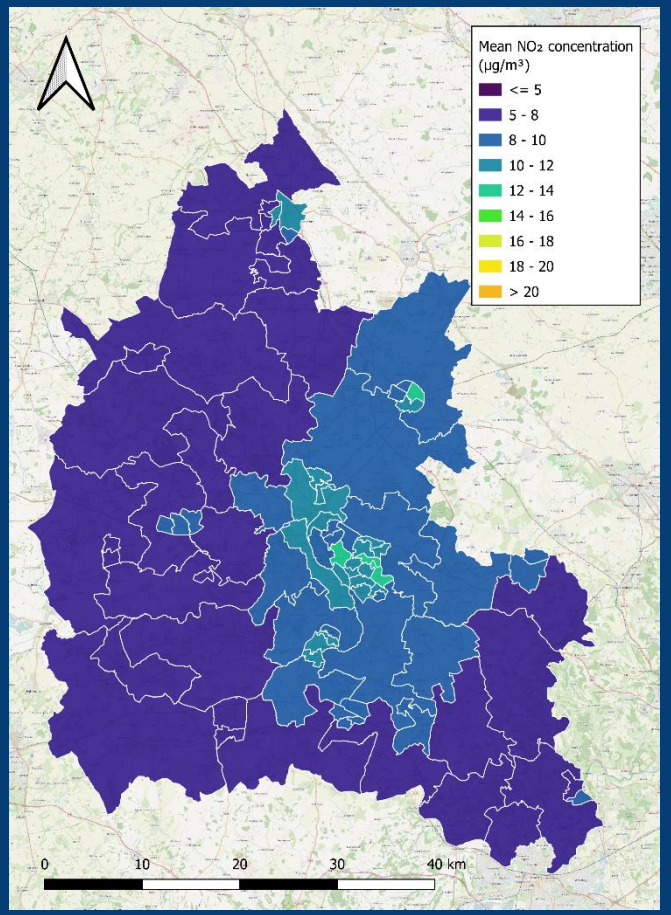


Modelling health impacts of emission mitigation pathways for Oxfordshire

David Jinks (CERC) &

Melissa Nikkhah-Eshghi (Oxfordshire County Council)

ADMS-Urban & ADMS-Roads User Group Meeting

27 November 2025

Bristol

Project Overview

Scope

- Air Quality modelling across Oxfordshire for base year and future year scenarios

Stage 1

- Model verification
- Base year concentrations

Stage 2

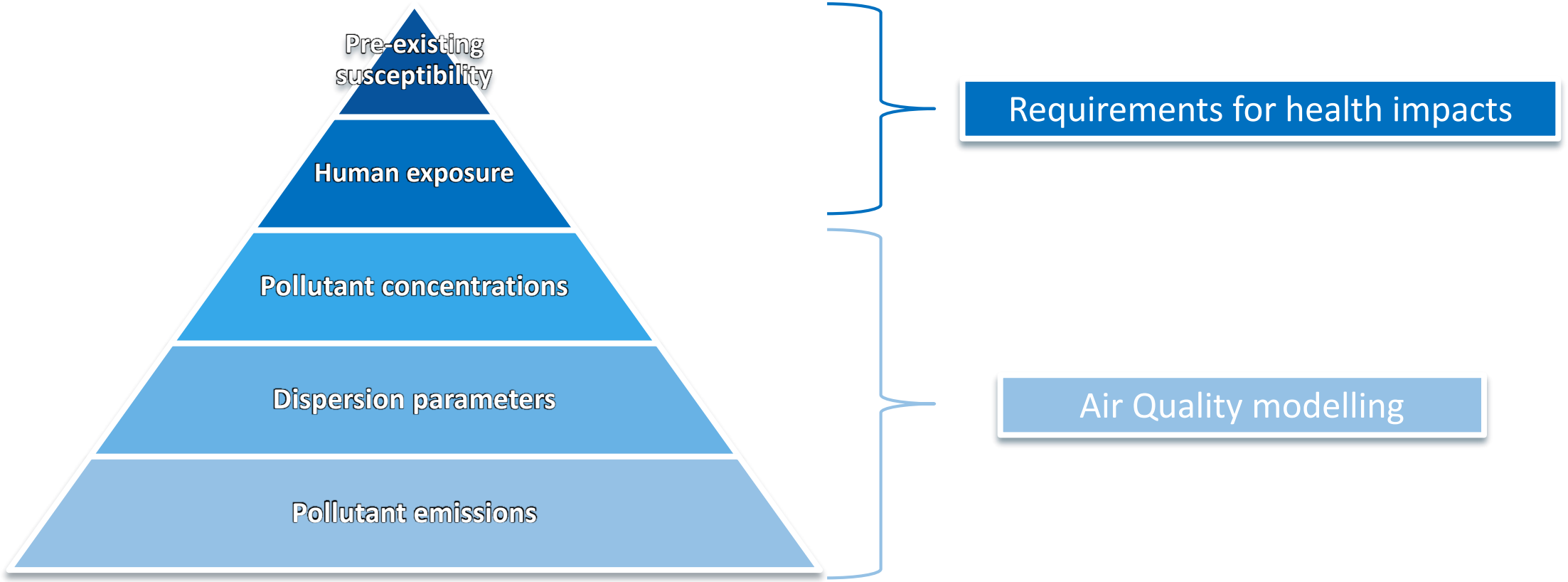
- 2035 future year scenarios concentrations
- Emission mitigation scenarios are based on Net Zero policies

Stage 3

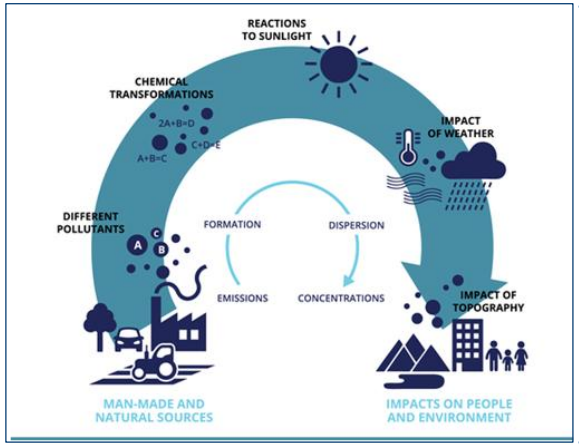
- Calculate health impacts of air pollution for base year and future year scenarios

Oxfordshire Project

- Calculation of health impacts requires information on top of standard air quality modelling



Oxfordshire Project

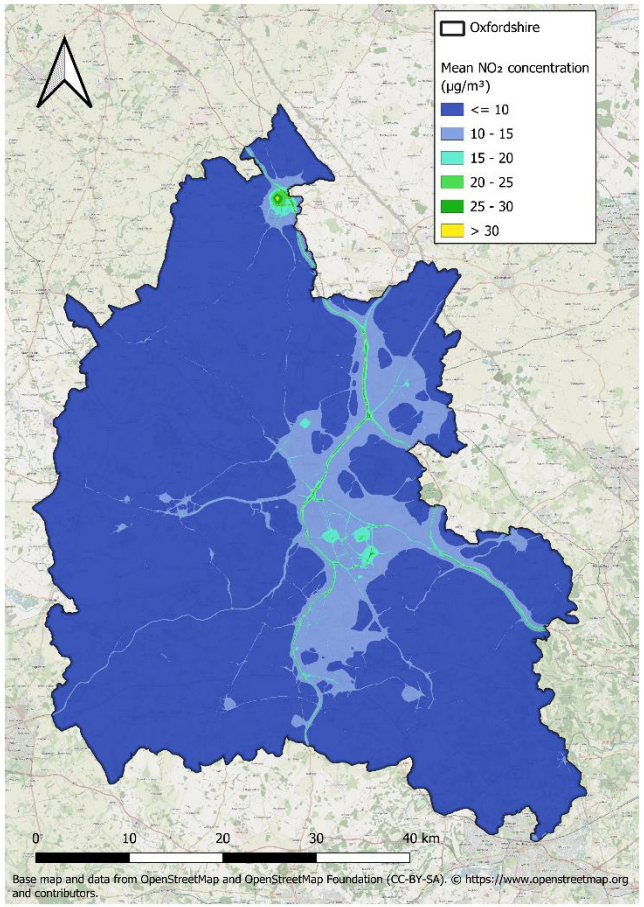


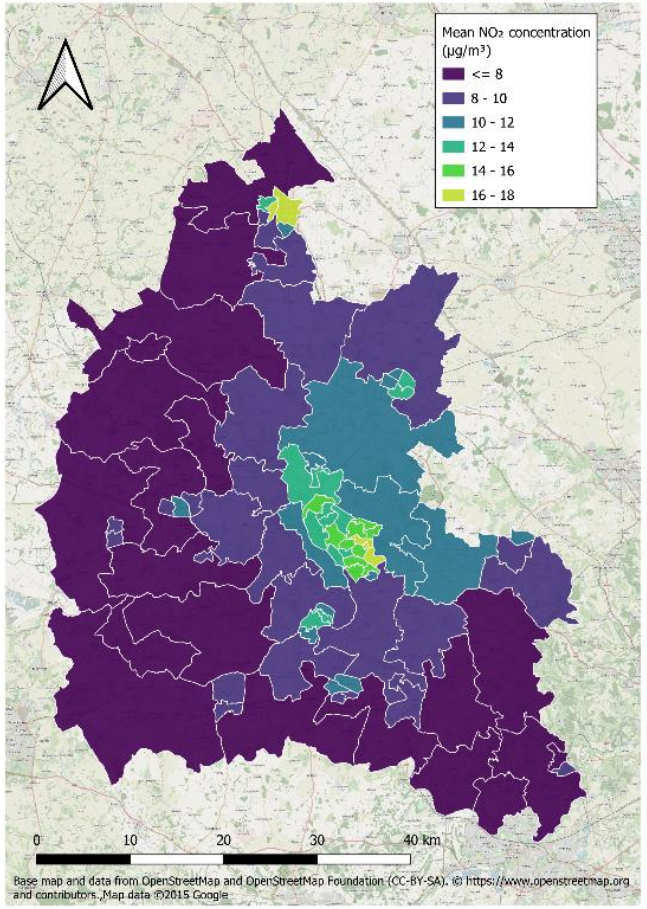
Oxfordshire to utilise University of Birmingham's Air Quality Lifecourse Assessment Tool (AQ-LAT)

AQ-LAT uses pollutant concentrations provided over Census areas to compare to Census statistics

Oxfordshire Modelling – Input

- Concentrations calculated across Oxfordshire at high-resolution
- Results then averaged over Census areas (LSOAs and MSOAs)





Stage 1

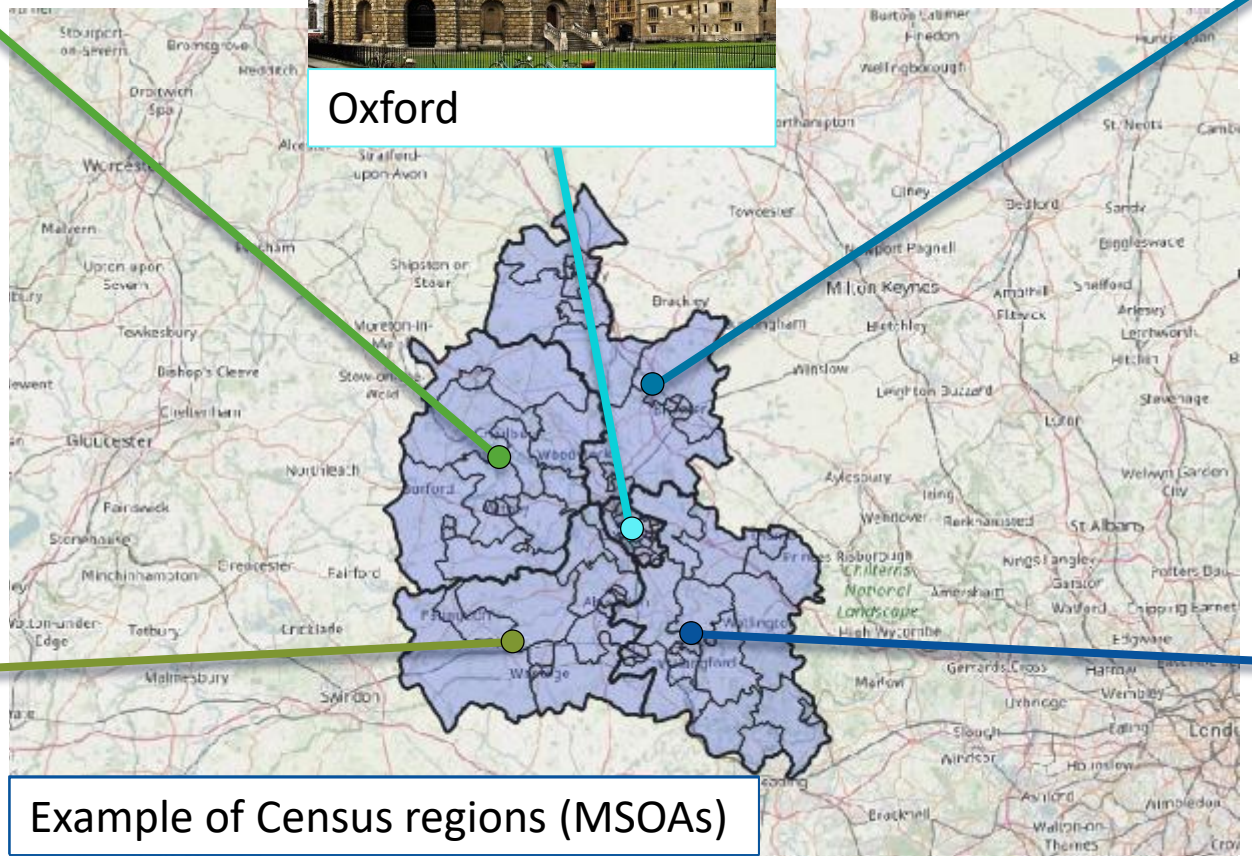
Base Year Modelling

Oxfordshire Modelling Domain

West Oxfordshire

Oxford

Cherwell



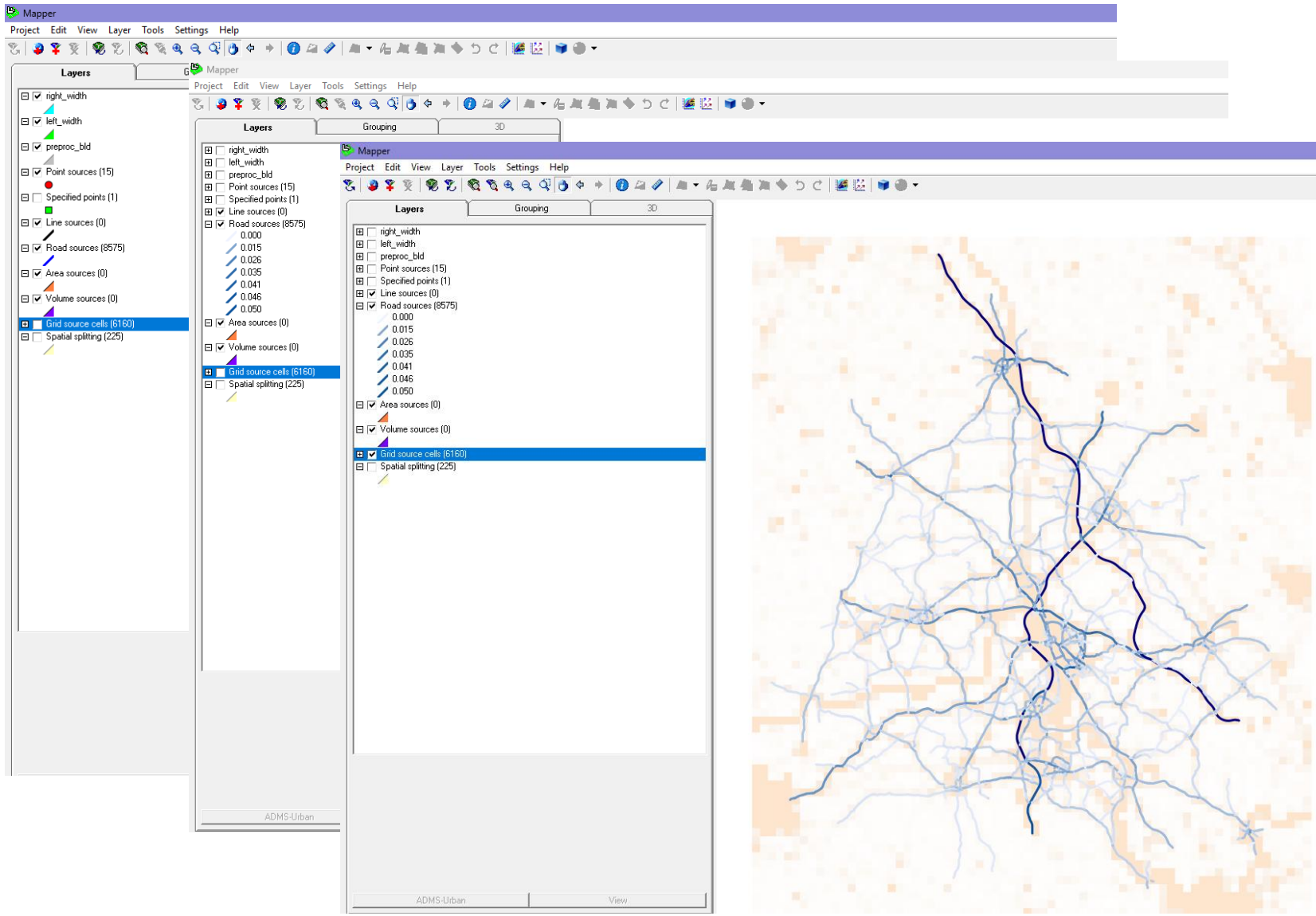
Example of Census regions (MSOAs)

Vale of White Horse

South Oxfordshire

2023 Base year modelling

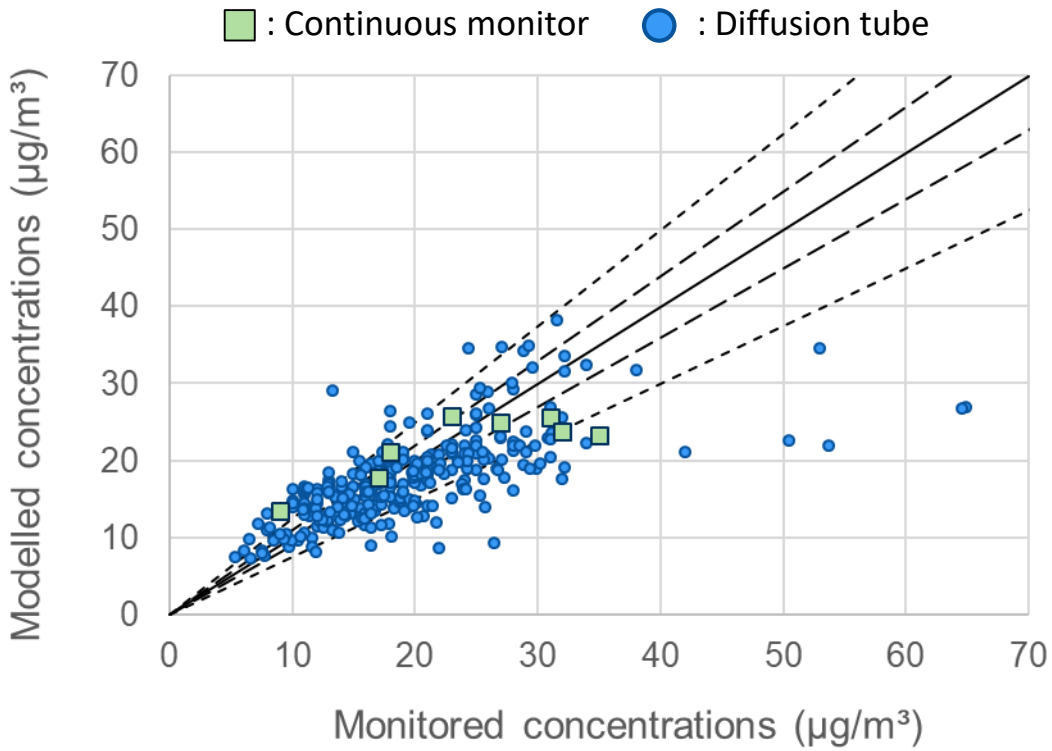
- Model set-up
  - Meteorology
  - Background
  - Canyons
  - Road emissions
  - Gridded emissions



Final model verification

- No model adjustment factor
- Model verification across 317 locations shows good agreement
- Modelled value within 10% of monitored value at 99 locations (31%)
- Modelled value within 25% of monitored value at 237 locations (74%)
- Most outliers not at locations relevant for human exposure

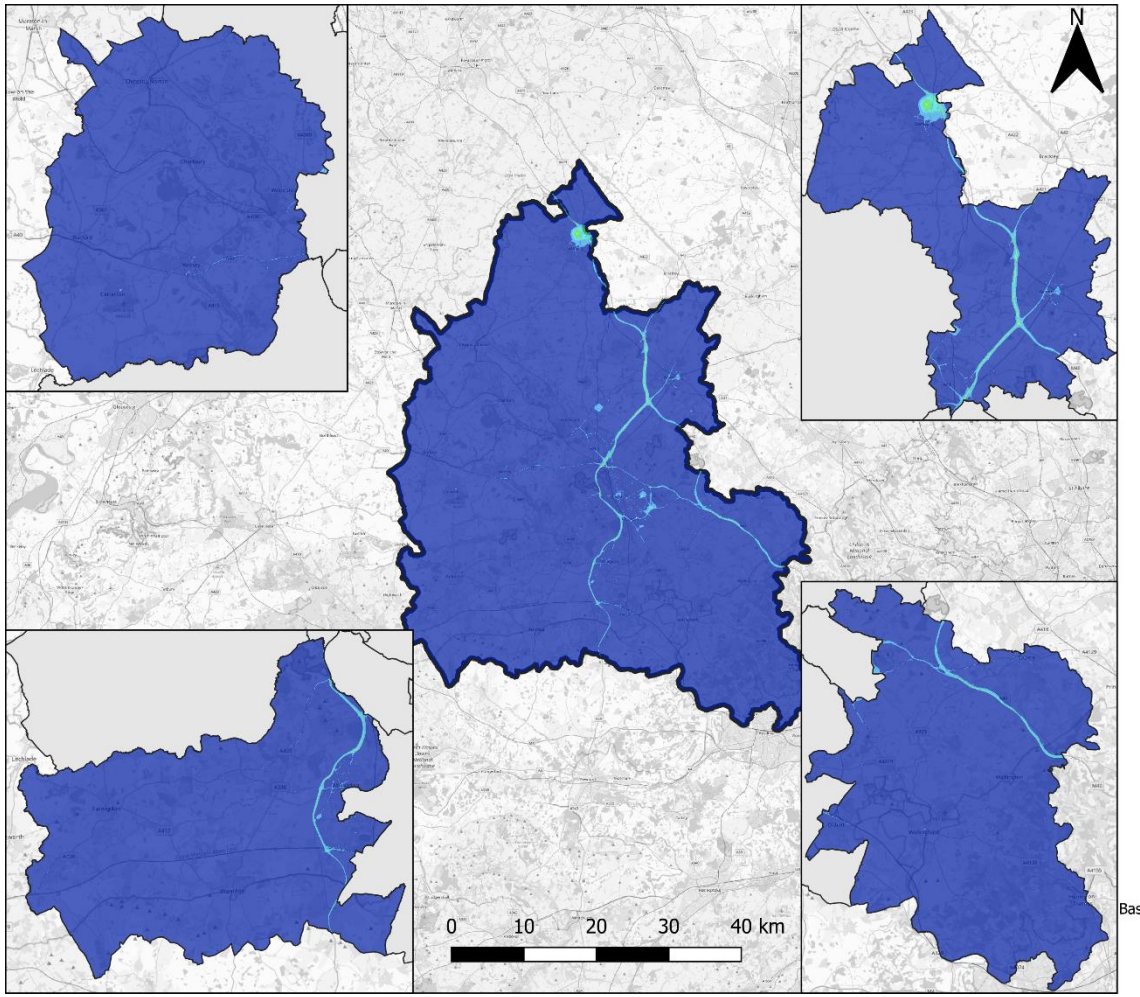
Oxfordshire NO_2 statistics	Monitored	Modelled
Average (µg/m³)	19.3	17.7
Standard deviation (µg/m³)	8.20	5.2
Root Mean Square Error (µg/m³)	5.8	
Fractional Bias	- 0.09	
Correlation Coefficient	0.74	



2023 Base year modelling

West Oxfordshire

Cherwell



Legend

Local Authorities

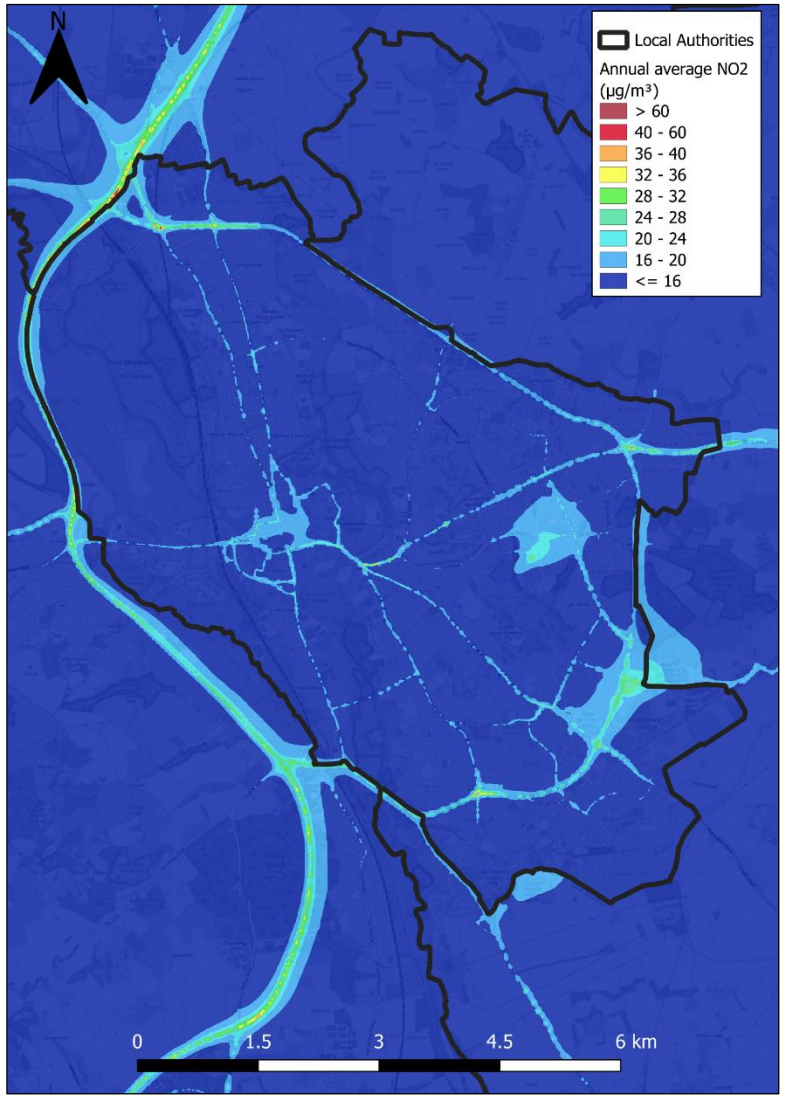
Annual average NO2 (µg/m³)

- <= 16
- 16 - 20
- 20 - 24
- 24 - 28
- 28 - 32
- 32 - 36
- 36 - 40
- 40 - 60
- > 60

Vale of White Horse

South Oxfordshire

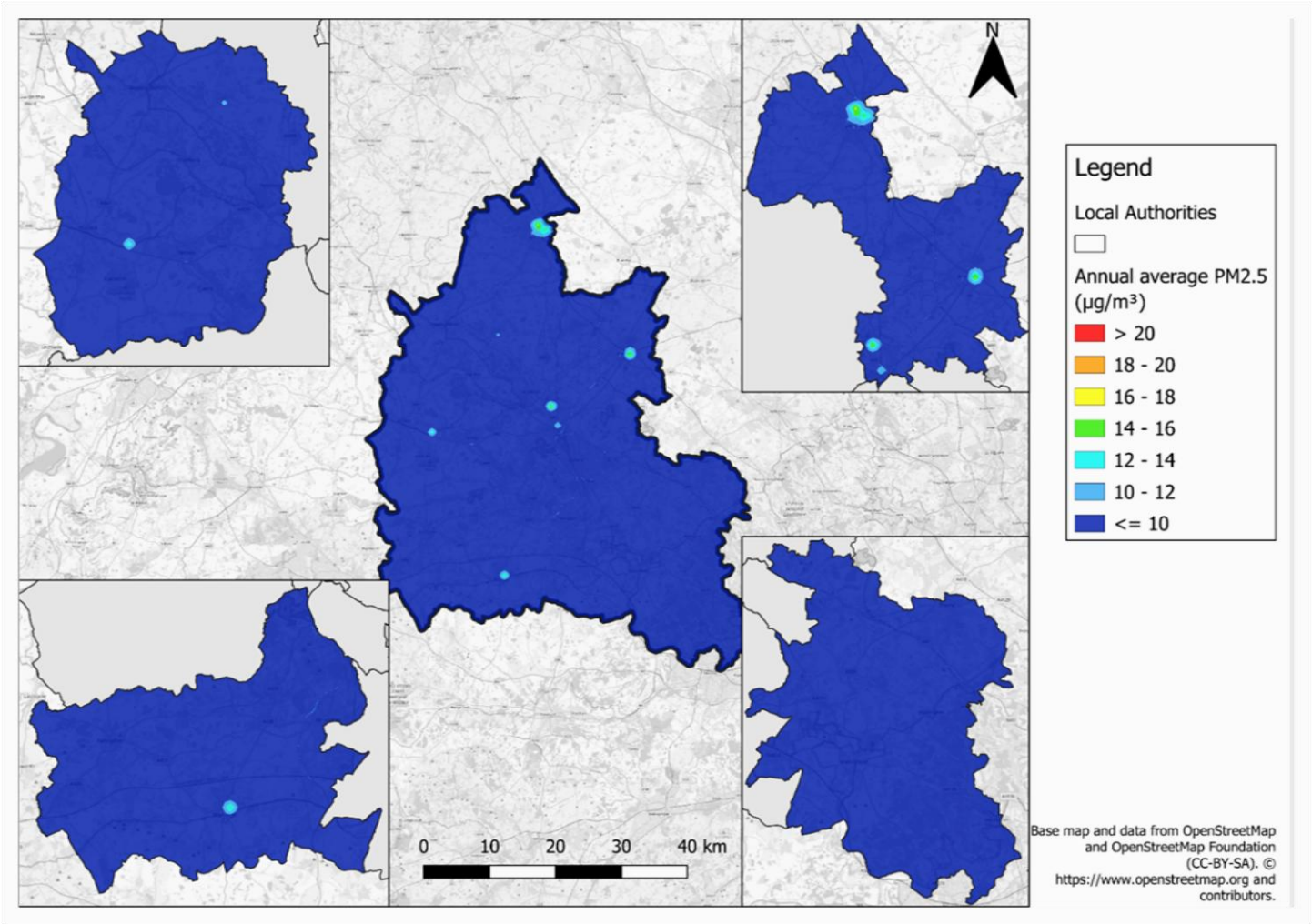
City of Oxford



2023 Base year modelling

West Oxfordshire

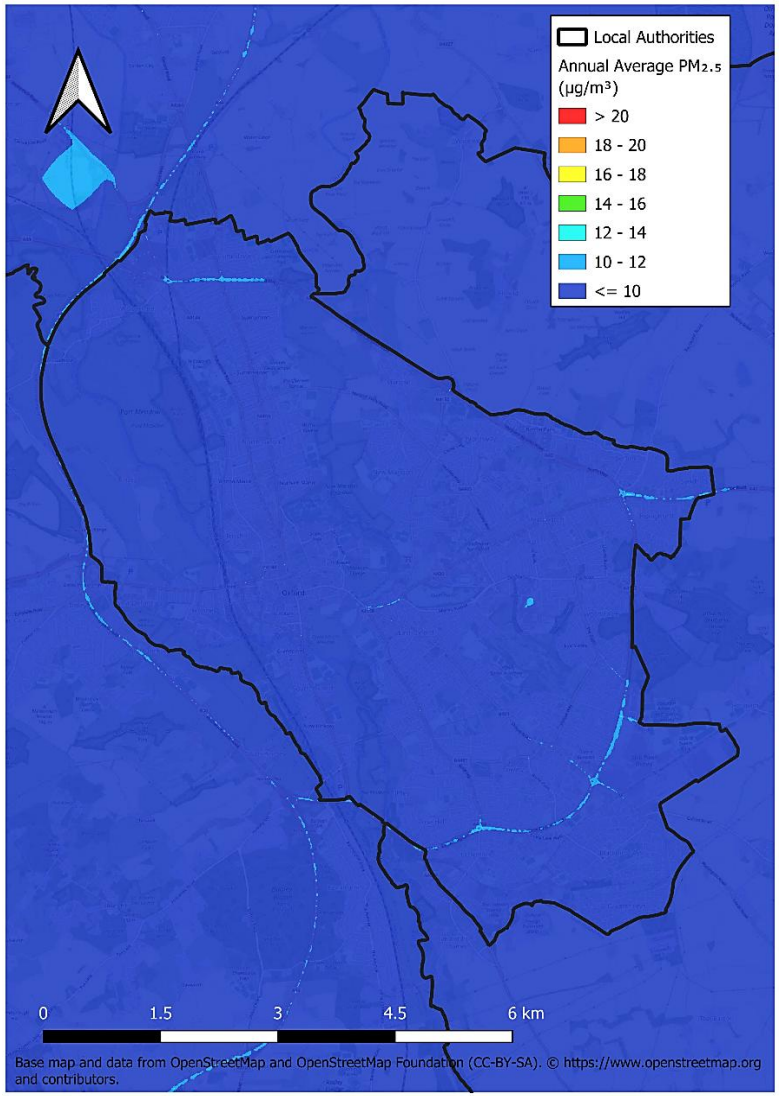
Cherwell



Vale of White Horse

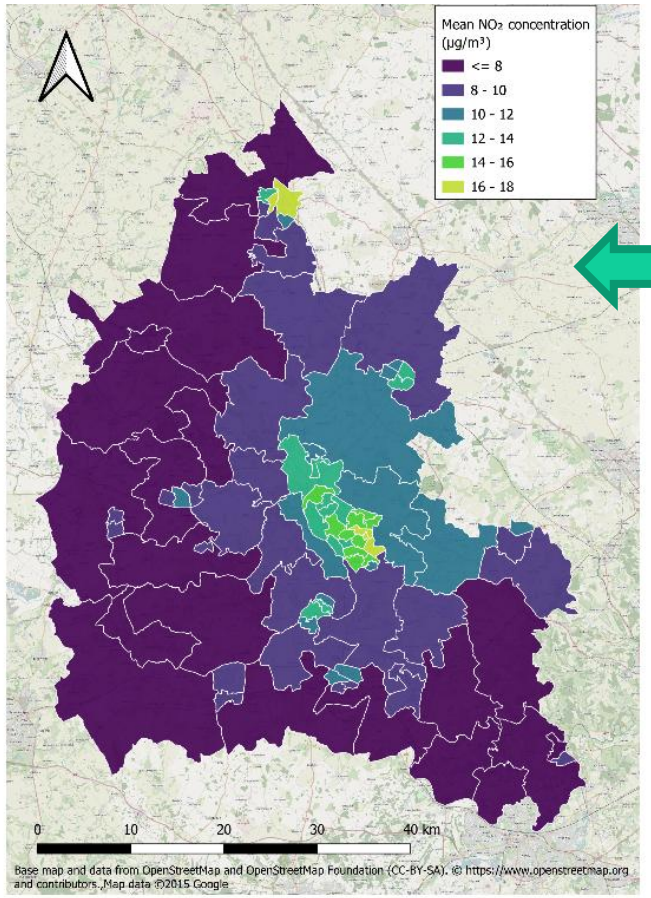
South Oxfordshire

City of Oxford



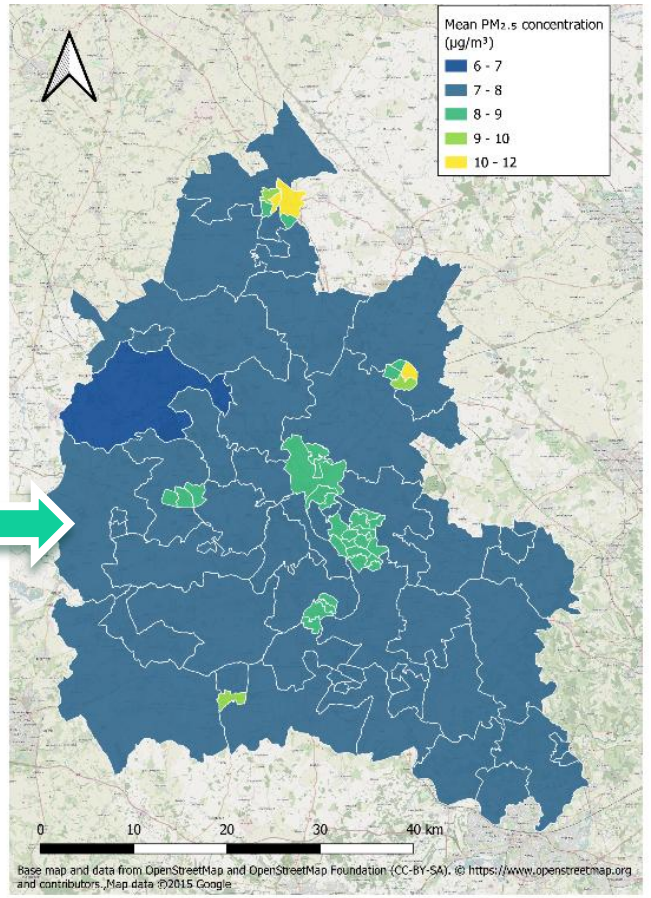
2023 Base year modelling

- Concentrations then aggregated onto Census areas using QGIS Zonal Statistics
- Aggregated values used as input into AQ-LAT



NO_2

$PM_{2.5}$



2023 Base year modelling

- Easy to convert ADMS-Urban output to Census Areas in GIS software

Baseline 2023 modelling results on 5m resolution

Local Authority	NO2	PM10	PM2.5
Cherwell	10.63	13.51	7.75
Oxford	13.22	13.74	8.03
South Oxfordshire	9.73	12.72	7.53
Vale of White Horse	9.07	12.68	7.51
West Oxfordshire	8.33	12.83	7.43

MSOA21NM	NO2	PM10	PM2.5
Cherwell 001	8.57	12.82	7.40
Cherwell 002	13.33	15.92	9.82
Cherwell 003	18.25	17.90	11.46
Cherwell 004	18.89	17.57	11.18
Cherwell 005	10.90	14.88	8.73
Cherwell 006	10.14	13.90	8.04
Cherwell 007	11.64	14.56	8.46
Cherwell 008	9.99	13.30	7.57
Cherwell 009	7.66	12.80	7.29
Cherwell 010	9.45	13.51	7.45
Cherwell 011	11.49	13.68	7.74
Cherwell 012	13.52	15.44	8.82
Cherwell 013	15.24	17.48	11.01
Cherwell 014	13.42	15.23	8.61
Cherwell 015	14.83	16.13	9.89
Cherwell 016	12.35	13.50	7.84
Cherwell 017	12.90	14.62	8.77
Cherwell 018	14.46	14.88	8.77
Cherwell 019	13.87	14.62	8.80
Oxford 001	13.99	13.45	7.98
Oxford 002	11.75	13.45	7.92
Oxford 003	11.95	13.32	7.79
Oxford 004	11.79	13.35	7.80
Oxford 005	13.31	13.98	8.02
Oxford 006	13.84	14.02	8.05
Oxford 007	14.32	14.32	8.28
Oxford 008	14.36	14.11	8.01
Oxford 009	12.05	13.01	7.73
Oxford 010	15.14	14.33	8.29
Oxford 011	13.70	14.44	8.21
Oxford 012	12.98	13.46	7.94
Oxford 014	12.92	14.00	8.15
Oxford 015	13.37	14.22	8.36
Oxford 016	13.57	13.91	8.26

LSOA21NM	NO2	PM10	PM2.5
Cherwell 001A	8.77	12.73	7.29
Cherwell 001B	10.89	13.37	7.83
Cherwell 001C	7.00	12.48	7.13
Cherwell 001E	7.77	12.68	7.34
Cherwell 001F	8.78	13.30	7.77
Cherwell 002A	18.77	18.00	11.80
Cherwell 002C	10.47	14.54	8.56
Cherwell 002D	12.23	15.54	9.18
Cherwell 002E	11.34	15.20	9.26
Cherwell 002F	11.15	15.43	9.34
Cherwell 003A	21.88	19.09	12.77
Cherwell 003B	17.26	17.72	11.23
Cherwell 003C	14.72	16.60	9.99
Cherwell 003D	13.22	16.03	9.46
Cherwell 004A	15.68	16.60	9.98
Cherwell 004C	19.16	17.75	11.21
Cherwell 004E	17.48	18.66	12.08
Cherwell 004F	17.69	18.38	11.72
Cherwell 004G	14.53	15.62	9.43
Cherwell 004H	14.88	16.23	9.80
Cherwell 004I	22.97	18.42	12.22
Cherwell 004J	18.56	18.59	12.05
Cherwell 005A	11.26	15.06	8.82
Cherwell 005B	10.04	14.37	8.42
Cherwell 005C	10.32	14.50	8.49
Cherwell 005D	12.64	15.80	9.30
Cherwell 005E	9.82	14.34	8.42
Cherwell 005F	11.52	15.33	9.03
Cherwell 006A	14.17	16.18	9.62
Cherwell 006B	12.99	15.36	8.98
Cherwell 006C	10.84	14.37	8.35
Cherwell 006D	10.35	14.12	8.15
Cherwell 006E	9.26	13.39	7.71
Cherwell 007A	11.03	14.26	8.28
Cherwell 007B	13.69	15.52	9.12

Stage 2

Future Scenarios

Future scenarios for 2035

Phase 1 scenarios
National Net Zero Strategy
Oxfordshire Leading the Way

Phase 2 scenarios
Electrification of bus fleet in specified towns
Local Transport and Connectivity Plan (-25% car trips)
Industrial emission reduction (-78% emissions)
Agricultural emission reduction (-72% emissions)
No domestic wood burning
NHS Green Transport Plan
Oxford University Health scenario

Phase 1 scenarios

- National
  - Based on CO_2 emission reduction targets in the BEIS 2021 Net Zero Strategy[1].
  - Adjustment made to NAEI emissions by sector.
  - Targets not based on explicit policies.

SNAP Sector	BEIS pollutant	NO_x / $PM_{2.5}$ adjustment
SNAP01_energy	CO_2	0.52
SNAP02_domcom	CO_2	0.47
SNAP03_indcom	CO_2	0.36
SNAP04_indproc	CO_2	0.36
SNAP05_offshore	n/a	n/a
SNAP06_solvents	CO_2	0.36
SNAP07_roadTran	CO_2	0.38
SNAP08_otherTran	CO_2	0.38
SNAP09_waste	CO_2	0.65
SNAP10_agriculture	CO_2	0.65
SNAP11_nature	n/a	n/a

1 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1066450/nzs-charts-tables-v1.1.xlsx

Phase 1 scenarios

- Oxfordshire Leading the Way
  - Based on Oxfordshire Net Zero Route Map[2].
  - Emission reductions based on actionable targets
    - Activity change
    - Uptake of renewables
    - Fuel mix

SNAP Sector	NO_x adjustment	$PM_{2.5}$ adjustment
SNAP01_energy	0.42	0.42
SNAP02_domcom	0.55	0.29
SNAP03_indcom	0.67	0.40
SNAP04_indproc	0.67	0.40
SNAP05_offshore	n/a	n/a
SNAP06_solvents	0.67	0.40
SNAP07_roadTran	Calculated from vehicle fleet change and traffic reductions	
SNAP08_otherTran	Calculated from rail electrification	
SNAP09_waste	n/a	n/a
SNAP10_agriculture	n/a	n/a
SNAP11_nature	n/a	n/a

2 https://cdn.prod.website-files.com/64bfc2696e3a5a80360d3c60/64fb93ec4927a6fb9023d790_Oxfordshire-NZ-Route-Map-Action-Plan-City-Science-Dec-2022-vFinal.pdf

Phase 1 scenarios

- Oxfordshire Leading the Way

Year	2020	2025	2030	2035	2040	2045	2050
Demand Reduction							
Demand Reduction of Personal Trips vs. Baseline (% of Vehicle Miles)	0%	-10%	-10%	-25%	-25%	-25%	-25%
Mode Shift of Personal Trips vs. Baseline (% of Vehicle Miles)	0%	-5%	-10%	-10%	-10%	-10%	-10%
Freight Trip Efficiency	0%	5%	10%	10%	10%	10%	10%

Vehicle Stock Changes							
Private Vehicles (Cars & Motorcycles): Electric	3,777 (<1%)	25,000 (7%)	120,000 (36%)	200,000 (61%)	343,029 (100%)	359,369 (100%)	375,710 (100%)
Public Transport (Buses & Coaches): Zero Carbon	0 (0%)	200 (5%)	1,000 (19%)	2,000 (36%)	6,174 (100%)	6,751 (100%)	7,328 (100%)
LGVs: Electric	0 (0%)	2,500 (6%)	15,000 (35%)	35,000 (76%)	49,508 (100%)	53,158 (100%)	57,077 (100%)
HGVs: Zero Carbon	0 (0%)	200 (4%)	900 (19%)	2,800 (55%)	5,456 (100%)	5,858 (100%)	6,290 (100%)

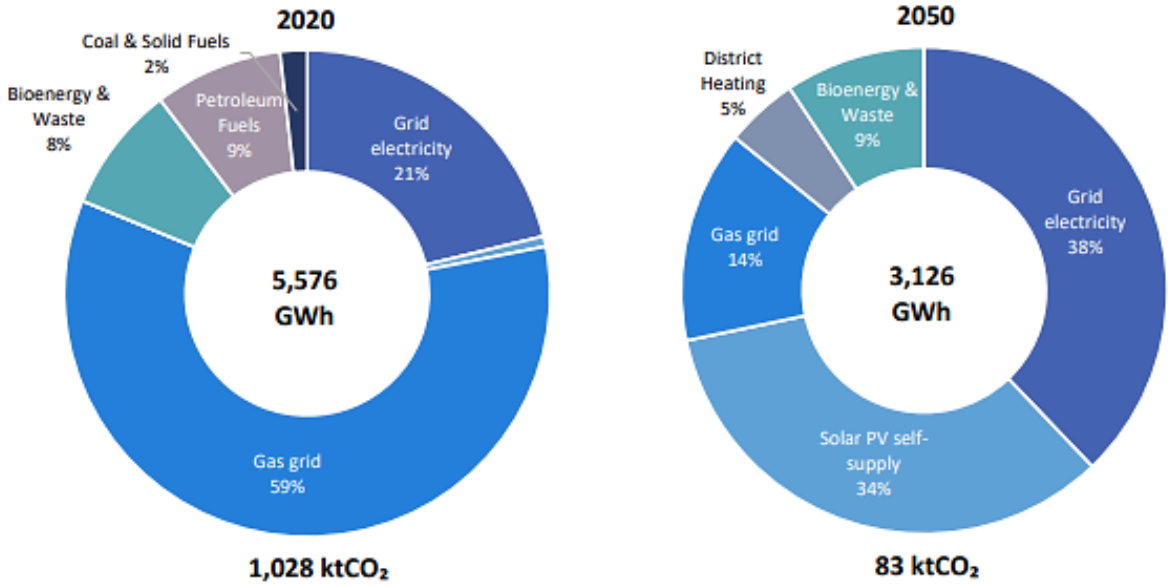
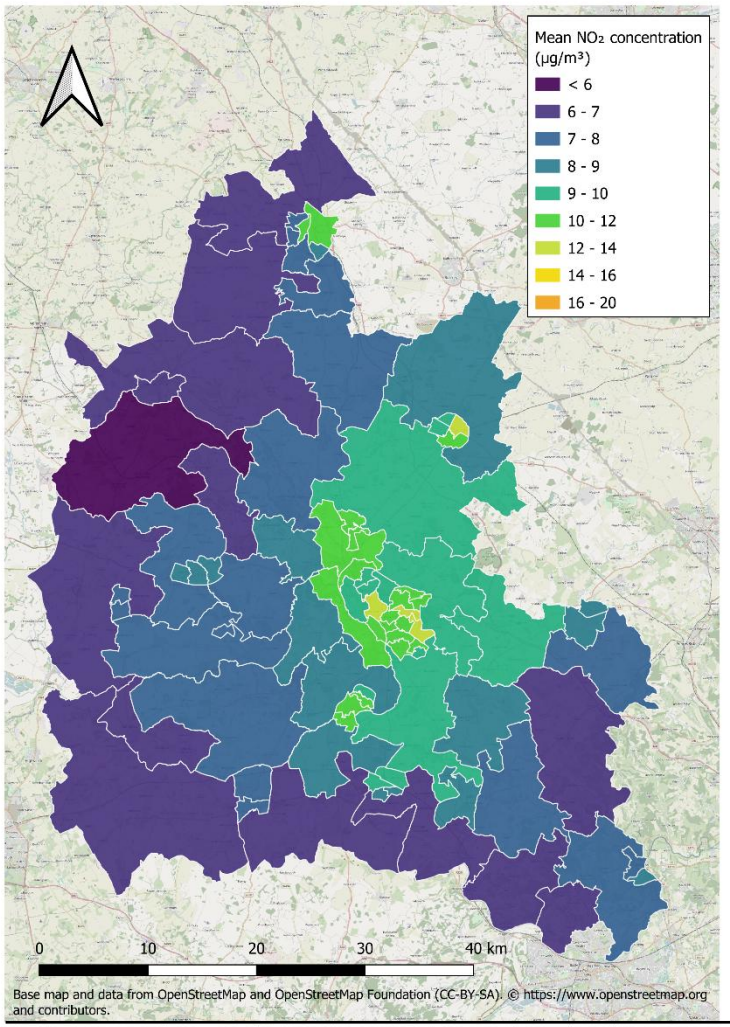


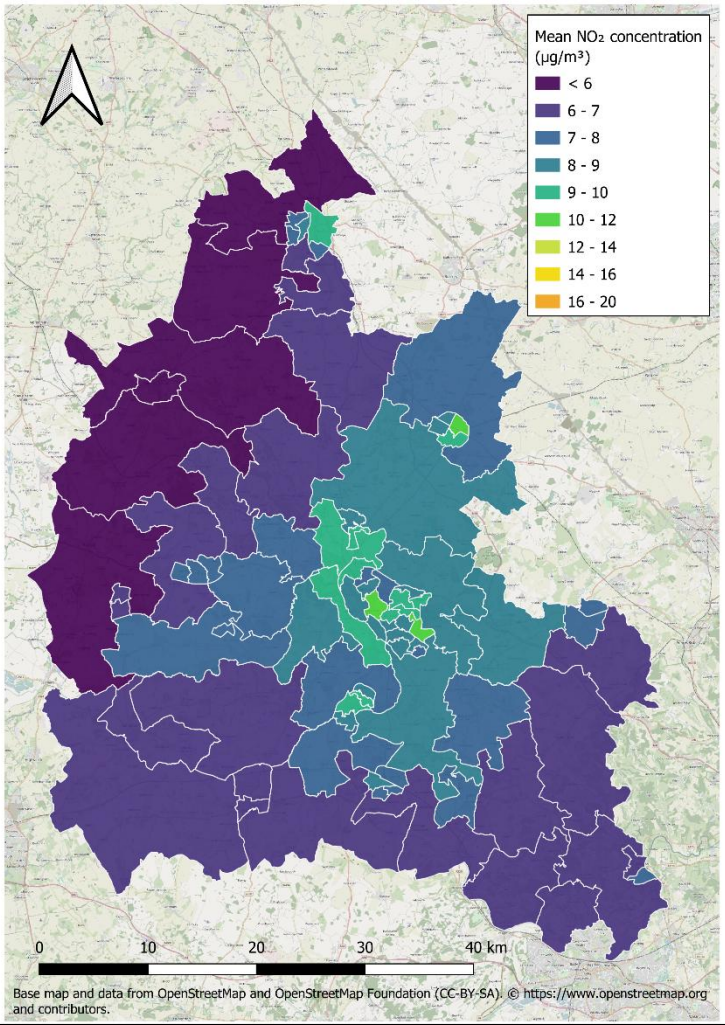
Figure 2-14: Housing Sector Pathway Energy Mix 2020 and 2050

2 https://cdn.prod.website-files.com/64bfc2696e3a5a80360d3c60/64fb93ec4927a6fb9023d790_Oxfordshire-NZ-Route-Map-Action-Plan-City-Science-Dec-2022-vFinal.pdf

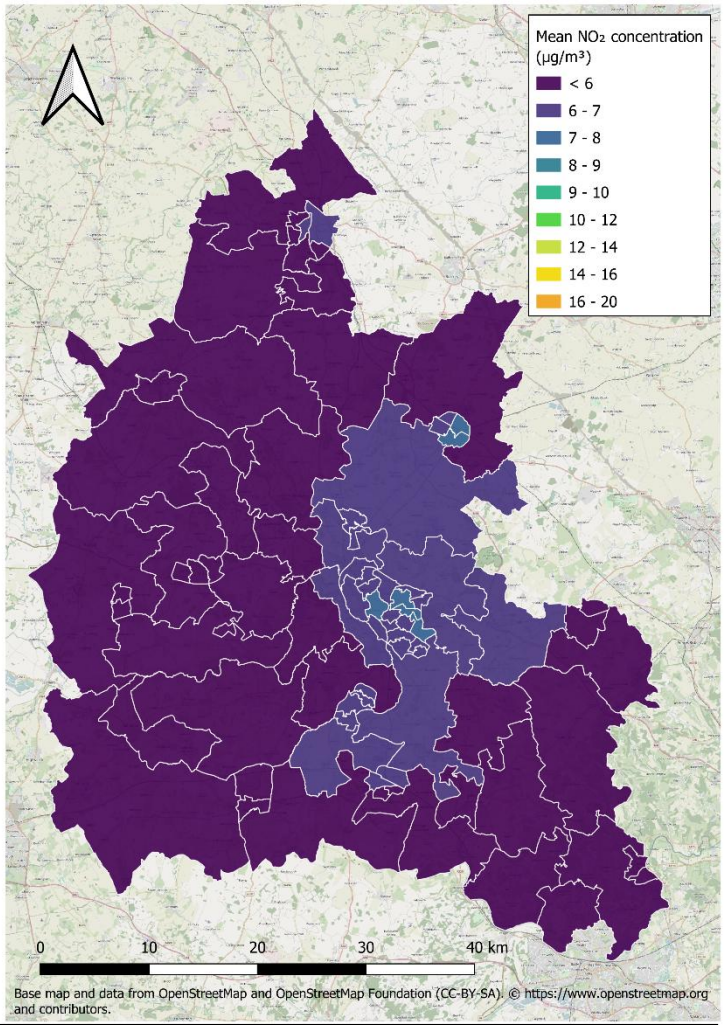
Phase 1 results NO_2



2035 Baseline

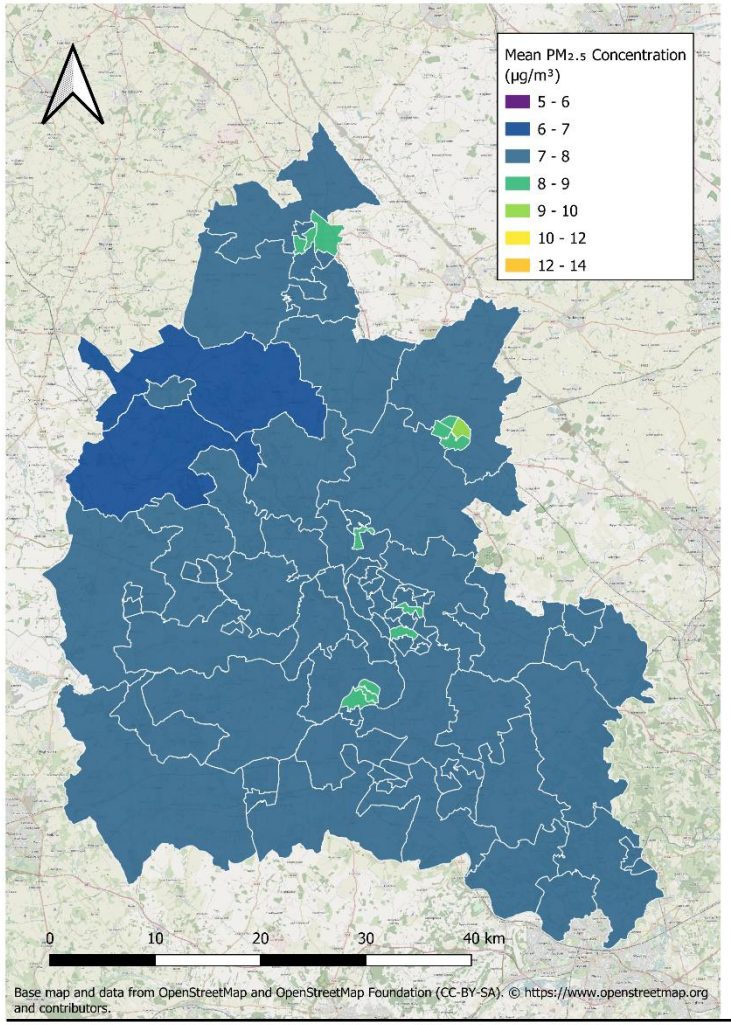


2035 Oxfordshire Leading the Way

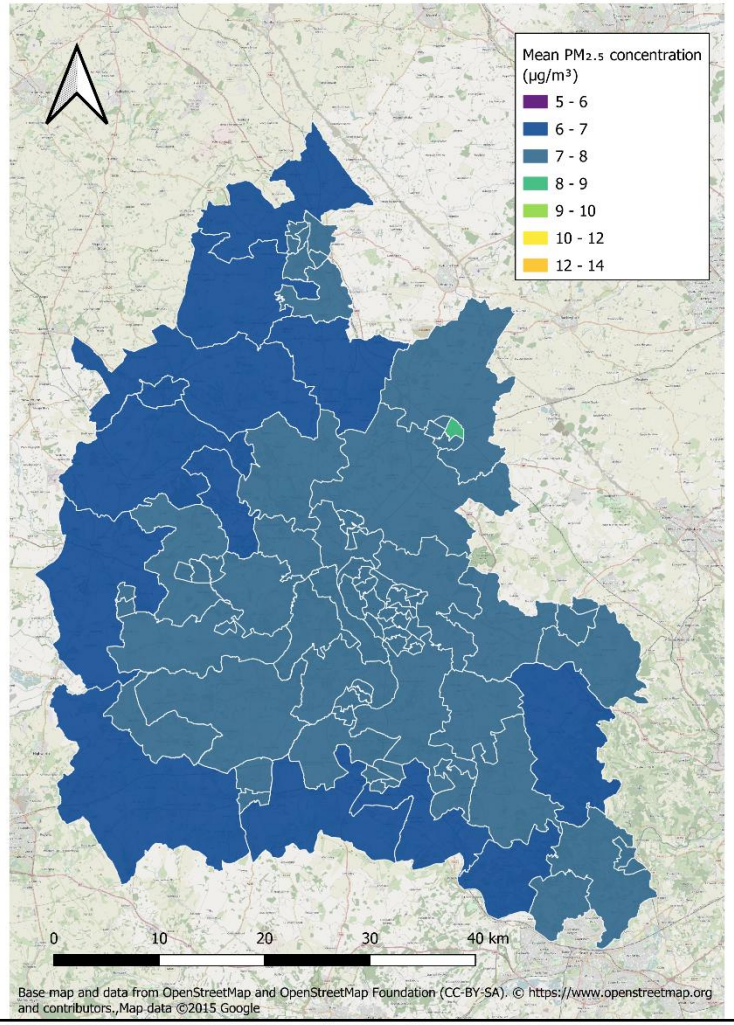


2035 National Net Zero Strategy

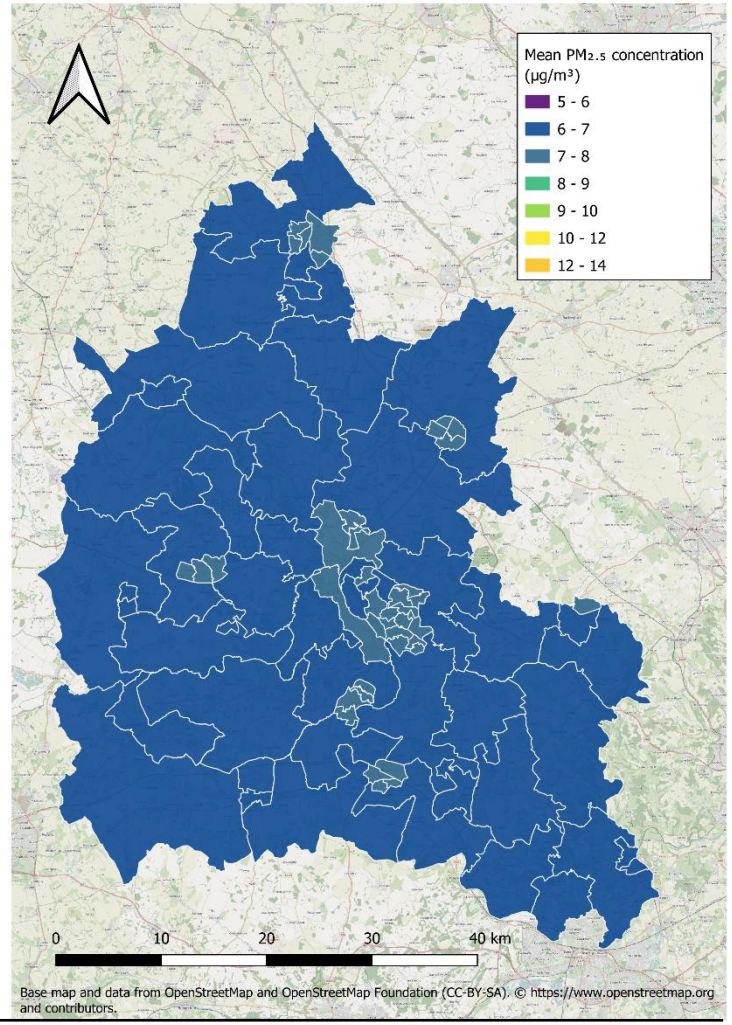
Phase 1 results $PM_{2.5}$



2035 Baseline



2035 Oxfordshire Leading the Way



2035 National Net Zero Strategy

Modelling results for AQ-LAT inputs

- Model results displayed numerically

2023 Baseline

	A	B	C	D	E
1	MSOA21NM	NO2	PM10	PM2.5	
2	Cherwell 001	8.57	12.82	7.40	
3	Cherwell 002	13.33	15.92	9.82	
4	Cherwell 003	18.25	17.90	11.46	
5	Cherwell 004	18.89	17.57	11.18	
6	Cherwell 005	10.90	14.88	8.73	
7	Cherwell 006	10.14	13.90	8.04	
8	Cherwell 007	11.64	14.56	8.46	
9	Cherwell 008	9.99	13.30	7.57	
10	Cherwell 009	7.66	12.80	7.29	
11	Cherwell 010	9.45	13.51	7.45	
12	Cherwell 011	11.49	13.68	7.74	
13	Cherwell 012	13.52	15.44	8.82	
14	Cherwell 013	15.24	17.48	11.01	
15	Cherwell 014	13.42	15.23		
16	Cherwell 015	14.83	16.13		
17	Cherwell 016	12.35	13.50	7.84	
18	Cherwell 017	12.90	14.62	8.77	
19	Cherwell 018	14.46	14.88	8.77	
20	Cherwell 019	13.87	14.62	8.80	
21	Oxford 001	13.99	13.45	7.98	
22	Oxford 002	11.75	13.45	7.92	
23	Oxford 003	11.95	13.32	7.79	
24	Oxford 004	11.79	13.35	7.80	
25	Oxford 005	13.31	13.98	8.02	
26	Oxford 006	13.84	14.02	8.05	
27	Oxford 007	14.32	14.32	8.28	
28	Oxford 008	14.36	14.11	8.01	
29	Oxford 009	12.05	13.01	7.73	
30	Oxford 010	15.14	14.33	8.29	
31	Oxford 011	13.70	14.44	8.21	

... LA_SCA | LA_1_in_4 | MSOA_Baseline | MSOA_future_Baseline | MSOA_National_LCA

2035 Future Baseline

	A	B	C	D	E
1	MSOA21NM	NO2	PM10	PM2.5	
2	Cherwell 001	6.48	12.51	7.09	
3	Cherwell 002	7.93	13.88	7.96	
4	Cherwell 003	10.38	15.13	8.83	
5	Cherwell 004	11.36	14.63	8.35	
6	Cherwell 005	7.84	14.32	8.20	
7	Cherwell 006	7.48	13.38	7.55	
8	Cherwell 007	8.38	13.80	7.73	
9	Cherwell 008	7.32	12.99	7.25	
10	Cherwell 009	6.15	12.54	7.03	
11	Cherwell 010	7.35	13.22	7.15	
12	Cherwell 011	8.73	13.31	7.36	
13	Cherwell 012	9.69	14.78	8.18	
14	Cherwell 013	12.70	15.99	9.54	
15	Cherwell 014	9.71	14.70		
16	Cherwell 015	11.61	15.11		
17	Cherwell 016	9.33	13.11	7.43	
18	Cherwell 017	10.20	13.72	7.88	
19	Cherwell 018	10.95	14.19	8.05	
20	Cherwell 019	10.56	13.61	7.82	
21	Oxford 001	10.12	13.00	7.65	
22	Oxford 002	9.30	13.09	7.63	
23	Oxford 003	9.94	13.12	7.58	
24	Oxford 004	9.46	13.04	7.54	
25	Oxford 005	10.68	13.65	7.75	
26	Oxford 006	11.90	13.78	7.82	
27	Oxford 007	10.79	13.83	7.91	
28	Oxford 008	12.82	13.96	7.87	
29	Oxford 009	9.91	12.80	7.52	
30	Oxford 010	12.38	14.05	8.03	
31	Oxford 011	11.05	14.13	7.92	

... LA_SCA | LA_1_in_4 | MSOA_Baseline | MSOA_future_Baseline | MSOA_National_LCA

2035 National Net Zero Strategy

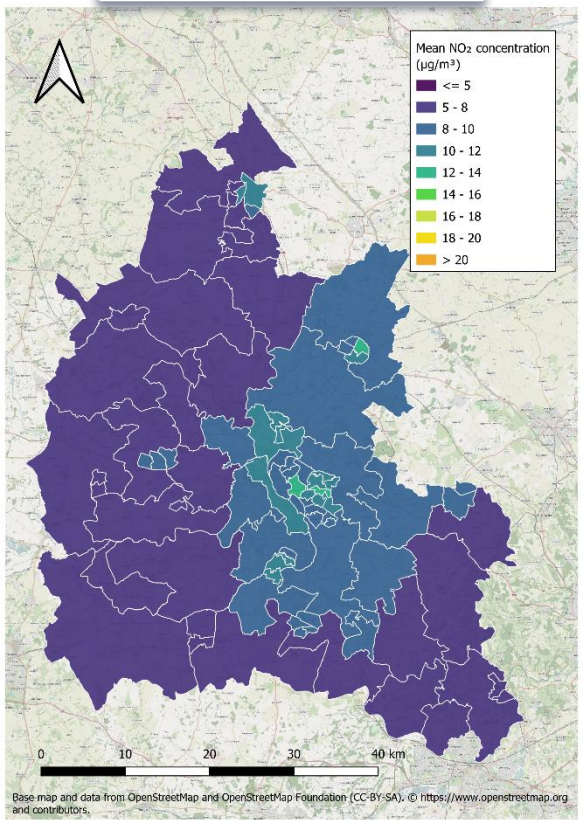
	A	B	C	D	E	F
1	MSOA21NM	NO2	PM10	PM2.5		
2	Cherwell 001	4.87	11.43	6.74		
3	Cherwell 002	5.49	11.99	7.14		
4	Cherwell 003	6.47	12.50	7.51		
5	Cherwell 004	6.86	12.32	7.30		
6	Cherwell 005	5.47	12.12	7.21		
7	Cherwell 006	5.32	11.82	6.97		
8	Cherwell 007	5.70	12.00	7.08		
9	Cherwell 008	5.23	11.67	6.84		
10	Cherwell 009	4.75	11.49	6.73		
11	Cherwell 010	5.26	11.89	6.80		
12	Cherwell 011	5.87	11.84	6.90		
13	Cherwell 012	6.27	12.44	7.31		
14	Cherwell 013	7.49	12.81	7.78		
15	Cherwell 014	6.27	12.42	7.25		
16	Cherwell 015	7.03	12.44	7.51		
17	Cherwell 016	6.08	11.67	6.93		
18	Cherwell 017	6.39	11.89	7.14		
19	Cherwell 018	6.71	12.07	7.21		
20	Cherwell 019	6.55	11.81	7.08		
21	Oxford 001	6.31	11.46	7.00		
22	Oxford 002	6.06	11.53	7.02		
23	Oxford 003	6.34	11.52	6.99		
24	Oxford 004	6.17	11.49	6.98		
25	Oxford 005	6.66	11.75	7.08		
26	Oxford 006	7.21	11.79	7.11		
27	Oxford 007	6.70	11.82	7.16		
28	Oxford 008	7.67	11.83	7.11		
29	Oxford 009	6.25	11.38	6.94		
30	Oxford 010	7.41	11.90	7.20		
31	Oxford 011	6.86	11.92	7.15		

... LA_SCA | LA_1_in_4 | MSOA_Baseline | MSOA_future_Baseline | MSOA_National_LCA

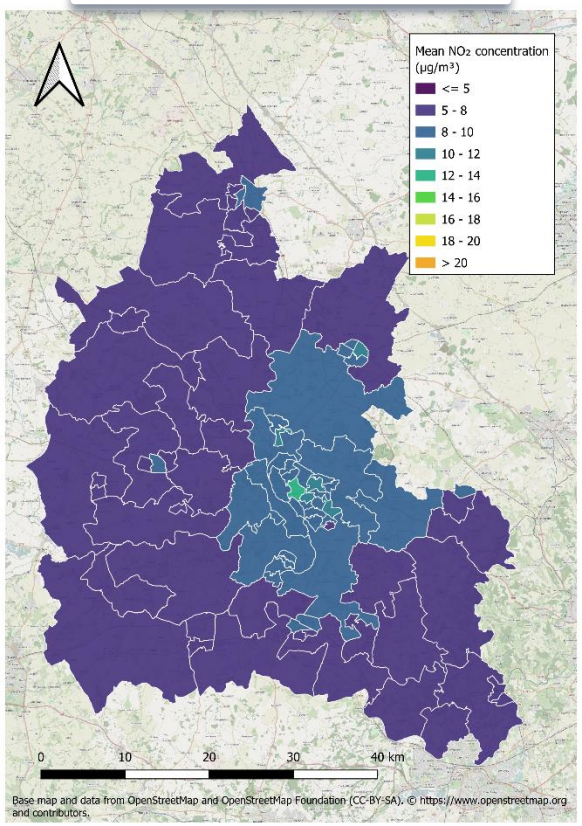
Phase 2 scenarios

- Examples of NO_2 results for Phase 2 scenarios

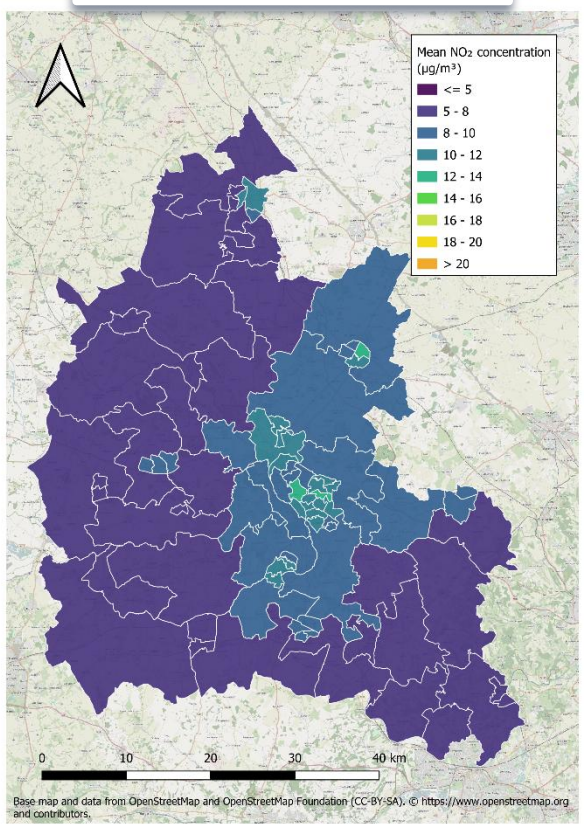
Local Transport Connectivity Plan



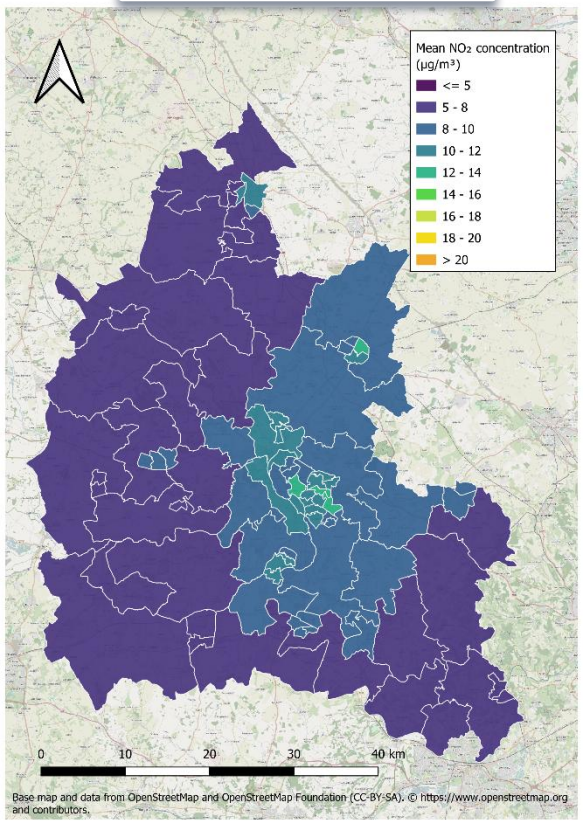
Industrial Emissions reduction



Agricultural Emissions reduction



No Domestic wood burning



Phase 2 scenarios

- Phase 2 scenario statistics for NO_2
  - Most impactful to reduce industrial or road traffic emissions

Phase 2 Scenario	Concentrations (µg/m³)							
	Business as Usual	Industrial reductions	Agricultural reductions	OUH	LTCP	E-Buses	Remove domestic wood burning	NHS Green Transport Plan
MIN	**5.92**	5.69	5.76	5.91	5.89	5.92	5.92	5.92
AVG	**8.83**	8.11	8.69	8.70	8.71	8.80	8.82	8.83
MAX	**12.82**	12.32	12.74	12.63	12.61	12.67	12.80	12.81

Phase 2 scenarios

- Phase 2 scenario statistics for $PM_{2.5}$
  - Most impactful to reduce domestic combustion or industrial emissions

Phase 2 Scenario	Concentrations (µg/m³)							
	Business as Usual	Remove domestic wood burning	Industrial reductions	Agricultural reductions	LTCP	NHS Green Transport Plan	OUH	E-Buses
MIN	**6.95**	6.87	6.89	6.93	6.94	6.94	6.95	6.95
AVG	**7.61**	7.38	7.44	7.59	7.58	7.60	7.60	7.61
MAX	**9.54**	9.11	8.23	9.53	9.50	9.54	9.54	9.54

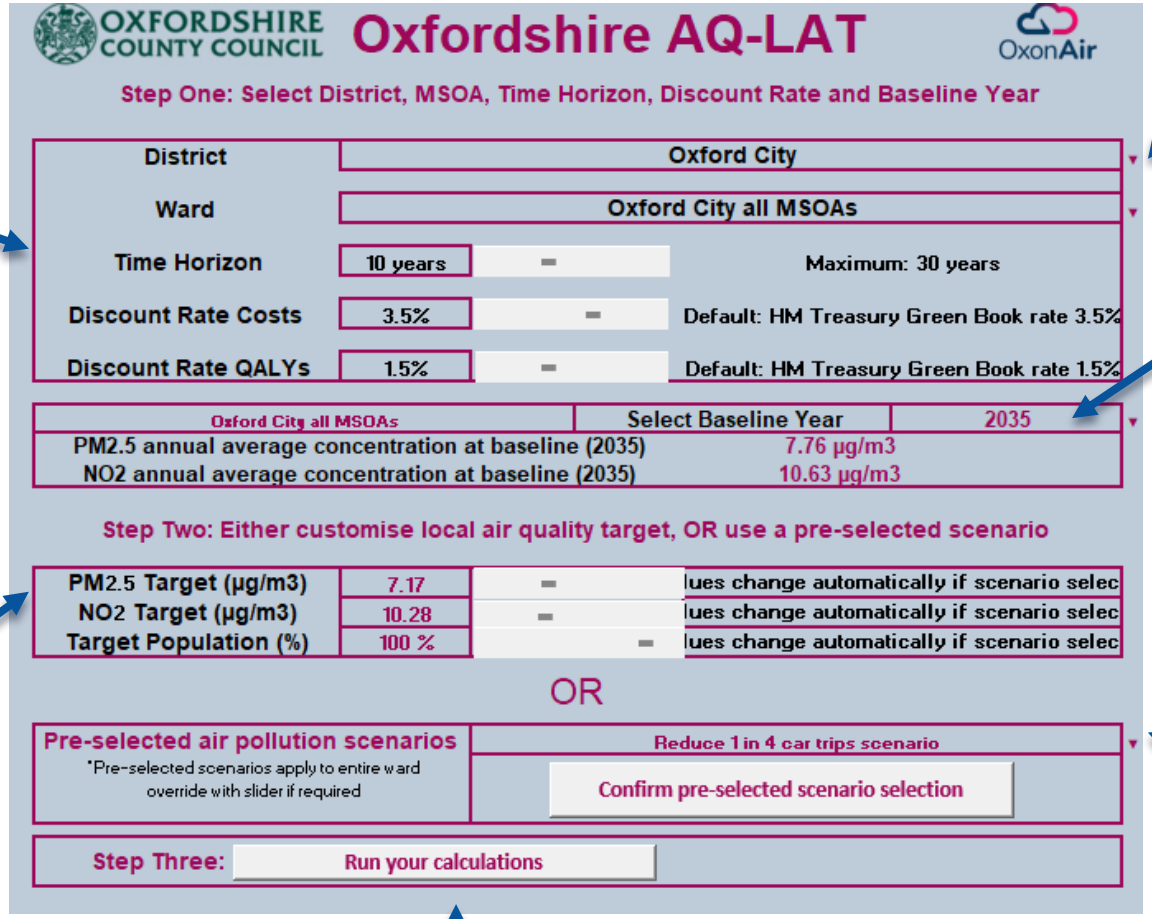
Stage 3

Calculate Health Impacts

Air Quality Lifecourse Assessment Tool (AQ-LAT)

- Obtained information on local health impacts of long-term air pollution exposure (NO_2 and $PM_{2.5}$)
- Linked the modelled air pollutant concentrations to health impact tool made by University of Birmingham *(Department of Applied Health Sciences)*
  - Peer-reviewed tool
  - Improved granularity of tool
  - Input pre-selected scenarios: modelling results from baseline and future year, and phase 1 and 2 scenarios
  - Calculates **health economic savings**

AQ-LAT User Dashboard



Time frame

Select desired locations

Choose modelled base year concentrations to compare against

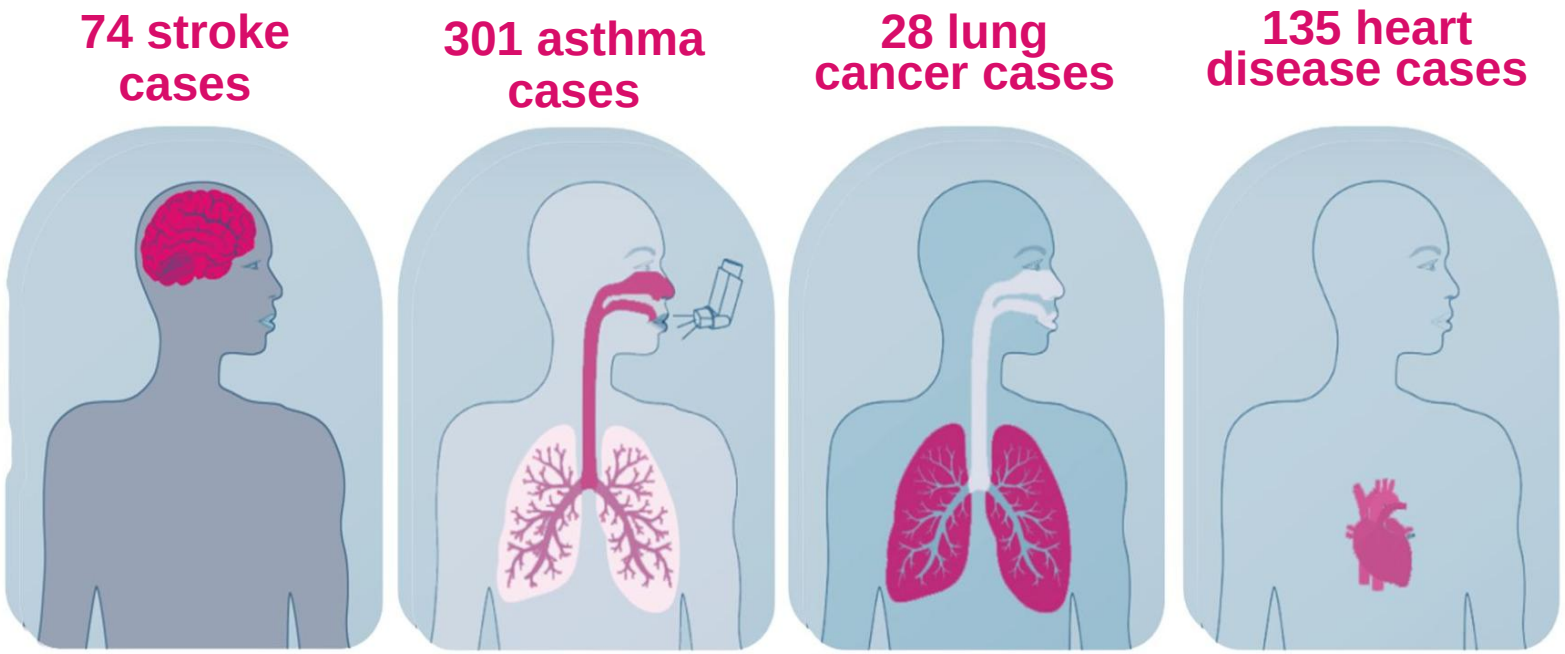
Option 1: Manually enter local air quality target

Option 2: Click on pre-selected scenarios that have been modelled

Calculate

AQ-LAT Output

- The 2023 baseline data showed the health burden from exposure to air pollution in Oxfordshire amounts to:
- **£1.54 million** NHS costs
- **£428,000** productivity costs
- **£772,000** social care costs
- **339 early deaths** attributed to air pollution



AQ-LAT Uses

AQLAT current uses

- Input into strategic documents to provide local context on air pollution and its effects e.g. Local Cycling and Walking Infrastructure Plan
- Make business cases for improvements
- Reaching out to other teams

AQ-LAT Uses

AQLAT potential uses

- Embed into internal bidding processes e.g. Community Infrastructure Levy and Active Travel England
- Monitoring and evaluation of Air Quality Action Plan measures and use to help calculate health impact KPIs

Oxfordshire Results

Health impacts caused by long-term exposure to NO_2 and $PM_{2.5}$

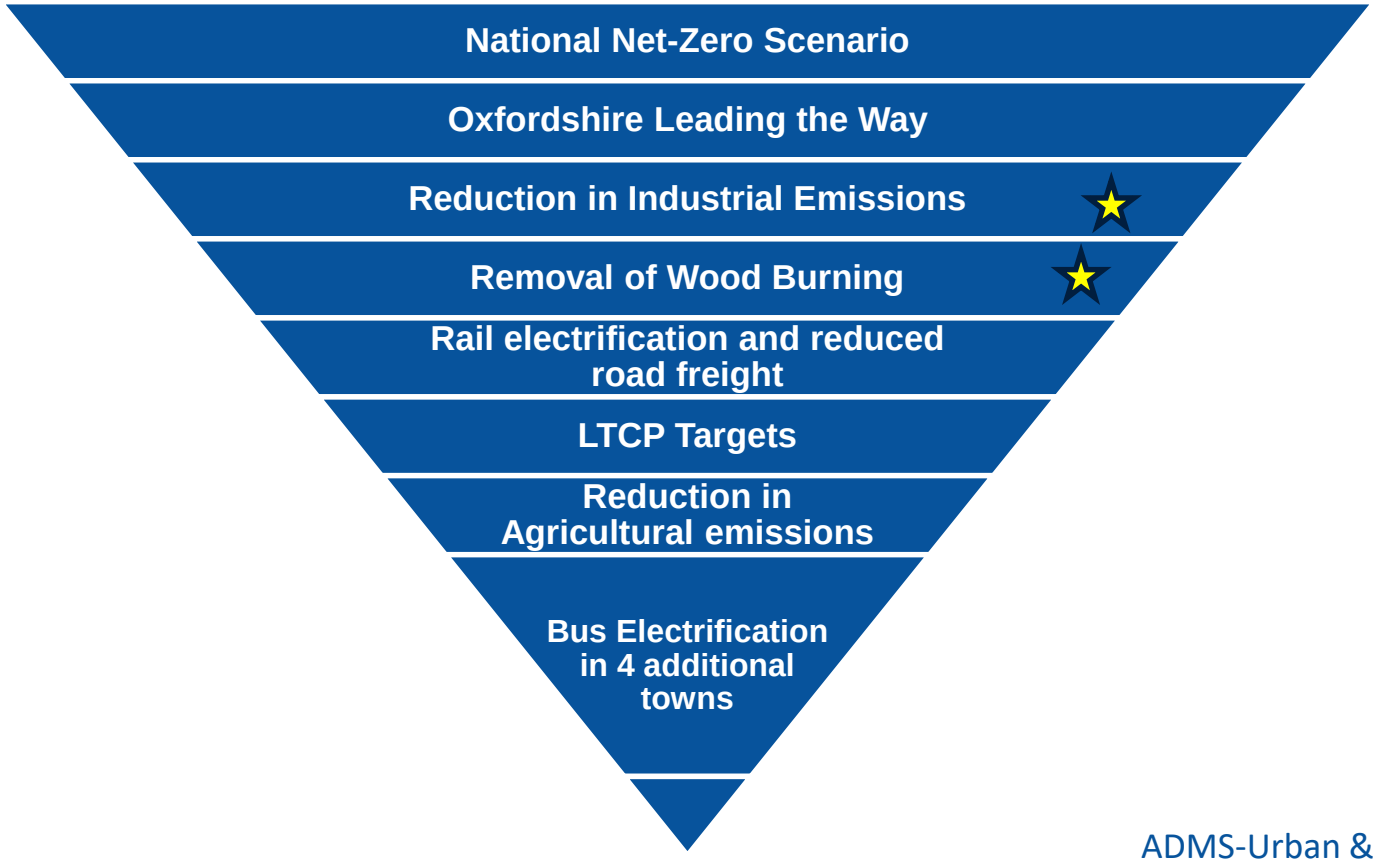
Calculated health impacts **per district** and took the **sum for the county**

Calculated the total sum of:

- Cost savings
- QALYs gained
- Early deaths prevented
- **Grouped health cases** (stroke, CHD, lung cancer and asthma cases)

Oxfordshire Results

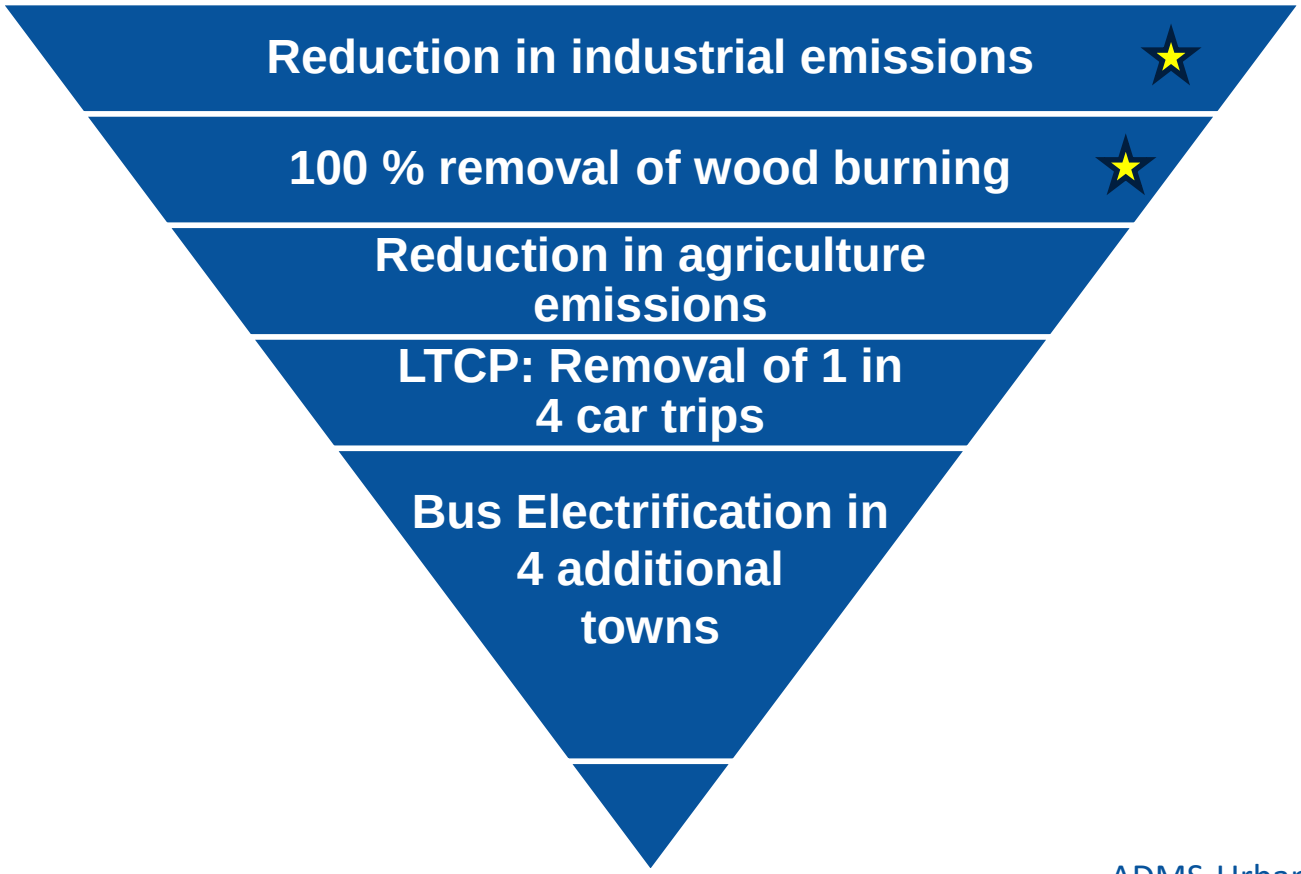
- Calculated health impact savings from both multi and single sector interventions
- Order of health impacts caused by exposure to NO_2 and $PM_{2.5}$:



★ For health impact **costs, QALYs gained and early deaths prevented** rather than **health cases prevented**, removal of wood-burning emissions has higher reductions than reduction in industrial emissions

Oxfordshire Results

- Calculated health impact savings from single-sector interventions
- Order of health impacts caused by exposure to NO_2 and $PM_{2.5}$:



★ For health impact **costs, QALYs gained and early deaths prevented** rather than **health cases prevented**, removal of wood-burning emissions has higher reductions than reduction in industrial emissions

Next Steps

- Local government reorganisation

- If we decide to update our AQ strategy in the interim period:
  - Use evidence base to update AQ strategy and priorities
  - Decide on a local air quality target

Thank you for listening

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