Towards a robust European policy on particulate matter

The European Commission proclaimed 2013 as the Year of Air. Now that it is near to its end it is the right time to consider where we are now, where we want to be in the near future and what major challenges remain. Because proposals for new legislation and policy were not finalised when our contribution had to go in press, comparing our observations with the proposals of the Commission must be left to the reader.

Firstly, it is only fair to acknowledge the considerable achievements which have been made already. With source oriented regulation for industrial activities and vehicles, Europe is on the right track to control emissions, though full implementation may need some time. The proposal for the revised National Emissions Ceilings Directive, when adopted, should consolidate that approach; this will make tighter air quality limit values both feasible and credible. It is also important to note that citizens across Europe are quite aware nowadays of environmental pressures and expect authorities to take action to reduce them. Their claims for clean air appear legitimate against estimates that Europeans still have an average of six months reduction in life expectancy due to air pollution.

In early 2011 the Commission, after a long internal debate, agreed that there was a need for a renewed and comprehensive air quality policy. Over the last three years, DG Environment has identified the weak elements in its present policies and explored its options to address them, in dialogue with institutions, scientists, experts, stakeholders and the general public.
The existing Thematic Strategy on Air Pollution (TSAP) for the period 2006-2010 in fact dates from 2005; at that time the "One atmosphere approach" for an integration of air quality and climate policies had not reached the policy agenda. The TSAP was meant to serve as the agenda for policy development for the next period; unfortunately, it also had a limitative impact on the dialogue with Member States. When WMO and UNEP placed the short-lived climate forcers on the policy agenda[1], the Commission, therefore, could not move easily. Considering the persistent health problems which are posed by tropospheric ozone and particulate matter and the immense challenge of averting serious damage from global warming, the opportunity for a quick start was, unfortunately, missed.

Other parties responded, however. In 2010 EFCA advised the Commission through a Policy Initiative on the need to link air pollution and climate change in its legislation[2]. It was followed by another Policy Initiative in 2012 which highlighted the policy options for Black Carbon Particles[3]; addressing them will make compliance with air quality legislation easier, because the taking account of the benefits for climate change objectives will increase overall cost-effectiveness.
The UN-ECE Convention on Long-range Transboundary Air Pollution - where the need for integrated approaches was recognised in an early stage - had by then included an option in its revised Gothenburg Protocol to report on Black Carbon emissions on a voluntary basis. And also, in 2012, the Climate and Clean Air Coalition was founded and now stimulates the development of policies that address the Short-lived Climate *Pollutants*, methane, ozone and black carbon, worldwide.

In Europe, air quality ambition-levels for fine particulate matter will remain specified on the basis of the metrics PM_{10}/$PM_{2.5}$, at least until 2020. These 'container metrics' which are, unlike gaseous pollutants, not easily linked to specific sources, ignore the different chemical identities and toxicities in the PM mixture as well as the specific risks of its ultrafine fractions. Policies on this basis are also unsuitable to create co-benefits for climate objectives.

In EFCA we have been considering what can be learned from the policy process in recent years and recent research findings. The requirements for an adequate approach of the European PM problem we identified, listed below, may help to make options for action and gaps on knowledge more visible.

- A robust policy requires that particulate matter is addressed through a fraction-by-fraction approach in all cases where a causal relation with health endpoints seems likely.
- A robust policy on particulate matter requires a source-specific approach: without that its implementation will create unhelpful compliance difficulties for Member States
- A robust policy on particulate matter should consider the options that also serve climate objectives

It should be clear that a robust policy option based on another metric is simply not available at present. In the recent REVIHAAP-project experts of WHO Europe concluded that the essential epidemiological information on long-term health effects, which provides the association with excess mortality for PM_{10}/$PM_{2.5}$, is inconclusive for black carbon. Reported results for sulphates are not helpful because their contamination by other components is not taken into account; they are, rather, indicators of PM. For other fractions long-term epidemiological information does not exist.

BCP, PNC or OC?

Apart from Black Carbon Particles (BCP), Particle Numbers Concentration (PNC) and the fractions of Primary and Secondary Organic Aerosols (POA/SOA) qualify for efforts to unravel their possibly causal contribution to excess mortality. As alternative for a BC policy the reduction of the PNC has been advocated for several years. It has been introduced in Swiss regulations and also been made an additional requirement in the EURO VI Regulation on Heavy Vehicles. This is certainly a no-regret policy and effective to reduce emissions of Black Carbon Particles as well. However, it is not possible to estimate its benefits for long-term health risks, because epidemiological data are lacking.

Long-term health effects studies require the availability of monitoring data over a period of about ten years. The absence of such data prevents progress in answering the causality question for long-term health effects. However, because these fractions are not regulated there is presently no obligation for Member States to monitor their concentration levels. Working with pilot networks that monitor fractions of particulate matter for which a causal relation with health endpoints seems likely, may partly solve this.

Fortunately, there is increasing interest in BC and PNC monitoring in Europe, which also includes harmonisation of the methodologies. For the organic fractions, POA and SOA, the methodology needs further development for application in a network setting. The stimulation of progress here is greatly needed, certainly in the roll-out phase of the technique, because several recent studies suggest that the organic fraction could be responsible for serious health risks.

Organic Carbon

It has been observed in California[4] that, on sunny days that favour the formation of ozone and photochemical smog, the character of the smog changes during the day: the ‘aged smog’, which is also responsible for the regular visibility reduction, appears to be more toxic.

The availability of the method of Time-of-Flight Mass Spectrometry, developed in Switzerland[5], has thrown light on this phenomenon and confirmed that during the day a chemically different, secondary organic aerosol fraction is formed by photochemical conversion of semi-volatile polycyclic aromatics (PCAs)[6]. PCAs are predominantly emitted as gases, e.g. by traffic, because the exhaust gas is hot; this means that they are likely to pass diesel particle filters. In the atmosphere they condense at the surface of particles where they may be converted and produce *reactive oxidative species*. The resulting SOA fraction is more active in genotoxic tests and consists of ultrafine particles (<170 nm); it is, therefore, likely to cause oxidative stress in humans. Oxidative stress is thought to be responsible for initiating cardiovascular diseases, neurotoxic effects which could lead to Alzheimer and possibly for adverse birth outcomes.
A further reason for concern is that recent Australian research[7, 8] revealed that biofuels produce much more reactive oxidative species in simulation experiments in comparison to fossil fuels and consequently may increase health risks. The key finding is that the oxygenated ingredients like ethanol and biodiesel are responsible, also in mixtures with fossil fuels which consist of hydrocarbons.

In summary, these novel findings suggest some alerts for future policy development:

- Policies to reduce tropospheric ozone, apart from reducing the mass of particulate matter in the atmosphere, may also reduce its toxicity.
- The use of biomass-based motor fuels, already controversial because of their impacts on deforestation and on land use and connected food security, requires a new impact assessment which includes its consequences for air quality.
- The introduction of particle diesel filters may only solve part of the traffic related atmospheric PM-problem.

With respect to the proposals of the Commission the intentions that were communicated so far make it very unlikely that black carbon will be included as additional indicator in the Air Quality Directive. It is possible, however, that the proposal for the revised NEC Directive supports the recommendation in the Gothenburg Protocol which encourages European countries to report their black carbon emissions on a voluntary basis. This would also be in line with a recent report by the European Environment Agency which pleads for its monitoring.

The expectation further is that in the Thematic Strategy on Air Pollution for the next period, the Short-lived Climate Polluters will be included as components for which an additional policy should be developed. This would support EFCA's recommendation for a fraction-by-fraction approach for PM as outlined above.

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