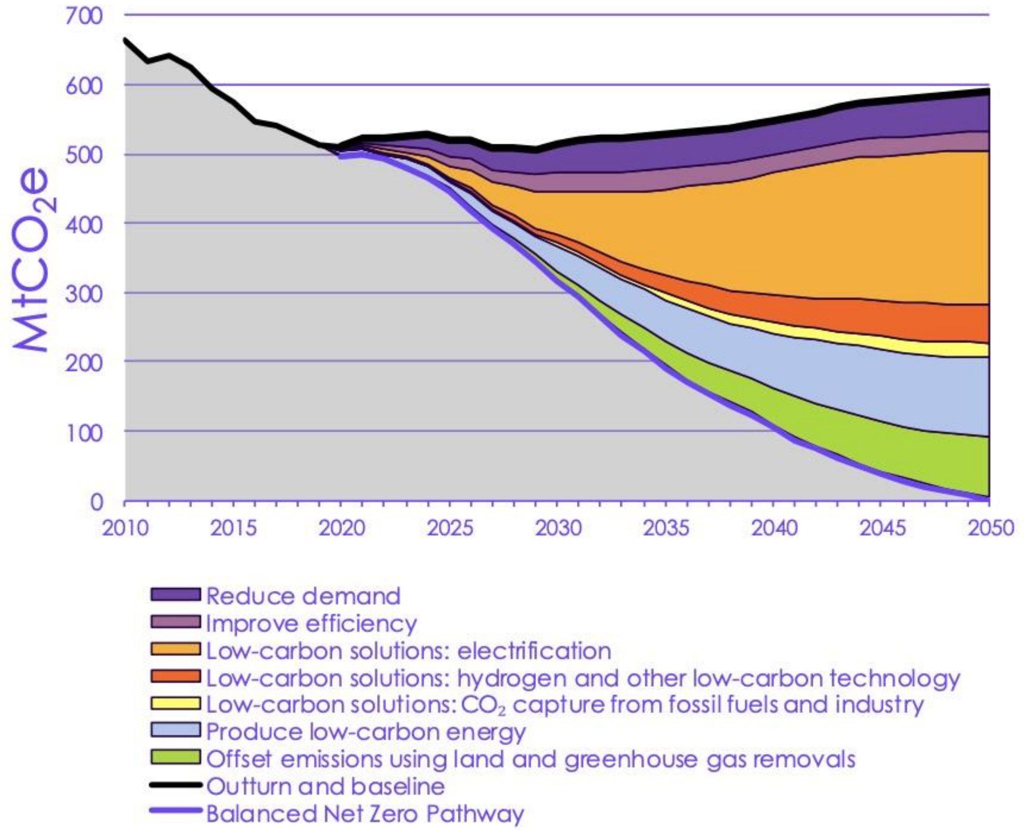
Net Zero pathways

Each carbon budget is set based on recommendations from the **Committee on Climate Change (CCC)**, an independent advisory body, ensuring that they are science-based and aligned with the goal of limiting global warming to 1.5°C.

These budgets are essential tools for achieving the long-term target of **net-zero emissions by 2050**

Different pathways
Tailwinds Pathway – rapid technological and behaviour changes
Headwinds Pathway – slower technological changes and lower behaviour change
Widspread Engagement Pathway – extensive societal change towards low carbon living
Widespread Innovation Pathway – cost reduction in new technology and high use.
Balanced Net Zero Pathway – a central recommendation balancing technology and societal change

Figure 4 Types of abatement in the Balanced Net Zero Pathway



https://www.theccc.org.uk/wp-content/uploads/2020/12/The-Sixth-Carbon-Budget-The-UKs-path-to-Net-Zero.pdf

6th Carbon Budget Data

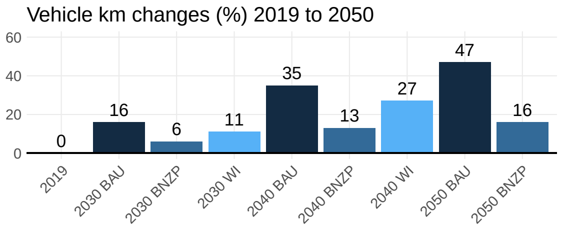
Traffic, buildings, active travel

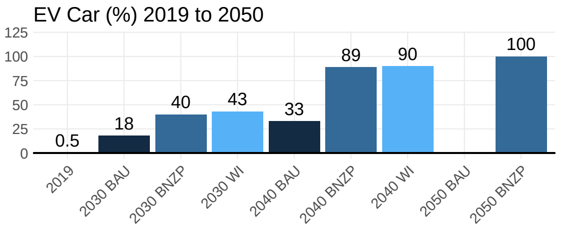
The active travel level is not predicted to change under 2030 and 2040 BAU.

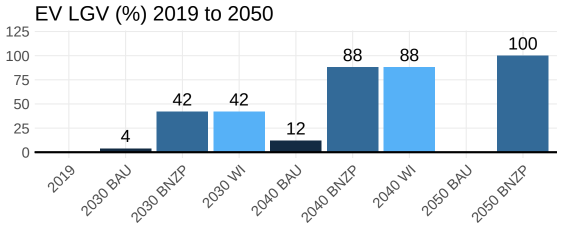
The **walking cohort** will **grow steadily** from 2019 by +5% (2030 BNZP), +7.5% (2040 BNZP). WI = BNZP.

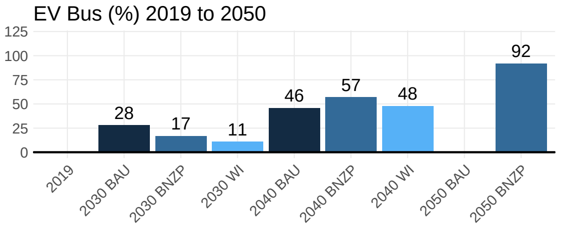
The **cycling cohort** will see a **huge rise** from 2019 by 300% in (2030 BNZP), +458% (2040 BNZP).

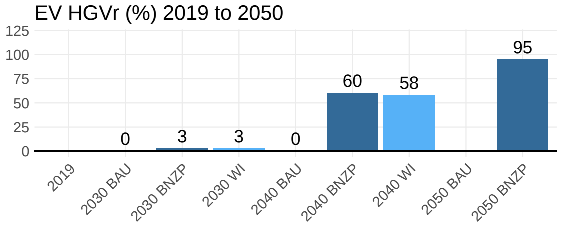
The **WI scenario** - **even higher increase** from 2019 by +427% by 2030 and +664% by 2040. WI > BNZP due to e-bike uptake.

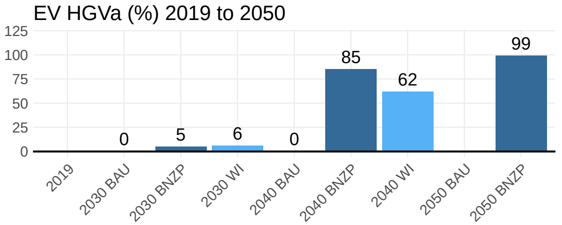








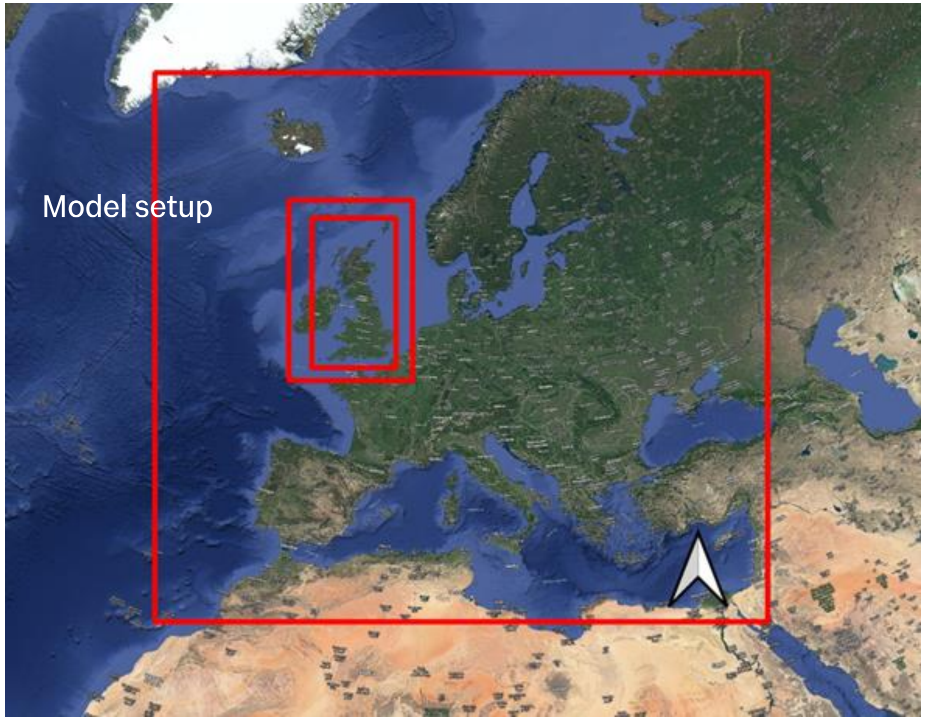




CCC BNZP Millions Households	2019	2030	2040	2050
Energy efficiency measures	11	18	25	28
Low Carbon District Heating		1.3	3.8	5.5
Heat Pumps	0.3	3.6	14.7	22.8
New Homes		2.4	5.9	7.4
Cooking				28.3

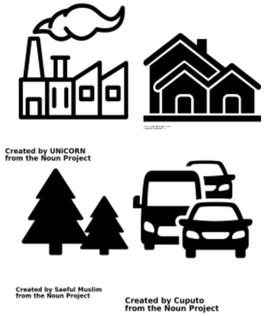
CMAQ-urban

Predicting air quality



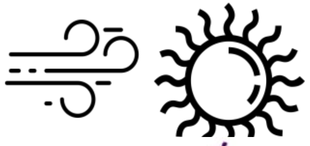
Land/terrain/oceans

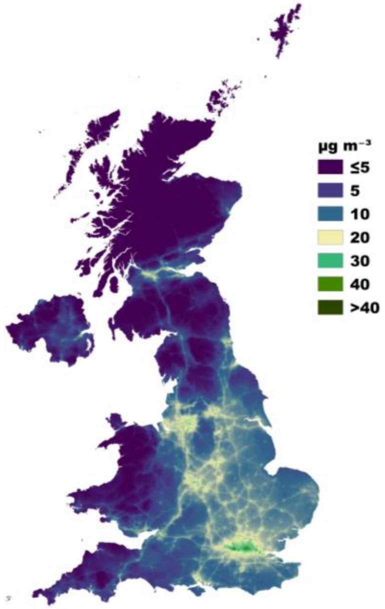
Emissions



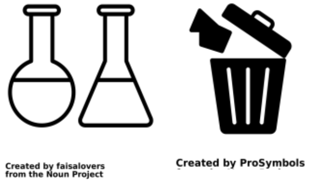
Boundary conditions

Meteorology: Weather Researching and forecasting model

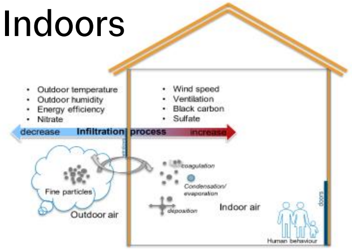




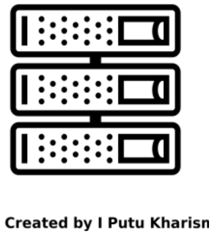
Chemistry/deposition



Indoors



High Performance computers



~ 400 fixed Measurements

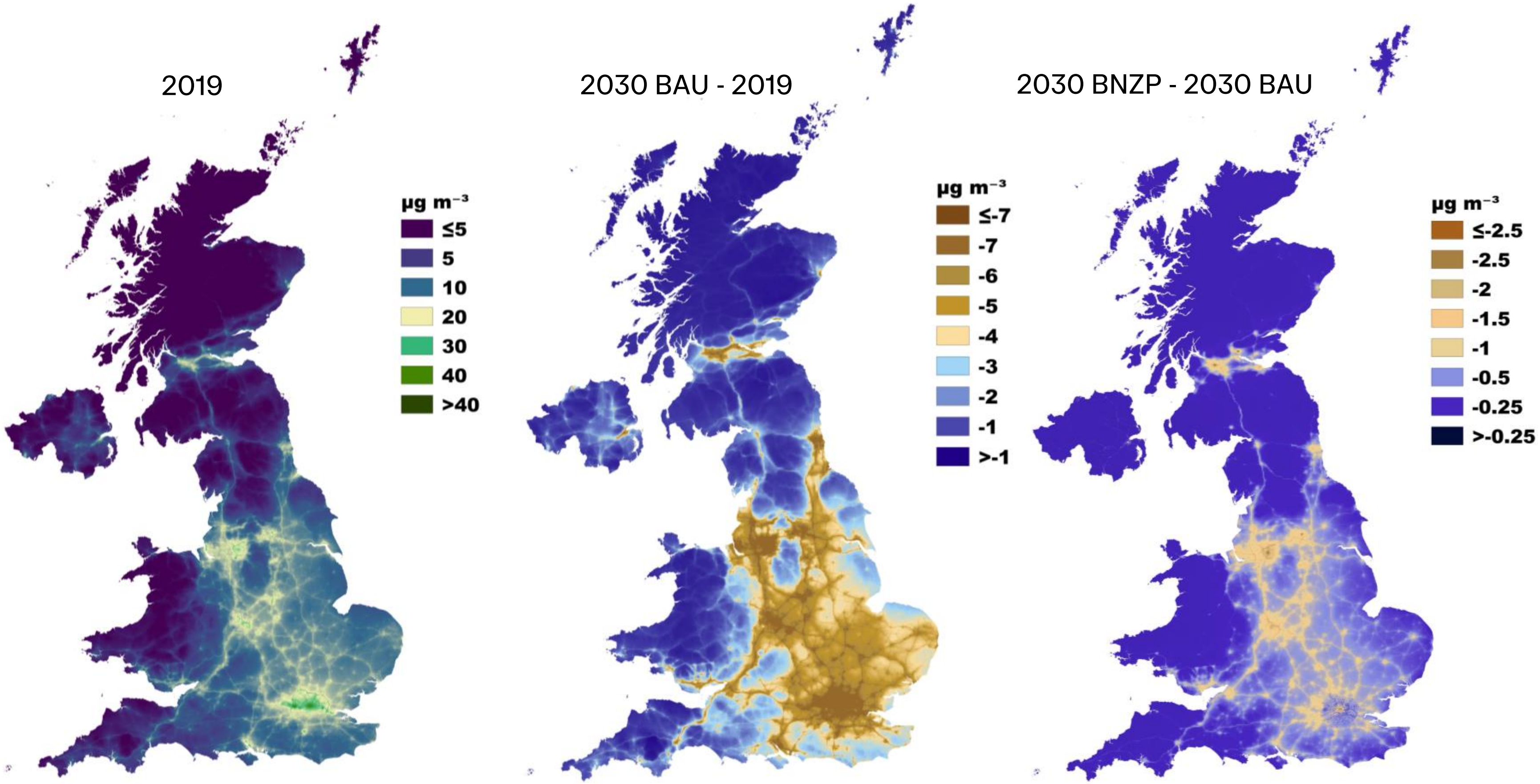
Model predictions

NO_2 – BAU vs. BNZP

The switch to cleaner vehicles between 2019 and 2030 under BAU and the integration of electric vehicles (EV) and low carbon building heating under BNZP, reduced average UK concentrations of NO_2, with the largest changes in urban areas and close to major roads.

When weighted by population the average UK NO_2 concentrations reduced by 6 $\mu g\ m^{-3}$ (2030 BAU vs. 2019) and by a further 0·8 $\mu g\ m^{-3}$ (2030 BNZP vs. 2030 BAU).

Model source apportionment showed reductions in domestic heating NO_X emissions in the BNZP becoming increasingly important by 2040.



Health impacts

Morbidity, mortality, active travel

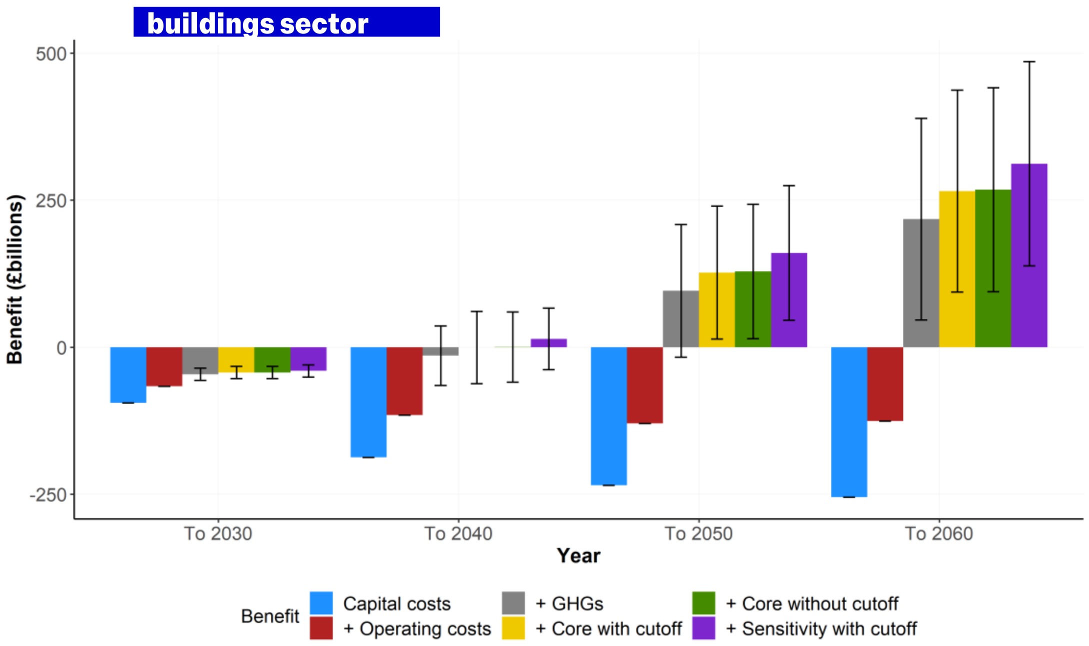
Mortality: Used methods of COMEAP 2018 NO_2 report updated by 2022 COMEAP statement on $PM_{2.5}$ (O_3 sensitivity from WHO AQG) UK 2019 population and deaths at Wards and LAs (Incorporated birth projections and mortality improvements) and followed through 2019-2050 and for 105 years after 2050 (life years) or for 105 years from 2019 (life expectancy)

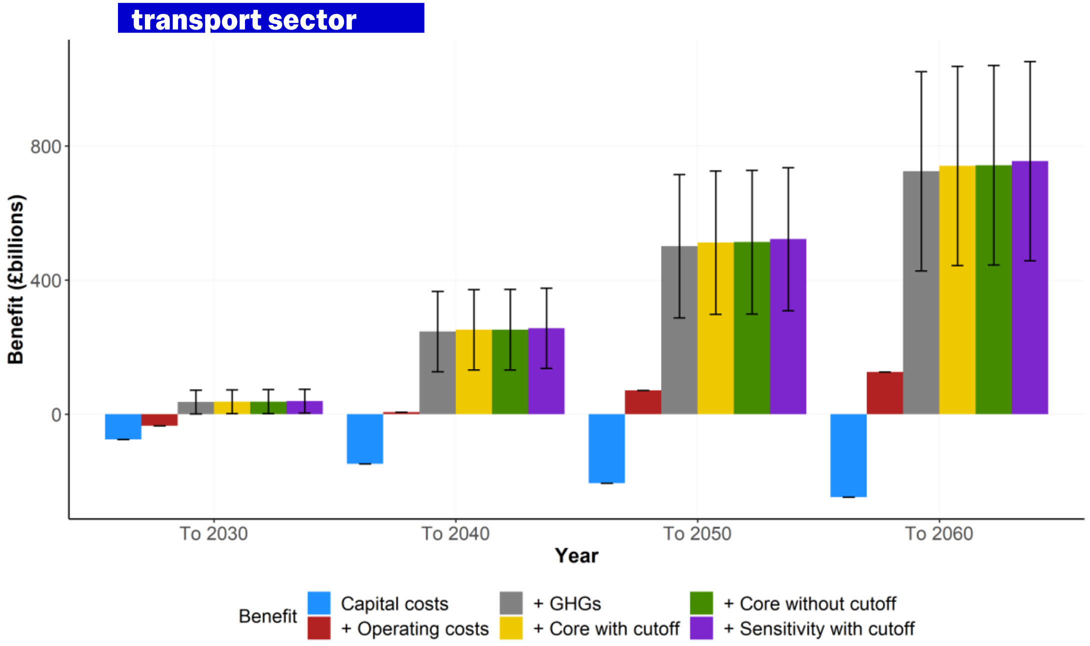
Morbidity: Recommendations from COMEAP (IHD, stroke, chronic phlegm, HA) and WHO EMAPEC (MI, stroke, COPD, HA, asthma in children and adults, dementia, ALRI in children, diabetes).
Account for changes in population - effect of AP on mortality/pop, changes in the population at risk, for lung cancer, projections of incidence trends.

For ***physical activity*** use the average MET hours per person per week (Kelly et al 2014)
Assessed switch to active travel for the CCC scenarios, covering walking, cycling including e-bikes - considering substitution to active transport and change for those who are active, and inactive

Costs and benefits

Buildings and transport sectors

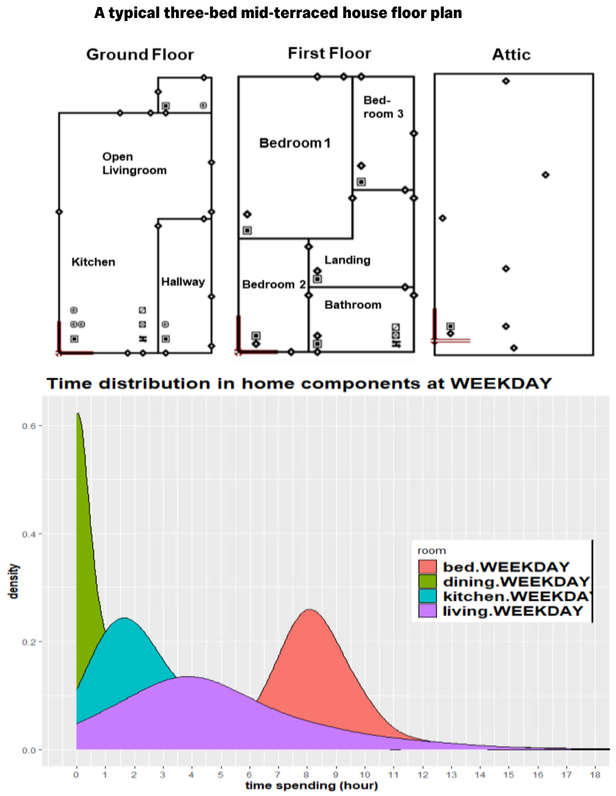




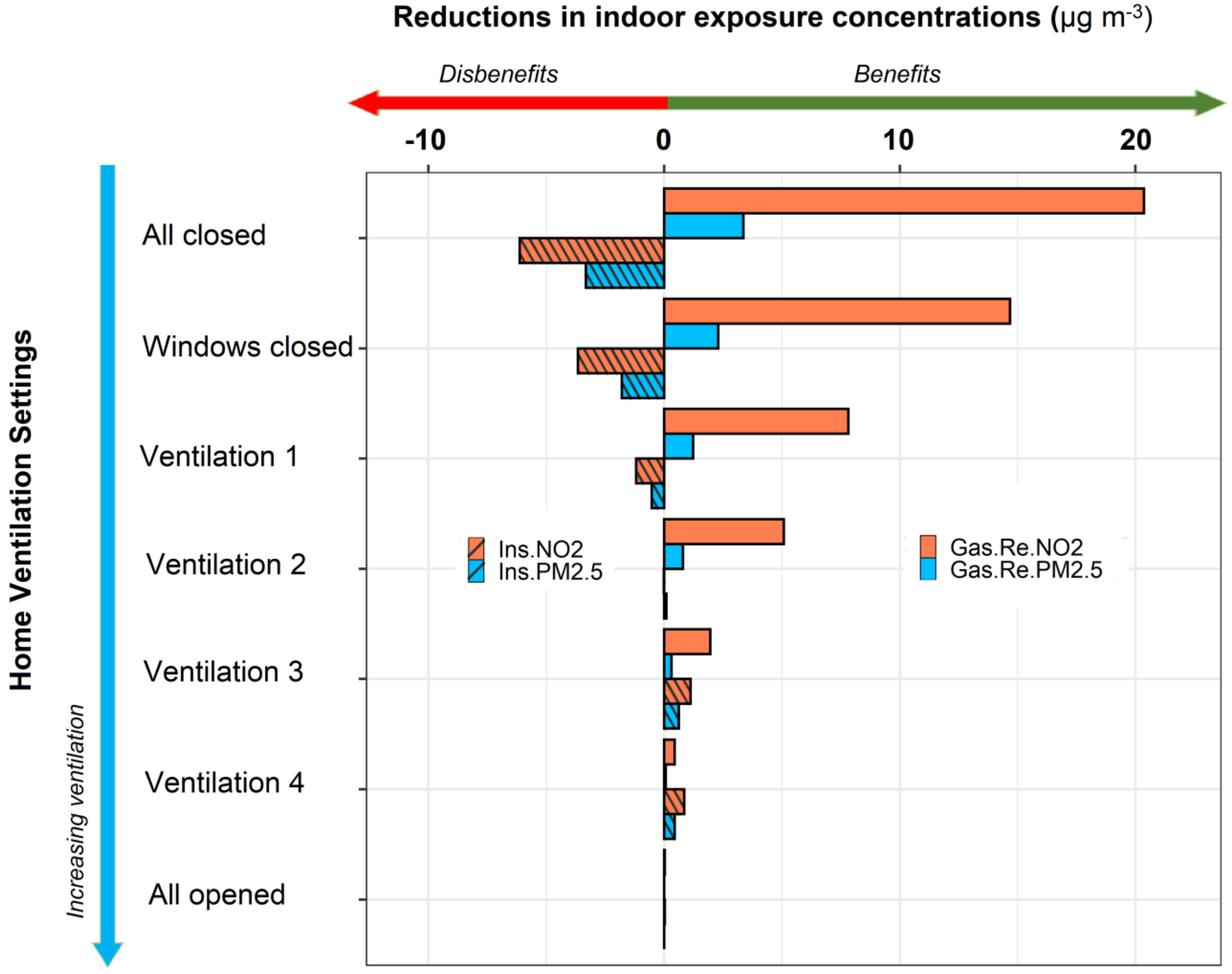
- In this case, air pollution benefits were sufficient to advance time to break-even by 3.1 years when including “core” health effects, or 6.3 years when adding in the “sensitivity” effects, or from 2052 to between 2046 and 2049.
- For the transport sector, the mortality related benefits of reductions in NO_2 would be twice those for $PM_{2.5}$ given the larger changes in NO_2 relative to $PM_{2.5}$.

Indoor air pollution

$PM_{2.5}$ and NO_2 exposure



Ventilation scenarios: *All closed*: Cooking hoods and windows were closed; *Windows closed*: all windows were closed, except cooking extractor fans; *Ventilation 1*: Rear kitchen window was opened during cooking; *Ventilation 2*: Rear kitchen and front lounge windows were opened during cooking; *Ventilation 3*: Windows in kitchen, living, and bedroom were opened during cooking; *Ventilation 4*: Windows in kitchen were opened all the time while others are opened during cooking. *All opened*: All windows were opened all the time.



Changes in indoor exposure concentrations of $PM_{2.5}$ and NO_2 due to home insulation (Ins.) and gas cooking removal (Gas.Re.) with various home ventilation settings.

Conclusions

Policy implications

What is striking from the NZ transition, especially for buildings, is the scale of change required in the coming decades, with millions of homes requiring new insulation and heat pumps. This points to the need for considerable public engagement, to increase awareness, to encourage political ambition, technology and incentives, and to create a convincing narrative for the large scale of change that is needed.

Our results forecast important economic benefits of removing fossil fuel burning whilst improving energy efficiency in UK homes. Whilst UK targets for both insulation and heat pump installations exist, this research should encourage more ambitious policy, especially targeted to help those most in need in society and to address affordability.

The CBA showed that NZ changes to the vehicle fleets were cost effective and that air pollution health impacts improved things further. Our core analysis provides a possibly conservative view on air pollution benefits, with a preference for estimates linked to NO_2 rather than $PM_{2.5}$, which would have seen them doubled. This should encourage ambitious policies to ensure the EV transition continues.

Conclusions cont'd

Policy implications

We found that meeting road transport net zero relies on increasing active travel to reduce future travel demand and improve city congestion. Yet whilst the CCC's scenario projected a significant increase for future cycling, scenario levels of walking barely changed and are deserving of more attention.

Recognition of co-benefits is an important element in achieving efficient use of resources across policy areas, with this study highlighting this across climate, air pollution, exercise and inequalities.

Further reading:

Beevers et al., 2025 https://doi.org/10.1016/j.envint.2024.109164

Assareh et al., 2025 - https://pubs.acs.org/doi/10.1021/acs.est.4c05601#

Liu et l., 2024; https://doi.org/10.1016/j.envint.2024.109065

Walton 2025; https://doi.org/10.1016/j.envint.2025.109283

Questions and acknowledgements

Thank you, any questions?

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