

Net-Zero policies in the UK: The air pollution co-benefits on mortality and morbidity

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Background

There is a strong body of evidence linking air pollution and climate change-related factors to health, mostly mortality, as well as co-benefits. Most studies used hypothetical future scenarios of single sector emission reductions. Studies relating specifically to Net Zero (NZ), health, electric vehicles, housing and active travel are small in number.

Objective

Our aim was to conduct the most detailed air pollution modelling study of existing UK NZ policies up to 2050 for road transport, building, heating, indoor gas cooking and active travel, including Business-as-Usual (BAU) and the Climate Change Committee Balanced Net Zero (BNZP) and Widespread Innovation (WI) scenarios. By comparing BAU with BNZP and WI in 2040, we have addressed the question: ‘How the UK’s public health burden from air pollution can be reduced by the introduction of Net Zero climate policies in 2040?’

Methods

Outdoor concentrations of NO₂, PM_{2.5} and O₃ were predicted across the UK, using the CMAQ-urban model for all scenarios. For cycling and walking, changes in trip numbers, distance travelled and physical activity (in METh/week), using propensities to switch were modelled.

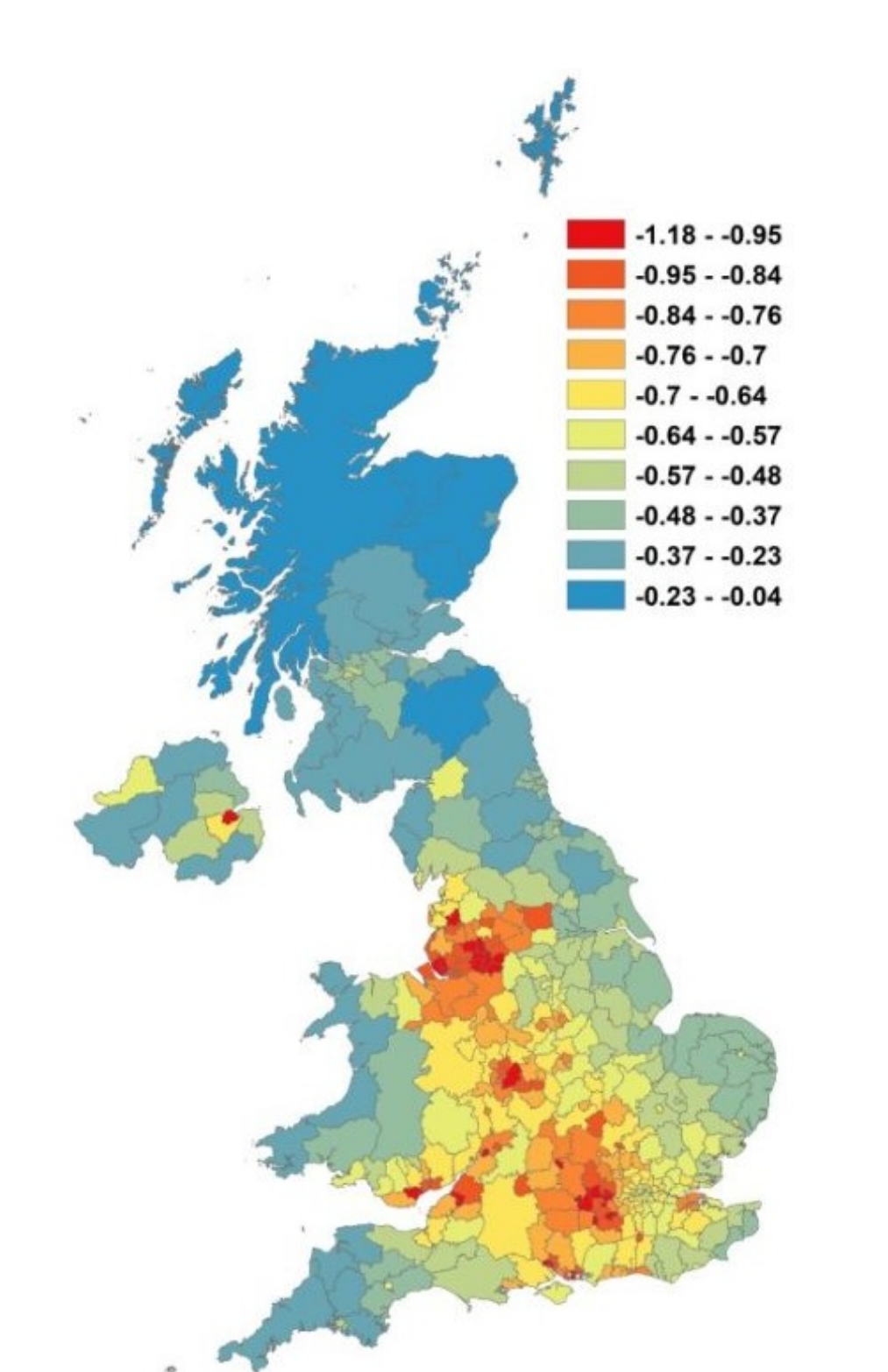


Figure 1. Predicted difference in PM_{2.5} concentrations (in µg/m³) in 2040 between BAU and BNZP.

Population-weighted average concentrations for PM_{2.5}, NO₂ and O₃ were derived at UK local authority and country level up to 2040 and remained constant after that (Fig. 1).

For the mortality impacts for air quality and active travel, as well as the morbidity impacts for air quality (active travel-morbidity outcomes were not analysed), modelling methods were applied from 2019 to 2154, i.e., a lifetime after 2050.

Mortality impact calculations used lifetable analysis including changes in age structure and population size. Birth projections, baseline rates and mortality improvements were incorporated into the lifetables. Impacts were expressed as life years gained (LYG) when comparing different scenarios.

Annual number of morbidity cases attributed to air pollution, including acute myocardial infarction (AMI), ischemic heart disease (IHD), stroke, chronic obstructive pulmonary disease (COPD), asthma in children and adults, lung cancer and cardiorespiratory hospital admissions in our core analysis, were estimated as the attributable fraction for air quality reductions.

Concentration-response functions (CRFs) for mortality/morbidity and PM_{2.5}/NO₂/O₃ were taken from the WHO’s EMAPEC project and COMEAP recommendations. Incidence, prevalence and baseline morbidity rates were taken from hospital or primary care statistics, survey data or research studies. Number of avoidable cases and LYG were estimated for a reduction down to zero or predefined cut-off levels, i.e., 5 µg/m³ for PM_{2.5} and 10 µg/m³ for NO₂.

Sensitivity analysis included outcomes for which there was uncertainty in the estimated CRFs or baseline rates, i.e., diabetes, dementia, acute lower respiratory infection (ALRI) in children and chronic phlegm.

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Results

- Adoption of BNZP or WI policies will result in 4.9 (4.0-5.8) and 5.4 (4.4-6.4) million LYG compared to BAU in the UK up to 2154 (Table 1).
- Air pollution reductions have the greatest benefits. As the NZ policies focused on e-bikes, cycling contributed a lot, but walking did not.

Risk Factor	Total life years saved (Central estimate [95% confidence interval])	
	BNZP 2040 vs BAU 2040	WI 2040 vs BAU 2040
Air Pollution (PM _{2.5})	3,810,000 [2,890,000, 4,260,000]	3,660,000 [2,770,000, 4,090,000]
Commuting by cycling	1,210,000 [714,000, 1,730,000]	1,820,000 [1,070,000 to 2,600,000]
Commuting by walking	-85,200 [-134,000, -40,700]	-85,200 [-134,000, -40,700]
Total	4,940,000 [4,080,000, 5,800,000]	5,390,000 [4,380,000, 6,400,000]

Table 1. Total life years gained across the UK population in 2019 to 2154 for PM_{2.5} (no cut-off), comparing 2040 BNZP/WI with 2040 BNZP.

- Great benefits were observed for cardiovascular and respiratory outcomes under 2040 BNZP in our core analysis outcomes, e.g., 365,000 (280,000-445,000) avoidable stroke cases (Fig. 2).

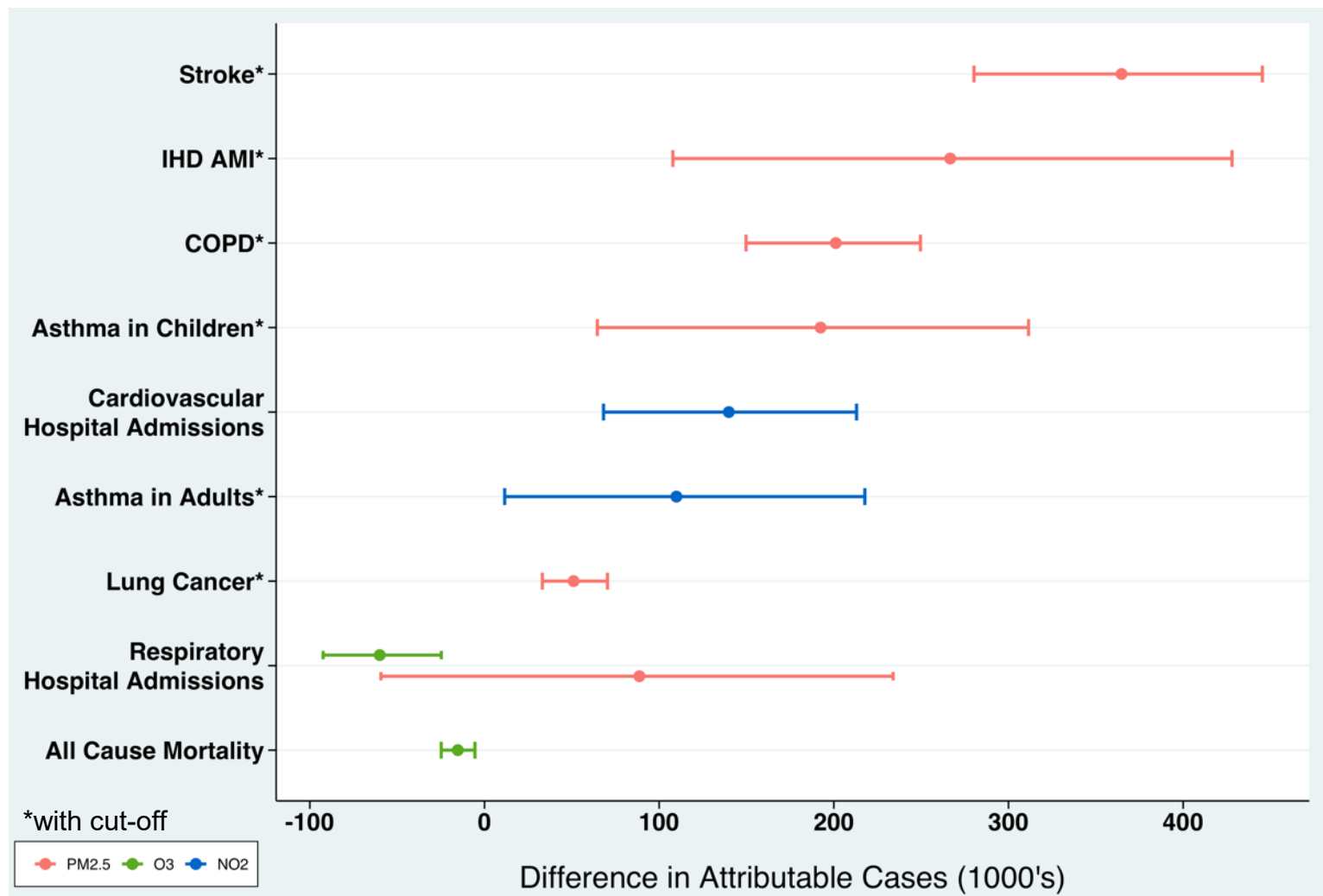


Figure 2. Sum of attributable cases to PM_{2.5}, NO₂ and O₃ avoided from 2019 to 2154 from implementing BNZP 2040 compared with BAU 2040.

- Sensitivity analysis showed more health benefits for other outcomes but with more uncertainty around the estimation (Table 2).

Disease incidence – Sensitivity analysis Attributable cases central estimate [95% confidence interval]		
Health Outcome (Pollutant)	BNZP 2040 vs BAU 2040	WI 2040 vs BAU 2040
Dementia (PM _{2.5})	794,000 [440,000, 1,150,000]	761,000 [422,000, 1,100,000]
ALRI in children (NO ₂)	1,860,000 [641,000, 3,190,000]	1,790,000 [616,000, 3,060,000]
Chronic phlegm (PM ₁₀)	293,000 [26,800, 438,000]	279,000 [25,500, 417,000]
Diabetes (PM _{2.5})	332,000 [104,000, 571,000]	319,000 [100,000, 548,000]
School absences (PM _{2.5})	6,680,000 [2,190,000, 11,000,000]	6,400,000 [2,100,000, 10,600,000]

Table 2. Sum of attributable cases to PM_{2.5}, NO₂ and PM₁₀ avoided from 2019 to 2154 from implementing BNZP/WI 2040 compared with BAU 2040. Sensitivity analysis outcomes. Results with cut-off for PM_{2.5} and NO₂.

Conclusions

- Inclusion of air quality/physical activity-related health benefits adds further justification to adoption of climate change policies
- Co-benefits of climate measures need to be disseminated to build positive public engagement and the political leadership necessary to achieve NZ aims.