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Proposed Air Quality Directive: Assessment of the environmental impact of Parliament's amended Proposal

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CONTENTS

MAIN CONCLUSIONS

- The air quality target and limit values proposed by European Commission, Council and Parliament would all require consistent additional EU-legislation on emission reductions. However, even assuming full implementation of maximum technical feasible reductions, attainment of limit values everywhere in Europe is unlikely before 2020. Non-technical measures at the local or regional scale would still be required.
- Of the different limit values for PM_{10} and $PM_{2.5}$, the Parliament's proposed annual limit value for PM_{10} and the equivalent current daily limit value for PM_{10} seem to be the most binding constraints in densely populated and polluted areas. However, if natural contributions to the concentration of particulate matter may be subtracted, there could be a fifty-fifty chance that the $PM_{2.5}$ limit value proposed by the Parliament becomes the most stringent.
- The Parliament proposal to tighten the annual limit for PM_{10} to 30μg/m^3 will ensure better equivalence with the current daily limit value. However, at the same time it allows - in specific circumstances - an extension of the number of days that this daily limit value can be exceeded. The latter seems to be redundant and makes the system more complex. Additionally, this approach weakens the daily limit value, thus making the annual limit value for PM_{10} the stronger limit value.
- The multiple and partly overlapping air quality standards and the various possibilities for derogation offered by Parliament, Council and Commission could hamper policy enforcement and there may be a risk that the intended improvement of environmental conditions will not occur.
- Particulate matter is a major environmental factor affecting human health. There are indications that benefits of the emission reduction ambitions of the European Parliament outweigh the costs. However, uncertainties in emissions, air quality monitoring and health effects are large. It is recommended that a European long term health study is initiated, but in the meantime policy makers have to decide whether they would take precautionary actions on the basis of the available data, or target their efforts to no-regret actions focusing on components of PM suggested to be more toxic.
- In order to reach an equitable implementation of the limit values differences in measurement strategies and methods between Member States need special attention. Differences in the number of monitoring stations, monitoring locations, resolution of models and modelling accuracy might result in unjustified differences in the attainment of limit values.

EXECUTIVE SUMMARY

This briefing considers three proposals for future European air quality legislation. These are the Commission's proposal as put forward on 21 September 2005, the European Parliament's position as adopted on 21 June 2006 and the Council's general approach, as adopted on 27 June 2006. The briefing reviews the environmental impacts, costs and benefits of three proposals for future European air quality legislation, as well as the practicalities of meeting the proposed limit and target values, such as through existing legislation. The briefing does not make any judgement on which proposal is 'better'. It is up to policy makers to consider environmental impacts, health benefits and costs in their decision making process, and it is essential to do this in the context of the need for consistency with emission reductions, homogeneity of enforcement procedures, decreasing complexity of target setting and the remaining uncertainties in health impact assessments. The key findings are summarised below.

Stringency of proposals

- The proposals on target and limit values from all three institutions would require additional emission reduction measures compared to those required under adopted legislation to realize the proposed limit and target values. The largest emission reduction efforts are needed to meet the Parliament's proposal, due to the stringency of the combination of the existing daily limit value and the proposed 30μg/m^3 yearly limit value for PM_{10} to be met in 2010. Smaller, but still considerable efforts are needed to meet the Commission's and Council's proposals. Most stringent in the latter two proposals is the existing daily limit value for PM_{10}.
- In all three proposals, PM_{10} is the dominant factor in densely populated and industrialized areas and cities where exceedances are expected occur. This is due to the stringency of PM_{10} limit values compared to the target/limit values proposed for $PM_{2.5}$. This is surprising because in recent years, the PM risk assessment and abatement strategy have focused on $PM_{2.5}$, as the most health effect-relevant particle size fraction. However, evidence also shows that the coarse particle fraction (PM_{10}-$PM_{2.5}$) cannot be considered as harmless. Moreover, under certain conditions, natural contributions may be subtracted from the measured PM levels. Since most natural contributions consist of particles coarser than $PM_{2.5}$, there is a fifty-fifty chance that the $PM_{2.5}$ limit value proposed by the Parliament becomes most stringent. Even then PM_{10} will remain the dominant factor in the Commission's and Council's proposals.
- The proposal by the Parliament to increase the number of exceedances allowed for the daily limit value to 55 days would correspond to an average annual concentration of 35μg/m^3, so equivalence between the daily and yearly limit value is not achieved and measures will be driven by the need to meet the proposed annual limit value of 30μg/m^3.

- All proposals contain a combination of limit and target values for both PM_{10} and $PM_{2.5}$ for different averaging periods, and have different approaches to derogation and margins of tolerance. These multiple and partly overlapping targets require complex assessment and reporting strategies in Member States. In general the increasing complexity in environmental policies could hamper enforcement and might not result in the intended improvement of environmental conditions. Therefore it is recommended to keep the number of limit values as low as possible and these should be directed to those limit values that protect public health most effectively.
- The introduction of the - not legally binding - $PM_{2.5}$ exposure reduction target of 0-20% may trigger measures that lead to European wide reductions of PM concentrations in urban air. The potential health benefits of this approach (if implemented) may be larger than the health benefits resulting from local measures that are required to meet the proposed limit values at individual locations.

Attainability of the proposed target and limit values

- At many places in Europe limit values for PM_{10} as well as the proposed limit values for $PM_{2.5}$ are already met at present. However, exceedances will remain, particularly for the PM_{10} and the $PM_{2.5}$ limit values proposed by the Parliament in densely populated and industrialized areas, such as the Po-valley, areas in Central European countries, the Ruhr-area, the BeNeLux countries, as well as specific large cities in Europe.
- Meeting the proposed limit and target values will require further emission reductions beyond adopted legislation. Policy efforts in line with the Thematic Strategy will be needed, and beyond this in areas with high emission densities. It is prudent that the Parliament proposes a direct link between missing Community measures and possibilities for concentration derogations, but this will not provide sufficient room to meet the limit values.
- In the Parliament's proposal it is stated that plans and programmes should not involve measures for industry beyond Best Available Techniques (BAT). Also, Member States have few possibilities at the national level to reduce traffic emissions through technical changes. Therefore, the room for Member States for more stringent emission reductions than those foreseen in the Thematic Strategy is limited, as far as technical measures are concerned. Furthermore, as additional policy needs time to take effect, the proposed derogation periods may not be sufficient for all situations.
- Even with application of maximum technical feasible reductions, attainment of all limit values anywhere in Europe is unlikely before 2020. Non-technical measures such as non-technical transport measures at the local or regional scale would still be required. There has been no thorough assessment that these measures will lead to attaining the proposed limit values in densely populated and industrialized regions and cities.
- Consistency is needed between air quality policies, national emission ceilings, and emission standards, taking into account the limited possibilities for Member States for more stringent, technical and non-technical, emission reductions than those foreseen in the Thematic Strategy. In the implementation of the Thematic Strategy the cost-effective balance between additional EU-wide measures and additional local and national measures should be taken into account.

Integrated Assessment

- Results of the cost-benefit analysis support a shift from emission reductions provided for in adopted legislation to implementation of the ambitions of the Thematic Strategy. The incremental benefits exceed the incremental costs in almost all countries.
- The appropriateness of policy action up to maximum technically feasible reductions depends on the value that policy makers would give to the reduction of health effects.

Uncertainties

- Uncertainties in assessing concentrations of $PM_{2.5}$ and PM_{10} are large. Although the operational European network of PM_{10} stations consists of 1800 sites, the consistency of measured data is hampered because the monitoring strategies and techniques differ among countries. Data on $PM_{2.5}$ are scarce because the European $PM_{2.5}$ network thus far consists of only about 120 sites. Modelling of particulate matter has its drawbacks because models generally underestimate measured levels for various reasons. Although uncertainty analysis was taken into account in our conclusions on the attainability of limit values, caution is still needed.
- Particulate matter is a major environmental factor affecting public health. There are indications that, from a macro-economic perspective, the benefits of further reductions of the PM levels in Europe outweigh the costs. However, uncertainties in emissions, air quality monitoring and health effects are large. For example, it is not clear whether the relationship between long term exposure of $PM_{2.5}$ and mortality that is found in epidemiological studies in the United States can be transferred to Europe, even though recent European studies suggest effects from long-term exposure to air pollution on life expectancy. According to the advice from WHO the coarse fraction of particulate matter is likely to have an effect on morbidity. There are indications that certain sources might be in particular relevant for health effects such as traffic. It is recommended that a European long term health study is initiated, but in the meantime policy makers have to decide whether they would take precautionary actions on the basis of the available data or target their efforts to no-regret actions focusing on components of PM suggested to be more toxic.
- In order to reach an equitable implementation of the limit values, differences in measurement strategies and methods between Member States need special attention. Differences in the number of monitoring stations, monitoring locations, resolution of models and modelling accuracy might result in unjustified differences in the assessment of attainment of limit values.

1 INTRODUCTION AND BACKGROUND

European Union air quality legislation is currently based on a framework Directive[1], which *inter alia* sets out provisions regarding the assessment and monitoring of air quality and requirements relating to informing the public and taking action to improve air quality, where necessary. The air quality limit and target values are left to a series of daughter Directives covering:

- Sulphur dioxide (SO_2) and the oxides of nitrogen (particularly nitrogen dioxide, NO_2), particulate matter (PM_{10}, i.e. particulates with a diameter of smaller than 10μm) and lead (the first daughter Directive)[2];
- Benzene and carbon monoxide (CO) (the second daughter Directive)[3];
- Ozone (the third daughter Directive)[4]; and
- Arsenic, cadmium, nickel, mercury and polycyclic aromatic hydrocarbons (the fourth daughter Directive)[5].

In 2005, the European Commission published the Thematic Strategy on Air Pollution[6], which was accompanied by a proposal for a Directive[7]. The proposed Directive would consolidate four of the existing air quality Directives into one Directive[8], and would also introduce some changes, particularly in relation to derogations, and would also cover $PM_{2.5}$ for the first time.

At its first reading, the European Parliament's Environment Committee agreed its report on the proposed Directive in its meeting of 21 June 2006[9], while the Environment Council agreed a 'general approach' to the proposal at its meeting of 27 June[10] on the basis of a revised draft of the proposal[11].

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[1] Directive 96/62/EC of the European Parliament and the Council on ambient air quality assessment and management, OJ L 296, 21.11.1996, page 55

[2] Directive 1999/30/EC of the European Parliament and the Council relating to limit values for sulphur dioxide and the oxides of nitrogen, particulate matter and lead in ambient air, OJ L 163, 29.6.1999, page 41

[3] Directive 2000/69/EC of the European Parliament and the Council relating to limit values for benzene and carbon monoxide in ambient air, OJ L 313, 13.12.2000, page 12

[4] Directive 2002/3/EC of the European Parliament and the Council relating to ozone in ambient air, OJ L 67, 9.3.2002, page 14

[5] Directive 2004/107/EC of the European Parliament and the Council relating to arsenic, cadmium, nickel, mercury and polycyclic aromatic hydrocarbons in ambient air, OJ L 23, 26.1.2005, page 3

[6] Communication from the Commission to the Council and European Parliament *Thematic Strategy on air pollution* COM(2005)446

[7] Proposal for a Directive of the European Parliament an the Council on ambient air quality and cleaner air for Europe, COM(2005)447

[8] The fourth daughter Directive will not be consolidated, yet, instead it will be added into the revised Directive at a later date.

[9] European Parliament Committee on the Environment, Public Health and Food Safety , Draft European Parliament Legislative Resolution on the proposal for a directive of the European Parliament and of the Council on ambient air quality and cleaner air for Europe, (COM(2005)0447 – C6-0356/2005 – 2005/0183(COD)) 29.6.2006

[10] Council of the European Union, Press release (10876, Presse 192) of the conclusions of the Environment Council meeting of 27 June 2006, Provisional version

[11] General Secretariat of the Council of the European Union, Document number: 10453/06 ADD 1

In the remainder of the briefing, references to the various positions will be as follows:

- 'Existing or adopted legislation' will mean the relevant Directive, i.e. the air quality framework Directive or one of its daughter Directives, as noted above, as well as adopted emission reduction policies.
- 'The Commission's proposal' means the Directive proposed by the European Commission alongside the Thematic Strategy (as noted above).
- 'The Parliament's proposal' means the approach set out in the report agreed at the Environment Committee's meeting of 21 June (as noted above).
- 'The Council's proposal' refers to the approach discussed at the meeting of the Environment Council on 27 June 2006 (as noted above).

The purpose of this briefing is to:

- Review and summarise the environmental impacts of the Commission's proposal;
- Compare the environmental impacts with the existing legislation in place;
- Assess the environmental impacts of the European Parliament's Environment Committee position as adopted on 21 June 2006 and the Council's general approach, as adopted on 27 June 2006. In particular, the assessment focuses on $PM_{2.5}$ and PM_{10}, by making a brief comparative analysis of the different positions, taking into account i) implementation and ii) values and derogations; and
- Advise on improvement of unclear formulation of compromise articles.

It is important to point out that the focus of the briefing on $PM_{2.5}$ and PM_{10} should not be taken as suggesting that other pollutants no longer impact adversely on human health or ecosystems, or that limit values for other pollutants are not exceeded. On the contrary, there are still exceedances of air quality standards of ozone and nitrogen dioxide, but the Parliament nor the Council makes an attempt to change the Commission's provisions in relation to ozone, or the limit values of the other pollutants, hence there is nothing to compare (except for slight differences in derogation terms for nitrogen dioxide and benzene, see table 5.1). However, the way in which Parliament proposes to treat $PM_{2.5}$ and PM_{10}, does substantially differ from those proposed by the Commission and the Council, hence the focus of this briefing.

This briefing is structured, as follows:

- Sections 2 and 3 compare the approach of the three EU institutions with respect to PM_{10} and $PM_{2.5}$, respectively.
- Section 4 assesses the relationship between the proposed limit values for $PM_{2.5}$ and PM_{10}.
- Section 5 discusses the three institutions' approach to derogations.
- Section 6 addresses a couple of other issues that we felt were important to mention.
- Section 7 concludes the briefing with a summary of the findings.

The methodology that was used to assess future exceedances of PM limit values is outlined in Annex 1. In annexes 2 and 3 a detailed comparison of the institutions' proposals is presented. Health benefits and costs of future reductions of $PM_{2.5}$ are discussed in Annex 4.

2 COMPARING THE APPROACHES TAKEN TO PM_{10}

2.1 The Institutions' proposals with respect to PM_{10}

As can be seen in Table 1 in Annex 2, the key difference in approach between the Parliament and the other institutions in relation to the ***daily limit value*** of PM_{10} for the protection of human health is not in relation to the limit value itself – as this is $50\mu g/m^3$ in all cases – but the number of days a year on which the limit value can potentially be exceeded.

Since 2005, adopted legislation allows the limit value to be exceeded on no more than 35 occasions per year[12]. The Commission and the Council propose not to change the daily limit value already in place. However, the Parliament's position will allow Member States to permit the limit value to be exceeded on up to 55 occasions, if it is not possible to limit exceedances to 35 days because of 'site-specific dispersion characteristics, adverse meteorological or geographical conditions'.

The Parliament, on the one hand, and the Commission and Council, on the other, differ in their approach regarding the ***annual limit value*** for PM_{10} for the protection of human health. Neither the Commission nor the Council proposes to alter the current limit value of $40\mu g/m^3$ for the yearly average concentration of PM_{10}, while the Parliament proposes a tighter limit value of $30\mu g/m^3$ by 2010[13].

2.2 Environmental impacts of PM_{10} proposals

This section sets out the extent to which the current limit values for PM_{10} are met, assesses possible future developments in relation to PM_{10} concentrations and discusses the equivalence of daily and annual limit values for PM_{10}.

2.2.1 Observed exceedances of the current and proposed limit values of PM_{10}

In many parts of Europe the concentrations of PM_{10} are currently lower than the EU air quality limit values that have been in force since 2005 (see Figure 2.1). However, measurements in 2004 also show that the limit value for the average yearly concentration ($40\mu g/m^3$) was exceeded in several areas in the South of Europe, the BeNeLux countries and Germany, as well as in various Central and Eastern European countries. Furthermore, the limit value for the daily average PM_{10} concentration, which is generally found to be more stringent[14] than the existing limit value for the yearly average concentration, is currently exceeded in larger areas in the above countries and in cities of several other Member States.

An exceedance of this daily limit value coincides with an exceedance of a yearly average level of $30\mu g/m^3$ (on average), and is also depicted in Figure 2.1.

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[12] Additionally, current legislation proposed that, from 2010, the same limit value should be exceeded on no more than 7 occasions, annually.

[13] Current legislation proposes that from 2010 this limit value be reduced to $20ug/m^3$.

[14] The issue of equivalence and stringency of the daily and yearly limit values is discussed in section 2.2.3.

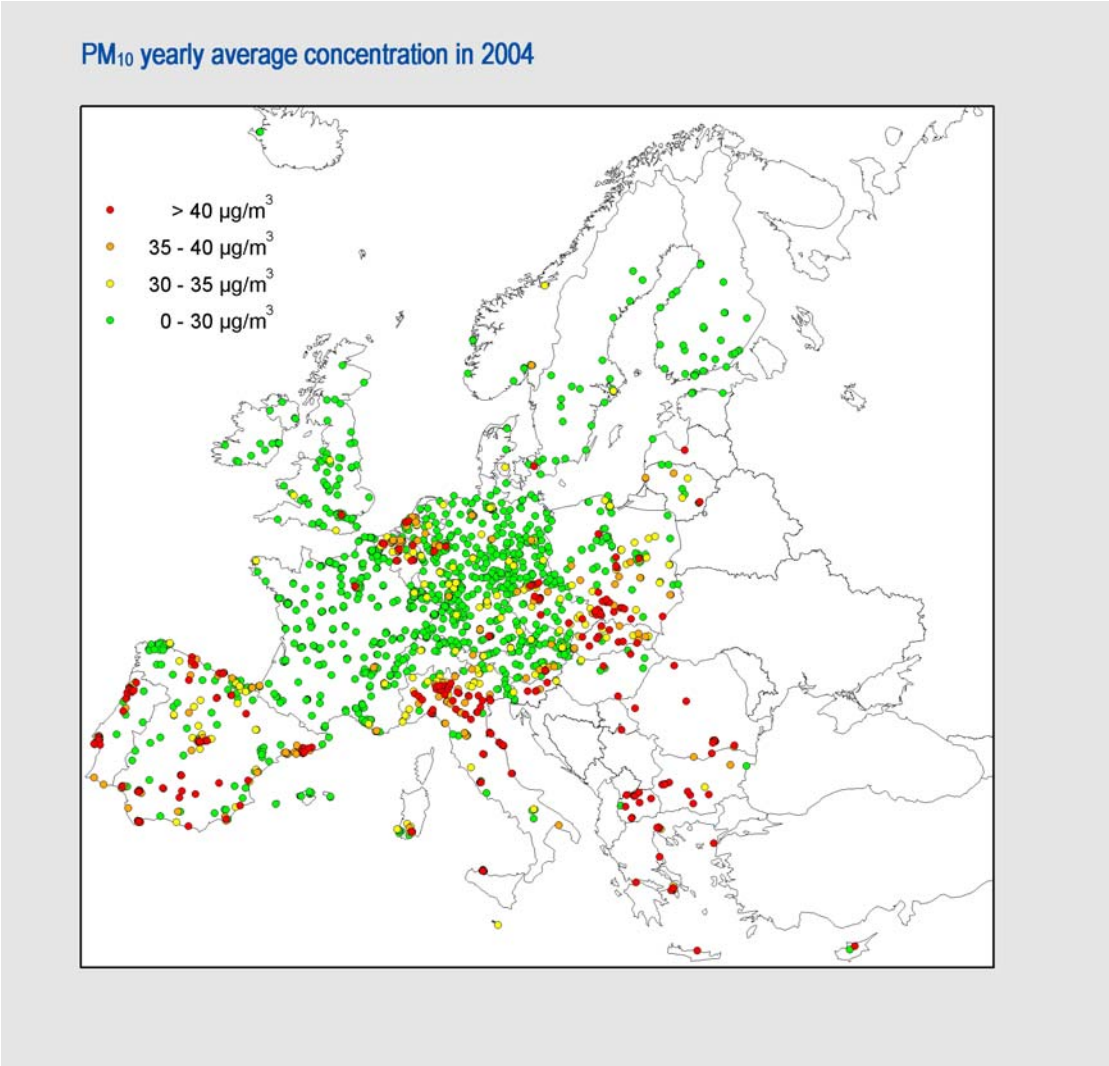

Figure 2.1 Yearly averaged concentrations of PM_{10} measured and reported to AirBase in 2004 (all regional, urban background, and street stations with data capture larger than 75%). Data source: Airbase, EEA (http://air-climate.eionet.europa.eu/databases/airbase).

2.2.2 Future developments in the concentration of PM_{10}

Based on a scan of the limited number of plans or programmes required under the Air Quality Framework Directive[15], several countries (e.g. Germany, Netherlands, Sweden) expect that they will not be able to meet the present PM_{10} limit values at all their measurement locations in 2010. It seems likely, therefore, that other Member States are also expecting to experience compliance problems with the current PM_{10} limit values. In this context, it is also important to note that assessment methods substantially differ between Member States (see Box 2.1), which is a further complication when it comes to assessing compliance between countries.

[15] These are available in the Common Data Repository of the European Environment Agency, see (http://cdr.eionet.europa.eu/).

Future exceedances PM_{10} limit values have been estimated by subtracting modelled effects of policy measures from measured concentration levels in 2004 (see Annex 1, which also sets out the caveats relating to the use of this approach). Three emission reduction scenarios have been considered[16,17]:

1. Current Legislation (CLE), which reflects developments assuming the current abatement policies;
2. The Thematic Strategy (TS), which shows the assessment of exceedances as a result of emission levels put forward in the Thematic Strategy; and
3. Maximum Technically Feasible Reductions (MTFR), which gives an indication of the occurrence of exceedances when Maximum Technical Feasible emission reductions would be implemented in the EU. Note that the use of non-technical emission reduction measures is not considered in this scenario.

The emission reductions discussed by the Parliament would be between those of the Thematic Strategy and Maximum Technical Feasible Reductions.

Box 2.1: Assessment methods of PM10 and PM2.5 differ between Member States

The comparison of measurements of particulate matter (both PM10 and PM2.5) between countries is hampered because monitoring strategies differ among countries. Not only the monitoring techniques differ between countries (with the gravimetric, TEOM, β-absorption methods being used most frequently), but also correction factors applied to the data differ widely. Moreover, large differences exist in the shares of rural, (sub)urban and traffic stations. The comparability of the PM measurements has therefore been recognized as a major issue of concern (CAFE-WGPM, 2004).
While some countries assess compliance with the limit values using measurements only, some countries also make use of models to assess compliance (AEAT, 2004). The resolution of these models differs, and this will influence the number of exceedances found. This is because more exceedances will be found with models that can simulate concentrations at the street level as compared to coarser resolution models.
The Council proposes to change the requirements for the siting of measurement stations, from 5 to 10 meters from the kerbside. This will imply changes in the monitoring network in many countries. This change will reduce measured concentrations at traffic stations since the concentration of air pollutants decreases rapidly within the first few meters from the kerbside. The change will not influence the analysis in this report because it is based on measurements at urban background stations.

- CAFE-WGPM, 2004. Second Position Paper on Particulate Matter.
- AEAT, Service contract on the preparation of the review of Directive1999/30/EC regarding the use of modelling for air quality assessment, a report produced for DG Environment, European Commission, June 2004.

[16] Amann, M., I. Bertok, R. Cabala, J. Cofala, C. Heyes, Z. Klimont, W. Schöpp, L.Tarrason, D. Simpson, P. Wind, J-E. Jonson (2004). The "Current Legislation" and the "Maximum Technically Feasible Reduction" cases for the CAFE Baseline emission projections. CAFE Scenario Analysis Report nr. 2. International Institute for Applied Systems Analysis, Laxenburg, Austria.

[17] Amann, M., I. Bertok, R. Cabala, J. Cofala, C. Heyes, F. Gyarfas, Z. Klimont, W. Schöpp, F. Wagner (2005). A further emission control scenario for the Clean Air For Europe (CAFE) programme. CAFE Scenario Analysis Report nr. 7. International Institute for Applied Systems Analysis, Laxenburg, Austria.

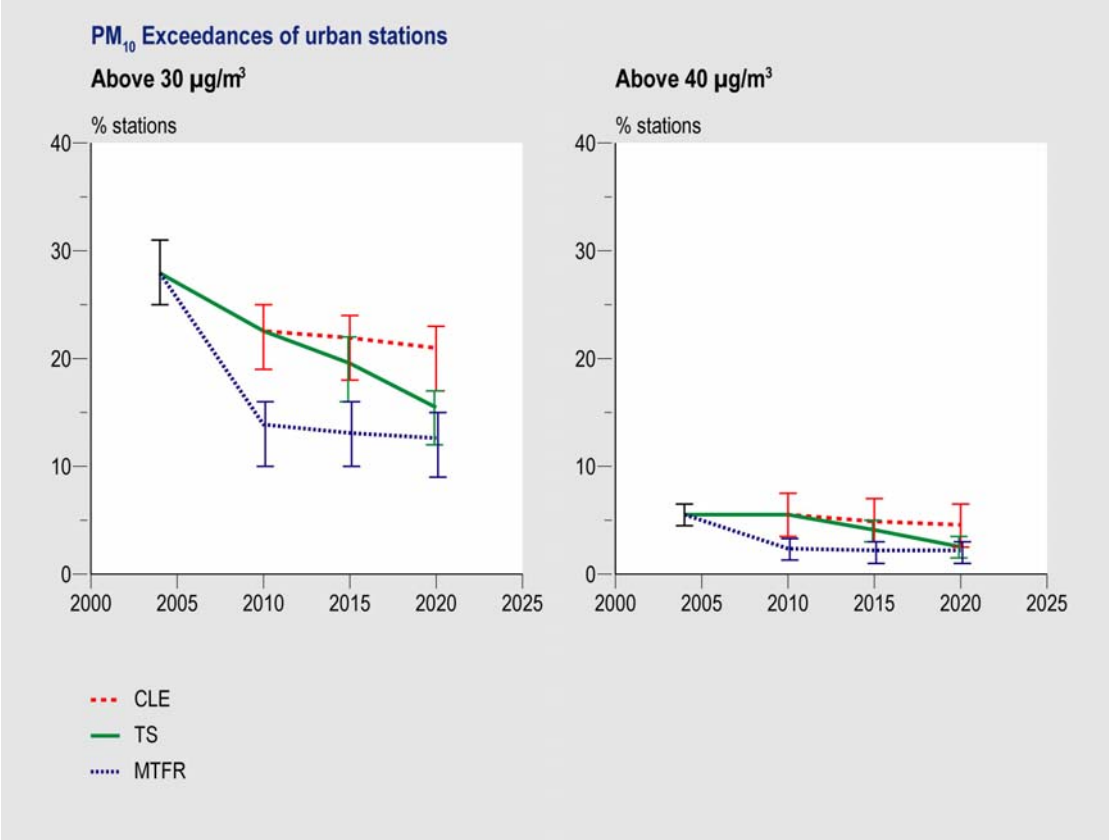

Figure 2.2 Estimated fraction of urban PM_{10} monitoring stations with exceedances of the 30µg/m^3 and 40µg/m^3 levels, and their 95% confidence limits accounting for statistical uncertainties.

Figure 2.2 illustrates an estimate of the development of the number of exceedances at urban background stations, according to different ambitions of emission reductions. The Figure shows exceedances of the current PM_{10} yearly limit value of 40µg/m^3 as well as exceedances of the yearly average concentration level of 30µg/m^3, which is equivalent to the current limit value for daily average PM_{10} concentrations and is the new PM_{10} yearly limit value proposed by the Parliament. It is clear that the number of exceedances of the yearly limit value of 40µg/m^3 in 2004 and 2015 is relatively limited compared to the exceedances of the level of 30µg/m^3 in these years. After 2010, only a few exceedances are expected to occur of the yearly limit value of 40µg/m^3. However, even assuming full implementation of the emission reductions of the Thematic Strategy, it is unlikely that the concentration level of 30µg/m^3 will be met everywhere in Europe in the period up to 2020. Exceedances would particularly occur in urban areas in densely populated and industrialized areas, such as the Po-valley, areas in Central European countries, the Ruhr-area, the BeNeLux countries, as well as specific large cities in Europe. This is even the case when maximum technical feasible emission reductions are applied throughout Europe. Since concentration levels will be higher at the street level, and local measures are likely to be less effective than application of maximum feasible reductions throughout Europe, exceedances of the current daily average limit value for PM_{10} may still occur in these areas in the period up to 2020.

We note that the attainability of the PM_{10} limit value will become larger if natural contributions to the PM_{10} concentration may be subtracted from the measured concentrations.

Member States are currently exploring the fraction of the PM_{10} concentration originating from natural sources. Current estimates of modelled concentrations of particulate matter from natural sources range from 1 to 5µg/m^3 across Europe[18].

2.2.3 Equivalence of the daily and yearly limit values for PM_{10}

There is a strong correlation between the observed yearly averaged concentration and the number of exceedances of the daily limit value at measurement locations in Europe (Figure 2.3). Extensive analysis using all PM_{10} measurement stations in AirBase for 2004 indicates that the daily averaged limit value of 50µg/m^3 PM_{10} which may be exceeded on no more than 35 days per year corresponds with an yearly average PM_{10} concentration of about 30µg/m^3. This is a statistical relationship based on observed values, as presented in Figure 2.3. Consequently, within the current system the daily limit value is more stringent than the yearly standard of 40µg/m^3.

Importantly, the correlation also implies that a limit value for daily averaged concentrations of PM_{10}, on the basis of current knowledge, will also protect against long-term health effects of PM_{10}. Hence, already one rather than two limit values already suffices to protect against both the short-term and long-term health effects of PM_{10}.

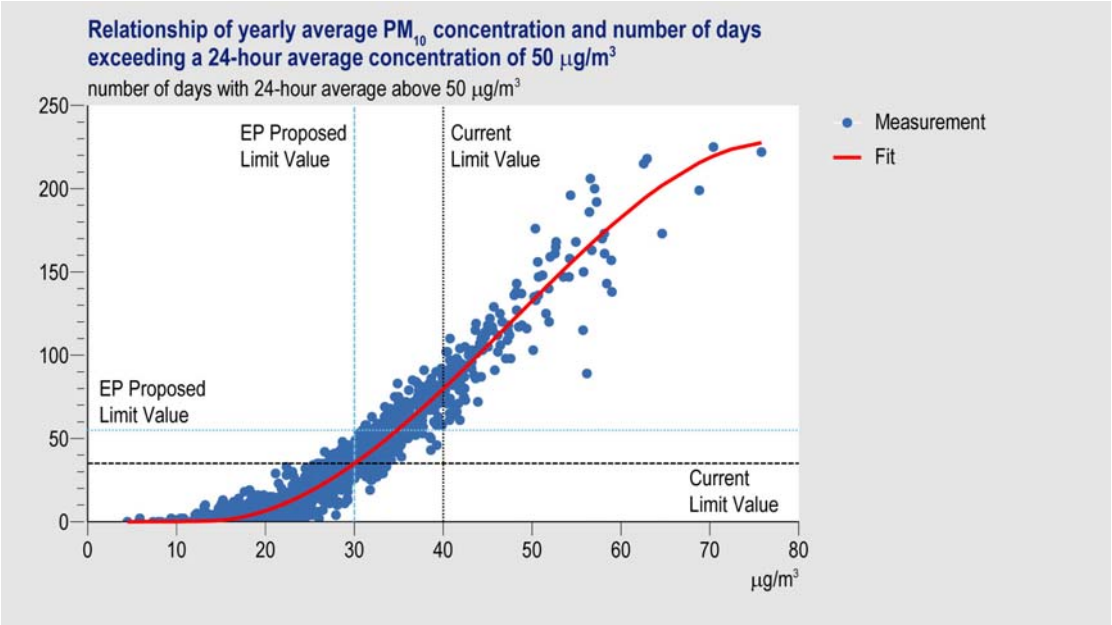

Figure 2.3 Illustration of the relationship between the yearly average PM_{10} concentration and the number of days with a daily average concentration above 50 µg/m^3, derived from Airbase data of Europe in 2004. The black dotted lines indicate the current limit values for PM_{10}. The blue dotted lines indicate the limit values for PM_{10} proposed by the Parliament. Data source: Airbase, EEA (http://air-climate.eionet.europa.eu/databases/airbase).

In Figure 2.3, four quadrants can be distinguished (separated by the vertical line at 30µg/m^3 for the yearly average concentration and by the horizontal line at 35 days at which the daily limit value is exceeded).

[18] EMEP Report 4/2006 (2006) Transboundary particulate matter in Europe. Status Report 2006.

For stations in the lower left and upper right quadrants, adjustment of the limit values as proposed by the Parliament does not change their compliance status: stations in the lower left quadrant continue to comply with both the daily and the yearly limit value, and stations in the upper right continue to exceed at least one of these limit values. For stations in the lower right quadrant, the sharpening of the yearly limit value from 40μg/m^3 to 30μg/m^3 as proposed by the Parliament will lead to a sharpening of the PM_{10} standards, and to a shift from compliance to non-compliance with the limit values. For stations in the upper left quadrant, the proposed increase of the number of days that the daily limit value may be exceeded, from 35 to a maximum of 55 days, leads to a shift from non-compliance to compliance with the limit values, if an appeal can be made to exemptions allowed (viz. site-specific dispersion characteristics, adverse meteorological or geographical conditions). For the stations for which the sharpening of the yearly limit value leads to non-compliance, the effect of sharpening is expected to be small for most stations. When assuming a downward trend in the average PM_{10} concentration of 0.5μg/m^3 per year (a value observed for some polluted areas), about 1-2 more years extra will, in many cases, be enough to attain both PM_{10} limit values. With the data available, it is not possible to assess whether the stations that potentially move from non-compliance to compliance, as a result of the Parliament's amendment, would in practice do so. For such information, it is necessary to look at EEA and Member State information in more detail.

From Figure 2.3 it also follows that every additional microgram of particulate matter results in about four more days at which the limit value for daily average concentration is exceeded. Thus, a (maximum) permitted number of 55 days of exceedance of the daily average concentration, as proposed by the Parliament under certain conditions, corresponds to a yearly average concentration of about 35μg/m^3. Hence, the intention of the Parliament to make both PM_{10} standards (daily and yearly average) more equivalent is thwarted by the Parliament's proposal to leave more room for exceedances of the daily limit value. Since no exemptions are made for the applicability of the more stringent proposal for the yearly limit value, the proposed yearly limit value will make the proposed increase of exemptions for the daily limit redundant for nearly all measurement locations. In other words the yearly limit of 30μg/m^3 will be stricter in almost all cases, making the consequences of the 55 days of exceedance exemption only marginal.

Altogether, the changes of the PM_{10} limit values proposed by the Parliament will lead to a shift of compliance status for only a limited number of stations. In the adopted legislation, the daily limit value is most stringent, and in the Parliament's proposal the yearly limit value will become most stringent.

3 COMPARING THE APPROACHES TAKEN TO $PM_{2.5}$

3.1 The Institutions' proposals with respect to $PM_{2.5}$

With respect to $PM_{2.5}$, the key difference between the approaches of the institutions relates to the level of the $PM_{2.5}$ limit value for annual average concentrations[19]. Other differences are: the derogation criteria and conditions; the Parliament and Council propose a target value in addition to the limit value, whereas the Commission does not; and the approaches taken to the exposure reduction target.

The Commission proposed an ***annual limit value***, in the form of a concentration cap, for $PM_{2.5}$ of 25μg/m^3 to be met by 2010. Existing legislation sets no targets for the reduction of levels of $PM_{2.5}$. The Parliament proposed a tighter limit value of 20μg/m^3, to be met by 2015, while the Council proposed the same standard as the Commission (i.e. 25μg/m^3), but to be met by 2015 (i.e. 5 years later than proposed by the Commission). However, there are also differences in the possibilities to apply for derogations, so the levels are not directly comparable. In addition, both the Parliament and Council also propose a target value at the same level as their respective limit values to enter into force in 2010, i.e. five years in advance of the limit value (see Table 2 in Annex 2).

In relation to the ***exposure reduction target*** the Commission proposes a 20% reduction target of average urban background concentrations to be achieved, where possible, by 2020 (compared with 2010), although where the exposure is less than 7μg/m^3, the exposure reduction target shall be zero. The Parliament proposes a slightly more sophisticated set of targets whereby different percentage reductions are required depending on the levels of original exposure (see Table 2 in Annex 2). A similar approach to that taken by the Parliament has been proposed by the Council. An analysis of the implications of these various approaches is given in Annex 3.

For initial values less than 20μg/m^3, the table in Annex 3 shows that the Parliament's proposed reduction targets are in practice less ambitious than those proposed by the Commission and the Council, so the approaches proposed by the two other institutions would lead to greater reductions in exposure levels in these circumstances. Where the initial level is higher than 25μg/m^3, the Parliament proposes that all 'appropriate measures' to achieve 20μg/m^3 be implemented, so for those places where initial exposure levels for $PM_{2.5}$ are relatively high, the Parliament's approach is potentially stronger than that proposed by the Commission. However, whether this would be the case in practice depends on the interpretation of the word 'appropriate', in the context of 'appropriate measures', by Member States and the Commission.

It is important to note, however, that the approaches of the Commission, Council and Parliament do not result in a mandatory exposure reduction target. All institutions, however, propose a revision of the exposure reduction target 5 years after entry into force of the Directive, to assess whether it should be made into a binding obligation.

[19] In fact, the Commission proposes a concentration cap, but for simplicity in this document this is referred to as a limit value. The reason is that, de facto, a concentration cap has the same legal implications as a limit value.

3.2 Environmental impacts of $PM_{2.5}$ proposals

This section sets out the existing and future situations in relation to $PM_{2.5}$.

3.2.1 Observed exceedances of the proposed limit values of $PM_{2.5}$

Observations of $PM_{2.5}$ in Europe are scarce. Only for about 120 stations in Europe are $PM_{2.5}$ data available for the year 2004; data before 2000 is virtually non-existent. In 2004, at most, mainly rural, measurement locations the yearly average concentration was not in exceedance of 20µg/m^3. However, in urban areas, concentrations higher than 20µg/m^3, and to a lesser extent higher than 25µg/m^3, were observed regularly (see Figure 3.1).

No trend can yet be observed in the measured concentrations, because the time-series are too short for this, and the year-to-year meteorological variations too large. It is likely however, that $PM_{2.5}$ concentrations have decreased somewhat during this period, because emissions of precursor gases and primary $PM_{2.5}$ in Europe have decreased.

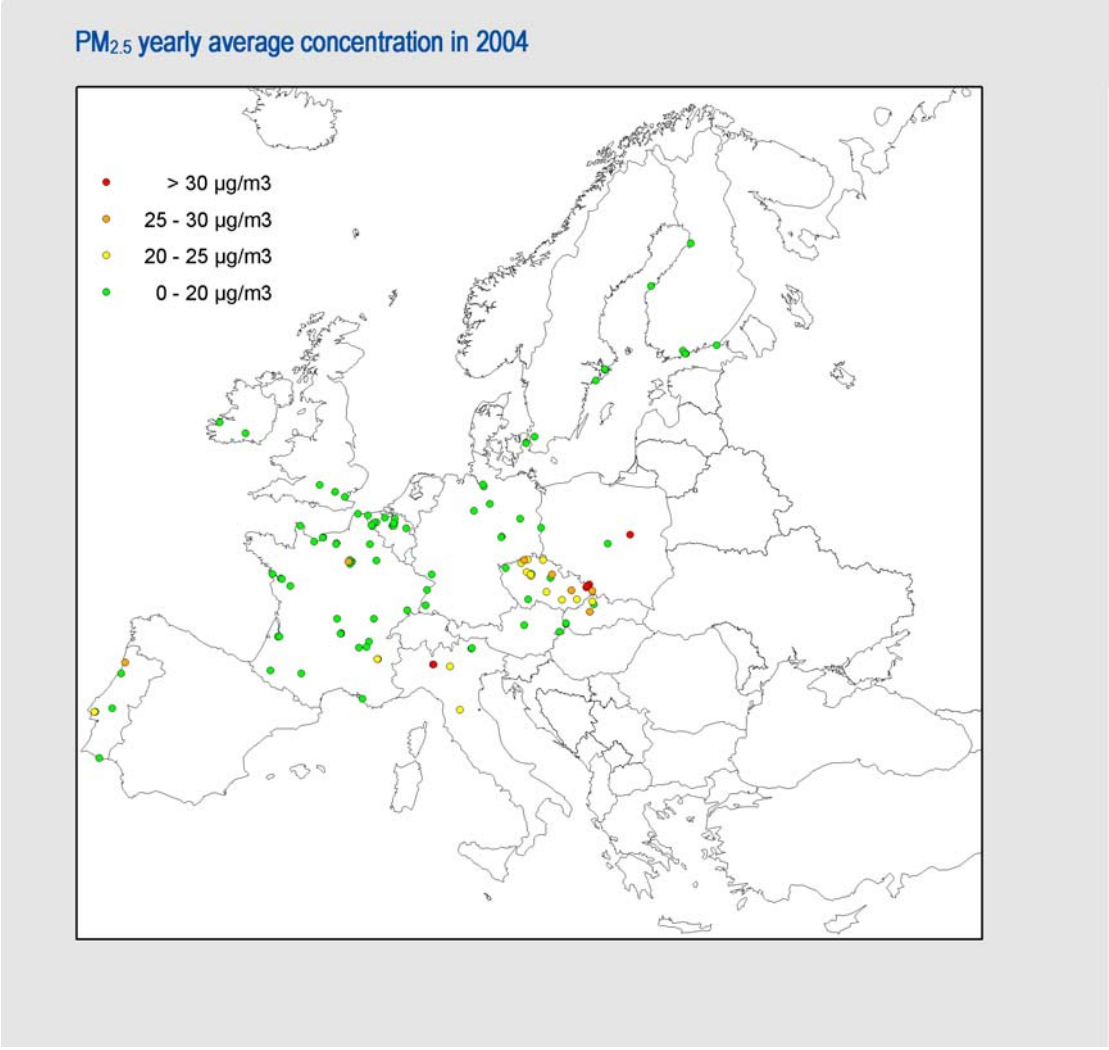

Figure 3.1 Yearly averaged concentrations of $PM_{2.5}$ measured and reported to AirBase in 2004 (all regional, urban background, and street stations with data capture larger than 75%). Data source: Airbase, EEA (http://air-climate.eionet.europa.eu/databases/airbase).

3.2.2 Future developments in the concentration of $PM_{2.5}$

Figure 3.2 shows the assessment of the number of exceedances at urban background stations, according to different ambitions of emission reductions. The limited information available suggests that after 2010, only a few exceedances of the proposed yearly average limit/target value of 25µg/m^3 may be expected. However, the information also suggests that with current policies, and even with the emission reductions of the Thematic Strategy, the level of 20µg/m^3 will most probably not be met everywhere in Europe in 2015. Particularly, urban background concentrations may then be close to, or exceed, the annual average concentration of 20µg/m^3 in densely populated and industrialized areas, such as the Po-valley, areas in Central European countries, the Ruhr-area, the BeNeLux countries, as well as specific large cities in Europe. At the street level, concentrations are expected to be higher than the urban background concentrations[20] by several µg/m^3, and hence, the attainability problems will most probably be larger at these locations.

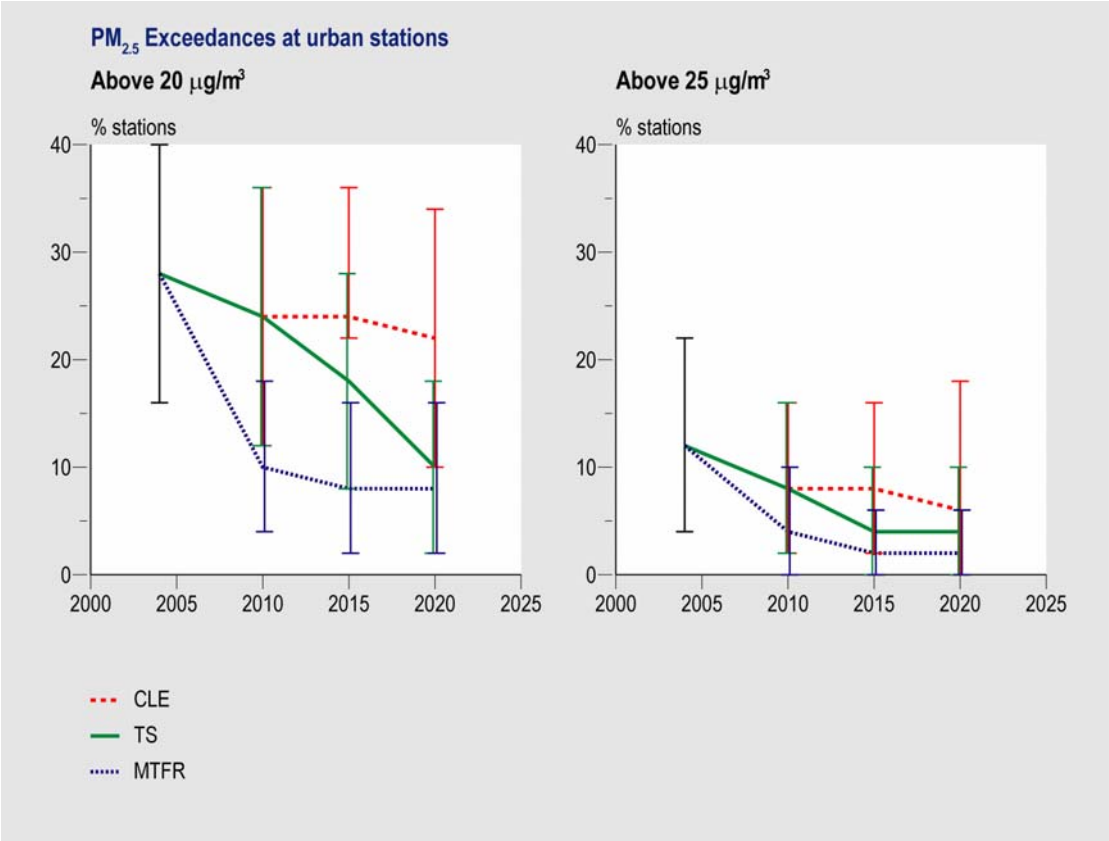

Figure 3.2. Estimated percentage of urban $PM_{2.5}$ monitoring stations with exceedances of the 20 µg/m^3 and 25 µg/m^3 levels, and their 95% confidence limits accounting for statistical uncertainties.

[20] EEA, 2006. Air pollution at street level in European cities, EEA Technical Report 1/2006.

3.2.3 Reducing average urban background concentrations of $PM_{2.5}$

In order to reduce the average urban background concentration of $PM_{2.5}$, the Commission proposes a concentration reduction target of 20%, which could later be converted into a legal obligation when more measurements of $PM_{2.5}$ would become available. The Commission recognizes that it would not be cost-effective to propose that all cities in Member States are required to reduce their urban background concentrations by the same percentage, and has accounted for this in its proposal. However, because of uncertainties, the Commission considers it prudent to wait for better data on monitoring, emissions, and projections, before establishing a more tailored reduction requirement for each country. Both the European Parliament and the Council have further elaborated in their proposals the concept of reduction targets depending on the initial concentration level.

Figure 3.3 shows the concentration reduction between 2010 (with current policy) to 2020 with the emission reductions proposed in the Thematic Strategy. The urban scale is not captured in this figure, hence attainability of the reduction target cannot be assessed at that scale. However, the figure seems to indicate that for countries with low concentration levels it may be difficult to reduce their urban background $PM_{2.5}$ concentration by 20% in 2020 with the emission policies from the Thematic Strategy only. Indeed, this was recognised and to some level accounted for in all proposals.

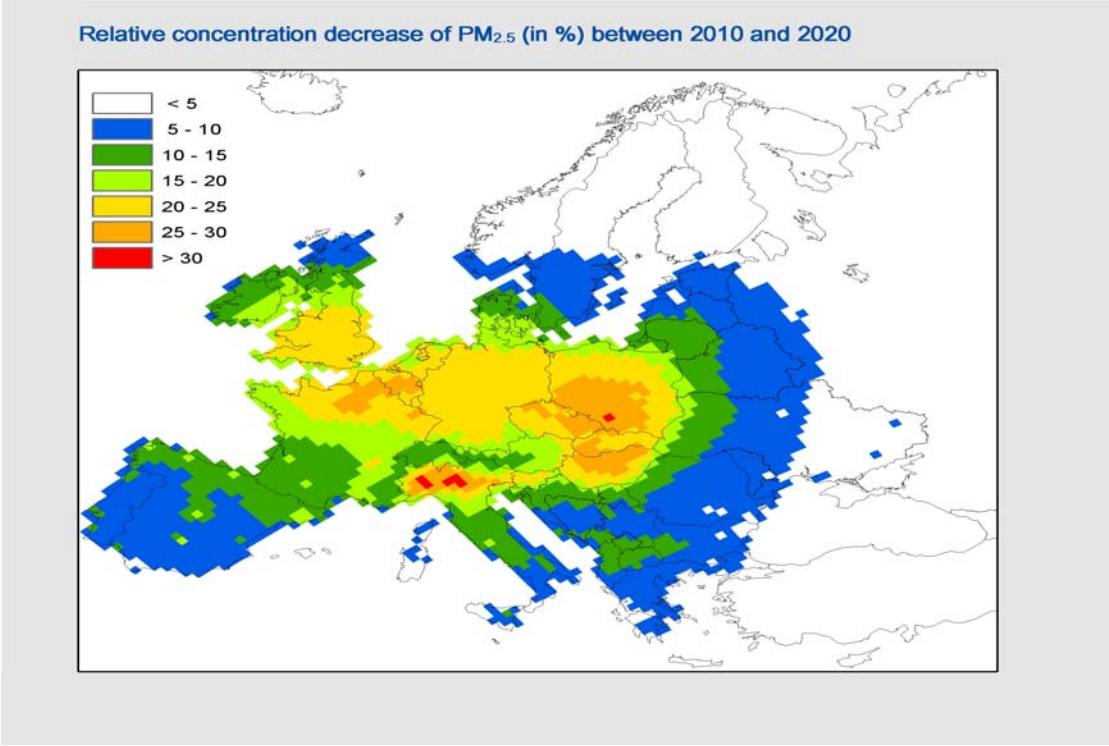

Figure 3.3 Relative concentration decrease (%) between 2010 and 2020, based on the Thematic Strategy scenario (assuming a non-modelled part of 5 µg/m³ $PM_{2.5}$ to account for the underestimation of models to measured concentration levels). Source: IIASA[21].

[21] Amann, M., I. Bertok, R. Cabala, J. Cofala, C. Heyes, F. Gyarfas, Z. Klimont, W. Schöpp, F. Wagner (2005). A further emission control scenario for the Clean Air For Europe (CAFE) programme. CAFE Scenario Analysis Report nr. 7. International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria.

4 RELATIONSHIP BETWEEN THE PROPOSED LIMIT VALUES FOR $PM_{2.5}$ AND PM_{10}

The relation between PM_{10} and $PM_{2.5}$ has been derived from measurements, and can vary substantially between different EU regions. Nevertheless, presently, the general picture is that the share of $PM_{2.5}$ within total PM_{10} along roadways – where highest concentrations will occur – is 60% on average. In rural areas this share of $PM_{2.5}$ is about 65 to 85%[22,23]. The lower fraction of $PM_{2.5}$ in PM_{10} along roadways is explained by the relatively large contribution of re-suspended road dust which is relatively coarse.

Using these $PM_{2.5}/PM_{10}$ ratios the yearly limit/target value $PM_{2.5}$, as proposed by the Commission and the Council (25µg/m^3), would correspond with a yearly averaged PM_{10} concentrations of 42µg/m^3 (traffic sites) to 29µg/m^3 (rural background sites). As the current PM_{10} daily limit value is equivalent to a yearly average concentration of 30µg/m^3, the air quality limit value for $PM_{2.5}$ as proposed by the Commission and Council, will be less stringent than the current daily limit value for PM_{10} at polluted stations and more-or-less equal to that at rural stations.

The yearly average $PM_{2.5}$ limit/target value of 20µg/m^3, as proposed by the European Parliament, corresponds to a yearly average PM_{10} concentration of 33µg/m^3 at traffic sites to 24µg/m^3 at rural background sites. Given that the daily limit value for PM_{10} corresponds to an annual limit value for PM_{10} of 30µg/m^3 (see Section 0), then Parliament's proposed $PM_{2.5}$ limit/target value is more stringent than the daily limit for PM_{10} in rural areas, ***but not in urban areas***, where most exceedances are likely to occur. Moreover, the Parliament proposes to tighten the yearly limit value for PM_{10} from 40µg/m^3 to 30µg/m^3. This revision ensures that the ***annual limit value for PM_{10} remains the more stringent limit value*** in the Parliament's proposal in spite of the proposed weakening of the daily limit value by increasing the number of daily exceedances allowed (as discussed in Section 2.2.3). Hence, in urban areas, air quality policy will still be driven by PM_{10} rather than $PM_{2.5}$ in all proposals. This seems unfortunate from a health protection point of view, as $PM_{2.5}$ is generally assumed to be more relevant for public health than PM_{10}, although recently, evidence has been building up that the coarse particle fraction ((PM_{10}-$PM_{2.5}$)) cannot be considered as harmless. We note that the reasoning above does not hold in situations with a large contribution of natural sources to PM levels, such as mineral dust. Under certain conditions, natural contributions may be subtracted from the measured PM levels, and since most natural contributions consist of particles coarser than $PM_{2.5}$, there is a fifty-fifty chance that the $PM_{2.5}$ limit value may become the stricter limit in the Parliament's proposal. In such cases, even then, PM_{10} is expected to remain the driving limit value in the proposals from the Commission and the Council.

Altogether the proposals of Commission, Council and Parliament require additional emission reduction measures in order to realize the limit and target values proposed.

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[22] Querol X, Alastuey A, Ruiz CR, Artinano B, Hansson HC, Harrison RM, Buringh E, Brink HM ten, Lutz M, Bruckmann P, Straehl P, Schneider J, 2004. Speciation and origin of PM10 and PM2.5 in selected European cities, Atmos. Env. 38, 6547-6555..

[23] Van Dingenen et al., 2004. A European aerosol phenomenology—1:physical characteristics of particulate matter at kerbside,urban, rural and background sites in Europe, Atmos. Env. 38, 2561-2577.

Largest emission reduction efforts are needed to meet the Parliament's proposal. Smaller, but still considerable efforts are needed to meet the Commission's and Council's proposals. We recommend that policy makers, in their decision making process, link future air quality standards with accompanying emission reductions that will be required. In this context, it is prudent that the Parliament proposes a direct link between missing Community measures and possibilities for concentration derogations[24].

In particular, in areas with a high emission density, emissions would have to decrease more than those projected in the Thematic Strategy to meet all air quality limit values. In the proposal of the Parliament, however, it is stated that plans or programmes should not involve measures for industry beyond Best Available Technologies (BAT)[25]. Also, Member States have few possibilities to reduce traffic emissions through national technical measures. Therefore, the room for Member States to introduce more stringent emission reductions than those foreseen in the Thematic Strategy is limited, as far as technical measures are concerned. Furthermore, as additional policy needs time to take effect, the proposed derogation periods may not be sufficient to allow limit values to be attained for all situations. Even with application of maximum technical feasible reductions, attainment of all limit values everywhere in Europe is unlikely before 2020. Non-technical measures such as non-technical measures in the transport system at the local or regional scale would still be required. Thus far, no thorough assessment has been made that these measures will lead to attaining the proposed limit values at these locations.

[24] Amendment 43, Article 30a (new).

[25] Amendment 10, recital 17a (new), and amendment 33, Article 21, paragraph 1, subparagraph 2a (new).

5 COMPARING THE APPROACHES TAKEN TO ALLOWING FOR DELAYS IN MEETING THE STANDARDS

As can be seen from Table 5.1 (a fuller version of which can be found in Table 3 of Annex 2), the institutions' approach to both the process of giving derogations and the length of these differ.

The Article 20 proposals are relatively similar in that, for a derogation to apply, a Member State must develop a plan to achieve the relevant limit values indicating how this is to be done, with all referring to the information contained within Annex XV. The Council's proposal is somewhat clearer than the Commission's proposal, as it is not clear why the latter requires two plans and how these might complement each other. The Parliamentary proposal is more prescriptive in indicating the specific elements that would be required in a plan. The interesting aspect of the Parliament's proposal is the link to Part B of Annex XV, which lists relevant Directives that can assist in protecting air quality. Both the approaches of the Commission and the Council's refer to this list, but only to the extent that the information concerning the status of implementation of the Directives needs to be supplied in, or along with, the plan or programme. Parliament's proposal requires Member States to demonstrate that all 'appropriate measures have been taken' inter alia the implementation of the Directives set out in Part B of Annex XV. As an additional condition, this approach is arguably stronger than that of either the Commission or Council.

However, it stills leaves questions, for example:

- Particularly in relation to non-EU measures, it is not clear what might be meant by 'appropriate' measures.
- In relation to the implementation of EU Directives, it is not clear what implementation means in the context of 'appropriate measures'. For example, would transposing the Directive count as implementation (or does it go beyond this)? Also is implementation only in respect of delivering air quality within a problem area required, or full implementation of all aspects across the whole country?

This lack of clarity would make it difficult for the Commission to decide on whether conditions have been met for a derogation and, therefore, the provision should be make clearer. Notwithstanding the above, the interpretation of the application of derogations will still lie with the Commission. Hence, whether the assessment of the conditions set by the Parliament will be interpreted in the way in which the Parliament desires will depend on their application by the Commission over which the Parliament has little control. One option might be for the Parliament to commit itself to reviewing the Commission's application of these conditions on a regular basis.

There is no difference in the proposals for derogations for SO_2, CO and lead. For benzene and NO_2, the Council follows the Commission proposal, but the Parliament proposes that the maximum derogation period is reduced by two years. The major differences concern particulates, with the Council seeking a slightly longer derogation for PM_{10} than the Commission and the Parliament a longer derogation for $PM_{2.5}$ than the Commission, but this also includes stricter limit values as described earlier in this briefing.

The Parliament follows the Commission's proposal for the limit value of 40µg/m^3 for PM_{10}, with longer derogation periods for the stricter limit values that it is proposing.

Table 5.1: Summary of the different approaches to derogations

	Commission proposal	**EP compromise**	**Council's proposal**
	Criteria for derogation		
Article 20(1)	Member States must: i) Develop and submit a plan or programme (in accordance with Article 21) in which it is indicated how the limit values will be met during the period of derogation; and ii) Member States must also prepare and submit an air pollution abatement programme, which – includes information on the implementation of relevant EU environmental Directives (as listed in Part B of Annex XV)	Member States must: i) Demonstrate that all appropriate measures have been take at national, regional and local level, including the implementation of EU environmental Directives (as listed in Part B of Annex XV) by the deadlines specified in those Directives, and that the background concentrations of the relevant pollutants show a downward trend. ii) Draw up and submit a plan or programme (in accordance with Article 21) in which it is indicated how the values will be met by the new deadline	Member States must: Develop and submit an air quality plan for the areas to which the derogation would apply (in accordance with Article 21) and be supplemented by the information in Section B of Annex XV related to the pollutants concerned and it shall demonstrate how conformity will be achieved with the limit values before the new deadline.
	Maximum derogation periods (Article 20)		
Benzene	2015	2013*	2015
NO2	2015	2013*	2015
PM2.5	2015 with 25µg/m^3	2013* + 5 = 2018 with 20µg/m^3	None (note that the limit value date for compliance is 2015)
PM10	2010 for 40µg/m^3 yearly value	2013* (until 2010 for old 40 µg/m^3 value, from 2010 until 2013 for new 30 µg/m^3 value) + second derogation until 2018 for new value	2011*
SO2	2010	2010	2008
CO	2010	2010	2008
Lead	2010	2010	2008

* Assuming that the Directive enters into force in 2008

6 OTHER ISSUES

Finally, it is also worth commenting on a couple of other issues that have arisen in reviewing Parliament's proposal.

First, we consider that the inclusion of Article XVIIa, and the reference to this in the amended Article 20.2a (Amendment 30), is not necessarily the most appropriate way of including possible future legislation in the Directive. Many of these proposals are still under consideration and may not subsequently appear in the form indicated. Hence, the inclusion of this list is a potential hostage to fortune. For example, if an alternative, but equivalent measure (in terms of emissions reductions), was introduced instead of the piece of legislation in the list, then Member States could point to the exclusion of the latter as a reason for non-compliance, without taking into account the alternative piece of legislation. An alternative solution might be for all new relevant emissions legislation to amend Article XV of the new air quality Directive to ensure that the latter refers to the new legislation. There also seems little point in listing possible amendments to Directives (such as IPPC) which are already listed in Annex XV.

Second, we believe that the additional paragraph in Article 21.1.2a (Amendment 33) potentially undermines and conflicts with IPPC legislation, as in the latter installations can be requested to go beyond BAT to meet EU environmental quality standards. Care should be taken to ensure that the Parliament does not propose an amendment which either conflicts with, or undermines, IPPC.

7 SUMMARY OF THE FINDINGS AND CONCLUSIONS

The Commission's, Council's and Parliament's proposals would require additional emission reduction measures compared to those required under adopted legislation in order to realize the proposed limit and target values. The largest emission reduction efforts are needed to meet the Parliament's proposal. This is caused by the stringency enforced through the combination of the existing daily limit value and the proposed 30μg/m^3 yearly limit value for PM_{10} to be met in 2010. Smaller, but still considerable efforts are needed to meet the Commission's and Council's proposals. Most stringent in the latter two proposals is the existing daily limit value for PM_{10}.

In all three proposals PM_{10} is the dominant factor due to the stringency of PM_{10} limit values compared to the target/limit values proposed for $PM_{2.5}$. This is surprising because in recent years, the PM risk assessment and abatement strategy have focused on $PM_{2.5}$, as the most health effect-relevant particle size fraction. Recently, however, evidence has been building up that the coarse particle fraction (PM_{10}–$PM_{2.5}$) cannot be considered as harmless. The limit values proposed by the Parliament for $PM_{2.5}$ may become more equivalent to the PM_{10} limit value when natural fractions of particulate matter could be subtracted from concentrations measured. Then there is a fifty-fifty chance that $PM_{2.5}$ may become the driving factor in the Parliament's proposal. The introduction of the - not legally binding - $PM_{2.5}$ exposure reduction target of 0% to 20% may trigger measures that lead to European wide reduction of PM concentrations in urban air. The potential health benefits of this approach (if implemented and achieved) may be larger than the health benefits resulting from local measures that are required to meet the proposed limit values at individual locations.

In terms of pure limit values, the reduction in the annual limit value for PM_{10} to 30μg/m^3 proposed by the Parliament makes the proposed daily and annual limit values more or less consistent. However, if, in any one location the daily limit was allowed to be exceeded on 55 occasions, then this would correspond to an annual limit value of 35μg/m^3, thus effectively weakening the daily limit value compared to the Parliament's proposed annual limit value. In this instance, the annual limit value may become the driver of policy. If the revised lower annual limit value were to be met, then it is unlikely that many locations would need to request to be allowed to exceed the daily limit on 55 occasions. However, the different messages being delivered, i.e. weakening the daily limit value, while strengthening the annual limit value, potentially give mixed messages.

Parliament's approaches to granting Member States derogation from meeting the limit values could be interpreted as being stronger, although there are issues with the interpretation, and thus application, of certain terms, such as 'appropriate' and 'implementation'. The interpretation of the latter term, in particular, needs to be given careful consideration. However, in practice, the relative strictness of the proposals would depend on the interpretation of, and the resources applied by, the Commission, which is difficult to stipulate in legislation.

At many places in Europe limit values for PM_{10} as well as the proposed limit values for $PM_{2.5}$ are already met at present. However, exceedances will remain, particularly for the PM_{10} and the $PM_{2.5}$ limit values proposed by the Parliament, in densely populated and industrialized areas, such as the Po-valley, areas in Central European countries, the Ruhr-area, the BeNeLux countries, as well as specific large cities in Europe. Meeting the proposed limit and target values will require further emission reductions beyond existing legislation. Policy efforts in line with the Thematic Strategy will be needed, and beyond this in areas with high emission densities.

Even with application of maximum technical feasible reductions, attainment of all limit values everywhere in Europe is unlikely before 2020. Structural changes in the transport system at the local or regional scale would still be required. Results of the cost-benefit analysis show that there is a robust case for implementation of the ambitions in the Thematic Strategy. The incremental benefits exceed the incremental costs in almost all countries.

Uncertainties in assessing concentrations of $PM_{2.5}$ and PM_{10} are large. Although the operational European network of PM_{10} stations consists of 1800 sites, the robustness and consistency of measured data are hampered because the monitoring strategies differ among countries. Data on $PM_{2.5}$ are scarce because the European $PM_{2.5}$ network thus far consists of only about 120 sites. Modelling of particulate matter has its drawbacks because models generally underestimate measured levels for various reasons. Although uncertainty analysis was taken into account in our conclusions on the attainability of limit values, caution is still needed. There are indications that further reductions of the PM levels in Europe are cost-effective. However uncertainties in emissions, air quality monitoring and health effects are large. For example, it is not clear whether the relationship between long term exposure of $PM_{2.5}$ and mortality that is found in epidemiological studies in the United States can be transferred to Europe.

In order to reach an equitable implementation of the limit values differences in measurement strategies and methods between Member States need special attention. Differences in the number of monitoring stations, monitoring locations, resolution of models and modelling accuracy might result in unjustified differences in the attainment of limit values.

Finally, there are a couple of other issues in the Parliament's proposal – in relation to BAT in the context of IPPC and future legislation – on which we felt it was important to comment. In particular, we believe that the reference to BAT, in the revised Article 21, potentially contradicts IPPC legislation, as it stands.

ANNEX 1: METHODOLOGY FOR ASSESSMENT OF FUTURE EXCEEDANCES OF PM LIMIT VALUES

Method

It is difficult to assess quantitatively the likelihood that the PM limit values will be met in European countries, because PM modelling work in the CAFE process only addressed the smaller fraction of particulate matter, viz. $PM_{2.5}$. Therefore, we have used the modelled $PM_{2.5}$ changes resulting from different ambitions of emission reductions from the CAFE programme to assess the reductions in both $PM_{2.5}$ and PM_{10} concentrations, by subtracting these modelled $PM_{2.5}$ concentration reductions from the levels of PM_{10} and $PM_{2.5}$ that are currently observed. The concentration reductions were modelled with the RAINS model, which gives average concentration reductions at 50x50 km scale. Three emission reduction scenarios have been considered: 1. Current Legislation (CLE), 2. the Thematic Strategy (TS) and 3. Maximum Technically Feasible Reductions (MTFR) (Amann et al., 2004; 2005). In this manner, future concentrations were calculated at locations of measurement stations according to different emission reduction scenarios. Statistical uncertainties, stemming from the limited number of monitoring stations, were addressed using the bootstrap sampling technique (with 1000 samples). This resulted in 95% confidence limits that account for statistical uncertainties. These confidence limits do not include uncertainties stemming from a non-optimal spatial distribution of sampling points or other uncertainties (see caveats section).

For the purpose of estimating the attainability of the $PM_{2.5}$ reduction target of 20% between 2010 and 2020 for urban areas, $5\mu g/m^3$ was added to the modelled concentrations in order to account for non-modelled part of $PM_{2.5}$. This was not necessary for the assessment of the proposed target/limit values, as this was based on measured levels from which modelled policy effects are subtracted.

Caveats

The RAINS model calculates average concentrations at 50x50 km scale. It is well recognised that the RAINS model is not able to calculate the high concentrations at the street level. Also at urban level, modelled concentrations will be lower than those that would be modelled if the RAINS model would have a higher spatial resolution. Therefore, also the effects of policy measures will be underestimated by the RAINS model in the vicinity of sources (such as cities), particularly for hot spot locations. Also, policy effects may be underestimated if sources are missing in the emission inventories, as no changes in these sources are assumed. This will lead to an overestimate of the concentrations at the urban scale in the method used in this assessment, and to too many exceedances of limit values. However, this is partly compensated by the fact that our analysis is limited to the urban background scale, and does not consider the higher concentrations at street-level. This has been one of the reasons to consider only urban concentrations, and not concentrations at street-level. Other reasons are that many people are exposed to urban background concentration levels, and that effects of local measures are hard to estimate.

For PM_{10}, the methodology is also expected to lead to an underestimation of the policy effect because only policy effects are assumed to occur in the $PM_{2.5}$ fraction. However, very few of the policy measures put forward within the CAFE programme specifically addressed the coarse fraction of particulate matter, i.e. particles with a diameter between $PM_{2.5}$ and PM_{10}. We therefore assume that the underestimation is small. Also, a sensitivity analysis was performed, in which equal relative concentration reductions were assumed for the coarse fraction within PM_{10} as that assumed for $PM_{2.5}$. While in this sensitivity study the policy effect for PM_{10} is likely to be overestimated instead of underestimated, this did not alter the conclusions regarding attainability of the PM_{10} limit values.

The number of measurement stations for $PM_{2.5}$ is very limited at present. Therefore, uncertainties in the concentration levels across Europe are even larger than for PM_{10}, because of this limited sampling. Moreover, both PM_{10} and $PM_{2.5}$ are difficult to measure, and various methods and correction factors are used. This hampers a comparison between countries.

ANNEX 2: DETAILED COMPARISON OF THE INSTITUTIONS' PROPOSALS

Table 1: Comparison of the different positions taken by the Commission, Parliament and Council compared to existing legislation

PM10	Adopted legislation	Commission's proposal	Parliament's proposal	Council's approach
Daily limit value for the protection of human health				
A limit value of 50µg/m^3 PM_{10}, not to be exceeded …	… more than 35 times a calendar year since 2005, and, as an indicative limit value, from 1 January 2010, more than 7 times a calendar year	… more than 35 times a calendar year since 2005. So same as adopted legislation requires from 2005.	… more than 35 times a calendar year (unless this cannot be achieved through site-specific dispersal characteristics, or adverse meteorological or geographical reasons in which case value can be exceeded on no more than 55 days)	… more than 35 times a calendar year since 2005. So same as adopted legislation requires from 2005.
Annual limit value for the protection of human health				
A limit value of …	… 40µg/m^3 PM_{10} since 2005, although a stricter limit value of 20µg/m^3 was proposed from 1 January 2010 as an indicative limit value	… 40µg/m^3 PM_{10} (so same as adopted legislation, although without the further reduction from 2010)	… 40µg/m^3 PM_{10} (in each year up to 2009) and 30µg/m^3 PM_{10} (from 2010)	… 40µg/m^3 PM_{10} (so same as adopted legislation, although without the further reduction from 2010)

Table 2: Air quality standards relating to PM2.5, as set out in the proposals of the Commission and the Parliament and the approach of the Council

Commission's proposal	Parliament's proposal	Council's approach
Exposure reduction target (relative to Average Exposure Indicator for 2010)		
20% (by 2020)	***Initial concentration in µg/m³*** ***Reduction target in percent*** ***< 10*** ***0 %*** ***= 10 – <15*** ***10 %*** ***= 15 – <20*** ***15 %*** ***= 20 – < 25*** ***20 %***	***Initial concentration in µg/m³*** ***Reduction target in percent*** ***< 7*** ***0 %*** ***= 7 – <13*** ***AEI x 1.5%*** ***>13*** ***20%*** To be met by 2020

	>25 ***All appropriate measures to achieve the target of 20 µg/m^3*** To be met by 2020	
Annual concentration cap		
25 µg/m^3 $PM_{2.5}$ (to be met by 1 January 2010)	Deleted	Deleted
Annual target value		
None	20 µg/m^3 $PM_{2.5}$ (to be met by 1 January 2010)	25 µg/m^3 $PM_{2.5}$ (to be met by 1 January 2010)
Annual limit value		
None	20 µg/m^3 $PM_{2.5}$ (to be met by 1 January 2015)	25 µg/m^3 $PM_{2.5}$ (to be met by 1 January 2015)

Table 3: Derogations to meeting the air quality limit values for PM

Issue	Commission Proposal	Parliament's Proposal	Council's Proposal
$PM_{2.5}$	*PM2.5 (Article 20.1 of COM(2005)447):* Deadline: 2010 A maximum delay of 5 years [i.e. to 2015] is allowed, as long as a) a plan	*For PM2.5 and PM10 (revised Article 20.1):* Deadline: 2010 (for *benzene, NO2 and PM2.5*) and from the entry into force of the Directive for PM10 A maximum of 5 years from the entry into force of	No derogation is permitted for the compliance with the PM2.5 exposure reduction target value for 2020 and limit value for 2015.

Table 3: Derogations to meeting the air quality limit values for PM

Issue	Commission Proposal	Parliament's Proposal	Council's Proposal
	or programme (in accordance with Article 21, which has to be put in place if a locality exceeds any of the limit values) has been developed for the area concerned; and b) an air pollution abatement plan (for the period of the extension, including information given in Annex XV) has been established to demonstrate that the required standard will be met before the new deadline.	this Directive [claim that this is 2013, so assumes entry into force in 2008] is allowed, as long as a) Member States shows that all appropriate measures have been taken at national, regional and local level to meet the deadlines; b) Directives referred to in Section B of Annex XV have been implemented by their respective deadlines; and c) background concentrations of the relevant pollutants show a downward trend. A plan or a programme shall be drawn up for the area concerned (in accordance with Article 21) demonstrating what measures will be taken in order to meet the limit values by the new deadline. *Additionally, for PM2.5 and PM10 (new Article 20.2a):* Member States may postpone the deadlines by an additional period of a maximum of five years for a particular zone or agglomeration, when the air quality plan noted above demonstrates that the limit values cannot be met, if the Member State shows that all appropriate measures have been taken at national, regional and local level to meet the deadlines referred to above, including	

Table 3: Derogations to meeting the air quality limit values for PM

Issue	Commission Proposal	Parliament's Proposal	Council's Proposal
		implementation of the Directives and Regulations referred to in section B of Annex XV and Annex XVIIa by the deadlines specified in those legal acts. A revised air quality plan shall explain the causes for the exceedance after the deadlines mentioned above and shall demonstrate what measures will be taken in order to meet the limit values within the additional period.	
PM_{10}	*For PM10 (Article 20.2 of COM(2005)447):* Deadline: From the entry into force of the Directive (all values are equivalent to those that should have been met in 2005) Where limit values cannot be achieved because of site-specific dispersion characteristics, adverse climatic conditions or transboundary contributions, Member States do not have to meet the limit values until 1 January 2010 (as long as conditions of		*For PM10 (revised Article 20.2):* Where limit values cannot be achieved because of site-specific dispersion characteristics, adverse climatic conditions or transboundary contributions, Member States shall be exempt from the obligation to apply those limit values until three years after entry into force of the Directive at the latest, provided that the conditions laid down in paragraph 1 are fulfilled

Table 3: Derogations to meeting the air quality limit values for PM

Issue	Commission Proposal	Parliament's Proposal	Council's Proposal
	a) and b), above, have been fulfilled).		
Notification	The Commission must be notified without delay where these conditions are applicable and the two plans (mentioned above) must also be communicated to the Commission for approval (Article 20.4).	The Commission and other Member States must be notified without delay where these conditions are applicable and the two plans (mentioned above) must also be communicated to the Commission for approval. [Note the reference to 'two plans' remains even though the requirement for the second of these in 20.1b has been deleted.]	*(revised Article 20.4)* In addition to the text on the requirement to notify the Commission in the current Commission proposal, the Council also proposes that the Commission in its assessment should take account of estimated effects of measures that have been taken by Member States as well as the effects of Community measures.

ANNEX 3: IMPLICATIONS OF THE VARIOUS APPROACHES TO THE EXPOSURE REDUCTION TARGET

	Reduction targets (%)			Reduction target (actual)			EP better than … by …	
Initial concentration	Commission	Parliament	Council	Commission	Parliament	Council	Commission	Council
6	0%	0%	0%	6	6	6	0	0
7	0%	0%	0%	7	7	7	0	0
8	20%	0%	12%	6.4	8	7.04	-1.6	-0.96
9	20%	0%	14%	7.2	9	7.785	-1.8	-1.215
10	20%	10%	15%	8	9	8.5	-1	-0.5
11	20%	10%	17%	8.8	9.9	9.185	-1.1	-0.715
12	20%	10%	18%	9.6	10.8	9.84	-1.2	-0.96
13	20%	10%	20%	10.4	11.7	10.465	-1.3	-1.235
14	20%	10%	20%	11.2	12.6	11.2	-1.4	-1.4
15	20%	15%	20%	12	12.75	12	-0.75	-0.75
16	20%	15%	20%	12.8	13.6	12.8	-0.8	-0.8
17	20%	15%	20%	13.6	14.45	13.6	-0.85	-0.85
18	20%	15%	20%	14.4	15.3	14.4	-0.9	-0.9
19	20%	15%	20%	15.2	16.15	15.2	-0.95	-0.95
20	20%	20%	20%	16	16	16	0	0

21	20%	20%	20%	16.8	16.8	16.8	0	0
22	20%	20%	20%	17.6	17.6	17.6	0	0
23	20%	20%	20%	18.4	18.4	18.4	0	0
24	20%	20%	20%	19.2	19.2	19.2	0	0
25	20%	0%	20%	20	20	20	0	0
26	20%	0%	20%	20.8	20	20.8	0.8	0.8
27	20%	0%	20%	21.6	20	21.6	1.6	1.6
28	20%	0%	20%	22.4	20	22.4	2.4	2.4
29	20%	0%	20%	23.2	20	23.2	3.2	3.2
30	20%	0%	20%	24	20	24	4	4

ANNEX 4: HEALTH BENEFITS AND COSTS OF FURTHER REDUCTIONS OF $PM_{2.5}$

1. Heath effects of particulate matter

Particulate matter is a major environmental factor affecting human health. The Apheis network[26] has recently updated the health impact and benefit assessment of ambient $PM_{2.5}$ in European cities[27], including the health impact of the proposed new limit values which are currently under discussion. The study has estimated the impact of long-term exposure to $PM_{2.5}$ on premature total mortality and the potentially preventable deaths assuming different levels of $PM_{2.5}$. The Commission and Council propose a yearly $PM_{2.5}$ limit value of 25µg/m^3 by 2010 and 2015, respectively, while the Parliament proposes a yearly limit value of 20µg/m^3 by 2015. In addition, the equivalent Environmental Protection Agency standard for the U.S. is 15µg/m^3, and the World Health Organization[28] recently recommended an air quality guideline for $PM_{2.5}$ of 10µg/m^3. Therefore, Apheis has determined the potential health benefits, all other things being kept equal, by reducing $PM_{2.5}$ yearly levels to 25, 20, 15 and 10µg/m^3, respectively. The $PM_{2.5}$ concentrations have been chosen as examples of proposed legislation, irrespective of the specific abatement strategies to reach those levels, their technical feasibility, or their associated costs.

The Apheis network has estimated the health impact of different concentrations of $PM_{2.5}$ in 26 European cities. The 26 cities, located in 15 European countries, are Athens, Barcelona, Bilbao, Bordeaux, Budapest, Cracow, Dublin, Gothenburg, Hamburg, Le Havre, Lille, Lisbon, Ljubljana, London, Lyon, Madrid, Marseille, Paris, Prague, Rome, Rotterdam, Rouen, Seville, Stockholm, Toulouse and Vienna. Population data, total deaths and yearly average concentrations of PM_{10} from the cities for the years 2001 or 2002 were used. The health impact assessment (HIA) exposure-response functions for total mortality were derived from Pope et al. (2002)[29]. PM_{10} measurements were corrected to compensate for losses of volatile particulates, and were subsequently converted to $PM_{2.5}$ using a local conversion factor. If not available, the default European factor of 0.7 was used.

Yearly average concentrations of PM_{10} ranged from 17 to 61µg/m^3. The derived $PM_{2.5}$ concentrations ranged from 7 to 43µg/m^3. Only Dublin had a yearly $PM_{2.5}$ concentration below 10µg/m^3, and seven cities had $PM_{2.5}$ yearly average concentrations above 25µg/m^3.

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[26] http://www.apheis.net/

[27] Ballester F, Medina S, Goodman P et al. (2006). Health impact assessment on the benefits of reducing $PM_{2.5}$ using mortality data from 28 European cities. ISEE-ISEA Conference, Paris 2-6 September 2006 (AP-003).

[28] WHO (2005). WHO air quality guidelines global update 2005, Report EUR/05/5046029.

[29] Pope A, Burnett R, Thun M, et al. (2002). Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution. JAMA 287:1132-41.

This Apheis study has estimated the potential benefits in terms of deaths that could be prevented by reducing $PM_{2.5}$ yearly levels in these 26 European cities to 25, 20, 15 or 10µg/m^3, respectively. If yearly $PM_{2.5}$ levels were reduced to 10µg/m^3, the combined reduction in the total burden of mortality among people aged 30 and above for all the cities would be 6.2% (95% confidence interval: 1.7-10.4 %; see Figure 1). The benefits clearly decrease when the reduction scenarios are less ambitious, and fall to 3.7% (1.0-6.2%), 2.0% (0.6-3.4%) and 1.2% (0.3-2.1 %) for $PM_{2.5}$ reductions to 15, 20 and 25µg/m3, respectively.

This study illustrates the large reduction in premature deaths that could be achieved by lowering yearly $PM_{2.5}$ levels in European cities. In specific, reducing yearly average levels of $PM_{2.5}$ to 15µg/m^3 could prevent three times more premature deaths in the cities considered than a reduction to 25µg/m^3 (13,300 vs. 4,500 deaths). This number could grow by up to five times if $PM_{2.5}$ levels were reduced to 10µg/m^3 (22,300 vs. 4,500 deaths).

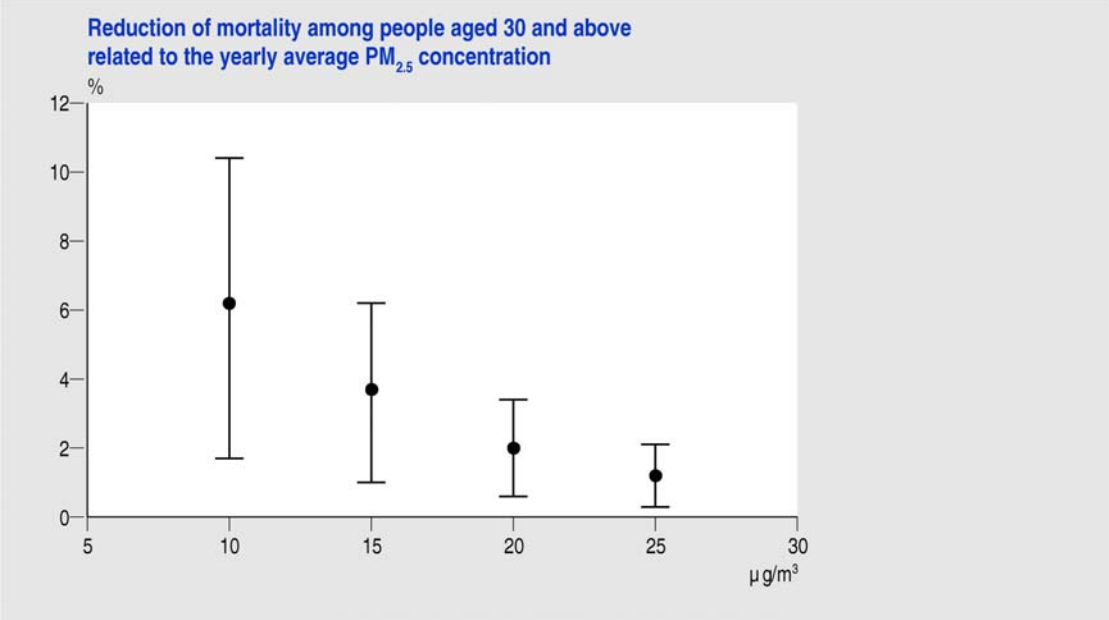

Figure 1: Potential reductions (central estimate and 95% confidence interval) in the total burden of premature mortality among people (with age of 30 years and above) when different proposed yearly $PM_{2.5}$ levels would be realized in 26 cities in 15 European countries.

Direct $PM_{2.5}$ measurements were not used in this HIA, but a previous study showed that converted $PM_{2.5}$ from measured PM_{10} levels were quite similar to measured levels in 12 cities where both $PM_{2.5}$ and PM_{10} data were available[30]. Compared to the current situation, a sustained reduction of the yearly average values to 15µg/m^3 $PM_{2.5}$ would translate into non-negligible gains in life expectancy. Depending on the city, the increase in life expectancy would be between 1 month and more than 2 years[31].

[30] Medina S, Boldo E, Saklad M and the contributing members of the Apheis group (2005). Apheis Health Impact Assessment of Air Pollution and Communications Strategy. Third year report, 2002-2003. Institut de Veille Sanitaire, Saint-Maurice, 232 pages (Available: http://www.apheis.net).

[31] Boldo E, Medina S, LeTertre A et al. on behalf of the Apheis group (2006). Apheis: Health impact assessment of long-term exposure to $PM_{2.5}$ in 23 European cities. Eur. J. Epidemiol. 21: 449-458 (Available: http://www.apheis.net).

According to the current state of knowledge, lowering $PM_{2.5}$ levels in urban locations in Europe is expected to result in a substantial decrease in the number of premature deaths and in a considerable gain in life expectancy of up to two years. Thereby, the lower the $PM_{2.5}$ concentration, the greater the benefit. In the context of the debate of future European legislation on PM, this outcome is important because scientific analyses do not seem to indicate a threshold for PM health effects in the population. The precise choice of a future limit or target value for $PM_{2.5}$ is therefore a political decision based on the willingness to accept certain health effects, even below the limit or target value.

The health impact and benefit assessment in this study has been made considering $PM_{2.5}$ as an indicator of the air pollution complex mixture. Although there have been suggestions that certain PM fractions, like the primary combustion-derived particles, have a higher toxic potential than others, like the secondary, inorganic components such as ammonium salts, sulphates, nitrates, chlorides, and wind-blown dust, it is currently not possible to precisely quantify the contribution of different sources and different PM components to the observed health effects[32]. In this respect, the WHO has recently stated that "it is, however, prudent to check that proposed control measures do indeed target those components of PM, which studies to date have suggested are relatively more toxic, or, equivalently, to check that reductions in PM are not achieved principally by reductions in the less toxic fractions"[33]. As several limitations in HIA methodology have been described[34], the results on health effects of PM should be seen as indicative.

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[32] WHO (2004). Health Aspects of Air Pollution with Particulate Matter, Ozone and Nitrogen Dioxide, Results from The WHO project 'Systematic Review of Health Effects of Air Pollution in Europe', Report E83080.

[33] WHO (2006). Health risks of particulate matter from long-range transboundary air pollution, Report E88189.

[34] WHO (2005). WHO air quality guidelines global update 2005, Report EUR/05/5046029.

Health effects from ground-level ozone exposure

Ground-level ozone is formed through chemical reactions between volatile organic compounds and nitrogen oxides in the presence of sunlight. Epidemiological studies show that short-term exposure to enhanced ozone levels during summer smog episodes appears to be associated with increased (premature) mortality and morbidity, hospital admissions, lung function decline, airway irritation, worsening of asthma, and airway and lung tissue damage and inflammation (WHO, 2003). Among the people with enhanced vulnerability for ozone effects are children, elderly, persons with pre-existing cardio-respiratory diseases, and persons exercising vigorously or spending more time outdoors in afternoon or early evening hours. Many of these effects have also been found in toxicological studies under nearly similar exposure conditions, strengthening the causal character of these exposure-response relationships. There is some evidence that long-term exposure to ozone may have chronic pulmonary effects, but the data base is still insufficient to assess possible health risks and to recommend an annual air quality guideline.

Evidence indicates that every year, in the 25 EU countries, exposure to ozone causes more than 21,000 deaths, 14,000 hospital admissions for respiratory causes, and hundreds of thousands of occurrences of respiratory symptoms that require the use of medication (WHO, 2006). Moreover, evidence has increased that for the short-term effects of ozone on mortality and morbidity, the effects are independent of the effects of ambient particulate matter (PM). A meta-analysis (WHO, 2004) indicates that daily mortality increases by about 0.3% with an increase of the daily maximum 8-hour mean ozone concentration by 10µg/m^3.

In 2000, the World Health Organisation (WHO, 2000) recommended an Air Quality Guideline (AQG) for short-term, daily ozone exposure: a maximum 8-hour mean value of 120µg/m^3. The EU adopted this guideline as a target value, not to be exceeded on more than 25 days per year. To date, exceedance of this value still occurs at many regions in Europe. Looking, however, at recent health effect studies on ozone, there has been mounting concern that this standard may offer inadequate protection of public health from acute and maybe also from repeated daily and long-term exposures to ozone. Recently, the WHO (2003; 2005) therefore proposed to the EU to skip the threshold concept for acute health effects of ozone and recommended a lower AQG of 100µg/m^3 for the daily maximum 8-hour mean value. Since health effects are now considered to occur at much lower ozone levels than earlier assumed, health impact assessments will result in considerably higher numbers of people affected. In addition, global background concentrations of ozone continue to rise, resulting in small increases in annual average concentrations of ozone (EEA 2003**)**.

Also climate change affects ozone concentrations and the projected increase in length and frequency of summer heat waves - conditions which favour ozone smog formation - may lead to a further increase in ozone-related health effects. Preliminary estimates in The Netherlands (Fischer et al. 2004) show that 25-40% of the alleged heat wave deaths may have been caused by air pollution including ozone.

Collectively, taking into consideration the non-threshold concept, a scenario of a modest decrease in ozone peak levels, a rise in background concentrations, climate change effects, and an increase of population group at risk, e.g. the elderly, it is suggested that the health impacts from ozone may continue to exist or may even increase over the next decades. Reducing health effects from ground-level ozone exposure will therefore need targeted environmental policy for the next decades.

Sources:

- EEA (2003). European Environment Agency. Europe's environment: the third assessment. Environmental Assessment Report no 10.
- Fischer et al. (2004). Air pollution related deaths during the 2003 heat wave in the Netherlands. Atmospheric Environment 38: 1083-1085.
- WHO (2000). World Health Organization - Air Quality Guidelines for Europe Second Edition.
- WHO (2003). World Health Organization- Health Aspects of Air Pollution with Particulate Matter, Ozone and Nitrogen Dioxide, Report on Systematic Review of Health Effects of Air Pollution for the EU CAFE programme, Report EUR/03/5042688.
- WHO (2004). Meta-analysis of time-series studies and panel studies of Particulate Matter (PM) and Ozone (O_3), Report EUR/04/5042688.
- WHO (2005). World Health Organization - WHO air quality guidelines global update 2005 – Report EUR/05/5046029.
- WHO (2006). Summary based on reports of the WHO Regional Office for Europe Air Quality and Health Programme (http://www.euro.who.int/HEN/Syntheses/short/20051128_1, Updated 01 April 2006)

2 Cost-benefit analysis

The assessment of the attainment of proposed limit values for PM shows that further emission reductions on top of Current Legislation (CLE) are needed to meet the proposed limit values in the future. Policy efforts in line with the Thematic Strategy and in some areas additional technical and even non-technical measures are needed.

For the EU25, costs for further action were estimated to amount to about €7.1 billion per annum in 2020 (in the case of Thematic Strategy) and approximately €39.7 billion per annum (in the case of MTFR) (Table 1). For individual countries the cost-increase is estimated to range from 4-16% compared to CLE (for the Strategy ambition) and 20-110% (for the MTFR scenario). The additional costs represent 0.05% and 0.3% of the EU-25 GDP in 2020 for CLE and MTFR respectively.

It is up to policy makers to judge whether the benefits for health and environment justify the costs of additional policies. The cost-benefit analysis that was performed by AEAT in the CAFE-programme (Clean Air for Europe)[35,36] could give some guidance for this decision. Health effects of different policy scenarios[37] were estimated in terms of life years lost (mortality) and were subsequently converted to a monetary equivalent to enable a comparison with the costs of measures. The economic effectiveness of further policy action can be assessed with the incremental benefit to cost ratio, as presented in Table 2. The larger the ratio, the more economically efficient is the movement to a more ambitious policy scenario.

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[35] AEAT, 2005. Cost-Benefit Analysis of Policy Option Scenarios for the Clean Air for Europe programme. August 2005. AEAT/ED48763001/CBA-CAFE ABC scenarios.

[36] AEA Technology Environment, Didcot, United Kingdom; AEAT, 2005. Cost-Benefit Analysis of the Thematic Strategy on Air Pollution. October 2005. AEAT/ED48763001/Thematic Strategy. AEA Technology Environment, Didcot, United Kingdom.

[37] Thematic Strategy, MTFR and a series of policy scenarios labelled A (Low ambition), B (medium ambition), C (high ambition). Ambition level of Strategy is situated between scenarios A and B.

A ratio smaller than 1 implies that, from a cost-effectiveness perspective, one should be cautious with further action as there is no clear evidence that benefits of further action will outweigh the costs. The economic optimum is the point where incremental costs and incremental benefits of going from one scenario to the other are equal.

The overall results of the cost-benefit analysis support a shift from Current legislation to the Thematic Strategy ambition (Table 2). In this case, the incremental benefits exceed the incremental costs in almost all countries, except for Cyprus and Finland. For the EU25 as a whole the health benefits of the Strategy exceed the costs by a factor of six (low estimate) to a factor of 19 times (high estimate for the monetary valuation of mortality). Results also show that an additional policy effort up to ambition C is still cost-effective in many countries; especially in the heavily populated EU-regions where the health benefits of measures largest.

Table 1: Emission control costs for the Current Legislation (CLE), Thematic Strategy, C-ambition scenario and Maximum Technically Feasible Reductions (MTFR) in 2020 in million € per annum. Source: AEAT, 2005.

	Total costs of emission control				Costs of further action on top of CLE		
	CLE	Strategy	C-ambition	MTFR	Strategy	C-ambition	MTFR
Austria	1401	1496	1717	2804	95	316	1403
Belgium	1959	2257	2686	2940	298	727	981
Cyprus	128	137	152	208	9	24	80
Czech Rep.	1324	1496	1563	1938	172	239	614
Denmark	1015	1101	1305	1815	86	290	800
Estonia	188	203	214	346	15	26	158
Finland	1092	1155	1300	2180	63	208	1088
France	7796	8973	10150	15583	1177	2354	7787
Germany	13937	15338	16257	18277	1401	2320	4340
Greece	1941	2015	2160	2941	74	219	1000
Hungary	1015	1159	1295	1582	144	280	567
Ireland	1035	1129	1295	1742	94	260	707
Italy	7466	8158	8915	10878	692	1449	3412
Latvia	217	231	250	354	14	33	137
Lithuania	384	432	528	817	48	144	433
Luxembourg	304	323	333	355	19	29	51
Malta	40	43	45	60	3	5	20
Netherlands	3340	3668	3798	4319	328	458	979
Poland	3966	4599	5072	7753	633	1106	3787
Portugal	1630	1783	1937	3087	153	307	1457
Slovakia	710	778	860	1077	68	150	367
Slovenia	270	299	337	457	29	67	187
Spain	5725	6413	7308	10174	688	1583	4449
Sweden	1657	1728	1995	3224	71	338	1567
UK	7321	8097	9241	10670	776	1920	3349
EU-25	65861	73011	80713	105581	7150	14852	39720

Table 2: Benefit to cost ratios for policy scenarios with different ambition levels, as defined in the Clean Air for Europe Programme (CAFE). The benefit to cost ratio is derived for the incremental changes between successive policy scenarios in 2020. Further policy action is cost-effective, i.e. leads to net benefits, when the ratio is larger than 1. Annualised benefits include the reduction of health damage due to particulate matter and ozone, but not the reduction of damage to ecosystems. Source: AEAT, 2005.

	LOW estimate for the monetary valuation of mortality		
	from CLE to Strategy	from Strategy to C	from C to MTFR
Austria	6,9	0,7	0,1
Belgium	4,8	0,7	0,8
Cyprus	0,7	0,1	0,1
Czech Rep.	6,9	2,3	0,5
Denmark	3,6	0,6	0,1
Estonia	1,8	0,7	0,1
Finland	0,7	0,1	0,1
France	5,0	1,0	0,3
Germany	7,3	1,8	0,6
Greece	4,1	0,5	0,1
Hungary	9,9	1,2	0,6
Ireland	2,0	0,3	0,1
Italy	6,2	1,3	0,3
Latvia	6,9	1,5	0,3
Lithuania	2,1	0,4	0,1
Luxembourg	4,2	1,6	0,5
Malta	4,0	1,1	0,2
Netherlands	7,7	3,4	0,6
Poland	6,2	1,0	0,2
Portugal	3,0	0,7	0,1
Slovakia	9,9	1,2	0,5
Slovenia	6,2	1,1	0,3
Spain	2,4	0,4	0,1
Sweden	2,9	0,6	0,1
UK	7,6	0,9	0,6
EU-25	5,8	1,0	0,3

	HIGH estimate for the monetary valuation of mortality		
	from CLE to Strategy	from Strategy to C	from C to MTFR
Austria	21,8	2,2	0,5
Belgium	15,1	2,3	2,5
Cyprus	1,6	0,2	0,1
Czech Rep.	22,9	7,4	1,6
Denmark	12,4	1,9	0,5
Estonia	6,7	2,6	0,4
Finland	2,1	0,5	0,2
France	14,8	2,9	0,7
Germany	25,2	6,0	2,0
Greece	15,0	1,6	0,5
Hungary	36,9	4,5	2,1
Ireland	5,1	0,8	0,2
Italy	23,3	4,7	1,3
Latvia	17,9	4,1	0,8
Lithuania	10,2	1,8	0,4
Luxembourg	9,9	3,9	1,1
Malta	12,0	2,8	0,7
Netherlands	23,2	10,2	2,0
Poland	19,3	3,1	0,8
Portugal	10,3	2,2	0,4
Slovakia	30,4	3,6	1,4
Slovenia	21,0	3,6	1,0
Spain	7,7	1,2	0,4
Sweden	9,2	2,0	0,3
UK	21,6	2,6	1,6
EU-25	**18,9**	**3,2**	**0,9**

The appropriateness of policy action beyond the C-ambition up to MTFR depends on the chosen method for the monetary valuation of mortality. When using low estimates for health benefits, further action beyond the C-ambition is not cost-effective; costs of additional measures outweigh the monetized benefits in all countries. When using the high estimate, further action up to MTFR may be justified in some of the highly populated regions (countries) in North-Western and Eastern Europe.

Apart from the impact of the chosen monetary valuation of mortality, the outcome is also strongly dependent on the uncertainties in the (epidemiological) estimation of the health effects of PM. This estimate is to a large extend derived from single, however extensive study (Pope et al, 2002). It can be concluded that there are indications for the (cost-)effectiveness of further lowering of PM levels, but those cannot yet be seen as proof.

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