Analysis of abatement strategies to reduce PM2.5 concentrations in the UK

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EMRC

Environment Act :
 2 long-term targets for PM2.5 in England & year to be achieved
     i) a target for reduction of population exposure
     ii) a limit value for PM2.5 concentrations

->>> investigation of a range of scenarios to 2050 to explore potential improvements and time scales

Analysis of abatement options to reduce $PM_{2.5}$ concentrations

Defra contract report: SNAPCS project

Support for National Air Pollution Control Strategies

March 2022

Imperial College London

UK Centre for Ecology & Hydrology

EMRC

UK integrated Assessment Model UKIAM

Starting point National Atmospheric Emissions Inventory, NAEI(2018)
+ adjustments e.g. cleaner post RDE diesels

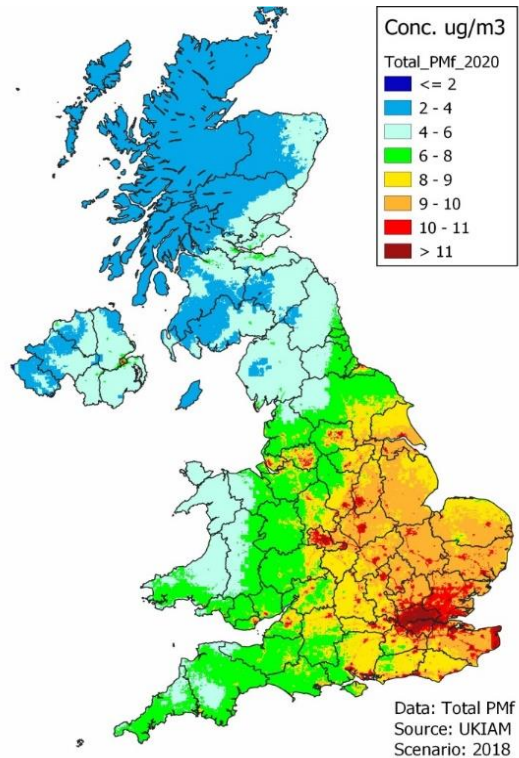*Interfaced via Scenario Modelling Tool, SMT plus BRUTAL model for road transport and EVs*

WAM & Mix55 scenarios other countries from IIASA

Shipping emissions+ modelling ECA/non ECA

Emissions by SNAP sector for 2018 & 2030

kt except $PM_{2.5}$ as 100 tons
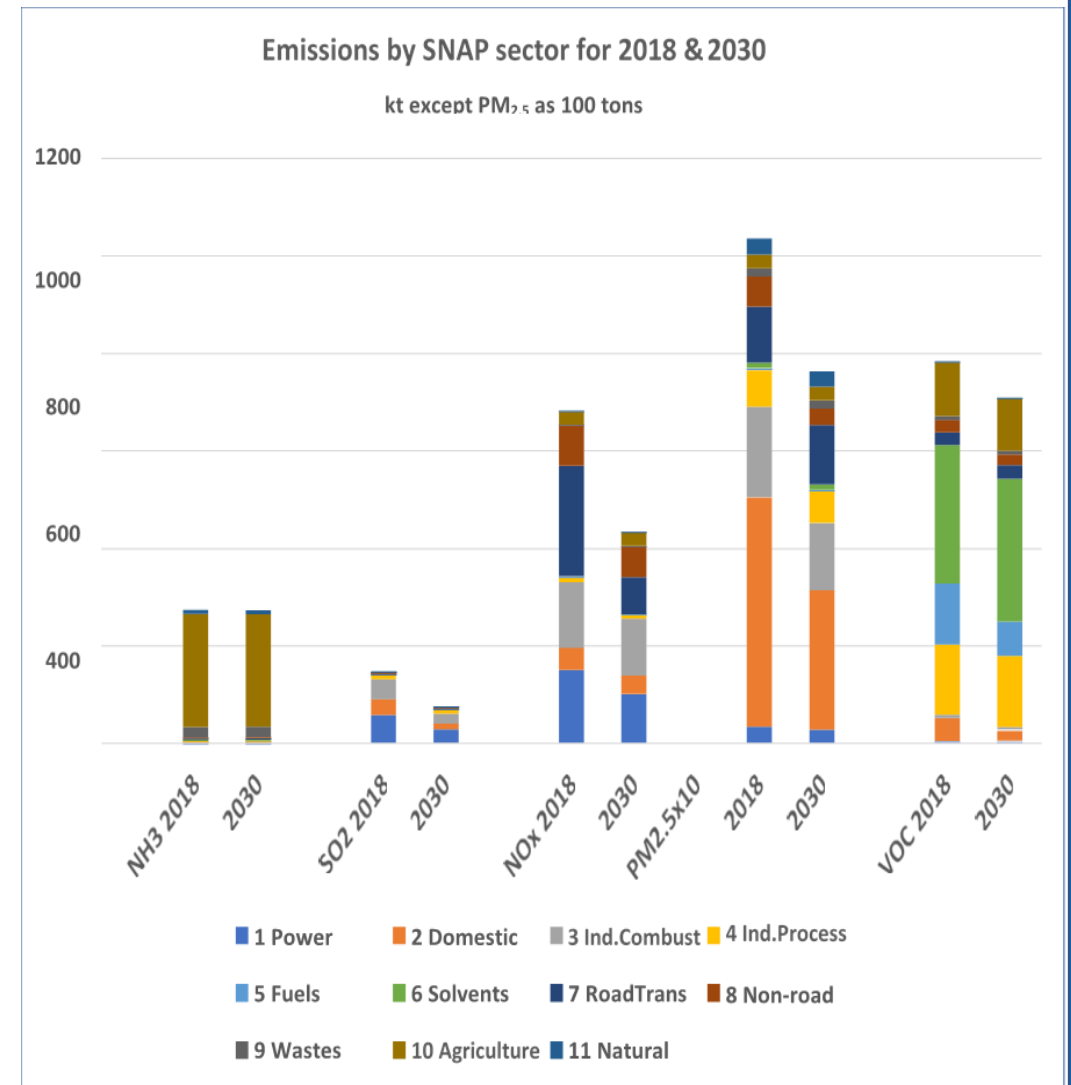
UKIAM:
Very simple but fast
Source footprints->
source apportionment
Annual meteorology

EMEP4UK (UKCEH)
Nested Eulerian with
full chemistry and
meteorology

| PWMC in µg m^{-3}	National	London	Urban	Rural
2018				
UKIAM	9.2	12.3	9.6	7.8
EMEP4UK (2018 meteorology)	9.2	11.7	9.5	8.1
EMEP4UK (2003 meteorology)	10.1	12.7	10.5	9.0
2040				
UKIAM	6.8	9.4	7.1	5.8
EMEP4UK (2018 meteorology)	6.2	7.9	6.4	5.5
EMEP4UK (2003 meteorology	6.7	8.3	6.9	5.9
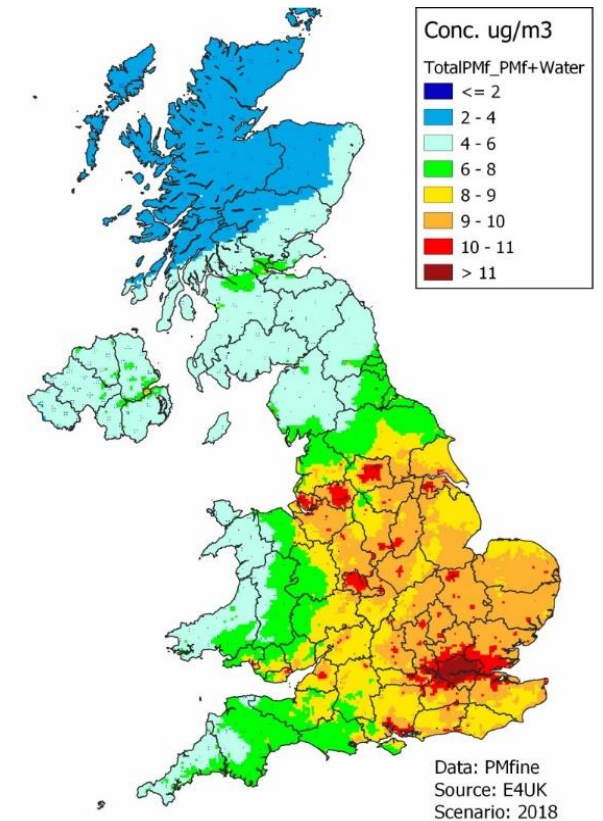
SECTORAL studies
Identify key sources and uncertainties and links with energy and transport policy

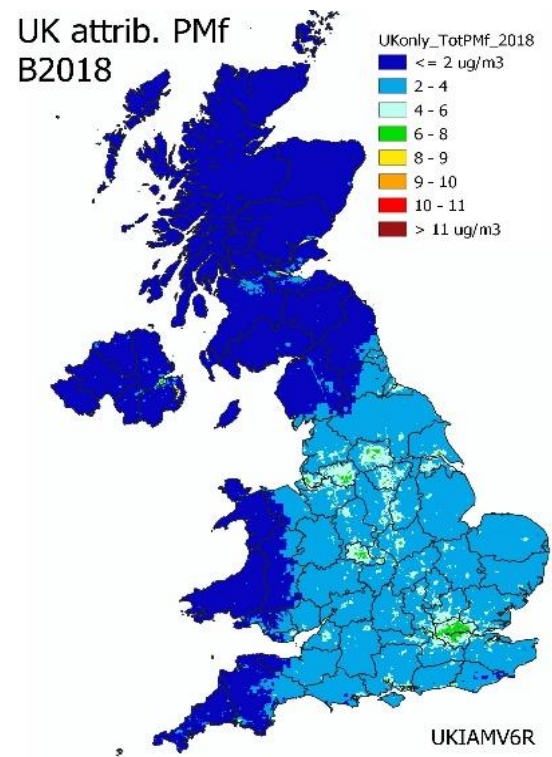Road transport- electrification of the fleet (EPCAC & paper in Atmosphere)

Domestic sector- wood burning important but uncertain, cooking…
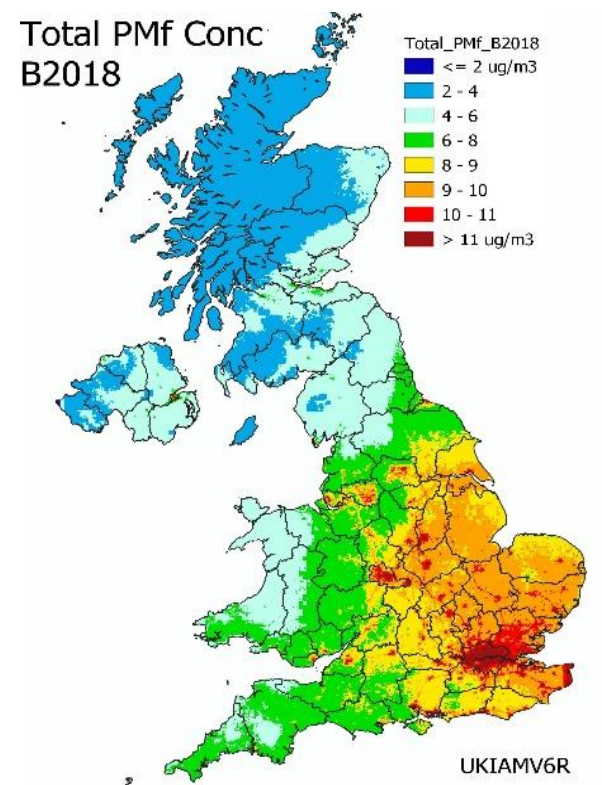
Energy and industry- use of biomass

Agriculture- changes in agricultural production as well as NH3 abatement
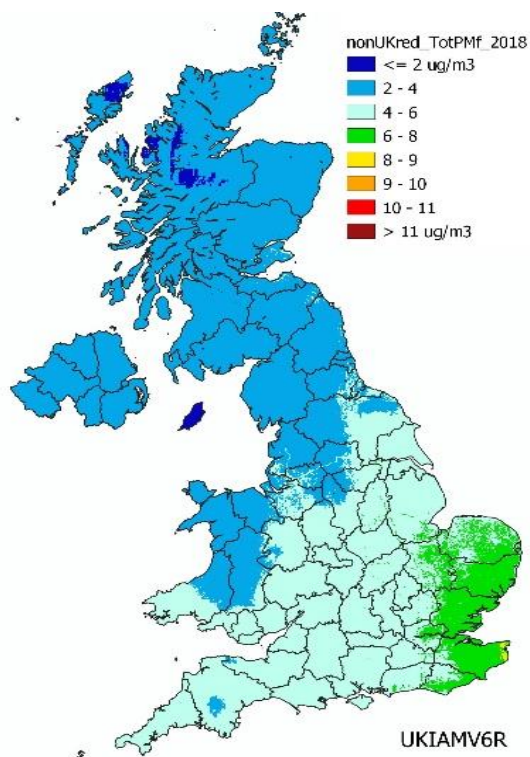
Other sources including imported and natural

**UK sources NOx,SO2,NH3,PPM2.5**

Total in 2018

Scenarios to 2050. defined by Defra + contractors+stakeholder consulting

| **Target baseline**	• Based on existing interventions and policies • Natural technology turnover • NAEI 2018 projections with some adjustments to account for recent legislation and updated data
Medium	• Based on measures/activity identified by the sector review • Implementation of proven technology and limited behaviour change, typical timescales and uptakes
High	• Based on measures/activity identified by the sector review • Technology considered likely to be implementable in the future by stakeholders, increased behaviour change and more rapid timescales
Speculative	• Based on measures/activity identified by the sector review • All feasible measures including emerging technology and significant behaviour change, optimistic timescales and uptakes

Plus Net Zero scenario defined by BEIS *(and NECR 2030 only)*

Except for baseline include electrification of road transport based on Dept for transport projections.
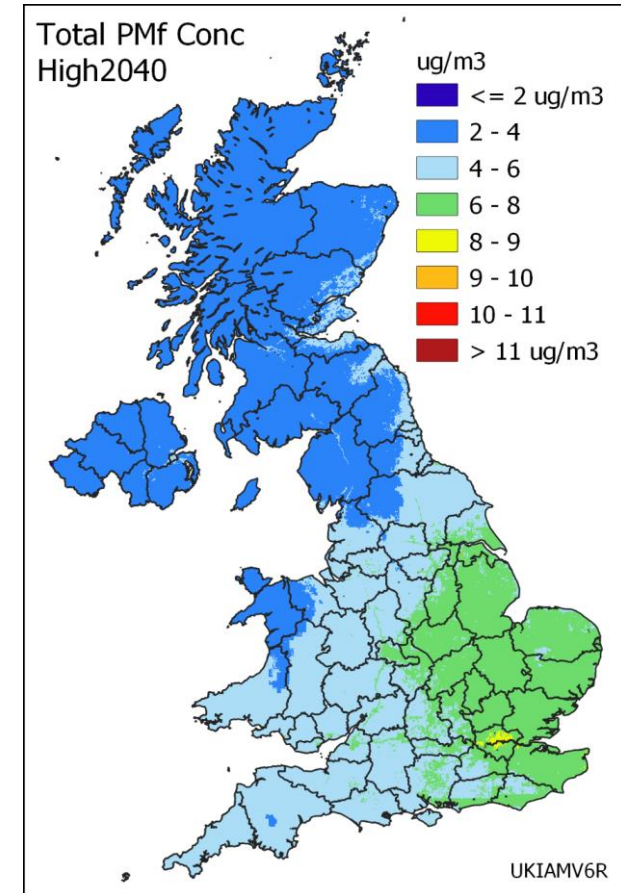
Example: High scenario- (areas in orange or worse at risk >10 ug/m3)
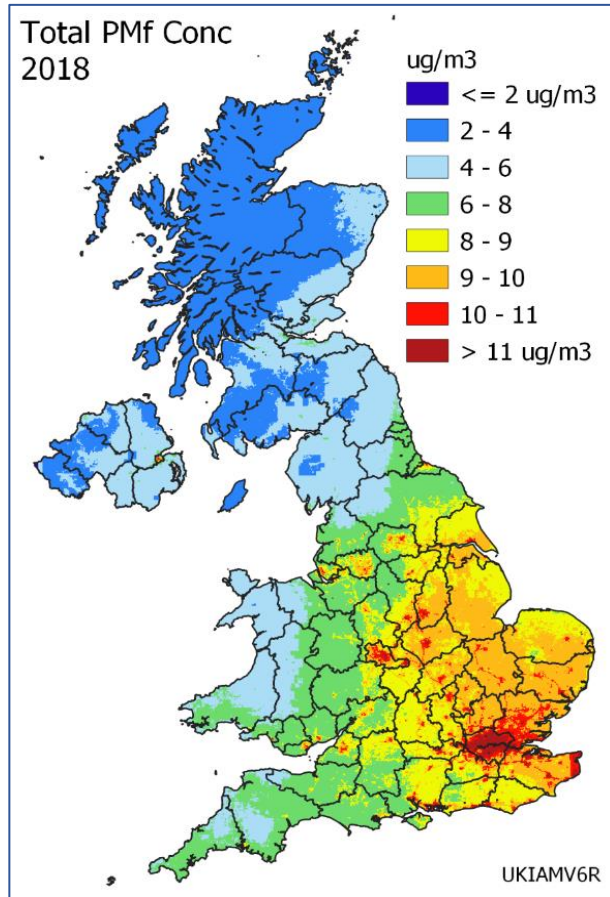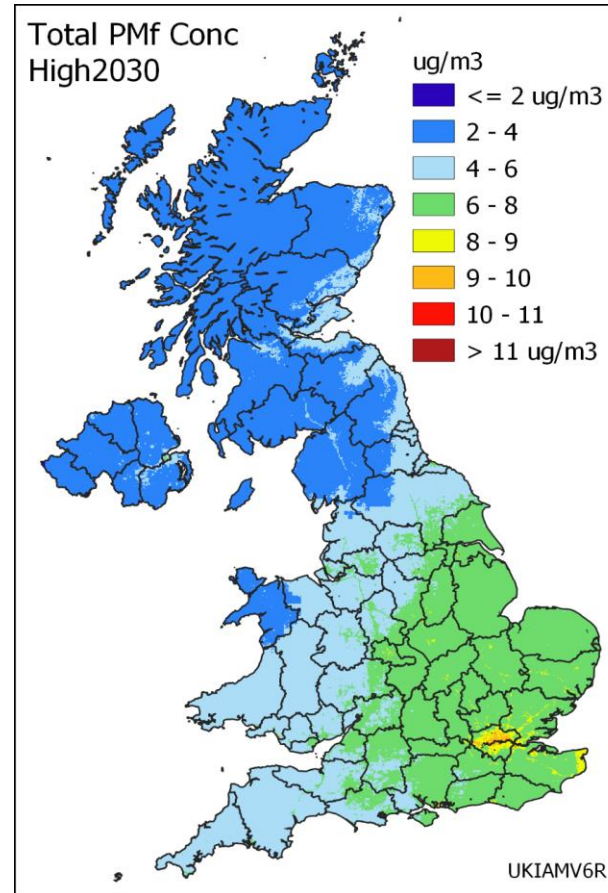
2018   **2030**   **2040**

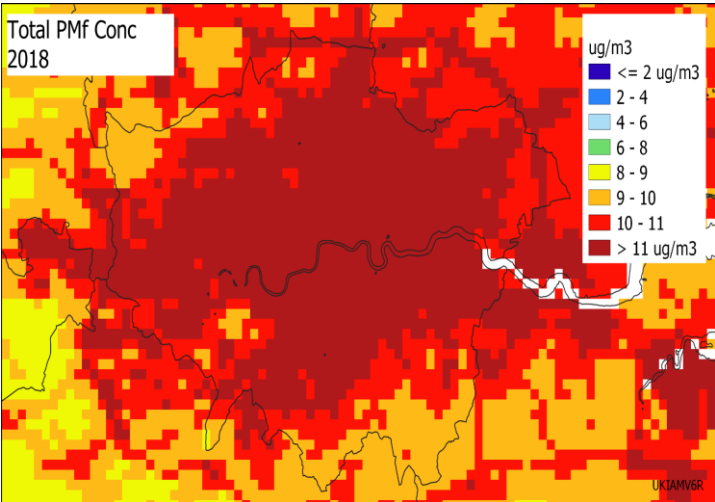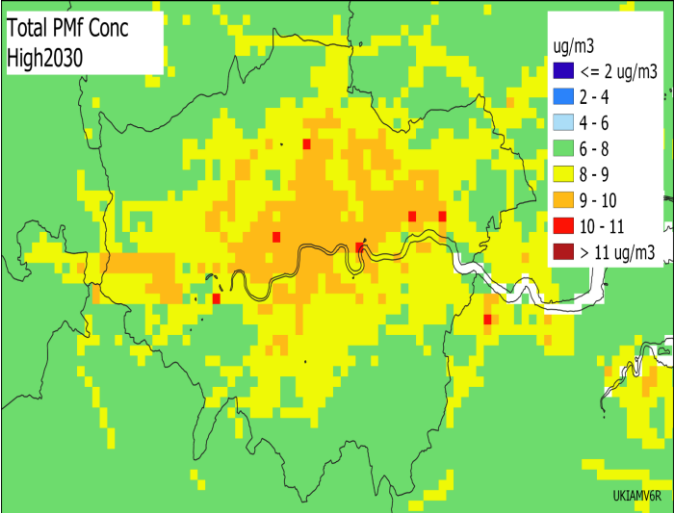## Still need to address persistent urban hot-spots particularly London

How to address London?

London 2018

London: high scenario 2030
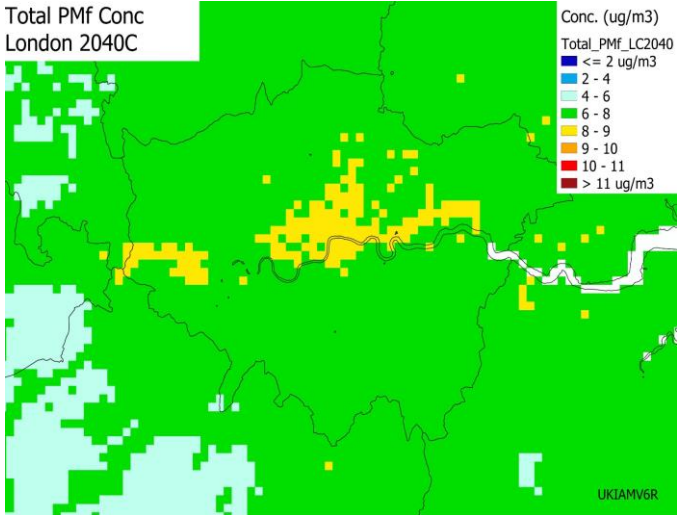
London: high scenario 2040 +additional measures in London e.g. traffic in extended ULEZ

Population weighted mean concentrations, PWMC ug/m
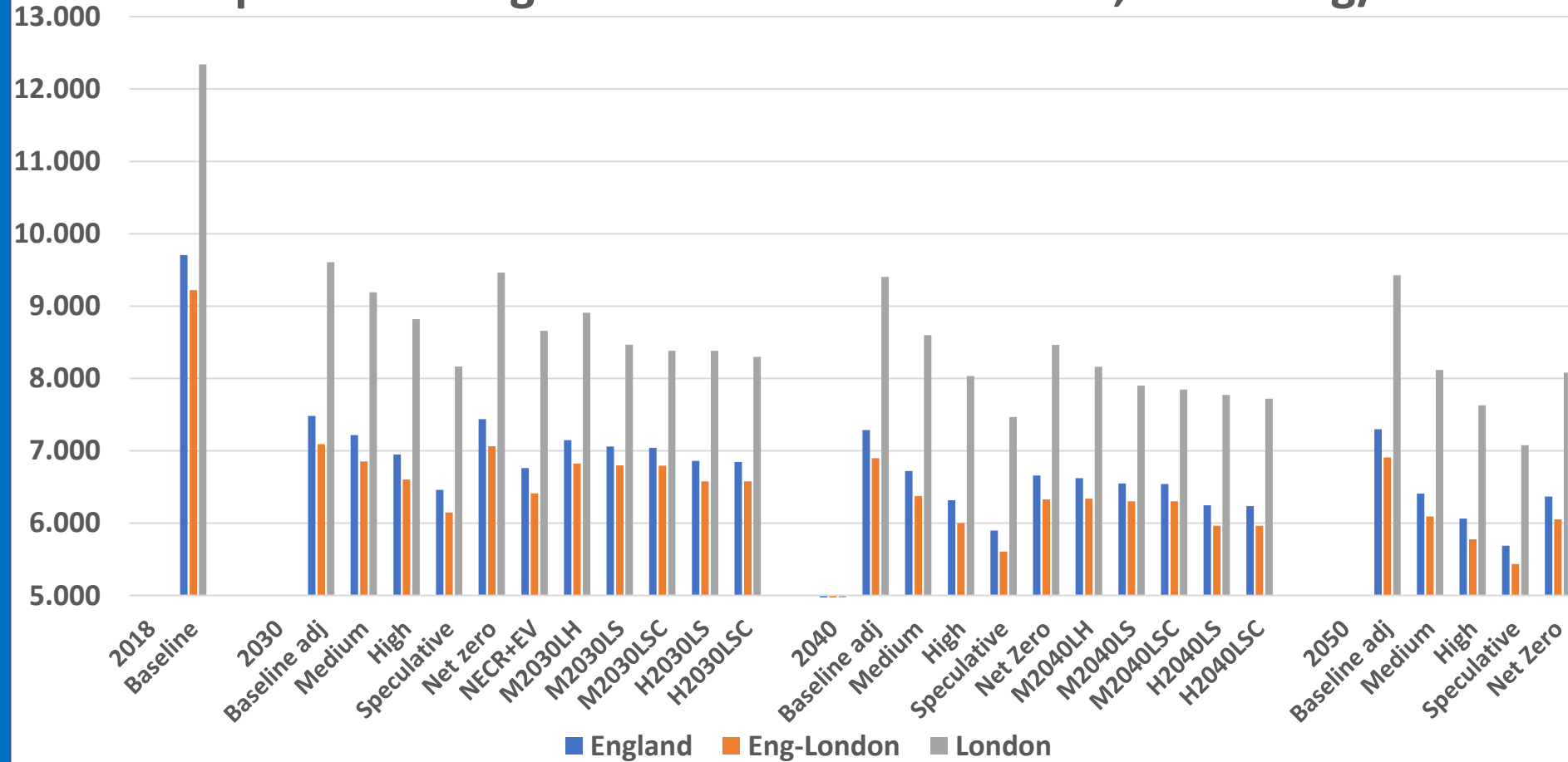
Express target as % reduction in PWMC for England and set year
% reduction has advantage of similar proportional reduction in less polluted areas and in cities/London

For 2030 reductions between 25% and 33%

For 2040 reductions between 30% and 39%

But need to allow for uncertainties e.g abatement of domestic wood burning plays a big role & potentially overestimated-> sensitivity study of effect on what could be achieved

Defra have proposed target of 35% reduction in population exposure by 2040 -> public consultation

Limit values

Calculate population weighted mean exceedance of different thresholds from 8 to 12 µg m^{-3} for different areas (England, England-London, and London)

$$\text{PWME} = \sum i,j \; Pij \; \times \max(Cij - t, 0) \; / \sum i,j \; Pij$$

This needs to be zero/negligible even for London for potential limit value

Safety margin of 1 µg m^{-3} to allow for model uncertainty/accuracy

+ sensitivity studies to key assumptions

> Traffic light diagrams- red very high PWME, yellow- medium, white-small, green negligible/zero

London	2018	BAU		Medium		Med &London+		High		High&London+	
		M2030	less wood	M2030LH	less wood	M2030LSC	less wood	High 2030	less wood	H2030LSC	less wood
8	4334	1078	1476	809	1320	350	1015	739	1271	299	968
9	3334	318	611	155	487	7	253	124	453	5	226
10	2338	14	89	3	47	0	8	2	40	0	6
11	1394	0	3	0	1	0	0	0	1	0	0
12	620	0	0	0	0	0	0	0	0	0	0
2040		M2040	less wood	M2040LH	less wood	M2040LSC	less wood	High 2040	less wood	H2040LSC	less wood
8		529	948	231	735	69	528	174	676	41	475
9		51	253	4	129	0	44	0	104	0	33
10		1	15	0	3	0	0	0	2	0	0
11		0	1	0	0	0	0	0	0	0	0
12		0	0	0	0	0	0	0	0	0	0

-> proposed limit value of 10 µg m^{-3} to be achieved by 2040 even in London
although achieved earlier elsewhere

BENEFITS: Net present value of benefits relative to the Baseline scenario for the periods 2023 to 2030, 2023 to 2040 and 2023 to 2050. Units, £million.

| Total estimates of benefits by scenario			
	2023-2030	**2023-2040**	**2023-2050**
Medium	6,380	23,150	51,163
High	9,930	37,891	76,887
Speculative	16,174	59,611	110,196
Benefits associated with reduced PM$_{2.5}$ exposure			
	2023-2030	**2023-2040**	**2023-2050**
Medium	5,378	18,229	38,005
High	8,690	31,780	61,478
Speculative	14,123	50,434	90,618
Net zero	448	8,488	24,105

Also shown that based on maps of deprivation index the scenarios reduce difference between most exposed and least exposed groups within the population

Legislation will be based on measurements

Modelling based on 1x1 km gridded values; excludes hot-spots e.g. close to roads

Measurements representative of urban agglomerations

-> fair agreement for population exposure but ?extension re limit values

Comparison of exposures calculated by UKIAM and exposures derived using measurements (2018)
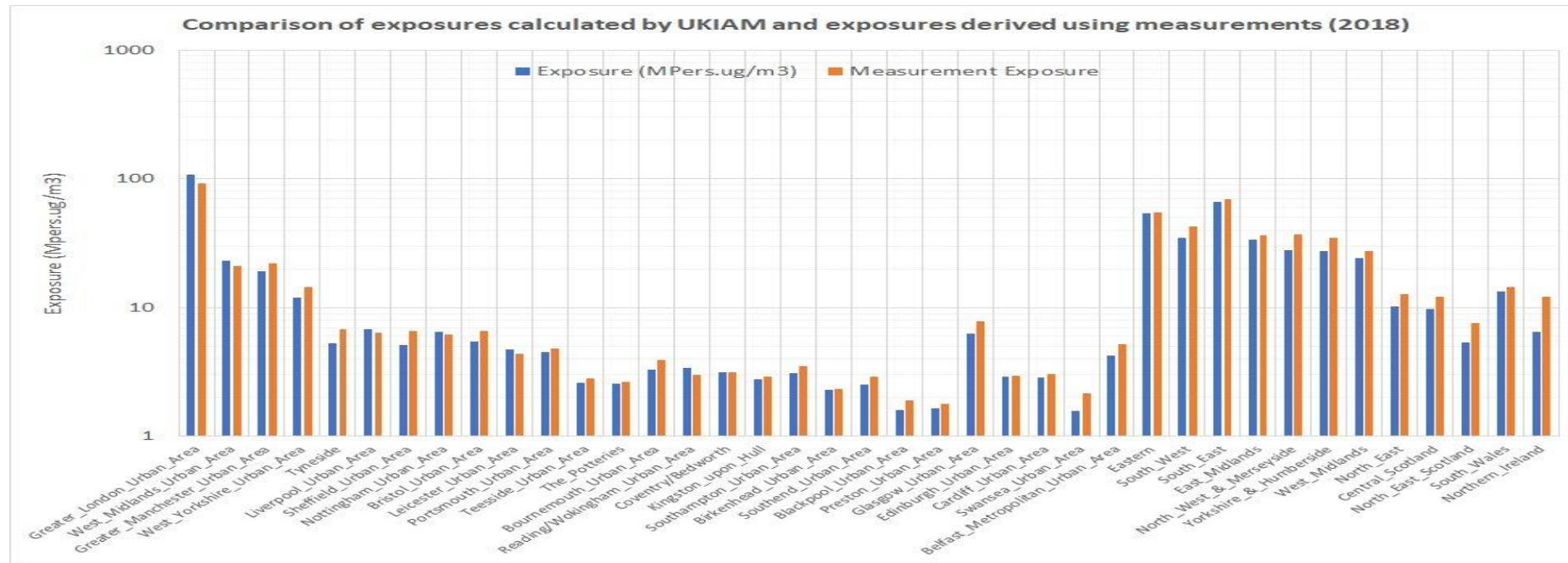
SUMMARY

Modelling of range of scenarios to 2050 towards proposed targets for PM2.5 which are now out for public consultation:

i)   Reduction in population exposure of 35% by 2040

i)   Limit value of 10 ug.m-3 to be achieved by 2040
(even in London though widely achieved elsewhere earlier)

Further work required to set interim 5 year targets

Also on uncertainties and on synergies between climate, transport and agricultural change and air quality