

Note on sensitivity scenario analysis for existing measures for PM₁₀ concentrations in London in 2011

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Introduction

This note summarises the results of a sensitivity analysis carried out to examine the impact of the following measures on the extent of exceedance of the 24-hour limit value for PM₁₀ in London in 2011:

- London Taxi Emission Strategy
- London Hybrid Bus Programme
- Euro 5 incentives for LGVs (National measure)
- Emission factor revision for motorcycles (not a measure but a correction to the baseline)

Roadside PM₁₀ concentrations in 2011 for the locations predicted to exceed the limit value in 2011 for the TEN baseline have been recalculated for the sensitivity scenarios by scaling the roadside increment and urban road traffic increments for exhaust emissions for the change in predicted emissions. All of the scenarios also incorporate the traffic growth factors for London provided by TfL.

London Taxi Emission Strategy

The London taxi emission strategy ensured that all pre-Euro 3 taxis were upgraded or replaced by 2008.

TfL have provided fleet composition data by Euro standard for the taxi fleets in the years 2005 to 2008. We have combined this with taxi census data for 2001 to produce a fleet model for 2011 both without and with the impact of the taxi emission strategy. TfL have also provided detailed information on the technologies used to upgrade pre-Euro 3 taxis as a result of the strategy and this information shows that particulate filters (dpf) have been fitted to 22% of the pre-Euro 3 fleet. Emission factors for different Euro standards have been derived from the TRL 2008 emission factors. The Euro 3 taxi emission factor seems to imply the presence of a dpf and we consider that this is unlikely to be representative of the Euro 3 taxis as a whole. We have therefore applied an emission factor of one half of the emission factor for Euro 2 to Euro 3. We have also applied this emission factor to pre-Euro 3 retrofits that do not have a dpf. We have applied the Euro 3 emission factor from TRL to the pre-Euro 3 retrofits that do have a dpf.

Our projections for the taxi fleet for 2011 are listed in Table 1.

Table 1. London Taxi fleet by Euro standard (number of taxis)

Euro Standard	Without taxi strategy	With taxi strategy
Pre-Euro 1	4	0
Euro 1	63	0
Euro 2	5147	0
Euro 3	7075	6132
Euro 4	5650	4397
Euro 5	3741	3741
Euro 6	0	0
Pre Euro 3 retrofit dpf	0	1912

Pre Euro 3 retrofit	0	6779
Total	21680	22961

We then calculated fleet weighted PM₁₀ exhaust emission rates per 1000 taxi km and this analysis showed that the emissions in 2011 with taxi strategy should be 72% of the 2011 emissions without the strategy. Taxi and car emissions on a link by link basis for 2010 were extracted from the 2004 LAEI and used to calculate an implied taxi emission in 2011 from the 2011 NAEI TEN baseline car emissions (which implicitly include taxis).

London Hybrid Bus Programme

TfL have informed us that a total of 500 hybrid buses out of a total bus fleet of 8,300 should be hybrids by 2011 and that these hybrid buses should have PM₁₀ emissions that are 30% lower than a Euro 4 bus with a dpf. Thus this represents a reduction in bus emission across the whole fleet of 1.8%.

Early Euro 5 for LGV

This measure was announced in the November 2008 pre budget report. From 1 January 2009, vans (LGV) that meet Euro 5 emissions standards, and are first registered between this date and 31 December 2010, will be eligible for a discounted rate of Vehicle Excise Duty. The impact of this measure on PM₁₀ emissions in 2011 has been estimated on the basis that 75% of newly registered LGVs during this period will meet Euro 5 standards. This is predicted to result in a decrease in UK PM₁₀ exhaust emissions in 2011 from LGVs of 0.59 ktonnes per year (out of a total of 7.59 ktonnes per year for LGVs, 16.03 ktonnes per year for all vehicles in this analysis).

Emission factor revision for motorcycles

The current emission factors for PM₁₀ for motorcycles within the NAEI do not show a decline with Euro Standard. The new 2008 emission factors for motorcycles from TRL show a decline in emissions with Euro standard which results in a reduction in fleet-weighted emission factor for motorcycles between 2005 and 2011 of about 50% and this is much more consistent with the trends for other vehicle types. In this sensitivity scenario we have therefore reduced the emissions from motorcycles by 50% in 2011 in comparison with our previous baseline.

Results

The results for the sensitivity scenarios are listed in Table 2. This table also shows the magnitude of the 'gap' between the predicted concentrations and the annual mean equivalent of the 24-hour limit value and the impact of each measure relative to the TfL traffic growth scenario, averaged across the 75 road links.

Table 2. Number of road links and length of road predicted to exceed the 24-hour limit value in 2011 and the magnitude of the exceedance. The average reductions in concentration across the 75 road links are also listed

	TEN baseline	TfL traffic growth	TfL traffic growth + taxi strategy	TfL traffic growth + hybrid buses	TfL traffic growth + Euro 5 LGV	TfL traffic growth + motorcycle emission factor	All existing measures
Number of links	75	46	34	46	45	28	14
Length of road (km)	38.0	22.3	17.0	22.3	20.8	12.7	16.5

Gap at London Marylebone Road ($\mu\text{g m}^{-3}$)	3.03	1.94	1.46	1.91	1.80	0.88	0.24
Maximum Gap ($\mu\text{g m}^{-3}$)	4.75	3.74	2.90	3.72	3.60	2.38	1.68
Average reduction as a result of measure ($\mu\text{g m}^{-3}$)	N/a	N/a	0.46	0.02	0.11	0.78	1.38

The results for the all measures sensitivity analysis are illustrated in Figures 1 and 2.

The calculation of these sensitivity scenarios can perhaps inform the choice of potential additional measures that could help close the gap.

- The hybrid buses could perhaps be targeted on routes influencing concentration at exceedence locations
- The taxi emission strategy could perhaps be extended to attempt to reduce emission from Euro 3 and pre-Euro 3 vehicles by early replacement or further retrofitting of dpfs (and perhaps SCR at the same time since we will be thinking about NO_2 in the near future)

Annex 2: Assessment of the impact of the Renewable Energy Strategy Consultation proposals (June 2008) on air quality

Background and scope

The use of biomass from sustainable sources to produce energy (electricity or heat) has the potential to contribute significantly towards the transition to a low carbon economy, as the carbon dioxide (CO₂) released during its combustion is offset by the CO₂ absorbed during growth. There are a number of policy drivers which are aimed at accelerating the uptake and use of biomass in the UK, as a contribution towards the UK meeting its climate change targets and commitments.

However, in comparison with gas and to a variable extent other fuels, the combustion of wood will result in increased emissions of PM and NO_x, both of which have a quantifiable impact on human health, and both of which are subject to mandatory EU air quality limit values (as PM₁₀, PM_{2.5} and NO₂). The difference in emissions is principally governed by the size and design of the combustion unit. Older, less efficient units, and those burning whole logs, will also tend to emit significant quantities of PAH, which is also subject to control at a European level. Annex A sets out the main relevant air quality limits and targets.

There is unlikely to be any significant uptake of the use of liquid biomass fuels for stationary energy production; liquid biomass fuels will in the main be directed to road fuels.

The main driver for the uptake of biofuels over the next decade or so is likely to be the UK target, set at EU level, for the provision of 15% of final energy demand from renewable sources by 2020. Achievement of this target will require different contributions from the three main energy sectors: transport electricity and heat. The consultation on a Renewable Energy Strategy¹ for the UK, published in June 2008, assumed that in order to meet the target, ~10% of transport energy will need to come from renewable sources, and 30-35% of electricity. This leaves heat, which currently accounts for around 49% of UK final energy demand, needing to provide ~14% from renewable sources, including biomass.

The consultation document suggested two levels of renewable heat uptake by 2020: 61TWh (11% of heat) and 84TWh (14% of heat). However, both scenarios limited biomass heat to 38TWh on the basis that a higher level would require a disproportionate import of biomass fuel, potentially compromising energy security and sustainability criteria.

In air quality terms, the use of biomass for large scale electricity production is less of a concern: all combustion plant rated above 20MW_{th} are subject to pollution control regimes, and regulated by local authorities, the Environment Agency (EA), the Scottish Environmental Protection Agency (SEPA) or equivalent authorities in Northern Ireland. Such plant are also likely to be relatively few in number, and where they replace coal fired plant, total emissions will be reduced. Units which burn certain types of waste wood (and exceed a minimum throughput) are also subject to stringent regulation under the Waste Incineration Directive.

For air quality, the main area of concern is the potential proliferation of wood fired units rated between 0-20MW_{th} for the production of heat, or as CHP units, sited either in or near urban areas.

¹ http://renewableconsultation.berr.gov.uk/consultation/consultation_summary

In an urban context, a high uptake of domestic biomass boilers is thought unlikely, so the main area of growth is likely to be in the range 200kW_{th} to 1MW_{th}, in the commercial, residential or public sectors.

Air Quality Impact Assessment

The majority of mechanisms which are aimed at increasing the uptake of biomass are market based. Therefore, while they may have an intended end point, i.e. achievement of the renewables targets, the route by which this is arrived at is not prescribed. This makes an assessment of their potential air quality impact problematic, as this relies on understanding the nature of the combustion source (its size, loading and emission characteristics), its location, the fuel which it uses and the fuel which it replaces². Impact assessment must therefore rely on assumptions for which there are no clear policy drivers, but which are based on advice from experts in the field, both within Government and elsewhere. In the case of biomass heat, the two key drivers for these assumptions are economics (e.g. the price differential between different fuel types) and practicability.

Initial impact analysis

The timescale for the production of the Renewable Energy Strategy consultation did not allow for a comprehensive assessment of the potential air quality impacts of biomass heat prior to its publication. For example, the final uptake targets were not set until relatively late in the process. Moreover, important information regarding the emissions performance of modern biomass heat units did not emerge until after the consultation was launched. Therefore, to help inform the development of policy proposals in the consultation document, an initial “ball park” analysis was undertaken. While this analysis gave an indication of the range of possible impacts, it used assumptions which were highly unlikely to be reflected in the real world:

- It assumed that uptake of biomass heat would be as a proportion of the current heat demand and that this uptake would follow the current heat demand patterns. Therefore, the majority of biomass use would be in urban areas with a great deal in the London area.
- There was no assumed fuel substitution, and so any emissions would be additional to the current emissions. There would therefore be an element of double counting.
- Final uptake was assumed to be 7% of total heat demand, equating to 52.6 TWh in 2020. The final RES consultation document capped total biomass heat uptake at 38 TWh in 2020.

The analysis calculated emission and concentration changes for primary PM₁₀ only, and used two descriptors for the emission performance of biomass plant:

- Medium quality: plant typical of those already installed in the UK, and described using an emission factor of 76 g/GJ PM₁₀ (100mg/m³, or 274 g/MWh energy input).
- High quality: plant typical of new, higher performing units being installed and commissioned in the UK, and described using an emission factor of 20 g/GJ PM₁₀ (20-30 mg/m³, or 72 g/MWh energy input)

² Current analysis of the heat market suggests that heat demand will decrease between now and 2020. Therefore, any biomass heat uptake must offset another fuel source, essentially gas, coal, oil or electricity.

Table 1 gives the key outputs from the analysis in terms of exceedences of the 24 hour limit value for PM₁₀³ and population weighted mean, and an extended summary of the assumptions used and the results obtained is shown in Annex B. Putting these results in context, the Air Quality Strategy for England, Scotland, Wales and Northern Ireland analysed a series of measures to improve air quality in terms of their costs and benefits. Combined Scenario R reduced population weighted concentrations by 0.926 µg/m³, at a cost of £33-1,211m (Net Present Value). Furthermore, the projected increase in concentrations rose to an additional 25 µg/m³, in central London, effectively doubling current concentrations at background locations.

Table 1: key outputs from “ball park” analysis of air quality impacts of biomass heat uptake by 2020.

	Roadside exceedences (km)	Background exceedences (km ²)	Changes in population weighted mean (µg/m ³)
Baseline ⁴	49	0	-
High quality units	187	9	0.344
Medium quality units	626	82	1.305

Based on the resultant concentration change modelling from this scenario an economic analysis was also undertaken to value the impact on societal welfare. This analysis was undertaken using the methodology established by the Interdepartmental Group on Costs and Benefits.⁵ This approach follows the logical progression from changes in sources of emissions, through dispersion modelling to estimate changes in exposure and thereby calculate the impact on a human health and the natural and man-made environment. Owing to the timescales set out above only a partial analysis was undertaken focussing on the impact on chronic mortality.⁶,

Table 2 presents both the marginal health outcomes in terms of life years lost and the annualised monetary values of these impacts relative to the baseline.

Table 2: Key economic outputs from “ball park” analysis.

	PM life years lost (000s) (2010 – 2109)	Annual present value PM life years lost (£million)	
		Central	0 – 40 year lag ¹
High quality units	2,767 – 5,280	£731	£354 - £831
Medium quality units	728 – 1,390	£2,803	£1,344 - £3,158

¹ The core IGCB analysis considers a lag range for chronic mortality impacts of between 0 and 40 years. The latest statements from COMEAP suggest that, although evidence was limited, the Committee's judgement tends towards a greater proportion of the effect occurring in the years sooner after the pollution reduction rather than later. The central

³ From the Ambient Air Quality Directive 2008/50/EC

⁴ The baseline has subsequently changed, and we are not currently projecting any exceedences beyond 2012.

⁵ More information on the IGCB approach to valuing changes in air quality is available on the IGCB website www.defra.gov.uk/environment/airquality/panels/igcb/index.htm.

⁶ While this does systematically underestimate the value of these impacts chronic mortality accounts for the vast majority of these benefits and so provides a reasonable estimate of the magnitude of the impact.

estimate reflects this by using a mean lag significantly closer to the zero lag estimate.

Due to the unrealistic nature of the scenario, these figures were not included in the final consultation document. However, they did demonstrate the need to control emissions from biomass heat, and to focus uptake in areas where non-gas heating fuels were used and away from urban areas.

Comprehensive analysis

In commissioning more comprehensive analysis, considerable effort was made to construct scenarios which reflected the assumptions made in the RES consultation document, and expert opinion within various Government Departments and elsewhere. This section sets out the outline of the scenarios and summarises the results.

Baseline: this is the business as usual assessment of air quality, incorporating all current policies contained in the most recent published energy projections, and all agreed national pollution control policies. The baseline used will also incorporate the Euro VI emission standard for HGVs (not fully agreed yet) and the London Low Emission Zone. The other assumptions in the baseline are as follows:

- **General**
 - 2005 Base year
 - NAEI 2005
 - Energy projections: UEP30
 - Area source dispersion kernels: 3x3km²
 - PM data correction for Partisols, no sea salt correction
 - Secondary PM projections: mapped EMEP source receptor
 - NO_x/NO₂ model: Murrells 2008 (from Tropospheric ozone work)
 - Primary NO₂: NAEI April 2008
- **Road transport**
 - New road transport emission maps produced based on updated DfT traffic projections, April 2008
 - RT emission factors from NAEI 2002
 - DfT traffic projections by vehicle, road and area type in each Government Office region (in Northern Ireland traffic growth at GB average rate)
 - Baseline maps include:
 - EURO 6 and EURO VI
 - London LEZ
 - Increased dieselisation of fleet

Uptake Rates: the RES consultation document suggests two possible levels of renewable heat uptake for 2020. However, biomass heat is capped at 38TWh (excluding biogas) and so is the same for both. It is assumed that all of this is derived from the combustion of woody biomass. However, 38TWh is a relatively cautious assumption, and it is thought that a higher level of uptake should be assessed for comparison; for this reason, a total uptake of 50TWh will also be examined.

This is set against a total heat demand in 2020 of 707 TWh, taking into account the share of electricity used for heating, and a total heat demand in 2005 of 844TWh (761TWh combustion based heating plus 83 TWh of electrical heating). Figures for demand are also available by sector (transport/ specific industrial sectors/ fuel types etc). The assumptions within the RES modelling for renewables uptake were in the form of a J curve rather than linear uptake. Additional renewable resource as a result of RES policies is assumed to go from zero in 2010 to 17 TWh in 2015 and 84 TWh in 2020 (under the 14% deployment scenario). No account is made of the change in air quality brought about through the uptake of other renewable heat options (a significant part of this will be users of electrical heat transferring to non-combustion renewable heat, generally with a positive impact on air quality).

Emission Factors: The scenarios will use two sets of emission factors, one representing current good practice (medium quality), and one representing the best currently available, which may become future good practice (high quality). There are a number of ways these could be used:

- Use both sets independently, i.e. run separate medium and high quality scenarios;
- Use the different sets sequentially, i.e. medium quality applies for installations up to a given date, then high quality thereafter;
- Use the different sets in different location, i.e. high quality in urban areas, medium quality elsewhere.

At the present time, only the first option in this set of potential scenarios has been examined.

The emissions factors to be used are:

- Medium quality: 60g/GJ PM₁₀, 45g/GJ PM_{2.4}, 100g/GJ NO_x
- High quality: 20g/GJ PM₁₀, 16g/GJ PM_{2.5}, 50g/GJ NO_x

Fuel and Location Bias: One fuel and location bias assumption will underlie all of the scenario runs. Under this assumption that the majority of biomass heat uptake will replace existing coal and oil heating. Under this assumption, biomass heat will replace coal and oil heating in the commercial, public and domestic sectors up to a level of 60% of fuel use, with generalised uptake in the commercial and public sectors (not domestic) thereafter, up to the totals of 38 and 50TWh. This additional, generalised uptake will also displace some oil and coal use, although this portion will be in proportion with the remaining activity across all heat sources.

There will be a bias away from installation in areas declared as Air Quality Management Areas (AQMA) under the Environment Act 1995. Different local authorities will adopt different policies with regard to biomass installation in their areas, regardless of the presence or otherwise of an AQMA. This means that fairly broad generalisations will have to be applied which may not be accurate in any given location, but which may provide a better picture at the UK level. For the purposes of this exercise, the AQMA boundaries will be mapped onto the 1km by 1km NAEI grid and:

- The AQMA bias will apply for any grid square which contains all or part of an AQMA (to allow for “buffer zone” policies in local authorities);
- Uptake in AQMAs declared for PM10 will be at a rate of 50%, in terms of heat demand, of that in equivalent non-AQMA squares;

- Uptake in AQMAs declared for NO₂ will be at a rate of 75%, in terms of heat demand, of that in equivalent non-AQMA squares;

Outputs: The scenarios were analysed for their impact on the concentrations of PM₁₀, PM_{2.5} and nitrogen dioxide (NO₂), with the results expressed in terms of:

- Emissions: changes and resultant total (i.e. change plus baseline)
- Concentrations: change in population weighted mean and resultant total
- Exceedences: additional exceedences of PM₁₀ and NO₂ limit values, exceedences of PM_{2.5} limit value, changes in Exposure Reduction for PM_{2.5} in 2020, using new Air Quality Directive methodology.
- Years: result will be shown for 2010, 2015 and 2020.

Summary: The modelling work produced the outputs described in the previous section for four scenarios plus baseline:

1. Baseline
2. Medium quality, 38TWh cap.
3. Medium quality, 50TWh cap.
4. High quality, 38TWh cap.
5. High quality, 50 TWh cap.

Results: emissions

The results of the emission assessment are summarised in Table 3, which shows the totals for Commercial, Residential and Public sector and the percentages changes relative to the baseline for each scenario. Note that these are the percentage changes for this sector only; the percentage change in UK emissions from all sources, including industry, transport and other sectors, will be smaller. In all instances the medium quality units scenario results in an increase in emissions. For NO_x and PM₁₀ the high quality units scenarios result in a small decrease in emissions in 2010 and 2015 (when only coal and oil emissions are being displaced) but an increase in emissions in 2020 when more gas is being displaced. The increases are smaller than for the medium quality units in 2020. PM_{2.5} emissions are always increased for the biomass scenarios, the difference from PM₁₀ being due to differences in the size distribution of emissions for different fuels. For NO_x the increases are quite small, for PM₁₀ and PM_{2.5} they are larger. This is because PM emissions are more dependent on fuel type than NO_x emissions.

Table 3a Summary of UK emissions from Commercial, Residential and Public sector heating (ktonnes per year)

Scenario	NOx 2006	NOx 2010	NOx 2015	NOx 2020
1. Baseline	124.42	110.61	100.36	87.14
2. Medium 38	124.42	110.92	102.04	94.21
3. Medium 50	124.42	110.92	102.04	96.21
4. High 38	124.42	110.05	99.65	87.89
5. High 50	124.42	110.05	99.65	88.57
Scenario	PM10 2006	PM10 2010	PM10 2015	PM10 2020
1. Baseline	18.30	15.22	14.03	13.22

2. Medium 38	18.30	15.69	16.16	20.80
3. Medium 50	18.30	15.69	16.16	22.74
4. High 38	18.30	14.82	13.77	14.49
5. High 50	18.30	14.82	13.77	15.10
Scenario	PM2.5 2006	PM2.5 2010	PM2.5 2015	PM2.5 2020
1. Baseline	10.43	8.84	8.33	7.95
2. Medium 38	10.43	9.51	10.41	14.20
3. Medium 50	10.43	9.51	10.41	15.65
4. High 38	10.43	8.88	8.68	9.62
5. High 50	10.43	8.88	8.68	10.11

Table 3b Summary of emissions from Commercial, Residential and Public sector heating (percentage differences from baseline, positive = increase)

Scenario	NOx 2006	NOx 2010	NOx 2015	NOx 2020
1. Baseline	0.0%	0.3%	1.7%	8.1%
2. Medium 38	0.0%	0.3%	1.7%	10.4%
3. Medium 50	0.0%	-0.5%	-0.7%	0.9%
4. High 38	0.0%	-0.5%	-0.7%	1.7%
5. High 50	0.0%	0.0%	0.0%	0.0%
Scenario	PM10 2006	PM10 2010	PM10 2015	PM10 2020
1. Baseline	0.0%	3.1%	15.1%	57.3%
2. Medium 38	0.0%	3.1%	15.1%	71.9%
3. Medium 50	0.0%	-2.6%	-1.9%	9.5%
4. High 38	0.0%	-2.6%	-1.9%	14.2%
5. High 50	0.0%	0.0%	0.0%	0.0%
Scenario	PM2.5 2006	PM2.5 2010	PM2.5 2015	PM2.5 2020
1. Baseline	0.0%	7.6%	25.0%	78.7%
2. Medium 38	0.0%	7.6%	25.0%	96.9%
3. Medium 50	0.0%	0.4%	4.2%	21.0%
4. High 38	0.0%	0.4%	4.2%	27.2%
5. High 50	0.0%	0.0%	0.0%	0.0%

Results: ambient air quality assessment

NO₂: The predicted changes in UK population weighted mean NO₂ concentration in 2020 for the scenarios are listed in Table 4. The predicted impact of biomass emissions on ambient NO₂ concentrations is expected to be small. Scenario projections have been calculated using our standard PCM model assumptions for primary NO₂ emissions and a more pessimistic assumption of 15% primary NO₂ from biomass. The results from the two sets of model runs are almost identical. The extent of road length predicted to exceed the annual mean limit value in 2020 is predicted to be increased from a baseline of 174 km to a maximum of 189 km for the Medium Quality, 50TWh scenario.

Table 4. Predicted changes in UK population-weighted mean NO₂ concentration in 2020 (µg m⁻³)

scenario	Change in concentration (+ve bad, -ve good)
Baseline	No change
Medium quality, 38TWh cap.	0.129
Medium quality, 50TWh cap.	0.171
High quality, 38TWh cap.	0.030
High quality, 50 TWh cap.	0.045

PM₁₀: The predicted changes in UK population-weighted mean PM₁₀ concentration in 2020 for the scenarios are listed in Table 5. The changes in UK population-weighted in 2010 and 2015 are predicted to be small for all scenarios, sometimes with a small decrease in 2010 or 2015 for the high quality units. Note that not only are these changes in population-weighted mean greater for PM₁₀ than for NO₂ but the associated health impacts per µg/m⁻³ are much greater (see economic analysis below).

Table 5. Predicted changes in UK population-weighted mean PM₁₀ concentration in 2020 (µg m⁻³)

scenario	Change in concentration (+ve bad, -ve good)
Baseline	No change
Medium quality, 38TWh cap.	0.329
Medium quality, 50TWh cap.	0.432
High quality, 38TWh cap.	0.084
High quality, 50 TWh cap.	0.112

The predicted increases are smaller than the increases suggested by the ‘ballpark’ calculations carried out previously, which showed increases of 1.31 µg m⁻³ and 0.34 µg m⁻³, for medium and high quality units with no fuel and location bias.

The increases implied for the medium quality units scenarios are unlikely to be acceptable, the increases for the high quality units are lower but are still going in the ‘wrong’ direction.

The changes in the predicted extent of exceedence of the daily PM₁₀ limit value in 2020 across the UK are listed in Table 6. Values are listed for both total concentrations with natural contribution (sea salt) included and excluded. These exceedences are in London.

Table 6. Predicted length of road exceeding the daily limit value for PM₁₀ in 2020 (km)

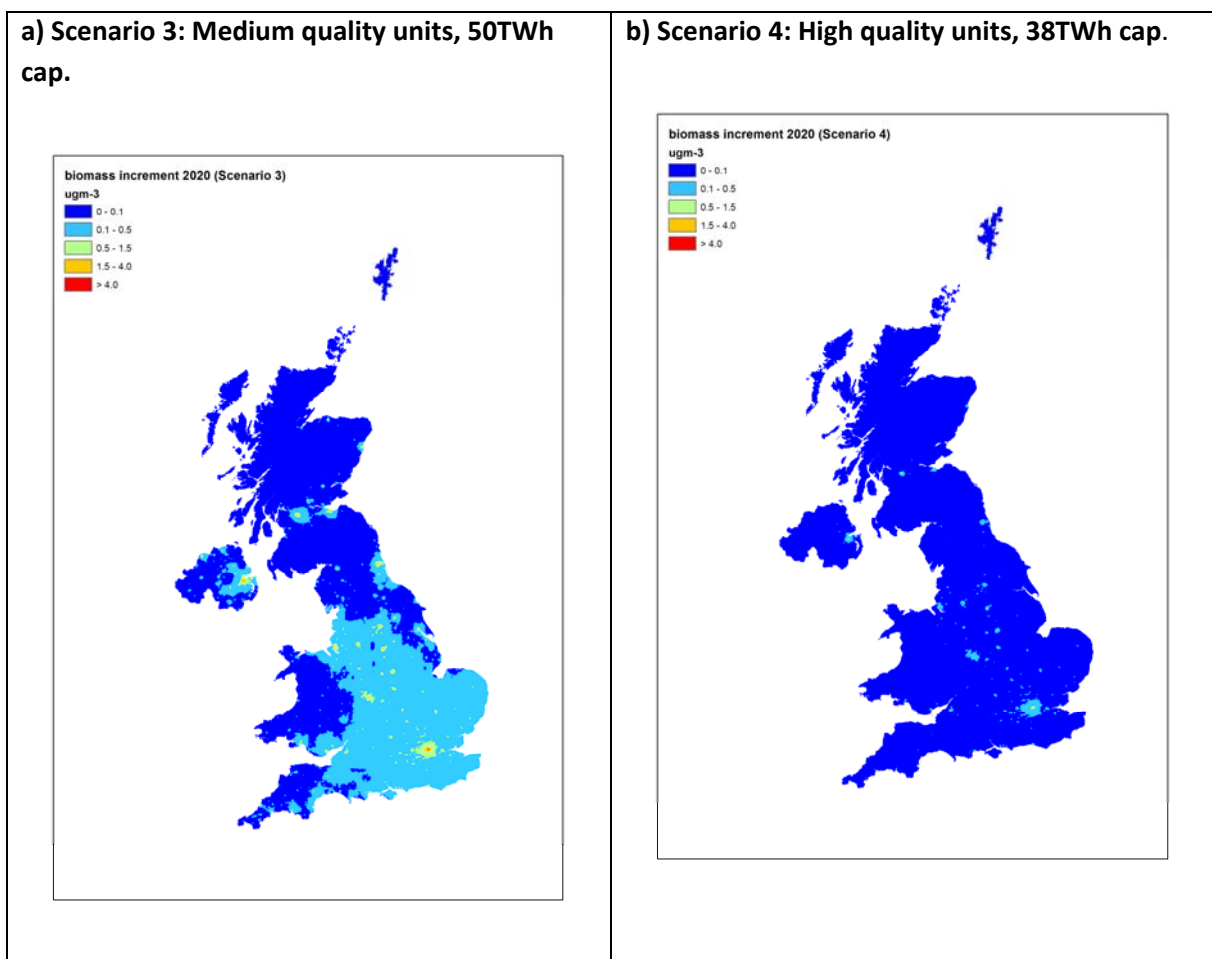
scenario	Natural included	Natural excluded	Range of biomass increment (µg m ⁻³)
Baseline	6.5	0	0
Medium quality, 38TWh cap.	35.5	9.3	-0.07 to 3.52
Medium quality, 50TWh cap.	61.6	20.3	-0.01 to 4.78
High quality, 38TWh cap.	11.5	2.6	-0.31 to 1.12
High quality, 50 TWh cap.	14.0	3.0	-0.29 to 1.53

The range of the ‘biomass increments’ relative to the baseline scenario are also listed in Table 6 for urban roadside locations across the UK. Negative increments are good and are at locations where ‘dirty fuels’ such as coal have been displaced and positive increments are bad. The largest positive increments are in London.

This analysis suggests that the increases in exceedences implied by the medium quality units would be unacceptable, given current efforts towards compliance. The extent of exceedence also increases for the high quality units. This would suggest that an additional policy might be required to avoid extensive biomass take up in central London, where the PM₁₀ compliance is most challenging due to emissions from other sources.

The incremental increases in annual mean PM₁₀ concentrations in 2020 relative to the baseline are illustrated in Figure 1 for scenarios 3 and 4, which have the largest and smallest increments respectively.

Figure 1 Modelled biomass increments for 2020



PM_{2.5}: The predicted changes in UK population-weighted mean PM_{2.5} concentration in 2020 for the scenarios are listed in Table 7. The changes in UK population-weighted in 2010 and 2015 are predicted to be small for all scenarios.

Table 7. Predicted changes in UK population-weighted mean PM_{2.5} concentration in 2020 ($\mu\text{g m}^{-3}$)

scenario	Change in concentration (+ve bad, -ve good)
Baseline	No change
Medium quality, 38TWh cap.	0.220
Medium quality, 50TWh cap.	0.297
High quality, 38TWh cap.	0.033
High quality, 50 TWh cap.	0.059

The increases implied for the medium quality units scenarios are unlikely to be acceptable, the increases for the high quality units are lower but are still going in the 'wrong' direction.

The extent of exceedence of the PM_{2.5} limit value of $20 \mu\text{g m}^{-3}$ in 2020 is zero for all scenarios except for the Medium Quality, 50 TWh scenario, which has a predicted extent of exceedence of 1.3 km.

The percentage exposure reduction for PM_{2.5} in agglomerations with a population of at least 100,000 between 2010 and 2020 is listed in Table 8. These reductions can be compared with a target of 10%

Table 8. Predicted PM_{2.5} exposure reduction

scenario	Exposure reduction (-ve good)
Baseline	-6.7%
Medium quality, 38TWh cap.	-4.0%
Medium quality, 50TWh cap.	-3.0%
High quality, 38TWh cap.	-6.1%
High quality, 50 TWh cap.	-5.7%

An economic analysis was undertaken based on these changes in air quality to value the impact on societal welfare. As with the ball park analysis this was undertaken in accordance with the IGCB methodology, focussing on the impact on chronic mortality.,

Table 9 presents both the health outcomes in terms of life years lost and the annualised monetary values of these impacts.

Table 9: Key economic outputs from comprehensive analysis.

	PM life years lost (000s) (2010 – 2109)	Annual present value PM life years lost (£million)	
		Central	0 – 40 year lag ¹
Medium quality 38TWh cap	698 – 1,332	£557	£281 - £663
Medium quality 50TWh cap	916 – 1,749	£732	£369 - £831
High quality 38TWh cap	178 - 340	£142	£72 - £162
High quality 50TWh cap	237 – 453	£189	£95 - £215
¹ The core IGCB analysis considers a lag range for chronic mortality impacts of between 0 and 40 years. The latest statements from COMEAP suggest that, although evidence was limited, the Committee's judgement tends towards a greater proportion of the effect occurring in the years sooner after the pollution reduction rather than later. The central estimate reflects this by using a mean lag significantly closer to the zero lag estimate.			