



The West Midlands Climate Health Explorer

A mixed-methods, multi-exposure decision-support tool for assessing the health and economic impacts of net-zero pathways in the West Midlands

Poster by Shi Chang & James Hall on behalf of the Net Zero Study Team

University of Birmingham and WM-Net Zero partners

Evidence | Insight | Action

WHY THIS TOOLKIT WAS NEEDED

PLACE

Local authorities need place-based evidence linking climate action to health, costs and equity.

MULTI

Climate policies affect health through multiple pathways, including air pollution, noise and physical activity, creating co-benefits, trade-offs and unintended effects.

CO-DEV

The Climate Health Explorer was co-developed to support practical regional decision-making.

Designed around a health-first question: what do climate pathways mean for people, places and inequalities?

METHODOLOGICAL STAGES

1

Co-development and policy scoping

Stakeholder workshops, public involvement and scenario design.

2

Population and disease modelling

Deterministic health and population cohort model for 1,719 LSOAs by age and sex, with 2024 baseline and 2036 projections.

3

Exposure modelling

PM_{2.5}, NO₂, road noise and physical inactivity; CO₂ as an environmental outcome.

4

Health and economic modelling

Attributable cases, deaths, Quality-adjusted life years (QALYs), NHS/social care costs and productivity losses.

5

Web dashboard and systems thinking

Interactive mapping, scenario comparison, equity views and systems maps to consider wider consequences.

TO SEE MORE AND USE THE EXPLORER

SCAN ME



THE DASHBOARD

Climate Health Explorer
Evidence, insight, and action for a healthier and more resilient West Midlands.

Pre-computed spatial datasets enable rapid exploration of environmental, demographic, health and economic results.

Choose environmental risks, outcomes or equity indicators

Compare 2024 and 2036 scenarios

View results by geography and population group

Toggle cases per 100,000 or attributable fraction

Environmental Risk Factors

Environmental Outcomes

Health Outcomes

Equity Indicators

West Midlands Combined Authority Area

Local Authority District

Climate Action Scenarios

2024 Baseline

Environmental Risk Factors

Particulate Matter (PM_{2.5})

Health Outcomes

Child asthma

Population

Total population

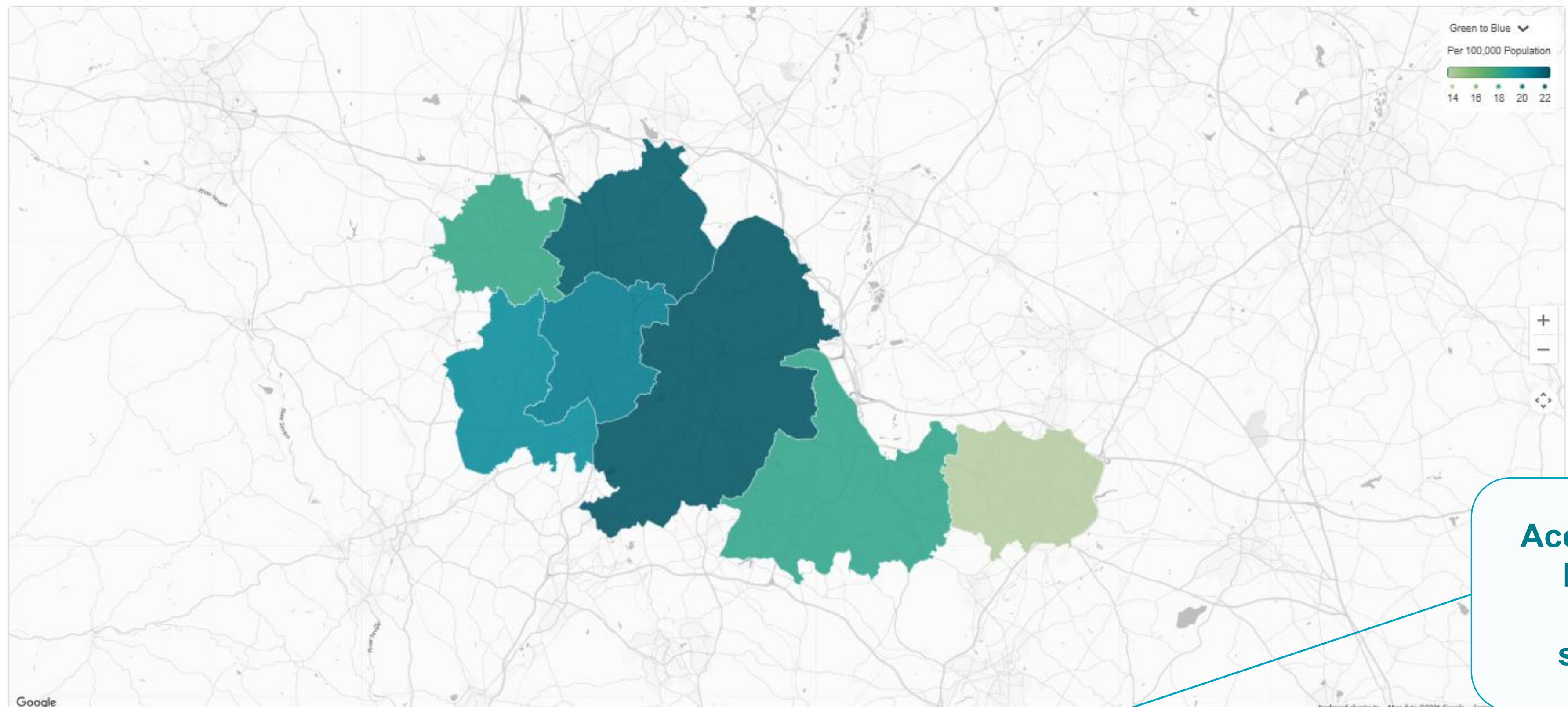
Time Horizon

1 Year

Display Total population figures as:

Cases per 100,000

Attributable fraction (%)



Access detailed health and economic summaries

Data Summary

Map currently shows Total population for Data summary for Asthma in childhood (< 15 years) for The average level of airborne particles that are less than 2.5 µm in diameter in the air over a one-year period

2024 BASELINE RESULTS

PM_{2.5}

PM_{2.5}-attributable disease cases
2,100 cases

£

Annual health system cost of environmental attributable disease
£160m

PM_{2.5}

PM_{2.5}-attributable mortality
1,650 deaths

NO₂

NO₂-attributable mortality
1,000 deaths

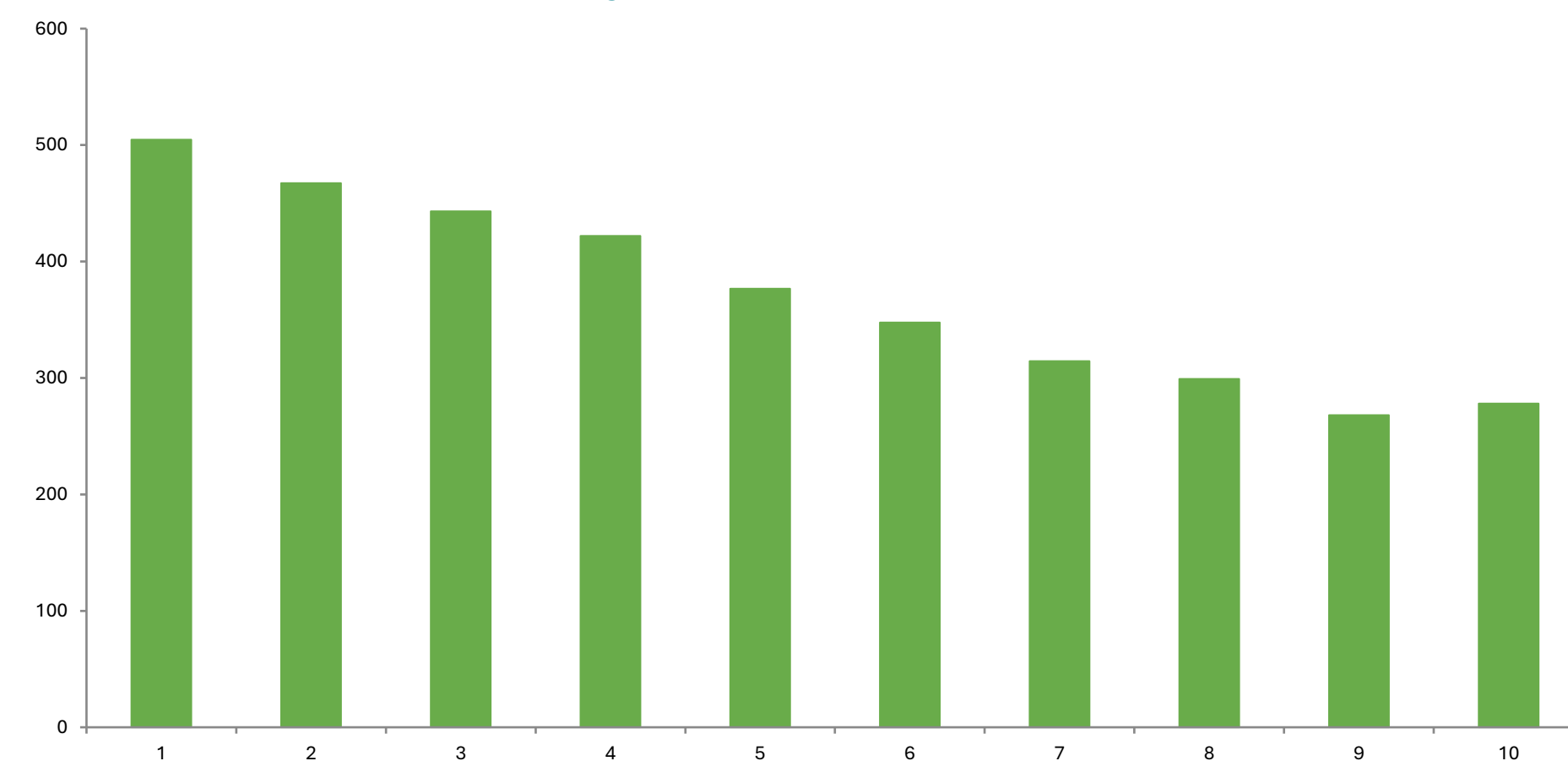
Physical inactivity

Physical inactivity-attributable mortality
2,750 deaths

EQUITY INSIGHTS

QALY losses from PM_{2.5}-attributable childhood asthma are highest in more deprived LSOAs.

QALY losses by IMD decile for child asthma (PM_{2.5})



Climate-related health burdens are not distributed evenly across communities.

2036 FUTURE vs 2024 BASELINE RESULTS

Outcomes and Indicators	2024	2036	Change
Population across WMCA	3.04m	3.45m	+13.5%
Total CO ₂ emissions	8.6m t/yr	7.0m t/yr	↓
Annual average PM _{2.5} concentration	7.7 µg/m ³	6.8 µg/m ³	↓
Annual average NO ₂ concentration	14.0 µg/m ³	8.8 µg/m ³	↓
% of population physically inactive	33.8%	34.2%	↑
Years of life lost*	62,000	68,800	↑
Health-related economic cost*	£4.7bn	£5.0bn	↑
PM _{2.5} -attributable mortality	1,650	1,850	↑
NO ₂ -attributable mortality	1,000	800	↓
Physical inactivity-attributable mortality	2,750	3,400	↑

*Years of life lost and economic cost of air pollution and physical inactivity

We predict air pollution and CO₂ indicators to improve by 2036, while absolute health burden rises as population grows and ages.

From 2036 Future to Net Zero: Air Quality Benefits of Road Transport Pathways in the West Midlands

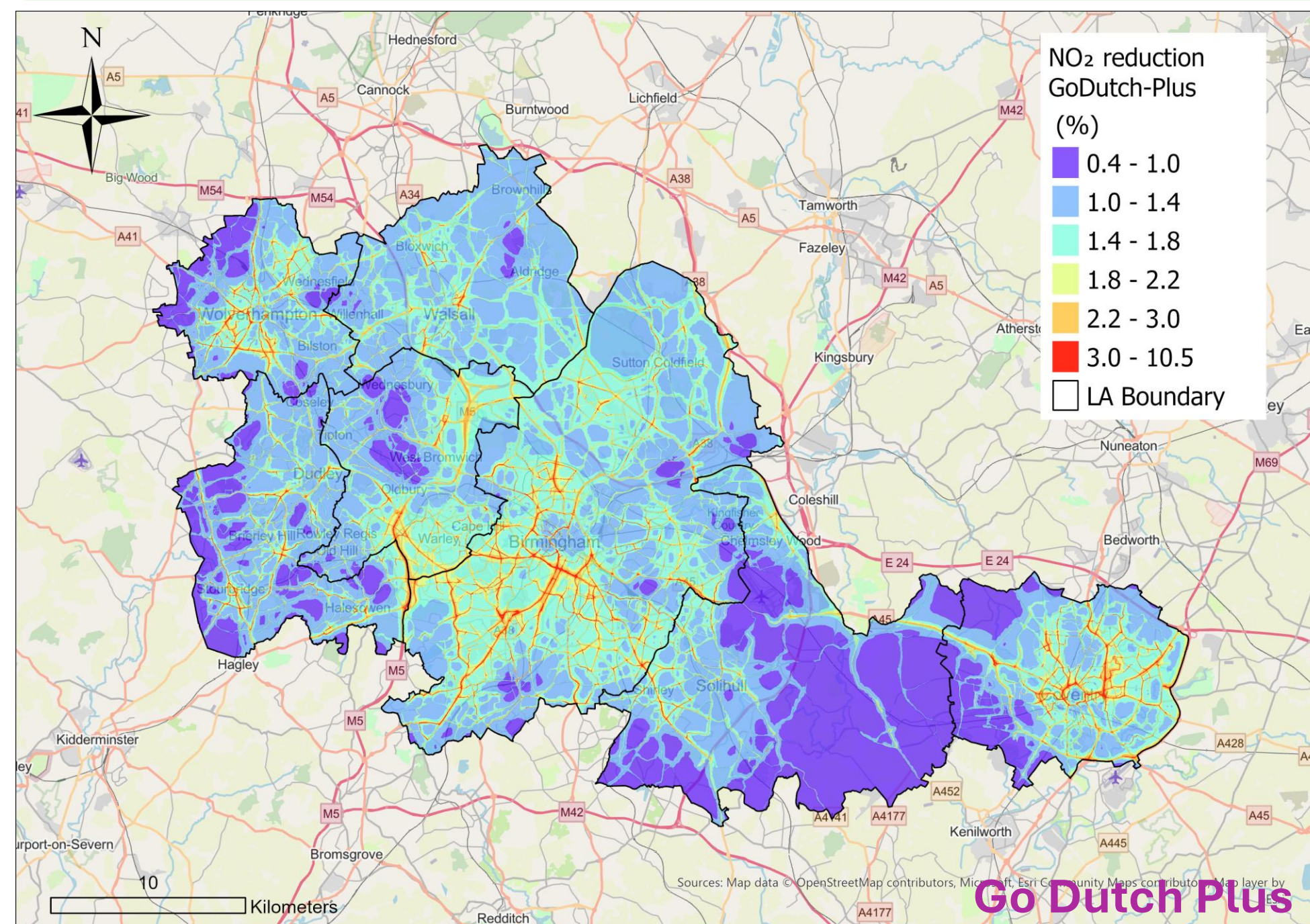
Nana Wei, Ye Hang, Jian Zhong, Kate Johnson, Jenny Stocker, Suzanne E. Bartington, Zongbo Shi, William J. Bloss and WM-NetZero Team

Key insights:

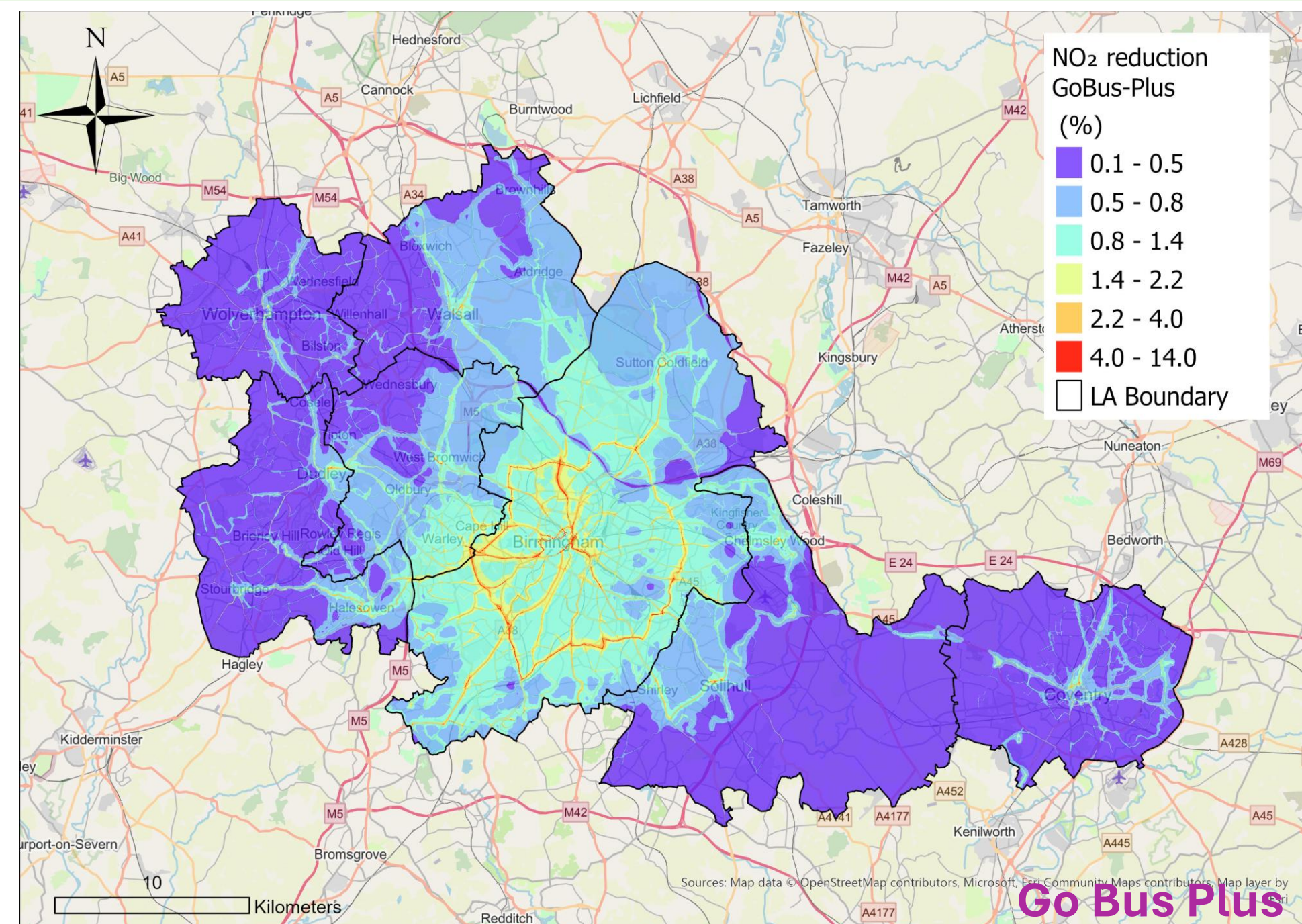
- Fully **electrifying road transport** gives the **largest NO₂ improvements**, especially along major roads, **shifting more journeys from cars to cycling** gives the largest **PM_{2.5} improvements**.
- The air quality modelling shows **where transport interventions could deliver the greatest local air quality gains**, supporting decisions on transport planning, active travel, bus investment and fleet transition.

1 Additional NO₂ and PM_{2.5} reductions beyond 2036 Future

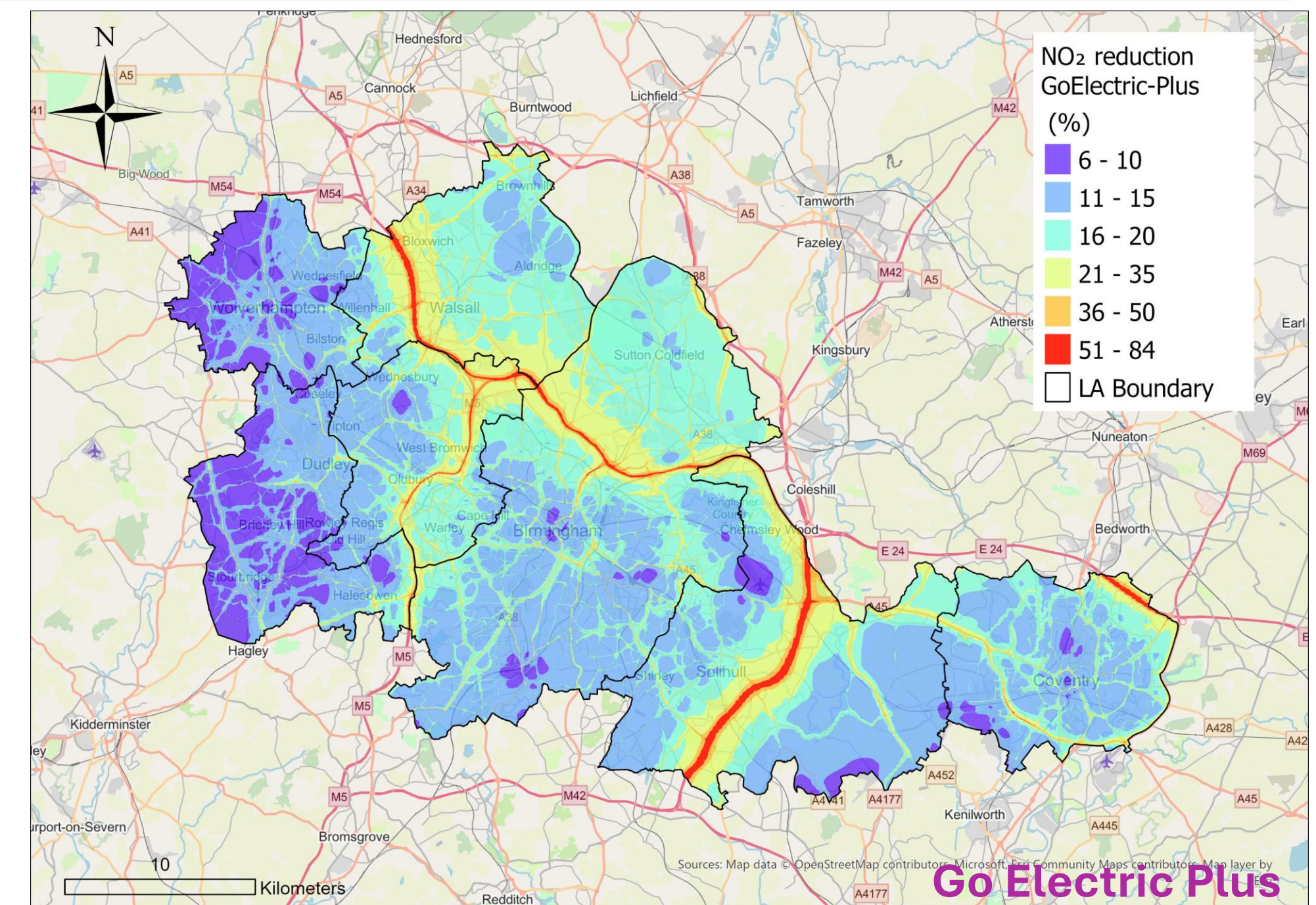
NO₂ reductions of net-zero scenarios relative to 2036 Future (%).



[Netherlands-level cycling, with fewer car trips]
NO₂ reductions follow the urban road network, reaching 3% - 10.5% in local hotspots.

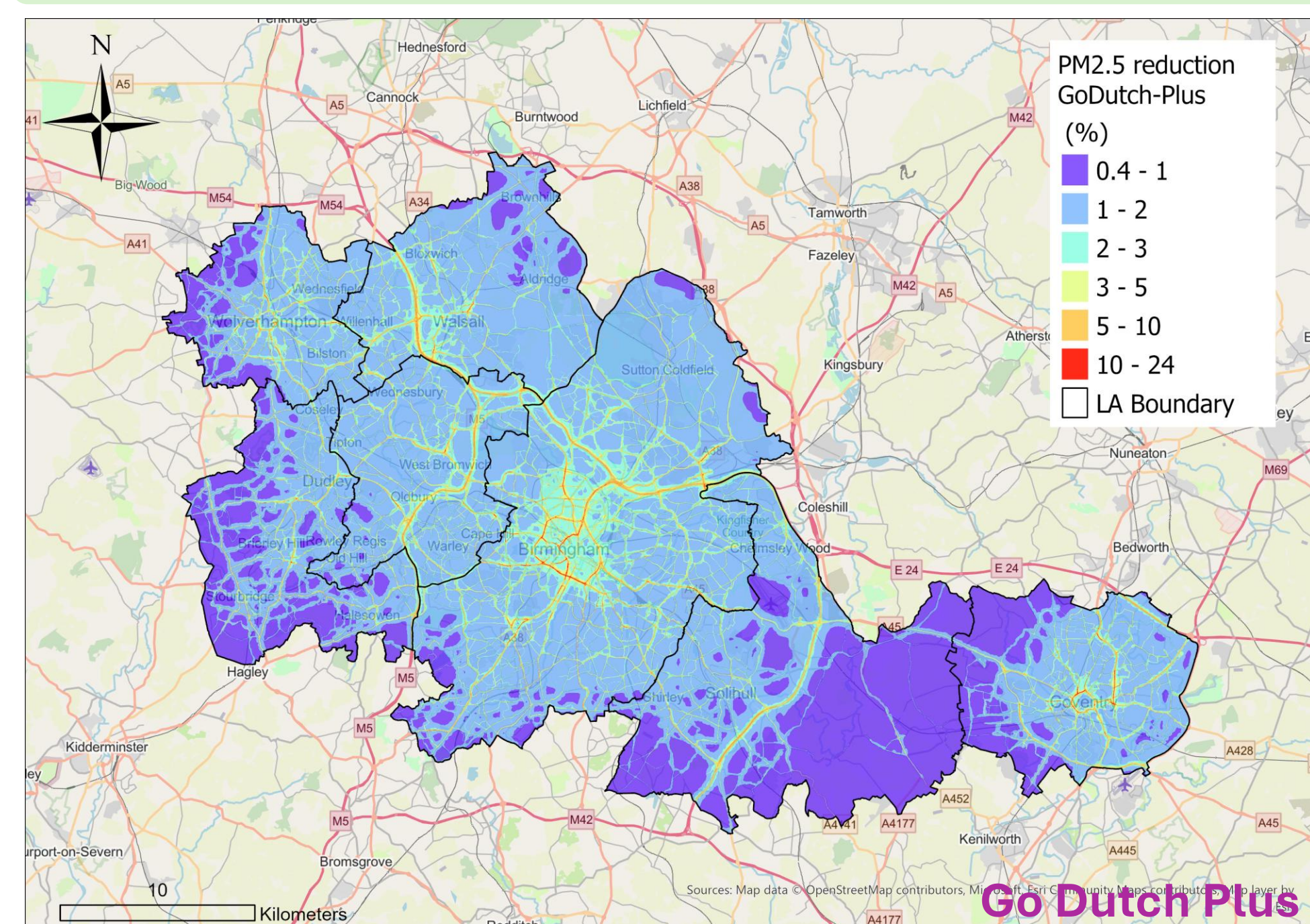


[More bus travel, with buses fully electric]
NO₂ benefits concentrate around Birmingham and selected transport corridors.

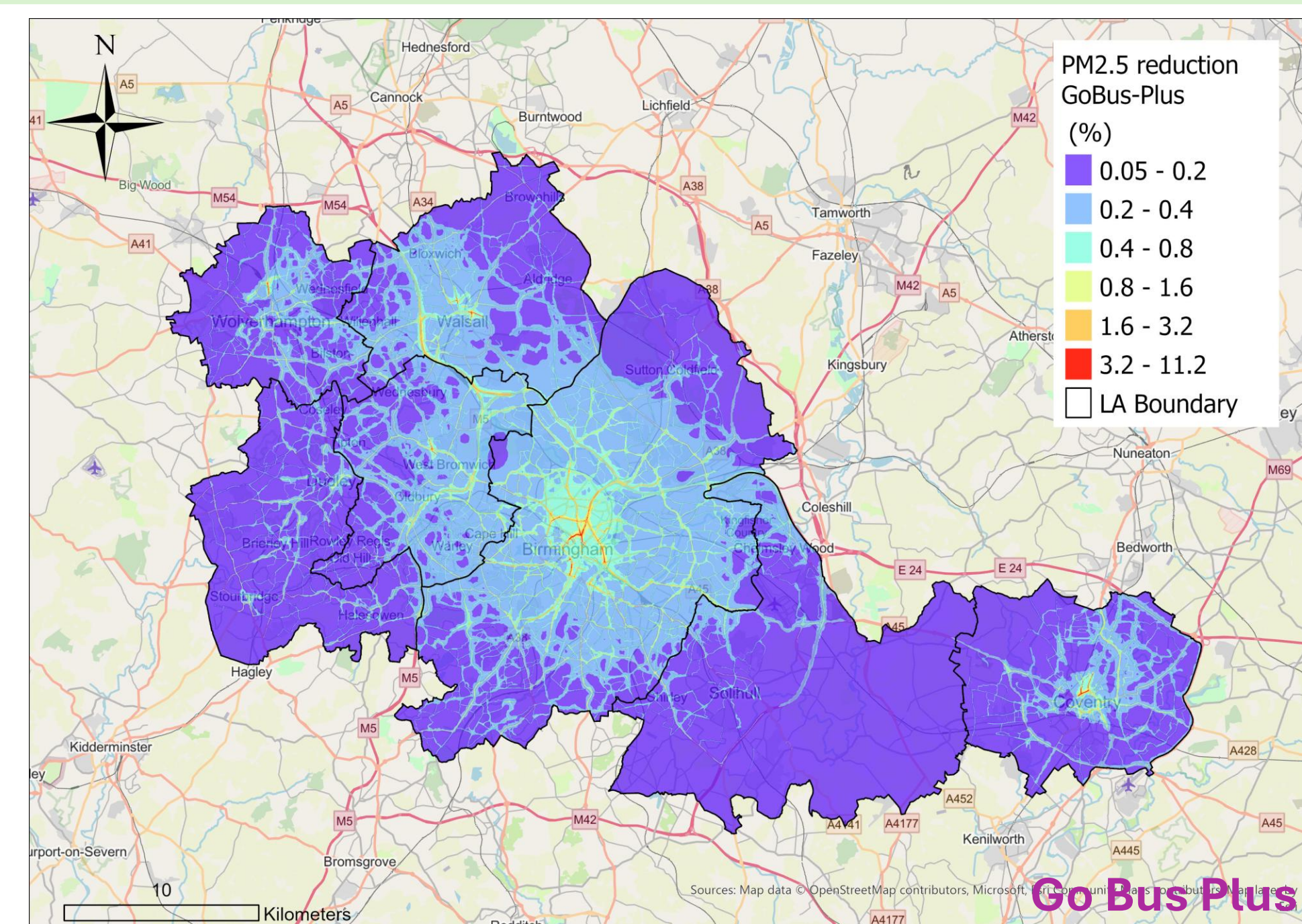


[Cars, vans, HGVs, buses and coaches fully electric]
Strongest NO₂ response: major roads show local reductions up to 51% - 84%.

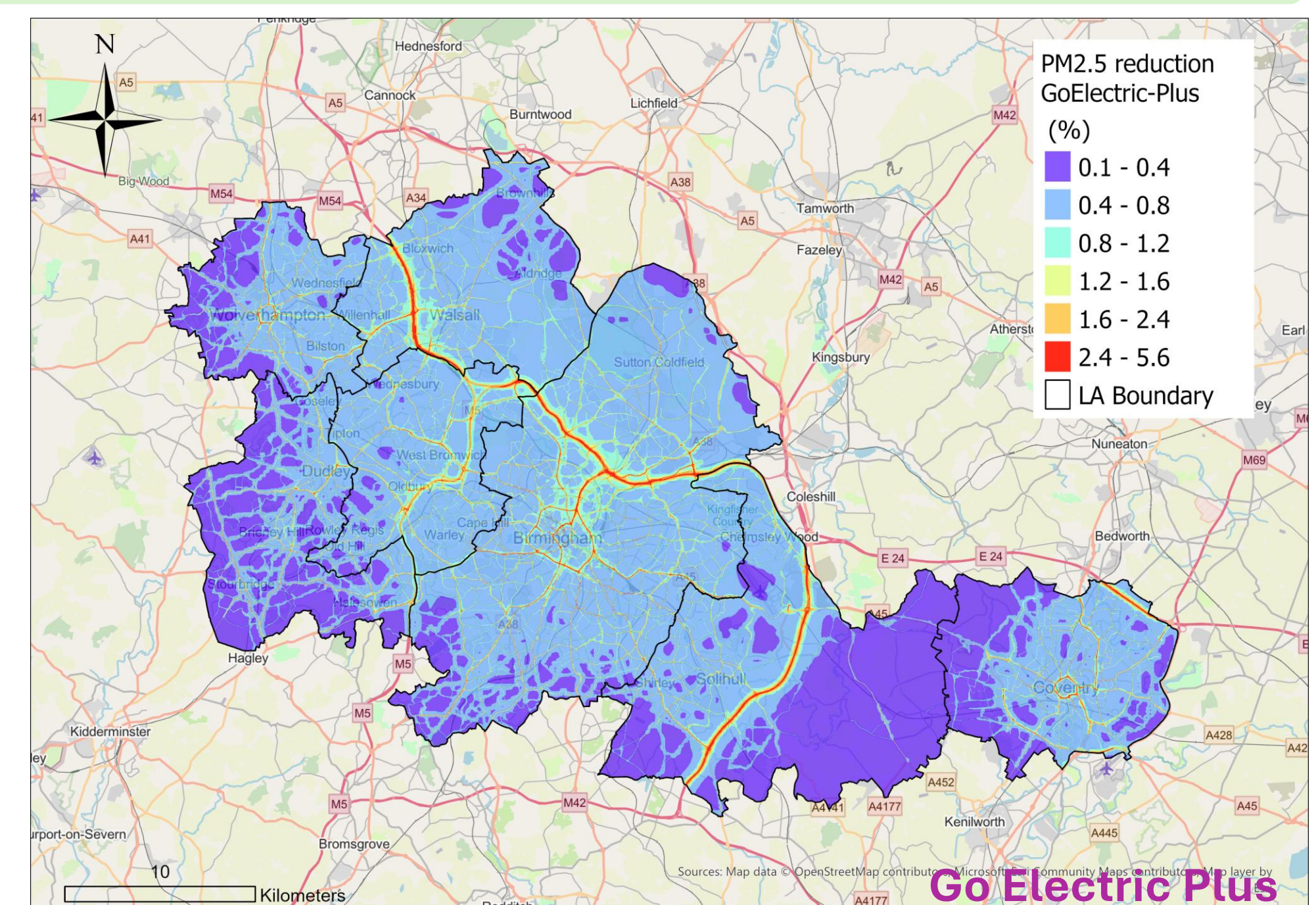
PM_{2.5} reductions of net-zero scenarios relative to 2036 Future (%).



Largest PM_{2.5} response: widespread reductions with local hotspots up to 10% - 24%.



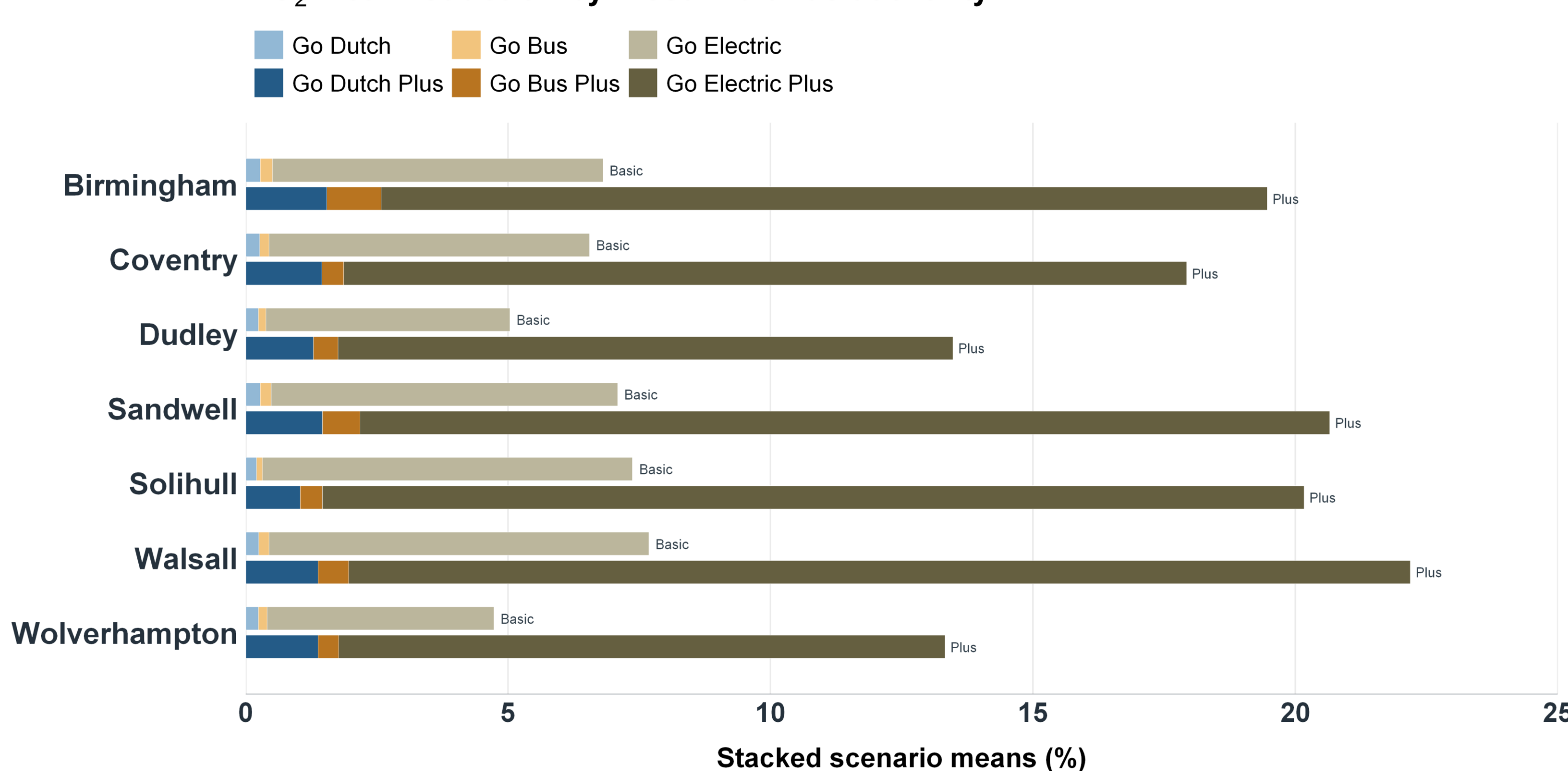
PM_{2.5} reductions are mostly modest, with stronger benefits in central Birmingham.



PM_{2.5} benefits follow major roads, with local reductions up to 2.4% - 5.6%.

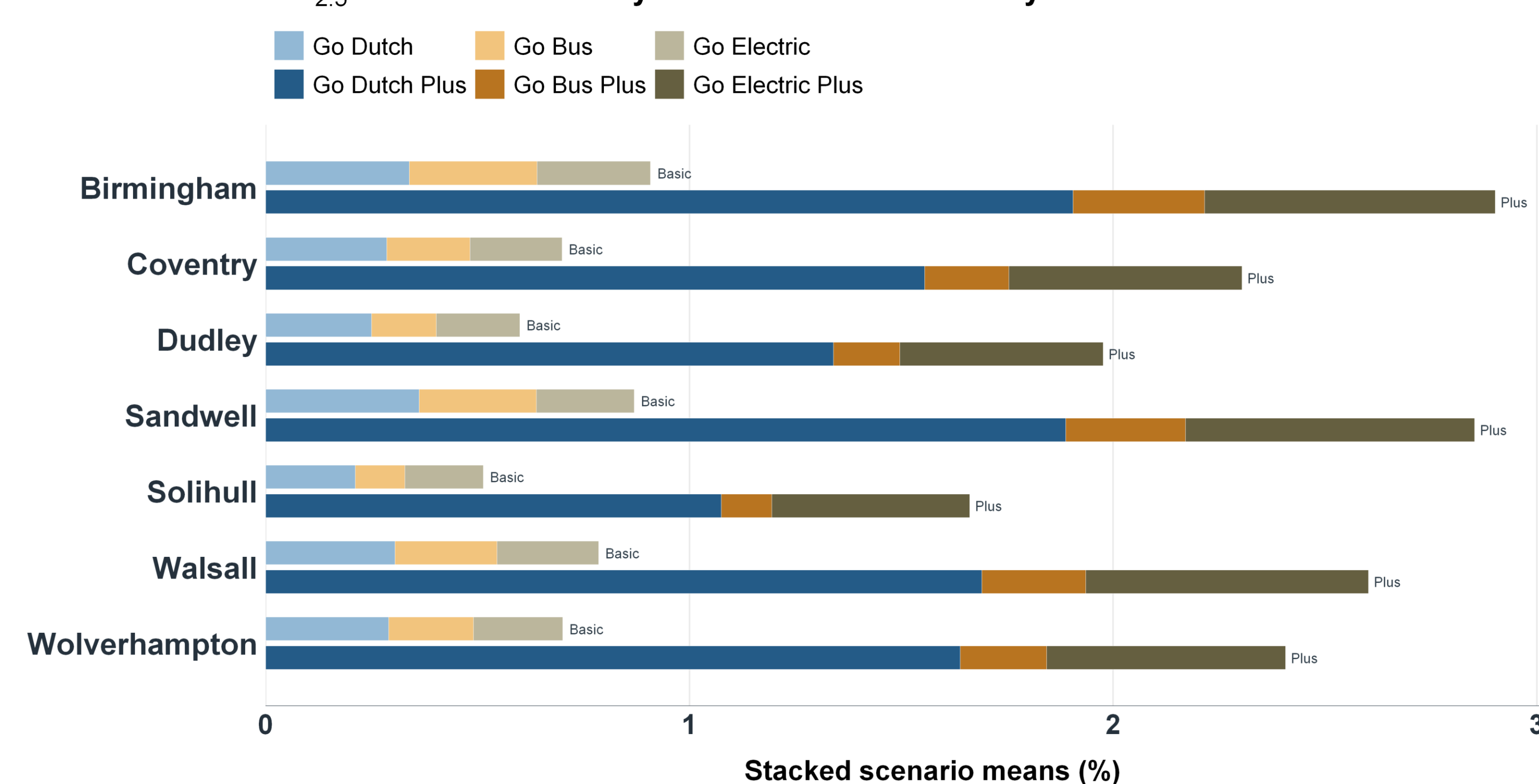
2 Mean reductions by West Midlands local authority

NO₂ mean reduction by West Midlands authority



.Each segment is the mean reduction relative to 2036 Future across the authority.

PM_{2.5} mean reduction by West Midlands authority



GoElectric Plus gives the largest mean NO₂ reduction in every authority; Walsall has the highest mean benefit. GoDutch Plus gives the largest mean PM_{2.5} reduction in every authority; Birmingham has the highest mean benefit.

Air Quality Changes in the West Midlands from Present 2024 to 2036 Future

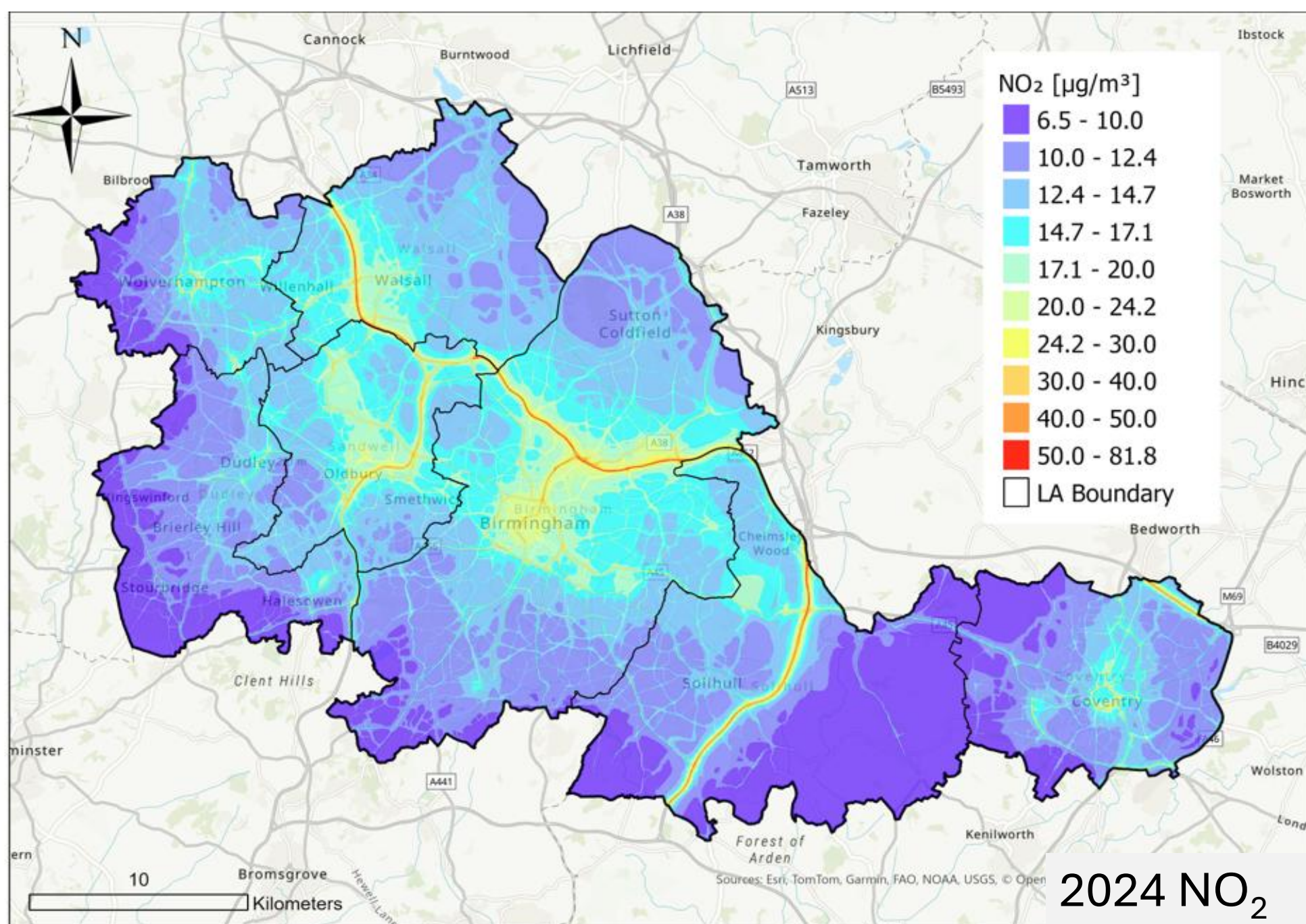
Nana Wei, Jian Zhong, Ye Hang, Kate Johnson, Jenny Stocker, Suzanne E. Bartington, Zongbo Shi, William J. Bloss and WM-NetZero Team

Key insights:

- NO₂:** Largest improvements are predicted along major roads, with reductions of up to **50–70%**.
- PM_{2.5}:** Reductions are smaller (**8.8–15.4%**) because PM_{2.5} comes from multiple local and transported sources.
- Local action:** Cleaner transport is key for NO₂, while reducing PM_{2.5} requires action across **transport, heating and other local sources**.

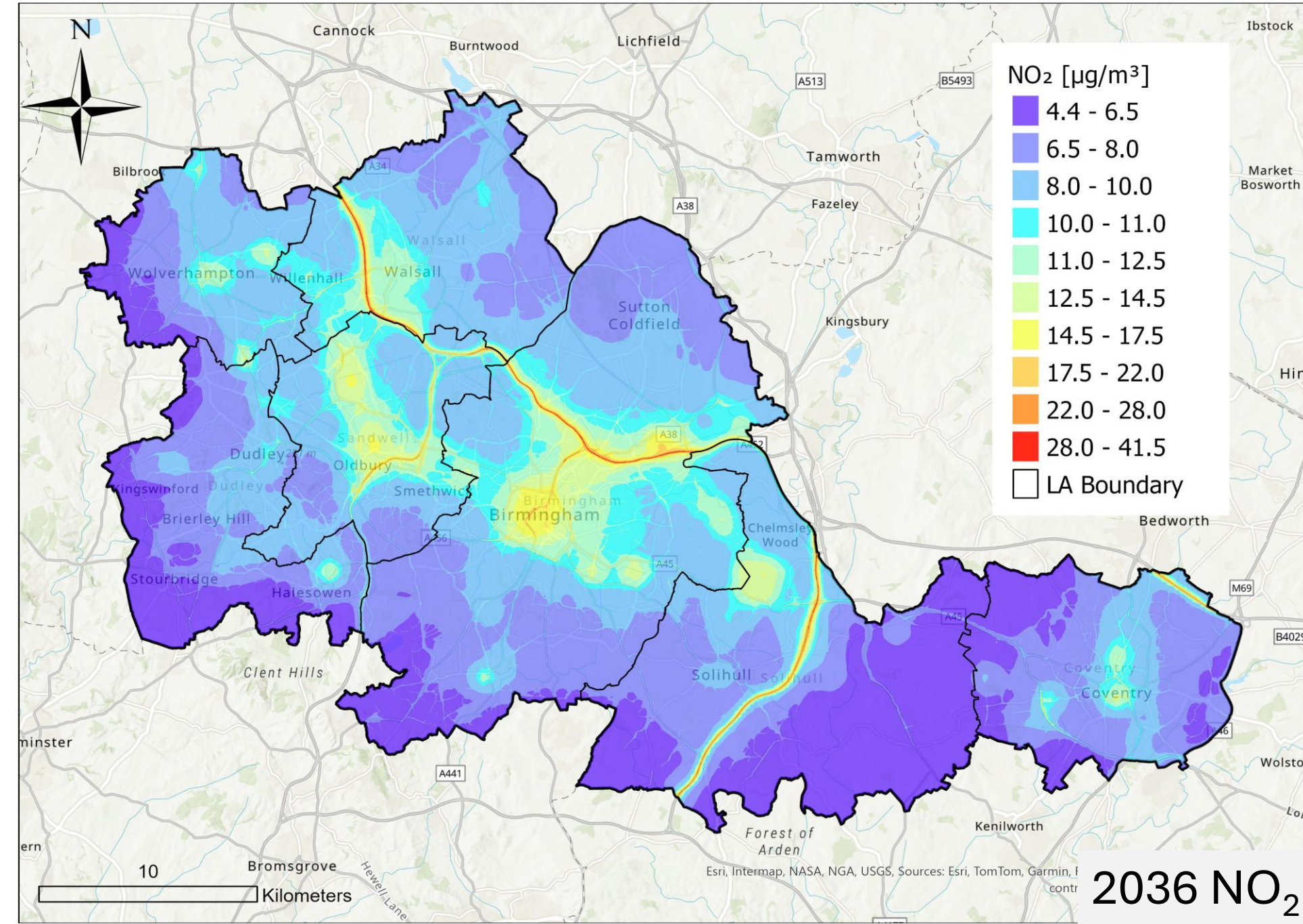
1 NO₂ concentrations from 2024 to 2036

2024 Annual Mean NO₂



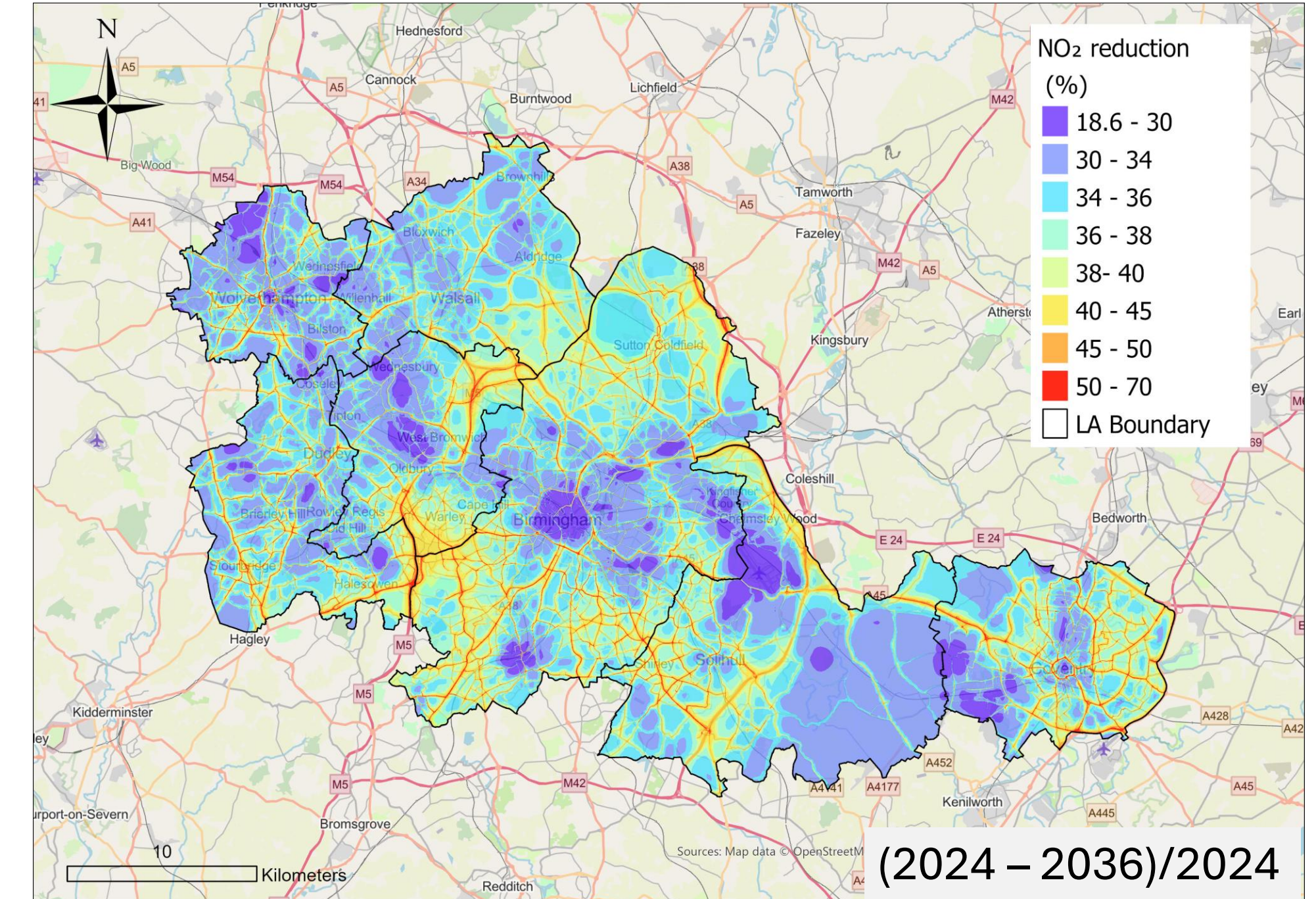
2024 NO₂ concentrated in central Birmingham and along major roads, lower levels occur across less urbanised parts of West Midlands.

2036 Annual Mean NO₂



By 2036, NO₂ concentrations are lower across most of the region, although higher concentrations remain around Birmingham and along key transport corridors.

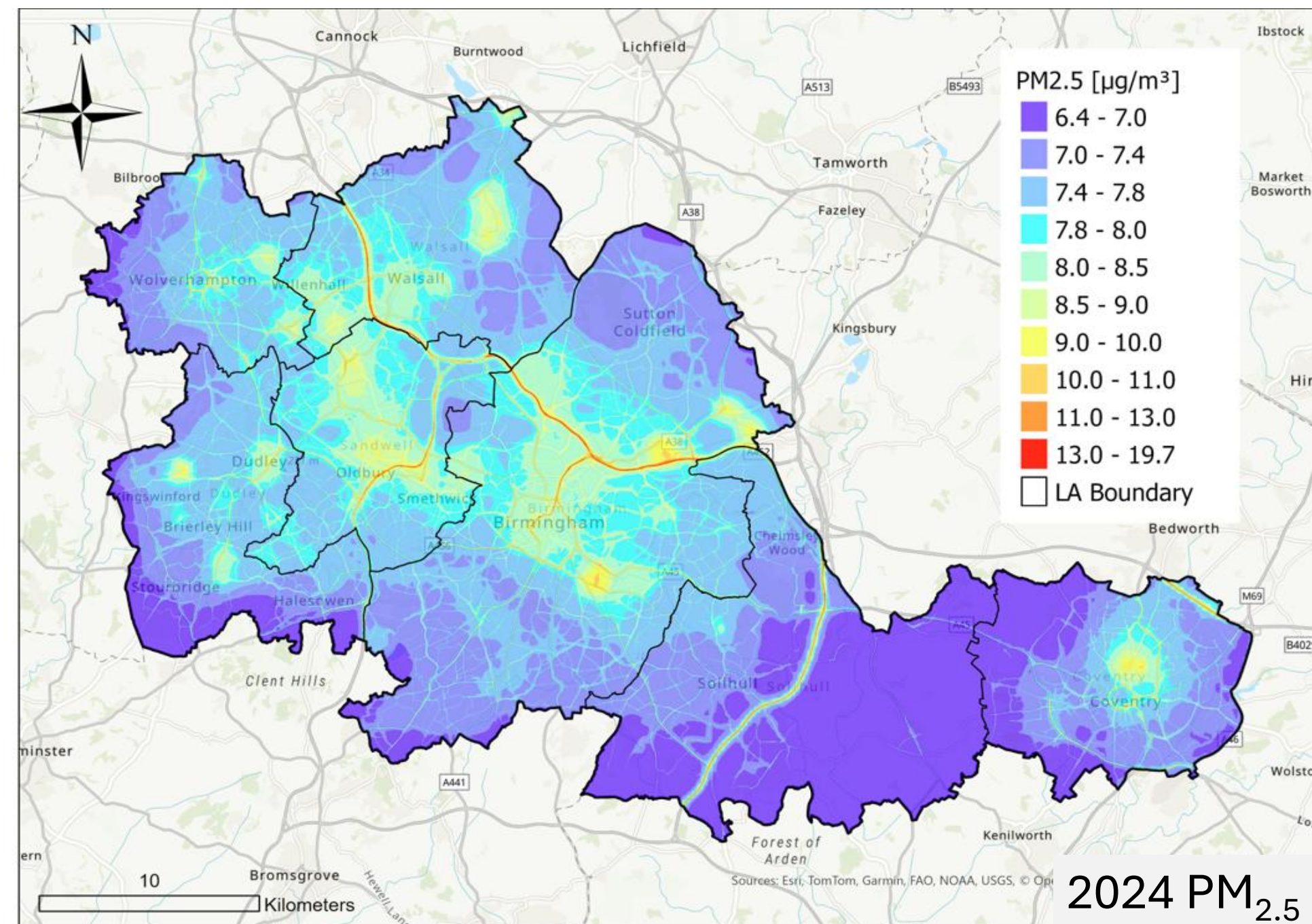
NO₂ reduction percentage from 2024 to 2036



NO₂ decreases across the whole region, typically by around 30–40%, with the largest reductions of 50–70% occurring along some major road corridors.

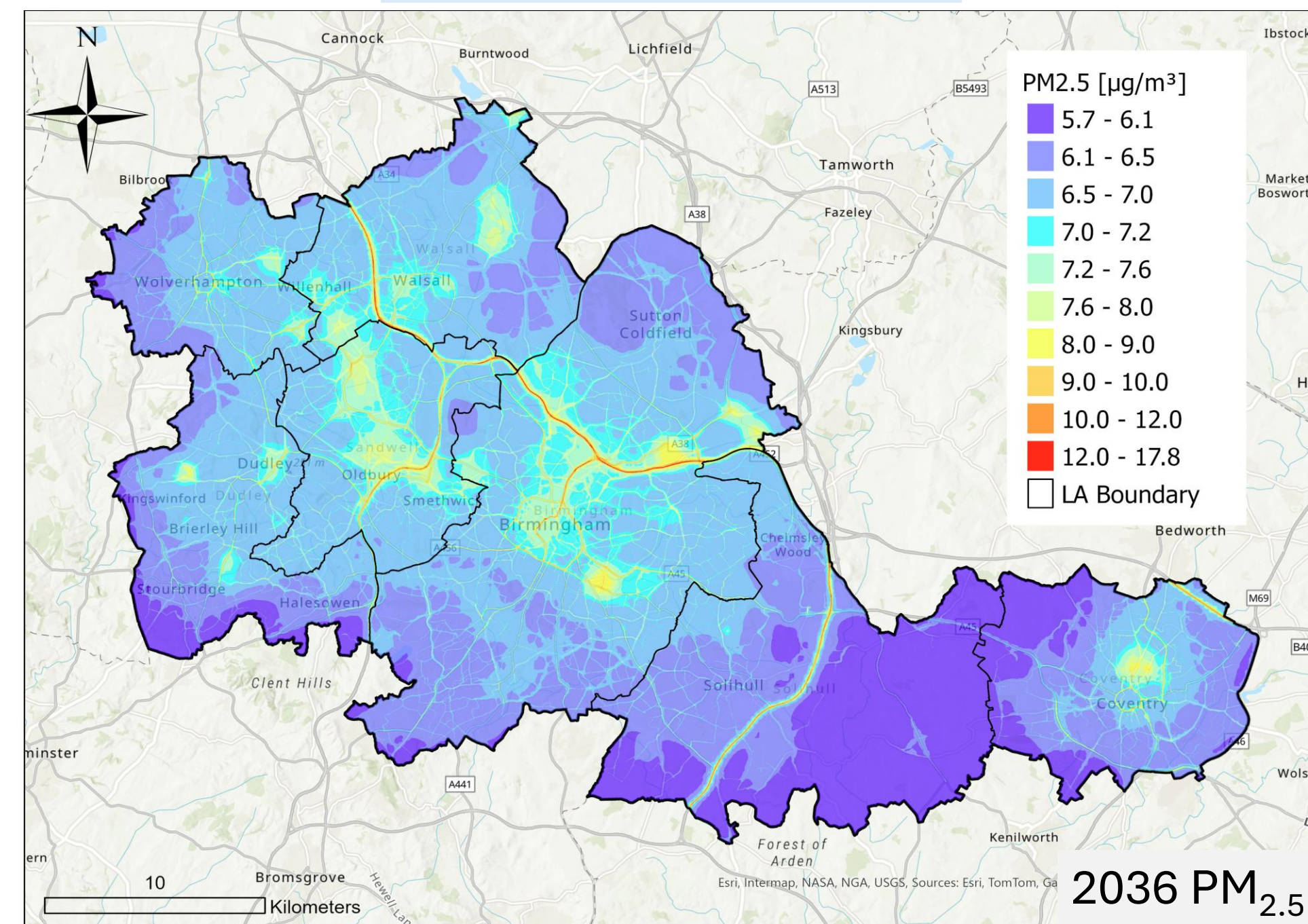
2 PM_{2.5} concentrations from 2024 to 2036

2024 Annual Mean PM_{2.5}



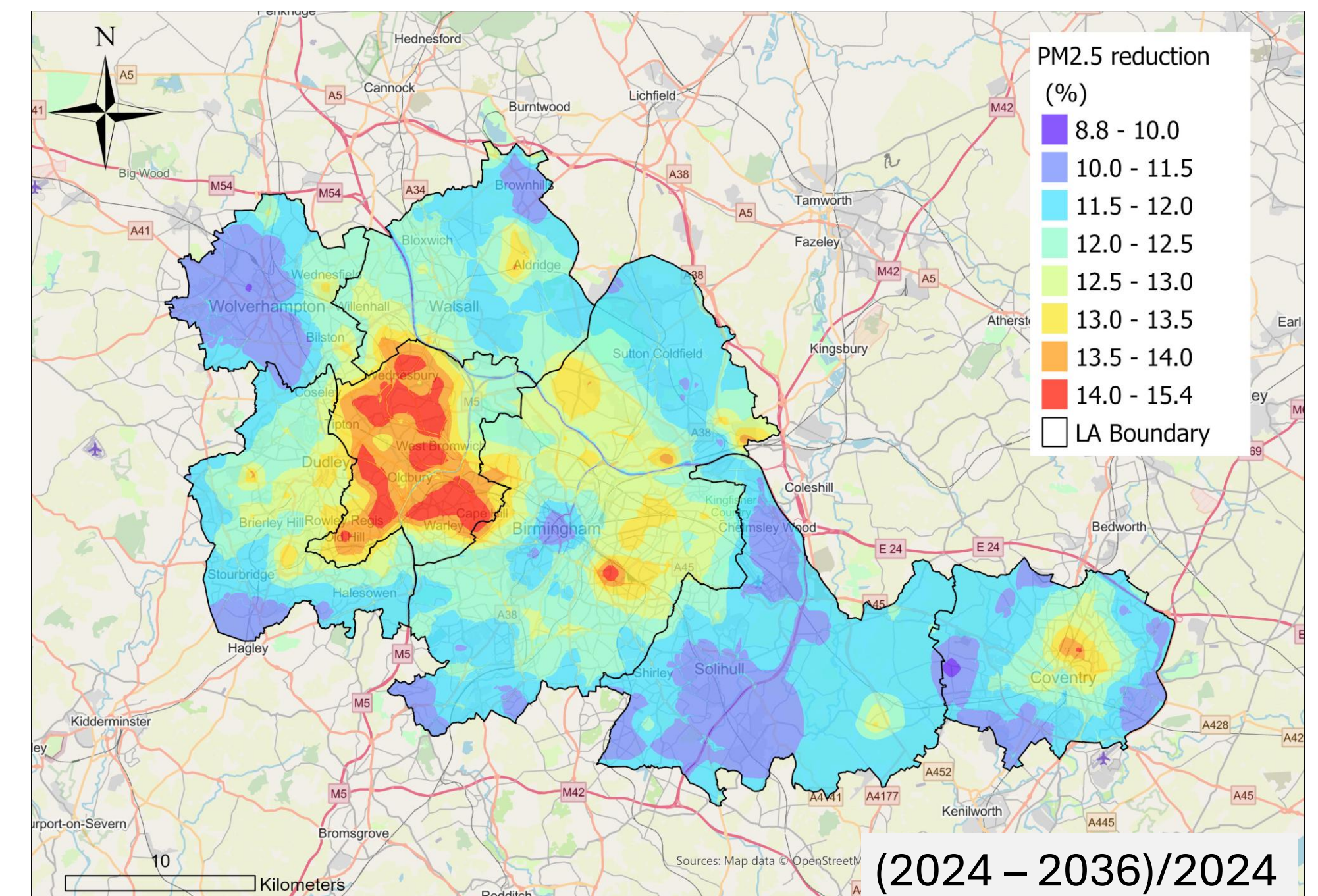
2024 PM_{2.5} concentrated across the more urbanised parts of Birmingham and the Black Country, with additional local industrial hotspots.

2036 Annual Mean PM_{2.5}



By 2036, PM_{2.5} is projected to decrease across the West Midlands, the overall spatial pattern remains similar.

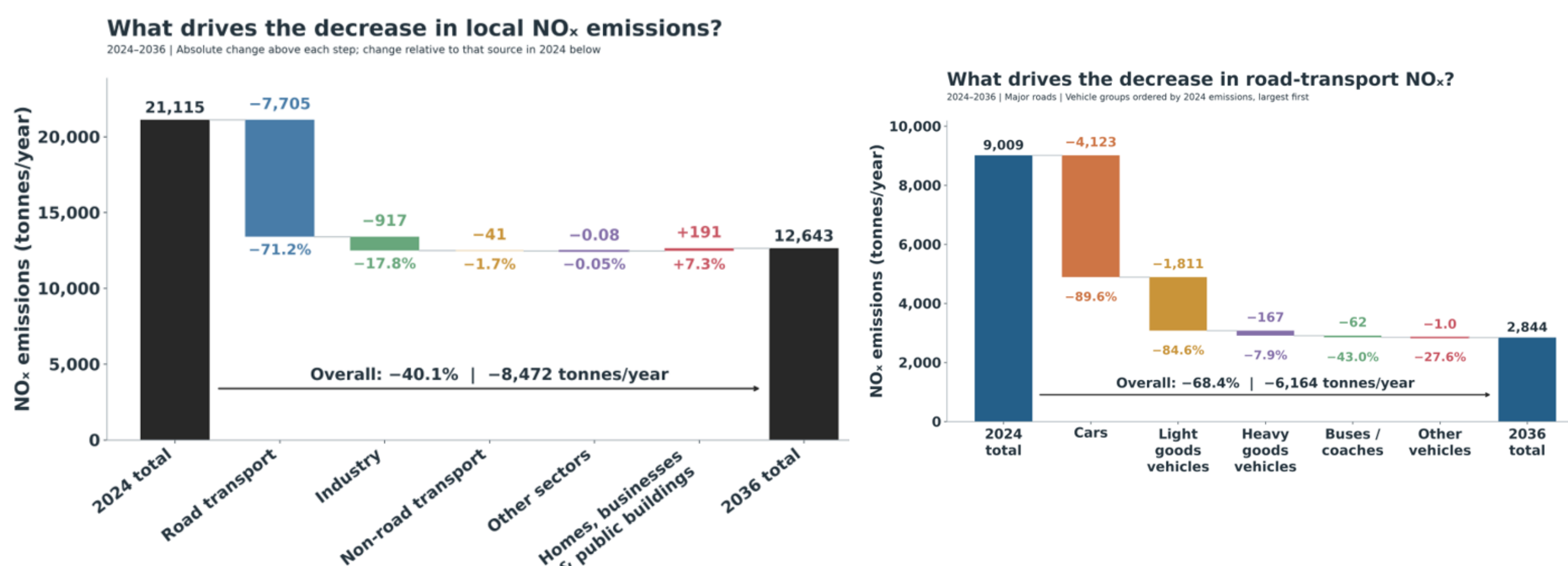
PM_{2.5} reduction percentage from 2024 to 2036



PM_{2.5} decreases across the region by ~8.8–15.4%, with the largest reductions around Sandwell, reductions elsewhere are more moderate and spatially widespread.

3 What drives NO₂ decrease locally?

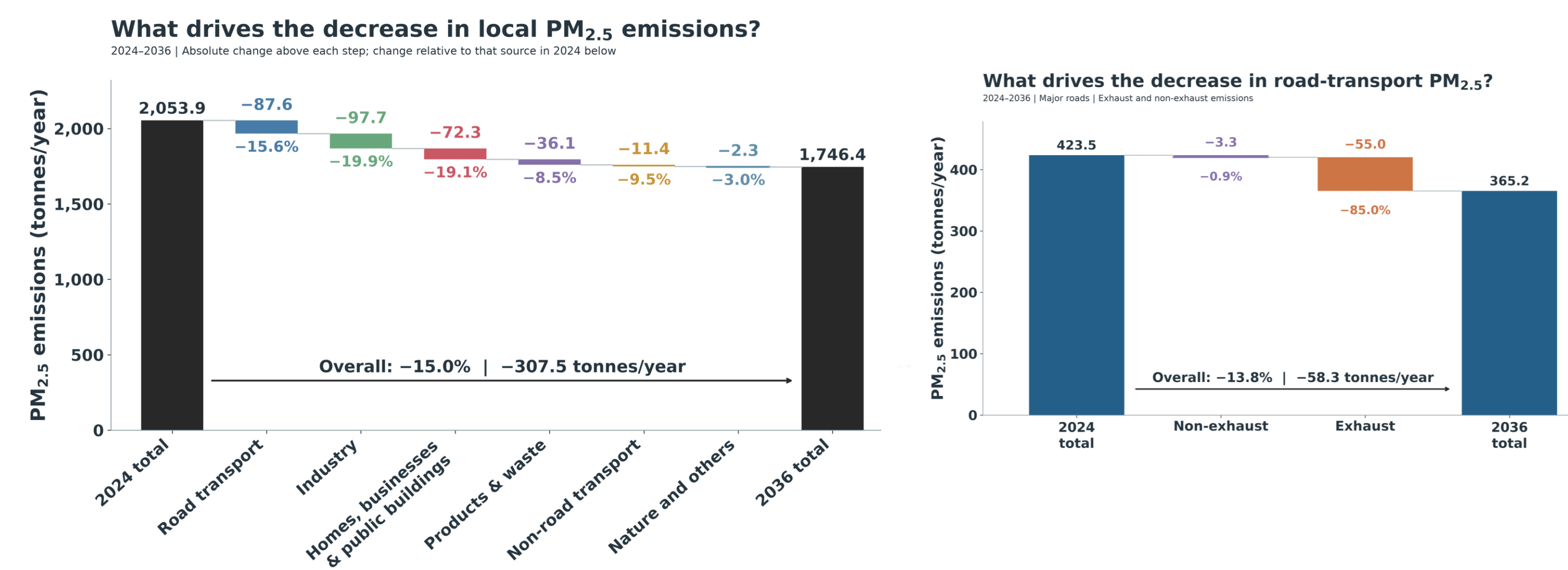
Cleaner road transport drives most of the projected fall in local NO₂ decrease, 2024-2036.



Traffic volumes in 2036 is projected broadly similar with 2024 (cars +8%, LGVs +9%, HGVs +5%; buses -5%), local NO_x emissions fall sharply as the fleet becomes much cleaner: petrol/diesel cars drop from ~97% to ~31%; hybrid and electric cars rise from ~3% to ~69%.

4 What drives PM_{2.5} decrease locally?

Local PM_{2.5} emissions reductions from road transport, industry and home/businesses/public buildings are the local drivers of the PM_{2.5} fall.



Within road transport, the reduction comes almost entirely from exhaust emissions, while non-exhaust PM_{2.5} changes little, showing that further gains require action beyond cleaner engines alone.

From 2036 Future to Net Zero Buildings: Air-Quality Benefits of Cleaner Heating in the West Midlands

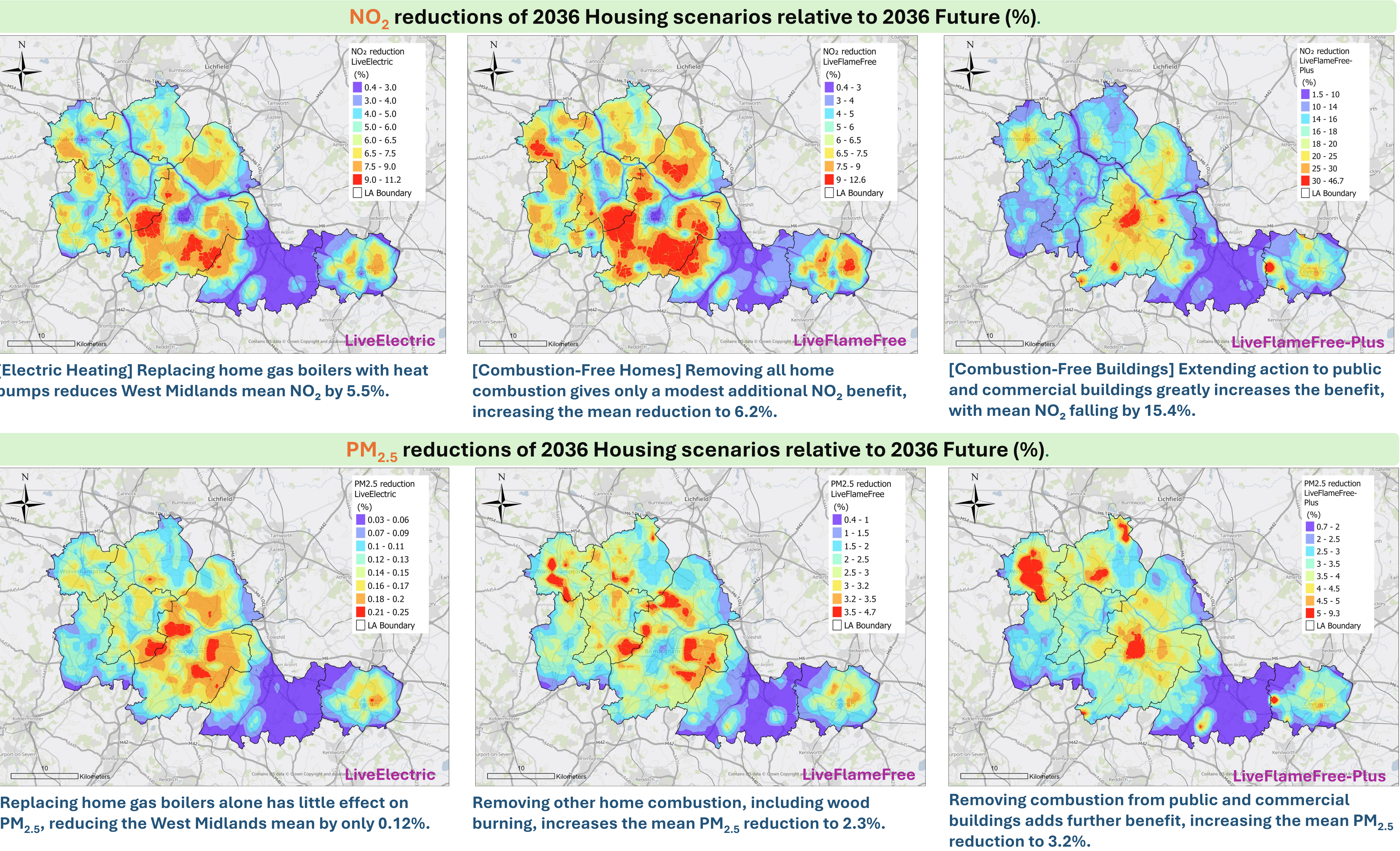
Nana Wei, Joseph Day, Ye Hang, Jenny Stocker, Kate Johnson, Jian Zhong, William J. Bloss, Suzanne E. Bartington, Zongbo Shi and WM-NetZero Team

Key insights:

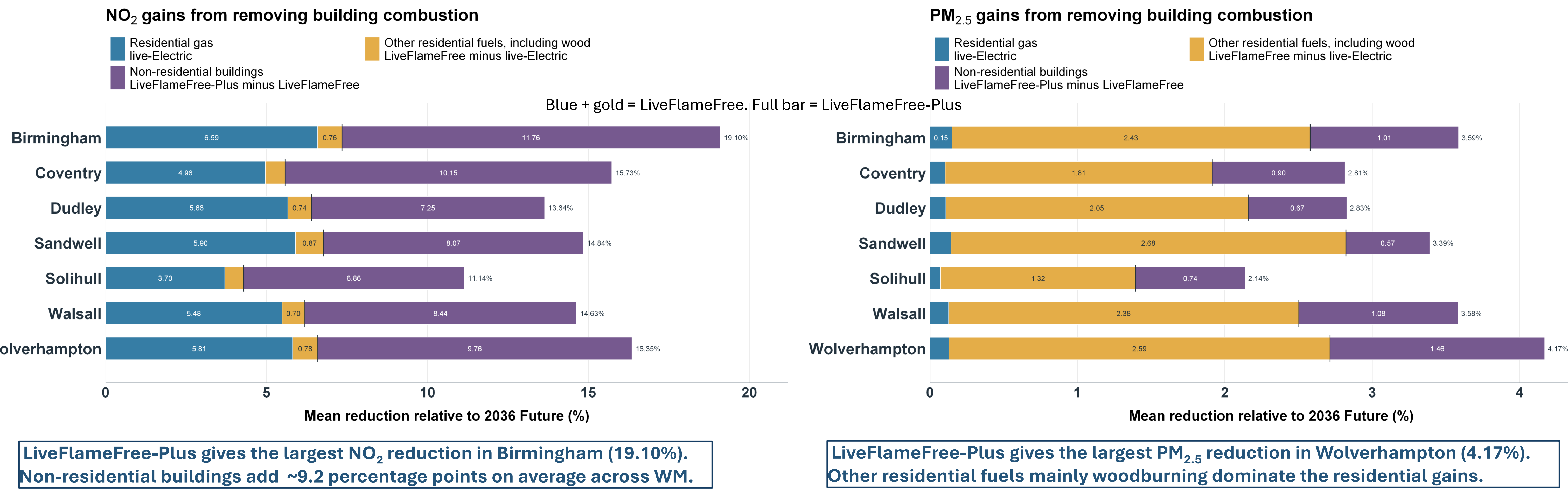
1. Cleaner heating delivers much larger NO₂ benefits when action extends beyond homes, increasing the West Midlands mean reduction from 5.5% to 15.4%.

2. Local action across the wider building stock matters: public and commercial buildings are important for NO₂, reducing solid-fuel and wood burning is particularly important for PM_{2.5}.

1 NO₂ and PM_{2.5} reductions in 2036 Housing Scenarios



2 Air quality gains from Housing scenarios for each authority



PM_{2.5} reductions are generally smaller because a substantial share of concentrations comes from regional and long-range transported pollution, which cannot be addressed by local measures alone and therefore requires coordinated regional and national action.

Castle Vale Came Out to Play

Shobhit Arya, Emily Prestwood, Suzanne Bartington, Zongbo Shi, WM-NZ Study Team

On 7 February 2026, Castle Vale came alive with a community event at Youngstaars Community Hub, bringing residents of all ages together for an afternoon. Families took a moment to settle in as the room filled with warmth and anticipation, while children lit up with excitement the moment the show began. The whole crowd turned its attention to the excellent jugglers and aerial silk performers taking Centre stage, their skill drawing gasps and applause throughout the room. As a Community Ambassador for the WM-NetZero study I spoke with residents about how the Local Net Zero Accelerator (LNZA) programme was set up to measure the impact of home retrofitting and improvements in air quality, encouraging people to see these changes within the wider picture across the neighbourhood rather than just their own home. Beyond the entertainment, the event opened a friendly doorway for residents to learn about the WM-NetZero air quality study happening on their street.

Engaged



Children join in as the juggling act unfolds

How it felt?

The reaction on the day was warm and welcoming. Families stayed, watched, and asked questions about the study once the performance wrapped up. Residents were curious about how their day-to-day actions affect indoor air quality. This curiosity led 15-20 families to show genuine interest in taking part in the study after the event, and they left their contact details to receive further information and follow-up.

Curious



Residents gather for the opening act at Youngstaars Community Hub, Aerial silks bring the atrium to life

What happened?

Almost 35 Families gathered at Youngstaars Community Hub in Castle Vale for a specialist circus performance, i.e., juggling, balancing acts and aerial silks, put on to draw residents in and open a conversation about the study happening on their street.

Alongside the performance, the team was on hand to explain the air quality sensors being installed in local homes as part of WM-NetZero, and to talk residents through what taking part would involve.

Excited



The WM-NetZero project is supported by Wellcome Trust (227150_Z_23_Z) under the *Advancing climate mitigation policy solutions with health co-benefits in G7 countries* scheme.





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BIRMINGHAM



CLEETS

WM-NET ZERO

Climate change is already affecting health across the West Midlands. Ambitious climate action is an opportunity to improve health and build more resilient communities.

The West Midlands in 2024



Road transport generates

3.5
million tonnes

of Carbon Dioxide each year.



Population ~3 million



Housing generates

2.3
million tonnes

of Carbon Dioxide each year.

Over 5000 people die early each year due to pollution and not being active.

Cycling equivalent to Netherlands and more walking

Cycling to work equivalent to Netherlands

All electric vehicles

Double bus trips and electric buses

Double bus trips

More electric vehicles

2036

Health benefits

Clean heating in all homes, businesses and civic buildings

Clean heating in all homes

Upgrade gas boilers to heat pumps in homes

Insulate all homes

Insulate older homes

More efficient homes

2036

Walking and wheeling so that everyone is active will cut 430,000 tonnes CO₂, save 3500 lives and £3.0 million health care costs.

Clean heating in all buildings will cut 2.9 million tonnes CO₂, save 190 lives & £6.6m health care costs



Walk and cycle more, drive less, electrify the rest



Remove gas boilers, use clean heating, stop burning wood

Explore climate and health in the West Midlands

www.climatehealth-explorer.org.uk



The WM-NetZero project is supported by Wellcome Trust (227150_Z_23_Z) under the Advancing Climate Mitigation Policy Solutions with Health Co-Benefits in G7 Countries scheme.



NERC Environmental Data Service



Development of Housing Scenarios for the Climate Health Explorer

Joseph Day, Ye Hang, Nana Wei, Annum Rafique, Suzanne Bartington, Zongbo Shi, WM-NZ Team, Energy Capital Team

Key Insights:

- Insulation alone offers limited air quality benefits but reduces cold homes.
- Heat pumps improve outdoor air quality but do not address pollution from woodburning or prevent cold homes.
- Insulation, electrified heating, and the elimination of solid fuel burning deliver the greatest health benefits.



1. Policy Context

- Housing scenarios were developed to evaluate the health impacts of climate change interventions on ambient air quality in the West Midlands.
- Relevant policy documents were reviewed. Key themes were energy security, tackling the cost living, improving housing conditions and developing a smart local energy system that manages the transition in a cost-effective and place-based approach. Smoke control areas also seek to improve air quality by reduced combustion of wood.
- Key technologies for the decarbonisation of housing include heat pumps, upgraded insulation, batteries and solar PV panels. If Clean Power is achieved by 2030, then electric heat pumps are a low carbon heating option. The government aims for 450,000 HPs to be installed annually 2030 (125,000 in 2025).

2. Scenario Selection

- Housing scenarios were co-developed with a working group of members with unique perspectives and experiences as shown in Table 1.
- A series of six themed group discussions based around the likely future mix of technologies and interventions were held. The predicted potential health outcomes affected and scale of impacts are displayed in Figure 1. Energy Capital were keen to find ways to spatially optimise retrofit spend, while the PIRG supported insulation measures to improve comfort.
- A longlist of 21 scenarios was derived. There was enthusiasm for a ‘Live-Nordic’ scenario, where homes become efficient as in Nordic countries. However, only ambient air quality effects were modelled. This led to a focus on woodburning while, solar PV and battery storage (microgeneration) were deemed to have less direct health impacts.

Table 1. The organisations represented in our working group and their contributions.

Organisation	What they brought to discussions?	Health outcome and reason for improvement				
		Ambient AQ (reduced gas burning)	Indoor AQ (better air flow)	Cold (less heat loss)	Overheating (less heat gain)	
PIRG	Energy sector career, grassroots community action and lived-experience	+	+ / -	+ +	+ / -	Large Positive Impact + +
Energy Capital (WMCA)	Regional policy context (especially Climate Change Five-Year Plan) and delivery experience	+ +			+ +	Small Positive Impact +
City-REDI	Technoeconomic expertise and historic pace of interventions		+ +			Potential Mixed Impact + / -
WM-Net Zero Researchers	Air quality expertise, health expertise and systems thinking					
Category of intervention(s)		Fabric	Heating or Cooling Systems	Ventilation Systems	Micro-generation	Behaviour Change
		+	+	+	+	

Figure 1. Potential interventions and their health outcomes. These informed the series of six group discussions.

3. List of Scenarios

Table 2. The final list of scenarios modelled and displayed in the Climate Health Explorer. Detailed results and modelling assumptions can be found at (<https://www.climatehealth-explorer.org.uk/>) In addition to these scenarios, two low carbon district heat network scenarios will have their health outcomes modelled as a bespoke piece of analysis for Birmingham City Council.

Scenario	Description	Impacts
2036 Future	Homes are slightly more energy efficient than today. New homes have high environmental standards. Older homes are heated by gas and new commercial developments add emissions.	Changes in building emissions do not improve air quality.
2036 LiveWarm	Older homes have had their lofts and walls insulated, reducing the amount of gas required to heat them.	Negligible changes in air quality but less people exposed to hazardous cold. If work isn’t done to a high-standard, there is risk of damp and mould.
2036 LiveWarm-Plus	All homes have had improvements to their energy efficiency through extensive insulation and modern gas boilers with controls.	Air quality very slightly improves and much less people exposed to hazardous cold or live in fuel poverty. Overheating could still present a risk.
2036 LiveElectric	Electrically powered heat pumps are rapidly installed in homes, entirely replacing gas boilers and removing their emissions.	Air quality improves, although people could be exposed to hazardous cold or live in fuel poverty, if homes uninsulated or electricity expensive.
2036 LiveFlameFree	Combustion of all fuels in homes is phased out, alongside a rapid adoption of heat pumps, eliminating all domestic emissions.	Air quality substantially improves but people could still be exposed to hazardous cold and continue to live in fuel poverty.
2036 LiveFlameFree-Plus	Combustion of all fuels in homes and public or commercial buildings is phased out, eliminating their emissions.	Air quality substantially improves but if electricity is expensive, services and businesses could see their operating costs increase.



Reducing Carbon Dioxide and Air Pollutant Emissions from the Housing Sector in the West Midlands

Ye Hang, Joseph Day, Nana Wei, Jenny Stocker, Jian Zhong, Kate Johnson, Yuli Shan, Suzanne Bartington, Zongbo Shi on behalf of the WM-Net Zero team and public members in the housing group

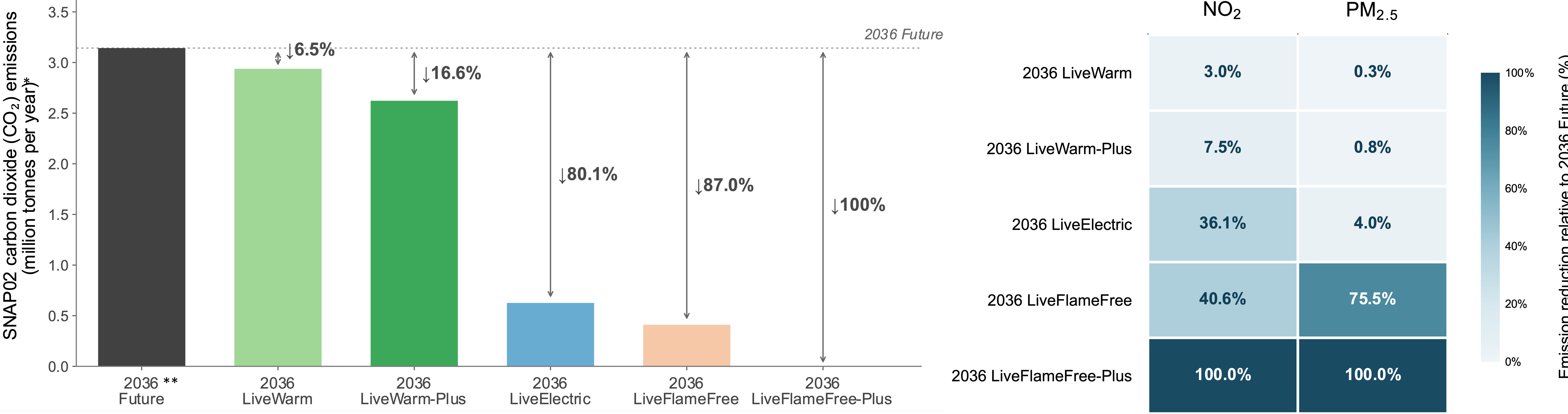
Key Insights

- 1. Energy-efficiency upgrades deliver modest emission reductions; deeper cuts require moving away from combustion-based heating.
- 2. Heat pump installations sharply reduces carbon dioxide and nitrogen dioxide emissions, but has limited impact on fine particulate pollution.
- 3. Phasing out all fuel combustion delivers the largest climate and air-quality benefits, especially in urban areas.

1. Future Housing Scenarios (2036)

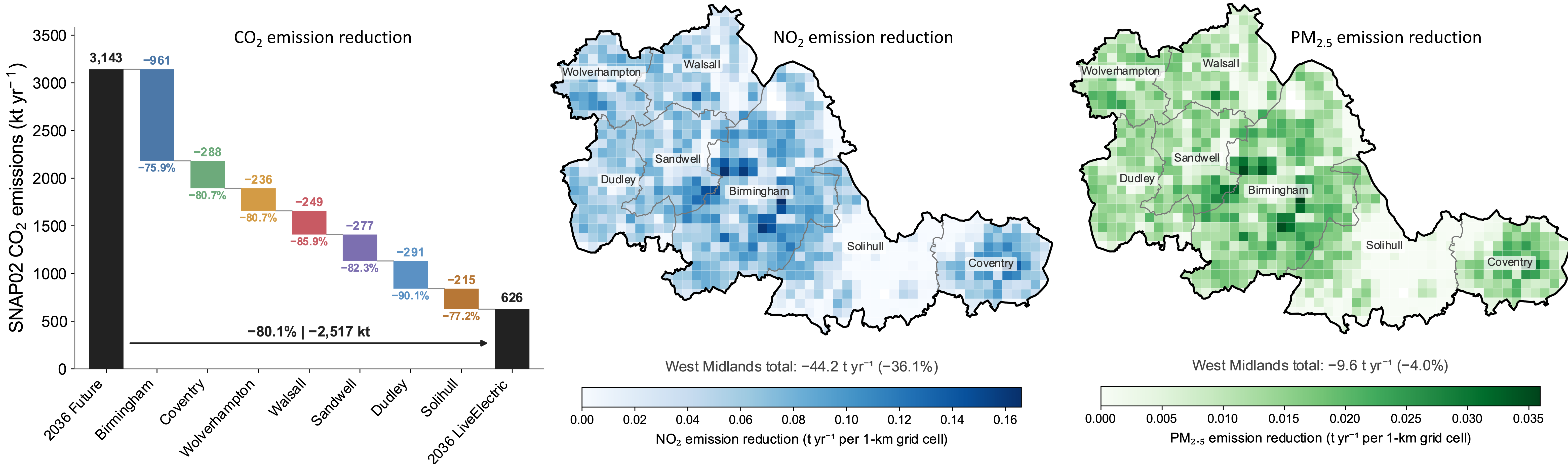
Scenario	Description
2036 Future	Homes are slightly more energy efficient than today. New homes have high environmental standards. Older homes are heated by gas and new commercial developments add emissions.
2036 LiveWarm	Older homes have had their lofts and walls insulated, reducing the amount of gas required to heat them.
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2. Housing CO₂ and Air Pollutant Emission Reductions



- Electrification delivers deep CO₂ reductions (80.1%) and substantial NO₂ benefits (36.1%), but only modest PM_{2.5} reductions (4.0%).
- Removing residential combustion broadens the benefits: LiveFlameFree reduces CO₂ by 87.0%, NO₂ by 40.6% and PM_{2.5} by 75.5%.
- LiveFlameFree-Plus delivers the maximum mitigation potential, eliminating CO₂, NO₂ and PM_{2.5} emissions from combustion in buildings (SNAP02).

3. 2036 LiveElectric: Regional and Spatial Emission Reductions



- Birmingham delivers the largest CO₂ reduction from combustion in buildings (SNAP02), accounting for ~38% of the West Midlands total reduction.
- CO₂ reductions are substantial across all seven local authorities, ranging from ~76% to 90%.
- NO₂ and PM_{2.5} reductions show similar spatial patterns, but PM_{2.5} benefits are much smaller overall (4.0% vs 36.1%).

Substantial between-home heterogeneity in indoor environmental quality and retrofit-associated changes in Dudley

Juncheng Qian, Yuqing Dai, Suzanne Bartington, Hui Li, Bowen Liu, Yuli Shan, Zongbo Shi and the WM-NetZero Team

1 What we measured

34 homes, two years

Occupied homes in Brockmoor, Dudley, monitored continuously from January 2024 to December 2025, one calibrated sensor each.

Four things at once

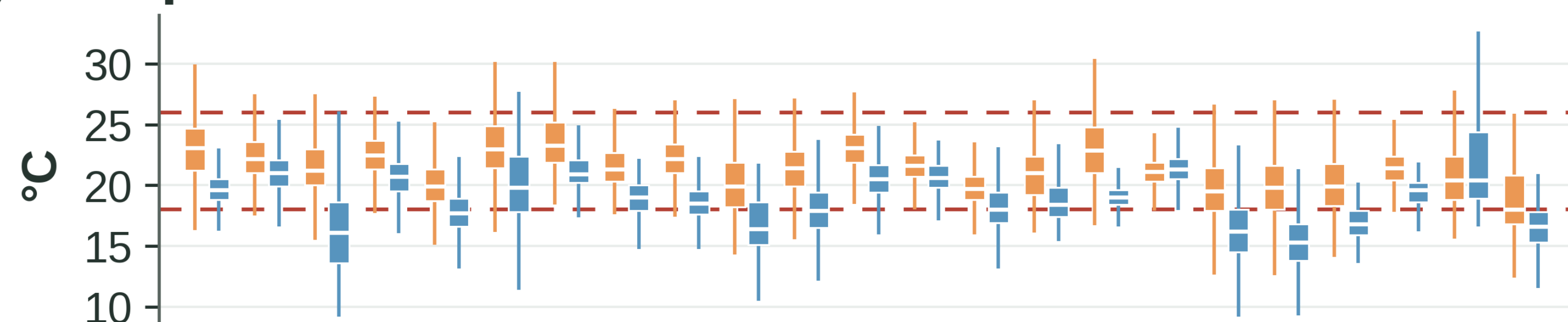
Temperature, relative humidity, fine particles (PM_{2.5}) and carbon dioxide (CO₂), logged every hour in the living room.

Why all four

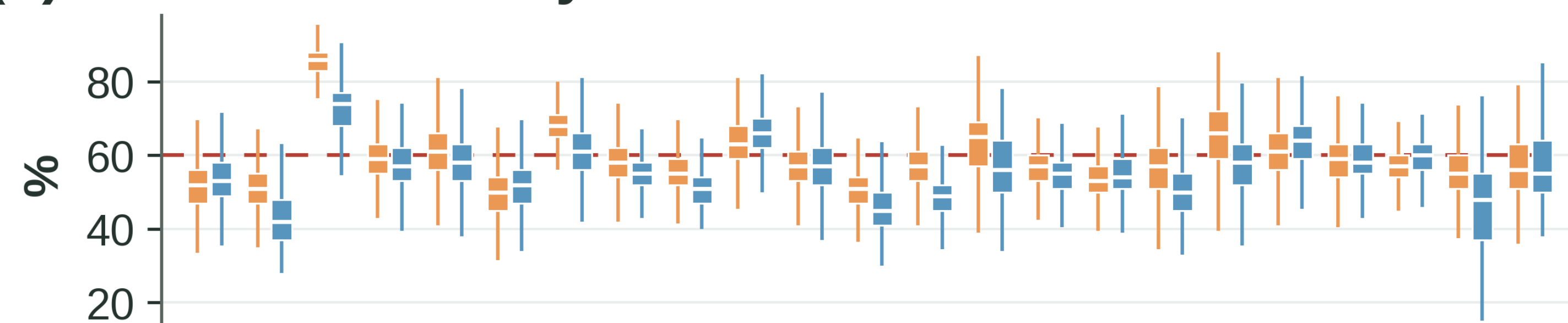
Comfort, damp, pollution and ventilation are different problems. A home can pass on one and fail badly on another.

2 Homes differ far more from each other than the seasons differ

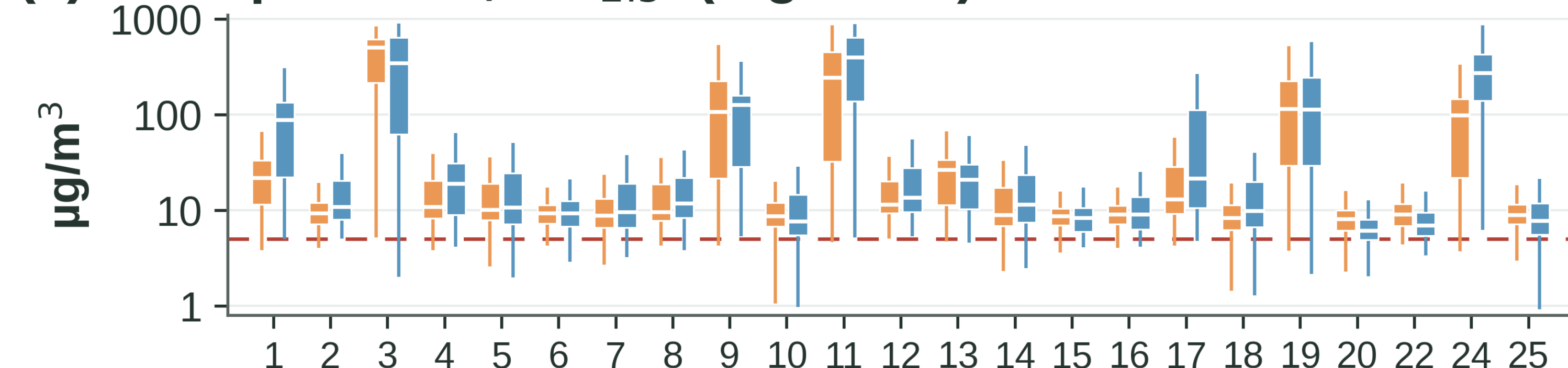
(a) Temperature



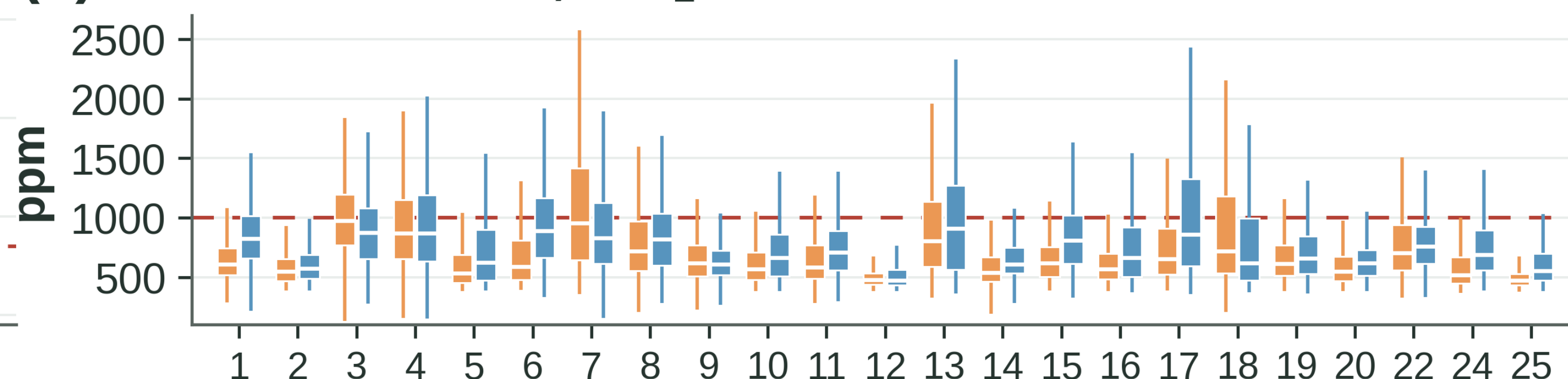
(b) Relative humidity



(c) Fine particles, PM_{2.5} (log scale)



(d) Carbon dioxide, CO₂



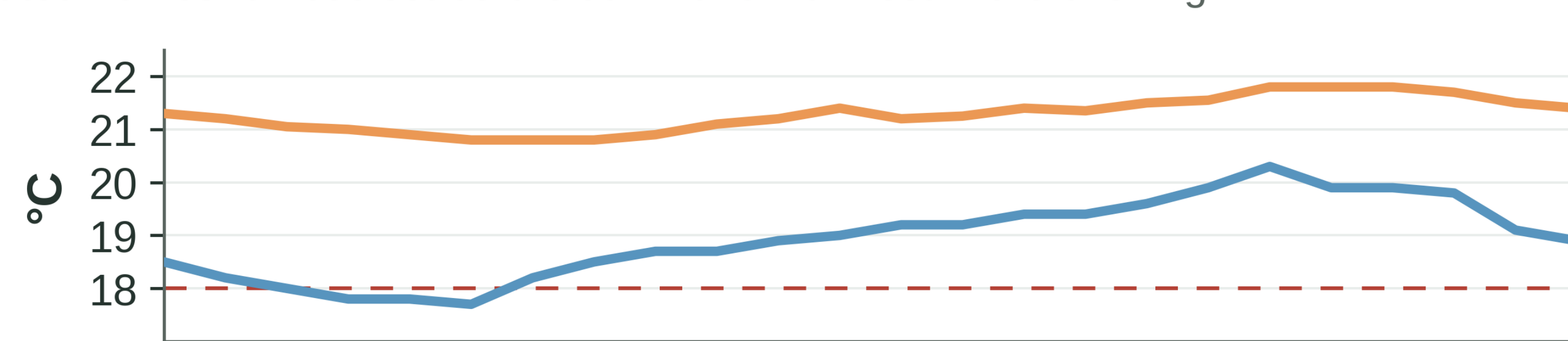
April to October November to March (heating season) --- reference values

Boxes: middle half of hourly readings; line: median

3 Every measure has its own daily rhythm

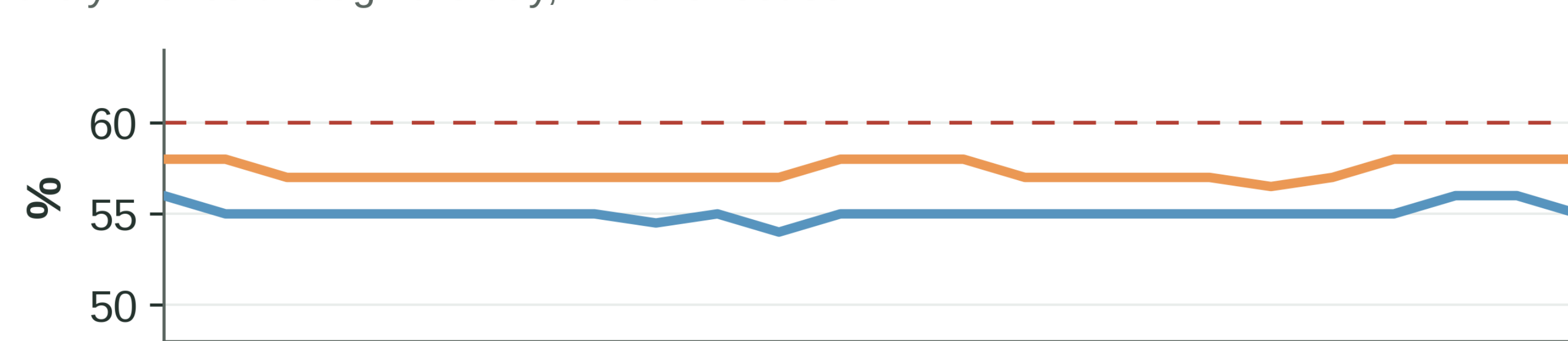
(a) Temperature

Heated homes run coolest before dawn and warmest in the evening



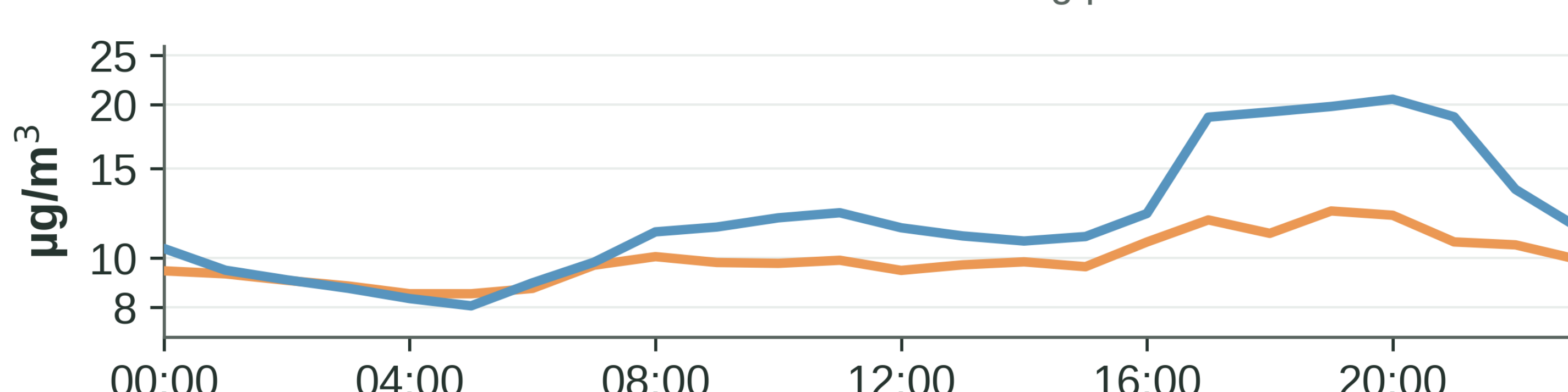
(b) Relative humidity

Barely moves through the day, in either season



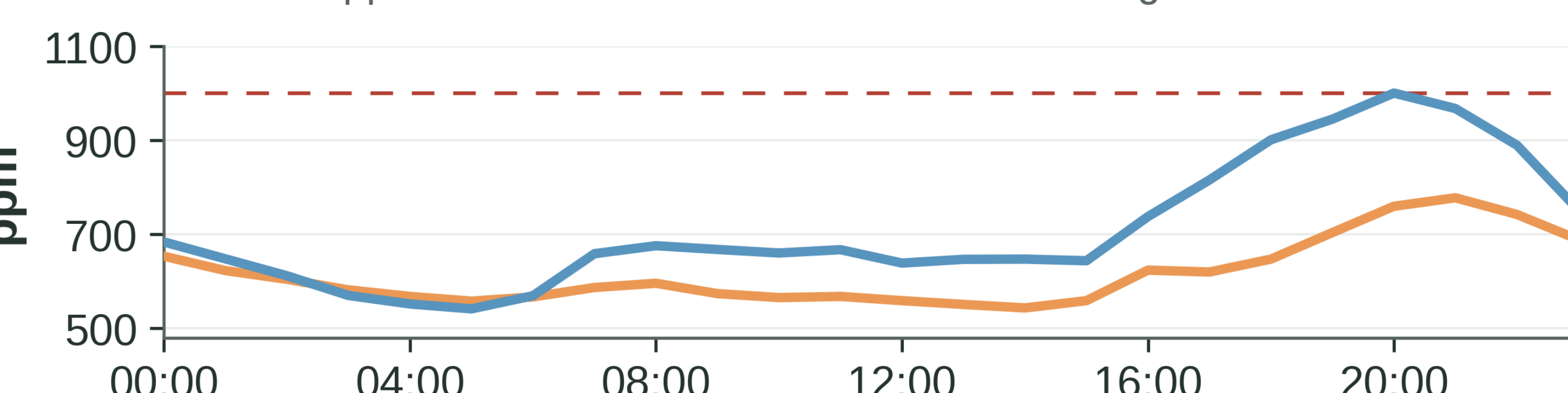
(c) Fine particles, PM_{2.5}

More than doubles between the small hours and the evening peak



(d) Carbon dioxide, CO₂

Reaches the 1000 ppm ventilation reference on winter evenings



April to October November to March (heating season) --- reference values

4 Key insights

Evaluate more than energy for retrofit

Assess indoor air quality, temperature, and humidity alongside energy performance when planning and evaluating retrofits.

Target support home by home

Use household-level monitoring to identify persistent indoor environmental problems and guide tailored support.

Address evening pollution peaks

Prioritize source control and effective ventilation during evening household activities, particularly in the heating season.

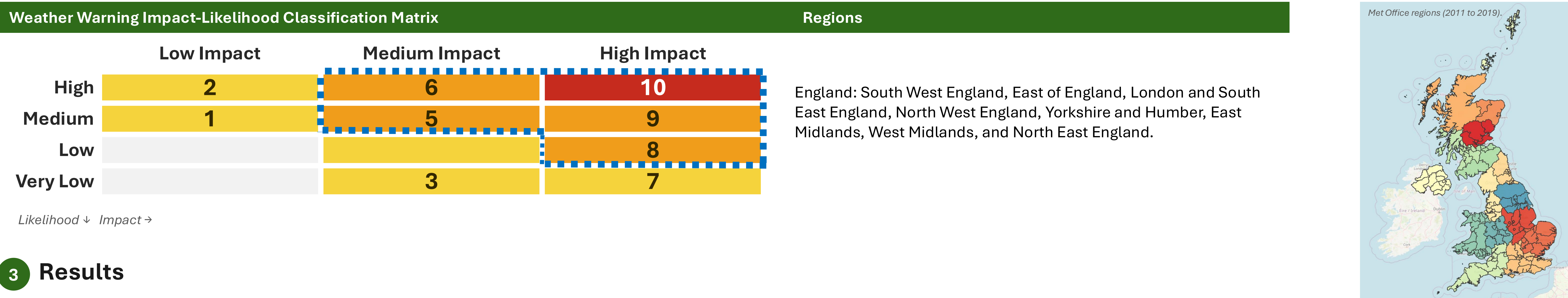
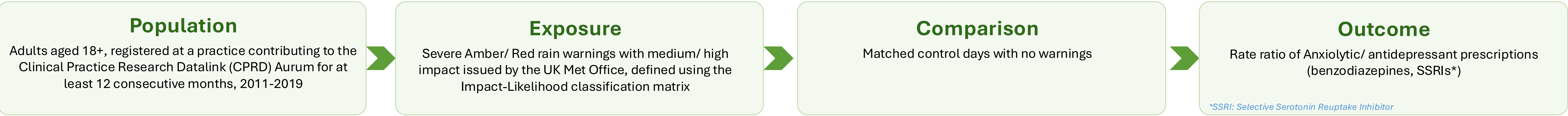
Exploring the association between National Severe Weather Warnings for rain and antidepressant and anxiolytic prescribing in GP practices in England: a retrospective time-series study.

Abeer Albdour, Chee Yap Chung, Laura Quinn, James Hall, Sue Jowett, Samuel Finnikin, Dan Suri, Zongbo Shi, Suzanne Bartington.

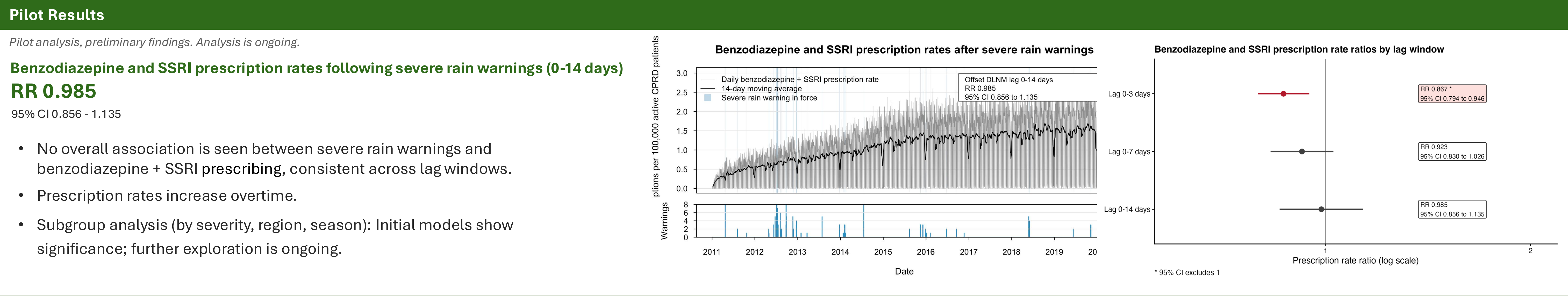
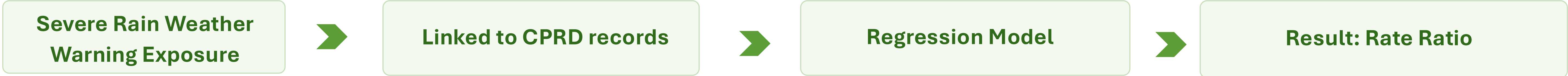
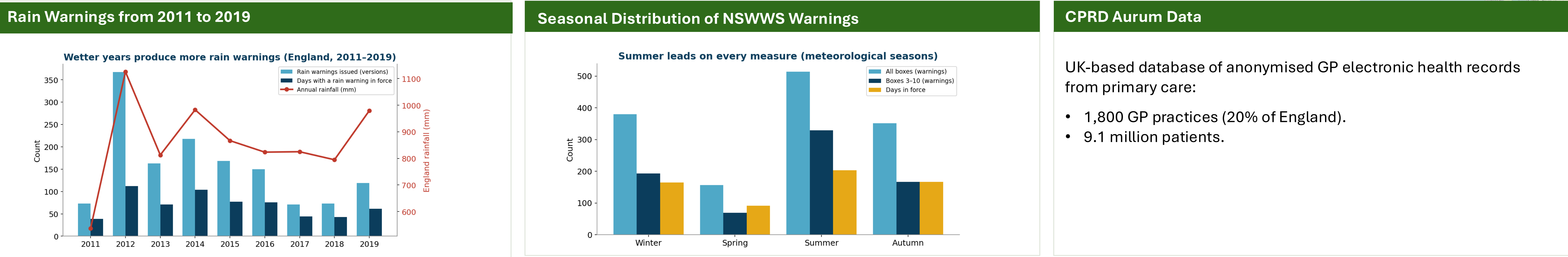
1 Background

- Extreme weather events are increasingly recognised as contributors to adverse mental health outcomes.
- The UK Met Office National Severe Weather Warning Service (NSWWS) issues warnings for forecasted severe weather, but the impact on mental health outcomes is unknown.
- This time-series study aims to describe the relationship between NSWWS rain warnings with antidepressants and anxiolytic prescribing in GP practices in England from (2011-2019).

2 Methods and Framework



3 Results



4 Strengths and limitations

- Nationwide high-quality primary care data
- High temporal resolution
- Robust self-controlled design
- Area-level exposure misclassification
- Residual time-varying confounding

5 Future Work

- Extend the analysis to other NSWWS warning types, such as ice and snow, to test possible associations.
- Consider the public health implications of the findings, such as preparedness, risk communication, and mental healthcare planning during extreme weather.

Study protocol
PROSPERO registration number: CRD42024555900



A governance analysis of the Net Zero Neighbourhood initiative in the West Midlands

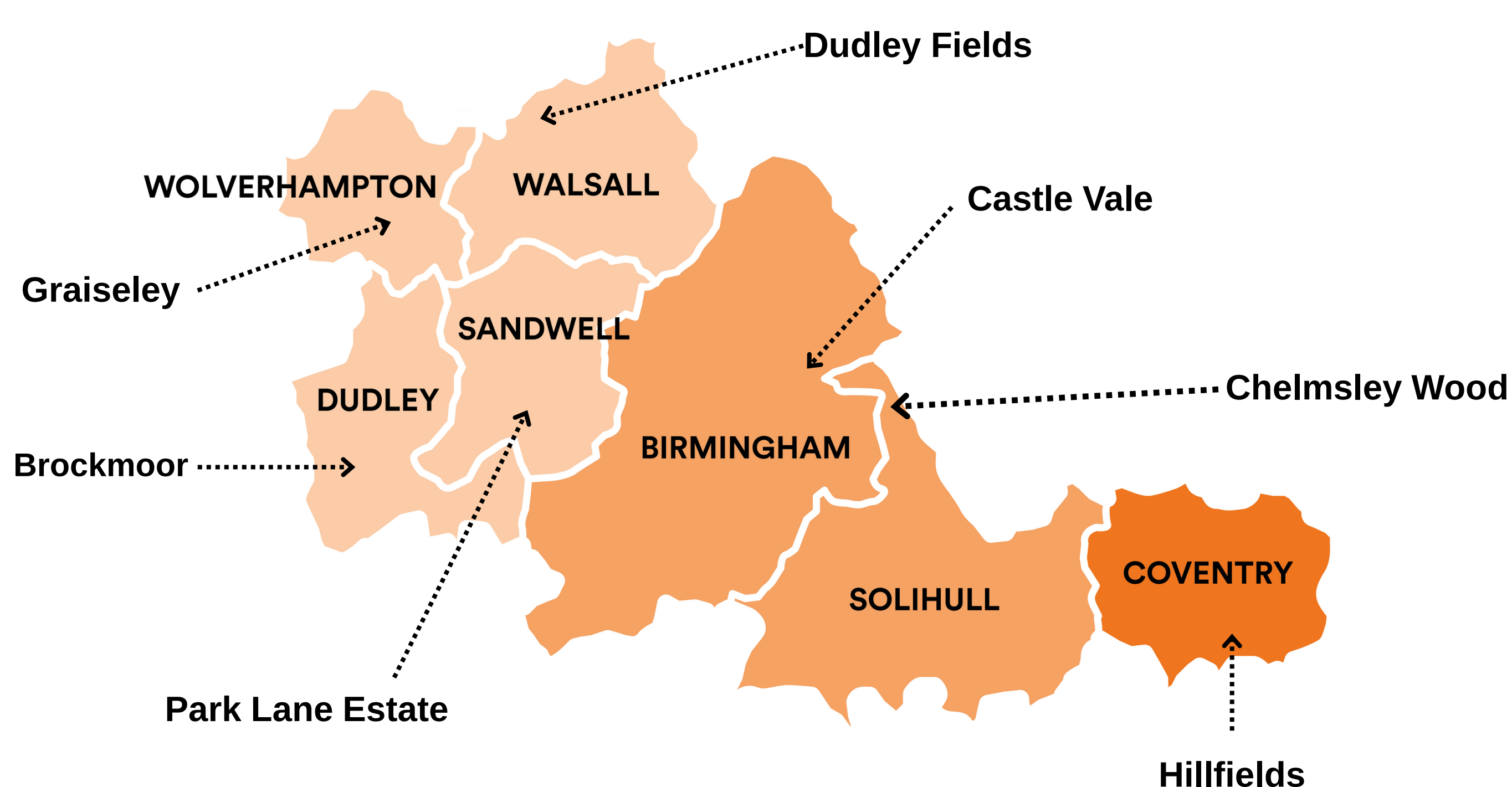
Carlo Luiu, Rosie Day, Aleksandra Čavoški and Louise Reardon on behalf of the WM Net Zero Team

Background

Place-based initiatives are emerging as an approach to achieve net zero by focusing on localised, community-driven solutions that can integrate sustainability across sectors, enhance local resilience and economy, and promote nature-based approaches for long-term climate impacts.

The West Midlands Combined Authority launched in 2023 the Net Zero Neighbourhoods (NZN) initiative to tackle fuel poverty and climate change.

NZNs can be understood as place-based experiments and test beds for innovation and include activities such as home retrofit improvements, air quality monitoring, active and low-carbon travel measures, green space improvements and community events.



The seven NZNs in the West Midlands region

Aim of the study

The study has two overarching aims:

- Understand the governance and effects of NZNs as a place-based initiative
- Identify key lessons learnt from the NZNs programmes for policy and practice to inform future similar initiatives

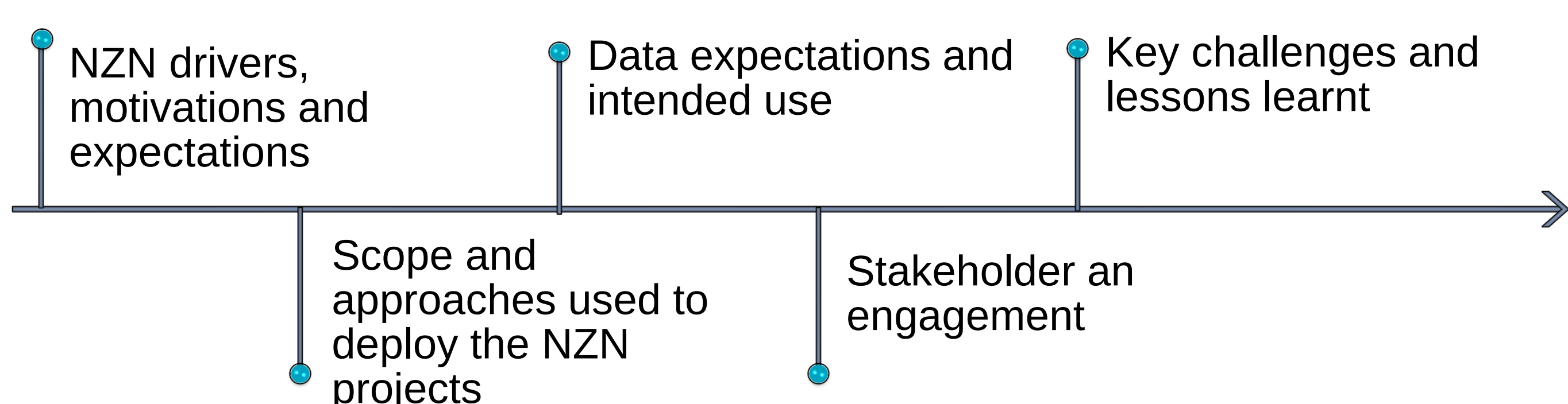
Methodology

Mixed-method approach comprising:

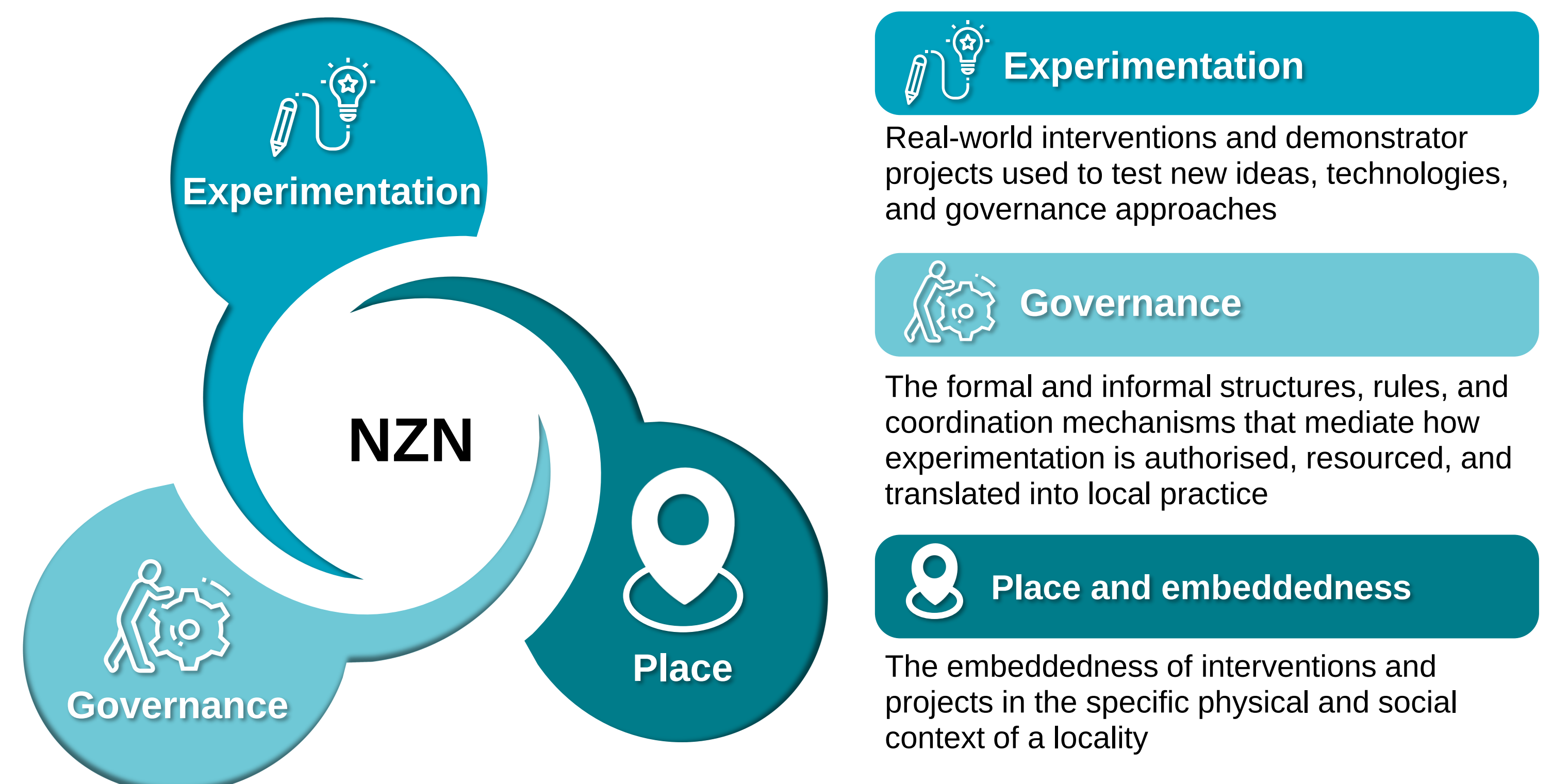
- documentary analysis and desk-based research focused on the stated objectives and design/implementation of the NZNs
- Stakeholder mapping to identify NZNs' governance actors
- 30 Semi-structured interviews with governance actors



Semi-structured interviews



Analytical framework



Key findings

1. Place and embeddedness matter

The NZNs were all designed under the same programme logic, funded through the same framework (apart from Dudley), and conceptualised to tackle the same challenges. Yet, they unfolded quite differently in terms of processes and design, depending on local leadership, existing partnerships, and communities engaged.

2. How knowledge and learning have been produced in the NZNs

Delivery and adaptation

Practical lessons from executing the work: learning from what didn't go to plan and what approaches needed fixing and adaptation once delivered on the ground

Engagement

What outreach approaches work better in specific contexts, and the importance of embedding local organisations and community champions to enhance trust-building processes

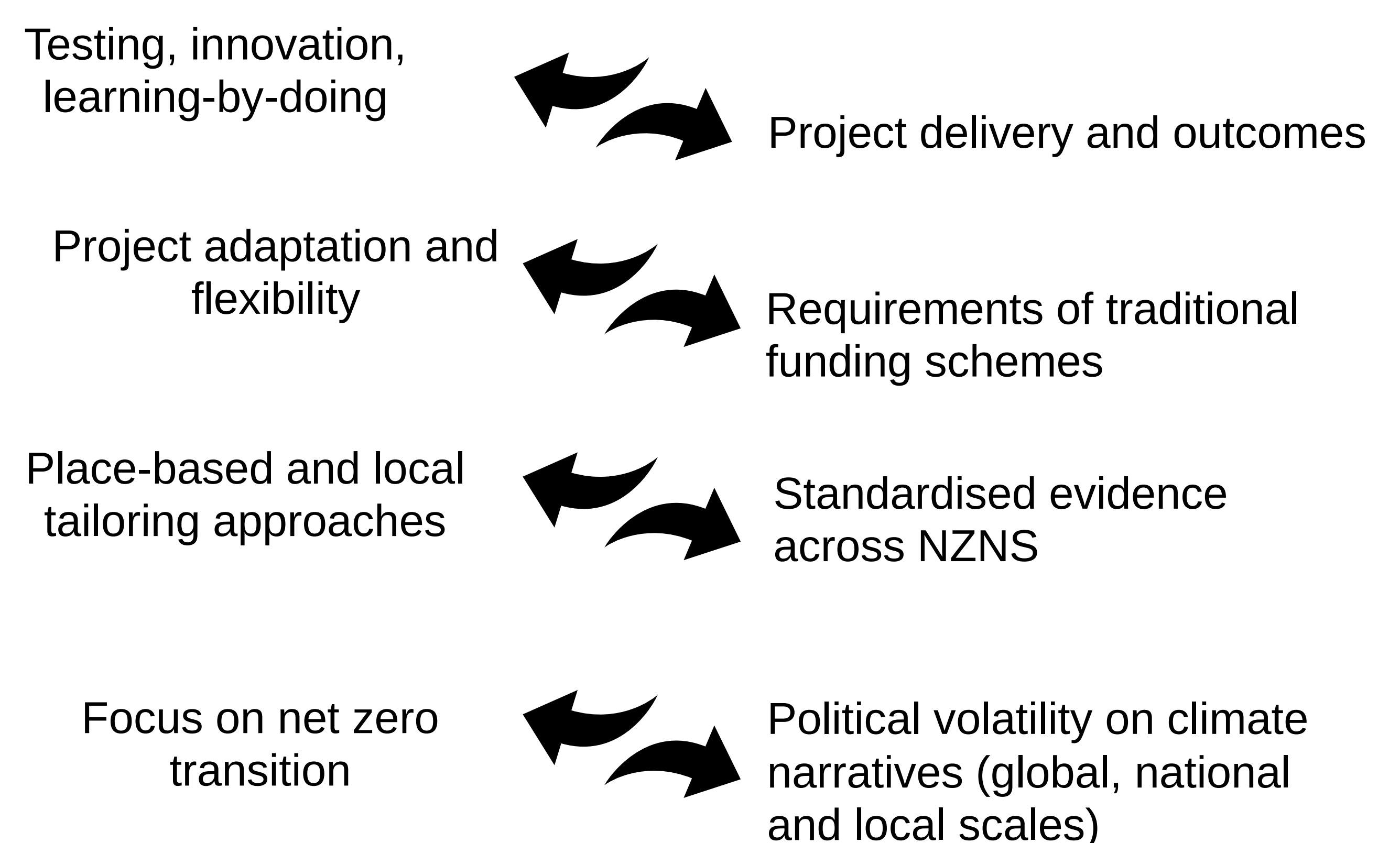
Capacity building

New skills development for staff involved in the initiative – and a knowledge-sharing environment set up by WMCA with the NZN working group meeting

Data collection

Baseline data (e.g. EPC, indoor air quality) to support business models and additional funding (e.g. Warm Homes Plan) and to show evidence of what has been delivered

3. Diversity in project approaches, but similar frictions experienced



The WM-NetZero project is supported by Wellcome Trust (227150_Z_23_Z) under the *Advancing climate mitigation policy solutions with health co-benefits in G7 countries* scheme.



Enhancing Accuracy of Indoor Air Quality Sensors via Automated Machine Learning Calibration

Juncheng Qian¹, Thomas Wynn¹, Bowen Liu², Yuli Shan¹, Suzanne E. Bartington³, Francis D. Pope¹, Yuqing Dai¹, Zongbo Shi¹, and WM-NetZero Team

1 Why indoor sensors need their own calibration

Indoor air is not outdoor air

Cooking and burning push indoor PM_{2.5} far above outdoor levels within minutes, then it falls just as fast.

Outdoor calibration fails indoors

Sensors corrected outdoors rarely meet these concentrations, so the correction does not hold when it matters most.

Sensors react to humidity too

Humidity and temperature also change the readings. A damp room makes a sensor report particles that are not there.

What calibration actually does

It compares every sensor with a research grade monitor and learns a correction, so the readings mean something.



2 How the calibration works

1 Measure side by side

Twenty units of each type spent three weeks in a test chamber beside a Fidas 200 research monitor, breathing the same air.

2 Let the data pick the model

Automated machine learning searched 30 candidate models, using each sensor's own reading plus temperature and humidity.

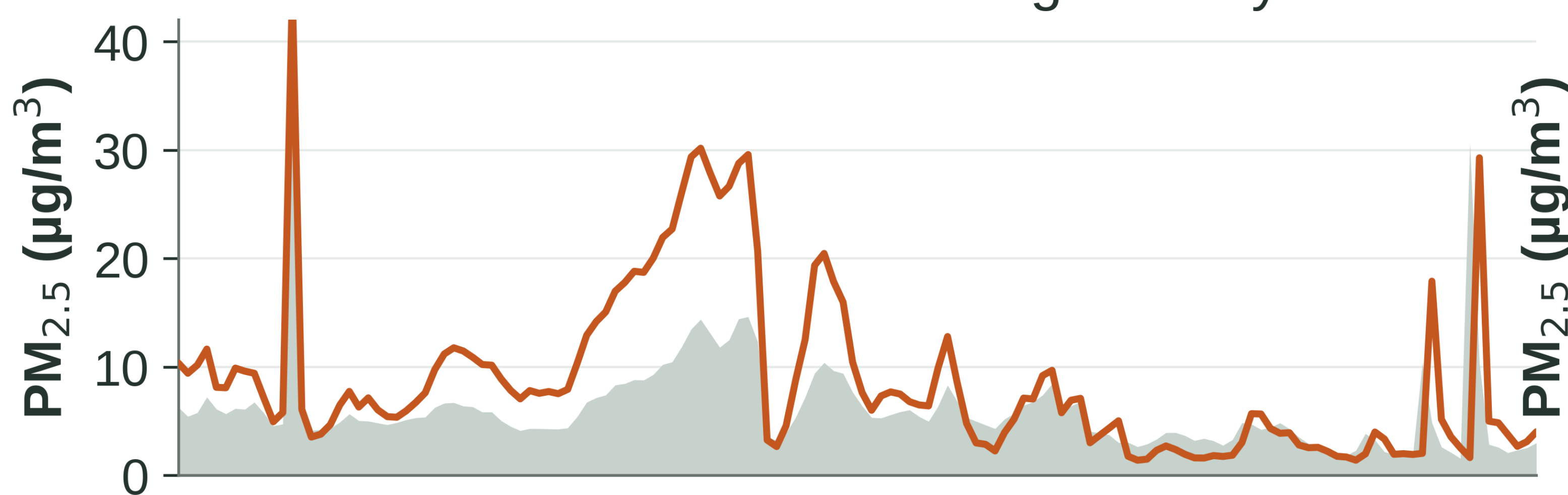
3 Split the range

Separate corrections handle everyday concentrations and pollution episodes, because sensors fail differently in each.

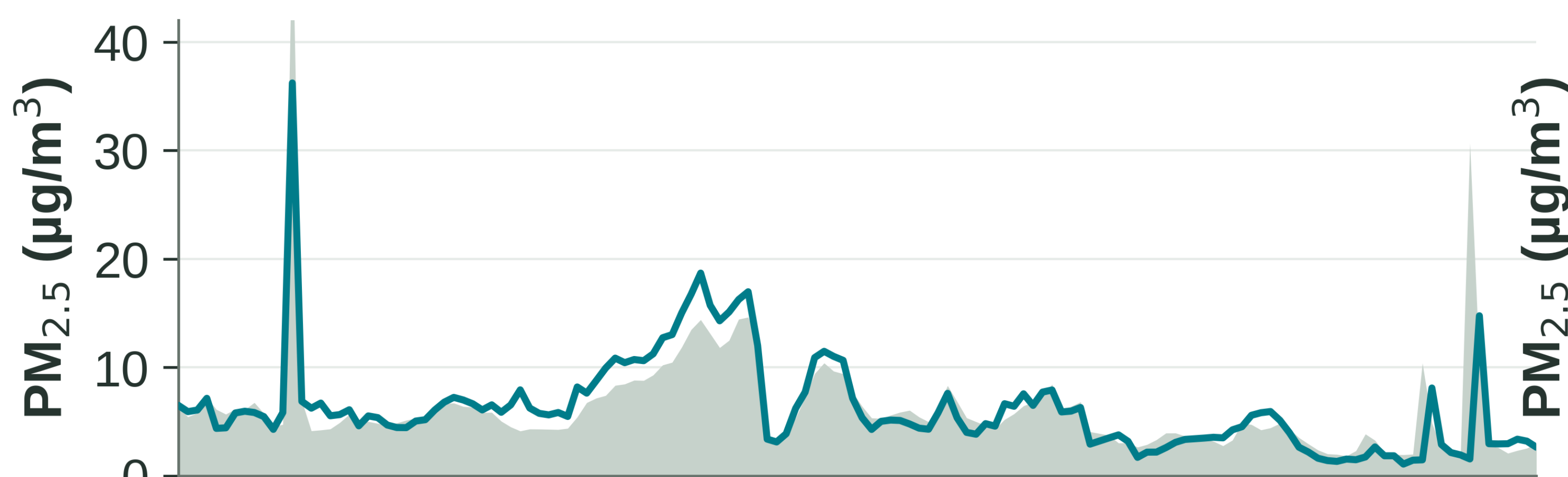
3 After calibration the sensors match the research monitor

(a) Everyday indoor air

Before calibration: reads too high all day

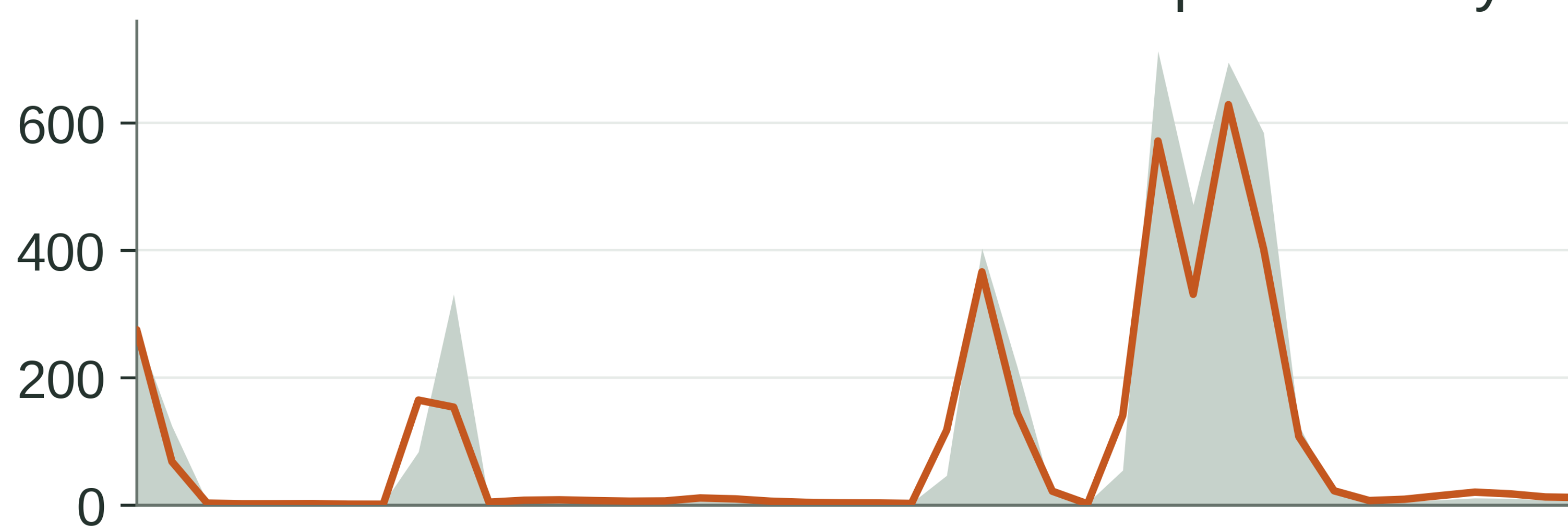


After calibration: sits on the true concentration

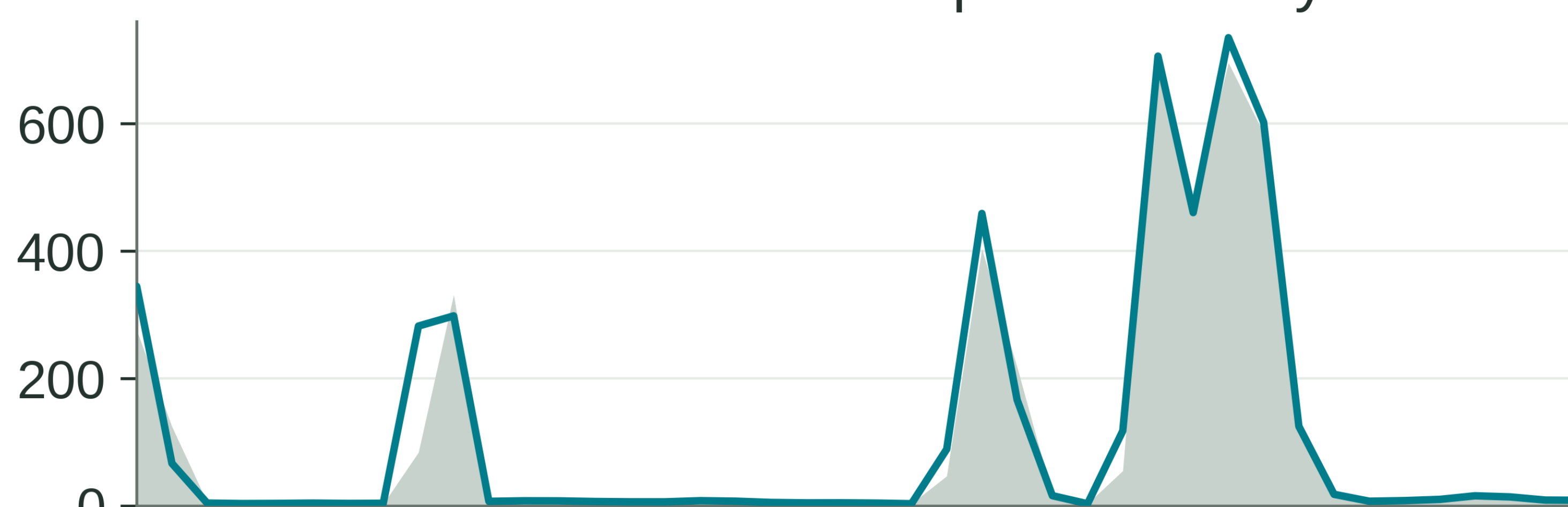


(b) A cooking and smoke episode

Before calibration: under-reads the peaks badly



After calibration: tracks the peaks closely



Shaded band: the true concentration measured by the Fidas 200 research monitor

4 What this means in practice

For housing and retrofit teams

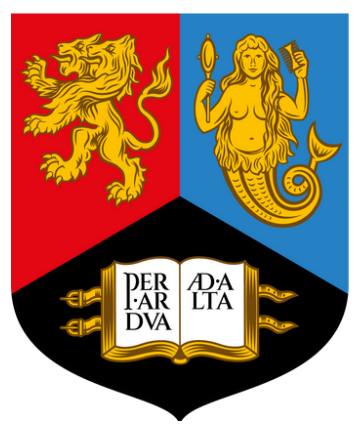
Calibrated monitoring shows whether a retrofit improved or worsened indoor air, not only whether the fabric performs as designed.

For local authorities and public health

Affordable sensor networks become reliable enough to find homes with persistent high exposure and target advice where it is needed.

For residents

The number on a home monitor becomes something people can act on, for example knowing when to open a window while cooking.



FROM MOBILITY DATA TO CLIMATE METRICS

Applying vehicle telematics to urban decarbonisation analysis

Omid Ghaffarpasand¹, Junjun Xiang¹, Sally James², Suzanne Bartington³, Zongbo Shi¹, and Francis D. Pope¹, on behalf of the WM Net Zero Team

1. School of Geography, Earth and Environmental Sciences, University of Birmingham, UK; 2. Birmingham City Council, Birmingham, UK; 3. Department of Applied Health Research, University of Birmingham, Birmingham, UK

Background

Road transport decisions need evidence at the scale where vehicles move and interventions occur. Vehicle telematics provide repeated observations of location, speed and acceleration, enabling a detailed digital shadow of urban mobility.

Study aim

Convert large-scale telematics data into spatial and temporal indicators of traffic activity, vehicle power, fuel use and emissions, then use those indicators to examine air-quality and decarbonisation strategies across an urban road network.

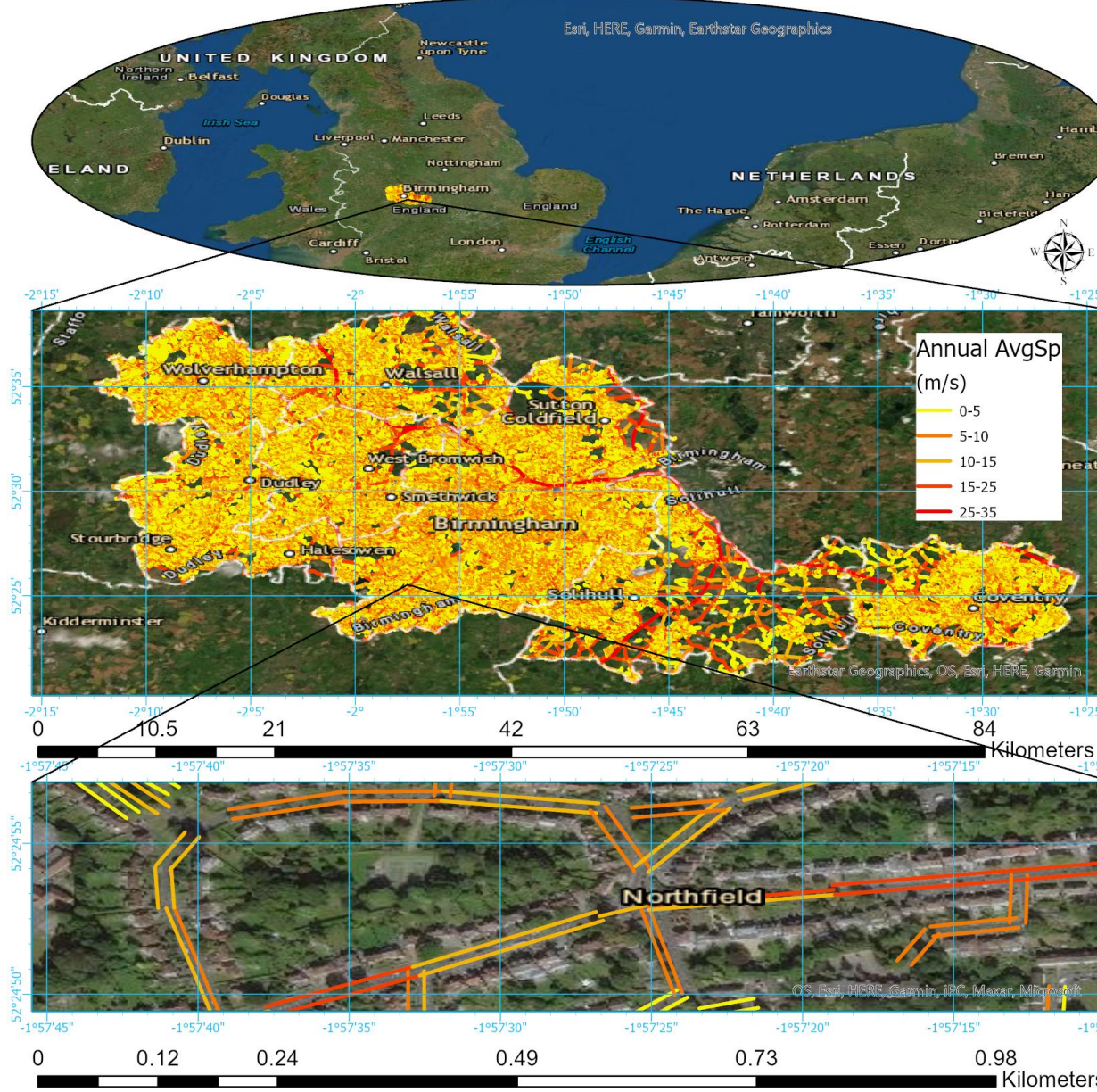
GeoSTMUM coverage

- Over 353,000 road segments in each year
- Over 17,700 km of represented road network
- 2016, 2018, 2021, 2022 and 2023
- 15 m spatial and 2 h temporal resolution
- 35 recurring day and time combinations

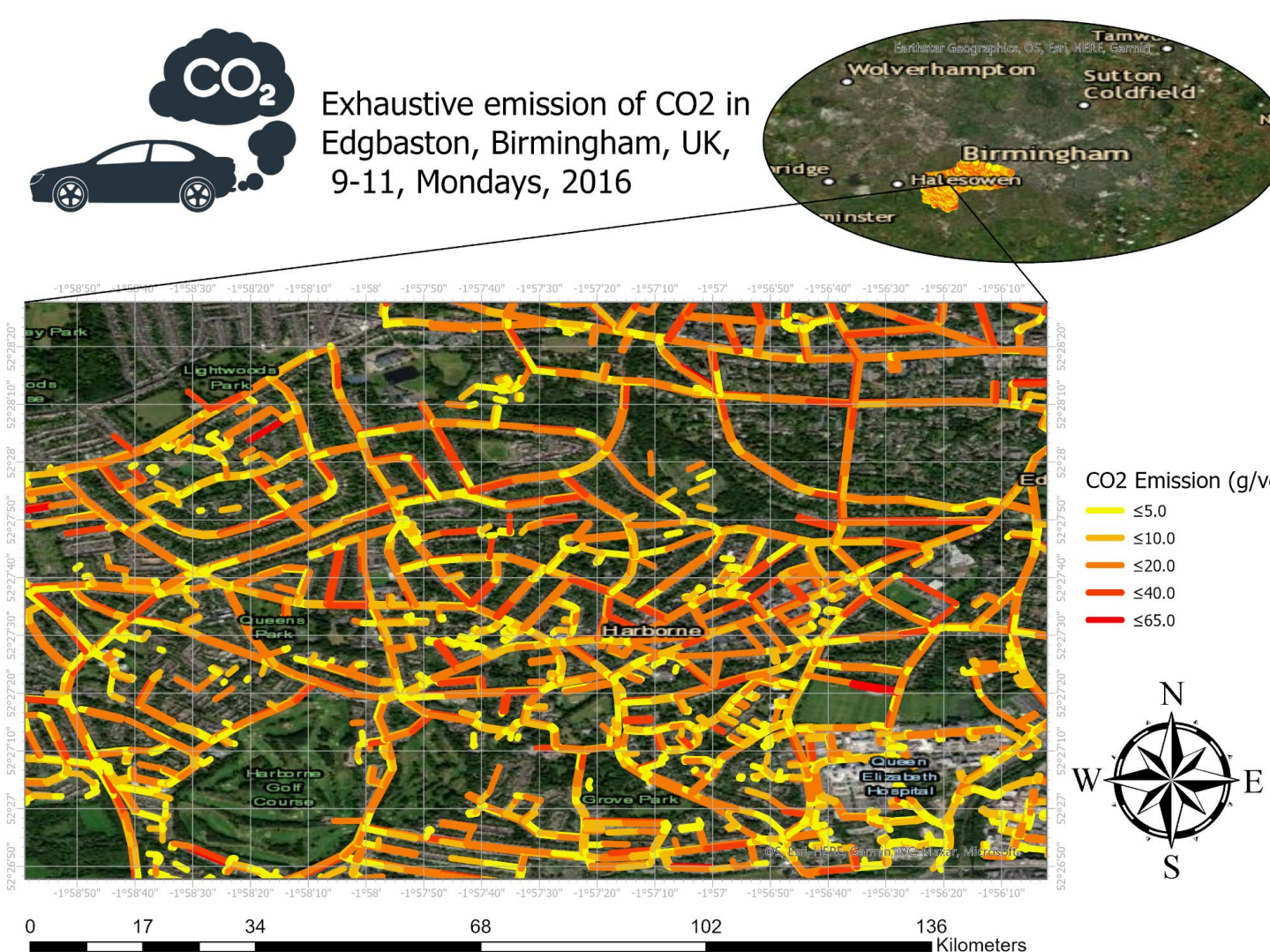
Telematics and the digital shadow of road transport



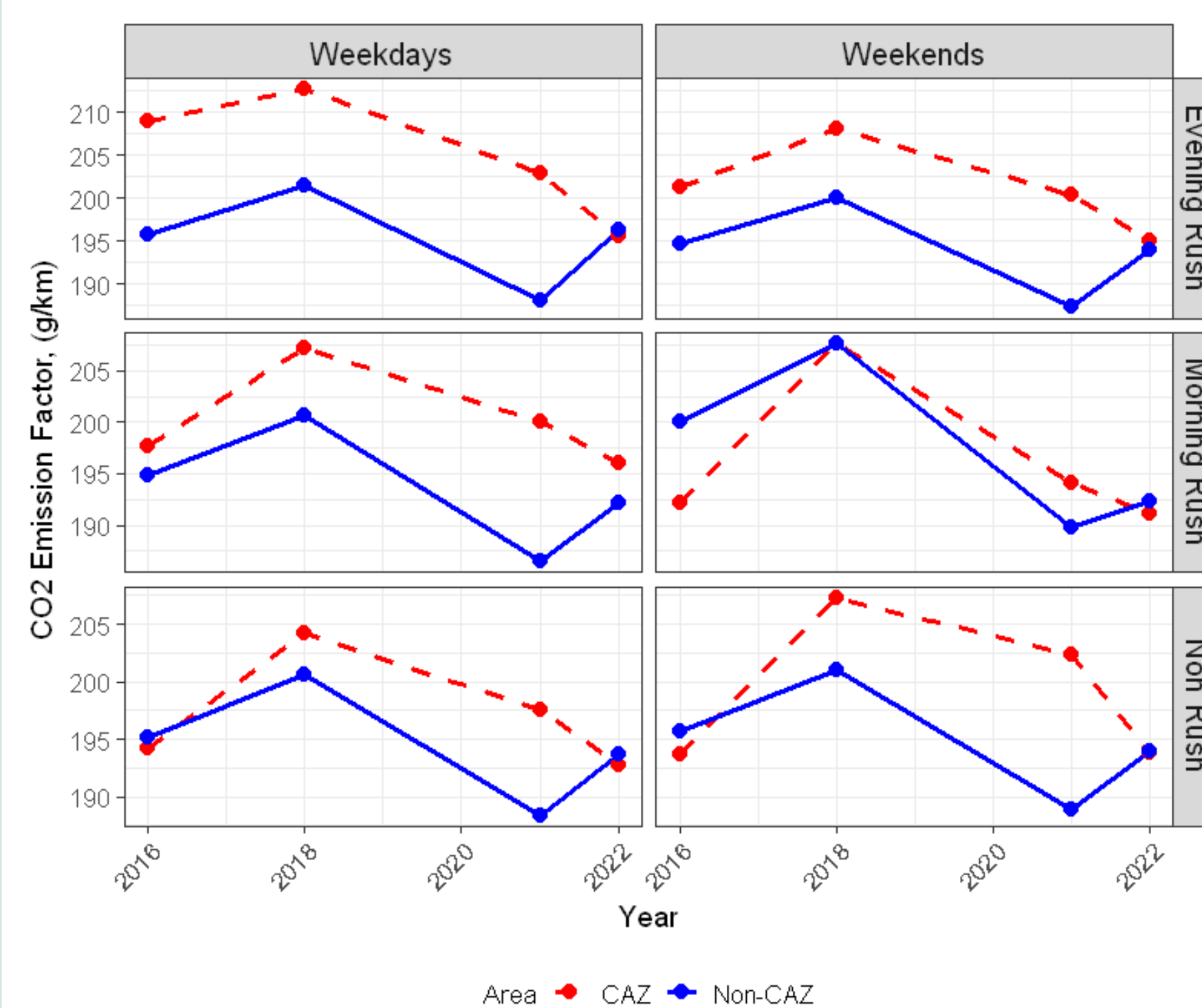
GeoSTMUM represents activity across a dense West Midlands road network, retaining road and place attributes for each segment.



Segment-level distributions preserve variation by location, time and driving conditions.



The GeoEmission layer translates mobility into interpretable fuel and emissions evidence for network-wide comparison.



Example comparison of trajectories inside and outside the Clean Air Zone.

What the framework provides

- A consistent spatial identity for every road segment
- Comparable outputs across years, road types, places and time periods
- A physical link between speed, acceleration, power demand and emissions
- Network-wide evidence for testing transport and climate interventions

Key interpretation

Air-quality improvement and decarbonisation do not always move together. GeoSTMUM makes these trade-offs visible at street and network scales, so analysts can identify where an intervention changes traffic behaviour and where emissions benefits occur.

Applications

- Clean Air Zone and counterfactual assessment
- Speed-limit and street-design evaluation
- Traffic, fuel and emissions scenario modelling
- Urban digital twins and decision-support tools
- Targeted evidence for local and regional authorities

Next step

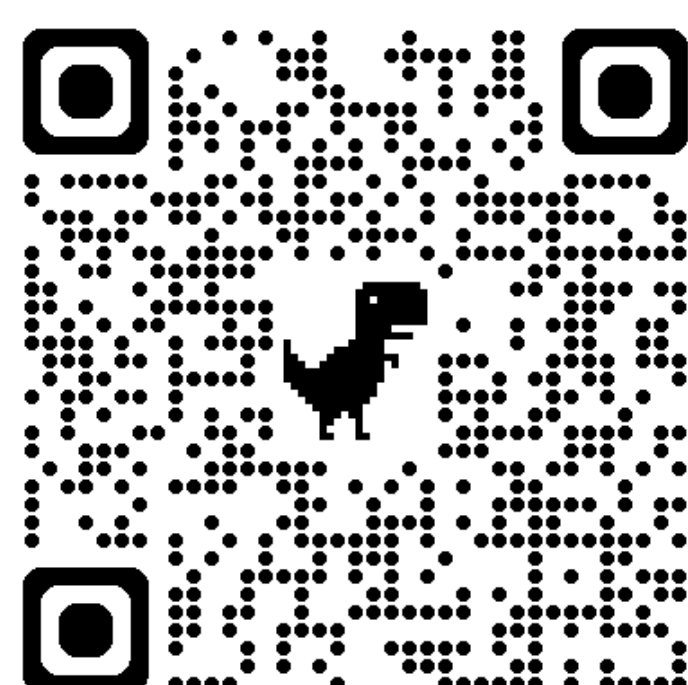
Integrate mobility, emissions, health, safety and distributional outcomes in 3DRED, a dynamic data-driven world model for street redesign decisions.



Fleet Composition



Method



The WM-NetZero project is supported by Wellcome Trust (227150_Z_23_Z) under the Advancing climate mitigation policy solutions with health co-benefits in G7 countries scheme.

Reducing Carbon Dioxide and Air Pollutant Emissions from Road Transport in the West Midlands

Ye Hang, Jian Zhong, Nana Wei, Jenny Stocker, Kate Johnson, Yuli Shan, Suzanne Bartington, Zongbo Shi on behalf of the WM-Net Zero team

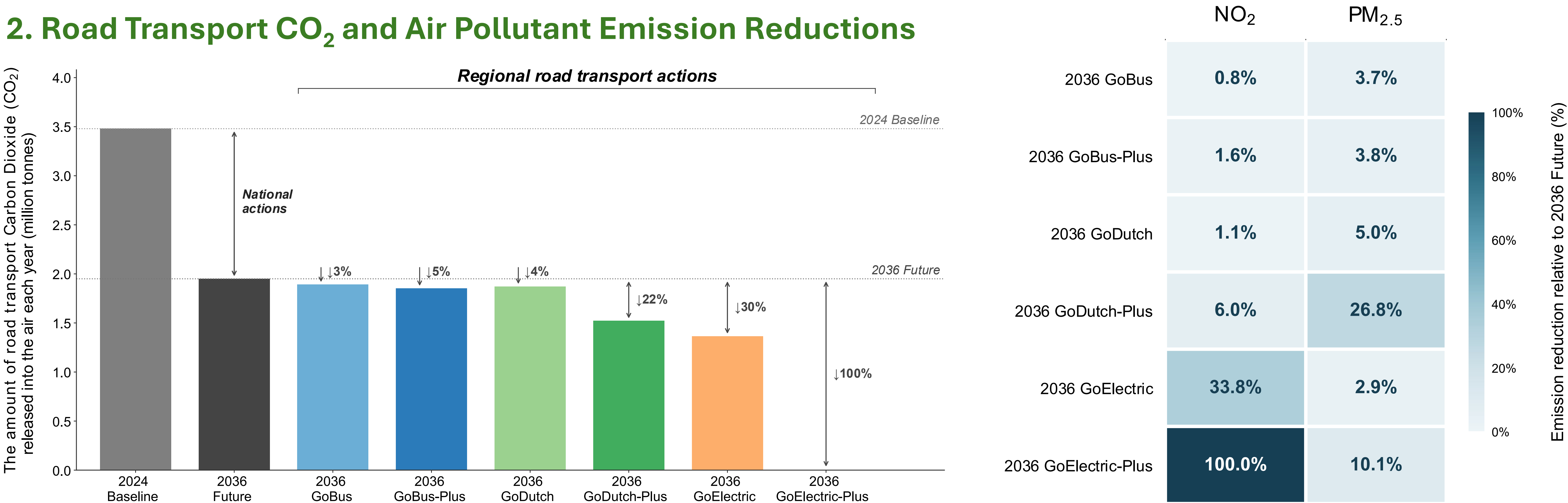
Key Insights

- Vehicle electrification cuts carbon dioxide and nitrogen dioxide emissions but does not eliminate fine particulate pollution.
- Shifting car trips to cycling and walking reduces fine particulate emissions and can complement electrification.
- Policies should accelerate electric vehicle uptake and reduce car use to maximise climate and air quality benefits.

1. Future Road Transport Scenarios (2036)

Scenario	Category	Definition
2036 Future	-	Modelled 2036 road traffic emissions aligned to the NAEI-based Future 2036 baseline, representing no additional measures beyond NAEI projections. EV uptake: 35% of cars; 18% of LGVs; 17% of buses and coaches; 0% of HGVs.
2036 GoDutch	SHIFT	Car-to-bicycle shift for commuting trips such that cycle to work reaches Netherlands-equivalent levels.
2036 GoDutch-Plus	SHIFT	Overall cycling mode share increases to a Netherlands-equivalent level, with a corresponding reduction in car trips.
2036 GoBus	SHIFT	Doubling bus trips (modal shift from cars to buses).
2036 GoBus-Plus	SHIFT & IMPROVE	Doubling bus trips (modal shift from cars to buses), with 100% bus electrification.
2036 GoElectric	IMPROVE	EV uptake reaches: 53% of cars; 40% of LGVs; 48% of buses and coaches; 37% of HGVs.
2036 GoElectric-Plus	IMPROVE	100% electrification of light and heavy vehicles (LGVs, cars, HGVs, buses and coaches).

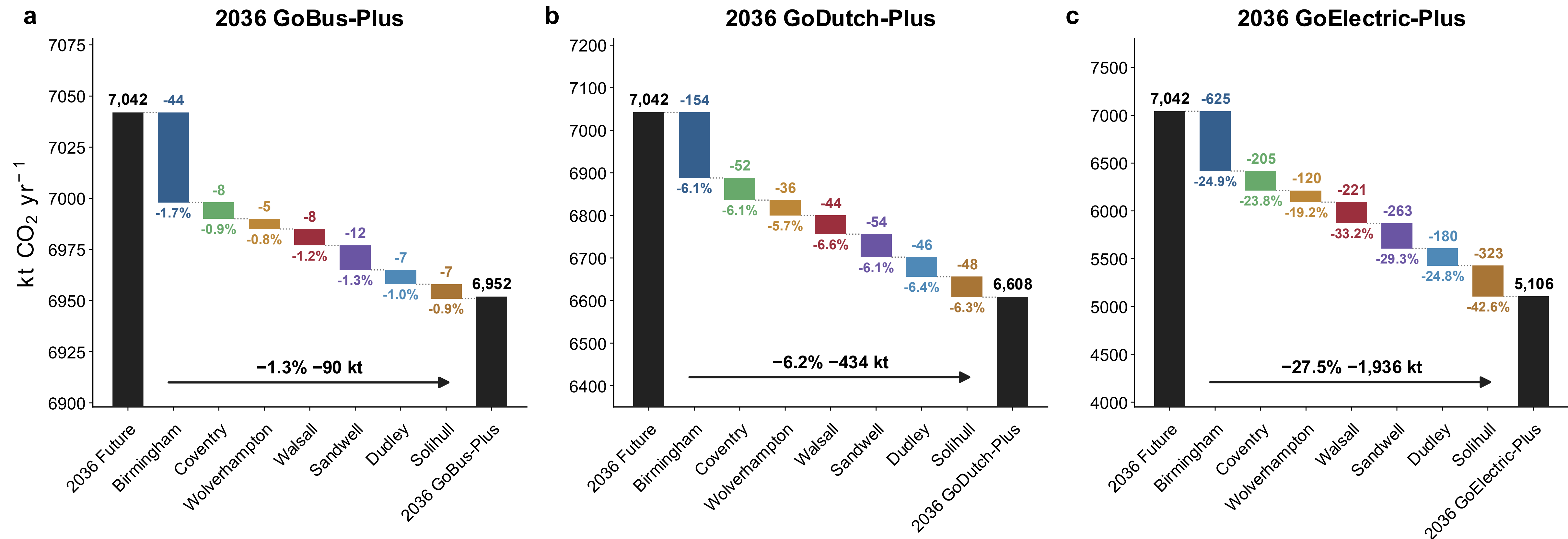
2. Road Transport CO₂ and Air Pollutant Emission Reductions



- Road transport CO₂ emissions fall from **~3.5 Mt in 2024** to **~2.0 Mt in 2036 Future**, indicating substantial reductions from **national actions**.
- GoBus, GoBus-Plus and GoDutch deliver modest additional reductions: **3–5% for CO₂**, **0.8–1.6% for NO₂** and **3.7–5.0% for PM_{2.5}**.
- GoDutch-Plus reduces CO₂ by **22%** and delivers the largest PM_{2.5} reduction (**26.8%**), while GoElectric cuts CO₂ by **30%** and NO₂ by **33.8%**.
- GoElectric-Plus achieves **100%** reductions in modelled road transport **CO₂ and NO₂**, but only **10.1% for PM_{2.5}**, highlighting the need for complementary measures.

3. Regional Total CO₂ Emission Reductions by Local Authority

Contributions to regional total CO₂ reductions under three Plus scenarios



- Regional total CO₂ reductions relative to 2036 Future reach **27.5% (1,936 kt yr⁻¹)** for GoElectric-Plus, **6.2% (434 kt yr⁻¹)** for GoDutch-Plus and **1.3% (90 kt yr⁻¹)** for GoBus-Plus.
- Birmingham** leads absolute reductions across all three. Local percentage reductions peak in **Birmingham (GoBus-Plus: 1.7%)**, **Walsall (GoDutch-Plus: 6.6%)** and **Solihull (GoElectric-Plus: 42.6%)**.

No research about us, without us!

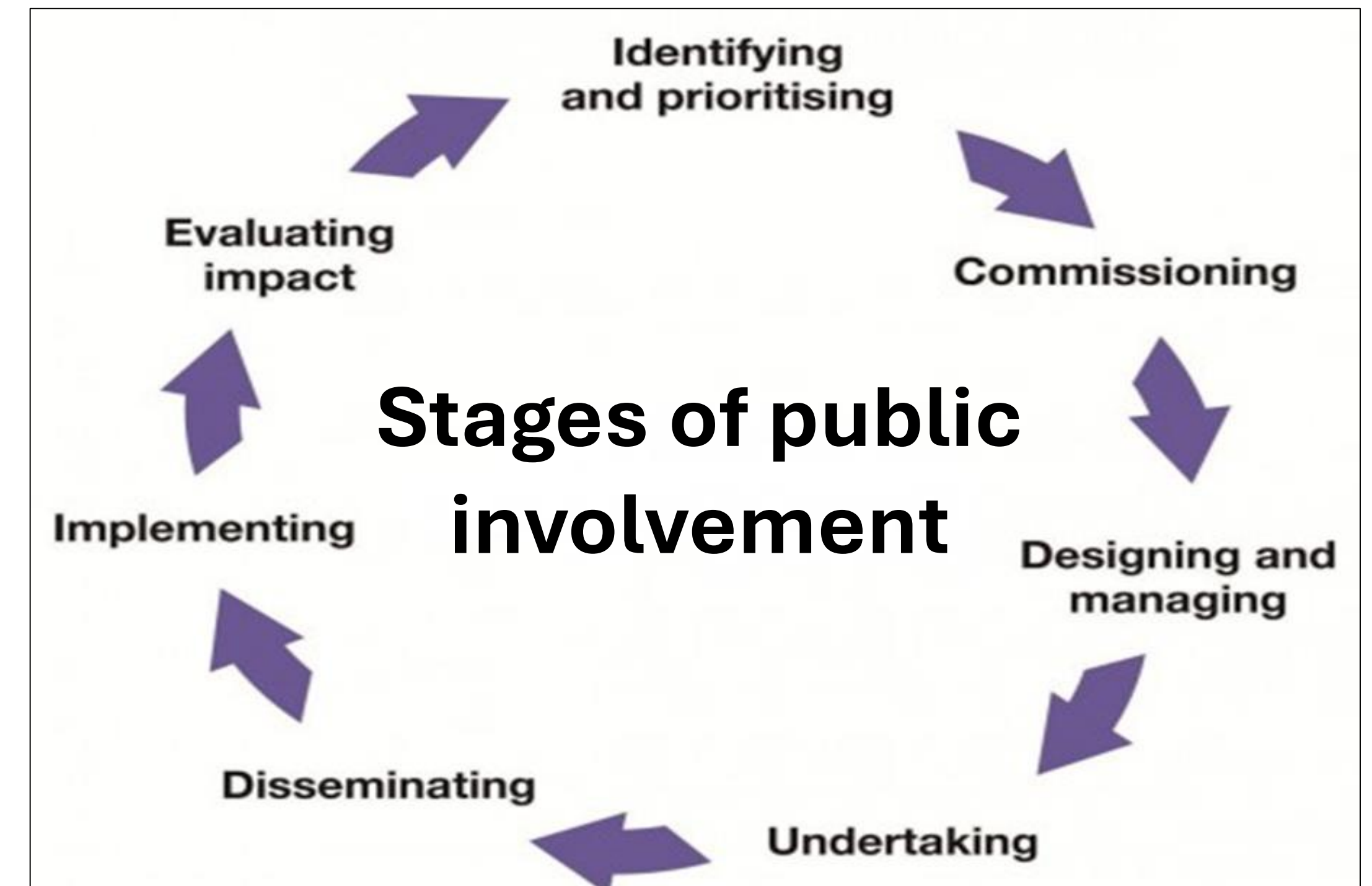
Public involvement in WM-Net Zero, the journey so far..

The WM-Net Zero Regional Public Involvement in Research Group

What is Public Involvement in research ?

Public involvement in research means research carried out “with” or “by” members of the public rather than “to”, “about” or “for them.”

Public partners help shape what research gets done, how it is done and how results are shared.



What have our public members done?

- Delivered engagement activities
- Shaped consent and participant feedback forms
- Named climate action scenarios
- Taken photographs to exhibit
- Spoken at the Climate Health Explorer launch
- Asked us difficult but important questions .. !



How do we achieve best practice?

- The WM-Net Zero research team undertook public involvement training. We worked together as a team and reflected regularly on our public partnerships.
There is always more we can do and should do..

Lessons learned:

- Public involvement takes **time, trust and energy**
- The team may need **bespoke training**
- **Ground rules** are important for all of us
- The **Birmingham Public Involvement Hub** has great support



Contribution of Wood Burning to Air Pollution in Dudley: Implications for the Transition to Net Zero

Yuqing Dai, Juncheng Qian, Thomas Wynn, Suzanne Bartington, Zongbo Shi and WM-NZ Team

Reducing combustion in homes as Dudley moves towards net zero could deliver cleaner air alongside carbon reductions.

1. Background

- Wood burning may contribute to local particle pollution, particularly during colder periods, alongside other sources such as road traffic.
- Understanding its potential contribution in Dudley can help assess how changes in domestic combustion may affect air quality during the transition to net zero.

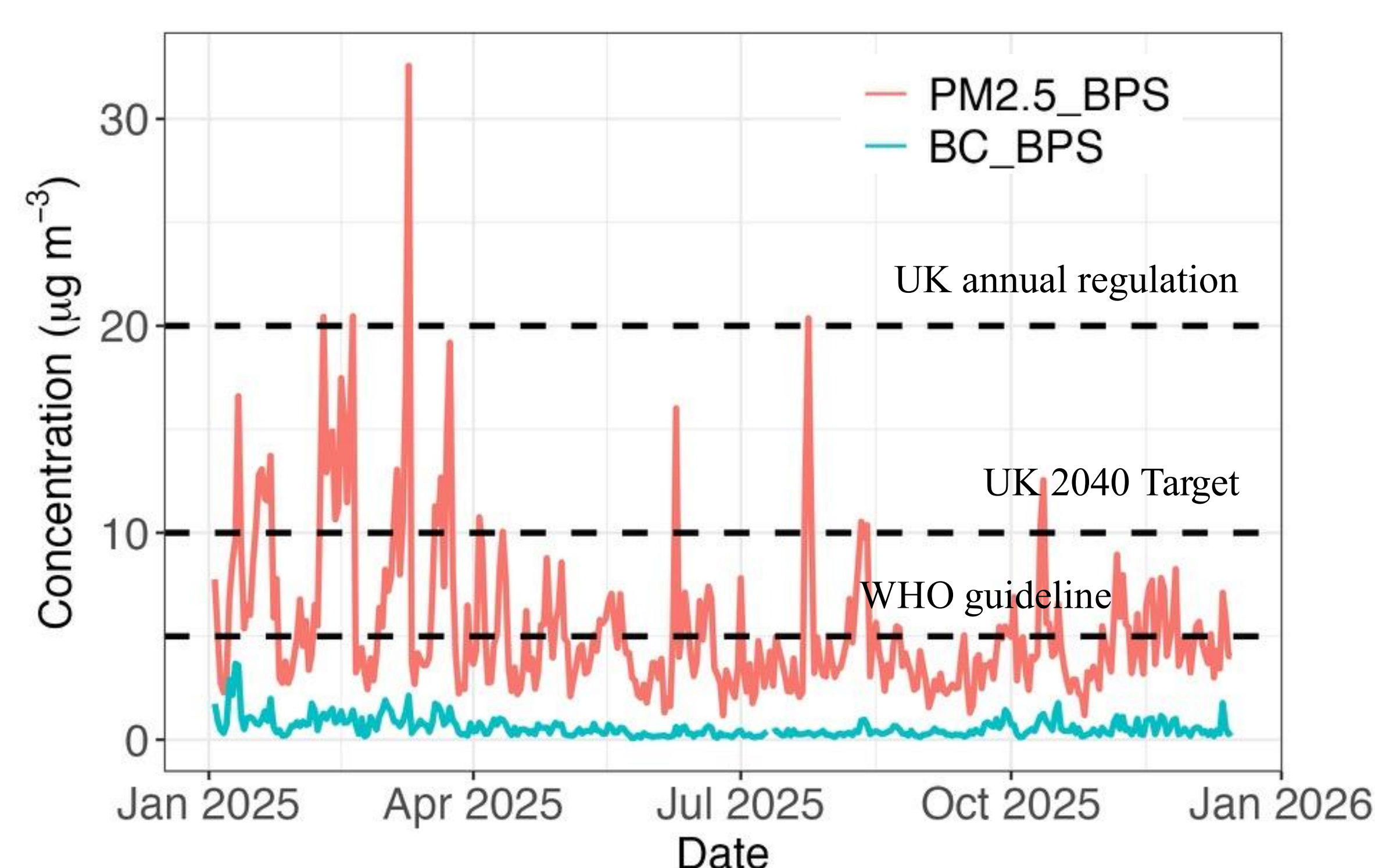
2. Air Quality Monitoring in Dudley



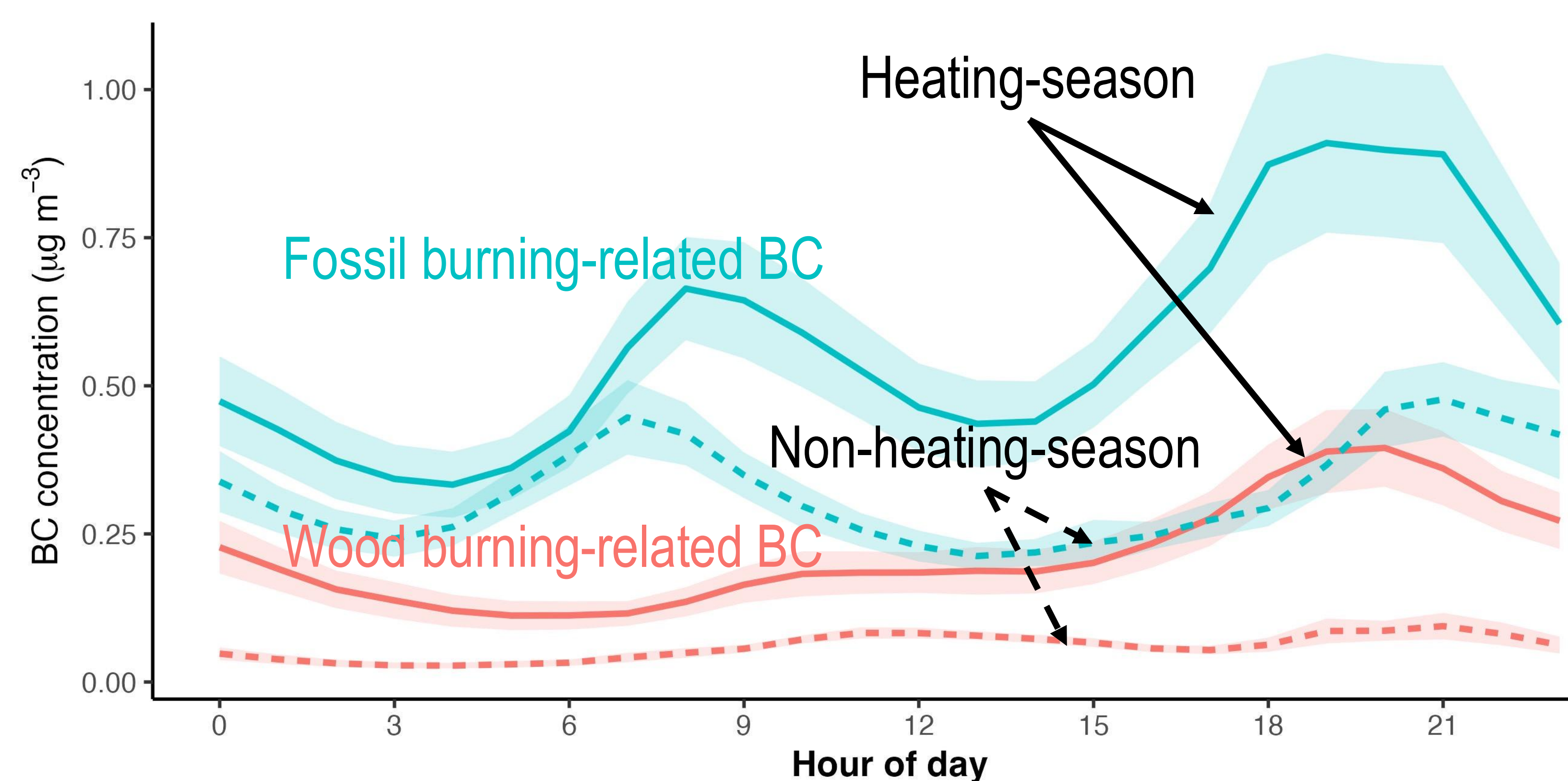
A. Monitoring Air Pollution Near Brockmoor Primary School, Dudley. The map shows the school location, the monitoring station, and surrounding measurement points.



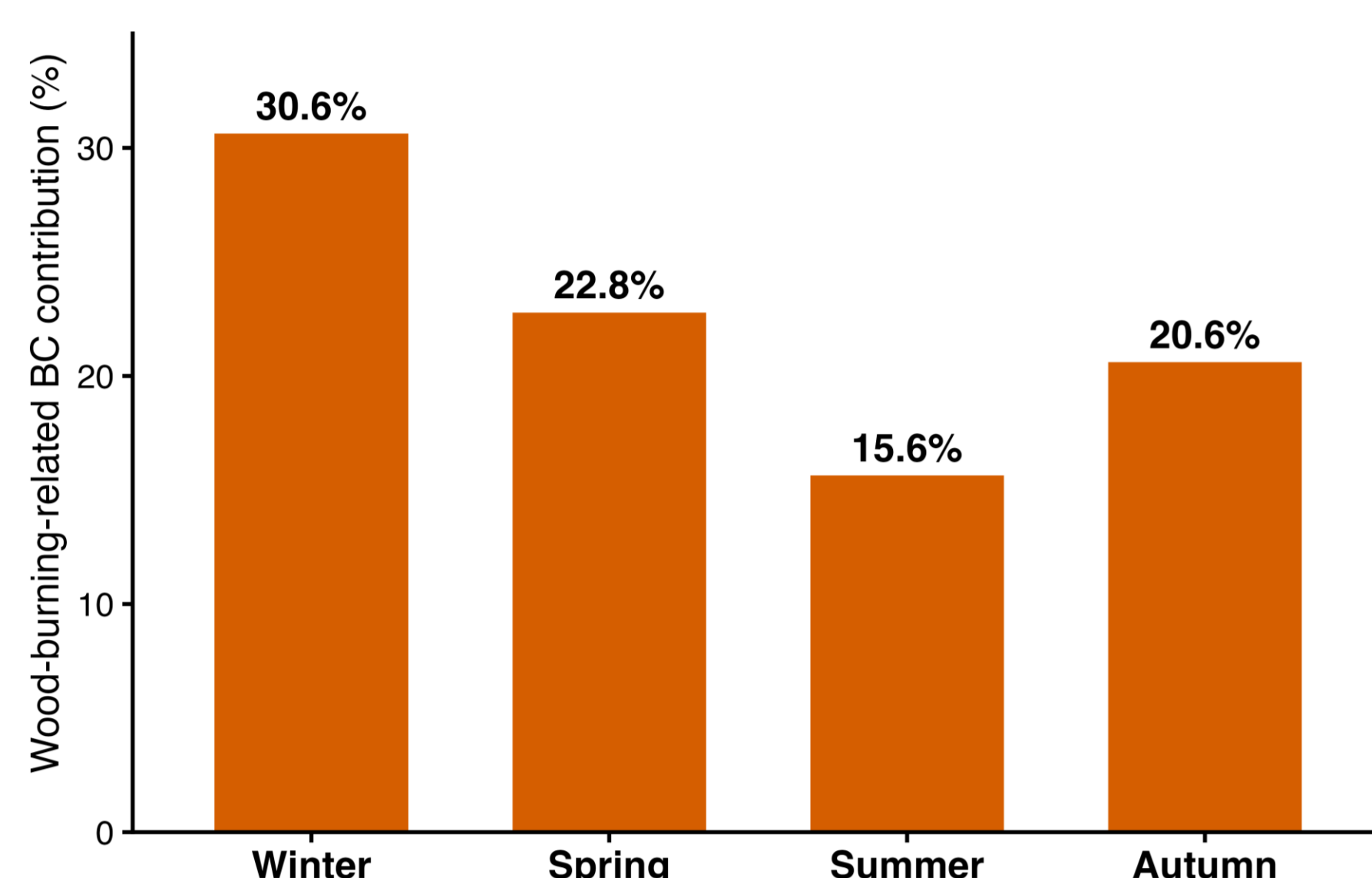
3. Results



B. Annual Variation in PM_{2.5} and Black Carbon at Brockmoor Primary School, 2025.



C. Daily Patterns of Wood-Burning and Fossil-Fuel Black Carbon in Heating and Non-Heating Seasons.



D. Seasonal contribution of wood burning to black carbon.

- Fossil-fuel-related BC shows clear morning and evening peaks, consistent with daily traffic activity.
- During the heating season, wood-burning-related BC rises in the evening, overlapping with the evening fossil-fuel peak.
- Wood-burning-related BC contributes most in winter (30.6%) and least in summer (15.8%).