EUROPEAN FEDERATION OF CLEAN AIR AND
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The European Symposium on Environmental Protection

Black Carbon Particles

Opportunities to strengthen policies on Air Quality and Climate Change in Europe

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Executive summary

Within the European scientific community the conviction that Black Carbon Particles (BCP) could be a valuable additional indicator for monitoring health risk has recently gained support; in 2011 and 2012 it was discussed at several occasions.
BCP constitutes a fraction of particulate matter which has stronger correlation with health effects in comparison to PM_{10} and $PM_{2.5}$, indicators which are currently being used in the EU and elsewhere. Because emission sources of BCP are well defined and quantified it would then be possible to develop more targeted policies for the protection of public health. In addition, the benefits of measures taken may be calculated more precise than those of measures on PM_{10} and $PM_{2.5}$. A Joint Task Force of the CLRTAP and WHO concluded this year that such an approach would be useful in evaluating local actions aimed at the reduction of population exposure to combustion PM (e.g. from motorised traffic).

Also in 2011 an authoritative assessment on the part of the short-lived climate forcers (SLCFs) in global warming was published under responsibility of UNEP and WMO. Black Carbon, methane and ozone are important SLCFs. Measures which reduce the emissions of BC and methane between 2010 and 2030 could undo a major part of the present global mean temperature rise of 0.5 ^{o}C and even more in Europe and the Arctic region which is attributed to atmospheric BC. Such measures are essential to keep the global temperature rise within the margin of 2 ^{o}C until 2050, because measures to reduce just CO_2-emissions cannot achieve this.

In recent years a consensus has been reached on the need to integrate policies on clean air and climate change: both are atmospheric in character and several components play a role in both. An integrated approach is likely to create co-benefits and make environmental policies as a whole more cost-effective.
This year the EU joined the global “Clean Air and Climate Coalition” which exactly intends to develop such co-benefits. In order to make the objectives of the Coalition operational the legislative activities of the EU seem most suitable and the regular revision processes of existing Directives with relevance for atmospheric issues provide an excellent opportunity.

In conclusion, the European Federation of Clean Air and Environmental Protection Associations,

- considering that BCP is the fraction of particulate matter which has the stronger health impact when compared with indicators of PM presently in use
- convinced of the need for a major reduction of the emissions of BC to slow down global warming in coming decades
- seeing the economic need to maximise cost-effectiveness of environmental policy and aware of the consensus that integration of related policies with differing objectives could achieve this
- feeling that, different from PM_{10}/$PM_{2.5}$ regulation, regulation on BCP will provide an instrument at de-central levels for the development of effective operational policies which will make a successful implementation of the Air Quality Directive more likely

strongly recommends to include in the present revision of the Air Quality Directive Black Carbon Particles as an additional indicator for particulate matter.

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1. Introduction

The oldest documented air pollutant possibly is Black Smoke [1, 2]. It is still one of the most discussed air pollutants, though presently rather referred to as Black Carbon (Particles) (BC or BCP). It is a ubiquitous primary aerosol in man-inhabited parts of the world because its emission is connected with all combustion processes. Consequently, it constitutes a major fraction of ambient particulate matter (PM); also, its correlation with a range of health endpoints is highest from all PM-fractions.

Black Carbon has also been recognised as a component which behaves like a greenhouse gas and substantially contributes to global warming. In addition, it specifically contributes to excess warming of the Arctic where it is deposited and alters the albedo of snow surfaces.

Policies to control black carbon emissions, therefore, will serve the objectives of the domains of clean air as well as climate change and are a perfect example to achieve co-benefits.

In this document a summary of recent developments is given which could support specific regulation of BCP. A discussion on present issues at stake, including a comparison with the alternative of regulating PN is then made and followed by conclusions and a recommendation.

2. Components of fine dust: Black Carbon, Organic Carbon, Elemental Carbon, Particle Numbers and Nanomaterials

Terminology

BCP	= Black Carbon Particles
EC	= Elemental Carbon
OC	= Organic Carbon
PN	= Particle Numbers

Black Carbon
BCP is considered to consist of solid material with a high carbon content, carrying adsorbed polycyclic aromatics (PCA) and other potentially toxic organic compounds with low volatility (OC). PCA formation is favoured in less well controlled combustion processes, such as in car engines, biomass burning and wildfires which also produce the black carbon. It has not been possible so far to attribute health effects to either the solid particles or to the adsorbed OC (or a possible synergic action of both)fraction.
Studies on combustion processes which are representative for car engines have revealed that BCP are primarily formed in the size range of 1-10 nm which then coagulate to form clusters, predominantly in the size range of 30 to 70 nm, before emitted; dilution in the atmosphere limits further coagulation.

Organic Carbon
With OC the organic compounds are meant which occur in the atmosphere as particulate matter; an important fraction of OC is found adsorbed to combustion-generated particles. The

second substantial fraction of OC is primarily of natural origin: terpenes, emitted from forests when oxidised in the atmosphere under the influence of sunlight are converted into particles which are responsible for haziness in summer. Their formation is a natural process; it is, however, accelerated by nitrogen oxides; these secondary particles are also known as summer smog. They are not black and generally do not occur associated with BCP in the air. Their formation is connected with photochemical production of ozone. They have not been reported as toxic themselves. Policies to control ozone and NO_2 may also reduce the formation of these secondary aerosols and there is no need to address them separately. Sampling particulate matter on filters may bring them together, however.

Elemental Carbon
EC is chemically a well-defined material: 100% C. One of the current measuring methods for PM just counts the amount of C-atoms in a sample, as such or after removal of OC by a suitable solvent (incinerating the filter content and measuring the resulting CO_2 formed); the outcome is presented in µg EC/m^3. However, amorphous carbon particles in pure form are not likely to be found in the atmosphere. Atmospheric PM contain varying amounts of metals; organic compounds with low volatility are generally adsorbed at their surface area.

Particle Numbers
BCP are predominantly found in the ultrafine particle fraction (<100nm). A legitimate question then is whether their small size is the decisive property for their toxicity. If so, particle numbers (PN) might be the preferred metric. Unfortunately, our present information is insufficient to support such a preference. A summary of what is known is included in paragraph 5.3

Nanomaterials
Last year the Commission adopted a Recommendation for a definition of Nanomaterials which reads as follows: “Nanomaterials are materials whose main constituents have a dimension between 1 and 100 billionth of a metre (1-100 nm)”. While the Recommendation was made for regulatory purposes for intentional industrial applications of nanomaterials under the REACH legislation the definition does not exclude the fraction of atmospheric particulate matter. It was noted that the Commission has started activities to assess nanomaterials [3]. The approach to check the risks of the many applications of nanomaterials is still in its infancy [4].

3. International developments

3.1 UNEP/WMO

In 2011 UNEP and WMO under joint responsibility published the Integrated Assessment of Black Carbon and Ozone [5]. Both components belong to the group of so-called short-lived climate forcers (SLCFs); another member is methane. Black Carbon (BC) and Ozone, however, have in common that they are also air pollutants.
The assessment identified a set of directly available measures to control emissions of BC and methane and calculated their effects, in comparison with a reference scenario without these measures. Measures which reduce the emissions of SLCFs have the advantage of an immediate effect. For BC and methane together measures taken in the period 2010-2030 could undo a major part of global mean temperature rise of 0,5^{o}C (0.2-0.7) attributed to these

SLCFs. Regionally, the effects are even bigger: in Europe the warming due to BC and methane amounts to 0.7 ^{o}C and in the Arctic to 0.9 ^{o}C. The measures are essential to keep warming within the margin of 2.0 ^{o}C; measures to reduce CO_2-emissions remain also needed.

3.2 CLRTAP - New Gothenburg Protocol

In May 2012 the Parties to the 1999 Gothenburg Protocol to abate Acidification, Eutrophication and Ground-level Ozone under the UNECE Convention on Long-range Transboundary Air Pollution (CLRTAP) approved a revised Protocol [6]. The Protocol now includes new national emission reduction commitments for the air pollutants previously covered (SO_2, NO_x, NH_3 and VOC) to be achieved in 2020 and beyond. In addition - for the first time - emission reduction commitments for fine particulate matter ($PM_{2.5}$) have been agreed.

Moreover, the Parties have broken new ground in international air pollution and climate change policy by specifically including the short-lived climate forcer, black carbon (or soot), as a component of particulate matter. Black carbon is known as a short-lived climate forcer, because it has a strong warming effect but does not persist in the atmosphere as long as carbon dioxide (CO_2), the main focus of emissions-cutting targets until now. However, more recent research shows that black carbon is 680 times more heat trapping than CO_2. Thus, in particular in the global context of glacier melting, reduced ice mass at the Poles, with the knock-on effects on flora and fauna and sea level rise, curbing black carbon emissions is a critical objective in tackling climate change in the near future.

3.3. CLRTAP/WHO

In 2012 a Joint Task Force on Health Effects of Air Pollutants published a report on a discussion on health effects of particulate matter and ozone [7]. The Task Force resorted under the Working Group of Effects of the Convention on Long-range Transboundary Air Pollution and was facilitated by the European Centre for Environment and Heath (WHO/ECEH) and chaired by its representative.
The Task Force, considering the epidemiological evidence, concluded that BC has a higher association with various health effects than PM_{10} or $PM_{2.5}$ per unit of mass concentration, in short-term as well as in long-term studies. However, the effect estimates were generally similar per interquartile range in pollutant levels. In short-term studies the associations for BC are more robust then for PM_{10} or $PM_{2.5}$, suggesting that BC is a better indicator of harmful particulate substances – especially from traffic – than undifferentiated PM mass. In multi-pollutant models the BC effects estimates were robust to adjustment for PM mass, whereas PM mass effect estimates decrease considerably after adjustment for BC. The evidence from long-term studies is inconclusive, however. The Task Force, while recommending continuation of to use of $PM_{2.5}$ as primary metric for quantifying the humane exposure to PM and its health effects, agreed that the use of BC as an additional indicator of combustion PM, such as from motorised traffic, may be useful.

3.4. Global Air Pollution Forum (IUAPPA/SEI) [8]

The Global Air Pollution Forum (GAP Forum) was founded in 2004 as a joint initiative of IUAPPA and the Stockholm Environment Institute (SEI). Its mission is, similar to IUAPPA's, dissemination of knowledge and furthering international cooperation on the protection of the environment, in particular the Earth atmosphere. It has since been managed by IUAPPA and SEI under the guidance of IUAPPA's International Board.
During its pre-founding years it had already alerted policymakers to consider the hemispheric transport of air pollutants. In response to that it started in 2004 the furthering of regional international cooperation for which the CLRTAP served as a model for the type of organisation needed. In 2007 the GAP Forum was formally recognised by UNEP which since agrees on its programme.
The GAP Forum also played a role, together with other organisations, including EFCA, in the plea for the development of integrated policies which serve clean air and climate change objectives together. It was among the first organisations which pointed to the potential of policies which address emissions of SLCFs and suggested an authoritative assessment of the matter which was then undertaken by UNEP and WMO.
The Assessment already made an impact at policy level. In February 2012 US Secretary of State Hillary Clinton announced the formation of the "Climate and Clean Air Coalition" which aims at reducing the emissions of SLCFs. Partners in the coalition are UNEP, the World Bank, the EU and many individual countries, among which the G7.

4. European legislation

The European Union is the single example in the world so far where states have transferred part of their sovereignty to a central authority. The rationale for that was the ambition to create a common market in Europe. Environment is one of the policy terrains of which the initiative was transferred to the European Commission in order to create a level playing field. In spite of different priorities the Member States, represented by the Council have, in cooperation with the European Parliament, succeeded to agree on an impressive system of legislation, regulations, commitments and other harmonisation initiatives.
The most relevant ones with respect to the BCP-option will be considered below shortly.

4.1. Climate change

In 2008 Member States agreed on the "Energy Package" [9]. With the approval of the European Parliament they committed themselves to the 20-20-20 strategy: 20% CO_2 reduction, 20% renewable energy and 20% improvement in energy efficiency by 2020. The agreement included details for CO_2 emissions of new cars, a fuel quality directive, and a directive on carbon capture and storage.
An important instrument in the Commission's hands is the Emissions Trading System (ETS) [10]. The ETS Directive implies that from 2013 an emission cap will be set at EU level with an annual cut to reach a 21% reduction in CO_2-emissions in 2020. Power stations and other big emitters will have to reduce their emissions or to buy an increasing amount of allowances. The ETS deals with CO_2 only; emission cuts of other warming agents are not being covered.

4.2. Air quality: Source-oriented legislation

The National Emissions Ceilings Directive (NECD) [11] sets ceilings for emissions of some major air pollutants: SO_2, NO_x, NH_3 and VOC for each Member State. The present NEC Directive dates from 2001; a proposal for revision is expected by the end of 2012. Details have not been given yet. Because the EU is a party to the Gothenburg Protocol the revision of the NECD might also be in line with the revised Gothenburg Protocol as approved in May 2012 [6]. This would mean that ceiling values for $PM_{2.5}$ will be included in the new NECD.

Since 2010 the Industrial Emissions Directive [12] sets standards for the emission of a variety of air pollutants from stationary sources, including the major air pollutants. For major sources, such as the Large Combustion Sources, detailed standards on the major air pollutants exist. For particulate matter the standard is specified as dust (including fine particulate matter).

Emissions from mobile sources are being controlled by a set of Regulations on the principle of type approval of new vehicles. Negotiations between the Commission and the automobile industry over the years have resulted in the Euro I-VI [13] and EURO 1-6 [14] sets of limit values (g/km) for emissions of CO, NO_x, VOC and PM, for respectively heavy vehicles and private cars. With the present sulphur-free fuels PM limit values may be considered as emission limits for black carbon. In EURO-VI a limit value for particle numbers in exhaust gases was introduced, in addition to the PM limit.

4.3. Air quality: Quality-oriented legislation

Complimentary to source-oriented legislation the Air Quality Directive (AQD) [15] defines limit values which apply to ambient air. The present AQD (2008) addresses the components SO_2, benzene, lead, NO_2, CO, PM_{10}, $PM_{2.5}$ and ozone. In 2011 the Commission announced the start of a revision process, to be concluded in 2013; a proposal for it is due by the end of 2012. The revision provides an opportunity to consider the introduction of a limit value for black carbon particles.

5. EFCA's role

EFCA's Mission is to help to achieve policies and measures that will protect the environment, climate and human health in Europe against the effects of pollution while fostering sustainable development.
In recent years EFCA developed several activities with respect to particulate matter and relevance for the BCP-option.

5.1. UFP-symposium series

In 2007 EFCA started a series of symposia, hosted by EFCA's German Member GUS with the support of the Karlsruhe Institute of Technology on "Ultrafine particles". At the third symposium (UFP-3, 2011) the preferred Metrics for PM was selected as the focus topic. The topic was given substance with several invited speakers and a dedicated Metrics session (see Annex 1). The Conference report of UFP-3 [16] includes a summary of the contributions on the focus topic. It may be considered as the BCP-proposal: to introduce Black Carbon Particles as an additional indicator for particulate matter for better protection of human health. The presentations have been collected on the CD-ROM with the symposium proceedings [17].

5.2. Co-benefits activities: Connecting clean air and climate change objectives

EFCA developed several activities to promote the integration of policies for clean air with those on climate change, most of these in cooperation with IUAPPA.
In 2008 an EFCA/IUAPPA symposium was held in Strasburg, hosted by EFCA Member APPA, titled "How to fight air pollution and climate change effectively together in Europe?" [18]. It was one of a series of activities on the same topic around the world that year under the auspices of the Global Air Pollution Forum, and addressed the scientific connections between climate and air pollution, the need for integration of policies on these topics and the means to harvest co-benefits. One of these was to consider the short-lived climate forcers, among which black carbon.
In 2009 the need for a "One atmosphere" approach was not disputed anymore among international policymakers. The question then was how to harvest its co-benefits. EFCA contributed that year to the discussions at a workshop in Gothenburg at the initiative of the Swedish EU-presidency on "Intermediate policies for air and climate", where it pleaded for the introduction of "co-benefit awareness" in some relevant EU Directives. This suggestion was developed into a more specific Policy Initiative, issued in 2010, "Linking air pollution and climate change: a challenge for European legislation" [19].

Local implementation
That same year EFCA arranged a special session at IUAPPA's World Clean Air Congress in Vancouver where experiences in Europe and elsewhere could be compared. What struck was the difficulty to involve administrations at State and local levels to develop policies which actually deliver the co-benefits [20].
In 2011 EFCA addressed this aspect in more detail at a conference in Paris: "One atmosphere: making the connections" which was hosted by APPA and conducted in cooperation with IUAPPA and the GAP Forum [21]. In a paper by Rambaud and Dearnly [22] confirmation was found of the general situation that many cities across Europe are engaged in policies towards CO_2-neutrality; such policies, however, do not bear a relation with their efforts to improve air quality. The exception was Scotland: regulation was introduced which requires that the effects of such policies consider its effects on air quality and vice versa. It was reported since that the Rotterdam-Rijnmond area is already using BC as an additional indicator, in agreement with the recommendation by the CLRTAP/WHO Task Force.

5.3. Forum discussion on the BCP-option

Between December 2011 and March of this year EFCA facilitated a discussion at the Forum of its website with the objective to bring more clarity on various aspects of the BCP-option (or the alternative of PN) and so collect arguments in favour or against it. Contributions and Summaries of Rounds I (Scientific Database) and Round II (Implementation Aspects) can be found at the website [23]. The outcome of this rough assessment was that the PN database is presently too meagre for even testing this alternative:

- Long-term epidemiological studies on PN have not been published and short-term studies are limited

- Systematic monitoring data of PN are hardly available; also, secondary formation of PN in the atmosphere makes data less source-specific
- PN correlate rather well with traffic, though not as well as BCP
- Emission factors for several road traffic categories exist for EC (EC ~ BCP – absorbed OC) as well as for PN, based on tunnel measurement; the latter, however, are not well defined with respect to size fractions; also, factors obtained under controlled conditions may be different from real-world emission factors
- This limited database for monitoring and emissions of PN, as well as its more dynamic behaviour in the atmosphere frustrate reliable computations of atmospheric levels

The impression from the internet discussion is that a reliable database for PN would require many years of research and studies; this finding rules out PN as candidate for short-term policy action to improve health protection.
This sharply contrasts with the situation with respect to BCP:

- An adequate database which supports BCP as a valuable, additional indicator for particulate matter and its implementation in air quality policy is available. For PN such a database does not exist presently.
- BCP is a no-regret option when considered against its alternative based on PN because measures to reduce BCP-emissions will also reduce PN-emissions. There is a need, however, to explore the option of PN-emissions reduction in more detail, with the aim to quantify its effects for health protection.

6. Discussion on the issues at stake

6.1. Protection against health risks

The basis of present legislation to protect the public against adverse effects of particulate matter in the EU makes use of the indicators PM_{10} and $PM_{2.5}$. There is scientific evidence for a stronger causal relation of short-term health effects for BCP when compared with $PM_{2.5}$ and PM_{10}. In addition, strong indications have been obtained that this is also valid for long-term health effects. The implication is that a policy which specifically addresses BCP will result in better protection against health risks.

In addition, sources of BCP-emissions, combustion processes, are well known, qualitatively as well as quantitatively. It is possible, therefore, to define measures which are effective indeed and enable policymakers to make a more precise estimate of the resulting reduction of health damage.

Though less than BC or EC, PM_{10} and $PM_{2.5}$ correlate with health effects as well. Unfortunately, none of them is a source-specific quantity: PM represents a mixture of contributions from different sources, including natural ones. The effectiveness of policies aiming at the reduction of PM-emissions may then vary with the specific measure which is chosen and, in the worst case, fail to improve the protection against health risks.

6.2. Epidemiological evidence

There is convincing evidence for a stronger causal relation between short-term health effects (hospital admission, mortality, and other) and exposure to elevated BCP-levels, in comparison to $PM_{2.5}$. However, the indications for a stronger relation for long-term mortality and BCP are considered to be inconclusive [7], because in the two published studies additional mortality could, in part, also be attributed to exposure to other pollutants, such as sulphates, NO_2 and ozone.

With respect to sulphates this is unexpected because their toxicity is relatively low in clinical studies. A possible explanation could be that atmospheric sulphates originate, at least partly, from the same sources as BCP, in particular combustion of coal and certain liquid fuels; sulphates may then be contaminated with BCP and carry their toxicity with them: that would explain why sulphates reduce the relative rate of correlation with BC in long term studies. Further research is needed to resolve these ambiguities.

6.3. Particle numbers

There is a legitimate concern that nanoparticles, irrespective of their chemical composition, are a health risk upon inhalation, merely because of their small size. Though still a suspicion confirmation would imply that policies are needed which focus on the reduction of particle numbers in exhaust gases. In anticipation, the EURO VI regulation [12] already has a requirement for vehicle producers to address PN-emissions.

It could be doubted whether it will be possible to develop a robust approach to regulate PN from vehicles when it does not consider chemical toxicity of particulate matter. Particles in the exhaust gas carry a substantial fraction of the toxic fraction of OC. The toxicity of particle emissions due to braking has not been assessed, but is not likely to be similar. This will be a complication for estimating the effectiveness of PN regulation.

For other reasons, it is anyway impossible presently to make an estimate of the effectiveness of PN emissions reductions with respect to health protection. As concluded by the discussion on the EFCA Forum [22] a database for such estimates hardly exists. Further research on short term and long term health effects, emission factors and atmospheric levels in relation to sources is required to develop a robust database which could support PN-focused policies.

In the urban environment where most exceedances of the PM_{10} limit value in Europe occur, traffic is the dominant emitter of BCP as well as PN: their correlation with traffic density is equal. Policy with BCP as indicator will, therefore, also be effective with respect to PN.
In semi-rural cities, where e.g. contributions from open agricultural waste burning may disturb an equal correlation, a source-oriented approach is also likely to be equally effective for BCP and PN.

6.4. Aerosol fractions and Global Warming

The UNEP/WMO report [5] concluded that Black Carbon is responsible for a substantial contribution to global warming worldwide and in particular in the Northern Hemisphere.

Major reduction of its emissions in the coming decades is an essential requirement, in addition to reduction of CO_2-emissions, in order to stay within the two degrees temperature rise in this century.

It should be noted that the atmosphere also contains ‘white aerosols’ which cool the atmosphere. They reflect incoming solar radiation and do not absorb the outgoing radiation from the earth surface. Their formation takes e.g. place through emission of sulphur compounds from biogenic sources which are converted in the atmosphere into sulphate particles. Anthropogenic activities may reinforce their formation. Because these particles act as condensation nuclei for cloud formation the effectiveness of sulphate particles in cooling the atmosphere is substantial.

The European Union is placed in the position to develop a policy to take its share in the coming years. The present policy of regulating PM_{10} or $PM_{2.5}$ may not necessarily contribute to climate change objectives because it does not discriminate between black and white aerosols. Regulation of BCP, however, as a means to improve air quality will contribute to slow down global warming. Because BC is a short-term climate forcer regulation is effective at short-term, both with respect to air quality and climate. This co-benefit of BCP-regulation will increase its cost-effectiveness substantially.

6.5. Impact of BCP regulation at national and local level

Agenda21 has made local officials quite aware of the risks of climate change. It has brought about broad actions of cities in Europe towards energy-, climate- or CO_2-neutrality. National and local officials still struggle to meet the limit values for PM_{10}/$PM_{2.5}$, because they have little grip on such ‘container’ components. For both reasons there is a need now for a legislative incentive which supports initiatives for integrated clean air and climate policies. By including a source-specific pollutant in the legislation for particulate matter de-central administrations will receive an instrument which favours a successful implementation of the European Air Quality Directive, results in better protection of the public and reduces national and local contributions to global warming.

6.6. Legislative integration on clean air and climate in the EU

The EU’s present environmental legislation still reflects the historic separate approach of Climate and Air Pollution policies. The implication is that it may be difficult to monitor the impact of policies in the Climate Action domain for air quality or the impacts of environmental policies for climate. Black Carbon is a perfect example: the likely benefits for health protection of a climate policy which aims at reducing BC-emissions cannot be assessed on the basis of PM_{10} or $PM_{2.5}$ monitoring data. As a partner in the ”Climate and Clean Air Coalition” the EU may want to actively develop effective ways to harvest the co-benefits of integrated policies. BCP may be presently the best available option to serve this objective.

6.7. BCP and the revision process for the Air Quality Directive

Introducing an additional indicator in the Air Quality Directive requires that the various technical procedures and requirements with respect to that indicator have been detailed and agreed. It could be that this would still require considerable time. In order to avoid a delay in completing the proposal for the revised AQD, BCP could be introduced under the condition that the technical aspects are to be added at a later date in an amendment to the Directive.

7. Conclusions

1. Health protection and BCP

Based on our present knowledge the regulation of BCP seems the optimal approach with respect to health protection:

- In comparison with PM_{10} and $PM_{2.5}$ BCP has the strongest correlation with health endpoints
- Sources of BCP are well known and emission data in Europe are already available
- In combination with a source-oriented approach BCP-regulation allows to estimate its costs and benefits and to measure its effectiveness with less uncertainty when compared with other PM fractions
- For PN as a potential alternative metric a knowledge base for regulation which could support its effectiveness with respect to health protection does not exist

2. BCP regulation is a no-regret policy

In the urban environment where most exceedances of PM_{10} limit values in Europe occur, traffic is the dominant emitter of BCP as well as PN: their correlation with traffic density is equal. Policy with BCP as indicator will, therefore, also be effective with respect to PN.

3. *BCP-regulation supports climate change objectives*

Regulation of BCP will result in a reduction of atmospheric Black Carbon worldwide and so reduce global warming. Policies which target an atmospheric decrease of BC are beneficial for clean air objectives as well as climate change objectives. They are likely to produce co-benefits and increase the overall cost-effectiveness of efforts for a better environment.

4. *BCP-regulation has a strong impact at the local level*

In comparison to $PM_{10}/PM_{2.5}$ regulation, a BCP-indicator will show more distinctly the impact of local traffic measures on air quality and health. BCP-regulation provides better opportunities for action at local levels and so furthers a successful implementation of the respective legislation.

8. Recommendation

The European Federation of Clean Air and Environmental Protection Associations,

- considering that BCP is the fraction of particulate matter which has the stronger health impact when compared with indicators of PM presently in use
- convinced of the need for a major reduction of the emissions of BC to slow down global warming in coming decades

- seeing the economic need to maximise cost-effectiveness of environmental policy and aware of the consensus that integration of related policies with differing objectives could achieve this
- feeling that, different from $PM_{10}/PM_{2.5}$ regulation, regulation on BCP will provide an instrument at de-central levels for the development of effective operational policies which will make a successful implementation of the Air Quality Directive more likely

strongly recommends to include in the present revision of the Air Quality Directive Black Carbon Particles as an additional indicator for particulate matter.

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Annex I

Scientific background on Preferred Metrics for Particulate Matter

At the third EFCA-symposium on “Ultrafine Particles: Sources, Effects, Risks and Mitigation Strategies (UFP-3)” in Brussels in May 2011, a dedicated session was conducted on the preferred Metrics for particulate matter. A proposal was launched to introduce Black Carbon Particles as an additional indicator for the protection of human health. The most relevant presentations with respect to this proposal are listed below.

Future prospects for UFPs and other metrics (*invited paper*)
Martin Williams, Kings College, London, United Kingdom

Atmospheric measurements in the field of PM (*invited paper*)
Xavier Querol, Institute of Environmental Assessment and Water Research, Barcelona, Spain

Value of measures of combustion particles as indicators of air quality in addition to PM mass (*invited paper*)
Nicole Janssen, RIVM, Bilthoven, The Netherlands

Is $PM_{2.5}$ a better metric for traffic emissions than PM_{10} or do we need a standard for Black Carbon?
S. van den Elshout, DCMR Environmental Protection Agency Rijnmond, Rotterdam, The Netherlands

European Regulation on ambient fine particles: why the overall mass concentration is no longer the only right metric
G. Guillossou, EDF Medical Studies Department, Levallois-Perret, France

Health impact assessment of elemental carbon in the period 1985-2008 in the city of Rotterdam, the Netherlands
M. Keuken, TNO, Utrecht, Netherlands

Black carbon instead particle mass concentration as indicator for the traffic related particles in the Brussels capital region
P. Vanderstraeten, Brussels Institute for the Management of the Environment, Brussels, Belgium

The role of airborne particulate matter in climate change (*invited paper*)
A. Ferrone, Karlsruhe Institute of Technology, Germany

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