Report of a Workshop on Environment and Health: Air Quality Research Needs in the EU 7th Framework Programme of Research, 15-16 January 2007

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ABSTRACT

An open international workshop was convened to debate research needs for the EU in the field of health effects of ambient air pollution in the wider context of environmental factors and public health. The workshop provided scientific updates in a number of key areas including toxicology, epidemiology and exposure assessment. Facilitated discussions amongst participants resulted in a series of recommendations which are summarised in the present report.

KEYWORDS

Air quality, health effects, research priorities

INTERNET

This report is available as an Adobe pdf file on the CONCAWE website (www.concawe.org).

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SUMMARY

Research needs for the EU in the field of health effects of ambient air pollution in the wider context of environmental factors and public health have been formulated in recent years in many different fora, including the European Commission's initiative for Clean Air for Europe (CAFE) and the Environment and Health Action Plan. This theme has now been incorporated into the seventh EU framework programme of research (FP7), scheduled to run from 2007 until 2013.

An open international workshop was convened by CONCAWE to debate priorities in this area of research and some associated organisational issues. The workshop provided scientific updates for a number of key disciplines including epidemiology, toxicology and exposure assessment, as well as presentations by representatives of several European bodies which evaluate and use the scientific data for policy advice. Facilitated discussions were organised among participants to generate recommendations for research topics and organisational improvements.

Priorities were established for strategic issues, necessary scientific projects and interactions of science and policy. For strategy these included:

- improved coordination of research in this area;
- more comprehensive and more frequent synthesis and interpretation of research findings, using standardised methodologies to evaluate the weight of scientific evidence;
- the need to creatively link funding available from different sources (EU, national, institutional).

Identified priorities for specific studies included:

- European prospective cohort analysis, with exposure assessment on the individual level including such features as biomarkers;
- assessment of public health impacts of traffic emissions;
- refinement of particulate matter metric(s) to measure health impacts;
- elucidation of mechanisms of toxic action;
- development of standardised toxicity screening protocols for emissions to air of existing and new technologies, building on the collective experience obtained in recent years in the EU in experimental programmes;
- improvements in cost-benefit analytical tools.

A set of recommendations is presented to improve the science-policy interface: research to track impacts of implemented policy measures ("accountability research"); improvements in interdisciplinary exchanges; and linkage of research project to time windows of expected policy needs.

1. INTRODUCTION

1.1. PURPOSE

It is widely accepted that human activities have an important influence on public health. Many conditions – from asthma and allergies to new infectious and emerging diseases – have been linked in some way to environmental pollution. The EU has been at the forefront of research in this area, expanding the knowledge of the complex links between environmental risk factors and their effects on the health of individuals and populations. The Environment and Health Action Plan (EHAP 2004-2010) has urged Europe to integrate it's expertise in the environment, health and research sectors.

Ambient air is one of the main environmental compartments where transmission of pollutants occurs and air quality has been at the centre of policy initiatives for a considerable time.

With a new research framework programme (Seventh Framework Programme of Research [FP7] – 2007-2013) starting[1], it was considered timely to organise an international workshop to examine the current state of scientific knowledge and to provide a forward looking perspective on emerging challenges and opportunities for strengthening policy-relevant research of air quality health effects.

The aim of the workshop was to provide opportunities for identifying research needs and priorities starting from the position that:

- An impressive amount of research has been reported but there are still important knowledge gaps and apparent inconsistencies;
- These knowledge gaps are most apparent for the health effects of specific pollutants and the underlying mechanisms of action;
- Over recent years, new methods/approaches for researching complex multi-causal impacts have become available – also the number of skilled groups able to contribute to such research has grown;
- Setting the right research priorities will benefit from the widest possible participation/consultation of leading scientists and other stakeholders;
- Good air quality is an international ambition with regional dimensions.

Important objectives of the workshop were to:

- foster a multidisciplinary approach to identifying research needs & opportunities in air quality;
- serve as a forum for international exchange and integration of data, particularly between disciplines (e.g. between toxicology & epidemiology);
- provide a forum for participants to discuss gaps in knowledge and future research needs.

The workshop covered the main areas of active research on ambient air pollutants and human health:

- Linking health effects to air pollution across regions and continents;
- Placing the health effects of air pollution in the wider public health perspective;

[1] http://cordis.europa.eu/fp7/home_en.html

- Mechanisms of air pollutants related health effects;
- Combustion-related emissions and adverse health effects;
- Mechanisms of action and risk assessment of air pollutant mixtures;
- Contribution of environmental health studies to the assessment of effectiveness of policy measures.

1.2. WORKSHOP FORMAT

The workshop consisted of a series of invited platform presentations and two facilitated discussion sessions. In addition, all participants had been encouraged to submit posters of ongoing or recently completed work.

The platform sessions were organised as follows:

- environmental factors and public health;
- advancing science to understand complex problems;
- overview of past, ongoing and planned research activities;
- approaches to assessing population exposure to air pollutants;
- expectations from modern epidemiology;
- integrating the science.

The detailed programme is presented in **Appendix 1**.

Workshop participants are listed in **Appendix 2**.

2. PRESENTED MATERIALS

The workshop featured a series of lectures by well-known scientists and stakeholder representatives with the principal purpose of providing updates in their field of expertise or responsibility. As such these presentations provided important inputs into the discussions. In order to document the proceedings as carefully as possible, invited speakers were asked to provide an abstract, a short biography and a copy of their slides.

Approximately 40 posters were presented during the workshop. A list of the posters is provided in **Appendix 3**.

The **enclosed CD** contains copies of platform presenters' material and posters. The presented materials were reviewed for recommendations; these were extracted and grouped along high-level themes by the authors of this report (**Appendix 4**).

Two sessions of facilitated discussion took place. A summary report of the first session (round table discussion of two standard questions) is attached in **Appendix 5**. The second session featured a series of parallel open space discussions on free themes. The report is attached in **Appendix 6**.

Finally, the participants were invited to provide feedback on the value of the workshop and whether the event met their expectations. A summary of their comments is attached in **Appendix 7**.

3. CONCLUSIONS AND RECOMMENDATIONS

In the course of the workshop a large number of inputs were generated in the form of recommendations presented by invited speakers, recommendations in posters, and collectively by the participants during the two discussion sessions. The recommendations were grouped and prioritised by the workshop organisers in collaboration with the session chairs and several participants who had offered to help.

3.1. STRATEGIC RESEARCH DIRECTION

3.1.1. Coordination of research, synthesis and interpretation of research findings at EU level

A large number of recommendations for research priorities were presented, both by the invited speakers and during the facilitated discussions. There are several EU activities where these recommendations would be of value. The EU, and specifically the European Commission's Environment and Research Directorate-General, periodically collect recommendations, for example in relation to the prioritisation and policy needs for the implementation of the goals of the EHAP or the prioritisation of research topics published in the annual calls for research proposals by the Research Directorate-General, which manages the framework programmes.

Recommendations from workshops such as the present one should be seen as complementary to the research and other reports from a wide variety of stakeholder groups. For example, a significant interpretation exercise at EU level was commissioned in the early days of the CAFE programme (2002-2006)[2]. Another review at EU level, in 2005 by the Scientific Committee for Environmental Health Risks (SCHER), managed by Health and Consumer Protection Directorate-General of the European Commission[3], was limited to answering a set of specific questions in relation to ambient air quality and research needs, not a strategic assessment of knowledge and gaps. Many of the ongoing research projects, funded by the 5th and 6th Framework Programmes of Research, have issued and will issue further research recommendations in the future.

Finally, there are technological and policy initiatives, such as the introduction of biofuels, diesel engine exhaust after-treatment, traffic management schemes and more, which create new questions and concerns regarding potential (positive and negative) impacts on public health, but at present there is no EU platform to consider these issues.

Together these considerations together lead to the conclusion, that there may be a lot of valuable research activities or fora to discuss ongoing research, but the efforts are fragmented and overall lack structure and coherence. As phrased by one of the workshop participants, “the EU needs to better coordinate its research and to *synthesise and interpret* research findings”.

Cues can be taken from the consultation and prioritisation processes adopted by the US Health Effects Institute (HEI) in formulating its research programme. The apparent gap that exists in the EU regions could perhaps be filled by a dedicated

[2] http://www.euro.who.int/air/activities/20030528_3

[3] http://ec.europa.eu/health/ph_risk/committees/04_scher/docs/scher_o_009.pdf

well structured network composed of e.g. national public health institutes. Alternatively, since a Coordination Action on the European level in the early 1990's successfully led to a series of collaborative project under FP4 and FP5, a new Coordination Action could be proposed to take up this role. In any case, the synthesis and interpretation activity should be linked to time windows of policy needs.

Synthesis and interpretation of research findings should be carried out more frequently and should follow a rigorous scientific weight-of-evidence methodology, in order to reach conclusions for which chance, bias and confounding can reasonably be ruled out.

3.1.2. Funding models for large and long term research projects

Population studies of air pollution health effects are very time-consuming and costly. In view of the large numbers of variables (population differences, individual susceptibility and habits, exposure differences and misclassification, differences in recording health outcomes, uncertainty about the causative agents and exposure duration etc.), studies need to be of a sufficiently large size and incorporate data from many sources in order to have the necessary power to detect an effect.

The time horizon of this type of large prospective study (10-20 years) exceeds the typical duration of EU and other institutional research framework programmes. The required size of the studies, the wide heterogeneity of air pollution exposures across regions, as well as the transboundary nature of air pollution imply that international efforts are required.

FP7 is expected to be one of the main sources of EU research funding for the period up to 2013 and population studies have been identified as high priority. However, costs of the main (US) studies that were used to inform the present European air quality policies far exceed the funds currently allocated for this area of research in FP7, and the same applies to the ongoing prospective Multi-Ethnic Cohort Air Pollution study of the University of Washington. It therefore appears necessary to increase the priority and availability of funding for this type of population cohort studies.

Participants were informed that by using the ERA-NET or ERA-NETPlus tool national RTD-Programmes can be coordinated and more effectively interlinked with the FP7. This is an important point, taking into account that there is a significant higher RTD-budget in the Member States than at European level only.

Other important areas of research include health impact assessments of technological innovation, assessment of policy measures in terms of reduced exposures and improvements in the science-policy interface.

Certain other groups may also wish to support/sponsor priority research for which EU funding is limited, provided a set of conditions are met that relate to scientific independence and policy- and stakeholder-relevant time horizons. CONCAWE (and other industry groups) could contribute in three possible ways to building knowledge by:

- directly funding studies;
- partnering/co-sponsoring studies;
- assisting investigators in accessing research funds.

3.2. PRIORITY PROJECTS

3.2.1. European population studies

Most existing cohort studies that have investigated relationships between air pollution, mortality and morbidity were originally designed to study other factors, such as the influence of nutrition on cancer rates. In addition, the leading studies were conducted in the US. One of the weaknesses of most previous studies was that, due to limitations in available exposure data from the relevant period and location, the researchers could only assume everyone in a particular area (i.e. a city) to have the same exposure to pollution. However, pollution varies across cities and over time and depends on variables like wind direction, topographic features and proximity to busy roads and other sources of pollution.

The European decision makers would benefit from a new prospective study that would make unprecedented efforts to characterise the air pollution exposures and profiles of the individual study subjects. This could be done by looking at time activity patterns and how those affect exposure. Also state of the art technologies including biomarkers, personal and home air quality monitoring would help to improve exposure estimations and would provide opportunities to look at impact of multiple exposures, exposures to mixtures and specific air pollution components. Europe provides a unique opportunity for a very informative population study given the wide variation between the regions in terms of population, characteristics of housing stock and other micro-environments, economic development, air pollution patterns and level and dynamic of the accession countries to catch up quickly with the rest of Europe. Data analysis methodologies should be further standardised to improve the basis for comparisons across studies.

3.2.2. Impact of traffic emissions on public health

There is a general concern about the (local) impact of heavy (motorised) traffic on health of nearby residents and in particular children in schools. A number of studies have addressed this using different metrics of exposure. It is noteworthy that the pollutant currently prioritised by policy makers ($PM_{2.5}$) in some cases does not show the best correlation with the reported incidence of effects. This has led researchers to suggest that it is the ‘mixture’ or totality of pollution which drives the effects, including non-exhaust traffic emissions and even noise (in relation to cardiovascular effects). Other investigators follow another path of reasoning and their research attempts to identify the most toxic component(s) in the mixture which, if successful, would allow development of specific and cost-effective control measures.

A parallel development is the use of a marker, such as NO_2, to characterise exposure to the traffic exhaust ‘mixture’. Recent technological changes in the after-treatment of diesel engine exhaust have resulted in a reduction of the principal emission of concern (particulate), but not in a reduction and in some cases even in an increase of nitrogen oxides. A logical consequence of this observation is that the validity of a chemical species to act as a marker for exposure to emissions is limited and dependant on local and temporal circumstances. A second consideration is that prior to introduction of new technologies there should be a form of toxicity screening on exhaust emissions. However, to date there is no consensus on the best choice for such a test (see also paragraph 3.2.4).

It is noted that HEI has convened an expert panel and commissioned a review of the literature related to impacts of traffic emissions on public health[4].

An avenue of research that has been pursued by several investigators is the epidemiology of workers occupationally exposed to elevated levels of outdoor air pollution (e.g. bus and taxi drivers, traffic wardens) and who thus might be expected to be more likely to exhibit effects if such exposures are causal. This area of research would possibly benefit from a form of pooled analysis, but is complicated by the 'healthy worker effect', a phenomenon often observed in occupational epidemiology studies where workers are healthier than the general population. Comparable initiatives may be conceived for other sub-populations with elevated exposure such as commuters.

In view of the complexity of the exact nature and extent of the impact of traffic emissions on health, any study programme needs to be multi-disciplinary. Carefully designed studies focussing on specific, well-defined aspects are needed to produce conclusions that can form the basis for policy decisions.

3.2.3. Elucidating mechanisms of toxic action

Several researchers suggested that for certain health end points, air pollutants may be promoting factors rather than independent, fully causal factors. Other types of interactions (e.g. synergistic or antagonistic) between pollutants may also be expected. These refinements of the hypothesis are in accord with known mechanisms of some well-studied risks (e.g. cigarette smoke carcinogenicity) and deserve further attention. In addition to multiplicity considerations also host susceptibility should be further investigated e.g. via biomarkers of susceptibility.

3.2.4. Development of toxicity screening test(s)

A multitude of health effects have been reported in the epidemiological literature and a variety of mechanisms of action have been postulated for the various individual pollutants and mixtures. The largest burden of disease is generally attributed to chronic illnesses resulting from long-term exposures, in particular cardiovascular diseases and respiratory disorders.

Amongst others, this has led to engineering approaches (such as particulate traps on diesel engines) to reduce emissions at source of putative causative agents. However, this has led, in some cases, to increased emissions of other components. There is a clear need to provide some reassurance that these engineering approaches are a move in the right direction prior to any large-scale implementation. Although a number of experimental toxicity screens are in use, none of them at present seems to be regarded as fully validated. For a test method to be useful, it needs to be indicative for events associated with the main reported chronic diseases, yet provide a result within a relatively short time-frame. It is unlikely that a single test method can be indicative for the reported range of health effects. Test method development has to be carried out in conjunction with conventional chronic studies and results should be published in appropriate scientific journals. Such a programme should also periodically take account of developing mechanistic knowledge in other programmes. Ultimately this should lead to the development of standardised protocols in order to move forward in a more validated and transparent

[4] http://www.healtheffects.org/

way. Standardised and systematic testing across a range of emissions of existing and new technologies is required in order to produce comparable results.

3.2.5. Refinement of particulate matter metric(s) to measure health impacts

There has long been debate about the biologically most appropriate metric to describe particulate matter in air. It is likely that different metrics are required for various end points in order to suitably describe relevant exposure and/or dose. Current EU legislation addresses PM_{10}, the thoracic fraction[5] of airborne particles. In parallel with the USA there have been proposals to introduce a new or alternative standard based on $PM_{2.5}$ measurement. $PM_{2.5}$ is considered by many investigators as a better measure for the fraction of anthropogenic airborne particulate viewed as potentially most harmful, dominated by combustion sources. As such it would link more directly to the outcome of policy measures. Measurement of $PM_{2.5}$ is still limited in the EU and should be intensified across regions.

There is experimental evidence that the fraction between 2.5 and 10 µm (aerodynamic diameter) can also affect biological systems.

Other metrics have been suggested, such as particles smaller than 1 or 0.1 µm, particle number per cm^3, or particle surface area, with a view to improve biological relevance of the metric. In addition to size ranges it has been recommended to study chemical composition of airborne particulate matter; this applies to all size ranges. Recently, a different type of metric has been suggested for particle-mediated health effects i.e. oxidative stress; the metric would need to express the level of pollution as oxidant activity or hydroxyl radical formation. Another option is mutagenic potential.

The results of a number of studies funded through previous FP's and other sources should be reviewed for indications of what constitutes the most meaningful metric(s) as a basis for air quality standard setting and compliance monitoring. Where significant gaps in knowledge emerge, targeted recommendations for further research should be made.

3.2.6. Cost-benefit analysis

Increasingly, environmental policy proposals need to be supported by an analysis of costs and benefits. Currently there are several methodologies in use including VSL (Value of Statistical Life) and VOLY (Value of Life Years Lost). As an alternative it has been proposed to apply estimates based on premium of life insurances.

The need was identified to develop a quick, practical and accepted tool by networking with parties in other policy domains and to resolve fundamental scientific differences related to the various methodologies applied and using age-based lifestyle influences.

[5] European standard EN 481 defines size fractions for the measurement of airborne particles in workplace atmospheres as follows:
- inhalable fraction: particles smaller than 100 µm (may be inhaled through the nose and mouth)
- thoracic fraction: particles smaller than 10 µm (inhaled particles which may penetrate beyond the larynx)
- respirable fraction: particles smaller than 4 µm (inhaled particles which penetrate to unciliated airways)

3.3. INTERACTION OF SCIENCE AND POLICY-MAKING

3.3.1. Accountability research

Air pollution measures/regulations that are intended to improve public health can be difficult and costly to implement. Studies to demonstrate the effectiveness of policy interventions should be conducted. Such studies should not be limited to examine whether the intervention has reduced pollution and that those reductions in turn reduce human exposures and health effects, but it should also adequately account for all factors involved including changes in medical care, economic status and dietary preferences. Developing assessment methods and tracking systems to identify changes in public health status will be critical for assessing the efficiency of standards and guidelines over a long period. In addition, changes in human behaviour will need to be taken into account.

3.3.2. Interdisciplinary information exchange

Technical information such as compositional information of emissions is available in one domain e.g. automotive engineering, and would be useful to other domains e.g. toxicology and atmospheric science. Other relevant disciplines include epidemiology, public health science, health economics, risk perception and political science. Presently there is no obvious platform where such an information exchange can take place and therefore initiatives to promote this type of exchange should be encouraged.

3.3.3. Timing considerations

Scientific laboratory and field work, such as toxicology studies and air quality monitoring campaigns, often require project schedules well in excess of a year. The ability of these studies to inform policy-making is also dependent on sufficient advance warning by authorities and regulatory bodies of potential initiatives leading to questions about health impacts. Individuals in key positions in national authorities or in WHO may be solicited periodically in ‘horizon-scanning’ exercises to define such information needs that may require multi-year projects.

APPENDIX 1 WORKSHOP PROGRAMME

PROGRAMME 15 January 2007

12.30 h	**Registration starts**
12.30-13.30	**Sandwich lunch in Foyer of the Armstrong Room**
13.30 - 13.45	**Workshop opening** **Introductory remarks - Wilhelm Bonse-Geuking, Chairman Board of Directors CONCAWE** **Organisational issues – Diana Parry / Min-Min Teh, workshop facilitators**
Plenary Session I **13.45 - 15.00**	**Environmental factors and public health** Chairperson: **Peter Pärt**, European Commission Directorate-General Joint Research Centre Institute of Environment and Sustainability, Ispra
	Theme: Environmental factors and public health – trends and regional differences in disease/public health concerns within EU – **Ingvar Andersson,** European Environment Agency, Copenhagen
	Theme: Environmental factors and health issues – state of knowledge/research recommendations – **Bo Jansson**, Stockholm University and EU Scientific Committee Health and Environmental Risks (SCHER), Stockholm
	Theme: Delivering on the European Environment & Health Strategy – **Laurent Bontoux**, European Commission Directorate-General Joint Research Centre, Brussels
	Discussion
15.00 - 15.30	**COFFEE BREAK**
Plenary Session II **15.30 – 17.30**	**Advancing science to understand complex problems** Chairperson: **Paolo Boffetta**, International Agency for Research on Cancer, Lyon
	Theme: Ultrafine particles – formation, transformation and exposure – **Thomas Kuhlbusch,** IUTA, Duisburg
	Theme: Risk assessment of ultrafine particles – **Paul Borm,** Centre of Expertise in Life Sciences**,** Hogeschool Zuyd, Heerlen
	Theme: Chronic Effects of Air Pollution: Future Research needs and approaches – **Nino Künzli,** Medical Research Institute, Barcelona
	Theme: Health Effects of Organic Aerosol in relation to Traffic Emissions – **Flemming Cassee,** RIVM, Bilthoven
	Discussion
17.30 – 18.30	**ROUND TABLES (discussion of charge questions) and feedback**
18.30 – 19.30	**Drinks and Poster viewing**
20.00 - …	**Dinner**

PROGRAMME 16 January 2007

8.30 – 8.35	**Recap Day 1 and Opening Day 2 - Rob Taalman,** CONCAWE organising committee
Plenary Session III **8.35 – 10.30**	**Past, ongoing and planned research activities and Approaches to exposure assessment** Chairperson: **Marek Jakubowski,** NOFER Institute, Lodz
	Theme: Main findings of FP5 and FP6 projects for air quality health effects and plans for FP7 plans – **Tuomo Karjalainen**, European Commission Directorate-General Research, Brussels
	Theme: Air Pollution and Health: Recent Findings and Key Questions Going Forward – **Dan Greenbaum,** Health Effects Institute, Boston
	Theme: COST Action 633: Particulate matter: properties related to health effects – **Regina Hitzenberger**, University of Vienna, Vienna
	Discussion
	Theme: Integrated exposure assessment for multiple environmental stressors – **David Briggs,** Imperial College, London
	Theme: Air pollution exposure patterns: Temporal and spatial differences across the EU – **Otto Hänninen** and Matti Jantunen **–** KTL, Kuopio
	Theme: Use of biomarkers in air pollution research - **Paolo Boffetta**, on behalf of the ECNIS Network of Excellence, International Agency for Research on Cancer, Lyon
	Discussion
10.30 – 11.00	**COFFE BREAK**
Plenary Session IV **11.00-12.30**	**Expectations from modern epidemiology and integrating the science** Chairperson: **Brian Miller**, IOM, Edinburgh
	Theme: Prospective Study of Atherosclerosis, Clinical Cardiovascular Disease, and Long-Term Exposure to Ambient Particulate Matter and Other Air Pollutants in a Multi-Ethnic Cohort (MESA Air) – **Joel Kaufman,** University of Washington, Seattle
	Theme: European studies on ambient particulate matter and health, with a focus on long-term exposure – **Carlo La Vecchia,** M. Negri Institute, Milan
	Theme: WHO activities on air pollution: recent update of Air Quality Guidelines – **Michal Krzyzanowski**, WHO/ECEH, Bonn
	Theme: NERAM- Network for Environmental Risk Assessment and Management - **Martin Williams**, DEFRA, London and Lorraine Craig, University of Waterloo
	Discussion
12.30 – 13.30	**LUNCH**

13.30 – 15.00	**OPEN SPACE DISCUSSIONS** **Feedback & news**
15.00	**Actions/Wrap-up/Thank you's** – C. Money and A. Heilbrunn on behalf of CONCAWE
15.30	**Workshop ends**
15.30 - ...	**COFFEE etc**

APPENDIX 2 LIST OF WORKSHOP PARTICIPANTS

	Name	First name	Association
1.	Andersson	Ingvar	European Environment Agency
2.	Annesi-Maesano	Isabella	INSERM & Univ. Paris
3.	Baer	Monika	BASF AG
4.	Baños	Eva	Eurocities
5.	Barbas	Antonios	European Commission, DG INFSO
6.	Bartonova	Alena	Norwegian Institute for Air Research
7.	Bartzis	John	University of West-Macedonia
8.	Baverstock	Suzie	BP
9.	Belkhiria	Sami	Dow Corning Europe
10.	Berghmans	Patrick	VITO
11.	Bernard	Alfred	UCL
12.	Bloemen	Louis	EXPONENT
13.	Boenke	Achim	European Commission, DG ENTR
14.	Boffetta	Paolo	International Agency for Research on Cancer
15.	Bonse-Geuking	Wilhelm	BP
16.	Bontoux	Laurent	European Commission, DG JRC
17.	Borkowski	Tomasz	Polski Koncern Naftowy ORLEN S.A.
18.	Borm	Paul	Centre of Expertise in Life Sciences, Hogeschool Zuyd
19.	Borrego	Carlos	University of Aveiro
20.	Brennecke	Detlef	CEFIC
21.	Briggs	David	Imperial College London
22.	Brunekreef	Bert	Institute for Risk Assessment Sciences - Utrecht University
23.	Brunerie	Philippe	European Commission
24.	Bucht	Anders	Swedish Defense Research Agency
25.	Byman	Jan	Swedish Environmental Protection Agency
26.	Casimiro	Elsa	INFOTOX - Enviro Consultants
27.	Cassee	Flemming	RIVM
28.	Chaves Chaparro	Juliana	SOST (Spanish Office of Science and Technology)
29.	Daponte	Antonio	Andalusian School of Public Health
30.	de Jong	Geert	Shell
31.	de Kluizenaar	Yvonne	TNO
32.	de Kok	Theo	University Maastricht
33.	Denier van der Gon	Hugo	TNO
34.	De Saeger	Emile	European Commission, DG JRC
35.	Dusinska	Maria	Norwegian Institute for Air Research
36.	Dussart	Jean-	Cabinet de la Ministre de l'Env. Région Bruxelles-Capitale
37.	Ezratty	Véronique	EDF - Gaz de France
38.	Finzi	Giovanna	University of Brescia
39.	Foltescu	Valentin	SMHI (Swedish Met. Office)
40.	Fourmeaux	Annick	DGRNE - DPA - Cellule Air
41.	Gallo	Giulio	European Commission, DG SANCO
42.	Gallus	Silvano	Istituto Mario Negri
43.	Gatti	Antonietta	University of Modena & Reggio Emilia
44.	Geiser Kamber	Marianne	University of Bern
45.	Gennart	Jean-Philippe	TOTAL
46.	Gephart	Larry	ExxonMobil

	Name	First name	Association
47.	Ghinea	Loredana	CEFIC
48.	Gies	Andreas	German Fed. Env. Agency (UBA)
49.	Green	David	King's College London
50.	Greenbaum	Dan	Health Effects Institute
51.	Hagemann	Randi	Statoil
52.	Hall	Diane	DH Consulting
53.	Hallmark	Nina	ExxonMobil
54.	Hammel	Cornelia	ThyssenKrupp Steel AG
55.	Hänninen	Otto	KTL
56.	Healy	David	University College Cork
57.	Heich	Hermann	HEICH Consult
58.	Heilbrunn	Alain	CONCAWE
59.	Hermanson	Robert	BP
60.	Heron	Richard	BP
61.	Heudorf	Ursel	Public Health Department
62.	Hitzenberger	Regina	University of Vienna, Institute for Experimental Physics
63.	Hoffmann	Barbara	University of Duisburg-Essen
64.	Housiadas	Christos	NCSR "DEMOKRITOS"
65.	Jakubowski	Marek	Nofer Institute of Occupational Medicine
66.	Jansson	Bo	Stockholm Univ. - Dept. of Applied Environmental Science
67.	Jasinska	Agnieszka	Polski Koncern Naftowy ORLEN S.A.
68.	Jørgensen	Robert	Statoil
69.	Karjalainen	Tuomo	European Commission
70.	Kaufman	Joel	University of Washington
71.	Kelly	Frank	King's College London
72.	King	Duncan	BP
73.	Kobe	Andrej	European Commission, DG ENV
74.	Kooter	Ingeborg	TNO
75.	Krzyzanowski	Michal	WHO
76.	Künzli	Nino	CREAL
77.	Kuhlbusch	Thomas	IUTA e.V.
78.	Kyrtopoulos	Soterios	National Hellenic Research Foundation
79.	La Vecchia	Carlo	Istituto Mario Negri
80.	Larsson	Stefan	ACEA
81.	Laupsa	Herdis	Norwegian Institute for Air Research
82.	Lemoine	Sylvie	European Solvents Industry Group
83.	Liu	Lee-Jane	University of Basel
84.	Lopez	Jose	University College Cork
85.	Lorusso	Leonardo	Lombardy Region
86.	Marano	Francelyne	University Paris
87.	Medina	Sylvia	INVS
88.	Miller	Brian	Institute of Occupational Medicine
89.	Money	Chris	ExxonMobil
90.	Morin	Jean-Paul	INSERM
91.	Moschitz	Silke	Eurocities
92.	Mücke	Hans-Guido	German Fed. Env. Agency (UBA)
93.	Nawrot	Tim	KUL University of Leuven
94.	Negri	Eva	Istituto Mario Negri
95.	Norbäck	Dan	Uppsala University

	Name	First name	Association
96.	Nordlinder	Rolf	Volvo Technology Corporation
97.	Ntziachristos	Leonidas	Lab of Applied Thermodynamics
98.	Ormandy	David	University of Warwick
99.	Parry	Diana	The Falling Apple Consultancy
100	Pärt	Peter	EU Commission DG JRC, Institute of Env. & Sustainability
101	Peré-Trepat	Emma	University College Cork
102	Perglova	Tana	CZELO - Czech Liaison Office for R&D
103	Phillips	Richard	ExxonMobil
104	Post	Lourens	CONCAWE
105	Rava	Marta	Universiy of Verona - Unit of Epidemiology
106	Reyskens	Freddy	RDSM
107	Riediker	Michael	Institute for Occupational Health Sciences
108	Roberts	Peter	Shell
109	Rose	Kenneth	CONCAWE
110	Rupprecht	Siegfried	Rupprecht Consult GmbH
111	Rydström	Anne-Marie	Volvo Technology Corporation
112	Samaras	Zissis	Lab of Applied Thermodynamics
113	Sanderson	Eric	Shell
114	Sandstrom	Thomas	Umen University
115	Schierl	Rudolf	Inst. for Occupational and Env. Medicine, University Munich
116	Schins	Roel	University Düsseldorf - I.U.F.
117	Schmid	Otmar	GSF - National Research Center for Env. and Health
118	Schouppe	Michel	European Commission, DG INFSO
119	Schuepbach	Evi	University of Bern
120	Schwarze	Per	Norwegian Institute of Public Health
121	Silvari	Virginia	University College Cork
122	Smith	Benjamin	Firmenich S.A. (representing IFRA)
123	Smith	Steven	King's College London
124	Sodeau	John	University College Cork
125	Stevens	Christine	Dow Corning Europe
126	Stütz	Barbara	Eurocities
127	Taalman	Rob	Shell
128	Teh	Min-Min	MMT Consulting Limited
129	Torfs	Rudi	VITO
130	Tsai	Shan	Shell
131	Umachandran	Meera	WRc Plc
132	Urbanus	Jan	CONCAWE
133	Van Bouwel	Eddy	ExxonMobil
134	Van de Vel	Karen	VITO
135	van Delft	Joost	Maastricht University
136	Van Deun	Jeroen	VITO
137	Vandermeiren	Karine	VAR
138	Vasilakos	Christos	Permanent Representation of Greece to EU
139	Verlato	Giuseppe	Univ. Verona - Unit of Epidemiology and Medical Statistics
140	Viso	Anne-	INVS
141	von Meyerinck	Lutz	BP
142	White	Les	Les White Associates
143	Williams	Martin	UK DEFRA
144	Williamson	Tim	UK DEFRA

	Name	First name	Association
145	Winkler	Michael	Mineralölwirtschaftsverband e.V.
146	Zellner	Reinhard	University Duisburg-Essen

APPENDIX 3 LIST OF POSTERS

	Name	First Name	Poster Title
1.	Bartonova	Alena	1) Urban exposure of children to particles - model calculations 2) Modelling personal exposure to particulate matter in the Haifa Bay Area 3) Children and adults in cities: differences in exposure to particulate matter
2.	Berghmans	Patrick	Assessment ultrafine aerosols: some case studies
3.	Borrego	Carlos	Air pollution exposure in urban areas
4.	Dusinska	Maria	Combinatorial Effects of Brominated Flame Retardants, Polychlorinated Biphenyls and Methylmercury on Neurotransmitter Uptake in Synaptosomes and Synaptic Vesicles in Vitro
5.	Ezratty	Véronique	Effect of formaldehyde on asthmatic response to inhaled allergen challenge
6.	Healy	David	Linking urban field measurements of inhalable particulate matter to their chemical analysis and effects on health
7.	Hoffmann	Barbara	Long-term exposure to traffic and coronary calcification
8.	Kyrtopoulos	Soterios	Mechanism-based approaches to improved risk assessment of ambient air polycyclic aromatic hydrocarbons (PAH): the AMBIPAH project
9.	Laupsa	Herdis	Air Quality Assessment for Europe from Regional to Continental Scale; The Air4EU Mapping Tool
10.	Lopez	Jose	ERITASK: A Marie Curie TOK project on Airborne Particulate Matter
11.	Morin	Jean-Paul	1) High NO_2/NO_x ratio in Diesel engine emission aerosol may represent a more important acute toxic trigger than particulate matter (PM) for lung tissue 2) Isoflavones (Genistein/Daidzein) protect against urban atmospheric pollutant toxicity in an *in vitro* model of organotypic air/liquid culture of rat lung tissue 3) Inhaled oxidation catalysis treated diesel engine emissions induce a marked systemic oxidant stress. Is NO_2 modulation the main trigger? 4) Electrocardiographic changes during exposure to diluted engine emissions in a rat model of myocardial infarction (MI)
12.	Nawrot	Tim	1) Stronger associations between daily mortality and fine particulate air pollution in summer than in winter. Evidence from a heavily polluted region in Western Europe 2) Lung cancer mortality and fine particulate exposure in Europe

	Name	First Name	Poster Title
13.	Norbäck	Dan	Lung function and respiratory symptoms in relation to NO2 from traffic exhaust outside dwellings in heavy trafficked streets in central Uppsala, Sweden
14.	Ntziachristos	Leonidas	Vehicle particle emissions (Results from the FP5 Particulates Project)
15.	Rava	Marta	A predictive model for residential exposure to nitrogen dioxide
16.	Schmid	Otmar	Relation between oxidative stress-related inflammation and organic contribution of different instilled carbonaceous nanoparticles
17.	Spruyt	M.	Passive Measurements to Explore and Identify the Organic Ambient and Indoor Air Pollution in a Belgian Urban Area (Mechelen)
18.	Torfs	Rudi	SHAPES: A systematic analysis of health risks and physical activity associated with cycling policies
19.	Umachandran	Meera	Interactions between polycyclic aromatic hydrocarbons in precision-cut rat lung slices
20.	Van Deun	Jeroen	Verification of the solvent directive with measurements - three cases in the printing sector demonstrated that fugitive emissions are underestimated
21.	Vandermeiren	Karine	Impact of tropospheric Ozone on food and feed quality of Brassica species (OFFQ)
22.	Van de Vel	Karen	Monitoring human exposure to air pollution using the AURORA air quality model

APPENDIX 4 RECOMMENDATIONS CONTAINED IN PRESENTATIONS AND POSTERS

Health effects of air pollution mixtures

- look at early exposure / late effects;
- address issues in Eastern Europe (including air and water borne diseases), and also the EU's impact on developing countries;
- increase focus on potential differences in susceptibility and vulnerability between population groups;
- epidemiological studies should investigate the relationship between particulate oxidant generation and health effects in the lung and cardiovascular system;
- chronic effects need to be investigated;
- use cigarette smoking as a model for estimation of long-term health effects;
- lung function development in children, chronic obstructive pulmonary disease (COPD) in adults, onset of atherosclerosis as the main end points;
- studies (in-vitro, animal models, volunteer studies) of automotive engine pollution mix strongly suggest PM is not the only causal factor – exclusively controlling particulate emissions is not appropriate;
- exploit heterogeneities across Europe from the point of view of:
    - chemical and physical properties of PM
    - particle sources
    - influence of PM on health;
- identify some 'super' (urban) regions for a series of in-depth investigations;
- investigate long-term exposure impact of gaseous pollutants and pollutant synergies;
- quantification of minor impacts is needed;
- improved information on underlying disease rates in populations is necessary;
- hypothesises that fine particulates accelerate atherosclerosis need to be further studied;
- long-term exposure to fine particulate air pollution is likely an important and measurable contributing risk factor to mortality, but causal interpretation remains open to discussion;
- more research is needed on role of individual susceptibility; (already mentioned above)
- study of the effect of the air pollution mixture is needed.

Emerging technologies and fuels

(See facilitated discussion outcome)

Approaches to assessing (population) exposure

- time resolution affects exposure estimation;
- low or intermittent doses, long-term effects need further investigation;
- more research is needed on multiple exposures, mixtures;
- improved exposure assessment at the individual level, moving away from 'city-averages' and accounting for differences between pollutants, is required;

- more biomarkers of exposure are required;
- focus should be on 'traffic emissions' and 'vicinity to roads';
- source-specific exposure assessment should be improved;
- studies of biomarkers of exposure to air pollution need to account for confounding by e.g. tobacco smoke and occupational exposures;
- inconsistencies in European studies may be due to underlying methodological differences between studies regarding exposure assessment.

Toxicology of air pollutants

- toxicity difference between particles as a function of location and source (including PM0.1 and secondary particulate) should be elucidated;
- development of rapid and simple assays or sensors to measure biological activity e.g. oxidant activity;
- standardisation of assays should be pursued;
- relative toxicity of PM from different sources – including indoor-generated particles – needs further investigation;
- more research is needed on mechanisms of action.

Assessing the public health impact of air quality actions/measures

- expand the analysis of the causal chain taking into account (changes to) driving forces and policy effects;
- 'accountability': follow up the implementation of air quality policies;
- more targeted assessments of particles/constituents toxicity (incl. standardisation) and exposures in order to optimize control strategies are necessary;
- environmental policies should focus on reduction of exposure of people.

(Methods) Innovation and validation

- source apportionment for ultrafine particles needs to be improved and include natural sources and secondary formation;
- the most appropriate PM metric(s) for the EU should be identified;
- measurements of PM2.5 should be harmonised and intensified to give representative data from Europe, and more Europe-based information on the exposure-response function PM2.5 is needed; [It is important to note that a standardised method is by now made available and a campaign is scheduled for the coming years as part of the Commission's Proposal for a new Air Quality Directive.]
- appropriateness of lumping all particles smaller than 100 nm together irrespective of differences in composition and physical properties should be assessed;
- mutual learning and extrapolation of data for the parallel areas of engineered nano-scale materials and ultrafine particulate pollution would be desirable;
- mass inadequately describes PM potency, and need to get beyond elemental and organic carbon.

Cross-cutting issues

- multi-causality and interactions / multiple stressors and synergies should be focused upon;
- development of an integrated environment and health information system would be useful;
- harmonisation, such as described in the E&H chapter of INSPIRE6, would be desirable;
- identification of factors that modulate environmental disease risk resulting from nutrition and lifestyle factors is needed;
- improved collaboration between epidemiologists, toxicologists, food scientists and molecular biologists should be encouraged;
- research needs should be based on answering relevant questions – why do it and should pass the 'so what' test;
- atmospheric scientists need to be involved to make link to climate change research and policies, including maximizing synergetic benefits of policies in both areas;
- the EU needs to better co-ordinate its research and to synthesise and interpret research findings;
- ERA-NET and/or ERA-NETPlus projects may allow for a better coordinated and streamlined RTD.

Science-policy interface

- the public health impact of environmental factors in the EU should be assessed;
- the sources to be regulated should be identified;
- science needs to better explain complexities to policy-makers;
- research is needed at the science-policy interface on institutional behaviours and attitudes;
- adequate presentation of uncertainty is required;
- continuous improvement of air quality should be attempted by setting challenging air quality guidelines which are presently not met in many cities in the world;
- power of local evidence should not be neglected for triggering and focusing action;
- work is required on a quick, practical and accepted tool by networking with other parties and resolving fundamental scientific differences related to the various methodologies applied and using age-based lifestyle influences: VSL (Value of Statistical Life); VOLY (Value of Life Years Lost); application of premium of life insurances.

[6] http://www.ec-gis.org/inspire/

APPENDIX 5 REPORT OF ROUNDTABLE DISCUSSIONS

Participants were asked to provide views/opinions on:

A) The Air Quality (air pollutants and human health) issues on the horizon;

B) The emerging challenges and opportunities for policy-relevant scientific research.

Main issues arising were:

- Exposure assessments/estimates in the relevant epidemiological studies are mostly inadequate, thereby limiting the value/power/resolution of the studies and contributing to the high level of uncertainty around risk calculations;
- Most historical epidemiological studies suffer from lack of consistency in health records/criteria, which makes comparison of dataset very difficult – there is a need for harmonisation of protocols - both clinical and analytical;
- Epidemiological study design should ideally start with describing a biologically plausible hypothesis (supported by toxicological data). To understand the limitations of any epidemiological study a feasibility study should be undertaken. Suggestions for epidemiology to test are factors such as susceptibility of subpopulations and potential of different PM species to induce oxidative stress;
- FP7 has not given high priority to mechanistic/fundamental type research– overall there is a lack of grass root fundamental research and controlled studies. (Authors note: The opposite is true – the new IDEAS programme is completely focused on frontier (basic research));
- Understanding the interaction between various air pollutants is an area that requires more attention and for that more knowledge is required of PM speciation;
- Most epidemiological studies have focussed on mortality and/or pulmonary disease as the leading health endpoints. Future studies should ideally cover additional leading health endpoints;
- Health impact assessment should be undertaken before 'new' fuels (composition/type/additives) and technologies are introduced in particular their possible impact on AQ should be investigated;
- A complex and interesting area of research is the link between air pollution and climate change – changes in global climate may alter temperature, precipitation, wildfire, and dust storm patterns all of which may affect air pollution and public health;
- Allocation of funds in FP7 should be such as to produce key data to address the most relevant questions on impact of Air Quality and public health – i.e. which health effects are convincingly associated with PM exposure and what are the quantitative risks associated with PM exposure – these questions could be answered by prospective EU epidemiology studies;
- New regulatory measures need to be tested for effectiveness and analysed carefully to avoid wasting of community resources – experience could be gained by conducting accountability studies i.e. investigate impact of e.g. energy policy measures (shift to biofuels both for energy and transport) on AQ using appropriate health metrics.

APPENDIX 6 REPORT OF OPEN SPACE DISCUSSIONS

On the second day of the workshop the open space discussions provided participants the opportunity to create and manage their own agenda of parallel working sessions around the theme of the workshop. This methodology has proven to be successful when the issues are complex, the people and ideas are diverse and the passion for resolution is high (more info on open space: http://www.opencirclecompany.com/ToolsForOpeningSpace.pdf).

The outcomes of the discussions from the break out groups are summarised below:

1. Theme: Taking human behaviour into account when assessing/estimating exposure

   - Establish more firmly the role of human behaviour in exposure assessment and exposure quantifications. Translate the knowledge into research (improved study design) and into relevant policy recommendations for exposure reduction;
   - Use alternative frameworks for exposure assessment, where the behaviour would be the starting point;
   - Information about time-activity patterns of populations or subpopulation is needed to reduce uncertainty when extrapolating results of epidemiological or other studies providing information on dose/concentration-effect relationships to population levels. Other use of this information would be to design more effective measures to prevent or mitigate adverse effects of exposures to pollutants.

2. Theme: Global aerosol assessment, assessment of PM phase, assessment of gas phase

   - Focus of many studies is on regulated emissions but there is a need to consider global aerosol impacts and include both PM/gas phase contributions;
   - Exposure scenarios for estimating exposure to air pollutants in traffic need further refinement and would benefit from measurements inside cars in addition to roadside measurements. Reliance on AQM networks only is mostly inadequate for 'in traffic' exposure estimation;
   - There are some indications that appearance and/or increase of certain diseases like infant bronchiolitis might be associated with the introduction and gradual penetration of oxidation catalysis in car fleets. This should be tested in epidemiological studies.

3. Theme: How to convince the EC to provide appropriate funding for AQ research?

   - The participants called for a more transparent process to set priorities for EU Research Framework programmes including wider stakeholder consultation;
   - Opportunities for cross-boundary research (across geographies, science disciplines, funding bodies, addressing various policies i.e. energy, climate change, environmental health) should be strengthened – i.e. epidemiological studies covering the wide EU region would require strategic leadership and co-ordination between EU and national research programmes;
   - US has a number of research schemes/organisations (e.g. NPACT[7], HEI) that could serve as good examples how EU could better organise the rather fragmented research efforts – also longer term funding is needed to deliver long term research - procedures for funding should be simplified further.

[7] http://www.healtheffects.org/Pubs/NPACT.pdf

4. Theme: Use of biomarkers in toxicology epidemiology and exposure assessment

- Work is underway to address the value and usefulness of biomarkers in community health research (actions under SCALE initiative[8]) but this area of research is longer term and application of biomarkers in epidemiology probably requires another 5-10 years of development and validation;
- Relevant biomarker development and validation requires a multidisciplinary approach: epidemiology needs toxicology for developing, validating and implementing (new) relevant biomarkers for exposure and effect;
- Development of a toxicogenomics-based toolset for effects of air pollutants, incl. mixtures, is desirable; the development needs well-characterised populations with respect to exposure (known compounds and doses) and classical biomarkers of exposure and effect, in order to identify the most promising new biomarkers (genes, proteins, metabolites) and to establish dose- response relationships.

5. Theme: Exposure characterization to investigate long-term contribution of air pollution to development of chronic systemic inflammatory diseases, in particular COPD and atherosclerosis

- Characterise individual-level long-term exposure using state of the art technology and access to data bases (e.g. traffic density for cities and regions) and investigate association with chronic pathologies relevant in the development of atherosclerosis or COPD in European population, in the young and mid-age adults where preclinical conditions can be well studied;
- Exposure, air pollution, and health researchers should collaborate with modelers to develop harmonised and validated approaches to model pollution distributions (GIS based) wherever relevant health data (i.e. inflammatory markers if they are markers of chronic inflammation, COPD + atherosclerosis) are collected or already available.

6. Theme: Indoor and outdoor risk factors for the development of asthma and allergies in schools, day care center and home environment – a global approach

There are limitations in studies on health effects of outdoor air pollution because of inadequate consideration and evaluation of the spatial variation of the outdoor air pollution as well as the variation of exposure in indoor environments.

- Need for standardised exposure measurements in people's different micro-environments (indoor/outdoor);
- Recommendation to conduct a longitudinal international cohort study on children's development of asthma, respiratory illness, lung function development and allergies in relation to measured exposure;
- Need to perform intervention studies to understand impact of micro environment changes/measures (e.g. in schools: increased cleaning, ventilation, build schools in area with low traffic density).

7. Theme: Approaches for making rational public health policy choices

- Development and implementation of EU policies will be more efficient if institutional structures that constitute barriers to achieving balanced and integrated public health policy are removed, e.g. DG Environment versus DG SANCO versus DG TREN, etc.;

[8] http://ec.europa.eu/environment/health/action_plan.htm

- Any policy should include measures of effectiveness in order to evaluate (and prioritise) policy refinements and interventions;
- The processes by which uncertainty is accounted for needs to be strengthened and made more transparent. Is precaution the only solution?
- The process of science evaluation and policy development/prioritisation needs to be more transparent. This will help avoid any tendency to political expediency;
- The economics of public health science need to be strengthened and better harmonised. What constitute cost effective interventions?
- Public health scientists need improved access to policy makers at all levels (local, national and EU). Good policy should actively seek out and feed off science and not simply seek recourse to it on a case by case bases.

8. Theme: Source Apportionment & (personal) exposure

The aim of research in this area is to link source with personal exposure. Expanding/refining the tool box to help characterise personal exposure would include linking dispersion modeling to emission inventories, chemical/particulates transport models (incl. outdoor/indoor distribution) and personal exposure measurements. While each tool separately is not capable of answering the questions of source apportionment and personal exposure, in combination they could provide insight into contributions e.g. by traffic, wood burning, industrial emissions etc.

9. Theme: Calculate Health effects of all types of PM on European populations in a robust way.

The most important issue was the lack of an appropriate European epidemiology study and reliable information on the response to pollutants at realistic concentrations.

The basis for a robust assessment of risk could be:

- A chronic prospective study with a new European cohort designed to include – subjects/populations spread over the EU regions – a systematic sampling from different forms of PM (sulfate, nitrate, carbonaceous) and gases - a more refined clinical measure of response - a more refined measure of exposure – collection of individual level data addressing both respiration and cardiovascular effect;
- The study should aim to distinguish real from confounding effects, for example the gaseous SO_2 versus particulate matter effect. Confounders are one source of uncertainty, but there are many others including the representativeness of the study cohort of the different European populations. The extent to which historical exposure determines future response also needs addressing. Scope should not be limited to the most sensitive issues but also embrace morbidity, general ill health and temporary incapacity;
- It was proposed to look at populations 'unnaturally' exposed to air pollutants because of their occupations to provide information on morbidity and well-being. Possible target groups would be public service workers (bus drivers, taxi drivers, toll booth operators, traffic wardens etc.). These “ought” to be already within occupational hygiene monitoring studies and should be traceable over useful timescales;
- By taking different groups it ought to be able to cover a wide range of exposures and thus get greater clarity of how the risk factors depend on concentrations.

10. Theme: Use Life Table Method for Health Impact Assessment on PM

- Estimate PM attributable mortality among EU countries;
- Continuing understanding of relationship between life expectancy and attributable deaths from PM.

Advantages of such approach:

- Relative low costs;
- Can be finished in one year if relevant data are available – e.g. comparison between two cities with gap in life expectancy could clarify whether the gap is attributable to PM.

11. Theme: Rapid environmental changes in new membership states offer a unique opportunity for research

Rapid technological changes are expected to drastically change all aspects of life in the new membership states. These changes might encompass:

- Switching to other technologies (e.g. renewable energies, efficient fuel consumption, reduced atmospheric pollution);
- Changing life styles;
- Shift in socio-economic status.

Interesting fields of study ("outdoor laboratory" for)

- Regional climate change;
- Health studies:
  - start new cohorts
  - APHEIS – practical example for successful cooperation of environment + health surveillance (west/central/eastern Europe)
  - individual perception of happiness (an important factor for health?)
  - test predictive models (on e.g. mortality);
- Effect of legislative intervention on target parameter e.g. atmospheric pollution or health (accountability).

Funding under FP8 would be too late since most drastic changes will have been occurred by 2013. Therefore, FP7 should mark this as a unique opportunity and provide funds to support above-mentioned studies.

12. Theme: Perinatal and developmental effects of current air pollution

- An unexplored area in air quality research is the investigation into perinatal and development effects. Such studies should be truly prospective and would encompass studies in pregnant women / newborns with a follow for ten years or more. Such studies should include a range of developmental effects including (but not restricted to) immune system functioning and allergy, asthma, respiratory infections, otitis media, development of early markers of CVD risk such as intima media thickness, and neurodevelopmental effects;
- Population size depends on frequency of endpoint; for rare endpoints joint studies in several countries would be indicated;

- Air pollution exposure assessment can be (and should be) state of the art, with adequate PM speciation chemically biologically and physically.

13. Theme: Systematic review of evidence on health aspects of air pollution

- Policy development should rely on/benefit from full integration/evaluation of scientific data and systematic review of literature (following transparent methodology/protocol) that has taken notice of publication bias and that has focussed on leading highly informative studies to assess health risks;
- More attention should be paid to effects of policy measures – lessons should be drawn from the past. Also there needs to be an evaluation of links/synergies/conflicts with climate change policies and on key AQ & Health Science issues that could be driving future decisions (5-10 years perspective).

APPENDIX 7 SUMMARY OF FEEDBACK COMMENTS

Additional topics that would have been interesting:

- To have a thematic approach to environment & health such as air quality is very good but a global vision of AQ is important with links with other aspects such as indoor / climate change / technology / chemistry;
- Fuels of the future & their PM relevance;
- The lack of standardisation on monitoring and characterisation should be addressed;
- The big themes in society that fuel research could be mentioned (energy use, mobility, ageing);
- More information on relationship between air emission, specifically $PM_{2.5}$ and health, is needed;
- Better advice is needed for monitoring industrial emissions.

Expectations and suggestions for follow-up:

- Continuing platform for exchange on meta level (not individual project);
- It would be good to have a follow-up in 2 years;
- Information on new areas, aspects tackled during the meeting, research projects, results.