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Air Quality Intelligence

Aeris Urban Air Quality Study

The Impact of Diesel Use on Air Quality in European Cities

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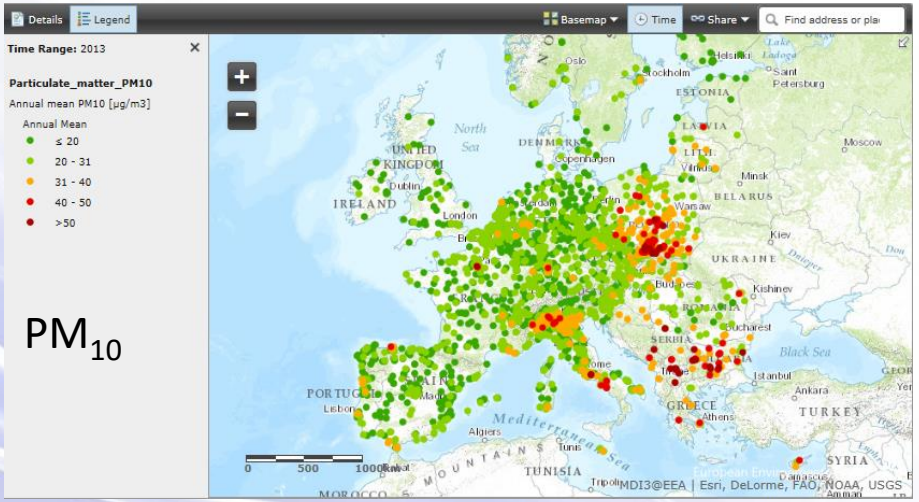
Presentation Outline

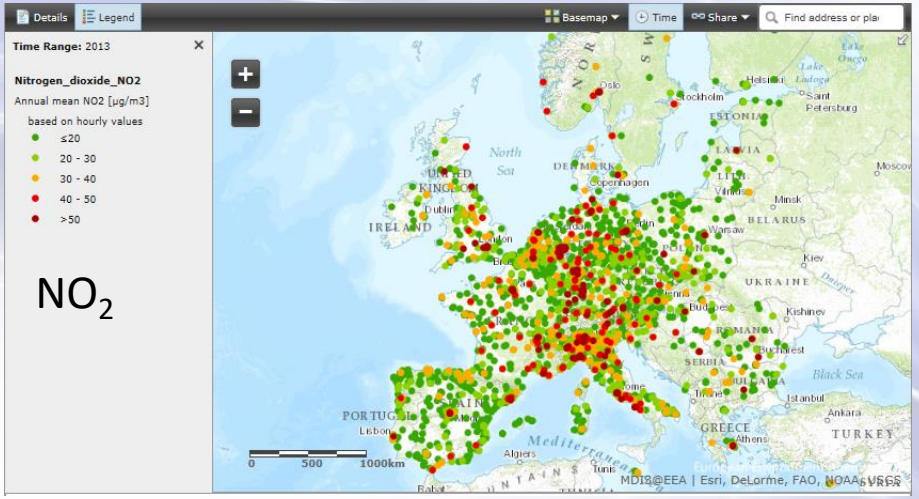
- Introduction
  - Current compliance with air quality standards
- Background
  - Current emissions situation: reality vs. perception for
    - Particulate Matter (PM)
    - Nitrogen dioxide (NO_2)
- Study description
  - Modelling transport scenarios and their impacts on compliance with ambient air quality standards
- Key findings
  - Concawe study findings for PM and NO_2.
  - Example local measures: UK DEFRA NO_2 Compliance Modelling
- First Exploration of Population Exposure
- Conclusions

Introduction: Current Compliance with Ambient Air Quality Directive (2008/50/EC)

Current non-compliance with ambient air quality limit values, particularly for NO_2 and PM ($PM_{2.5}$ and PM_{10}), is a high priority concern for policy makers at European, Member State and local levels. This has triggered action at national and local urban level.

Increasing concern on health effects of diesel exhaust intensifying pressure on diesel transport and drawing considerable attention from the media…..





[Source EEA. Airbase]

"Diesel Disease"
14 February 2017, The Times leader

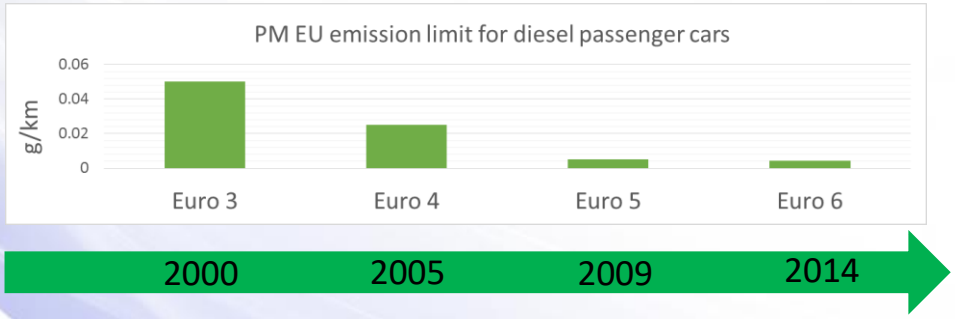
"Air pollution from road traffic can raise blood pressure". **Science for Environment Policy. EC. 24.06.2014**

"OECD study reveals health cost of road transport emissions". **Euroactiv 22.05.2014**

Background: PM emissions reality vs. perception

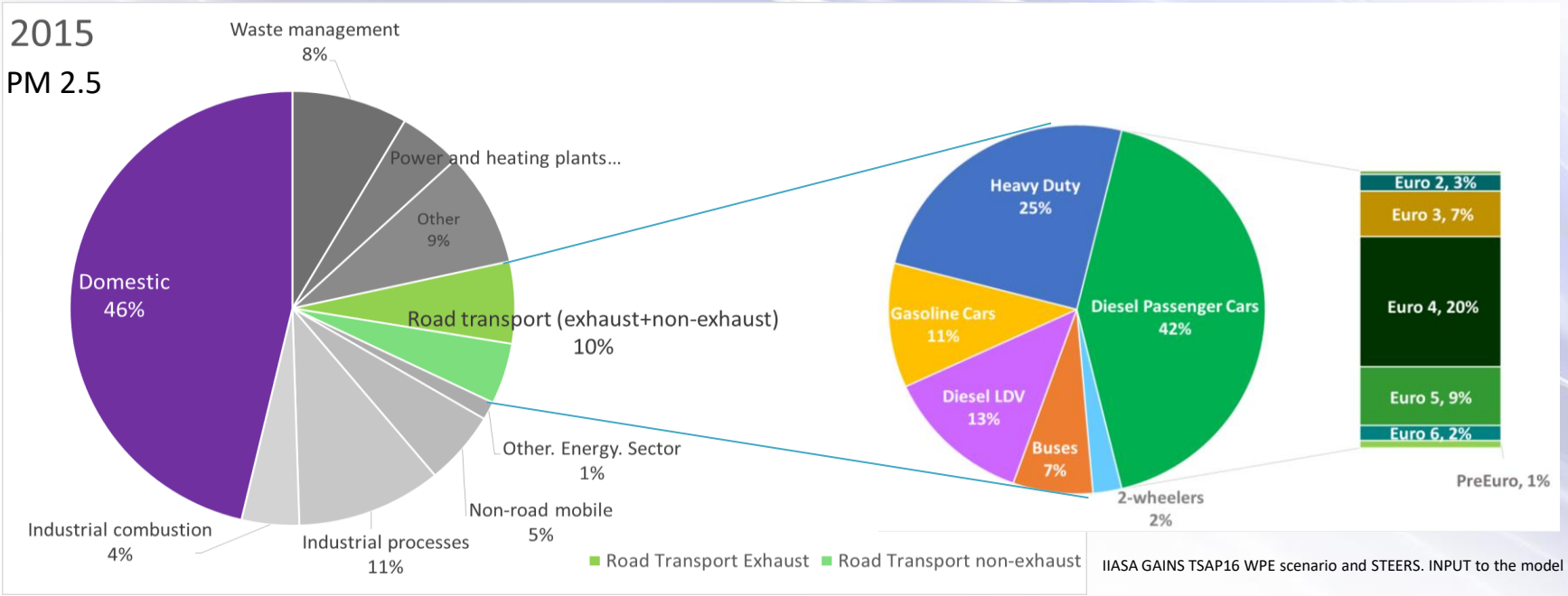
Vehicle regulation and technology have addressed PM issue.

There are concerns that vehicles exceed limits for other emissions, but technology has still reduced PM emissions dramatically.



Road transport is currently a small contributor to total PM emissions:

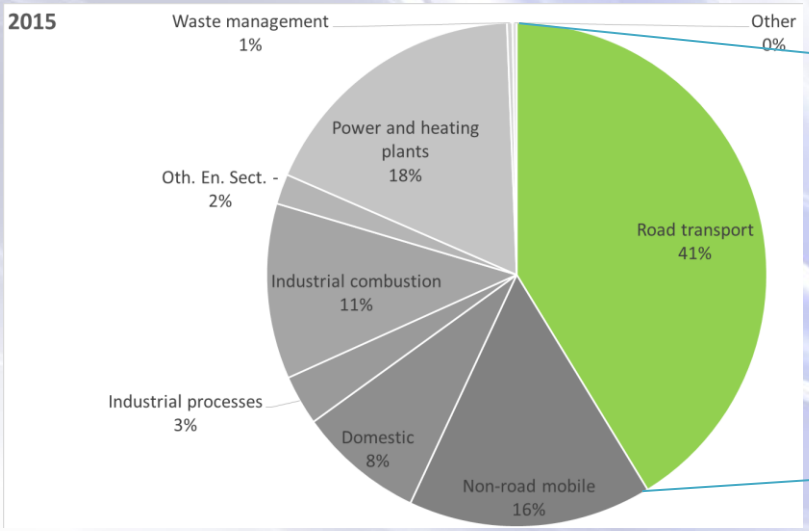
Domestic fuel burning (coal/wood) dominant source of urban $PM_{2.5}$ emissions.

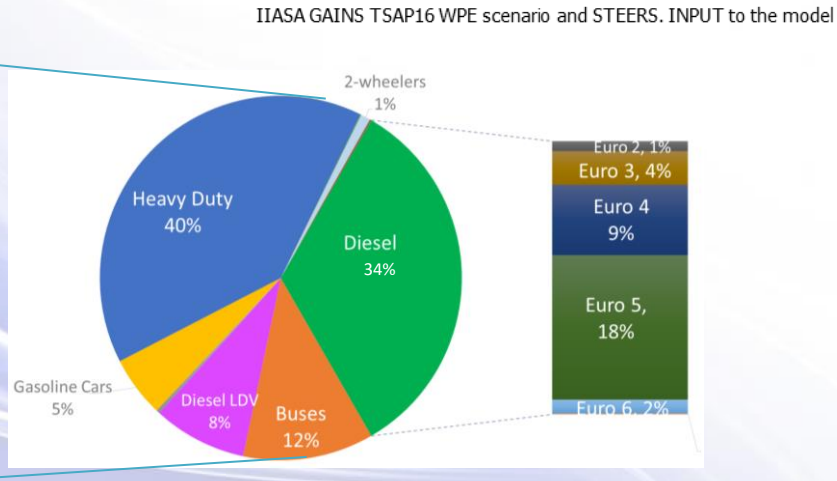


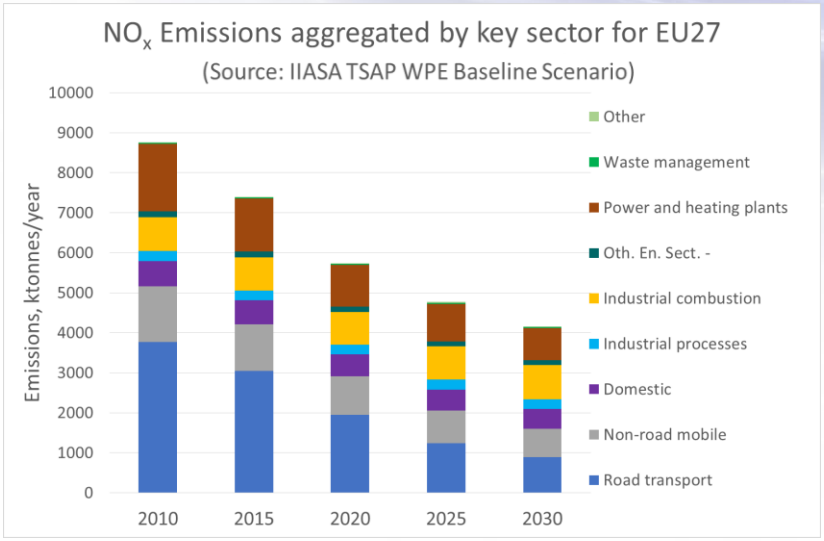
IIASA GAINS TSAP16 WPE scenario and STEERS. INPUT to the model

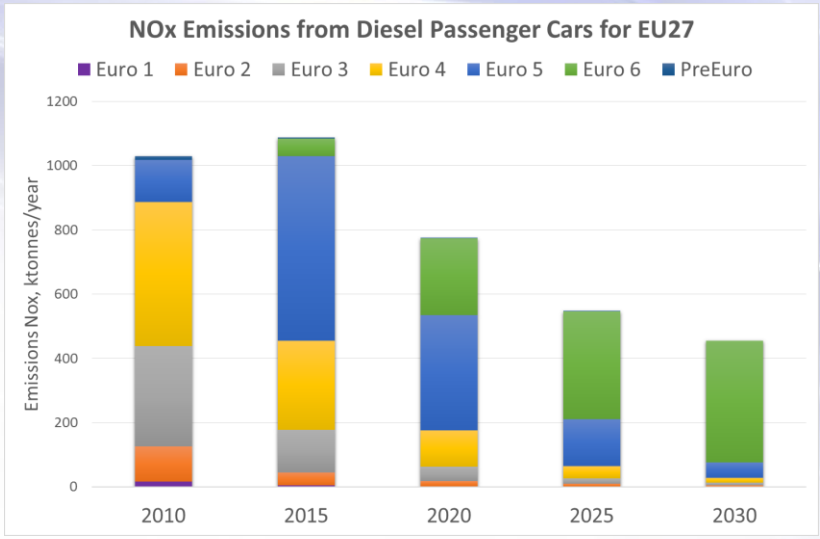
NO_x - Situation very different from PM

- Road transport today accounts for over 40% of the total NO_x emissions:









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Urban Air Quality Study background

- Concawe commissioned a study in October 2014
  - The study was undertaken by Aeris Europe
- Study carried out to understand the diesel contribution to air quality compliance both short term (2015-2020) and longer term (out to 2030) and in relation to the contribution of other sectors
- Modelling different scenarios for road transportation and their impact on compliance with Ambient Air Quality Standards in cities in 2015 - 2030 timeframe
- Study included modelling of
  - The impact of fleet turnover with more stringent emissions standards in place
  - Sensitivity cases based around the level of achievement of the Euro 6 standards
  - The effect of removing diesel vehicles on air quality compliance
  - The effect of other potential policy measures which could be taken

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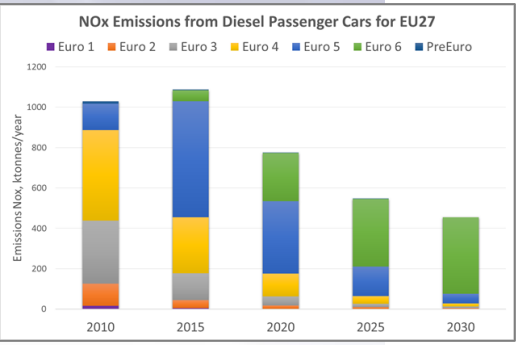
Study Description: Modelling of transport impacts on urban air quality and comparison with other sectors

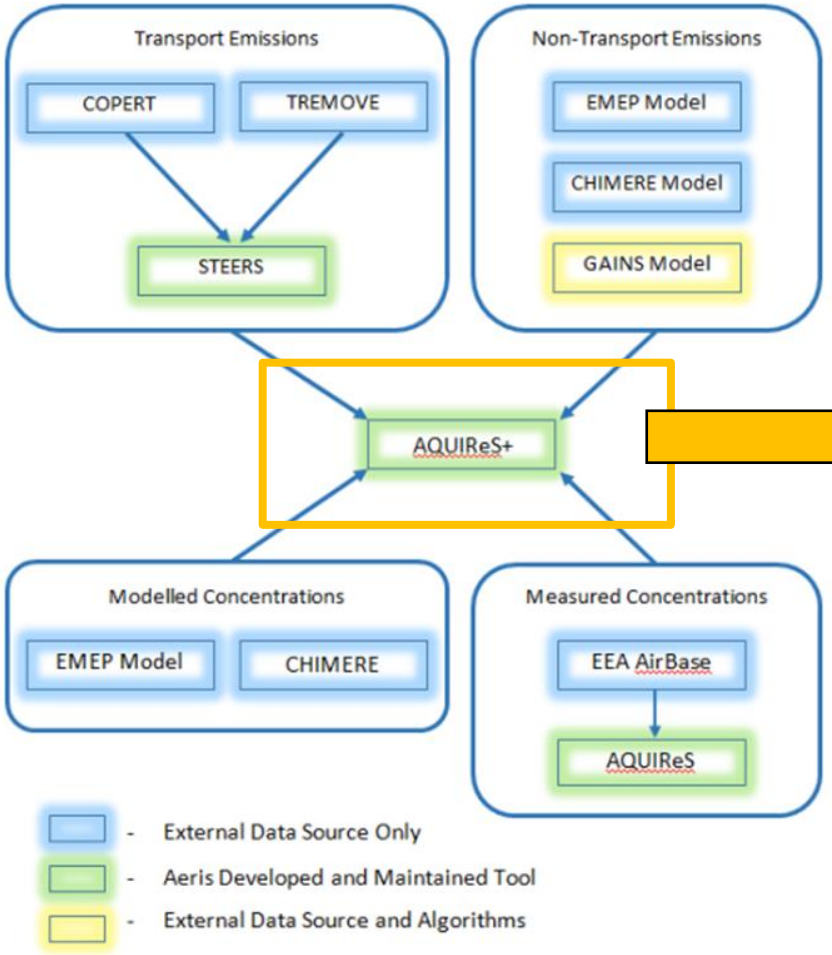
Scenario		NOx Conformity factor used for Euro 6 vehicles (*)	Description
A+		2.8	Limit of 20 mg/m^3 for $PM_{2.5}$ by 2020. $PM_{2.5}$ AAQ Stage 2 Implementation
A		2.8	Eliminating of solid fuel combustion in the domestic sector
B		2.8	Eliminating all diesel exhaust emissions from urban areas
C		2.8	Accelerating older vehicle scrappage and fleet turnover C1: 100% of remaining pre-Euro5 vehicles are replaced. C2:25% of the remaining pre-Euro 5 vehicles are replaced
D	D1	2.8	Removal exhaust emissions from all diesel passenger cars (PCD) in the urban environment
	D2		D1+ removal exhaust emissions from all diesel light duty vehicles (LDV) in the urban environment.
	D3		D2+ removal exhaust emissions from all diesel heavy duty vehicles (HDV) in the urban environment.
	D4		D3+ removal exhaust emissions from all buses (BUS) in the urban environment.
E	SN1a	2015-2020 : 7	2020 onwards: 2.8
	SN1b	2015-2020: 7	2020 onwards: 1.5
	SN1c	2015-2017: 7	2017 onwards: 1.5
	7xLLV	7	
	ZEPCD	All diesel passenger cars registered from Jan 1, 2015 produce zero NOx emissions	

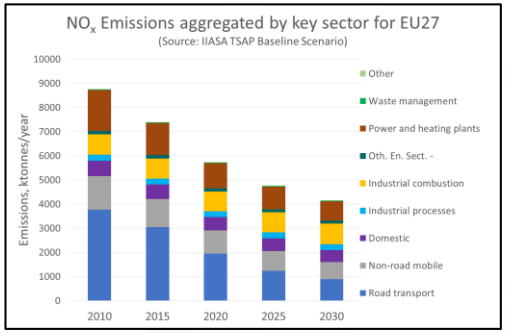
Euro 6 performance scenarios

- Equivalent CF based on analysis of Copert and legislated standards

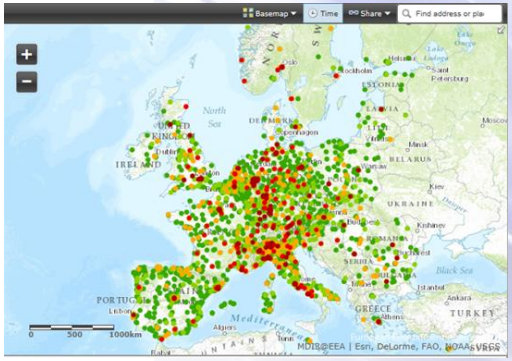
Study Description: Modelling tools employed







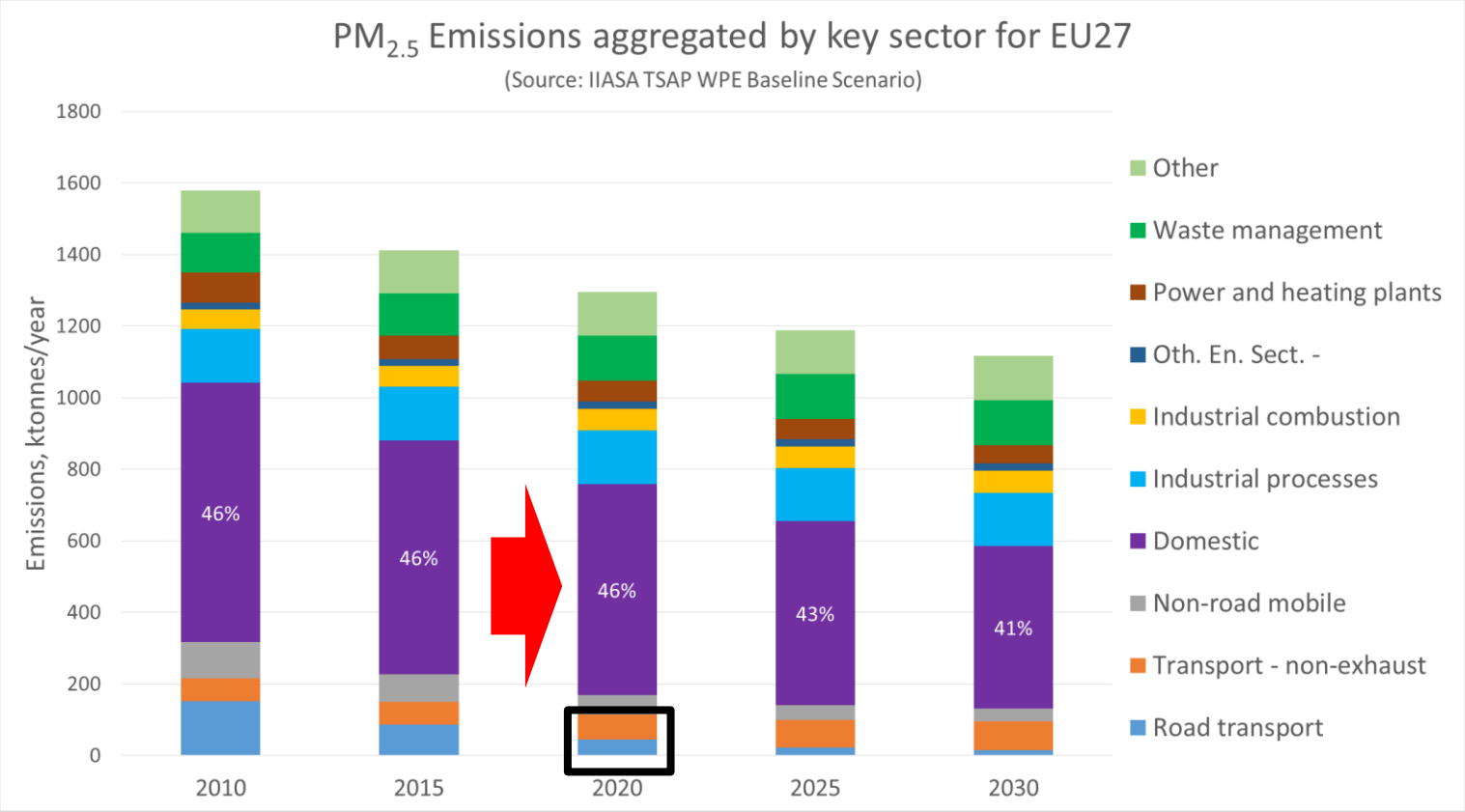
Key Findings



Concawe - Aeris study: Key Findings: PM emissions

Primary PM_{10} and $PM_{2.5}$ emissions from engine/exhaust road transport is a decreasingly small contributor to the total urban emissions:

- By 2020 non-exhaust transport emissions become the main road transportation source.
- PM emissions from road transport become independent from the powertrain.
- The domestic sector is the main contributor to primary PM_{10} and $PM_{2.5}$ emissions.



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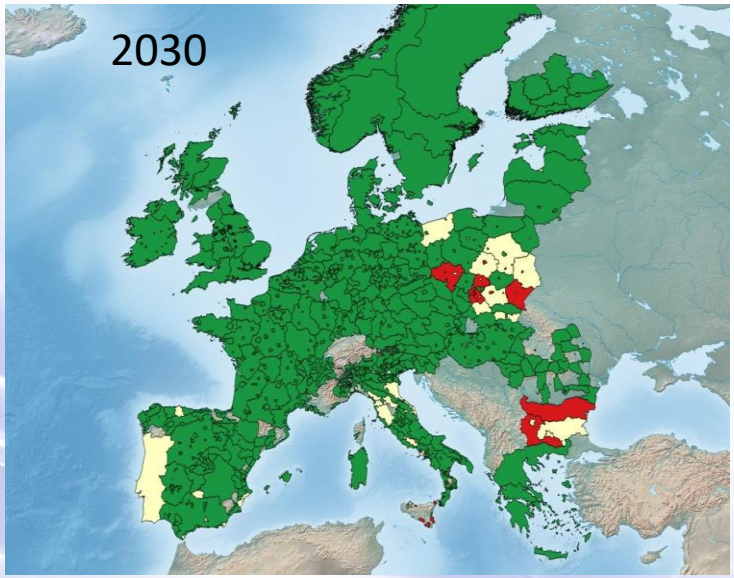
Concawe-Aeris study: Key Findings: PM air quality

Elimination of diesel exhaust emissions in the studied timeframe will not help to achieve earlier PM compliance with air quality standards.

Non-transport measures would need to be put in place to address PM compliance with ambient air quality standards.

Most of the residual PM non-compliance by 2030 is attributable to the PPM emissions from domestic combustion of solid fuels in Eastern Europe.

Replacement of solid fuels with cleaner burning alternatives in these areas is expected to help achieve future compliance.



$PM_{2.5}$	% of population					
	Living in likely compliant zones			Living in likely uncompliant zones		
	Base case	Scenario A: banning solid fuel domestic heating	Scenario B: elimination of diesel exhaust emissions	Base case	Scenario A: banning solid fuel domestic heating	Scenario B: elimination of diesel exhaust emissions
2020	77%	85%	77%	4%	3%	4%
2030	81%	89%	81%	4%	3%	4%

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Concawe-Aeris study Key Findings: NO_2

- Early replacement of 100% of pre-Euro 5 vehicles delivers an improvement in the compliance with ambient air quality standards in the short term (2015-2020):
  - In 2020, the improvement of the "***percentage of EU population***" living in likely compliant zones increases from 83% in the base case to 88%.
  - Beyond 2025 those living in likely non-compliant zones remains at 5%.
- Removing all diesel exhaust emissions from the urban environment provides benefits in the short term:
  - By 2030, however, gives similar results to early replacement of pre-Euro 5 vehicles in terms of % of those living in likely compliance zones.

NO_2	% of EU population					
	Living in likely compliant zones			Living in likely uncompliant zones		
	Base case	Scenario C 1: accelerated turnover of the fleet	Scenario B: removal of diesel exhaust emissions from urban areas	Base case	Scenario C 1: accelerated turnover of the fleet	Scenario B: removal of diesel exhaust emissions from urban areas
2015	69%	69%	69%	18%	18%	18%
2020	83%	88%	94%	10%	6%	0%
2025	90%	91%	95%	5%	5%	0%
2030	93%	93%	95%	5%	5%	0%

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Future NO_2 noncompliance: confined to discrete areas

Figure 6.16 - Base Case - NO_2 - Air Quality Management Zone Compliance - 2010

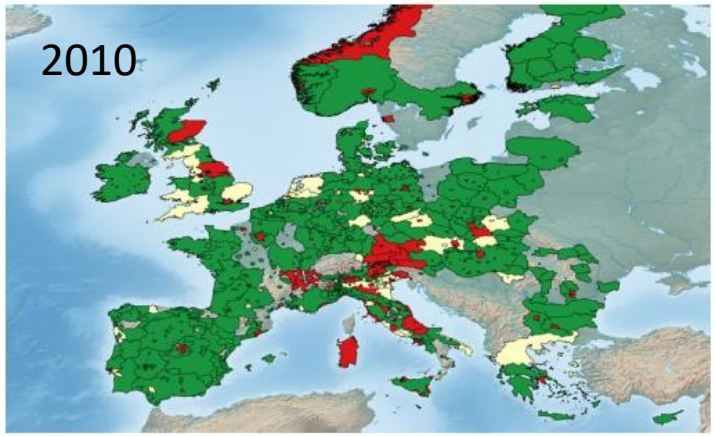


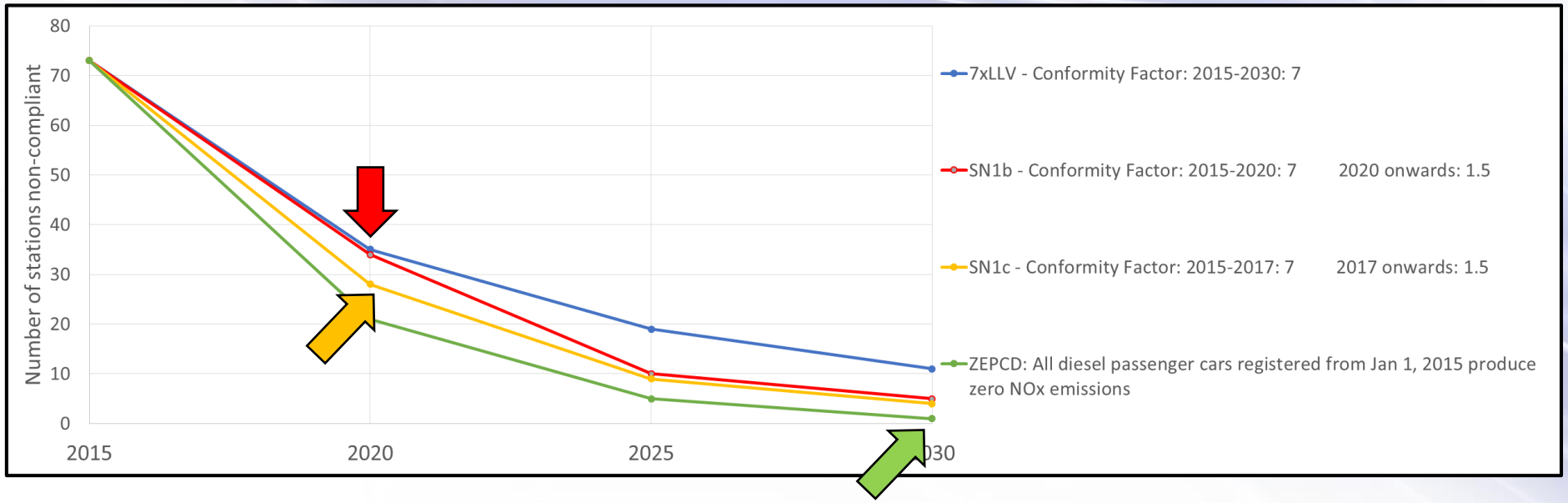
Figure 6.17 - Base Case - NO_2 - Air Quality Management Zone Compliance - 2020

Figure 6.18 - Base Case - NO_2 - Air Quality Management Zone Compliance - 2025

Figure 6.19 - Base Case - NO_2 - Air Quality Management Zone Compliance - 2030

Concawe-Aeris study: Key Findings NO_2

- In the short term, the acceleration of achievement of the lowest conformity factor (1.5 from 2020 → 2017) (SN1c) gives significant benefits comparable with the closest scenario to that legislated (SN1b: 1.5 from 2020)
- In the long term, in either case the number of remaining non compliant stations is small. The zero emission passenger car situation is also shown (ZEPCD)
- As residual NO_2 compliance issues are confined to very small areas, very local and tailored-made strategies should help to deliver results within the same time horizon



Note: 1477 urban stations in study population (Report table 5.3)

Example local measures

DEFRA NO_2 Compliance Modelling (UK)

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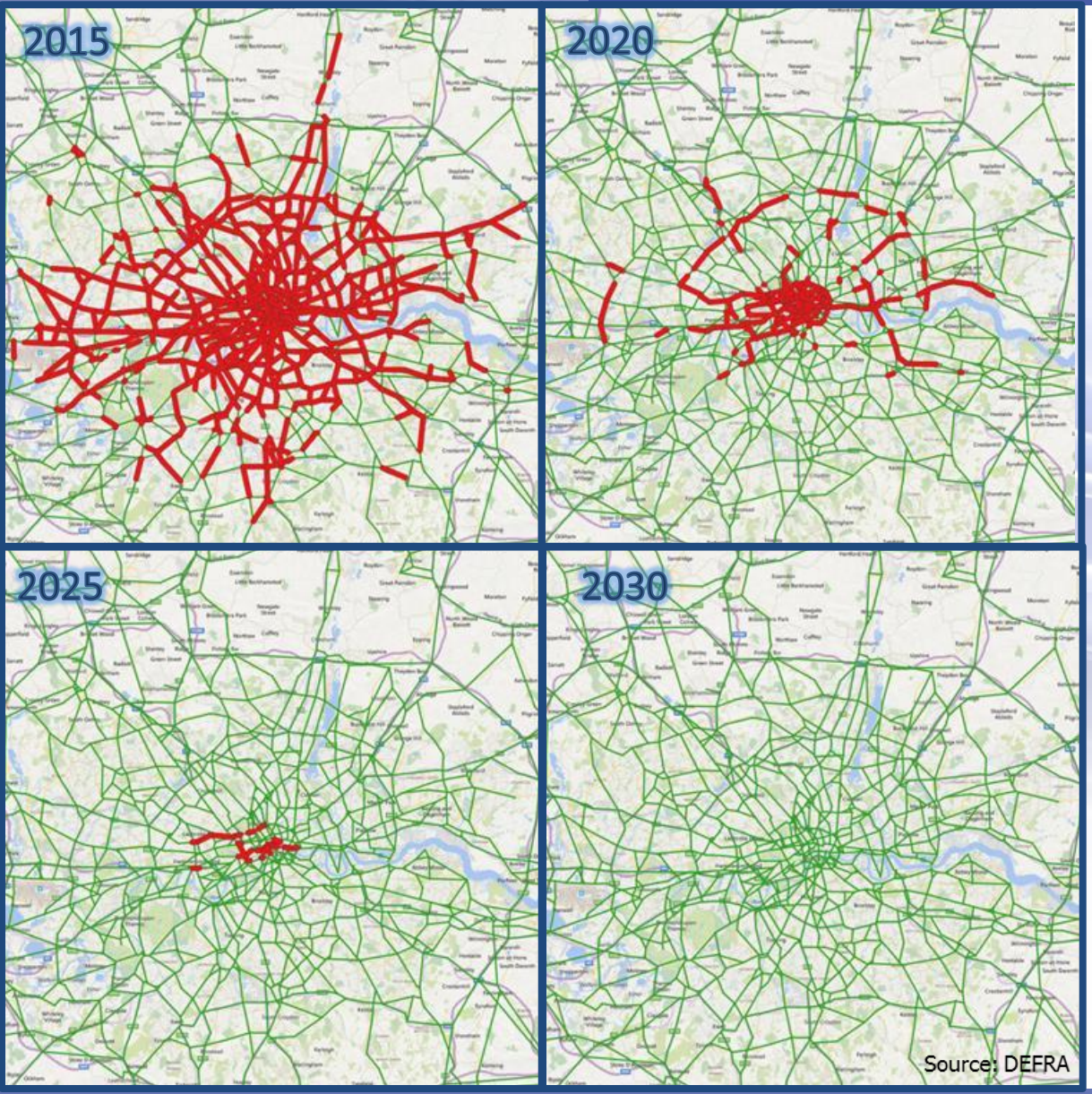
Example local measures: DEFRA NO_2 Compliance Modelling - London



- Comprehensive (UK-wide) road link modelling undertaken in UK by DEFRA.
- Non-compliance (Red) with NO_2 limit value extensive in 'Now' to 2020 period but post 2020, as Euro 6 technology becomes significant part of fleet, areas of non-compliance rapidly reduce.
- By 2025 non compliance limited to some 25 kilometres of road; by 2030 full compliance on all roads is foreseen.
- Emission Factors used by DEFRA were COPERT4v11

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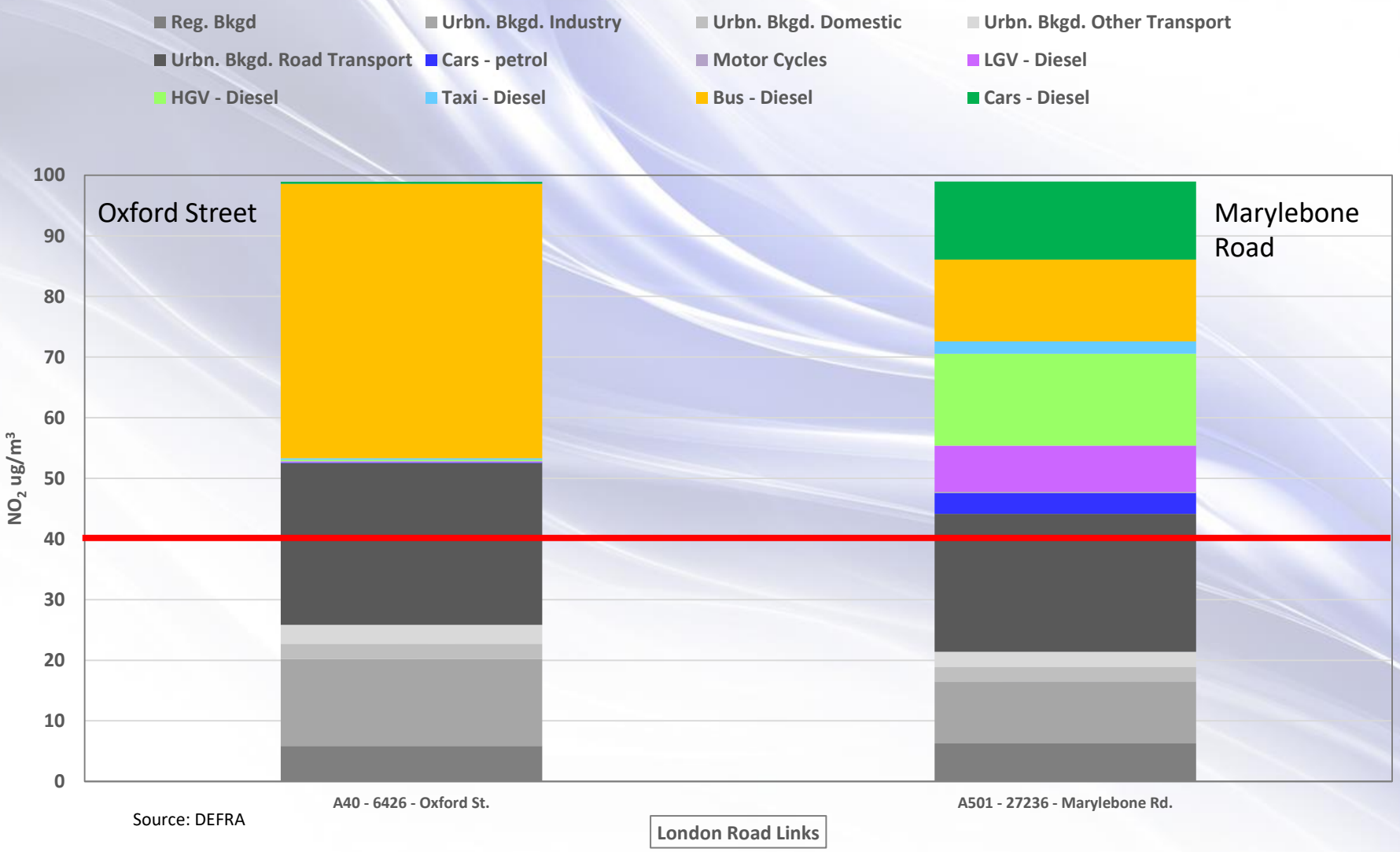
Source Apportionment - the key to designing appropriate responses



Source: DEFRA

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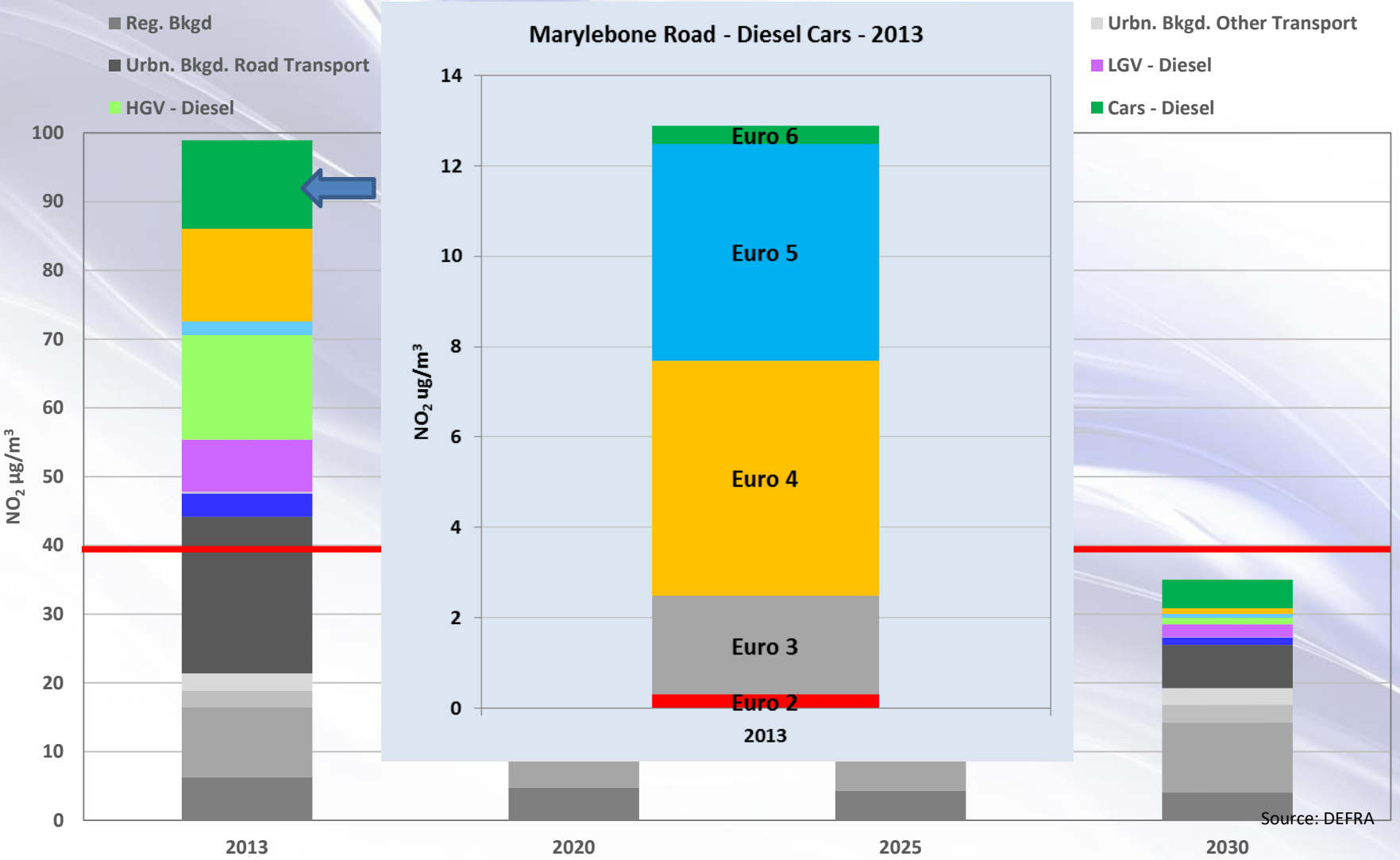
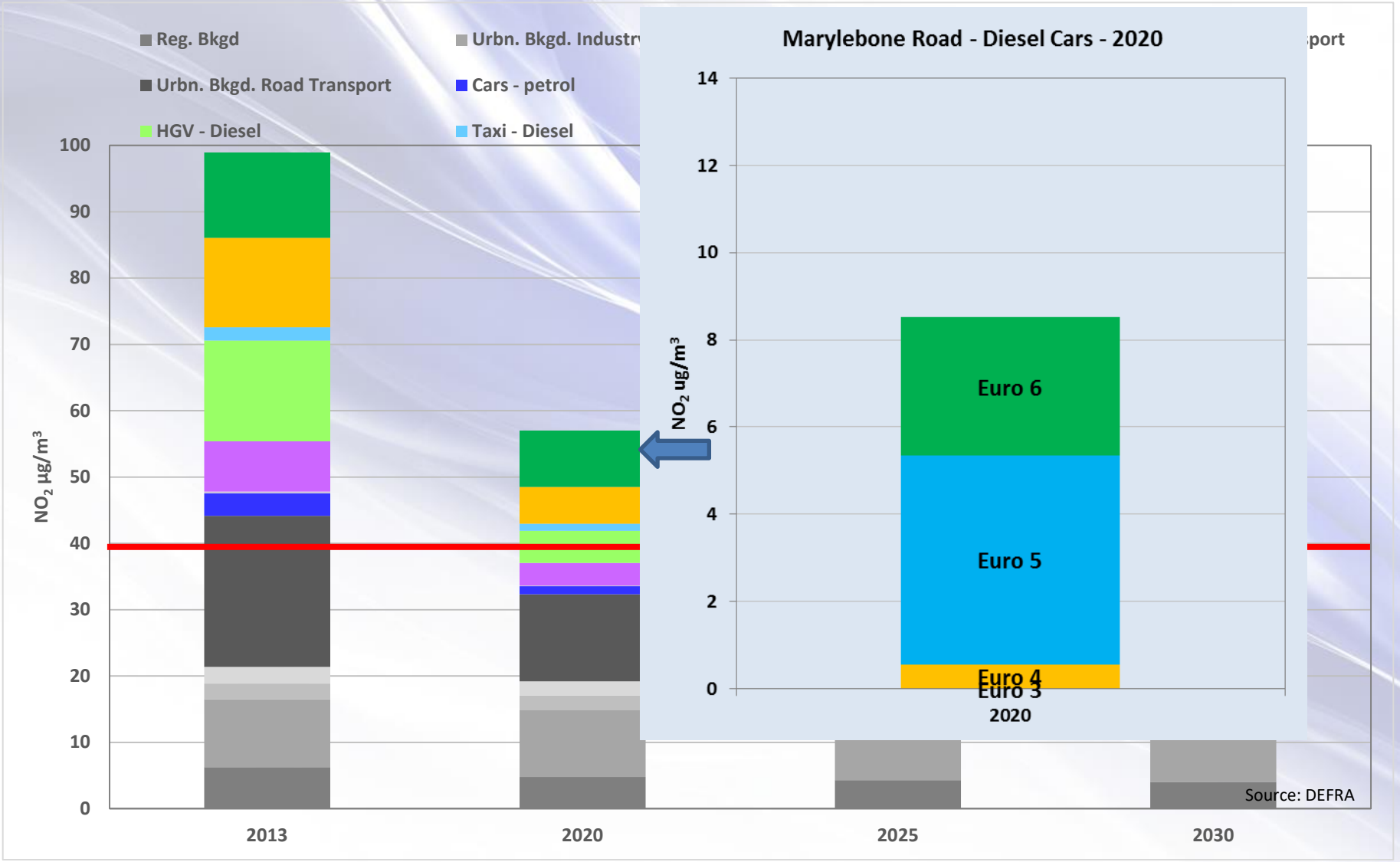
Example local measures: DEFRA NO_2 Compliance Modelling
London - Marylebone Road - High Diesel Passenger Car Contribution



Example local measures: DEFRA NO_2 Compliance Modelling
London - Marylebone Road - High Diesel Passenger Car Contribution



A First Exploration of Population Exposure Analysis in London

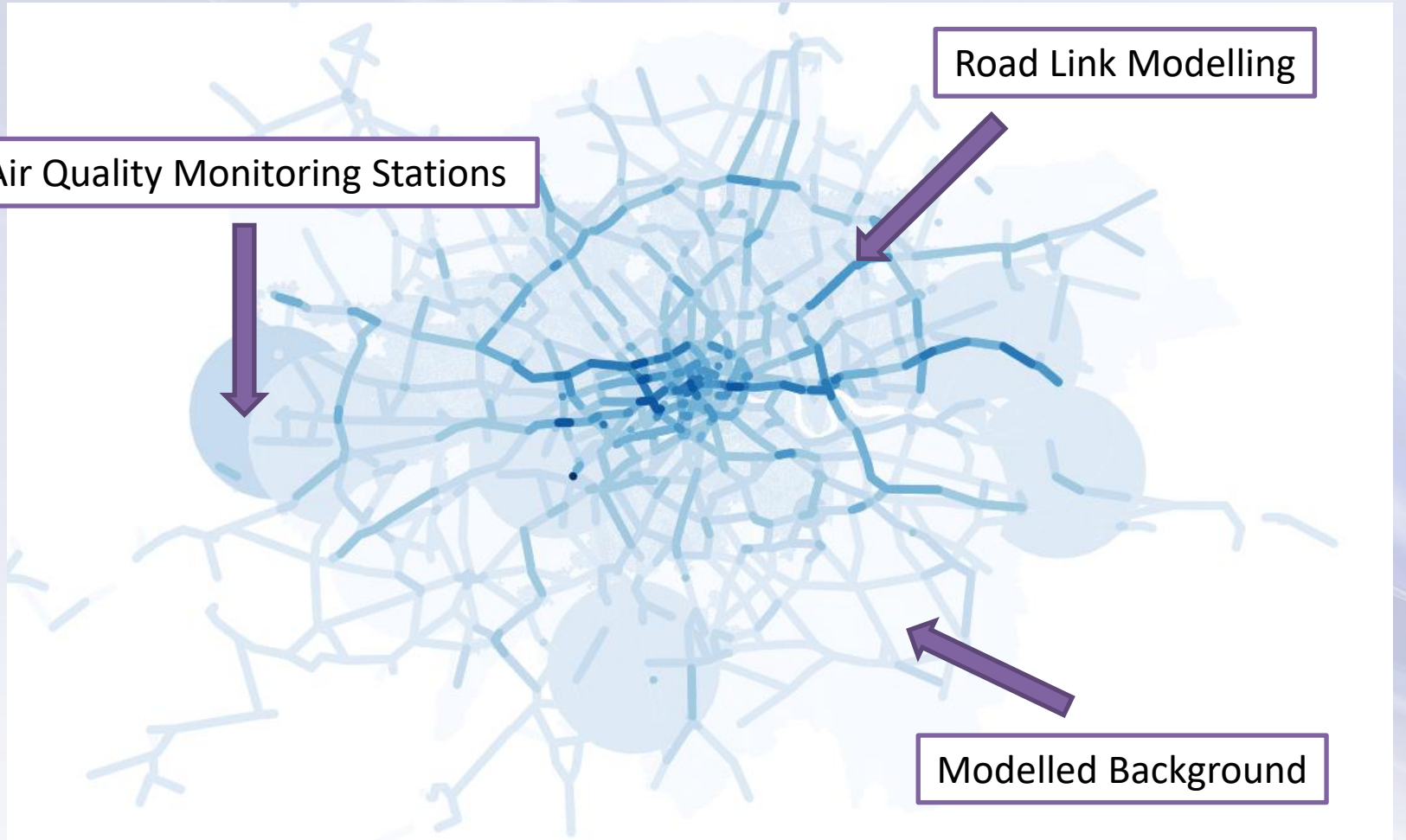
Background

Areas of Representativeness (AoR)

- Assign AoRs to London's air quality monitoring network using the rules laid down in the AAQD
- Using the rules for traffic stations apply AoRs to the modelled road links in London
- Modelled background concentration (1x1km) for the rest of London
- Handle overlapping AoRs
  - Averaging background stations
  - Highest of monitoring station, modelled background and road link

Urban Air Quality

London NO_2 Concentrations



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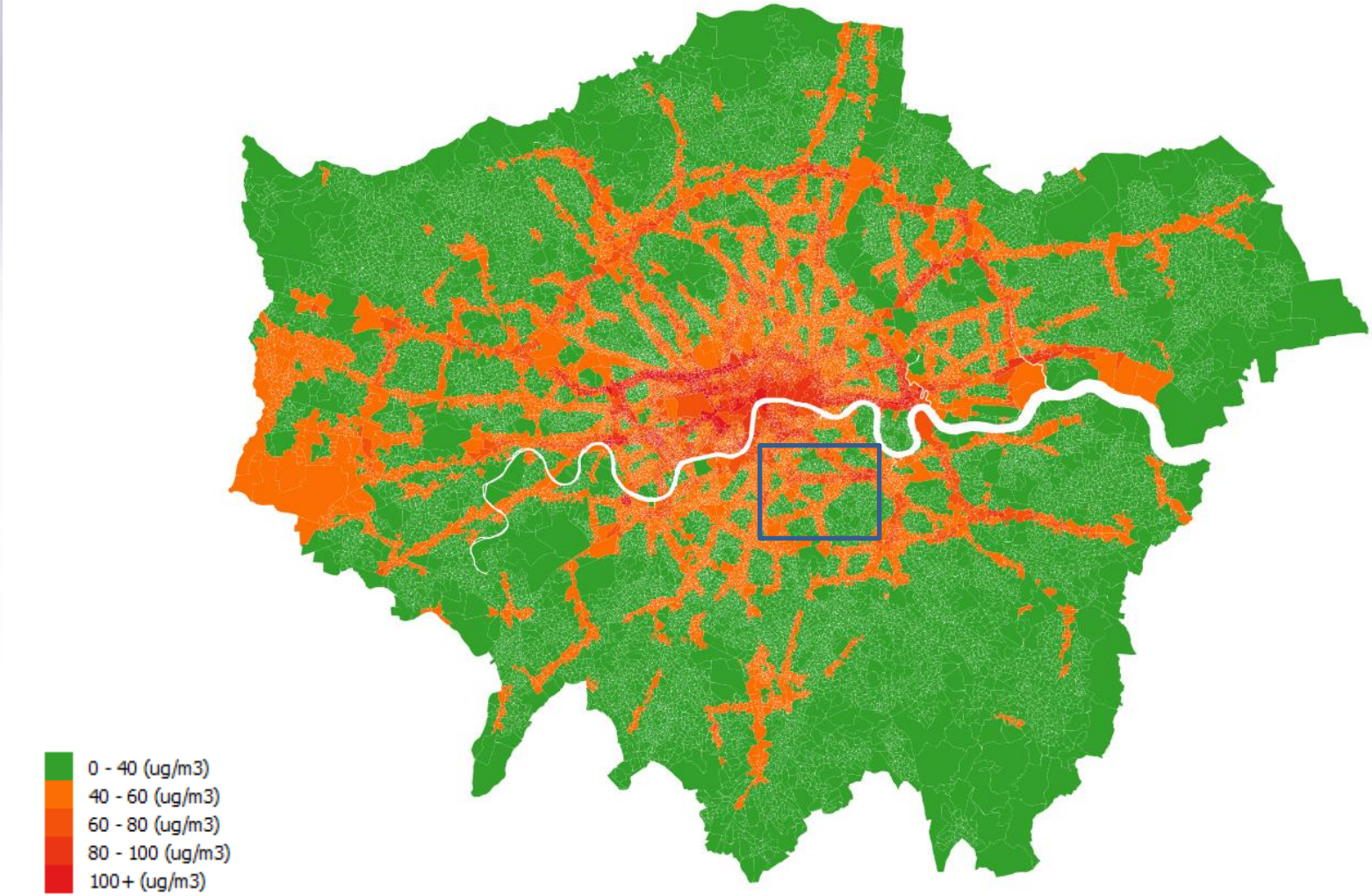
London 2013 Base Case (NO_2)

2013



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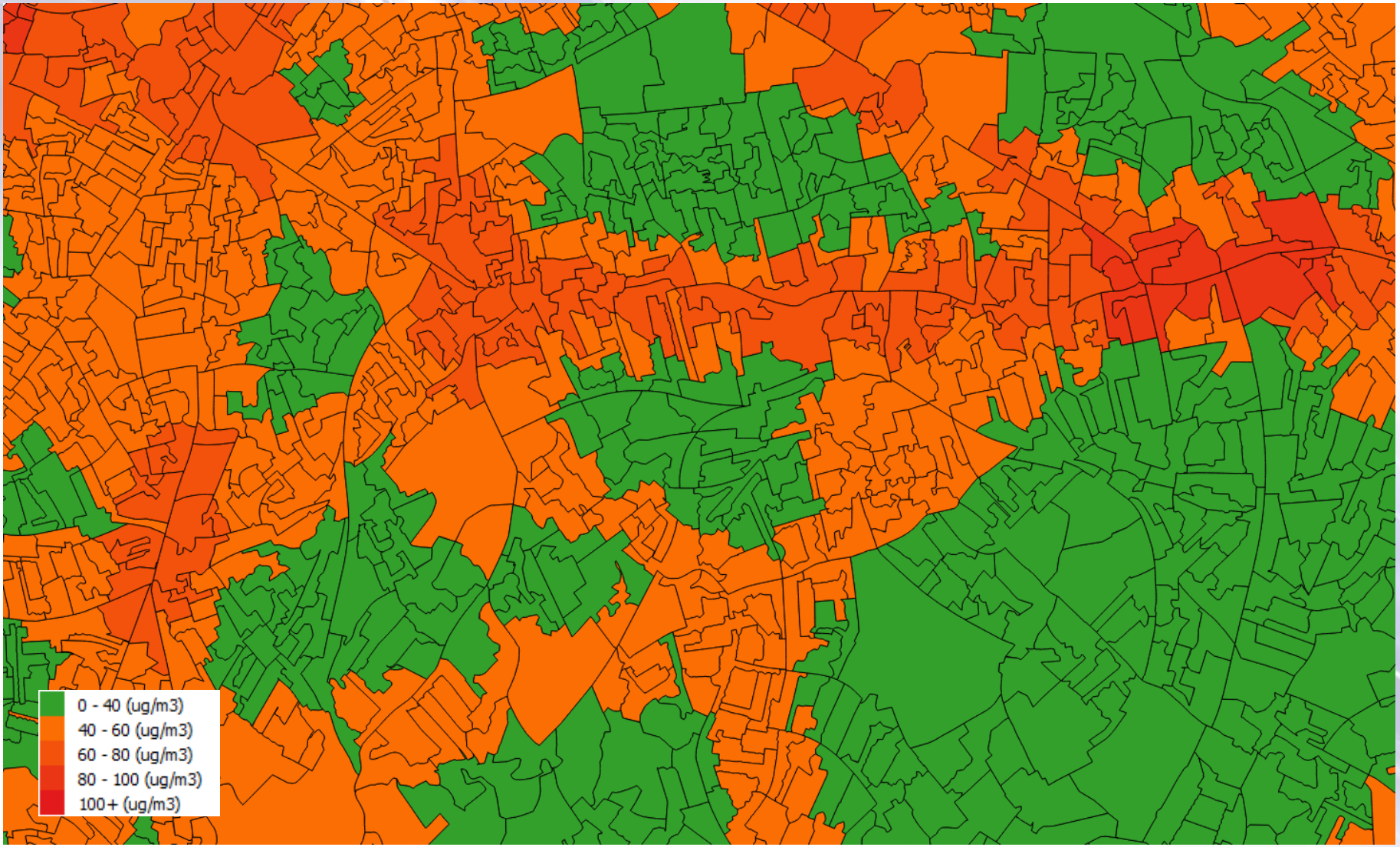
London 2013 Base Case (NO_2)



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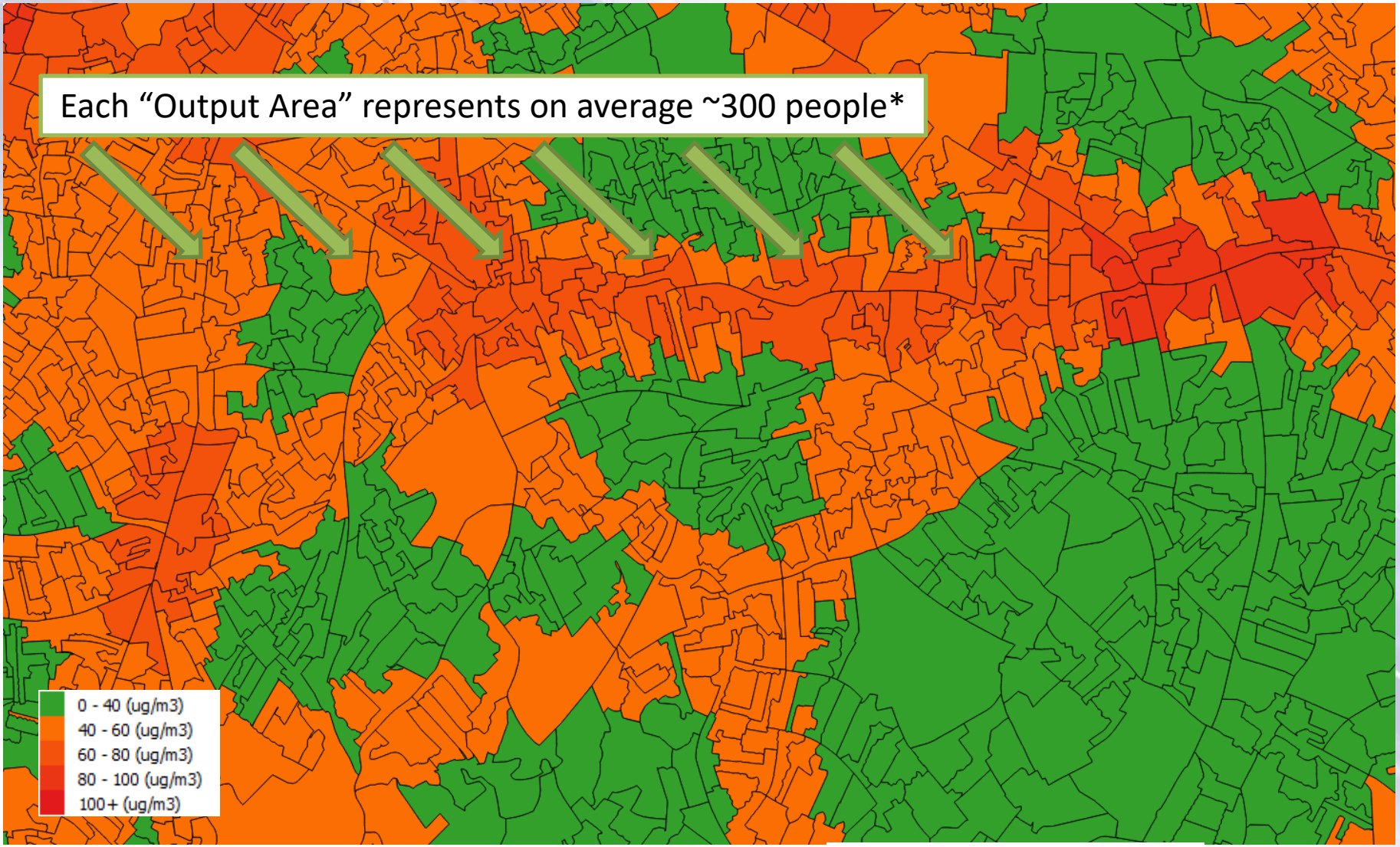
London 2013 Base Case (NO_2)



*We have exact numbers for each OA

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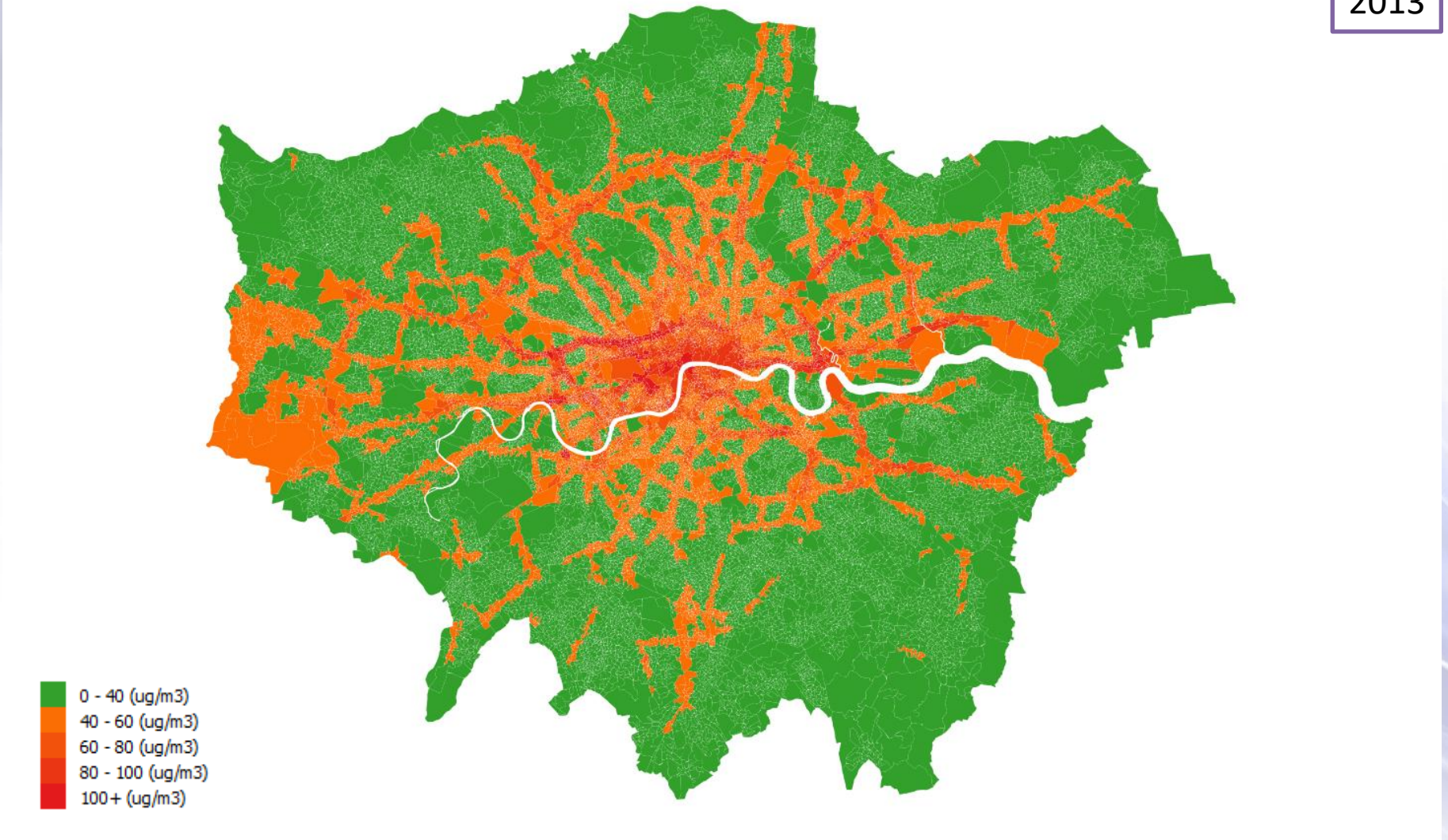
London 2013 Base Case (NO_2)

2013



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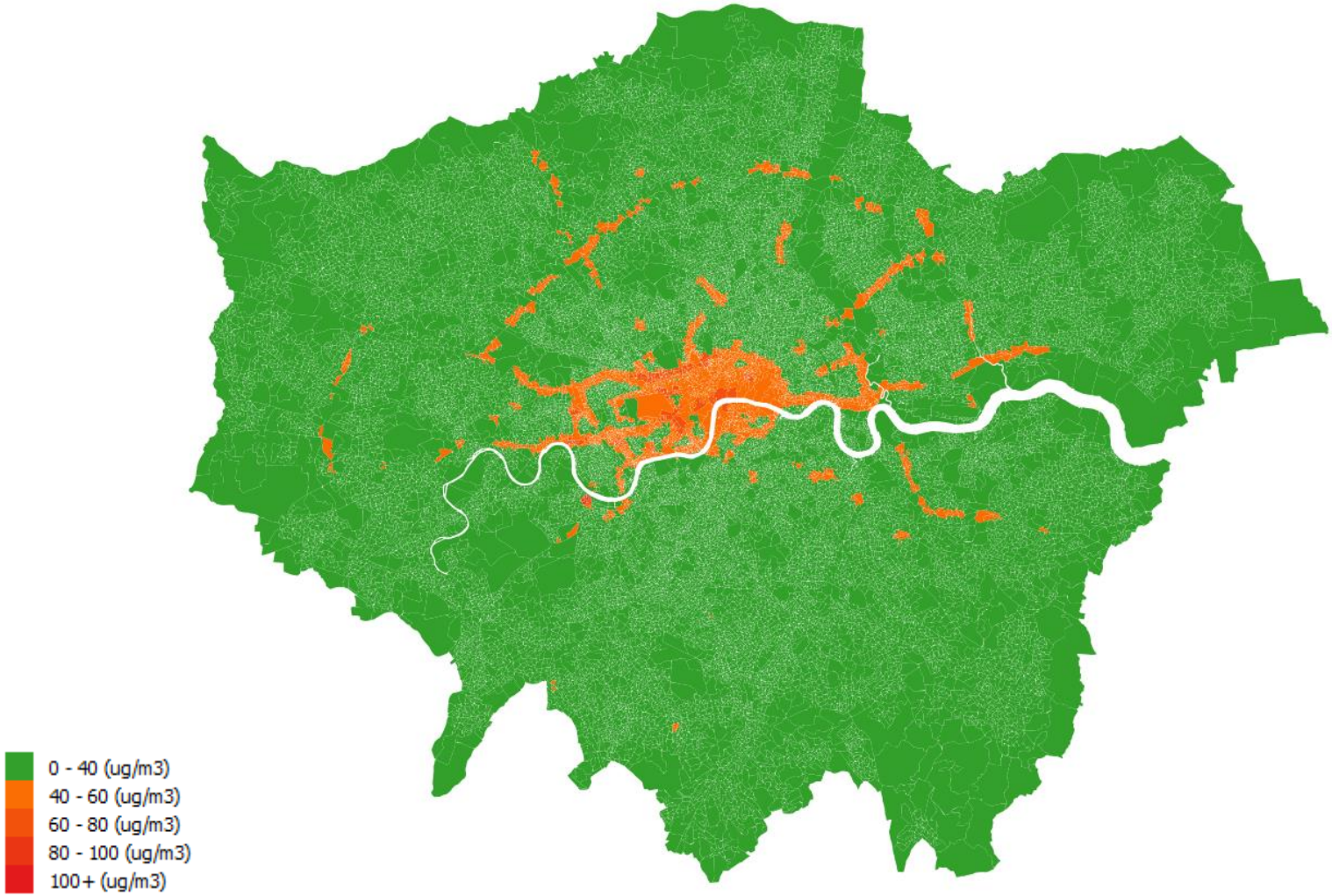
London 2020 Base Case (NO_2)

2020



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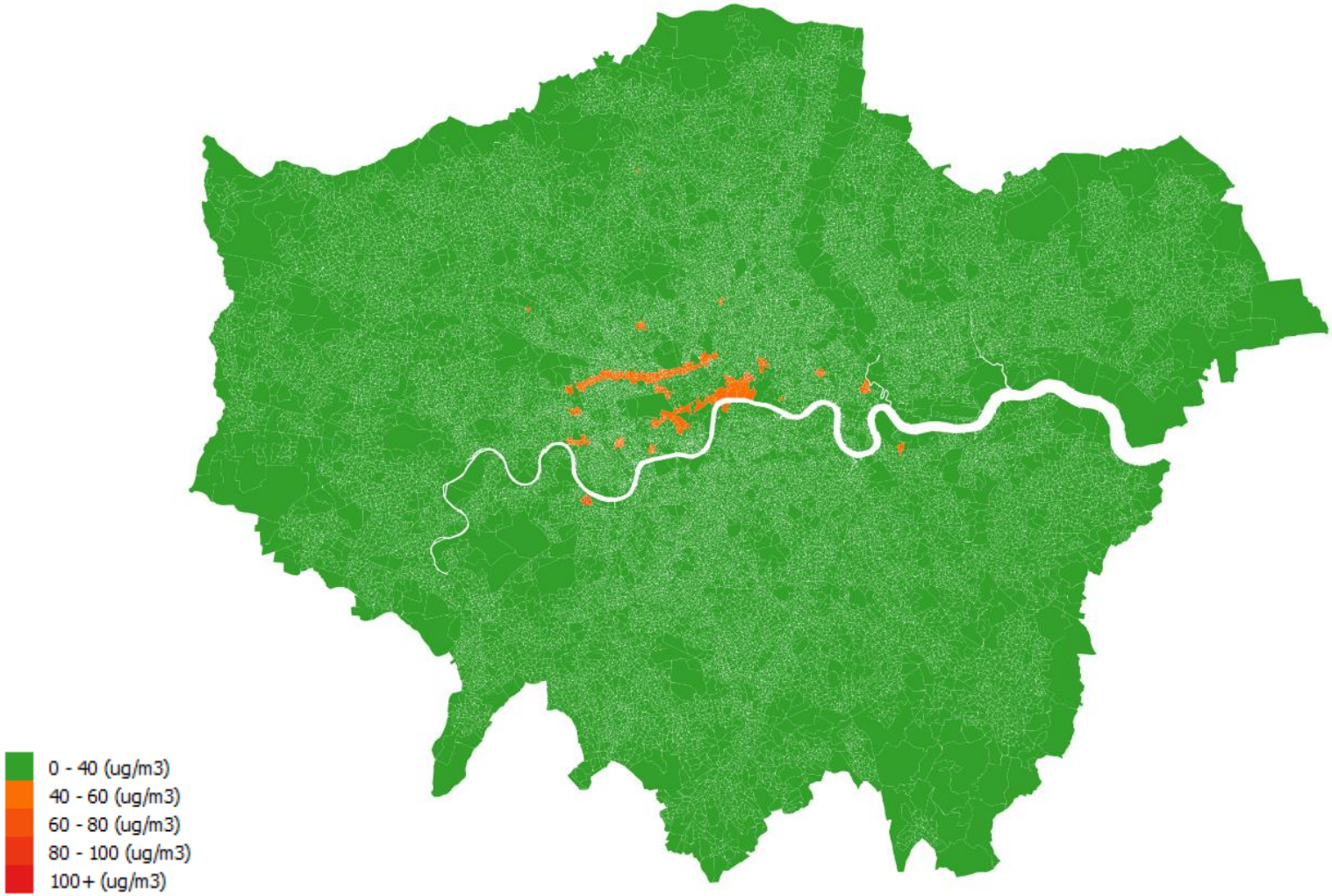
London 2025 Base Case (NO_2)

2025



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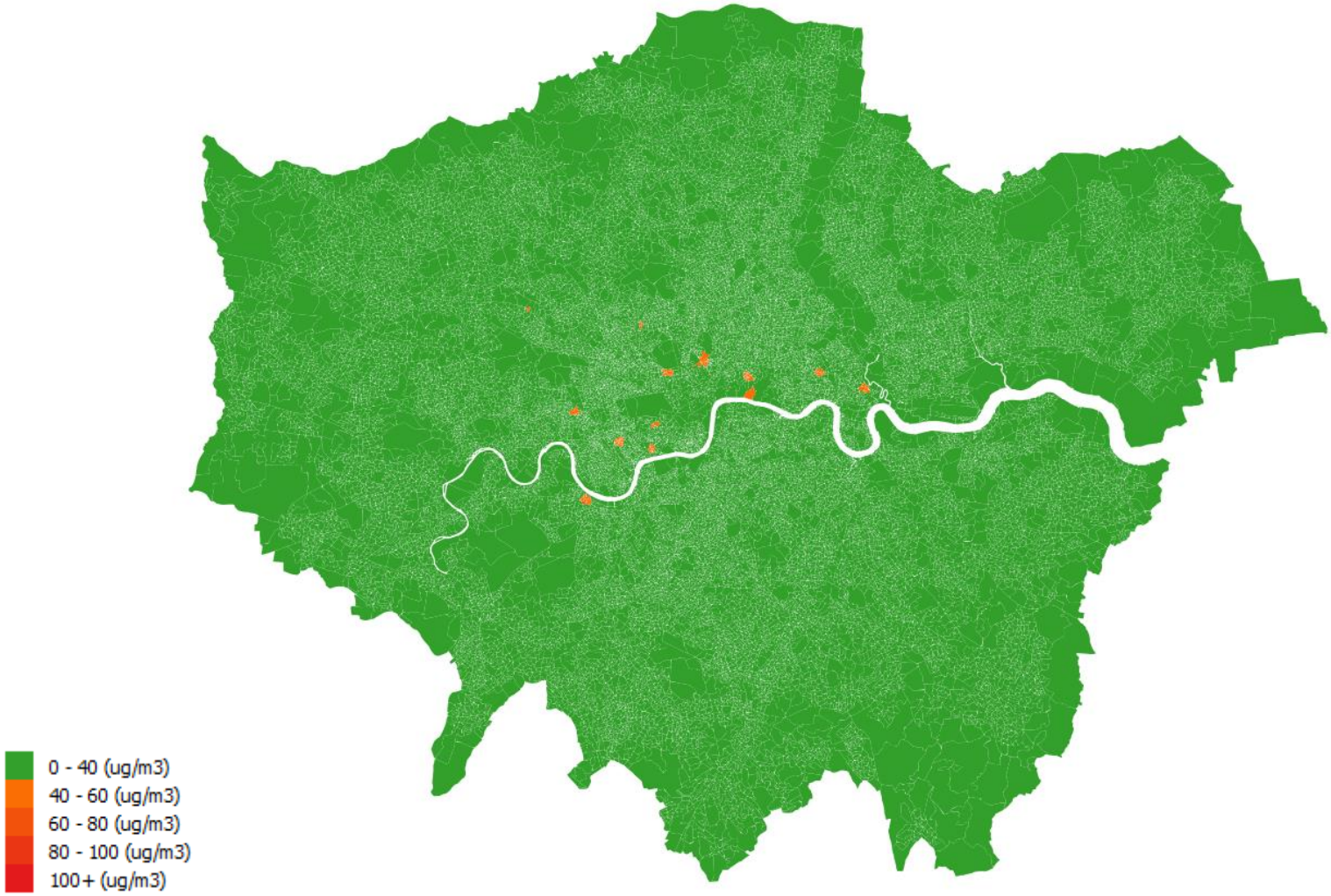
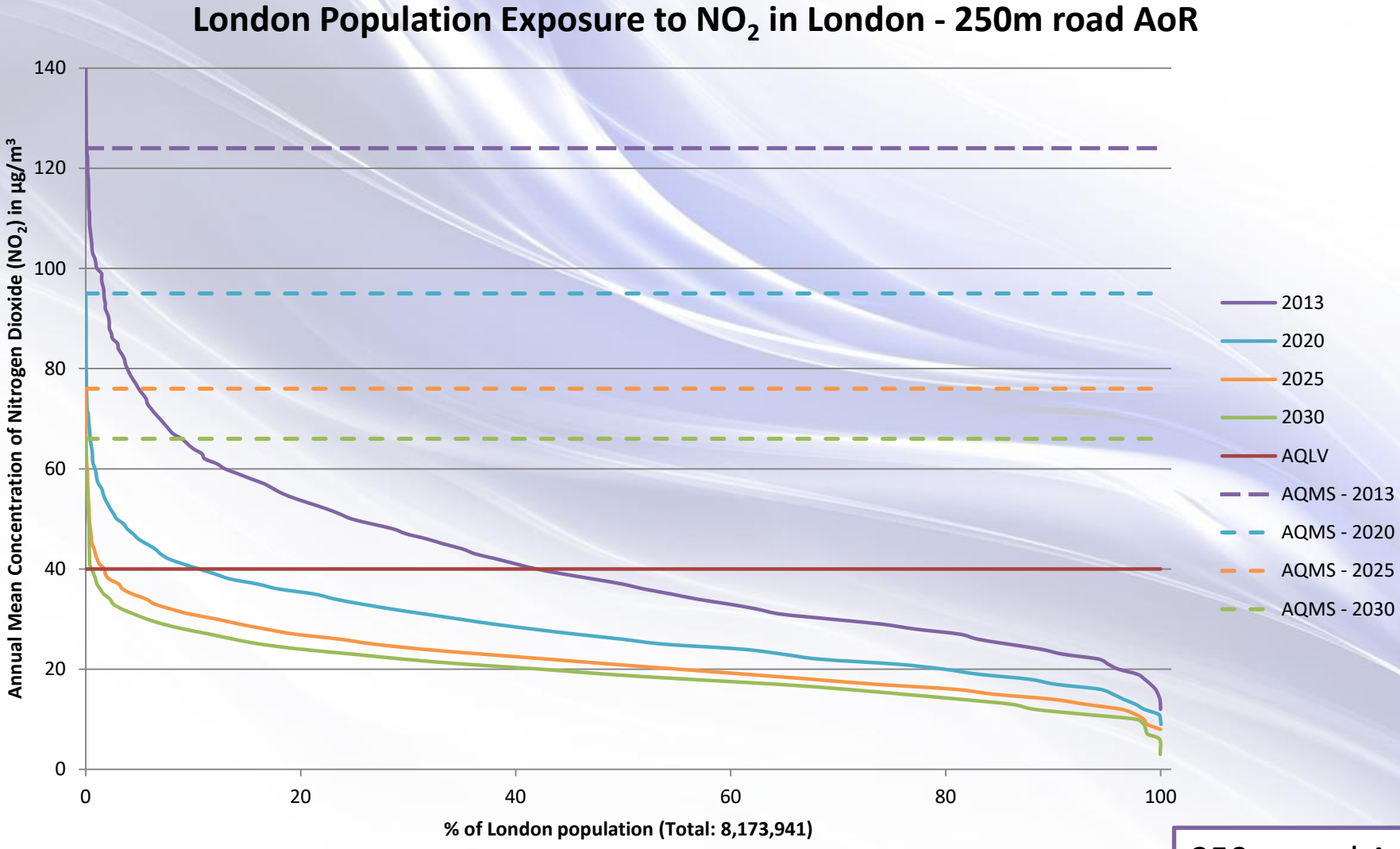
London 2030 Base Case (NO_2)

2030



London Population Exposure (Base Case)



250m road AoR

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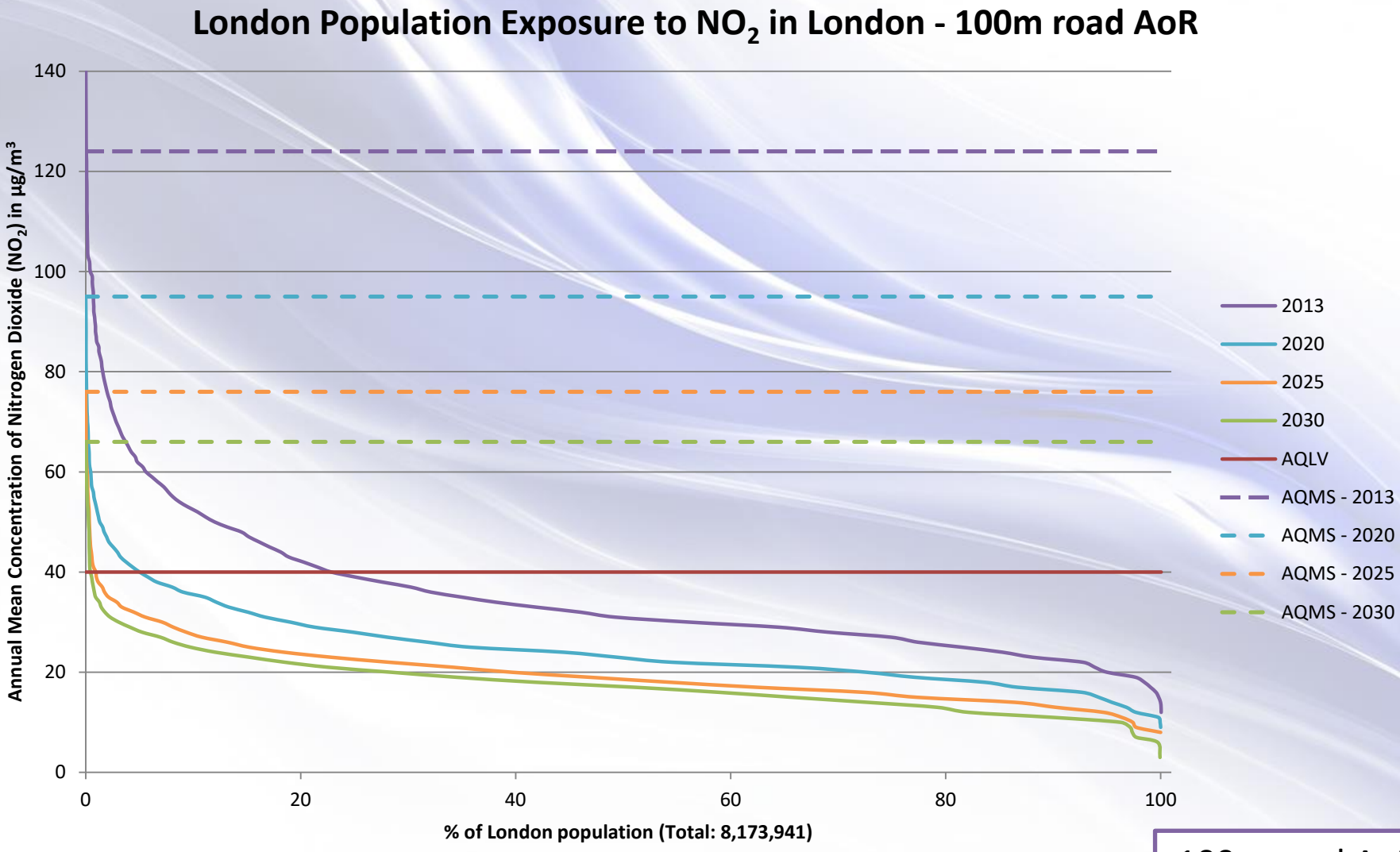
London Population Exposure (Base Case)



100m road AoR

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Overall Conclusions: PM and NO_2

- Primary PM_{10} and $PM_{2.5}$ emissions from engine/exhaust road transport is a decreasingly small contributor to the total emissions
- For PM, elimination of diesel exhaust emissions in the studied timeframe will not help to achieve earlier compliance with air quality standards
  - Replacement of solid fuels with cleaner burning alternatives in selected areas of non-compliance is expected to help achieve future compliance
- NO_2 ambient air quality compliance is reliant on:
  - The short term (2020 horizon): targeted local measures
  - The medium-long term (2025 -2030 horizon): Euro 6/VI achieving compliance with conformity factors
- Targeted local options for NO_2 could include:
  - Accelerating the replacement of pre-Euro 5 by newer vehicles
  - Targeting measures (including retrofitting) to 'captive fleets' (e.g. buses)
  - Introducing 'Ultra Low Emission Zones' (ULEZ) where necessary
- Source apportionment is key to designing appropriate local responses
- Careful investigation of population exposure would be worthwhile

Thank you for your attention

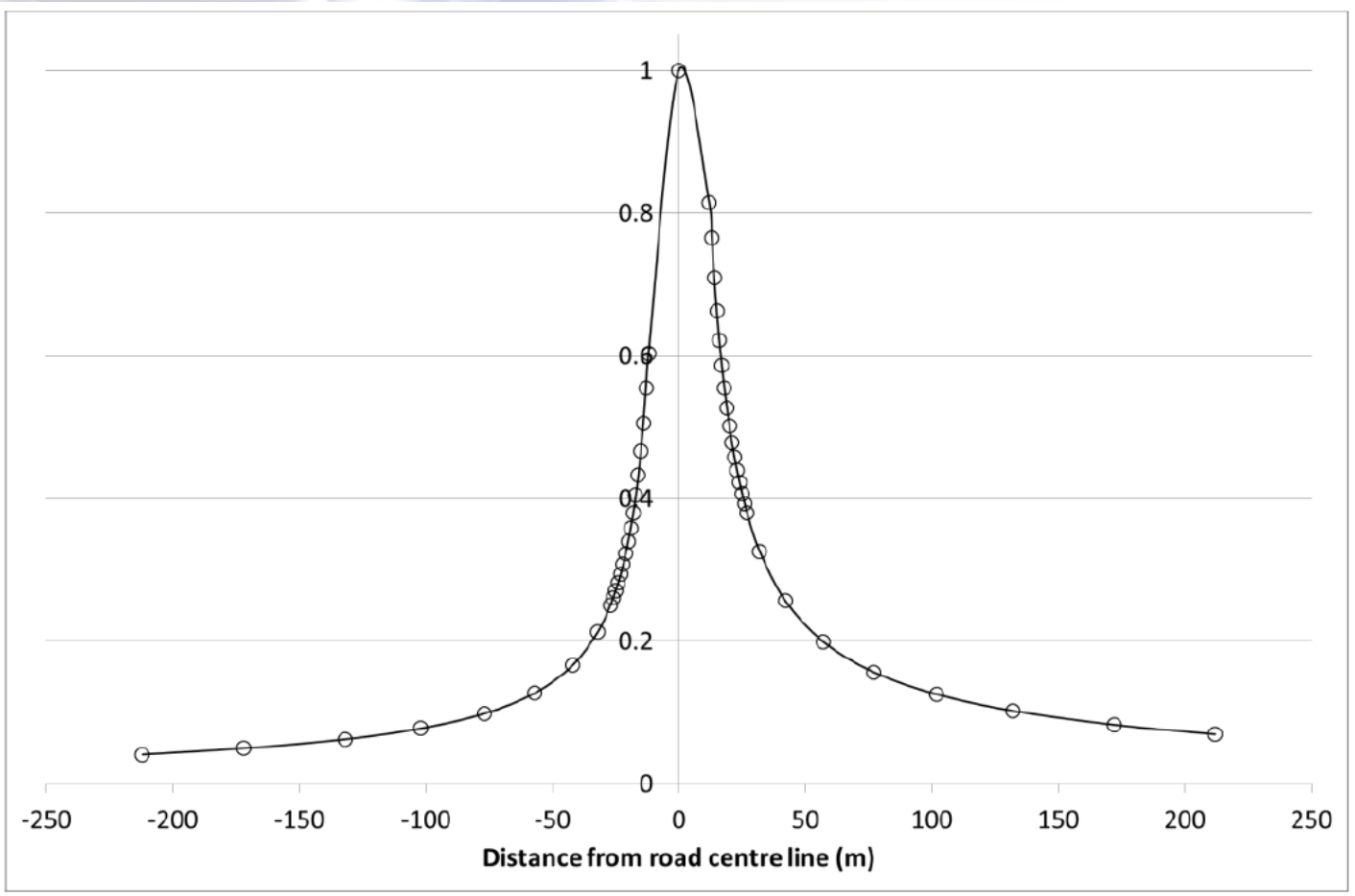
Urban Air Quality Study (report no. 11/16)

https://www.concawe.eu/publications/concawe-reports/

Back-up Slides

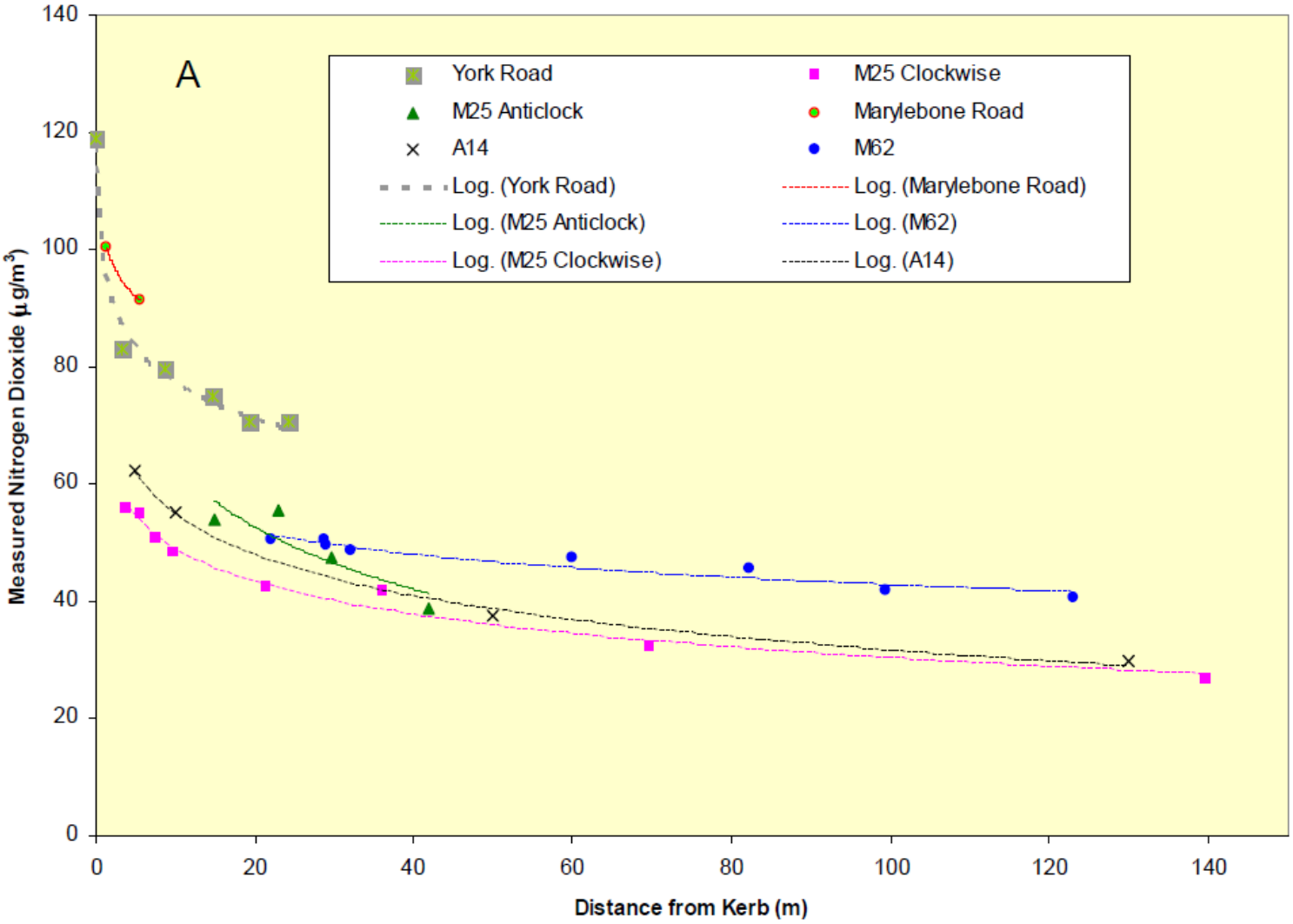
NO_2 Attenuation with Distance from Road

NO2 Attenuation -vs- Distance from Road



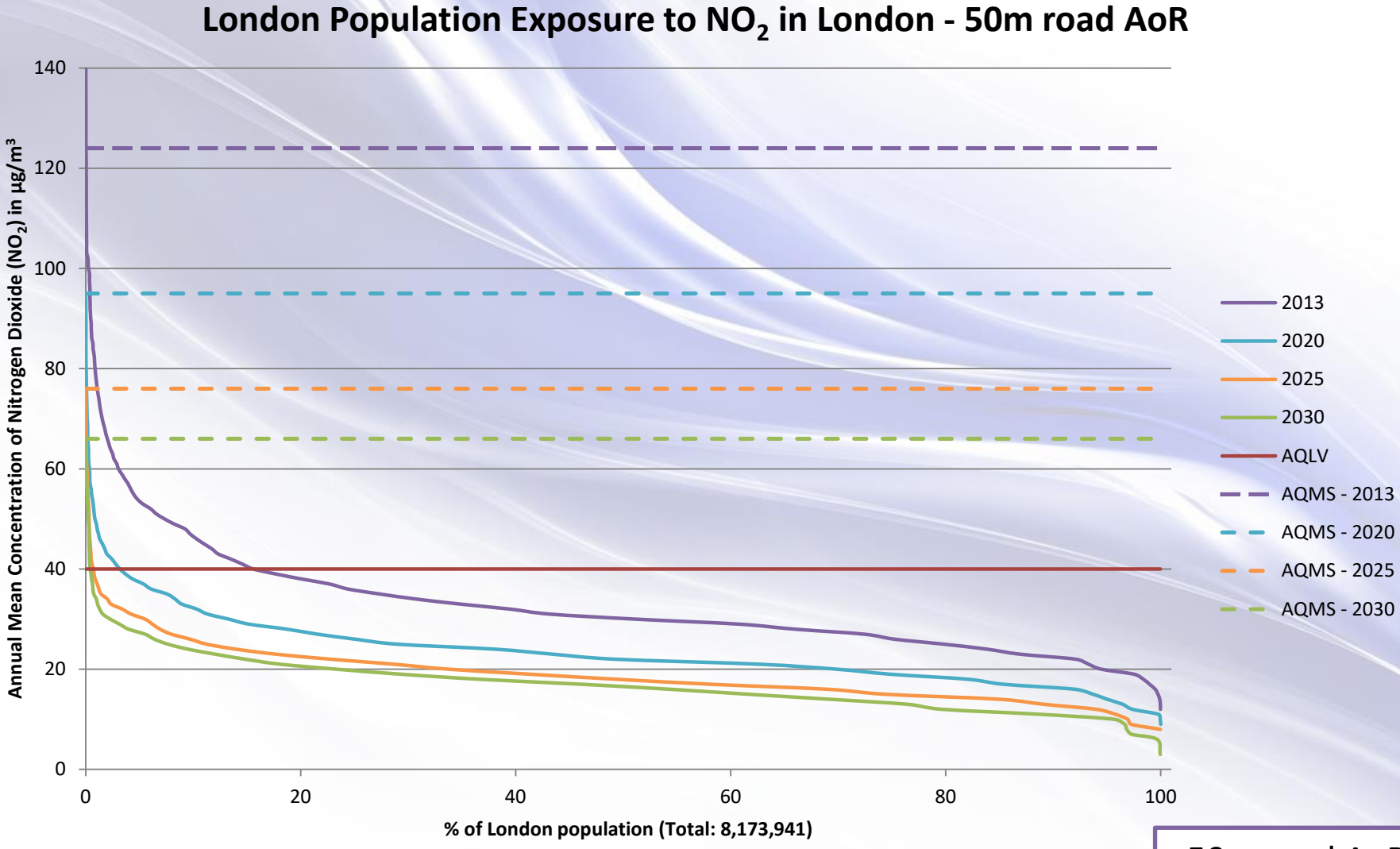
Source: DEFRA Technical Report December 2015, Annex B, Figure B.2 – Example normalised concentration profile

NO2 Attenuation -vs- Distance from Road



Source: *NO2 Concentrations and Distance from Roads*, Air Quality Consultants, July 2008

London Population Exposure (Base Case)



50m road AoR

DEFRA NO2 Action Plan 2015

2015 NO2 projections data (2013 reference year)

Projections for concentrations of nitrogen dioxide (NO2) and oxides of nitrogen (NOx) across the UK in 2020, 2025 and 2030 have been calculated as part of a Pollution Climate Mapping (PCM) model assessment for the development of the 2015 Air Quality plan: Improving air quality in the UK: Tackling nitrogen dioxide in our towns and cities.

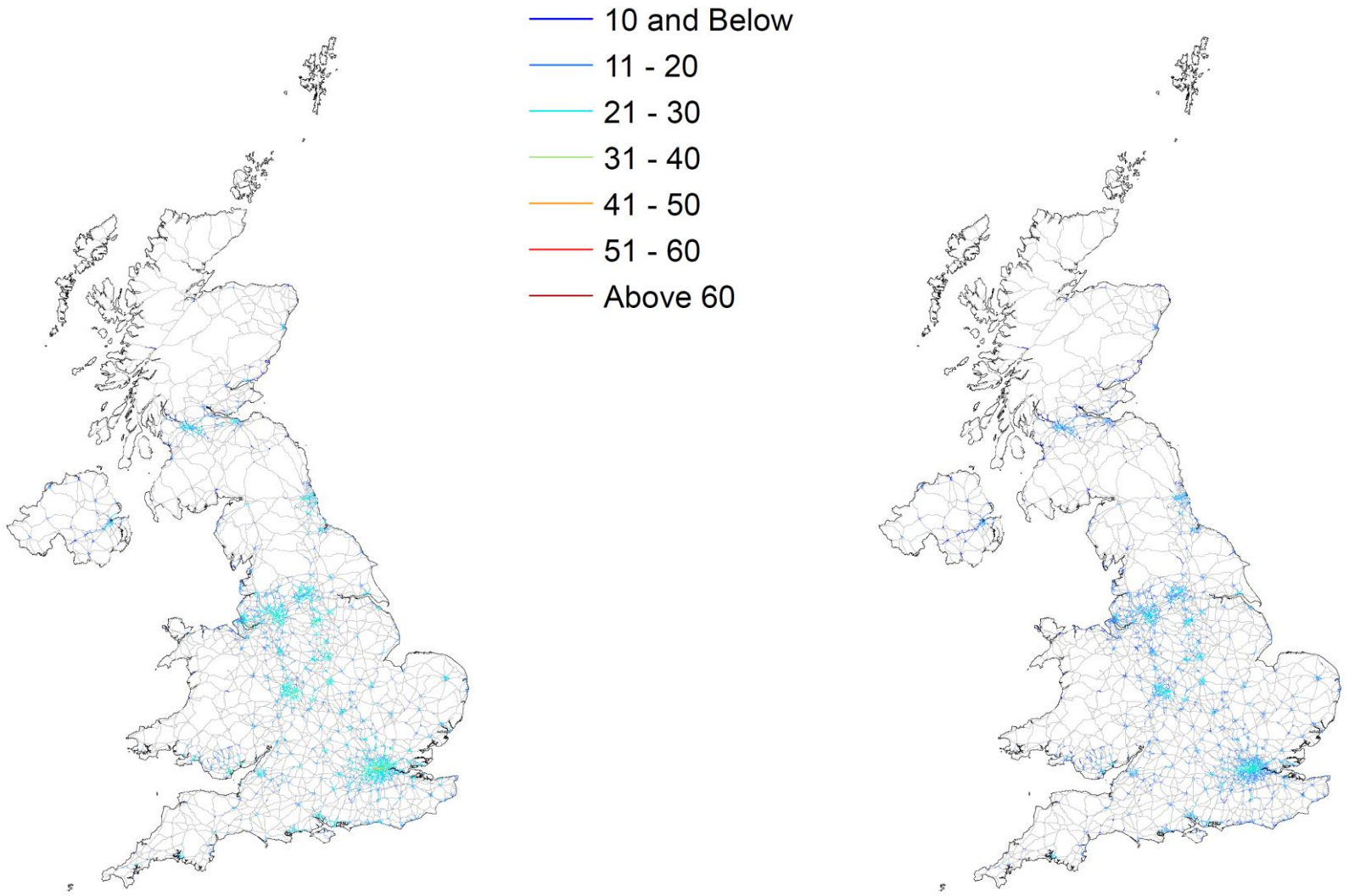
The baseline projections represent the projected concentrations assuming no further action beyond the air quality measures that were committed by the reference year (2013). A GIS shapefile containing baseline projected roadside NOx and NO2 concentrations for approximately 9,000 road links may be downloaded via the link below. This file also includes background NOx and NO2 concentrations, which have been modelled at a 1x1km resolution for each of the road links.

The plan scenario projections represent the projected concentrations assuming additional measures are implemented, as outlined in the 2015 Air Quality Plan for NO2. A GIS shapefile containing projected roadside NOx and NO2 concentrations based on the 2015 plan for NO2 at approximately 9,000 representative roadside locations may be downloaded via the link below.

The projected annual mean NOx source apportionment for the projected baseline situation is also available to download for each zone via the links below.

https://uk-air.defra.gov.uk/library/no2ten/2015-no2-projections-from-2013-data

https://uk-air.defra.gov.uk/library/no2ten/index



DEFRA UK NO2 plan 2015 scenario, high resolution map of urban major roads, annual mean roadside NO2 concentration: 2020 left, 2025 right (µgm-3)