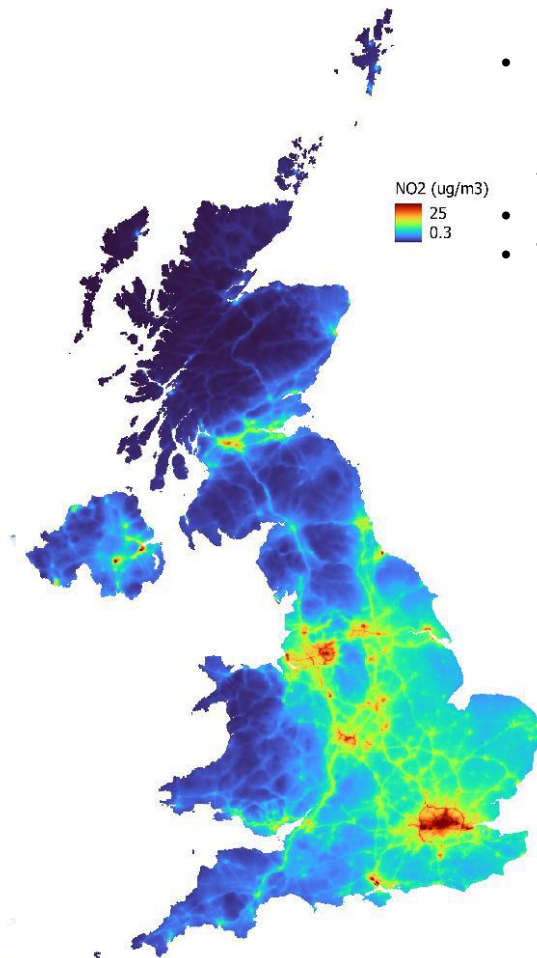


Air pollution modelling and its role in policy development, human health and Net Zero

Environmental Research Group

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AQ co-benefits of Net Zero policy



- Co-benefits of reduced Nitrogen Dioxide (NO₂), Ozone (O₃), and Particulate Matter (PM), through Net Zero (NZ) climate policy in the UK
- UK existing policy, Business as Usual (BAU)
- Two alternative NZ scenarios, the Balanced Net Zero (BNZP) and Widespread Innovation (WI) pathways, from the UK Climate Change Committee's 6th Carbon Budget



The model (WRF/CMAQ/ADMS)

The outputs

The applications

Boundary



Created by Chris Tucker from the Meun Project

Meteorology



Created by Isaac Prosser from the Meun Project

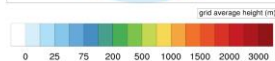
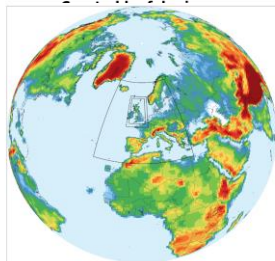
Emissions



Created by MRC/Imperial from the Meun Project



Created by Capiote from the Meun Project



Computers



Created by I Putu Kharisn

Measurements



Chemistry/deposition



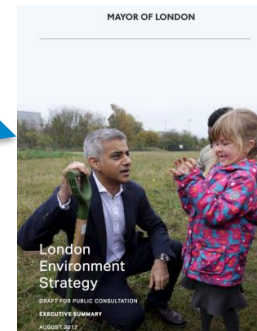
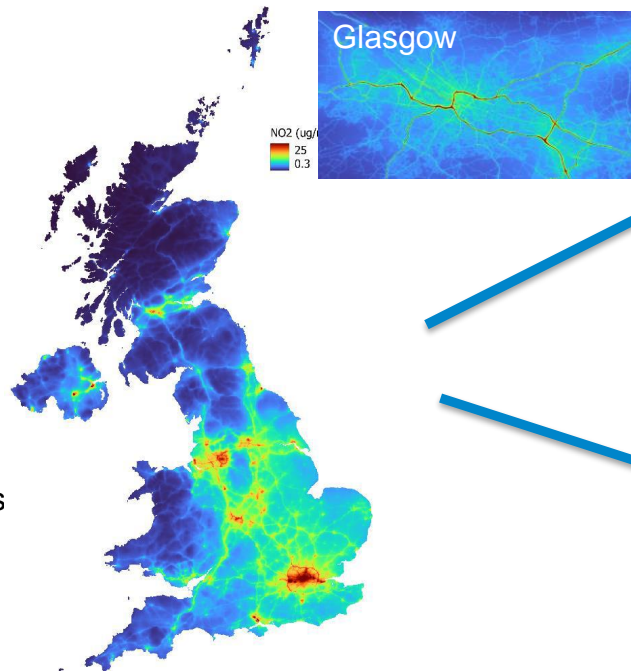
Created by Jahnemann from the Meun Project

Created by ProSymbols

Land/terrain/oceans



Created by Chaiwat Kink



The UK has adopted legally binding targets for Net Zero (NZ) that are consistent with the Paris agreement

Independent advice on achieving NZ goals from the Climate Change Committee (CCC)

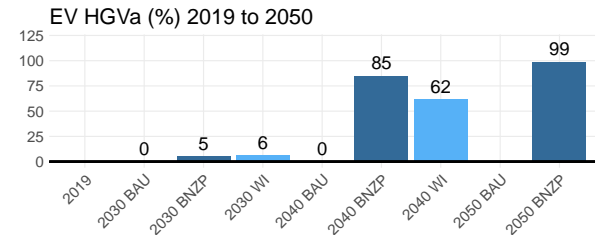
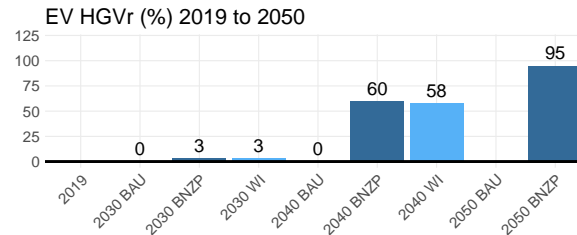
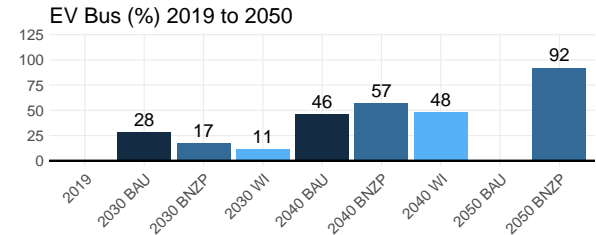
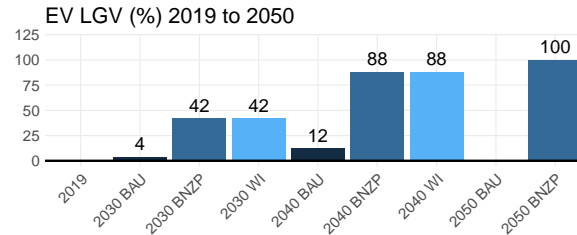
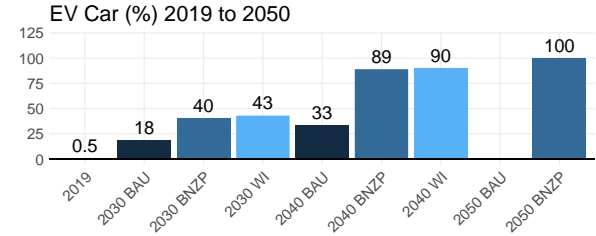
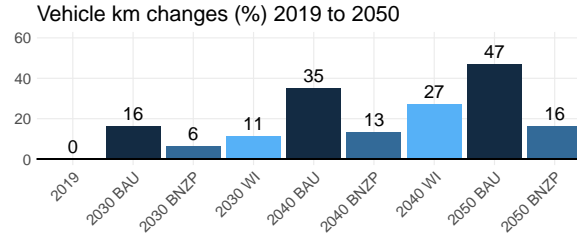
Business as usual – agreed air quality policy

From the CCC's 6th Carbon Budget we have investigated the Balanced Net Zero Pathway (BNZP), a 'middle ambition' pathway for compliance with UK Net Zero commitments by 2050, which is projected to reduce greenhouse gas emissions to 78% below 1990 levels by 2035.

Widespread Innovation (WI) pathway, which assumes greater success in reducing costs of low-carbon technologies, allowing more widespread electrification and active transport.

Road Transport assumptions

- Vehicle km
- EV proportions
- HGV options
- Non-exhaust emissions

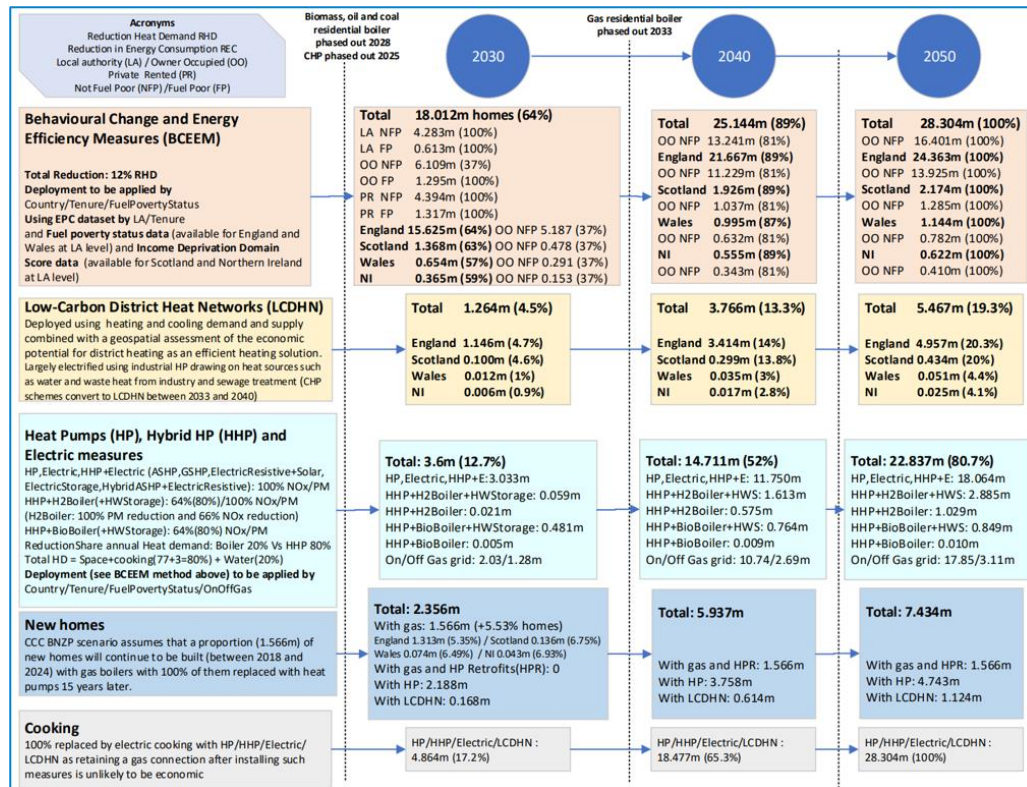


England and Wales – active travel

- Walking is expected to grow steadily from 2019 by +5% (by 2030 BNZP), to +7.5% (by 2040 BNZP). WI and BNZP scenarios have the same level of walking.
 - Cycling will see a huge rise from 2019 to 300% in 2030 (BNZP), +458% 2040 (BNZP).
 - WI scenario has even higher increases +427% by 2030 and +664% by 2040. WI > BNZP due to e-bike uptake.
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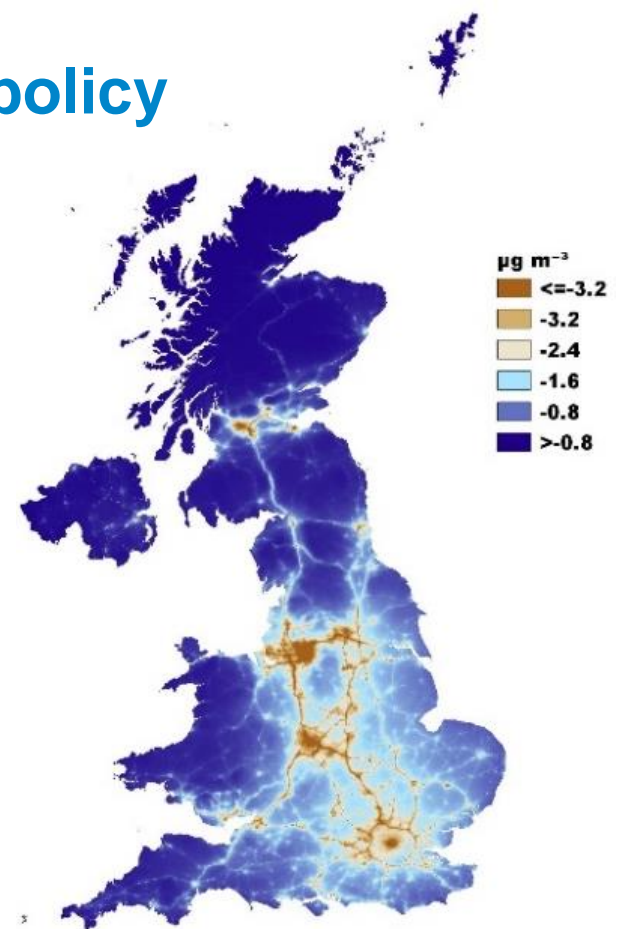
Building emissions

- Behaviour and energy efficiency
- Low carbon district heating
- Heat pumps
- New homes
- Cooking



Co-benefits of Net Zero policy air pollution

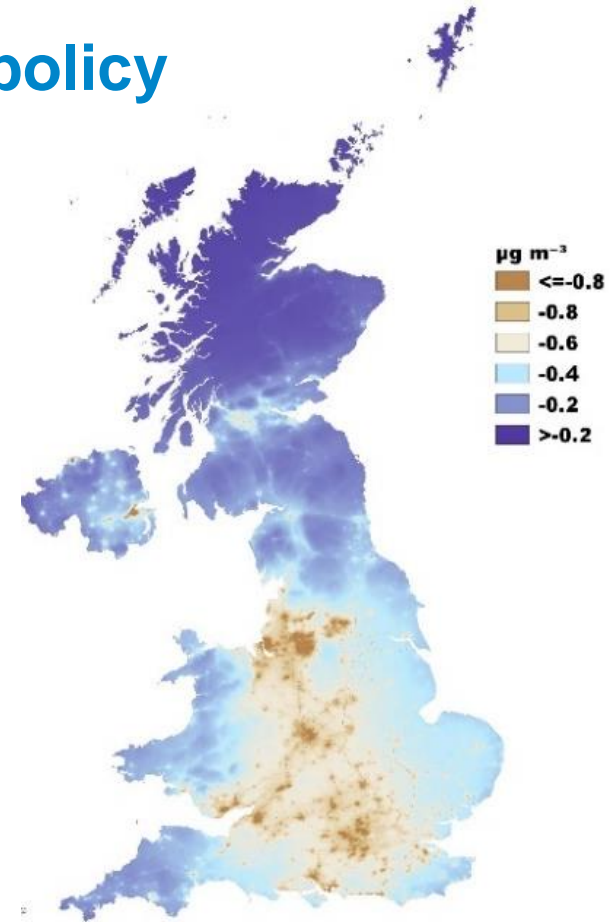
- Under Business as Usual (BAU) reductions in NO₂ and PM were predicted by 2030 due to new vehicle technologies, but plateau by 2040.
- The BNZP and WI 2040 benefits were driven by accelerated electric vehicle (EV) uptake, reduced veh-km and low-carbon heating in buildings, with the building contribution to PM reduction being 2-3 times greater than road transport.
- NZ transition to EVs (cars and vans) reduces both exhaust and non-exhaust emissions.
- O₃ trends are complex with a small overall increase by 2030 and a decrease by 2040.
- Although uncertain, 2050 predictions of BNZP showed important additional air pollution benefits.



NO₂, 2040BNZP - 2040BAU

Co-benefits of Net Zero policy Health

- The BNZP vs. BAU resulted in 4.9 (1.0-9.0) million life-years gained (LYG) for the UK population to 2154, and 1.1 (0.7-1.6) million LYG from active travel improvements.
- Avoided case for stroke, childhood asthma and cardiovascular diseases such as acute myocardial infarction, asthma in adults and lung cancer.
- Some outcomes with weaker evidence for the health effects, were included in sensitivity analysis, e.g. dementia, diabetes and acute lower respiratory infections in children.
- Monetised morbidity benefits of £95.3b (75.0-116) exceeded the mortality benefits of £78.9b (43.5-92.0).
- Total yearly monetised benefits for BNZP vs BAU summed to 2154 for air pollution and active travel were from £198b (171-226) up to £325b (271-380), including outcomes with weaker evidence.
- There were higher physical activity benefits for WI than BNZP.

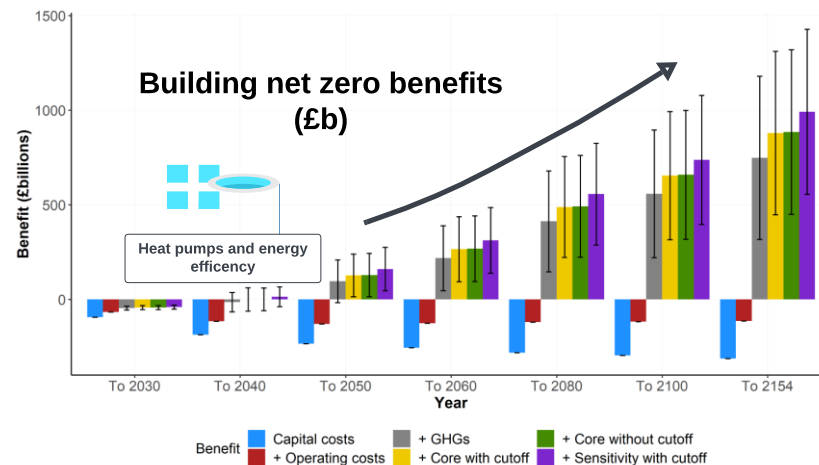


PM_{2.5}, 2040BNZP - 2030BAU

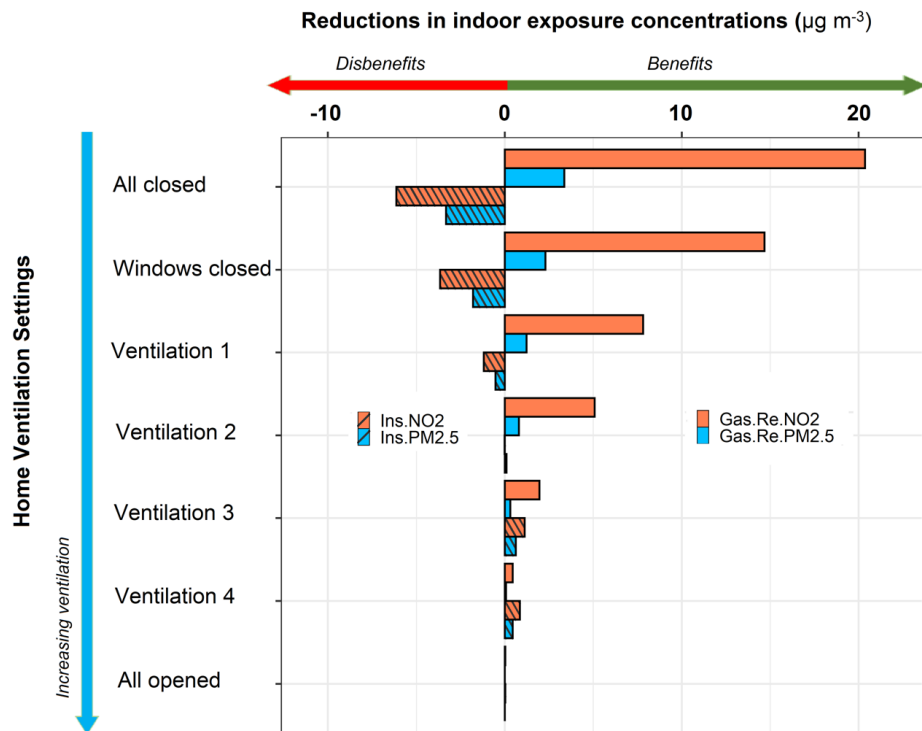
Imperial College London

Co-benefits of Net Zero policy Money

- Air quality (“core”) health benefits for the BNZP buildings sector were £31.1 billion (24.9 to 37.4) by 2050 and £130.7 billion (104.8 to 156.6) by 2154.
- Results for transport were £10.7 billion (8.4 to 12.9) by 2050 and £43.0 billion (33.9 to 52.1) by 2154.
- NZ building sector operating costs did not achieve break-even via efficiency savings, but with GHG (lower benefits) break-even was achieved in 2052.
- With additional air pollution health benefits the building sector time to break-even improved by between 5.4 (4.7 to 6.1) and 8.1 (6.8 to 9.1) years to between 2044 and 2047.



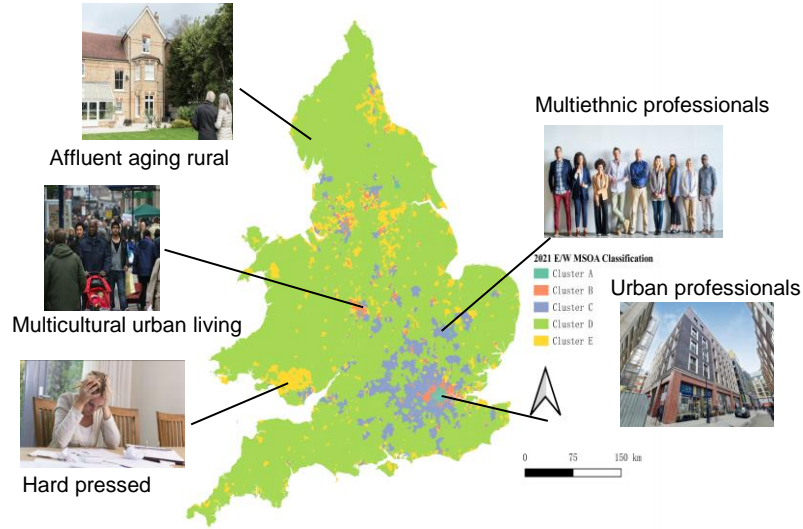
Indoor air pollution exposure



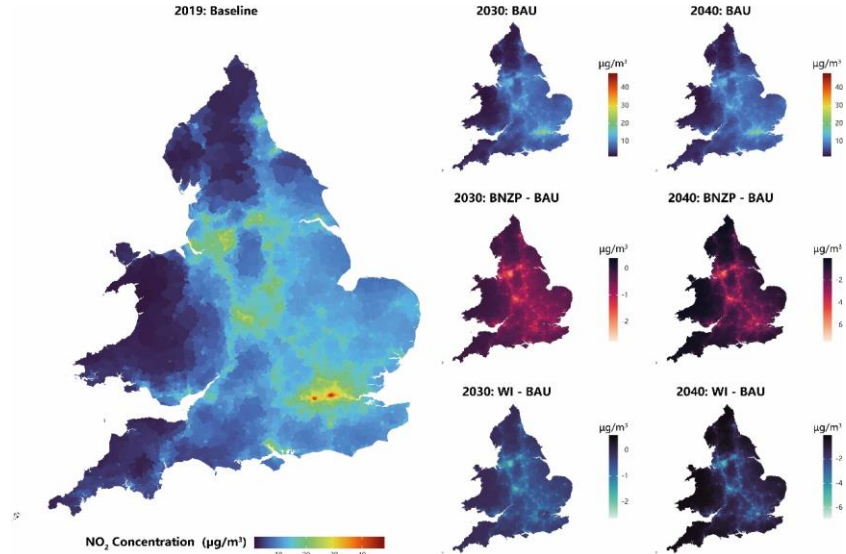
- Removing gas cooking at home, for NZ, may result in greater exposure reductions than outdoor air pollution, especially for NO_2 .
- Improved insulation and NZ transition provides an important opportunity to reduce the inequality gap and to benefit cold, damp and mouldy homes.

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.

Geodemographic Classification for England & Wales five distinct clusters based on 2021 UK Census variables



- Urban professionals
- Multicultural urban living
- Multiethnic professionals
- Affluent aging rural
- Hard pressed



Nitrogen dioxide (NO₂)

2019 exposure inequality patterns persisted into the future under all scenarios but to a lesser degree, due in part to NZ policies.

Thank you to the air pollution modelling team

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Fei Gao and Phillip Punter

Any Questions?

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<https://vimeo.com/807838264>

NIHR funded project – A 50-minute film on the views and opinions on air pollution and climate change of two groups of students from near Glasgow and London.

Imperial College London Co-benefits BNZP - annual average NO₂ (μg m⁻³)

