Fifty years of air quality conservation

As important today as it was 50 years ago

Looking back over 50 years, it is clear why attention to air quality and its relationship with emissions has been, and still is, one of the leading activities carried out by CONCAWE for its members. The concerns of the 1960s, addressed by enormous efforts over the following 50 years, are centre stage again in the 2013 'Year of Air' which re-focuses on urban air quality as it is affected by emissions from domestic, small industry, commercial and transport sources. The main difference is that now we deal in reducing residual risk as we move towards a policy target of 'zero' impact to human health and the environment, whereas 50 years ago the need was to address visible impacts.

In 1963, air quality was very much poorer for many than it is now, especially in towns and cities. Awareness of the links between air quality and health effects was high. Only 10 years earlier, the 'great smog' of London resulted in thousands of deaths. This led directly to the first UK Clean Air Act (1956). Focusing on urban air quality, this act sought to prevent emissions of 'black smoke' and reduce emissions of dust and grit by introducing emission control areas—'smokeless zones' where only certain fuels could be burned for domestic heating. Measures were taken on heavy transport—including steam-powered railways and inland waterway barges!

By 1960, environmental awareness was rising fast, as was the scientific understanding of air pollution and its causes. In parts of Europe, one in ten members of the population already owned a car. In the USA, ownership was four times greater and incidents of pollution related to automotive emissions were on the increase, especially in California. These episodes involved not just directly emitted substances but pollutants formed in the atmosphere by chemical reaction, i.e. 'photochemical smog'. In 1960, Congress funded the first studies on the health effects of air quality due to motor vehicle emissions. In 1963, the USA launched its first Clean Air Act with a focus on assisting emissions abatement. In 1964, Germany established TA Luft (Technical Instructions on Air Quality Control).

So, at the start of CONCAWE's life in 1963, air quality was already established as an important environmental issue and the science of air quality assessment and management was growing quickly. In 1962 Pasquill published his seminal book, *Atmospheric Diffusion: The Dispersion of Windborne Material from Industrial and other Sources.* In 1968 large-scale experiments were being carried out in the USA to determine input data for these types of stack models (which remained in use well into the 2000s). In 1968, the first revision of the UK Clean Air Act required tall stacks to ensure the 'safe dispersion' of industrial pollutants away from local sources.

Europe was also taking common action on environmental matters. The first European Action Programme started in 1973 and set the basis for what is now known as 'sustainable development'. It recommended actions on the control of air and water pollution. The 'polluter pays' principle was set out in 1974 in the Environmental Liability Directive (2004/35/CE) which also introduced the now familiar concepts of Integrated Pollution Prevention Control, environmental monitoring, external costs of pollution, protection of nature and biodiversity.

Internationally the consequences of the tall stacks policies of the 1960s were being felt. Long-range transport of SO_2 from Western Europe was found to have been causing damage to lakes and rivers, particularly in Scandinavia, and to forests in Scandinavia and Northern Europe. Although concentrations were small, the year-after-year deposition of material was turning water and soils acidic. The term 'acid rain' captured the public imagination. Because of the cross-border nature of long-range pollution, international collaborative action was needed to address it. The Convention on Long-range Transboundary Air Pollution (CLRTAP) was ratified in 1979. Under the Convention, protocol agreements were developed to reduce SO_2 (1985, 1994), NO_x (1988) and volatile organic compounds (VOCs) (1991). A first multi-pollutant, multi-effect protocol for all of these pollutants plus ammonia was adopted in Gothenburg in 1999.

In 1984 the Convention importantly put in place the cooperative European Monitoring and Evaluation Programme (EMEP) as its scientific base for the monitoring and evaluation of transboundary pollutants. The protocols under the Convention specify emission reductions to take place at a national scale by setting environmental objectives and determining the pollutant reductions needed for these to be met. A sound science base is needed to cover all the elements of this assessment. Activities include compiling emission inventories, modelling emission impacts, studying environmental damages, assessing control methods and their costs, and designing emission reduction scenarios to generate environmental gains. CONCAWE has worked closely with the EMEP scientists and national experts since the EMEP inception.

In 1993, the European Commission introduced its fifth Action Programme on the environment, entitled *Towards Sustainability*. This built on the strong growth in environmentalism in the late 1980s and, importantly, introduced the concept of setting both medium- and long-term objectives for environmental policy.

A major concern in the 1990s was to avoid the adverse effects of photochemical air pollution in Europe. The main emission culprits were VOC emissions, from solvent use, and from partial combustion, CO and NO_x. CONCAWE provided extensive assistance to the Commission during the development of Directive 94/63/EC on the control of VOC emissions resulting from the storage of petrol and its distribution from terminals to service stations (Stage 1). Rising motor emissions were a major source. The Auto/Oil programmes (1992–1996,1997–2000) were set up to identify environmental objectives for air quality, forecast future emissions and air quality, establish emission reduction targets (or appropriate functional relationships), collect input data on costs and effects of potential measures to reduce emissions, and carry out a cost-effectiveness assessment as a basis for a future air quality strategy. CONCAWE's contribution to these programmes included the assessment of air quality impacts and future emissions as well as the associated need for, and delivery of, changes to road fuels. Major changes that resulted were the lowering by stages of the sulphur content of fuel and the phase out of lead in gasoline. The sulphur content of gasoline and diesel was reduced to enable the activity of the catalyst devices that car manufacturers could fit to reduce vehicle emissions, and not exclusively to reduce the impacts of SO_2 in the environment.

As part of this work CONCAWE developed the 'STEERS' model to evaluate future fleet composition, fuel demand and automotive emissions. This model, much updated from Auto/Oil and coherent with the tools used for EU policy assessments, allows transport pollutant emissions to be forecast for the 2013 Air Quality Policy review.

The methodologies developed under the CLRTAP and set out in the EC's fifth Action Programme on the environment reflect the importance of setting environmental goals. CONCAWE fully supported (and still does) an environmental quality-driven approach to air-related issues because it leads to cost-effective solutions. An example of this was the technical input given to the European Commission when updating the 'Gas Oil Directive' (93/12/EEC). What would be an overall optimal sulphur content for heating gas oil that would reduce environmental impacts sufficiently but be readily able to be produced? By air quality modelling of two example cities (London and Cologne), assessing the refining implications of making lower sulphur gas oil and considering other strategies it was found that a sulphur content below 0.2% for heating oil was not justified. The air quality targets for SO_2 would be met through other legislation in force and by the increased use of natural gas. This study remarked on the CO_2 penalty of the extra refining steps which is now a cross-media effect of paramount importance.

CONCAWE has also used environmentally-driven arguments to assess how best to reduce the impact of emissions from international shipping. The results were to support discussions within the International Maritime Organization (IMO) which, at the time, was considering limiting the maximum sulphur content of ships' fuel. CONCAWE argued that it was more important to control those emissions close to land and in places where there was a definite adverse effect. CONCAWE went on to demonstrate that controls in a limited area were just as effective in reducing environmental impacts and much less costly to implement. This concept of 'SO_2 Emission Control Areas' (SECAs) was embraced in Annex VI of the International Convention for the Prevention of Pollution from Ships (the MARPOL Convention) in 1997, although the regulation did not come into force until 2005. Several SECAs are now in place around the world. When the convention was revised in 2006–2008, some stakeholders sought simplification of the regulation by proposing a global fuel specification that would have put impossible pressures on refineries. The European Commission was also keen to benefit from ship emission controls as it saw these as complementing on-land measures. CONCAWE provided technical support to other industry associations, the foremost being IPIECA, commissioning an emission inventory for the Mediterranean and carrying out several scenario studies. Much of this work involved European-wide air quality modelling. This was done through the Eurodelta project which looked at many important aspects of the modelling work done under CAFE (Clean Air for Europe). The two Eurodelta reports (2005, 2008) illustrated key uncertainty studies that need to take place in robust assessment of national emission ceilings.

The Air Quality Framework Directive (96/62/EC), which came into force in November 1996, paved the way for the Commission to adopt a more comprehensive environmental quality approach to future policy development. Its purpose was to establish a framework for the setting and attainment of air quality objectives as well as specific limit values for a list of air pollutants including SO_2, NO_2, particulate matter (PM), lead, ozone, benzene and CO. The Directive also set out requirements for the monitoring and assessment of air quality, and encouraged the development of measurement networks adding $PM_{2.5}$ (particulate matter with an aerodynamic diameter of 2.5 µm or less) to existing PM_{10}. In the years since 2000, focus has been on these smaller particles as being most harmful to human health. As mentioned earlier, the (1999) Gothenburg Protocol under the CLRTAP was the first multi-effect and multi-pollutant protocol. It set emission ceilings to be met by 2010 for four major pollutants. The EU adopted slightly stricter ceilings for this date using the same modelling. This was done through the National Emissions Ceilings Directive (NECD) in 2001. CONCAWE played an active part in the development of both the Gothenburg Protocol and the NECD, and especially in the subsequent EU activity known as CAFE. CONCAWE developed its own version of the Integrated Assessment Model that is at the heart of the cost-effectiveness policy. This model, known as SMARTER, has been invaluable in allowing scenario testing of the policy approach, and in assessing many of the underlying inputs.

CAFE (1999–2004) was a large project following the Gothenburg Protocol, and which aimed to meet the objectives set out in the fifth and sixth Framework programmes, i.e. to have a long-term strategy for air quality, hereafter the Thematic Strategy on Air Pollution (TSAP). The present structure of the CONCAWE air quality team was designed to ensure that we could contribute on all areas—energy scenarios, emissions, modelling for dispersion and impacts, costs and the assessment of cost-effectiveness. A new area for CONCAWE was the quantification of health effects and their monetisation. A special cost-benefit group was formed for this new area of expertise and this remains active today.

It was expected that the TSAP would deliver two major policy proposals: a revised air quality directive and a revised NECD for Europe. The air quality directive was revised but without change to the limit values set in 1996. These were limits that progressively decreased from 2000, to reach their current values in 2005, so as to allow time for management plans to work and for assessment data to be available. Proposals for a new NECD were not made due to a combination of events. Firstly ‘climate’ began to be recognised as a major issue at the beginning of the decade and reached critical mass during CAFE. The legislation on Climate and Energy (2008) changed the view of the future, and hence the future emissions embedded in the CAFE technical assessments. Secondly, the financial crisis (2007) in Europe struck and meant that the view of the future was even more uncertain.

CONCAWE has always supported its Member Companies and contributed to the CLRTAP programme by advising on emissions. We review published information on emission factors and feed these into the Task Force on Emission Inventories and Projections (TFEIP) for publication in the emissions inventory guidebook. In 2007 we formalised this with an ‘ever-green’ emissions guide-book to assist regulatory reporting under the European Pollutant Emission Register, now replaced by the European Pollutant Release and Transfer Register (E-PRTR). An update was published in 2009 and another will be prepared in 2013. As part of this work we conduct studies to fill knowledge gaps where data is not available from published literature. Since 2010 we have been running projects to quantify fugitive emissions from refinery sources and to improve methods for quantification by remote sensing. Reports on this work are being prepared for publication in 2013 and will set the basis for a remote sensing protocol.

Also since 2007, and of foremost importance today, is the refinery contribution to the review of the reference document describing the best available techniques to use to abate emissions in the refinery industry, known as the REF BREF for short. Since the Directive on Industrial Emissions came into force in December 2010, these reference documents, and especially their conclusions, have a legally binding nature. The BREF process will finish in March 2013 from a technical aspect. CONCAWE has contributed very significantly over the review process which was launched in 2008. There have been many challenges along the way as the review started under one set of legislation and ended under another.

So what challenges are immediately ahead? This year, 2013, has been decreed the 'Year of Air' by the EU Commission and, by reviewing the Thematic Strategy on Air Pollution, will set objectives for emissions reduction and air quality improvements for the next 15 years (time horizon 2025–2030). To do this, the scientific basis must be sound, uncertainties explored and expectations should be realistic. CONCAWE will contribute to this debate recognising that the years from the present to 2020 will be very challenging. Several key policy actions on decarbonisation, energy efficiency, transport and industrial emissions control take effect.

Three major challenges stand out:

- The emissions of NO_x from road transport seem intractable. Since 2008 it has been recognised that the technical measures in place in good faith had not been as effective as expected.
- The emissions of ammonia from agriculture simply have to be reduced if the worst environmental pressures, eutrophication and the health effects of secondary particulates are to be eased. Improvement targets being considered in the context of the 'Year of Air' need substantial reductions. Compensation by reducing NO_x from remaining industry and transport seems unlikely to be possible and hugely expensive.
- The third challenge is to account for the interplay between climate and air quality. Removing sulphur has, in particular, led to awareness of the importance of cooling emissions having a short lifetime in the atmosphere. Abatement leads immediately (in climate terms) to a perturbation which may have environmental consequences that climate modelling is not able yet to answer. Compensation by removing short-lived climate forcers is sought—hence discussions on limiting black carbon and methane sit across the air quality and climate barriers.

In 1963 focus was on abatement of local emission effects. One of the policy measures put in place, tall stacks for industry, helped resolve local air quality issues, but the resulting long-range transport of SO_2 across borders led to another problem—that of acidification. The collaborative and international efforts have largely resolved the acidification issue, but new questions are now emerging about the effects on climate, as it is recognised that SO_2 emissions have a globally significant cooling effect. The relationship between climate change and the air pollutants that we have been dealing with over the past 50 years has become an important element of the air quality debate. Concerns have moved from local level to global level in just 50 years. What further developments will the next 50 years bring?