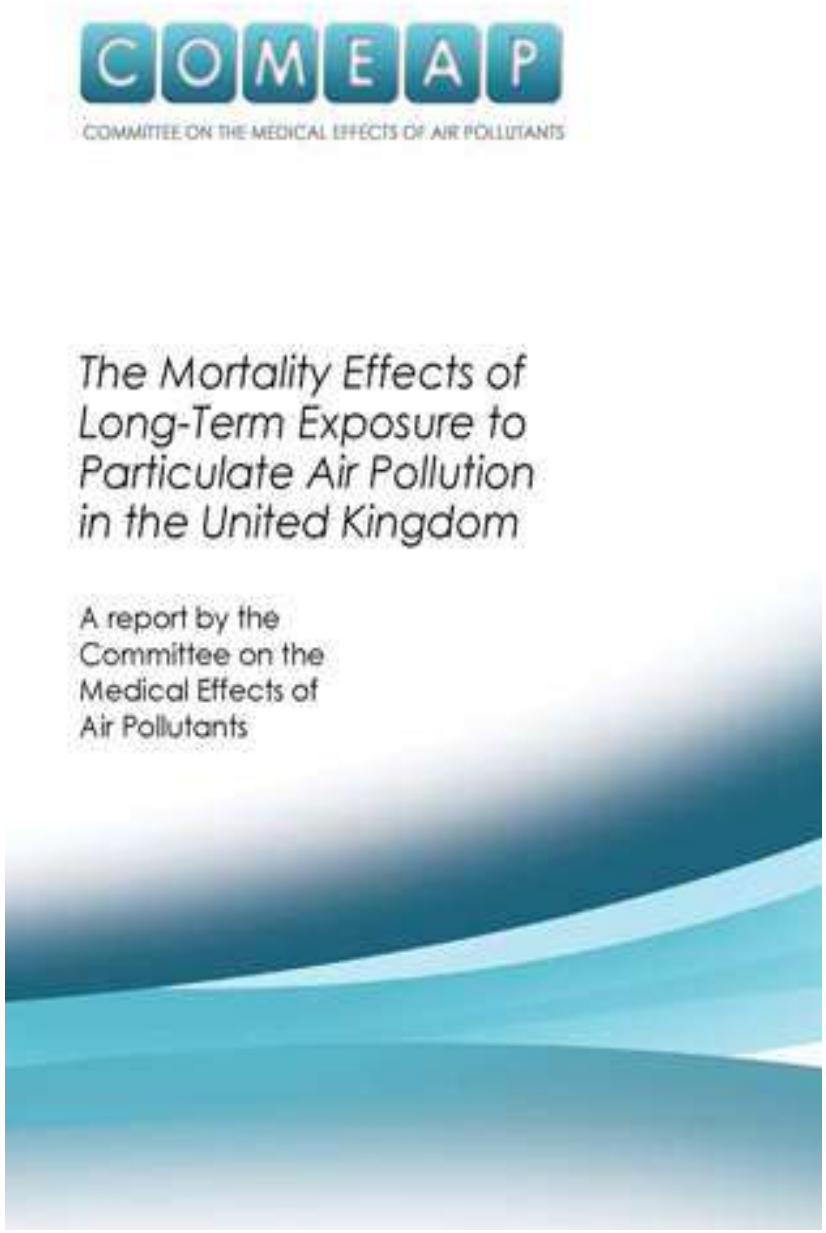
Climate Change and Air Quality

Professor Martin Williams

Welsh Air Quality Forum
Fforwm Ansawdd Awyr Cymru

Annual Seminar
4 October 2018

MRC-HPA Centre for Environment & Health
Imperial College London
MRC
KING'S College LONDON



Across the UK poor air quality.....

• equivalent of 29,000 premature deaths due to breathing tiny particles released into the air (in 2008 data)

• the average loss of life was 6 months, (although the actual amount varies between individuals, from a few days to many years)

•'...air pollution may have made some contribution to the earlier deaths of up to 200,000 people in 2008, with an average loss of life of about 2 years per death affected...'

•Economic cost of the order of £8-20 billion per year (from IGCB)

Published December 2010

Estimates of the impact of air pollution on health are developing as evidence on NO_2 strengthens

World Health Organization
REGIONAL OFFICE FOR Europe

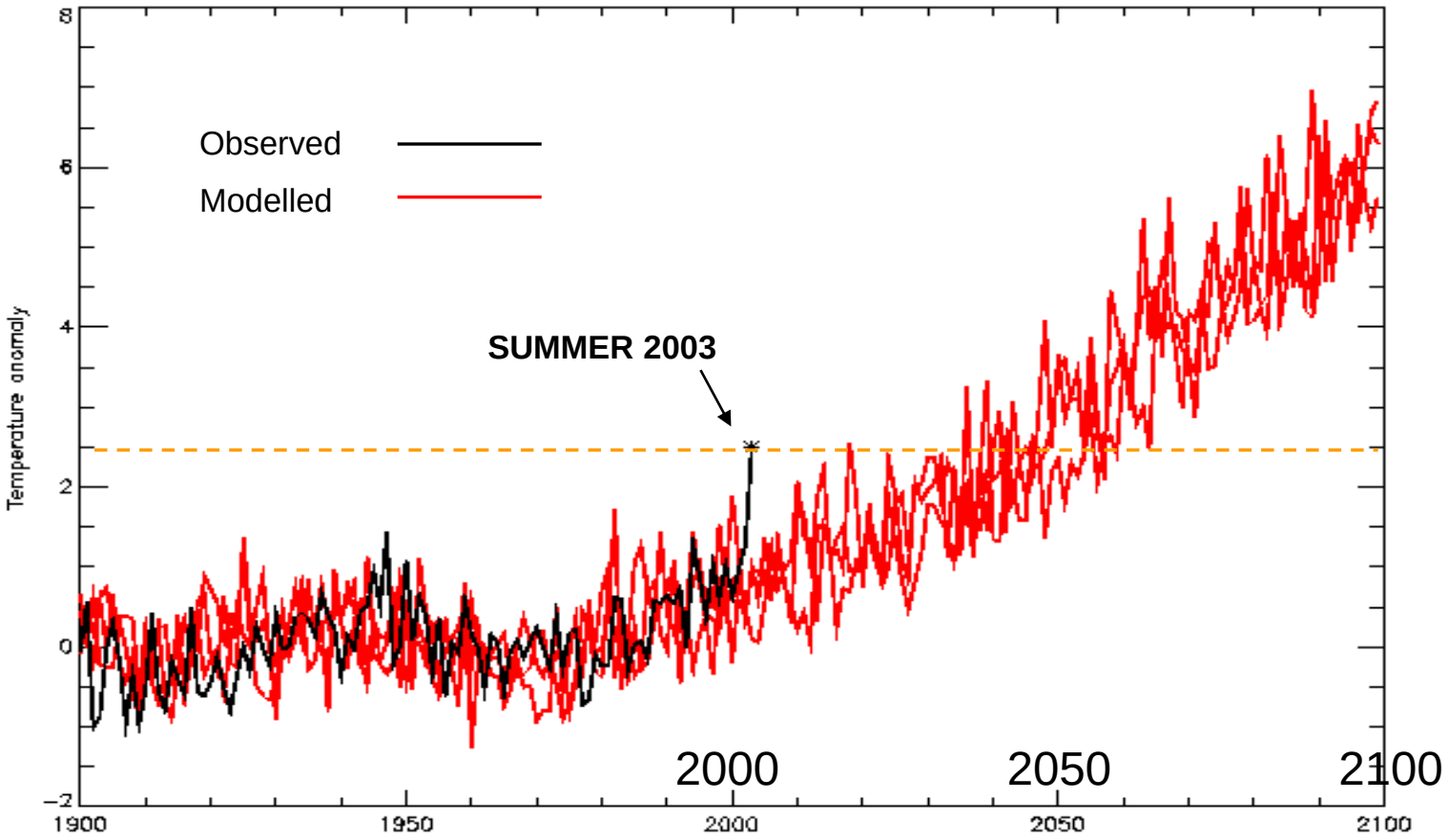
Health risks of air pollution in Europe – HRAPIE project

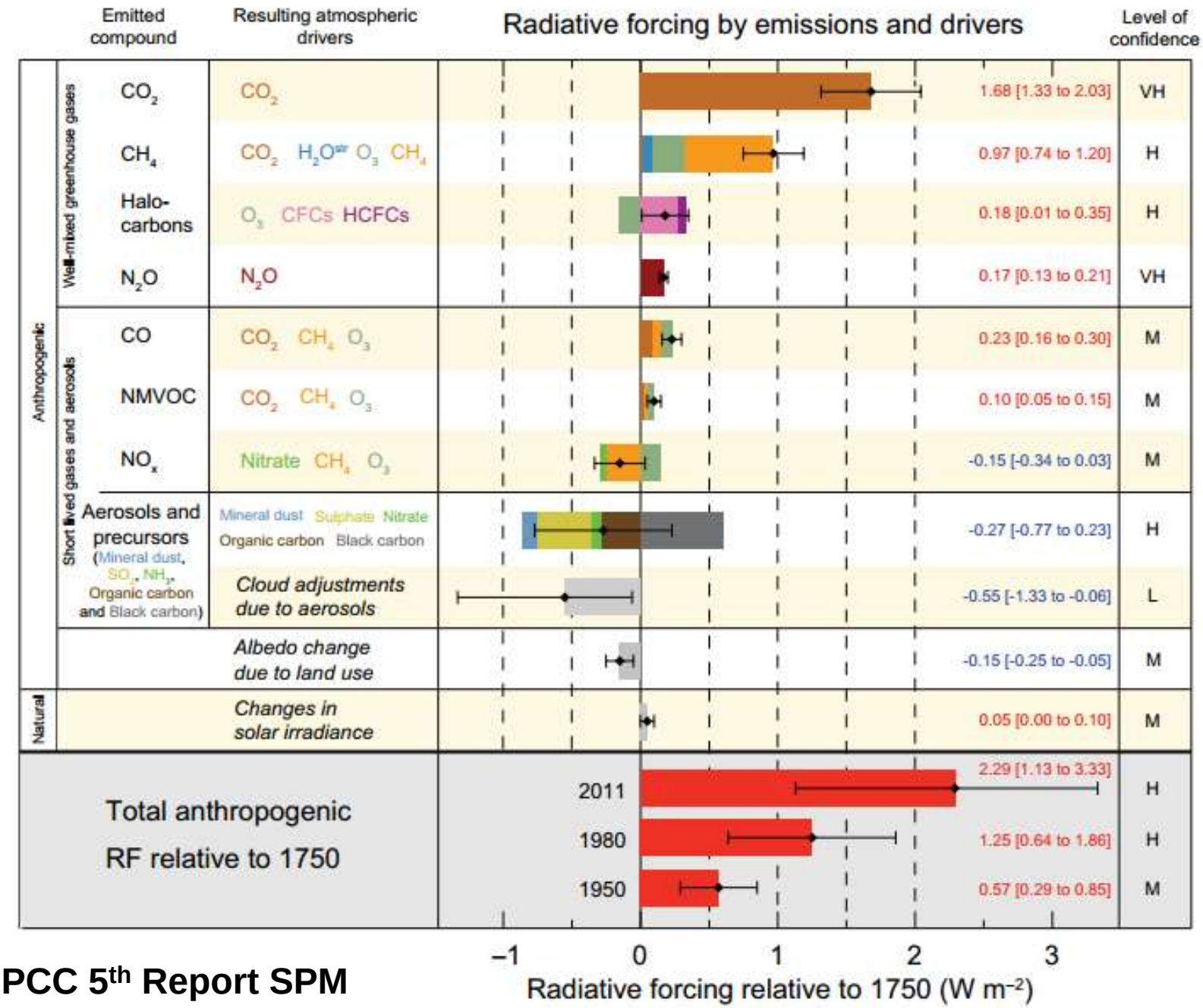
COMEAP
COMMITTEE ON THE MEDICAL EFFECTS OF AIR POLLUTANTS

Associations of long-term average concentrations of nitrogen dioxide with mortality

A report by the Committee on the Medical Effects of Air Pollutants

Possible Future European Summer Temperatures





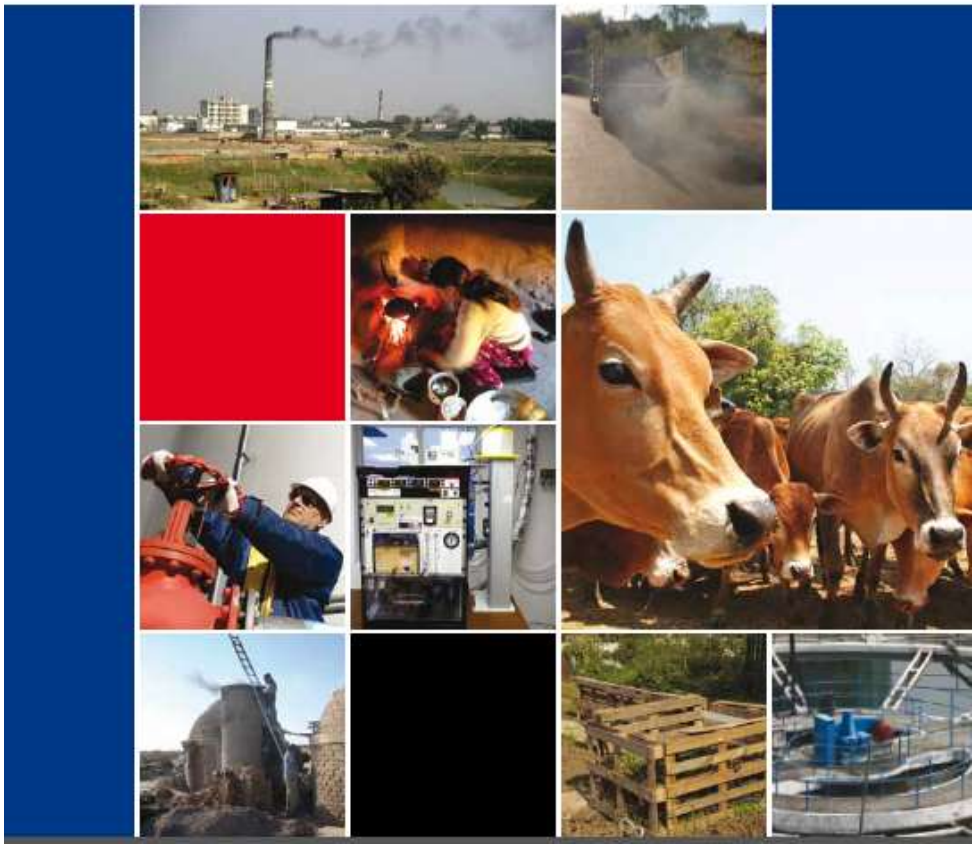
IPCC 5th Report SPM

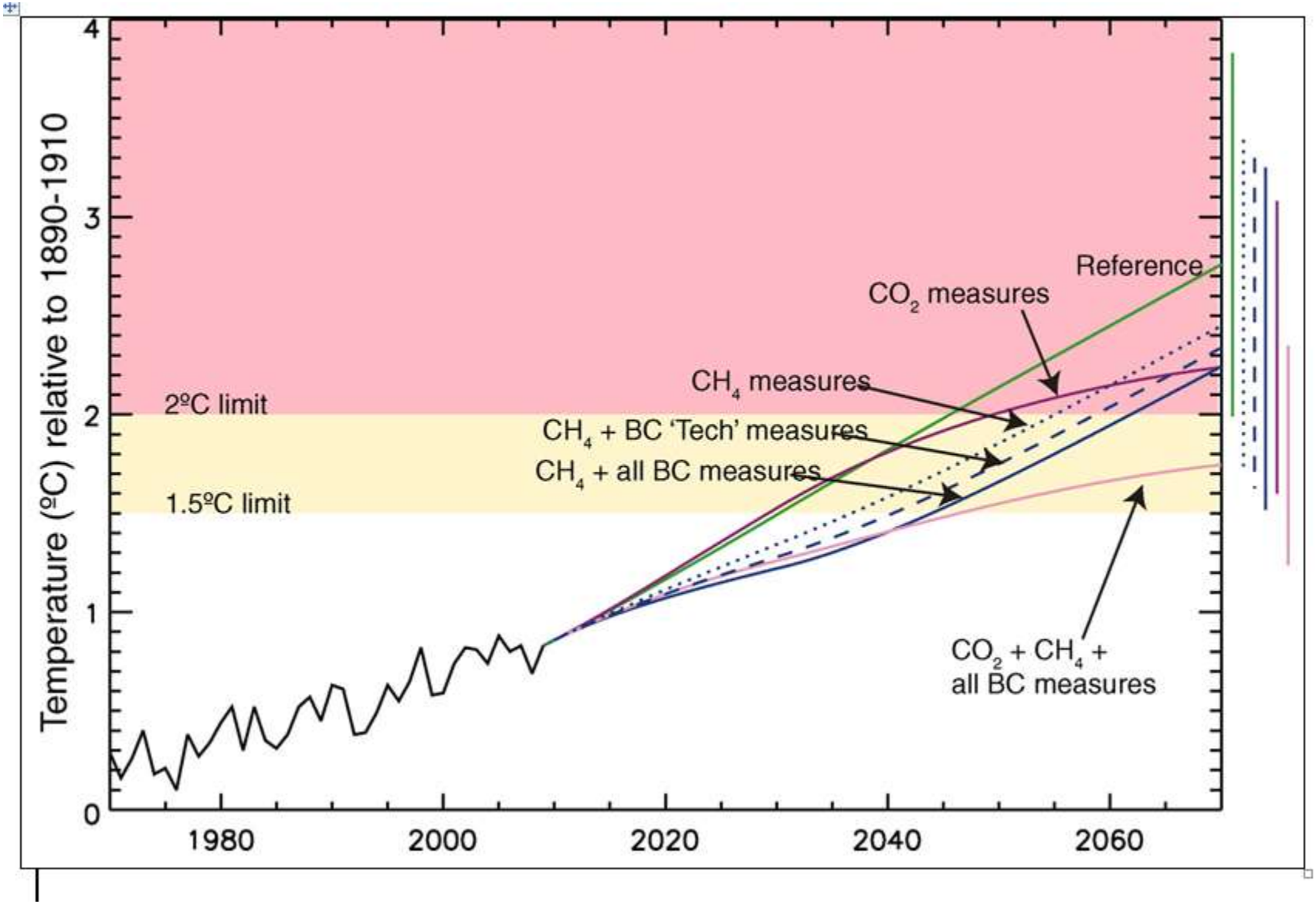
UNEP

World Meteorological Organization

Integrated Assessment of Black Carbon and Tropospheric Ozone

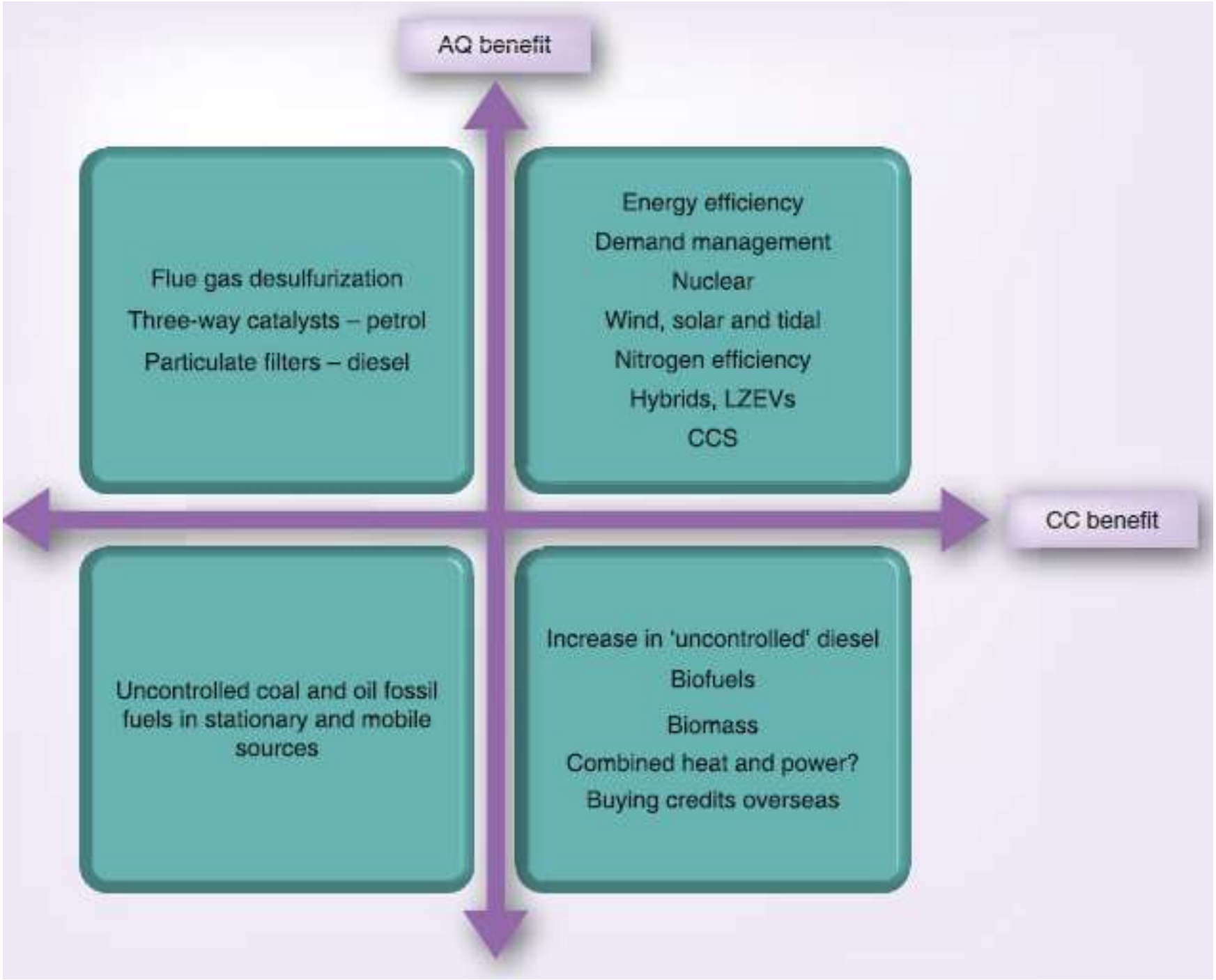
Summary for Decision Makers



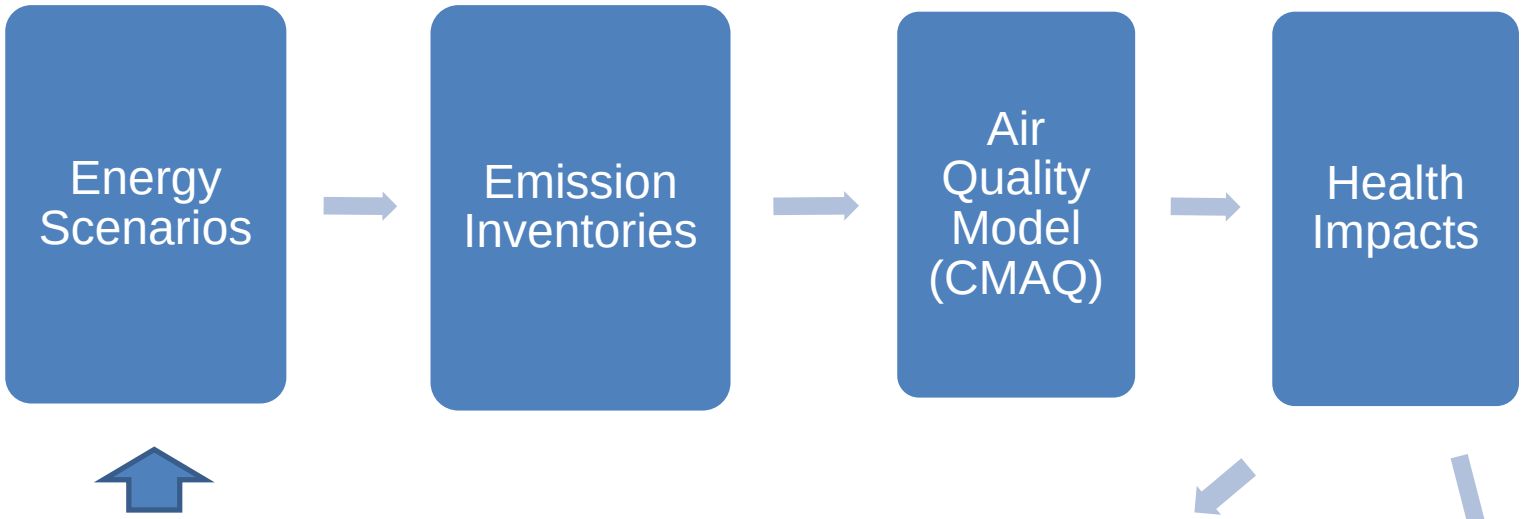

Temperature (ºC) relative to 1890-1910
0
1
2
3
4
1980
2000
2020
2040
2060
2ºC limit
1.5ºC limit
Reference
CO2 measures
CH4 measures
CH4 + BC 'Tech' measures
CH4 + all BC measures
CO2 + CH4 +
all BC measures

UK Climate Change Act 2008

- The UK has set a target of ***80% reduction in CO_2 equivalents by 2050*** (on a 1990 base)
- Making the right choices to achieve the Climate Change Act target offers potentially the biggest air quality & public health improvements since the Clean Air Act of 1956
- BUT – the policies need to be ***carefully chosen*** to avoid unnecessary adverse public health impacts – e.g. minimise diesel, biomass, CHP use in urban centres


AQ benefit
Flue gas desulfurization
Three-way catalysts – petrol
Particulate filters – diesel
Energy efficiency
Demand management
Nuclear
Wind, solar and tidal
Nitrogen efficiency
Hybrids, LZEVs
CCS
CC benefit
Uncontrolled coal and oil fossil fuels in stationary and mobile sources
Increase in 'uncontrolled' diesel
Biofuels
Biomass
Combined heat and power?
Buying credits overseas

NIHR funded project

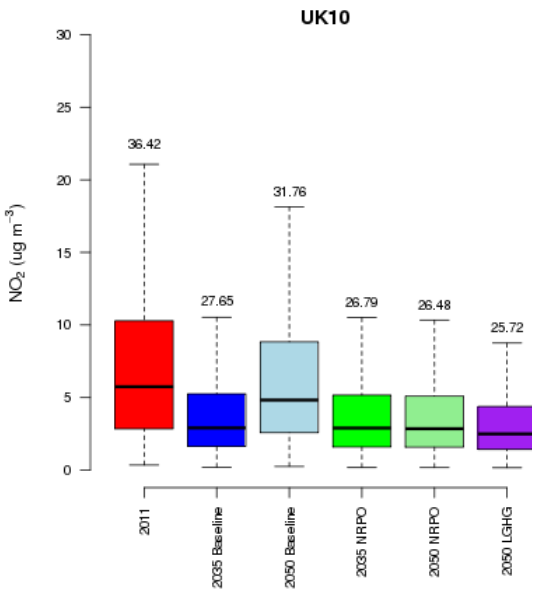


Working with UCL who provided energy scenarios

MRC-PHE
Centre for Environment & Health

Public Health England | MRC | Imperial College London | King's College London

Scenario	Description	
Baseline	Baseline (no further carbon mitigation)	Nuclear phasing out
Reference	Same as Base + 30 GBP/tonne carbon price - increasing linearly from 0-30 GBP over the period of 2010-2030 (0-30 GBP) and then plateaued at 30 from 2030 onward; no constraints on nuclear	Nuclear expansion
Low GHG	80% reduction by 2050 + interim carbon budgets (through the 4th budget); no damage costs included for non-GHG air pollutants	In addition to 2010 and 2050, will look at an interim year (2030/5) to show the impact of the mid-term increase in residential biomass use for CHP
Nuclear – replacement only	LowGHG scenario + constraint on nuclear so that it can only maintain its current capacity levels.	Nuclear capacity capped at 10 GW (i.e. current levels)


UK10
NO2 (ug m-3)
30
25
20
15
10
5
0
36.42
27.65
31.76
26.79
26.48
25.72
2011
2035 Baseline
2050 Baseline
2035 NRPO
2050 NRPO
2050 LGHG


NO2 : 2011
ug m-3
0 6 14 22 30


NO2 : 2035 Baseline
ug m-3
0 6 14 22 30

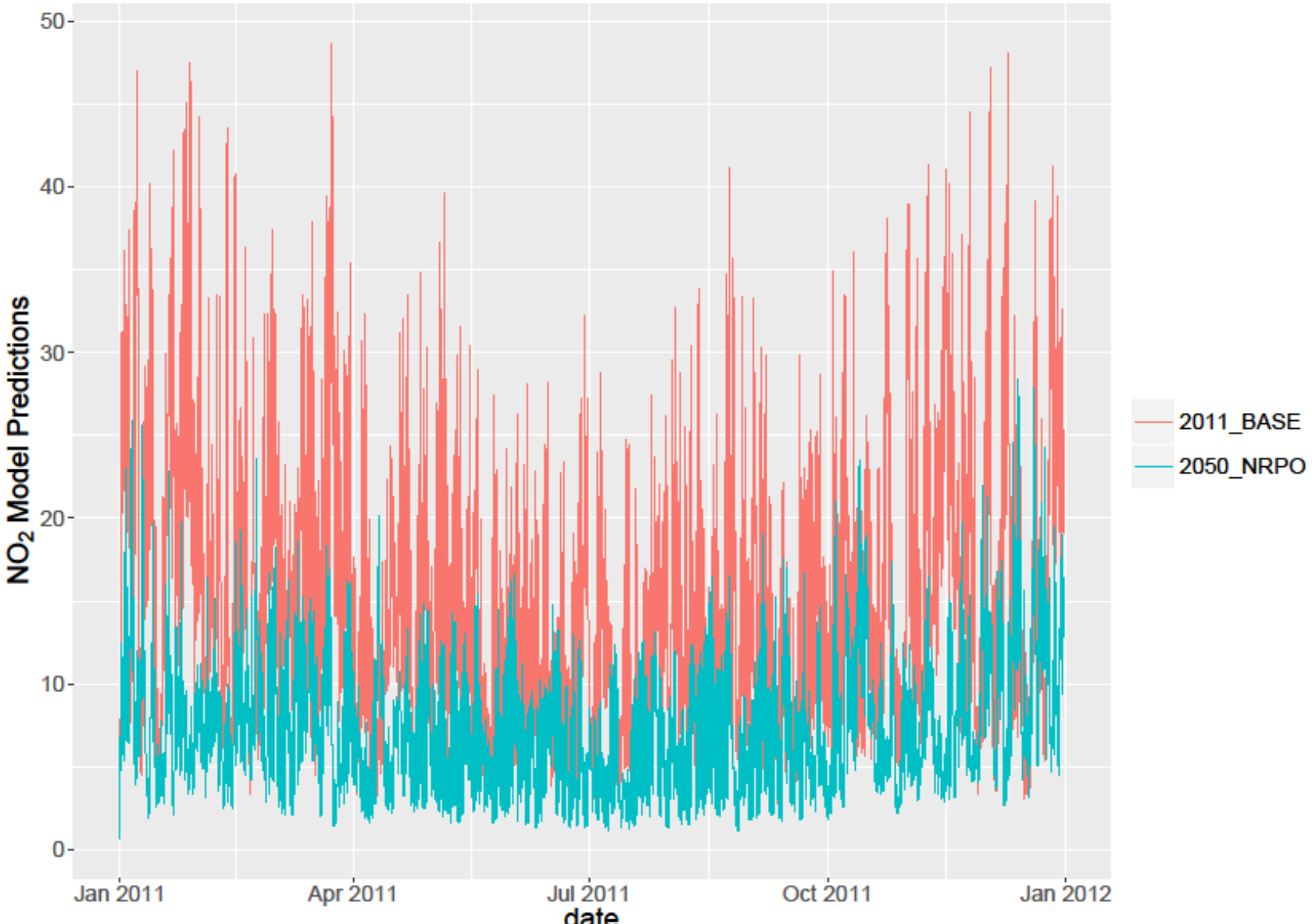

NO2 : 2050 Baseline
ug m-3
0 6 14 22 30

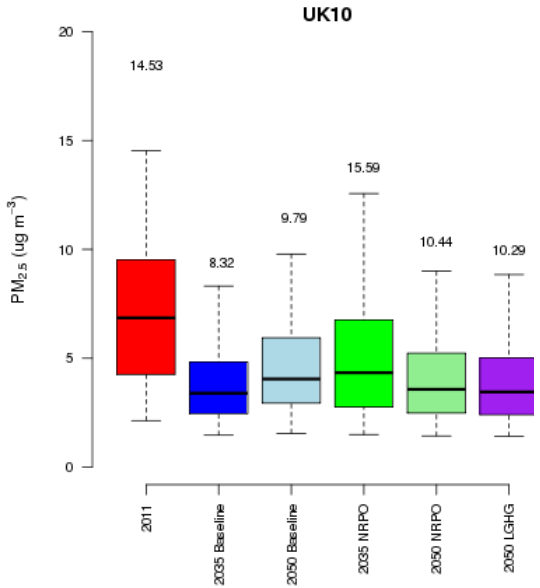

NO2 : 2050 LGHG
ug m-3
0 6 14 22 30

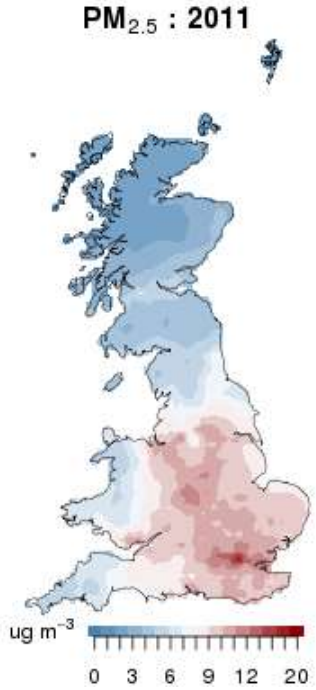

NO2 : 2035 NRPO
ug m-3
0 6 14 22 30

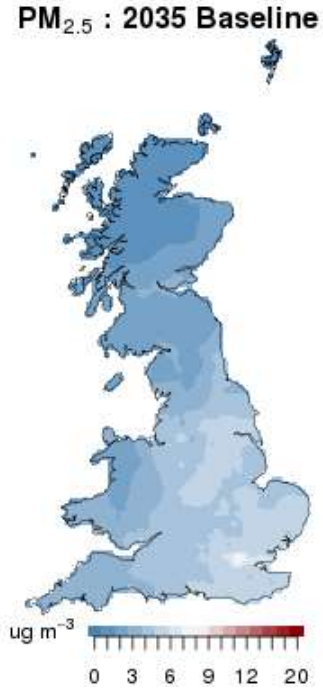

NO2 : 2050 NRPO
ug m-3
0 6 14 22 30

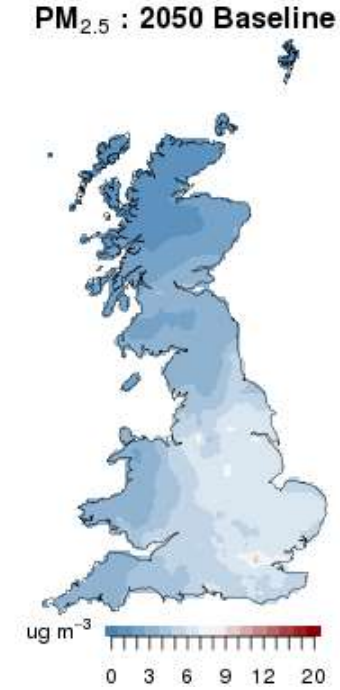
Hourly NO_2 concentrations – all GB sites



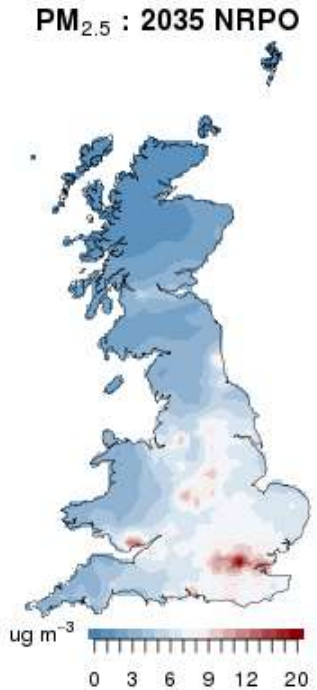

UK10
PM2.5 (ug m-3)
20
15
10
5
0
14.53
8.32
9.79
15.59
10.44
10.29
2011
2035 Baseline
2050 Baseline
2035 NRPO
2050 NRPO
2050 LGHG


PM2.5 : 2011
ug m-3
0 3 6 9 12 20


PM2.5 : 2035 Baseline
ug m-3
0 3 6 9 12 20


PM2.5 : 2050 Baseline
ug m-3
0 3 6 9 12 20


PM2.5 : 2050 LGHG
ug m-3
0 3 6 9 12 20


PM2.5 : 2035 NRPO
ug m-3
0 3 6 9 12 20


PM2.5 : 2050 NRPO
ug m-3
0 3 6 9 12 20

EC + OA : 2011

EC + OA : 2035 Baseline

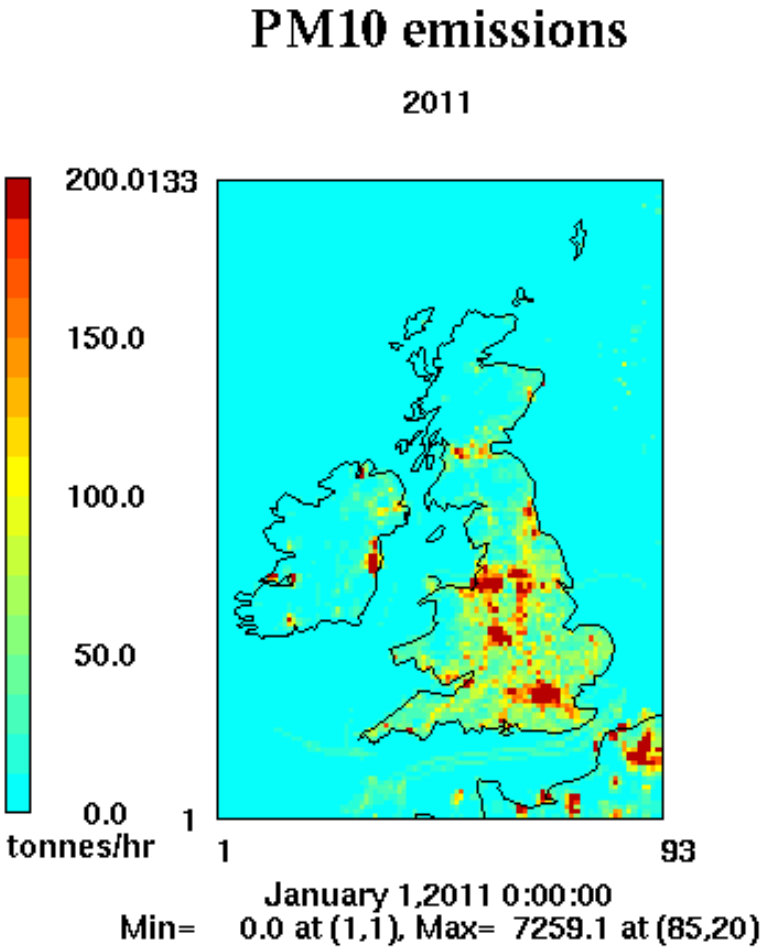
EC + OA : 2050 Baseline

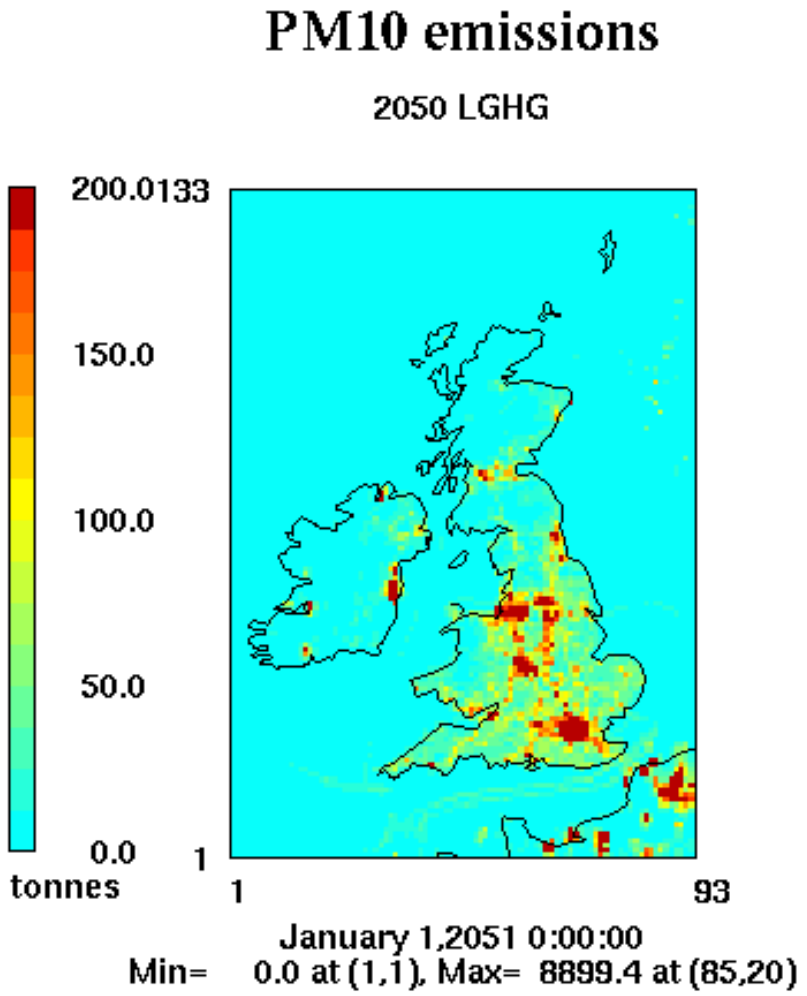
EC + OA : 2050 LGHG

EC + OA : 2035 NRPO

EC + OA : 2050 NRPO

Primary PM10 emissions don't decrease – non – exhaust emissions important (toxicity?)

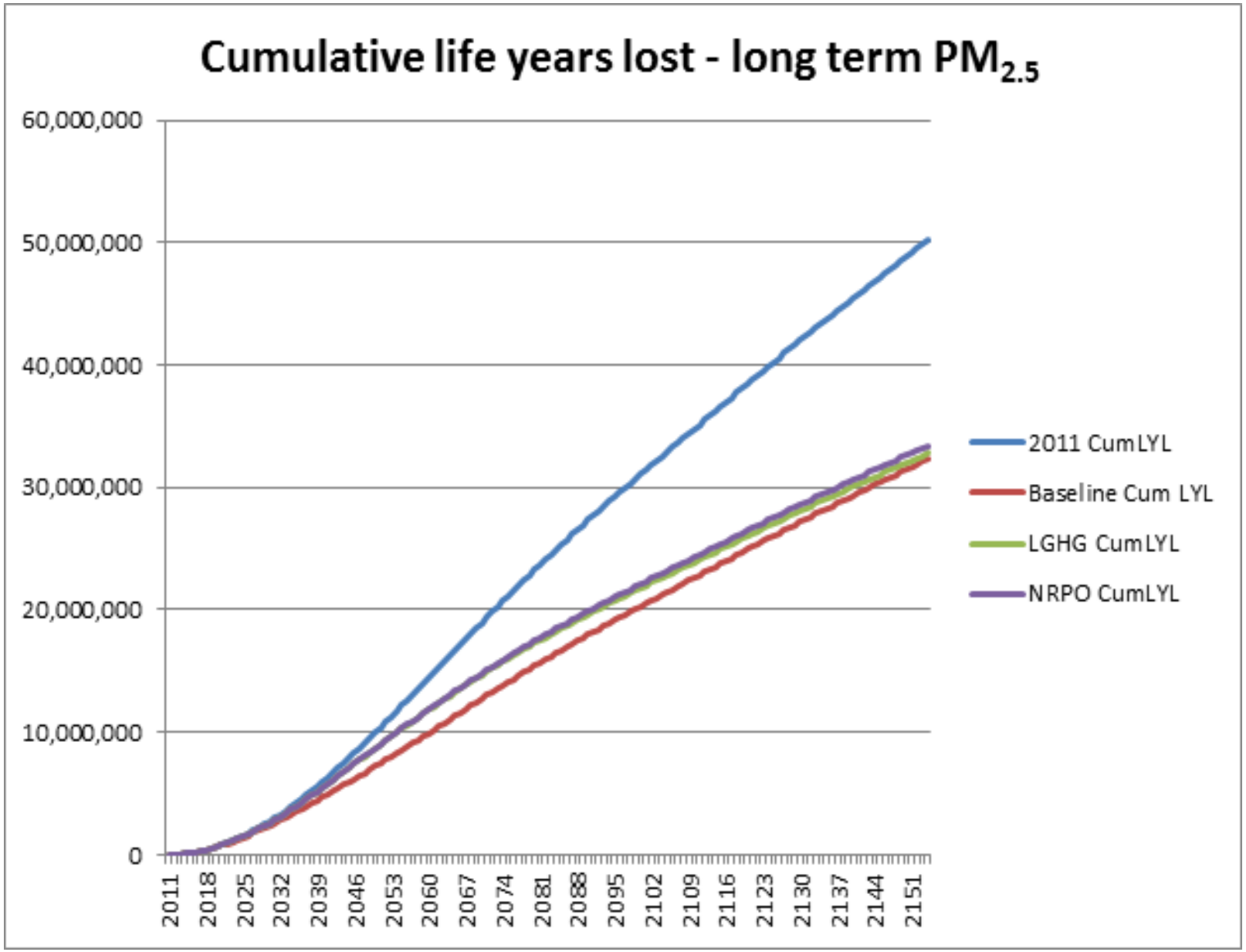


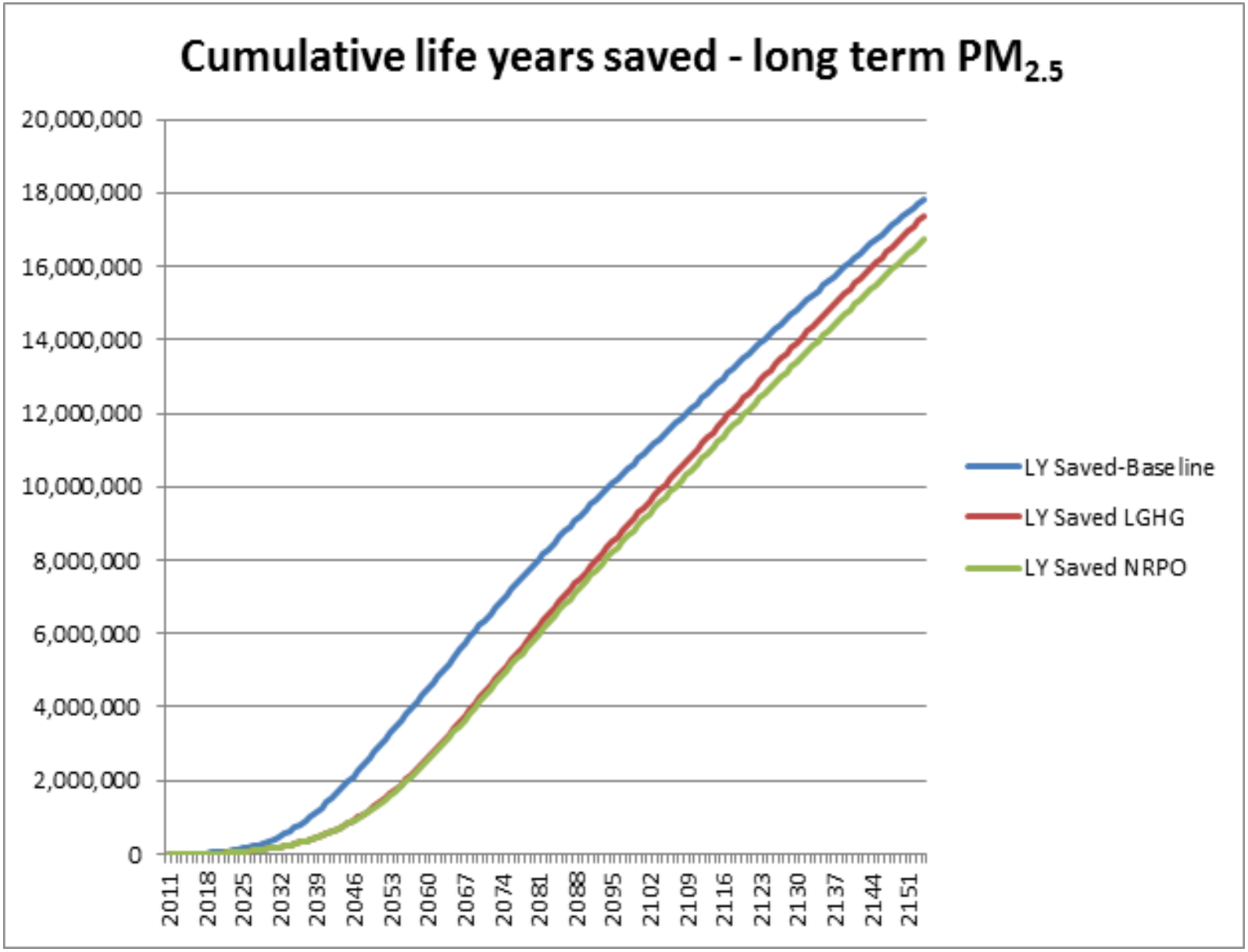


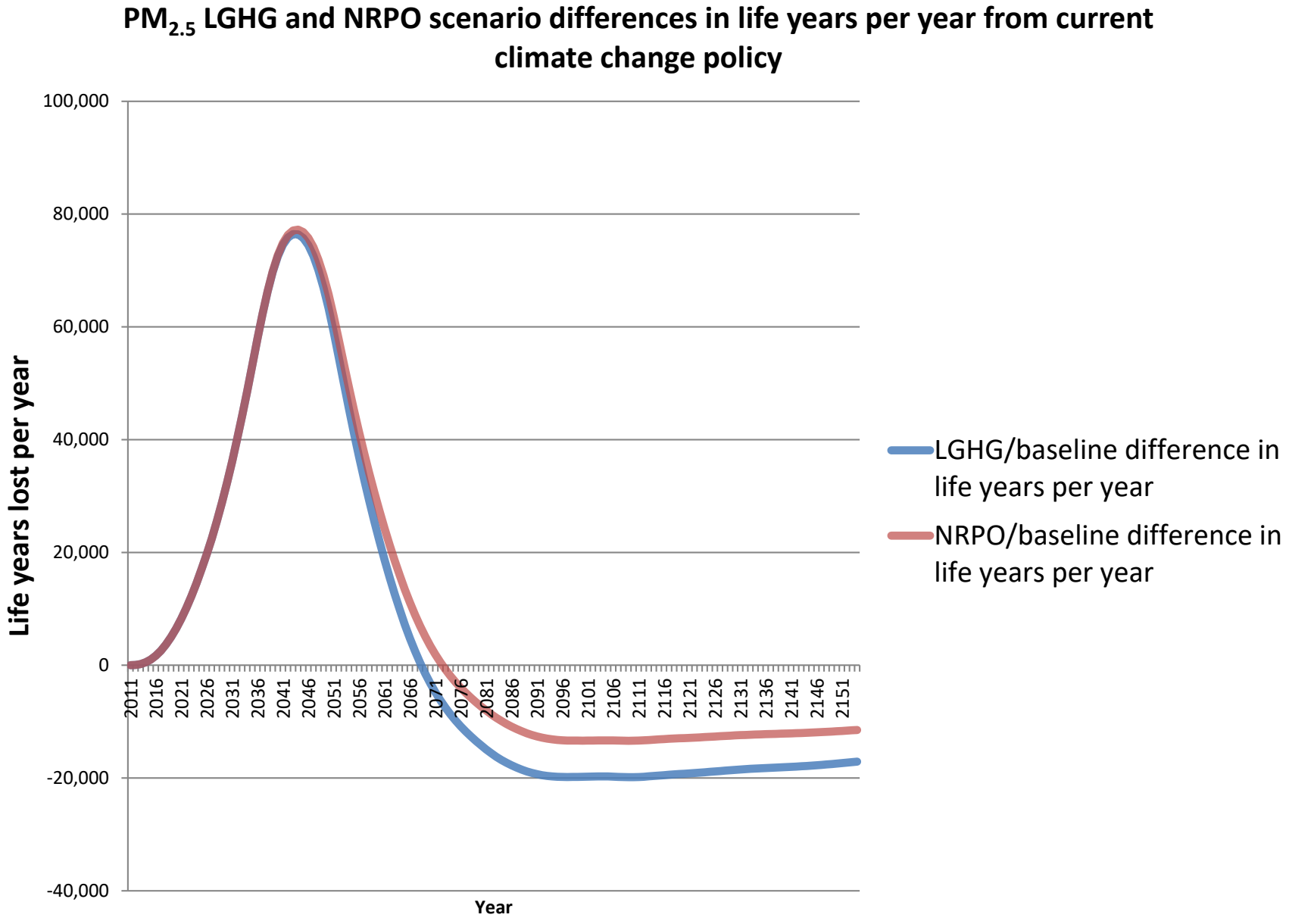
Health Impact Assessment method for long term exposure to $PM_{2.5}$ and NO_2

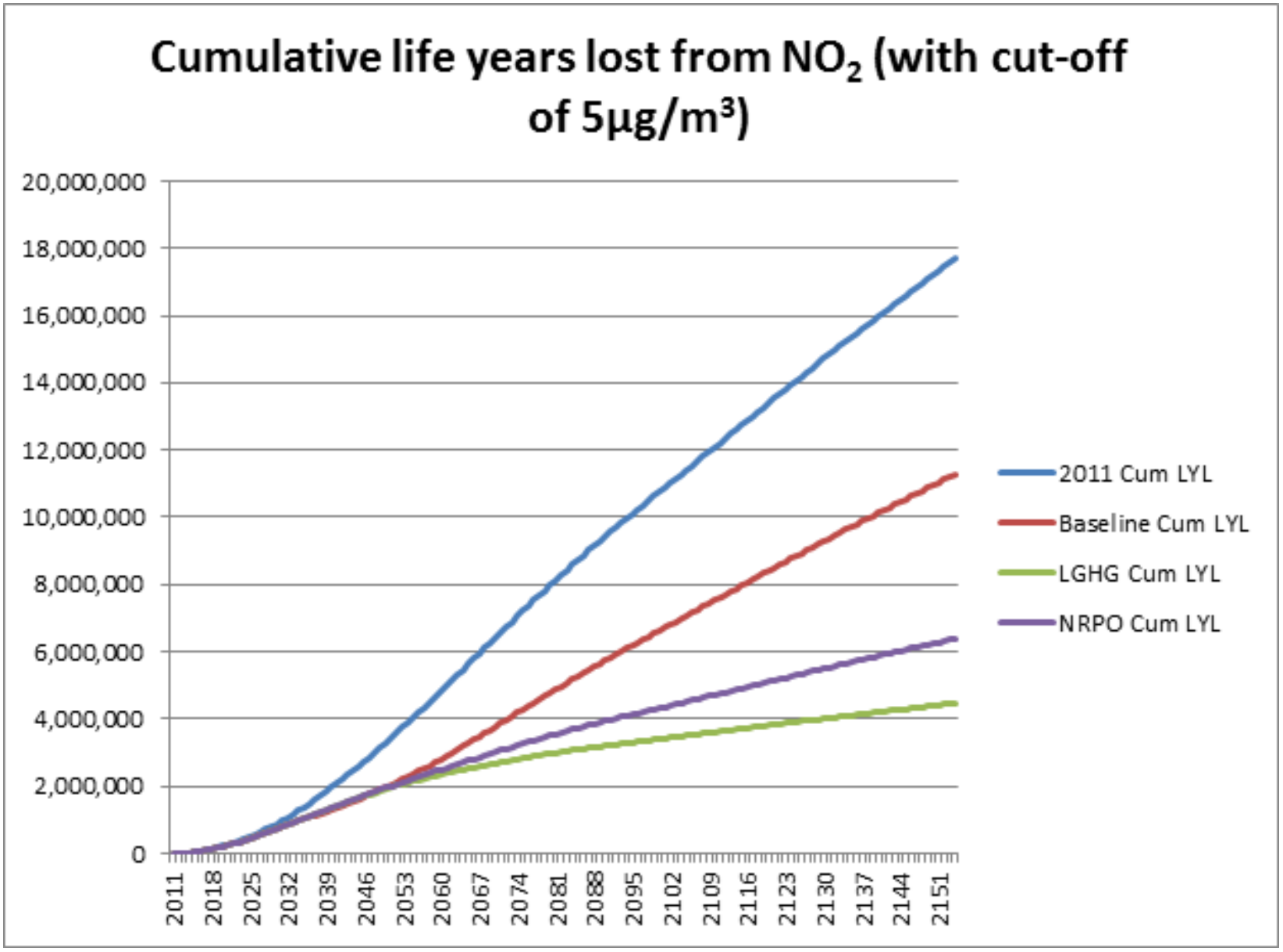
Full Impact methodology

- Uses life tables of pop. and death in 2010 by single year age group
- Follow life tables through for a lifetime 105 years to 2114, with new birth cohorts
- Use EPA lag 30% effect first year, 12.5% years 2-5, 20% years 5-20
- Results can be summarised as total Life Years and loss of Life Expectancy from birth
- Impact of future reduction scenarios on Life Years and life-expectancy

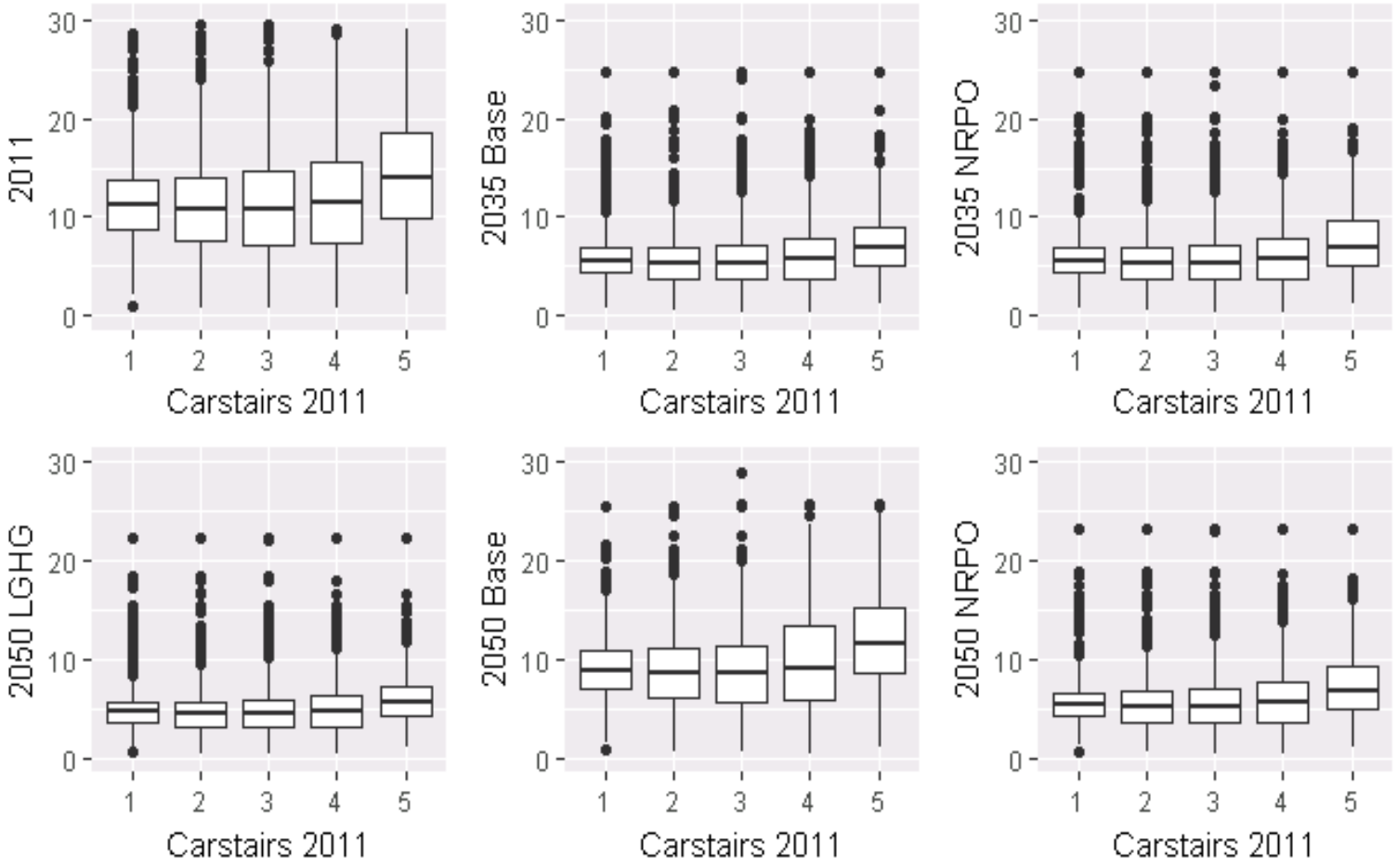

Cumulative life years lost - long term PM2.5
60,000,000
50,000,000
40,000,000
30,000,000
20,000,000
10,000,000
0
2011
2018
2025
2032
2039
2046
2053
2060
2067
2074
2081
2088
2095
2102
2109
2116
2123
2130
2137
2144
2151
2011 CumLYL
Baseline Cum LYL
LGHG CumLYL
NRPO CumLYL


Cumulative life years saved - long term PM2.5
20,000,000
18,000,000
16,000,000
14,000,000
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
2011
2018
2025
2032
2039
2046
2053
2060
2067
2074
2081
2088
2095
2102
2109
2116
2123
2130
2137
2144
2151
LY Saved-Baseline
LY Saved LGHG
LY Saved NRPO


PM2.5 LGHG and NRPO scenario differences in life years per year from current climate change policy
Life years lost per year
100,000
80,000
60,000
40,000
20,000
0
-20,000
-40,000
2011
2016
2021
2026
2031
2036
2041
2046
2051
2056
2061
2066
2071
2076
2081
2086
2091
2096
2101
2106
2111
2116
2121
2126
2131
2136
2141
2146
2151
Year
LGHG/baseline difference in life years per year
NRPO/baseline difference in life years per year


Cumulative life years lost from NO2 (with cut-off of 5µg/m3)
20,000,000
18,000,000
16,000,000
14,000,000
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
2011
2018
2025
2032
2039
2046
2053
2060
2067
2074
2081
2088
2095
2102
2109
2116
2123
2130
2137
2144
2151
2011 Cum LYL
Baseline Cum LYL
LGHG Cum LYL
NRPO Cum LYL

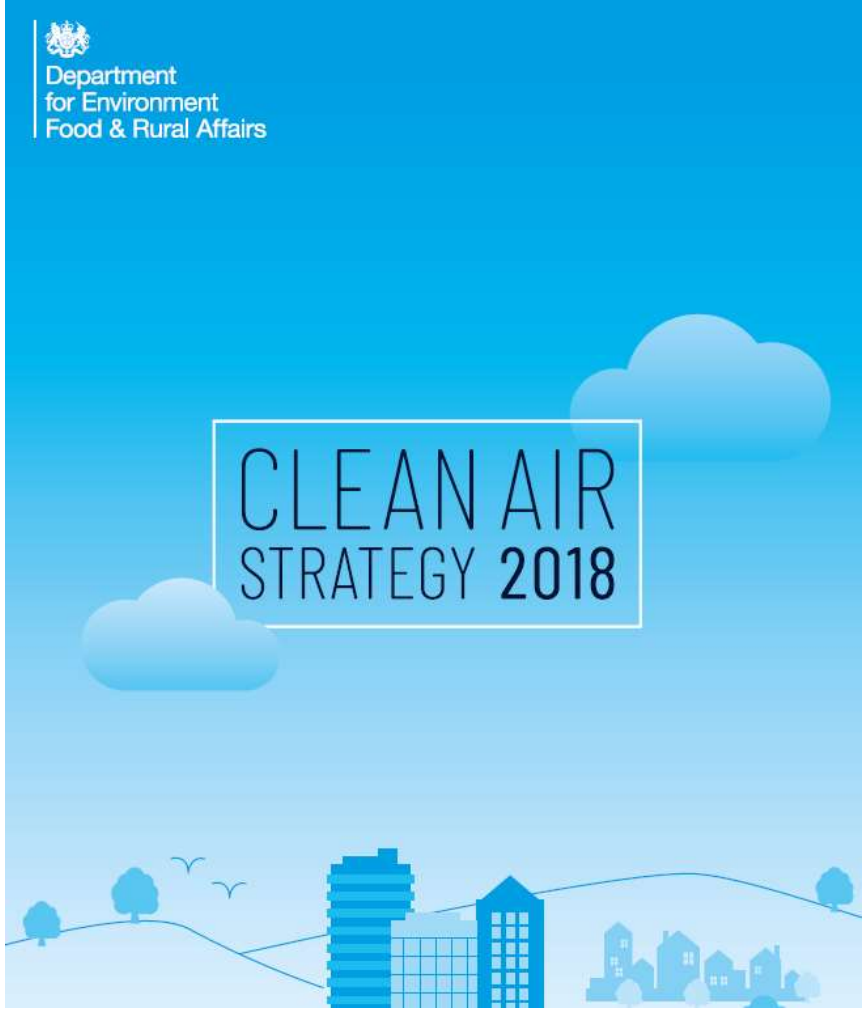
Exposure to NO_2/deprivation stratified by Ward



Conclusions and Policy Messages

- Urban levels of NO_2 should decrease significantly with corresponding improvements for public health and legal compliance
- PM concentrations should also decrease
- ***BUT*** in some scenarios, further policies to attain the CCA 2050 target may not give any additional public health benefit beyond policies already in place

- The incentivisation of biomass could lead to an ***increase*** in exposure to *primary PM combustion products*, including carcinogens in the period 2030-2035
- Non-exhaust PM concentrations will probably increase – how toxic are they?
- Currently accepted metrics for long- and short-term ozone exposure change in *different directions* in future – more health effect evidence on a possible threshold is needed



UK CLIMATE CHANGE ACT

At last we have signs that there is emerging dialogue between the two biggest atmospheric problems we face…