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PART 2/4

COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT

Accompanying the documents

Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and he Committee of the Regions a Clean Air Programme for Europe

Proposal for a Directive of the European Parliament and of the Council on the limitation of emissions of certain pollutants into the air from medium combustion plants

Proposal for a Directive of the European Parliament and of the Council on the reduction of national emissions of certain atmospheric pollutants and amending Directive 2003/35/EC

Proposal for a Council Decision on the acceptance of the Amendment to the 1999 Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution to Abate Acidification, Eutrophication and Ground-level Ozone

{COM(2013) 917 final}
{COM(2013) 918 final}
{COM(2013) 919 final}
{COM(2013) 920 final}
{SWD(2013) 532 final}

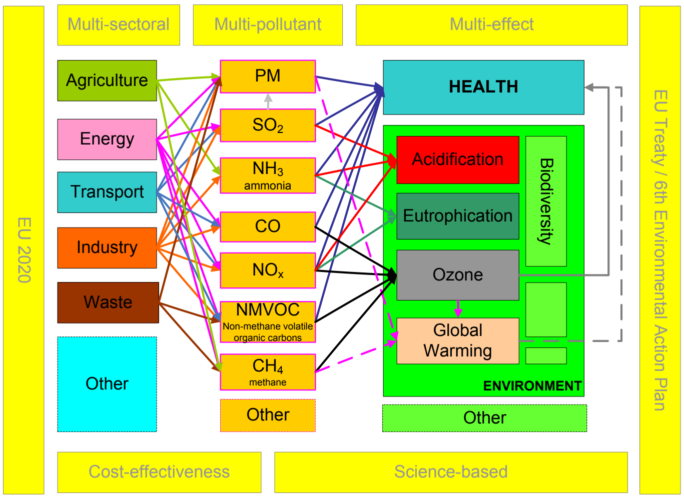
3. THE THEMATIC STRATEGY ON AIR POLLUTION

3.1. Objectives, scope and approach

The environmental and socio-economic scope of the TSAP 2005 is summarized in Box A.4.1.

It incorporates the above mentioned multi-effect, multi-pollutant and multi-sectoral methodology developed at the international level.

Box A.4.1: Summary of the environmental and socio-economic scope and context of the TSAP



The analysis underpinning the 2005 TSAP was based on a previous generation of the same suite of models used for the current assessment.[168] The objective of the analysis was to identify to what extent cost-effective progress could be made by 2020 towards the 6EAP objectives of no significant impact on human health or the environment from air pollution, focusing on five major impacts of air pollution: health impacts of particulate matter; health impacts of ground-level ozone; plant impacts of ozone; ecosystem impacts of acidification; and ecosystem impacts of eutrophication.

Impacts were calculated based on spatial modelling of pollution concentrations and depositions taking into account meteorological and topographic conditions that were characteristic for the respective regions in the EU. For ecosystem impacts, the depositions are compared with 'critical loads' calculated for each ecosystem type, which are deposition rates beyond which the ecosystem suffers damage, to determine the ecosystem area affected. For human health, the concentrations were combined with population data to determine exposure to those concentrations, and those were in turn combined with concentration-response functions established by the WHO based on a thorough scientific review, and baseline health impact data for the endpoints in question, to estimate the resulting years of life lost, or premature deaths.

Based on this assessment, the 2005 TSAP set out interim objectives for headline health and environmental indicators (Table 1) and accompanying pollutant emission reduction objectives (Table 2) for 2020 that would be required to meet those impact objectives.[169]

Table 1: TSAP Health & Environmental Targets (target year 2020)

168 See Annex 2 of SEC(2005)1133 for detail

169 One technical point is that the 2005 TSAP interim objectives for 2020 were formulated in terms of percentage reduction compared to 2000 as the base year, and for the EU25 rather than the current EU28. The present review is based on assessments for EU28 based on an updated energy baseline and with 2005 chosen as the base year (because emission inventory data are of better quality). Hence, the tables include a column with the equivalent TSAP objectives for 2020 presented on the revised basis.

Headline Health and Environmental Impacts	2020 "Interim Targets"	
	%Δ vs 2000	%Δ vs 2005
Loss of life expectancy due to PM exposure	47%	40%
Acute mortalities due to ozone exposure	10%	0%
Excess acid deposition in forest areas	74%	67%
Excess acid deposition in fresh surface water areas	39%	32%
Areas or ecosystems exposed to eutrophication [170]	31%	29%
Forest Area exceeded by ozone (M Km^2)[171]	15%	12%

Table 2: TSAP Emission Reduction Targets (indicative for target year 2020)

Headline Emission Reduction Targets	2020 "Interim Targets"	
	%Δ vs 2000	%Δ vs 2005
Primary Particulate Matter (PM2.5)	59%	52%
Nitrogen Oxides (NOx)	60%	56%
Sulphur Oxides (SOx)	82%	76%
Non-Methane Volatile Organic Compounds (NMVOC)	51%	38%
Ammonia (NH3)	27%	24%

The TSAP objectives were politically endorsed by Council and EP conclusions but have no formal legal status.[172]

3.2. Monitoring, Reporting and Evaluation

Progress towards the TSAP objectives is monitored through several indicators, most directly through trends in air pollutant emissions based on national emission inventories established by the Member States according to the requirements of the NECD (referring to the guidelines adopted by the CLRTAP-EMEP) and collated by the EEA.[173]

Impacts on health, acidification and eutrophication are calculated regularly and published on the occasion of comprehensive reviews conducted by the European Commission and the EEA or the CLRTAP.[174] The effectiveness of the TSAP has also been tracked through the EEA's annual report on Air Quality in Europe which collates monitored air quality data reported through EIONET in

170 The figure in the original strategy is 43%, but based on updated scientific methodology the 2005 emission reductions correspond to a reduction in impact of only 31%.

171 Rebased as percentage reduction in ozone flux, where the latter is defined as phytotoxic ozone dose (mmol/m2) over a threshold of 1 nmol/m2/s.

172 Council Conclusions on TSAP, 9 March 2006, available on: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2012:225:0011:0019:EN:PDF.

173 See http://www.eea.europa.eu/data-and-maps/indicators for air pollution related indicators and assesments.

174 See for example the CLRTAP co-ordination centre for effects annual status reports; 2012 report available on http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2012:225:0011:0019:EN:PDF.

accordance with the implementing decisions adopted under the Ambient Air Quality Directives (See section 4).[175]

The TSAP was furthermore evaluated in the review of the 6EAP with regard to the breadth and quality of its analysis. [176] The review process builds on these monitoring and evaluation mechanisms and included extensive further consultation of stakeholders.

3.3. Relevance

The analysis under the current review of EU air policy has confirmed that the overall scope, objectives, parameters and sources identified in the TSAP remain relevant and appropriate to address the main air pollution challenges in the EU. The main impacts focused on in 2005 remain the key air quality impacts today. Successive reviews of the science underlying the problems have confirmed that the pollutants addressed are indeed the main problem drivers.[177] A review of evidence has confirmed that particulate matter and ozone are the two substances for which the evidence of health impacts in the EU is strongest.[178] For ecosystem impacts, while acidification has reduced dramatically, eutrophication remains substantial.[179] The modelling framework was further developed and updated in the period 2006-2013, with in-depth stakeholder consultation.[180] It was concluded that the approach to identify pollution reduction objectives, sources and legislative instruments remains valid.

Stakeholders have stressed the importance of maintaining, and where possible extending, the inter-relation between air quality and climate change policy analysis.[181] Likewise, the inter-relation between the AAQD and the NECD could be strengthened.[182]A number of tasks related to climate change and its effect on air pollution also require consideration on broader spatial scales whilst at the same time there is increasing need for more detailed information on pollution levels within Member States' territories that require assessments with finer spatial resolution. [183] It was noted that EU

175 See most recent report, Air Quality in Europe – 2012 report, p34 for current emissions and historical trends; report available on http://www.eea.europa.eu/publications/air-quality-in-europe-2012. The EEA's annual report on implementation of the NECD provides more detail on four of the five main TSAP pollutants (the exception being PM2.5, which is not currently regulated under the NECD). Latest report available on http://www.eea.europa.eu/highlights/publications/evaluation-progress-nec-2012.

176 See 'Final report for the assessment of the 6th environment action programme, DG ENV.1/SER/2009/0044, chapter 3.3 and Annex A, in particular p80 ff. For stakeholder consultation, see Chapters 1-2 and Annexes E-G. Report available on: http://www.ecologic.eu/files/attachments/Projects/2010/ecologic_6eap_report.pdf.

177 For an in-depth assessment of eutrophication and its underlying causes see *the European Nitrogen Assessment: Sources, Effects and Policy Perspectives*, Sutton, M A et al, Cambridge University Press 2011; for an in-depth assessment of the health impacts of air pollution and their underlying causes see the *Review of Evidence on the Health Aspects of Air Pollution,* WHO/Europe 2013 (see above or Annex 1 for ref.)

178 WHO Review of Evidence on Health Aspects of Air Pollution, 2013. Available on http://www.euro.who.int/en/what-we-do/health-topics/environment-and-health/air-quality/publications/2013/review-of-evidence-on-health-aspects-of-air-pollution-revihaap-project-final-technical-report.

179 Report 'Factors determining recent changes of emissions of air pollutants in Europe, ENV.C.3/SER/2011/0009 TSAP report #2.

180 In the context of the EC4MACs project, a preparatory project under the LIFE programme. See http://www.ec4macs.eu/.

181 See 'Survey of view of stakeholders, experts and citizens on the review of EU Air Policy. Part II: Detailed results', pp17-19 points 2 to 4. Available on http://ec.europa.eu/environment/air/review_air_policy.htm.

182 See report from Member State Expert Group meeting on Air Quality review (2012)

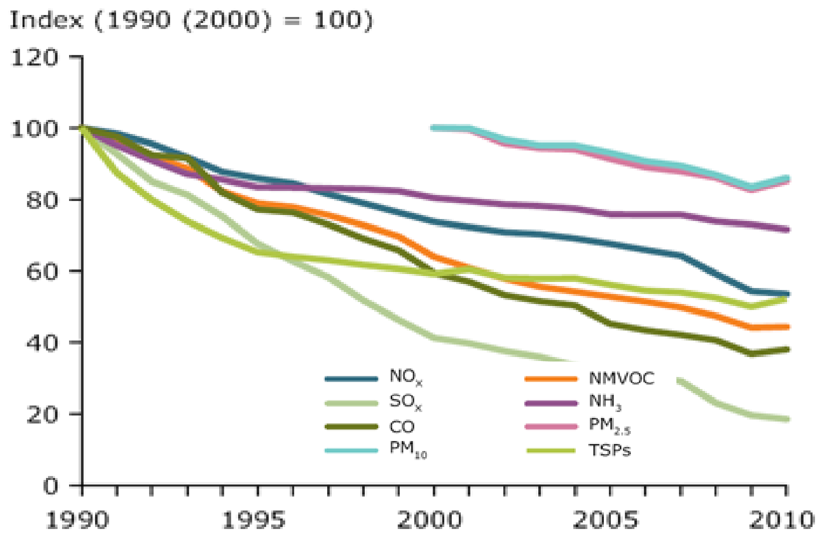
183 See reports from EMEP Steering Body and EMEP website.

provisions for monitoring ecosystems were lacking (See section 5 on NECD below. Finally, it has been suggested that in addition to the coverage of "traditional" sectors such as energy, industry, and transport, increasing attention should go to agriculture and maritime emissions as well as emissions from small and medium scale combustion.[184]

3.4. Effectiveness

As shown in Figure 1 below, substantial reductions have been achieved between 1990 and 2010 for the main air pollutants tracked by the TSAP.

Figure 1: EU air pollutant emissions 1990-2010 (EEA, 2012)

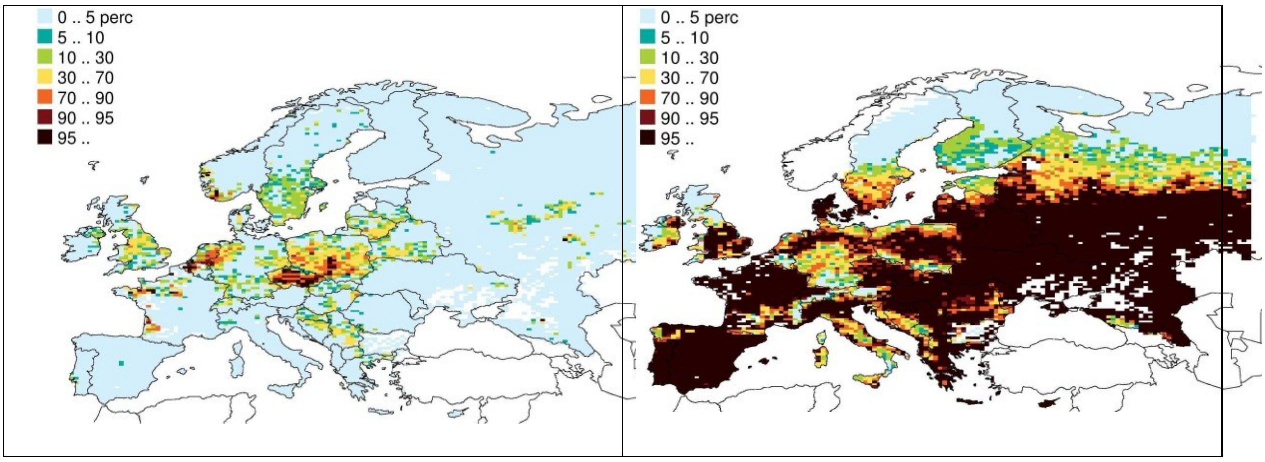


In consequence the EU's huge acid rain (acidification) problem is set to be broadly solved[185], the impact of lead from vehicle fuels has been eliminated, and the ambient air health risk from other heavy metals and carbon monoxide has been greatly reduced. The health impacts of particulate matter, the main cause of death from air pollution, have been reduced by around 20% between 2000 and 2010. Figure 2 shows the comparative success in eliminating acidification versus the large outstanding eutrophication problem.

184 See ‘Survey of view of stakeholders, experts and citizens on the review of EU Air Policy. Part II: Detailed results’, pp19-20, point 5.

185 The emission reductions are due to EU legislation on sulphur emissions from large combustion plants (LCPs), and to the low sulphur road transport fuel requirements that also enabled the use of catalytic converters from Euro 4 onwards.

Figure 2: EU ecosystems at risk of acidification and eutrophication



The present review has also developed updated projections related to the air pollutant emissions and air quality impacts for the period up to 2030 assuming no changes to current policy (see Annex 5).

Despite the progress made in addressing air pollution, several of the 2005 TSAP objectives will not be met - the health and environmental impacts of air pollution in the EU remain large.

As shown in Table 3, projected emission reductions without further measures will fall short of the 2020 TSAP targets for all main pollutants, most importantly for PM2.5 and ammonia (NH_3) and to a lesser extent for NOx and NMVOC.[186] The reasons for this shortfall are further discussed in the section relating to the NECD and source controls.

Table 3: Distance to TSAP Emission Reduction Targets for 2020 (latest projections)

Headline Emission Reduction Targets for 2020	%Δ vs 2005	%Δ vs 2005
	TSAP 2005	Projected[187]
Primary Particulate Matter ($PM_{2.5}$)	52%	24%
Nitrogen Oxides (NOx)	56%	51%
Sulphur Oxides (SOx)	76%	65%
Non-Methane Volatile Organic Compounds (NMVOC)	38%	34%
Ammonia (NH3)	24%	15%

As a consequence of failing to achieve the emission reduction targets, there is also under-achievement of the TSAP's headline health and environmental targets for reduction of PM2.5 mortality, eutrophication and forest acidification (Table 4). [188] However, the target for fresh water acidification

186 Emission projections carried out in the context of this review are documented in Annex 5.
187 Projected emission reductions by 2020 compared to 2005 are calculated based on data presented in Annex 5.
188 The first column gives the scale of the impact in 2000, the second the projected impact in 2020 on a business as usual scenario (baseline), and the third, the projection for 2020 on the basis of the maximum technically feasible reduction of air pollution (MTFR). Note that the impacts reported in this table are smaller than in chapter 3 of this impact assessment. This is because advancements in atmospheric dispersion modelling and ecosystem impact assessment have led to the upward revision of the magnitude of impacts. In % reduction terms, however conclusions have not substantially changed.

will be met, as well as the ozone mortality target (the latter represented a 10% reduction compared to 2000).

Table 4: Distance to TSAP Health & Environmental Targets (latest projections)

Headline Health and Environmental Impacts for 2020	%Δ vs 2005 TSAP 2005	%Δ vs 2005 Projected[189]
Loss of life expectancy due to PM exposure (M)	40%	26%
Acute mortalities due to ozone exposure (M)	0%	13%
Excess acid deposition in forest areas (M Km^2)	67%	64%
Excess acid deposition in fresh surface water areas (M Km^2)	32%	n.a.
Areas or ecosystems exposed to eutrophication (M Km^2)	29%	17%
Ozone flux (Forests (mmol/m^2 above effects threshold))	12%	13%

The updated human health impacts in the EU due to PM and ozone air pollution in 2010 are presented in Table 39.[190] The associated external costs and costs of implementation are discussed in the following section on efficiency. Air pollution remains the number one environmental cause of death in the EU, responsible for an estimated 406 000 premature deaths or ten times more than fatalities due to road traffic accidents.[191] In addition to premature mortality there are also substantial quality-of-life (well-being and morbidity) impacts, ranging from asthma to exacerbation of cardiovascular symptoms, which result in restricted activity days with associated productivity losses.

Table 5: Health Impacts in the EU Due to PM and Ozone Air Pollution in 2010 (EU28)

Acute Mortality (All ages)	Premature deaths	O3	26,525
Chronic Mortality (All ages) *	Life years lost	PM	4,030,653
Chronic Mortality (30yr +) *	Premature deaths	PM	379,420
Infant Mortality (0-1yr)	Premature deaths	PM	1,829
Chronic Bronchitis (27yr +)	Cases	PM	316,685
Bronchitis in children (6 to 12 years)	Cases	PM	6,231,812
Respiratory Hospital Admissions (All ages)	Cases	PM	142,243
Respiratory hospital admissions (>64)	Cases	O3	19,117
Cardiovascular Hospital Admissions (>18 years)	Cases	PM	108,989
Cardiovascular Hospital Admissions (>64)	Cases	O3	86,279
Restricted Activity Days (all ages)	Days	PM	436,351,761
Asthma symptom days (children 5-19yr)	Days	PM	11,290,673
Lost working days (15-64 years)	Days	PM	121,378,612
Minor Restricted Activity Days (MRADs all ages)	Days	O3	108,845,140

Notes: * These rows represent alternative measures of the same effect on mortality, and hence are not additive..

189 n.a. indicates that calculations are not available at this stage.
190 Source: EMRC 2013.
191 EUROSTAT statistics report the number of traffic fatalities in the range of 35,000 in the year 2010 across the EU 27.

3.5. Efficiency

Promoting cost-effective air pollution abatement actions

One of the principal aims of the TSAP was to promote cost-effective air pollution abatement actions in the EU and internalise externalities through the adherence to the polluter pays principal and optimal market based solutions.

As is set out in section 6 on EU source controls, the main focus of current air pollution policies has been on the major polluters. External costs associated with air pollution in the EU remains, however, very large. Table 40 below builds on table 39 above and shows the external costs associated with the main health impacts in the EU due to air pollution.

Table 6: External Costs Associated with Main Health Impacts in the EU Due to Air Pollution in 2010

Impact			€M/year
Acute Mortality (All ages)	Premature deaths	O3	1,531 – 3,679
Chronic Mortality (All ages) LYL median VOLY *	Life years lost	PM	232,569 – 559,052
Chronic Mortality (30yr +) deaths median VSL *	Premature deaths	PM	413,567 – 842,312
Infant Mortality (0-1yr) median VSL	Premature deaths	PM	2,990 – 6.090
Chronic Bronchitis (27yr +)	Cases	PM	19,001
Bronchitis in children (6 to 12 years)	Cases	PM	3,664
Respiratory Hospital Admissions (All ages)	Cases	PM	316
Respiratory hospital admissions (>64)	Cases	O3	42
Cardiac Hospital Admissions (>18 years)	Cases	PM	242
Cardiovascular hospital admissions (>64)	Cases	O3	192
Restricted Activity Days (all ages)	Days	PM	40,144
Asthma symptom days (children 5-19yr)	Days	PM	474
Lost working days (15-64 years)	Days	PM	15,779
Minor Restricted Activity Days (MRADs all ages)	Days	O3	4,571
Core median VOLY			**327,691**
Core mean VOLY			**657,913**
Core median VSL			**505,120**
Core mean VSL			**937,434**

Notes: * These rows represent alternative measures of the same effect on mortality, and hence are not additive.

The implementation costs of existing policy are given per sector in Table 41. Note that these are the costs for reducing pollution from a situation of no pollution mitigation at all, to the current pollution level. The pollution which would result from today's activity levels if there were no policy at all would be extremely high. The concentrations in such circumstances would be at least an order of magnitude higher than current concentrations, and although impacts are not linear over the whole concentration range, the impacts would also be several multiples of the current impacts.

Table 41: Pollution control costs for the baseline up to 2020 (EU28, M€)

	2010	2015	2020
Power generation	12700	12093	10711
Domestic sector	7476	9115	9629
Industrial combustion	2435	2468	2521
Industrial processes	4760	4983	5029
Fuel extraction	976	907	770
Solvent use	1638	1964	2140
Road transport	26022	34357	42023
Non-road mobile sources	1892	4320	6975
Waste treatment	0	1	1
Agriculture	1750	1775	1786
Total	59650	71983	81584

It can be seen that even on the most conservative valuation, the benefits of implementation of current policy hugely outweigh the costs. Despite the very substantial progress, the remaining impacts in 2010 still place a huge burden on society.

Enhancing the overall coherence of the principle TSAP instruments

Another principal efficiency related aim of the TSAP was to enhance the overall coherence of the main instruments put in place to achieve the TSAP objectives including the balance between Member State and EU action.

Whilst detailed comments are provided in the below sections relating to the respective instruments, the following areas for reinforcement of the strategy (and its underlying analysis) have been identified based on the public consultation for the TSAP review:

- A reinforced analysis of the impact of emission reductions (from source controls and national emission ceilings) on compliance with the AAQD air quality standards (it is now possible for the first time to model this at EU scale);[192]
- the interaction with other policies, in particular with the forthcoming climate and energy package;[193]
- the robustness of the proposed policy with respect to variations in the underlying analytical assumptions;[194]
- alternative instruments to those brought forward in 2005 (e.g. fiscal instruments); [195]

192 See next section for rationale; See also TSAP report #9, 'Modelling compliance with NO2 and PM10 air quality limit values in the GAINS model', IIASA 2013. This and all other reports referred to here are available on http://ec.europa.eu/environment/air/review_air_policy.htm, unless otherwise specified.

193 TSAP report #1, 'Future emissions of air pollutants in Europe – Current legislation baseline and the scope for further reductions', IIASA 2012, section on decarbonisation scenario impacts, pp43-48.

194 For an ex post analysis of the robustness of the assumptions made in the 2005 TSAP, see TSAP report #2 'Factors determining recent changes of emissions of air pollutants in Europe', IIASA 2012. For an assessment of the achievability of prospective future targets on alternative assumptions, see TSAP report #10, 'Policy Scenarios for the revision of the Thematic Strategy on Air Pollution' IIASA 2013 section 4.2 pp16-19.

- how action at Member State level can be supported and reinforced at EU level;[196]
- additional flexibilities in instruments compared with those assessed in 2005.[197]

3.6. Relation of the TSAP analysis to emission ceilings and ambient air quality targets

The TSAP modelling delivered as one of its direct outputs emission reduction objectives for SO_2, NOx, NMVOCs, ammonia and $PM_{2.5}$ not only for the EU as a whole but for individual Member States. These reductions took account of the transboundary impacts of the pollution concerned by determining the optimum spatial and sectoral profile of pollution reductions across Europe, so as to meet the desired health and environmental objectives. Thus the outcome of the modelling translated naturally into national emission ceilings for the various pollutants. The NECD had been adopted in 2001, and while it addressed human health impacts from ozone exposure, its main focus was on ecosystem impacts. The level of the ceilings set did not correspond to those required to meeting the 2005 TSAP objectives, and importantly, the Directive did not include a ceiling for $PM_{2.5}$. The TSAP proposed that these points be rectified by a revision of the Directive.

However, the relation of the TSAP and its associated modelling to the ambient air quality standards adopted was less direct. Those standards had been adopted based on scientific advice from the WHO, and on an assessment of the current levels of concentration and achievability of reduced levels.[198] The TSAP analysis was not optimised to achieve compliance with the air quality limit values, but rather to maximise the reduction in air pollution impacts across Europe. Nor was it possible to determine in detail the impacts of achieving the impact reduction objectives on compliance with the air quality standards, as the resolution of the model grid was too coarse (at 50x50km). The TSAP thus did not propose any adjustment to the limit values already adopted under framework and daughter directives on air quality, but did allow an extension of the timescale for meeting these values based on evidence that Member States had taken all possible action and still certain limit values were unlikely to be reached by the required deadlines.

4. THE AMBIENT AIR QUALITY DIRECTIVES

4.1. Objectives, scope and approach

Legislation on ambient air quality stems principally from the Air Quality Framework Directive 1996/62/EC. That Directive set out a framework for the establishment of ambient air quality standards and for air quality assessment, public information, and management with the aim of establishing a uniform minimum level of protection for human health and the environment. It also listed a set of key pollutants which had been identified as posing the most significant threats to human health and the environment. Standards for these pollutants were initially set in four subsequent ‘daughter’ Directives that were governed by the Framework Directive.

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195 JRC-IPTS 2013. Market based instruments to reduce air emissions from household heating appliances: Analysis of scrappage policy scenarios. To be published.

196 Addressed in: EEA Air Implementation Pilot ‘Lessons learned from the implementation of air quality legislation at urban level’, EEA report No 7/2013, available on http://www.eea.europa.eu/publications/air-implementation-pilot-2013; ‘Review of the Air Quality Directive and the 4th Daughter Directive, Service request no 6 under FW contract ENV.C.3/FRA/2009.0008. Final report 2012; ‘Final report of the PM Workshop Brussels 18-19 June 2012’ (service request 7 under FW contract ENV.C.3/FRA/2009/0008; ‘Services to assess the reasons for non-compliance with the ozone target value set by Directive 2008/50, and potential for air quality improvements in relation to ozone pollution’, Ecorys 2013.

197 The main two issues are offsetting for shipping NOx emissions and joint implementation for methane.

198 See Directive 1996/62/EC Annex 2, and Commission proposal for 1999/30 (COM(1997)500 final.

For SO_2, NO_2, PM_{10}, lead, benzene and carbon monoxide the standards were set as *limit* values, to be achieved everywhere; while standards for ozone were set as *target* values, in recognition of the difficulty in ensuring that the required concentration is met given the complex atmospheric chemistry involved in ozone production. The 4th Daughter Directive, 2004/107, covering heavy metals and polyaromatic hydrocarbons (PAHs), also established target values, on the basis that the desired concentrations of ambient air concentrations of arsenic, cadmium, nickel and polycyclic aromatic hydrocarbons (i.e. concentrations which would not pose a significant risk to human health) could not be achieved in a cost-effective manner in specific areas.[199] The implementation of target values does not require that measures entailing disproportionate costs be taken;[200] for an ambient air quality limit value, on the other hand, the obligation is binding as to the concentration to be achieved and Member States are obliged to put in place the necessary plans and programmes to reach compliance.

The 2005 TSAP was accompanied by a legislative proposal for amending the Ambient Air Quality Directives –eventually adopted as Directive 2008/50/EC. It significantly streamlined the legislation by merging the Air Quality Framework Directive and its first three daughter directives. It also included new flexibilities by introducing the possibility of time extensions for the PM_{10}, benzene, and NO_2 limit values originally established in 1999. New air quality standards were introduced for particulate matter ($PM_{2.5}$), based on the increasing evidence that health effects were dominated by long-term exposure to this pollutant. Finally, it called for further streamlining the existing implementing acts and further adapt them to reduce the administrative burden through making better use of electronic and automated data collection and processing technology. The latter consolidation was completed in 2011 through the adoption of the Commission Decision 2011/850/EU, consolidating and amending three implementing acts.

A particular innovation of Directive 2008/50/EC was to include a different kind of regulatory parameter for $PM_{2.5}$ in addition to the traditional ambient concentration: an average exposure indicator (AEI) designed to reflect the population exposure to $PM_{2.5}$ in an individual Member State, and with two related objectives.[201] The rationale was that there was no identifiable threshold below which $PM_{2,5}$ would not pose a risk, and so a mechanism was needed to prompt a general reduction of concentrations in the urban background to ensure that large sections of the population benefit from improved air quality. This would supplement the $PM_{2.5}$ limit value, the role of which is to ensure a minimum degree of health protection everywhere.[202]

Since the recent consolidation, ambient air quality standards are contained in the Directive 2008/50/EC and 2004/107/EC.

4.2. Monitoring, reporting and evaluation

The implementation of the ambient air quality standards is monitored according to specific provisions established in the relevant Directives and including provisions on zoning, the determination of the required assessment regime, criteria for location of sampling points (macro-scale and micro-scale

199 See Directive 2004/107/EC recital 3.
200 Ibid., recital 5.
201 A national exposure reduction target to be met by 2020 and an exposure concentration obligation to be met by 2015. See Annex IX of Directive 2008/50.
202 Directive 2008/50/EC recital 11.

siting), data quality objectives, reference methods for the assessment of concentration of pollutants, and the conditions under which modelling could be used in combination with fixed measurements.[203]

Data collection, quality assurance, and reporting of the resulting data is managed by the European Environment Agency (EEA). The EEA provides annually a consolidated report on implementation of the Directive.[204] Detailed data sets are maintained and publically available in the EEA's *Airbase*.[205]

It is noted that under the provisions of the new Decision 2011/850/EU a transition to electronic reporting compatible with the INSPIRE Directive will take place in 2014, allowing for further streamlined reporting and evaluation as well as enhanced public access to relevant air quality information.[206]

4.3. Relevance

The main issue of relevance for the Ambient Air Quality Directives is whether the pollutants regulated are indeed those of principal health concern, and whether the controls are set at the correct level. As part of the 2013 air policy review, the Commission asked WHO to carry out a review of the health effects of air pollution according to a series of questions identified in consultation with stakeholders.[207] Among the key questions were:

whether any developments in evidence would justify modifications to the emphasis on the main pollutants currently regulated (PM_{10} and $PM_{2.5}$, NO_2 and ozone), including:

- o whether any fractions of particulate matter should be regulated in preference to particulate mass;
- o whether new evidence affected the assumptions regarding a no-effect threshold for any pollutant;
- o whether the health evidence related to NO_2 indicated that it impacted directly on human health, or was a marker for some other component of air pollution.

- whether any parameters could be consolidated or deleted from the regulatory framework, or whether any should be added;
- which metrics, health outcomes and concentration-response functions could be used to assess the health impacts of PM, ozone and NO_2.

These questions covered all the main issues raised by stakeholders in the first public consultation.[208] The question of the independent health impacts of NO_2 was particularly important given (a) the widespread non-compliance with the NO_2 limit value and (b) the fact that while vehicle related PM pollution has been decreasing (due e.g. to implementation of the diesel particle filter), NO_2 concentrations have been stable and often above the EU AQ limit value, and in several places increasing levels.

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203 See e.g. Directive 2008/50/EC annexes I-VI.

204 The most recent being report No 4/2012, 'Air Quality in Europe – 2012 report'; see above for availability.

205 See http://www.eea.europa.eu/themes/air/air-quality/map/airbase.

206 Directive 2007/2/EC establishing an infrastructure for spatial information in the European Community.

207 WHO, 'Review of the impacts on health of air pollution', 2013. http://www.euro.who.int/en/what-we-do/health-topics/environment-and-health/air-quality/publications/2013/review-of-evidence-on-health-aspects-of-air-pollution-revihaap-project-final-technical-report

208 See report 'Survey of views of stakeholders, experts and citizens on the review of the EU Air Policy Part II: Detailed results.' In particular pp35-40.

The main conclusions from the WHO analysis are as follows:

- While there is some evidence linking particular sub-components of $PM_{2.5}$ with specific health impacts (for instance the sub-components related to primary combustion), the balance of evidence favours retaining $PM_{2.5}$ mass as the target for policy measures;[209]
- Evidence still supports the absence of a threshold for $PM_{2.5}$.[210] For ozone the evidence is inconclusive, but any threshold, if it exists, is likely to lie below 90 μg/m3.[211] (The EU target value is 120μg/m3.) Since 2005 there is new evidence indicating potential severe health impacts (premature mortality) of chronic exposure to ozone.
- Evidence indicates that there are independent effects of NO_2 on short-term health outcomes; the evidence for independent long-term effects is less clear-cut but still suggestive of a causal relationship.
- There are independent rationales for each of the current PM limit values.[212] In addition there is a potential rationale for a limit value on short-term average concentrations (as well as the current annual average).[213]
- Specifications on the metrics and concentration-response functions appropriate for health impact assessment were provided in this and the follow-up project (HRAPIE), and used in the ex-ante impact assessment for the new Strategy.[214] The recommendation was that air pollution health impact assessments should focus on chronic $PM_{2.5}$ exposure and acute ozone exposure, as in 2005, but that sensitivity analysis on chronic ozone impacts and chronic NO_2 impacts would also be warranted.
- While the parameters of the current legislation are all separately justified based on the health evidence, there is evidence indicating the need to revise WHO guidelines for PM, ozone (long-term exposure), NO_2 and SO_2.[215]

With regard to the level at which the EU limit and target values are set, with the exception of the NO_2 annual limit value these are less strict than the current WHO guidelines, and no values have been tightened since they were originally established. The WHO advised in particular that the levels at which the PM limit values are set are not sufficient to adequately protect human health.[216] Thus, even full compliance with the existing Ambient Air Quality Directive would be insufficient to protect human health: very substantial health impacts would remain.

The review also examined the levels at which controls are set for the substances regulated in the AAQD in the EU's main trading partners and the WHO guidelines. Appendix 2 sets out the levels established in the EU as compared with the WHO guidelines and the limit values in the USA, Japan, Switzerland, China, Korea, and India. The limit values set are broadly comparable to those of the EU even in emerging economies. For the health problem of most concern ($PM_{2.5}$), the USA limit value is substantially tighter than the EU limit (at 12 $\mu g/m^3$, as compared with 25$\mu g/m^3$ in the EU). For the pollutants for which compliance in the EU is most difficult, the following observations are made:

- NO_2 annual average: the limit in the USA is substantially higher (100$\mu g/m^3$ as compared with EU's 40$\mu g/m^3$), but China and India are the same and Switzerland is tighter (30$\mu g/m^3$).
- PM_{10} daily average: this is difficult to compare given the crucial role of the number of allowed exceptions. USA looks less stringent (at 150μg/m3 as compared with the EU's 50μg/m3), but (a)

209 WHO REVIHAAP report pp10-12, 182-183.
210 Ibid., pp38, 182-183.
211 Ibid., p59.
212 Ibid., p35.
213 Ibid., p32.
214 Ibid., pp41, 62, 117.
215 Ibid., ppp182-186.
216 Ibid., p83.

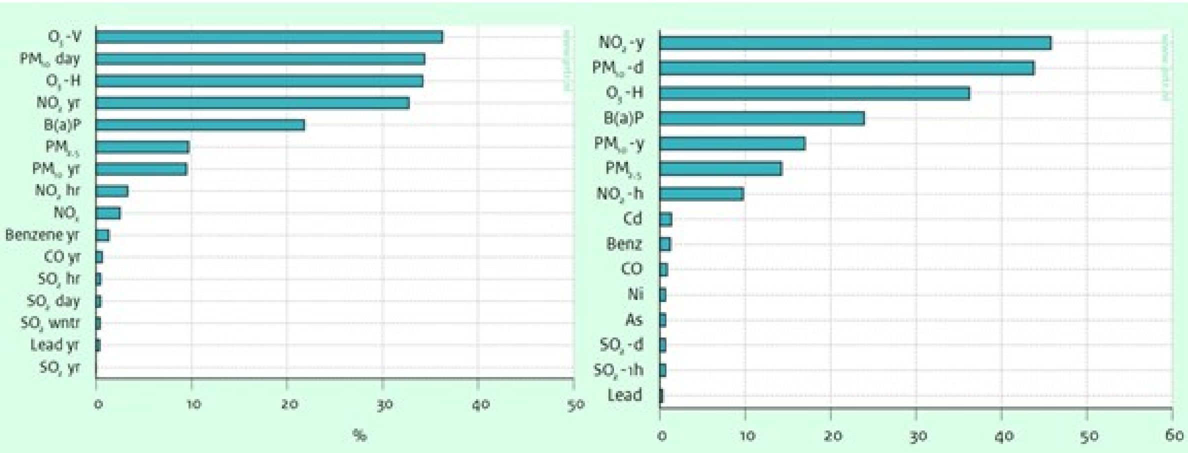
the USA strictly regulates the $PM_{2.5}$ sub-fraction of PM_{10} and (b) it allows only one day's exceedence a year as opposed to the EU's 35 days.

4.4. Effectiveness

The effectiveness of the AAQDs in achieving their objectives has been assessed in terms of the extent of compliance with the limit values set.

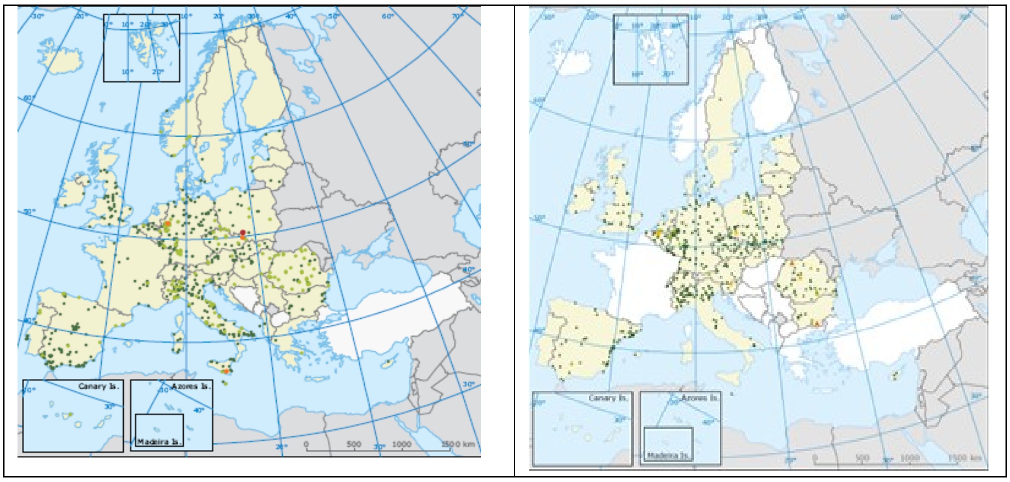
Figure 3 presents the summary compliance picture in graphical form. It shows the percentage of monitoring stations in exceedance of the limit or target values (left), and the percentage of the EU population potentially exposed to concentrations above those values (right).

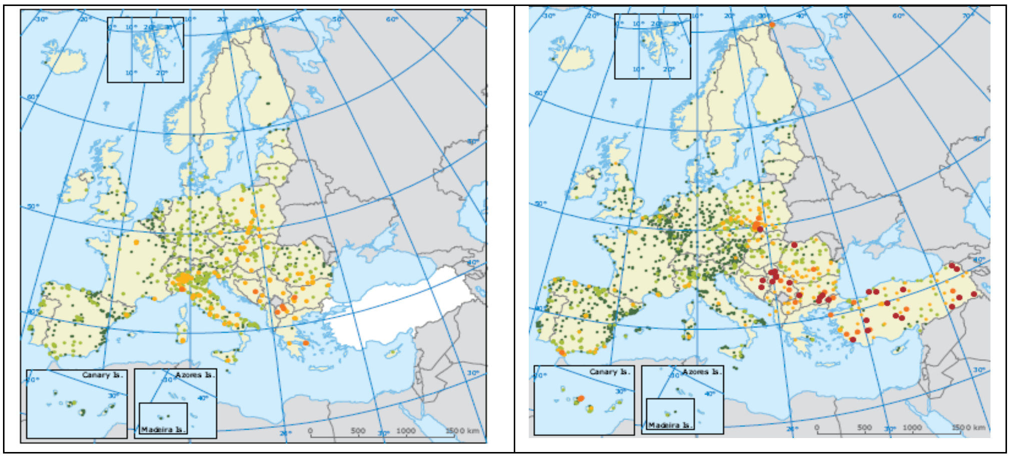
Figure 3: The 2010 AAQD Compliance and Population Exposure Picture (EEA)



Widespread compliance with the limit values for benzene, lead, CO, and SO_2 in the Directive has been achieved (Figure 4).

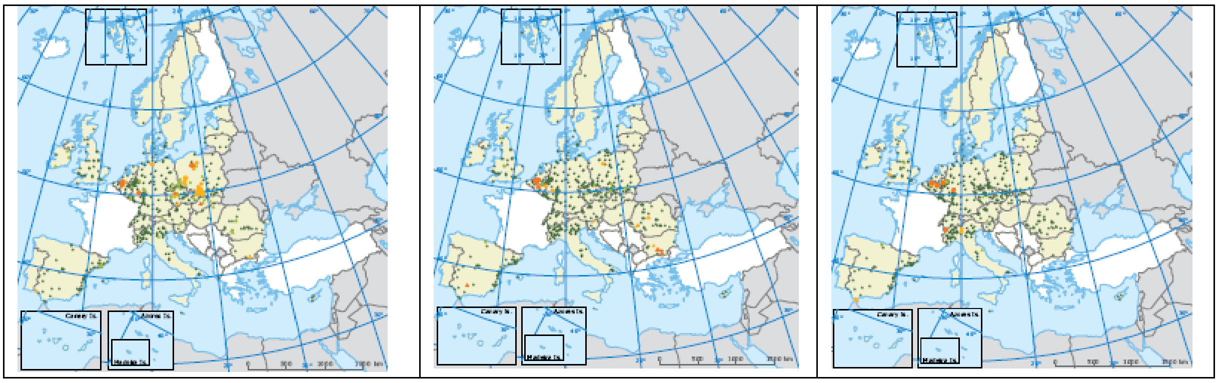
Figure 4: Status of compliance in 2010 with EU legally binding air quality standards for Benzene, Lead, CO, and SO_2 (clock wise from upper left onwards); EEA 2012





In addition, the non-binding target values for heavy metals (arsenic, cadmium, nickel) are also broadly complied with (Figure 5).

Figure 5: Level of compliance with non-binding target values for heavy metals (arsenic, cadmium, and nickel) in the EU

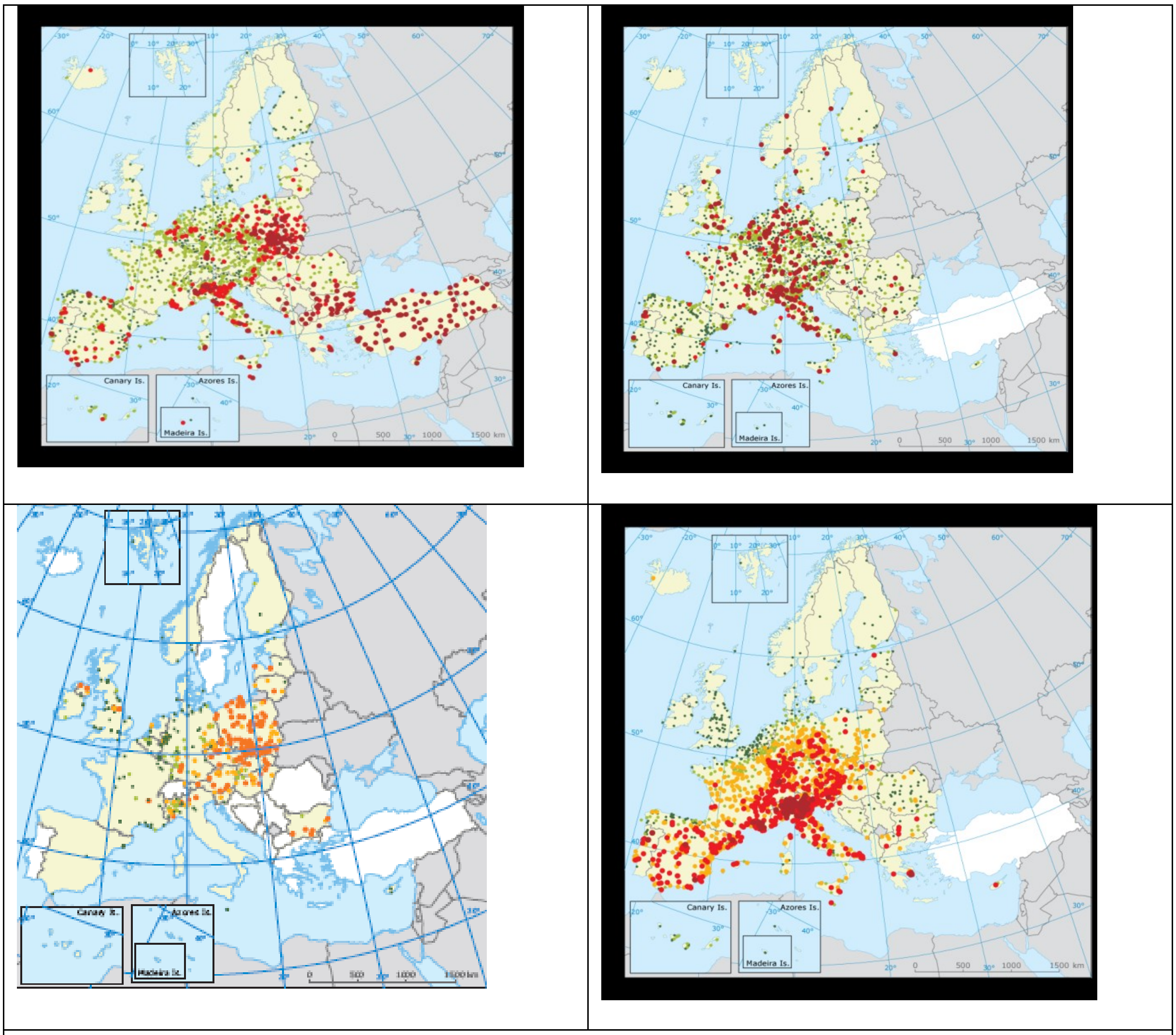


These successes have been mainly attributed to effective EU –level source controls including fuel quality measures (requiring the placing on the market of low-sulphur and unleaded fuels throughout the EU) and measures addressing large point sources such as the Large Combustion Plants Directive, the Waste Incineration Directive, and the Integrated Pollution Prevent and Control Directive, all now consolidated in the new Industrial Emissions Directive.

As shown in **Fehler! Verweisquelle konnte nicht gefunden werden.**, there remains however widespread non-compliance with the PM_{10} and the NO_2 limit values despite the time extensions provided in the Directive 2008/50/EC.[217] There is also widespread exceedance of the target value for benzo(a)pyrene (BaP, the marker for polyaromatic hydrocarbons), and the target value for ozone.

[217] For PM_{10} the daily limit value is the most demanding to meet; for $PM_{2.5}$ the the annual average limit value is the most demanding to meet.

Figure 6: Exceedance of EU air quality standards in 2010 for PM_{10}, NO_2, Ozone, and BaP (clockwise from upper right) in 2010 (EEA)



Dots represent individual monitoring stations; green dots indicate compliance with the standards, red dots exceedance.

For PM_{10}, infringement procedures have currently been launched against 17 MS. For NO_2, 18 MSs have requested time extensions up to 2015 in accordance with the time extension provisions in the Directive; taking into account the Commission's decisions on these requests, 18 MSs are currently in non-compliance with the NO_2 limit values. The enforcement options related to BaP and ozone are currently limited.

With respect to the new $PM_{2.5}$ standards introduced in 2008, the limit value of $25\mu g/m_3$ for 2015 is likely to be broadly complied with.[218] That standard is, however, less stringent than the PM_{10} daily limit value. Projections show that the Directive's indicative limit value for $PM_{2.5}$ of $20\mu g/m^3$ by 2020 is also likely to be broadly complied with, except in specific circumstances.

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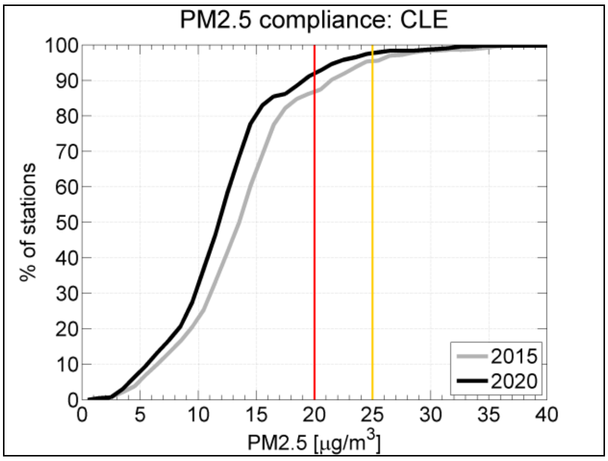
[218] In 2011, 17 MSs are already in compliance with the limit value, with a further 4 within the so-called margin of tolerance (indicating a sound trajectory towards compliance).

With regard to the $PM_{2.5}$ average exposure reduction objectives introduced in 2008, the first legal milestone is achieving the exposure concentration obligation of 20µg/m^3 in 2015 at the latest. Member States were asked to share their experiences with implementing the exposure reduction obligations, but there is little practical experience at this stage given that the first substantive obligation is for 2015, and it is too early to assess the effectiveness of the concept in delivering health impact reductions.[219]

Figure 7: Projected compliance with PM 2.5 limit values (2015 and 2020) assuming no change to current policies



Pollutant specific causes of non-compliance and outlook for improvements

Particulate Matter

The causes of non-compliance vary significantly depending on the pollutant and the national or local circumstances. The following is an assessment by pollutant of the main reasons for non-compliance.

Concentrated local pollution sources for PM are a problem mainly in large urban centres which are often densely populated, making the resulting health impacts particularly significant.[220] In most locations currently in exceedance of the PM standards, high PM concentrations are the compound effect of different sources that include traffic (notably older diesel vehicles, both heavy- and light-duty), domestic heating, industrial sources, power production and background concentrations including also secondary aerosols, i.e. emissions of PM precursors including SO_2, NO_x, VOCs and NH_3.[221]

Projections of the compliance picture assuming no changes to the current policy framework developed in Annex 5 show that by 2020, reductions delivered by implementation of current legislation will bring most stations situated in these "*normal*" areas into compliance.[222] For instance, the continued penetration of Euro 5 light duty vehicles and Euro VI heavy duty vehicles into the fleet will progressively reduce (primary) particulate matter in line with the stricter emission introduced by those Euro standards. Further PM emission reductions can also be expected in the period up to 2020 from robust pollution controls on other relevant sources such as industrial installations and the energy sector that have been regulated the recently revised Industrial Emissions Directive, including the

[219] See report, 'Review of the Air Quality Directive and the 4th Daughter Directive', RICARDO-AEA 2012, section 4.4.3 p64.

[220] E.g. some of the main population centres in Europe remain in non-compliance: Milan, Madrid, Barcelona, London and others.

[221] See EMEP country reports, 'Transboundary air pollution by main pollutants (S, N, O3) and PM in 2010' showing the extent of transboundary contributions to concentrations of those pollutants in all CLRTAP parties (including all Member States). All reports are available on: http://www.emep.int/mscw/mscw_publications.html; see for instance p19 of the Belgium country report for 2010 for the transboundary contribution to PM2.5 in BE (around 80%). BE report available on http://www.emep.int/publ/reports/2012/Country_Reports/report_BE.pdf.

[222] See Annex 5, section 5 for detail.

revision of the associated Best Available Technology Reference Documents and conclusions. As a consequence, implementation of current legislation will resolve most of the current compliance problems by 2020. (See also Annex 5).

However, this positive trend will not solve all non-compliance. Specific localised problems will remain related to special "*worst case*" circumstances that are particularly challenging to address at the local level. To identify the drivers responsible, the remaining areas of non-compliance were identified from the compliance modelling, and the reasons for non-compliance isolated, as follows.

Those are characterised by either (a) specific domestic solid fuel combustion issues, or (b) particularly concentrated local pollution sources, often combined with a particular topography.

- Domestic (household) solid fuel combustion has historically been a major driver of PM pollution in many Member States (for instance it caused the great London smog). Most Member States have restricted solid fuel use in response, but there are areas (notably the border region of PL, SK, CZ, and BG) where it remains the major pollution source. The required action has not been taken by the Member States in these regions mainly because the areas in question are often relatively poor, and the socio-economic impact of implementing the required restrictions is a deterrent. Pioneering initiatives have however been launched in a few locations, for instance Krakow.[223] The problem is not only continuing coal use, but also increase in biomass use, driven partly by renewables policy and (more recently) by the economic crisis which has caused some people to turn to wood burning and other forms of highly polluting and inefficient heating solutions. While action on the marketing and use of solid fuel combustion appliances will have an impact on the problem over time, the replacement rate of solid fuel installations is slow (and possibly even slower in low-income households), and open fireplaces will never be covered. Consequently, existing instruments such as the Ecodesign Directive,[224] which apply only to new products and do not affect existing installations, will not be sufficient; different approaches better adapted to specific local circumstances will be required.

- The problem is compounded in certain locations by a topography which limits effective dispersion of pollution, a factor that was explicitly recognised in Directive 2008/50/EC, which allowed time-bound flexibilities to deal with site specific dispersion characteristics. To reach compliance in such 'difficult' locations requires more comprehensive action than elsewhere on the relevant local pollution sources, to ensure that the economic benefits of the concentrated economic activity are not compromised by adverse health impacts.[225]

Further reductions in PM concentrations in the EU, beyond those required to achieve compliance with current air quality standards, will require reductions in background concentrations. This requires co-ordinated national and/or transboundary action on primary PM and on precursors. The lack of a primary $PM_{2.5}$ ceiling in the NECD, and of new stricter ceilings for PM precursors resulted in inadequate reductions in this regard. Also, the AAQD provisions on transboundary pollution problems (Art 25) are rarely used, and when used, ineffective.[226]

<u>Nitrogen Dioxide (NO_2)</u>

Type-approval emission requirements for motor vehicles have been tightened significantly through the introduction and subsequent revision of Euro standards. Figure 8 shows, however, that while

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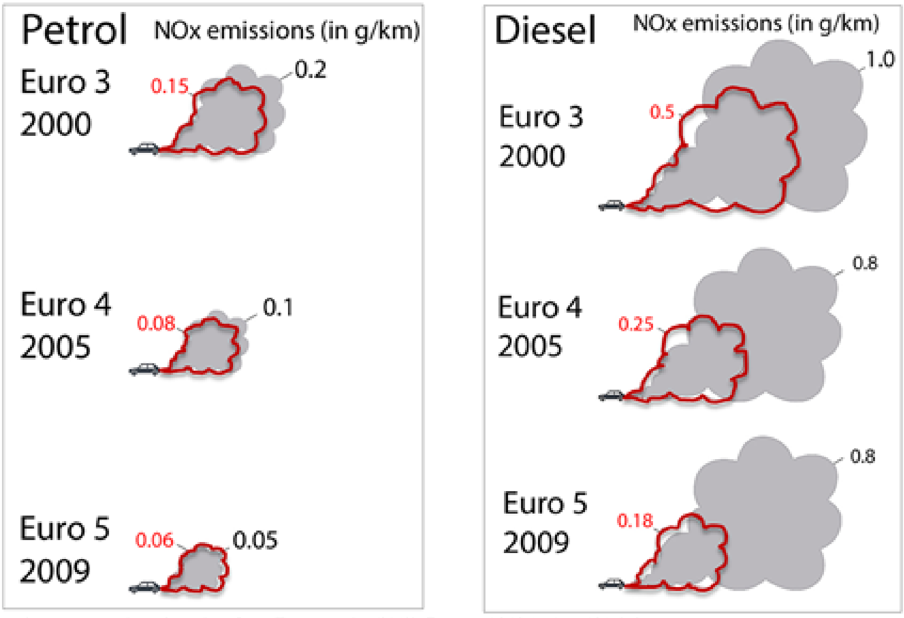
226 Few cases are known; DE made contacts with PL, and PL and CZ have had some contacts.

vehicles in general have delivered substantial emission reductions across the range of regulated pollutants, this is not true of NO_x emissions from diesel engines (especially light-duty vehicles).

Figure 8: Euro Emission standards and real world emissions for gasoline and diesel vehicles (ICCT, 2012)



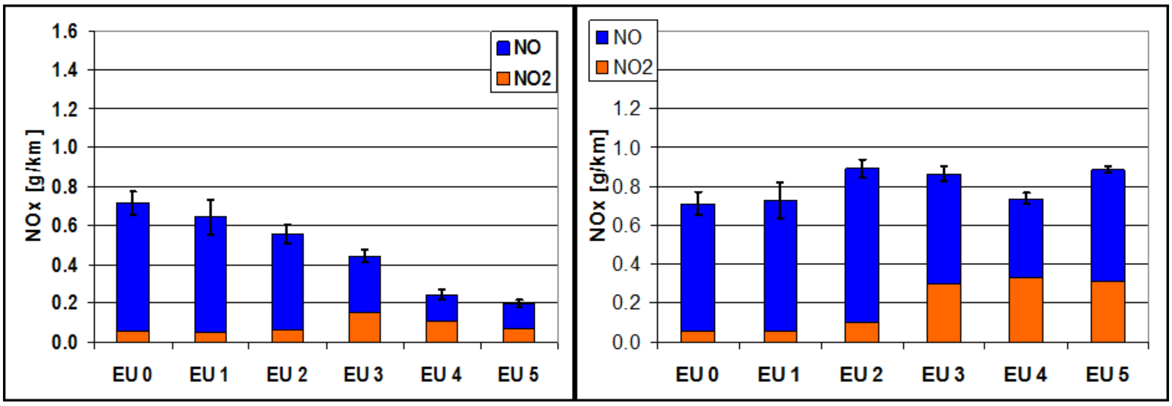
NO_x emissions of gasoline cars in the EU have decreased significantly since 2000, from about 0.2 grams per kilometer (g/km) to 0.05 g/km. This corresponds quite well with the Euro emission limits, which were adapted from 0.15 g/km to 0.06 g/km in the same time period. The Euro emission limits regulate how much specific pollutants, such as NO_x, may be emitted by a car when it is tested under laboratory conditions and using a specific driving cycle. In the case of gasoline vehicles, the NO_x emissions measured in the laboratory are fairly well in line with the level of emissions measured on-road, i.e., when driving the car under real-world conditions on a real road. This, however, is not the case for diesel cars. Diesel vehicles in the EU are allowed a much higher NOx emission level than gasoline cars. In 2000, when the Euro 3 standard was introduced, the allowed level was 0.5 g/km, more than twice as much as for gasoline vehicles. Yet, as vehicle tests show, even back then the real on-road emission levels were closer to 1.0 g/km, i.e., much more than actually allowed by the standard. Still, the vehicles received their type-approval and could be sold, as the Euro emission standards have to be met under laboratory conditions only. Over time, emission limits got stricter, and the current Euro 5 emission standard sets a limit of 0.18 g/km for NO_x diesel emissions. This is still more than three times as high as for gasoline vehicles, but of course much lower than back in 2000. However, research suggests that the on-road emissions did not really change at all during the last decade. The values measured are in the range of 0.8 g/km, only 20% lower than in 2000 and more than four times higher than allowed by the Euro 5 emission limit.[227]

[227] See for example the study carried out on on-road emission data from a by King's College London and the University of Leeds for the UK government. In total, emissions data from more than 80,000 vehicles were

The problem is due in part to the poor representativeness of the standardised test cycle used for type approval in the EU[228] and weaknesses of in-service conformity testing. Under the current regime an engine type has to meet the type-approval requirements when tested according to the test cycle, but under normal driving conditions the real emissions can be much higher.

Figure 9 shows that while the NOx emission limit values for diesel passenger cars have been tightened by approximately a factor of 4 from 1993 to 2009 (Euro 1 to Euro 5), the estimated average NOx emissions in real driving conditions have slightly increased. As a side-effect of engine technology developments, the share of direct NO_2 emissions in the NOx mixture has increased at the same time, posing additional challenges for the attainment of the NO_2 air quality standards.

Figure 9: type approval (left) and real-world emissions (right) from diesel light duty vehicles across Euro standards (source: COPERT analysis and IIASA[229])



While this has been observed for several years, many Member States continue to promote the sale and use of diesel vehicles compared to gasoline and other cleaner fuel vehicles. The consequences of the less than hoped for effects of the vehicle standards relating to diesel passenger cars and light-duty vehicles have been exacerbated by national taxation policies favouring diesels and increasing traffic volumes in urban areas (see also governance issues)[230].

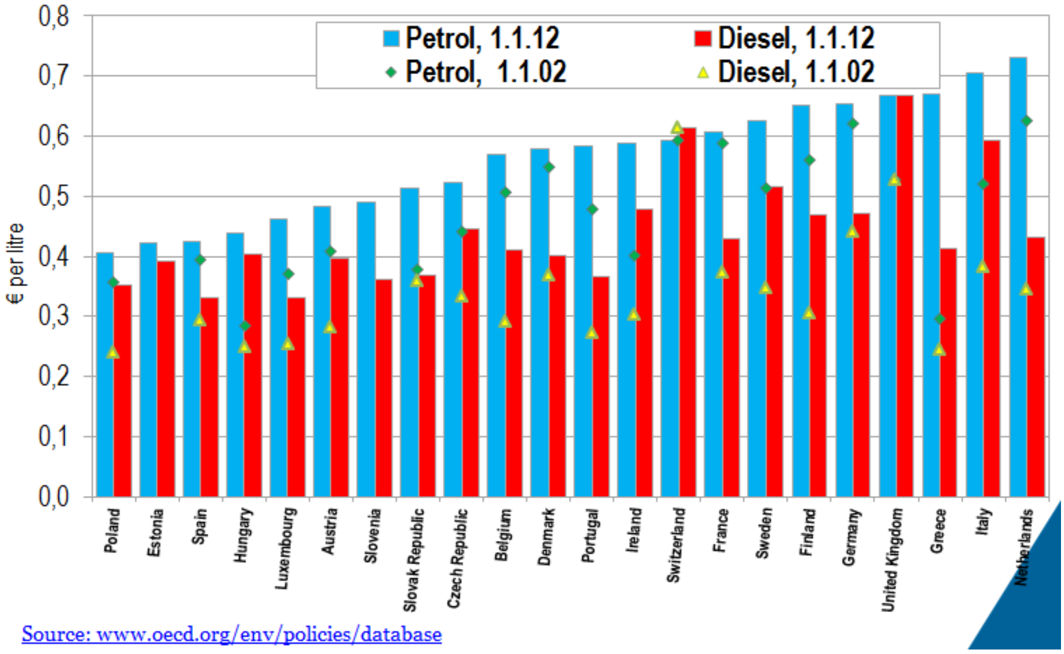
analyzed, and the authors conclude: “In the case of light duty diesel vehicles it is found that NO_x emissions have changed little over 20 years or so over a period when the proportion of directly emitted NO_2 has increased substantially”.

228 The New European Driving Cycle (NEDC).

229 https://circabc.europa.eu/sd/d/2f169597-2413-44e2-a42c-35bbbde6c315/TSAP-TRANSPORT-v2-20121128.pdf

230 See also OECD, 2013

Figure 10: Fuel tax rate comparisons in the EU and CH in 2002 and 2012 (OECD, 2012)



Source: www.oecd.org/env/policies/database

Sustained high levels of NO_x emissions and NO_2 concentrations are particularly related to these emissions and the associated AAQD and NECD compliance issues.

Ground-level ozone

For ground-level ozone, there has been significant reduction in ozone precursor emissions since 1990, and this has been mirrored by a general trend towards lower peak values for severe ozone episodes.[231] However, there is no corresponding downward trend in background concentrations.[232] A significant part of this discrepancy is likely to be due to hemispheric transport of ozone which is substantially influenced by methane emissions across the northern hemisphere (methane has a long atmospheric lifetime and influences ozone concentrations at substantial distances from the point of emission).[233]

Poly-Aromatic Hydrocarbons and BaP

For BaP the exceedance is largely due to domestic biomass combustion and thus is linked to the drivers of PM exceedances.[234]

4.5. Efficiency

In addition to the above pollutant- specific drivers of non-compliance, several governance related problems that affected the efficiency of the AAQD emerged from the review.

231 See 'Services to assess the reasons for non-compliance with the ozone target values set by Directive 2008/50', Ecorys 2013, pp15-19. See also the EEA's annual ozone report on http://www.eea.europa.eu/publications/air-pollution-by-ozone-across-EU-2012.

232 Ibid.

233 EEA report 4/2012, 'Air Quality in Europe – 2012 report', p11.

234 Ibid p14 and Chapter 8.

The AAQD works through the development of action plans at local and regional level designed to achieve compliance with the concentration limits by the relevant deadlines.[235] This reflects the "subsidiarity" principle, i.e. that action should be left to the Member States where it is most cost-effective do so.

In practice, many Member States have relied substantially on EU source control measures whilst evidence from the time extension notification[236] process under the AAQD 2008/50/EC shows that authorities often acted late in relation to the lead time necessary to bring air pollution down in "local" hotspots, with many plans and programmes developed only as the compliance deadlines approached and not fully implemented in practice. [237] In many cases responsibility for meeting ambient air quality standards rests at regional and/or local level, but the financial and other tools to meet those responsibilities are often lacking.

Late or insufficient action often relates to the fact that local action was not sufficiently supported by action in surrounding zones or at the national level, or in some cases between Member States to address transboundary pollution.[238]

Part of the problem is also related to the lack of the assessment and management capacity to develop, implement and monitor plans. For instance, local authorities have been unable to design effective air quality plans because no adequate inventories of the contributing local sources have ever been developed. In some cases, capacity has been further reduced in the wake of the economic crisis, including at the national level.[239]

The efficiency of the Directive 2008/50/EC in driving local action has nevertheless improved over time, as effort on enforcement at EU level has intensified. As a result, good practices have been emerging (see also section 7).

5. THE NATIONAL EMISSION CEILINGS DIRECTIVE

5.1. Objectives, scope and approach

The National Emission Ceilings Directive 2001/81/EC aims at controlling transboundary fluxes of air pollution for the purpose of meeting in a cost-effective way, air pollution impact objectives for acidification, eutrophication and the health and environmental impacts of ozone. It does so by setting ceilings on total national emissions of four pollutants (SO_2, NO_x, non-methane VOCs and NH_3) which are to be complied with by 2010 and thereafter.

The NECD covers all emission sources on the territory that constitute the national totals. They include all land-based sources and inland waterway and national maritime navigation, but the large emissions

[235] For more detail see EEA report 7/2013, ‘Air Implementation Pilot’, p37.

[236] The possibility under Directive 2008/50/EC (Article 22) for Member States to notify a postponement of the attainment deadlines for particulate matter (PM10), nitrogen dioxide and benzene, under certain conditions and subject to approval by the Commission.

[237] Internal assessment based on analysis of Time Extension Notifications.

[239] From exchange of views with national and local competent authorities.

associated with international maritime traffic are excluded.[240] Aviation emissions are included only for the relatively minor shares associated with the take-off and landing phases, while the larger emissions occurring during cruise are excluded.

The 2005 TSAP announced a revision of the NECD to set new ceilings for 2020 in line with the objectives set in the Strategy for those pollutants already regulated, plus primary particulate matter ($PM_{2.5}$) which is not regulated in Directive 2001/81/EC. The proposal for revision was finalised by the Commission services in 2008, but not adopted by the College.

5.2. Monitoring and Evaluation

The Directive requires Member States to calculate and report emission inventories and projected emissions for 2010 according to the methodologies specified under the LRTAP Convention. Reports were to include emission projections for 2010 including information to enable a quantitative understanding of the key socioeconomic assumptions used in their preparation.

The EEA annually establishes compiled emission inventories and projections on the basis of information reported by Member States. The information is publicly disseminated on the EEA's website both as data files, core environmental indicators and in online data viewers.[241] In addition, the EEA annually publishes technical reports including its assessment of the progress being made towards the implementation of the NEC Directive. [242]

5.3. Relevance

A review of evidence has confirmed the continued importance of ozone impacts, and ecosystem impacts from eutrophication and acidification, among the problems caused by air pollution,[243] and as commented above for the TSAP, successive reviews of the science underlying those problems have confirmed that the pollutants addressed in the NECD are indeed main problem drivers.[244] The approach of the NECD, to cap transboundary flows of air pollution by setting national ceilings, remains relevant to address the continuing evidence that very substantial proportions of pollution concentrations in many Member States are due to transboundary pollution[245], and to bring down the background concentrations that affect the prospects of achieving the ambient air quality standards. [246]

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240 To be precise, they are excluded from the emission ceilings, although not from the obligation to establish inventories.

241 http://www.eea.europa.eu/data-and-maps/data/data-viewers/emissions-nec-directive-viewer and http://www.eea.europa.eu/data-and-maps/indicators/#c5=agriculture&c7=all&c0=10&b_start=0.

242 See 2012 report on http://www.eea.europa.eu/publications/nec-directive-status-report-2012/at_download/file.

243 WHO Review of Evidence on Health Aspects of Air Pollution, 2013. Available on http://www.euro.who.int/en/what-we-do/health-topics/environment-and-health/air-quality/publications/2013/review-of-evidence-on-health-aspects-of-air-pollution-revihaap-project-final-technical-report.

244 For an in-depth assessment of eutrophication and its underlying causes see *the European Nitrogen Assessment: Sources, Effects and Policy Perspectives*, Sutton, M A et al, Cambridge University Press 2011; for an in-depth assessment of the health impacts of air pollution and their underlying causes see the *Review of Evidence on the Health Aspects of Air Pollution,* WHO/Europe 2013 (see above or Annex 1 for ref.)

245 See EMEP country reports, 'Transboundary air pollution by main pollutants (S, N, O3) and PM in 2010' showing the extent of transboundary contributions to concentrations of those pollutants in all CLRTAP parties (including all Member States). All reports are available on http://www.emep.int/mscw/mscw_publications.html; see for instance p19 of the Belgium country report for 2010 for the transboundary contribution to PM2.5 in BE (around 80%). BE report available on

However, the 2001 NECD does not explicitly address the health impacts of particulate matter, which was identified by the 2005 TSAP as the major health problem from air pollution in the EU (and confirmed as such by the current analysis).[247] While all pollutants regulated under the NECD are PM precursors, and so NECD reductions will influence PM concentration levels, the level of the ceilings in question was not determined on the basis of the required reductions in PM. Furthermore, the NECD includes no emission ceiling for primary particles. Such a ceiling was scheduled for introduction in the 2008 revision, along with tightening of the other ceilings for 2020.

A further issue is whether and how to regulate air pollutants which are also Short-Lived Climate Pollutants (black carbon and methane) under the NECD. For technical reasons[248] a separate ceiling for black carbon is currently not appropriate, but special attention to measures to limit black carbon emissions when designing national programmes for PM2.5 compliance, as agreed in the amended Gothenburg Protocol, would be sensible. Hemispheric methane emissions are a determining factor for background ozone concentrations, in addition to their climate forcing role.[249]

Thus there is a need to amend the NECD for the purpose of transposing the international obligations agreed under the Gothenburg Protocol of the LRTAP Convention, and also a case for considering an additional ceiling related to methane.

5.4. Effectiveness

The emissions ceilings have broadly been attained. Member States (EU27) reported for 2010 emissions breaches for in total 17 of the 108 ceilings, and the EU-wide emission ceilings (a combination of all Member States ceilings) were reached, except for a relatively limited exceedence of the NOx ceiling. Green bars and negative figures signify overachievement of the emission reduction objective; orange bars and positive figures signify exceedances.

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http://www.emep.int/publ/reports/2012/Country_Reports/report_BE.pdf.. For stakeholder comments on the importance of regulating transboundary pollution, see ‘Survey of views of stakeholders, experts and citizens on the review of the EU Air Policy: Part II’, p63.

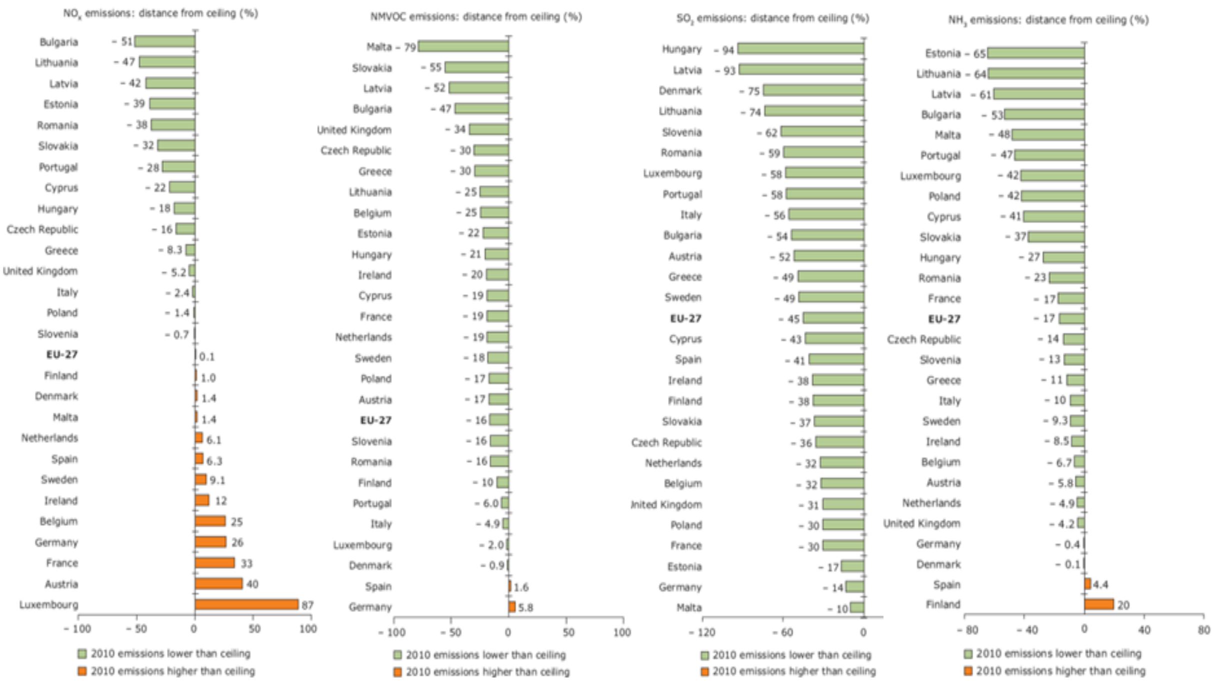
246 See for instance report on ‘PM Workshop Brussels 18-19 June 2012’, pp 5-6, 9,

247 See section 3.2.1 of the main Impact Assessment.

248 The need to introduce an inventory methodology. See report, 'Services to support the update of the EMEP EEA Emission Inventory Guidebook, in particular on methodologies for black carbon emissions', Ecorys 2013.[to appear on the EEA website within short]

249 For the impact of hemispheric methane emissions on ozone concentrations, see the Executive Summary of the LRTAP Task Force on Hemispheric Transport of Air Pollution (HTAP) 2010, p3 point 10 (report available on http://www.htap.org/). For the impact of methane on climate forcing, see the UNEP Synthesis Report, ‘Near-term climate protection and clean air benefits: actions for controlling short lived climate forcers’, UNEP 2011, Chapter 2 p3. Report available on http://www.unep.org/publications/ebooks/slcf/.

Figure 11: NECD Compliance Picture Related to 2010 Member State Obligations (EEA, 2012)



The extent to which action was driven specifically by the NECD varies by pollutant. This discussed in the section below dealing with source control measures.

The non-compliance issue is much smaller than for the AAQD. It relates mainly to the NOx ceilings, where nine Member States reported 2010 emissions that were above the ceilings.[250] In most cases, the less than expected emission reductions of the Euro standards for diesel vehicle NOx emissions have contributed to this situation.[251] The Commission launched a contract to identify the reasons for non-compliance with the ceilings. It concluded that for the vast majority of non-compliance cases, compliance could be achieved in a reasonable timescale with the appropriate effort from the Member States.[252]

The main message from the stakeholder consultation was that the NEC Directive is an effective instrument to bring down transboundary emissions, especially if the ceilings are supported by source legislation at European level, where cost-effective, and by identifying those national source controls which should contribute substantially towards achievement of the ceilings.[253]

As well as the NECD annual status report, the EEA produced a review of the overall achievements of the NECD in 2012 (the emissions data for the compliance year 2010 was available).[254] In performing an assessment of the progress made by the Directive in reducing harm caused by air pollution, the

250 In 2011 only 8 MSs are in breach, and the number of ceilings breached is lower than in 2010 (down to 11, from 17). See EEA 2012 report, op. cit.

251 Ref to IIASA report indicating how compliance with NEC ceilings depends on Euro emissions.

252 Specific contract, 'Services to assess the reasons for non-compliance with the emissions ceilings set in the National Emissions Ceilings Directive'. Final report pending; will be published on the review website http://ec.europa.eu/environment/air/review_air_policy.htm.

253 See 'Survey of views of stakeholders, experts and citizens on the review of the EU air policy Part II', p80 point 3.

254 See EEA report No 14/2012, 'Evaluation of progress under the EU National Emission Ceilings Directive', available on http://www.eea.europa.eu/publications/evaluation-progress-nec-2012.

EEA took account of advances in scientific knowledge since the Directive's adoption in 2001, such as updates in emission inventories, improvements in dispersion modeling (including a finer resolution), and refinements of the critical load thresholds needed to protect ecosystems from harm.[255] It did so by employing two approaches in assessing the progress achieved toward meeting the interim environmental objectives: one assuming the science available at the time of adoption; the other using current science. The report concluded that in some cases the emission reductions achieved under the NECD have been insufficient to reach the Directive's environmental objectives, because the reductions estimated on the basis of the science of 1999 underestimated the reductions that were actually needed.[256] However, the NECD had been broadly successful in its own terms, in that the reductions and objectives agreed in 2001 had been broadly achieved in practice.

5.5. Efficiency

The NECD requires that Member States draw up and implement national programmes to meet the emission ceilings, which should be revised if projections show that the ceilings are unlikely to be met. An ex-post review of the efficiency of the national programmes[257] showed that:

- the programme design was often suboptimal and in some cases the national measures were inadequate to meet the ceilings.
- the structure and organisation for the preparation of programs varied across the Member States although the Commission services had prepared recommendations and guidance for that purpose[258] and did often not secure public participation in the process nor a commitment of the national governments to implement the proposed measures.
- the reporting from the Member States on their programs was incoherent and did not allow an effective review of the programs at the EU level to secure that the environmental and health objectives were met by the target year 2010. [259]

With regard to the assessment framework, the inventories used for assessing compliance were highlighted as an issue. Reporting obligations are inconsistent with international requirements, but also the quality of the inventories requires improvement.

Two key reasons for the quality issues are:

Limited inventory review process and resources allocated. The effort on inventory review for the NECD has been limited and depends on the reviews by the LRTAP Convention. Resources are limited also because there are no provisions in the NECD for a detailed in depth inventory review. Nor are there provisions for following through adverse findings by Commission (and EEA). Active engagement with Member States would be needed to develop solutions based on training, capacity building, technical assistance programmes etc. Finally, there is no possibility to sanction incompleteness such as a provision authorising the Commission/EEA to complete any missing submissions for particular sectors or regions. (Such a provision has proven in the context of greenhouse gas reporting to offer a strong incentive for Member States to provide their own data.)

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255 Ibid., pp5-6 and Chapter 2.

256 Ibid., pp7-10..

257 Report, 'National Emission Ceilings Directive Review Task 1: In-depth analysis of the NEC national programmes', Entec UK, 2005. Available at: http://ec.europa.eu/environment/air/pollutants/pdf/final_report.pdf.

258 See http://ec.europa.eu/environment/air/pdf/recs_national_programmes.pdf

259 See summary report of above Task 1 (and the other review tasks): 'National Emission Ceilings Directive Review: Project Summary and Conclusions', Entec 2005, pp6-7. Available at: http://ec.europa.eu/environment/air/pollutants/pdf/recs.pdf.

- *Limited guidance for developing local emission inventories.* The Air Implementation Pilot[260] demonstrated the need for guidance to address the present situation where local emission inventories are developed independently from national emission inventories. The lack of detailed local emission inventories has caused delays in developing appropriate air pollution management programmes (e.g. for measures reducing pollution from domestic heating) whilst hampering comparison and exchange of good practice across local authorities.

The second point on the assessment regime is that there is currently no legal basis requiring systematic monitoring in the EU of the ecosystem impacts of air pollution. Again this is inconsistent with international obligations, and it compromises the prospects for any review of the environmental effectiveness of EU and international policy.

6. EU SOURCE CONTROL MEASURES

6.1. Objectives, scope and approach

As stated above, the principle of the AAQDs and NECD is that while the EU should set the standards and ceilings, Member States are best placed to determine the pollution reduction measures needed to achieve them. However, source control measures at EU level are an essential reinforcement to the ceilings and standards in two respects. First, emissions from products placed on the common EU market contribute substantially to air pollution problems and these must be regulated at EU level (e.g. light- and heavy-duty road transport, non-road mobile machinery, etc). Second, for a range of other pollution sources the co-legislators have determined also that control of emissions at source at EU level is appropriate (for instance the Directives recently consolidated into the Industrial Emissions Directive 2010/75/EU). There is now a substantial *acquis* of source control legislation in the fields of transport, energy, industrial emissions and (to a much lesser extent) agriculture. A (non-exhaustive) list of relevant source controls is provided in Appendix 5.

The approach taken in this review was to assess the effectiveness of the source legislation in controlling emissions relevant to the achievement of the air policy objectives, and in particular to assess progress against the proposals of the 2005 TSAP regarding source legislation (see next section). A detailed review of the success of each instrument in its own terms is beyond the scope of this exercise: source policies normally have objectives which go beyond the reduction of air pollution and a comprehensive review would normally be carried out when the source policy itself was reviewed.[261]

Although we have assessed the financial impact by sector of implementation of the *acquis*, both historically and projected to 2030 (see Table 41 below), we have not assessed the cumulative impact on particular sectors of the air quality policy in combination with other environmental policies. That is also beyond the scope of this exercise, and would normally be taken up in 'fitness check' exercises for individual sectors.

With regard to source controls, the 2005 TSAP proposed:

- for industrial installations, to examine options to streamline existing legislation. This resulted in the Industrial Emissions Directive (IED) adopted in 2010 which consolidated seven Directives;

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260 Reference: http://www.eea.europa.eu/publications/air-implementation-pilot-2013
261 See for instance the Impact Assessment accompanying the proposal for an Industrial Emissions Directive, SEC(2007)1679.

- for smaller combustion plants, to examine a lower threshold (below 50 MW thermal input) for combustion installations under the IPPC directive, harmonisation of technical standards for domestic heating and fuels (Ecodesign Directive), and energy efficiency for buildings (Energy Performance of Buildings Directive and the Energy Efficiency Directive);
- for transport, additional pollution controls for car and truck emissions (Euro 5 and Euro VI), and a range of transport initiatives which were later reflected in the 2011 Transport White Paper (proposals on infrastructure charging, guidance on externalities charging, green procurement, etc.);
- for VOC management for petrol stations, so-called Stage II petrol vapour recovery controls (Directive 2009/126/EC);
- for international shipping, a request for a mandate to negotiate tighter shipping fuel and emission standards at the IMO / MARPOL level, which resulted in the recent revision of the Sulphur Content of Fuel Directive (Directive 2012/33/EU);
- for energy, no measures were proposed beyond already planned Commission initiatives (indicative Renewable Energy targets and minimum targets for the share of biofuels);
- for agriculture, an integrated approach to nitrogen management, which has so far not been adopted; the potential positive impacts from the 2003 CAP reform and the Rural Development Regulation 2007-13 were also highlighted;
- for EU funding, promotion of the available possibilities in the Cohesion Policy 2007-13, principally measures to support sustainable transport and energy; and
- international initiatives within the UNECE LRTAP Convention on hemispheric transport of air pollution which culminated in the revision of the Gothenburg Protocol in May 2012.

6.2. Monitoring, reporting and evaluation

Monitoring, reporting, and evaluation provisions for EU source controls are defined and carried out in accordance with the provisions applying to the individual instruments. In addition, however, periodic assessments are undertaken by the EEA which also maintains a set of sustainability indicators tracking the contribution of key sectors such as transport and energy to air pollution in the EU.

6.3. Relevance

As an indicator of the extent to which source legislation has contributed towards the total emission reductions required by air policy, Table 7 below summarizes the contribution of EU versus national source legislation towards compliance with the NECD ceilings for the four regulated pollutants. [262]

Table 7: EU versus National actions driving compliance with the NECD

Pollutant	Main drivers of action
SO_2	Action was driven mainly by emission control measures for large combustion plans, mainly in the Large Combustion Plants Directive 2001/80/EC (LCPD), the application of Best Available Techniques (BAT) in accordance with the IPPC Directive 2008/1/EC, the Sulphur Content of Liquid Fuels Directive 99/32/EC and the Fuel Quality Directive 98/70/EC.
NO_x	Action was driven in roughly equal proportions by: - the LCPD and the IPPC Directive

262 Assessment by DG ENV based on the EEA SOER 2010 Air Thematic report pp31-37 (available on http://www.eea.europa.eu/soer/europe/air-pollution) and the EEA report 14/2012 on evaluation of progress under the NECD (http://www.eea.europa.eu/publications/evaluation-progress-nec-2012). See also the two reports 'Review and evaluation of national programmes 2002' (Entec UK 2005), and, 'Review and evaluation of national programmes 2006', AEA Energy and Environment, 2008). Available on http://ec.europa.eu/environment/air/pollutants/rev_nec_dir.htm.

	- the Euro vehicle standards - national and local action in NECD national programmes
NMVOCs	Action was driven largely by the Solvents Directive 1999/13/EC, the Paints Directive 2004/42/EC and the Petrol Vapour Recovery I (94/63/EC), and the IPPC Directive, and by EU and national labelling schemes to reduce VOC content in household products. At the national level, action on limiting use of solvents for in small and medium size enterprises was particularly important.
NH_3	The IPPC (for large scale pigs and poultry farms) and the Nitrates Directive (indirect effects e.g. due to thresholds for manure spreading) plus complementary national action going beyond the minimum requirement of the IED (scope and manure management), in particular aiming at meeting the NECD NH_3 ceilings.

The principal industrial, agro-industrial and power sector emissions contributing to air quality are regulated through the IPPC Directive 2008/1/EC[263] and the accompanying "sectoral" directives. From January 2014, these directives[264] will be replaced by the Industrial Emissions Directive 2010/75/EU (IED), which will tighten the requirements to apply Best Available Techniques (BAT) and set more stringent emission limits for large combustion plants.

Emissions from small (< 1 MW) and medium (1-50 MW) combustion plants have so far not been regulated at EU level. Plants under 1 MW capacity can only realistically be controlled through product legislation, which strongly motivates measures at EU level. The forthcoming Ecodesign measures on central heaters (up to 400 kW, including gas and oil boilers, the so-called Lot1), solid fuel central heaters (up to 1 MW, fueled by biomass or coal, Lot 15) and local room heaters (up to 50 kW, including appliances fired by gas, oil, biomass and coal, Lot 20) will partially cover this category. These Ecodesign measures do not address industrial or agricultural applications of such capacity, and it is not yet clear what a possible future Ecodesign measure for industrial ovens and furnaces (Lot 4) would cover. Moreover, Ecodesign requirements only apply to new installations placed on the market and do not cover existing installations so it will in general take about an average appliance lifetime of 15 years before more or less the whole stock complies through replacement. In any case there is a remaining gap in legislative coverage at EU level between 1 and 50 MW capacity, with significant potential for cost-effective emission reduction. An analysis was done on the potential contribution of Ecodesign measures to reduction of air pollution and the conclusions thereof are integrated into the main impact assessment.[265]

For road transport the main pollutant emissions relevant for air quality are in principle controlled by the EU legislation. [266] For Non-Road Mobile Machinery (NRMM) Directive the priority pollutants are addressed but there are gaps in the scope of the legislation which are being addressed in the

263 Codified version; originally 96/61/EC.
264 With the exception of the Large Combustion Plants Directive, which is repealed from January 2016.
265 TSAP report #5, 'Emissions from households and other small combustion sources and their reduction potential', IIASA 2012.
266 Regulation 715/2007/EC for light passenger and commercial vehicles; and Regulation 595/2009/EC for heavy duty vehicles.

current revision.[267] For inland waterway transport, the principal air emissions are not effectively taken into account by the NRMM Directive. The directive still allows for high PM and NO_x emissions, the impact of which is worsened by the long life span of the engines (up to 40 years). These ships are often navigating in near-urban areas and close to highly trafficked roads, adding to road pollution. The same reasoning holds for diesel trains, railcars and locomotives.

For international shipping, regulation proceeds through emission controls agreed at IMO which are then implemented at EU level. EU legislation to date has focused on implementing the internationally agreed provisions on sulphur content of liquid fuels; but IMO provisions on emissions of nitrogen oxides and particulate matter are also important and have not been addressed in the EU.[268]

Ammonia emissions decreased by less than 10% from 2000-2010 and are projected to remain at today's levels to 2020 and beyond. Agriculture is responsible for 90% of the burden and is the primary driver of eutrophication in Europe.[269] There is little EU source control of agricultural air emissions. The IED covers 20% of pig production, 60% of poultry and excludes cattle and other animals. The Nitrates Directive covers pollution to air only indirectly. Moreover, there is large variation in Member State controls, ranging from practically nothing to extensive national regulation. There is a large untapped potential to achieve significant and cost-effective emission reductions (around 30% for 2025), and many of the measures bring benefits to farmers, as they improve overall nitrogen efficiency and creates a playing level field for actors in agriculture. Many will also have climate co-benefits, by reducing nitrous oxide emissions (N_2O), a powerful greenhouse gas.[270]

6.4. Effectiveness

For large industrial installations, which still account for a considerable share of total emissions, the IPPC Directive and in particular the "sectoral" directives on large combustion plants, waste incineration and VOC emissions due to solvents use have successfully reduced emissions from the main polluting industries.[271] The implementation of the IED, in particular for large combustion plants, will contribute substantially to further reductions.

For road transport, Euro 5 (passenger cars and light duty vehicles) and Euro VI (heavy duty vehicles) emission requirements were implemented as scheduled in the type approval legislation for motor vehicles, with the European Parliament adding Euro 6 and VI in negotiations. The Euro standards have proved successful in reducing real-world emissions of particulate matter from road transport in line with the legislation. For petrol vehicles the same is true for NO_x emissions, but for diesel vehicles, real-world NO_x emissions are substantially higher than the limit values specified in the type

[267] See website on review of Directive 97/68/EC on http://ec.europa.eu/enterprise/sectors/mechanical/non-road-mobile-machinery/publications-studies/index_en.htm
[268] See report, ‘Specific evaluation of emissions from shipping including assessment for the establishment of possible new emission control areas in European Seas’, VITO 2013, pp5-7.
[269] TSAP report #3, ‘Emissions from agriculture and their control potentials’, Chapter 5 pp31-34.
[270] Ibid., pp24-26.
[271] See impact assessment for proposal for an Industrial Emissions Directive, SEC(2007)1679 (op. cit.).

approval legislation.[272] As indicated in the previous sections, this is a major factor contributing to non-compliance with the NO_2 ambient air quality limit value and the NO_x national emission ceiling.

Directive 1999/32/EC on Sulphur Content of Fuels has reduced emissions of sulphur from shipping as expected. The recent modification by Directive 2012/33/EU fulfils a TSAP commitment and will substantially further reduce the levels of secondary PM in the EU. [273]

The existing EU source legislation on air pollution emissions from agriculture is very limited in scope. While the NECD ceiling on ammonia has been reached for most Member States, and work has been done to implement the IPPC and the Nitrates Directives, these instruments have been weak to provide significant emission reductions from agriculture as a whole. Emissions of ammonia from agriculture have decreased by about 30 % from 1990 (and by 11% from 1999 to 2009), but this is less an effect of environmental policy measures than of structural changes in the sector, in particular a reduction in livestock numbers (especially cattle). To some extent it is also an effect of changes in the management of organic manures and from the decreased use of nitrogen mineral fertilisers, but it is unclear to what extent these changes have been policy-driven.

The 2008 climate and energy package was brought forward and agreed after the TSAP, but contributes substantially to air pollution reduction. The exception is the use of biomass in small and medium combustion installations, where the potential negative impact on air quality may be substantial and careful management will be needed.

Other relevant source measures outlined in the TSAP were either not proposed (integrated nitrogen management), rejected by Council (reduction of the IED threshold to 20 MW for combustion plants) or are yet to be fully implemented (Stage II vapour recovery).

Reasons for failure

The main areas of failure that are relevant for the achievement of the air quality objectives are the failure to control real world emissions from passenger cars and light duty diesels; the lack of effective regulation of ammonia emissions from agriculture; and the failure to control combustion from installations below $50MW_{th}$ capacity .[274] The reasons for each of these failures are considered in turn below.

(i) Real world emissions from diesel vehicles

As discussed already above, the main reason for failure of the Euro standards to control real world emissions of NO_x from diesels is the test cycle for both type approval and in service compliance, which does not reflect emissions in normal driving conditions. [275] This problem has been addressed

https://circabc.europa.eu/sd/d/2f169597-2413-44e2-a42c-35bbbde6c315/TSAP-TRANSPORT-v2-20121128.pdf

. See the impact assessment for the review of Directive 1999/32/EC, SEC(2011)919, pp6-7.

274 IIASA 2013 demonstrates that these are the most significant impacts on outstanding air pollution problems.

275 https://circabc.europa.eu/sd/d/2f169597-2413-44e2-a42c-35bbbde6c315/TSAP-TRANSPORT-v2-20121128.pdf

for new heavy duty vehicles, but tackling it for diesel passenger cars and light duty vehicles in the implementation of Euro 6 is a major outstanding issue for the transport sector. Where feasible, retrofit of vehicles already placed on the market should be considered. (This is mainly applicable to municipal vehicles and transport vehicles, such as captive fleets, which make intra-urban trips. For all these vehicles, deployment of cleaner alternative fuels is also to be considered.)[276]

(ii) Lack of effective regulation of ammonia emissions from agriculture

The initiative on integrated nitrogen management proposed in the TSAP has not yet materialised, in particular due to uncertainties as to how such an initiative would impacts on the implementation of existing legislation such as the Nitrates Directive, and the time and effort needed to agree to a regulatory approach to integrated nitrogen management at EU level. As to the reasons for the lack of effective EU control of agriculture emissions to date, the main ones have been identified as follows:

- A relatively low priority has historically been given to NH_3 compared with other air pollutants. Policy has historically been driven mainly by health concerns and has focused on pollutants posing a more immediate threat (in particular SO_2 and NO_x). As these emissions have drastically reduced, the relative importance of ammonia emissions has increased both in terms of contributing to increased levels of PM2.5 and for eutrophication, the major outstanding ecosystem issue.

- The Gothenburg Protocol and the 2010 NECD ceilings are, therefore, not particularly challenging. Most MS are well below the ceilings, even without putting additional measures in place.

- More generally, ammonia emissions have been given low priority in the context of EU's general environmental legal framework, where the focus with regard to agriculture has been on water protection (e.g. through the Nitrates Directive and the Water Framework Directive), pesticide use, and biodiversity protection (land management). While these environmental problems remain very challenging, the ecosystem impacts of air pollution are increasingly significant.

- The CAP framework did not list ammonia among the core measures eligible for support, nor subject to cross-compliance requirements. Instead, priority was given to other agri-environmental issues, such as water protection or biodiversity. This has been mitigated recently by the addition of ammonia to the focus areas of the Rural Development Programme in the recent CAP agreement.

Thus until now, there has been very little interest in developing EU source legislation to address ammonia emissions, the problem being largely left to Member States to regulate, with the consequent implications for the conditions of competition in the sector. In the air policy review, calls have been made from many stakeholders to regulate ammonia emissions at EU level to support the achievement of the ammonia reduction commitments in the NECD. [277]

(iii) Failure to control combustion from installations below 50MW

The proposed extension of the IED scope by lowering the combustion threshold down to 20MW was rejected in co-decision, mainly because of concerns regarding the administrative burden of imposing the IED permitting regime in that capacity range.

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276 See, 'Review of the Air Quality Directive and the 4th Daughter Directive', op. cit. pp56-57.

277 See, 'Report on the consultation of options for revision of the EU Thematic Strategy on Air Pollution and related policies', op. cit., p61.

6.5. Efficiency

Table 8 below summarizes the estimated implementation costs related to current EU air pollution control measures. It shows the extent to which EU air pollution controls have focused primarily on large sources, notably road transport and industrial emissions including energy production in large combustion installation. It also shows that existing legislation is still set to yield further reductions (and therefore also costs).

Table 8: Estimated air pollution control costs associated with current legislation (EU28)

	2005	2010	2015	2020
Power generation	12496	12700	12093	10711
Domestic combustion	5957	7476	9115	9629
Industrial combustion	2180	2435	2468	2521
Industrial Processes	4471	4760	4983	5029
Fuel extraction	1096	976	907	770
Solvent use	756	1638	1964	2140
Road transport	18663	26022	34357	42023
Non-road machinery	980	1892	4320	6975
Waste	0	0	1	1
Agriculture	1094	1750	1775	1786
Sum	47694	59650	71983	81584

As indicated above, it is beyond the scope of this review to assess the efficiency with which each source control instrument achieves its objectives. However, the following comments can be made.

For industrial emissions, emissions from road transport and emissions from non-road mobile machinery, there is no obviously more efficient way than the chosen source controls to achieve the desired emission reductions. However, for combustion plants below 50MW, it may indeed be possible to regulate with a lighter permitting regime than that of the IED.

For agriculture, an integrated approach to nitrogen management would be the most efficient way to regulate emissions,[278] but for reasons explained above this option may not currently be practicable. However, the analysis shows that there is a strong case for more action at both EU and at national level to reduce ammonia and PM emissions from agriculture, advocated also by other emitting sectors on the grounds that the lack of reductions in agriculture is imposing unreasonable constraints on their emissions.[279]

A range of regulatory and non-regulatory policy options have been assessed and the following identified as promising in consultation with stakeholders:

- Implementing measures for the agriculture sector in the NECD;
- Controls on manure management at EU level;

278 See 'The European Nitrogen Assessment', op. cit., Chapter 23 (pp541-550).

279 See, 'Report on the consultation of options for revision of the EU Thematic Strategy on Air Pollution and related policies', op. cit., p62, comments from power and heating, cement and multi-sector business associations.

- Measures to reduce use of urea-based fertilisers (perhaps in the context of the on-going review of the EU Fertilisers Regulation);
- Support for national implementation through the EU Rural Development Programs.

For international shipping, other mechanisms than low-sulphur fuel are potentially more cost-effective to reduce SO_2 emissions, and these alternatives (e.g. scrubbers) are enabled in the recent revision (2012/33/EU). Given the IMO legal framework governing emissions from international shipping, there is no obvious alternative for regulation than implementation of agreed IMO positions. However, international shipping emissions could potentially be brought under national emission ceilings, thus making more explicit the choice between regulating land-based or (through IMO) sea-based sources.[280]

7. NATIONAL AND LOCAL SOURCE CONTROL MEASURES

7.1. Objectives, scope and approach

National and local source controls comprise a large set of measures applied with varying geographical scope ranging from legal instruments to voluntary programs, technical to economic instruments. In principle they cover all measures that Member States can take in areas not regulated at EU level. The range of actions that Member States can undertake is illustrated in the Appendices 4.3 through 4.5.

The terms national and local action are used interchangeably although in practice national measures have most often been related to the implementation of the NECD whilst local measures have been related to the implementation of the AAQD.

National measures triggered by the NECD have focused mostly on SO_2, NO_x, and VOCs (less so on NH_3 due to the relatively generous ceilings). Local action triggered by the AAQD focused on reaching compliance with the legally binding standards for PM and NO_2 in the AAQD.

7.2. Monitoring, Reporting and Evaluation

Several processes have led to enhanced insights on the relevance, effectiveness, efficiency, and coherence of national source controls. These include the monitoring and reporting processes required under the AAQD and NECD, the notifications of derogations/extensions under the AAQD, and the infringement processes.

There are also important lessons learned on the design, implementation, and evaluation of national and local actions from the Air Implementation Pilot, a dedicated urban air quality project conducted jointly by the EEA, the Commission, and 12 EU cities. [281]. (See appendix 4.6).

It is noted that the Commission does not typically assess the effectiveness of individual measures but rather assesses overall policy packages in terms of the ability to reach the binding standards.

7.3. Relevance

Both the NECD and the AAQD set commonly agreed and effect-based air pollution and ambient air quality standards requiring action at source from the Member States. Whilst a significant portfolio of EU source measures has been established over time (see above), national and local action continues to be required. Its relevance continues to be related to the principle of subsidiarity and cost-

[280] See discussion in report, ‘Summary report for National Emission Ceilings Review’, op. cit., p12.
[281] EEA Report No 7/2013, op. cit.

effectiveness, i.e. national and local action ensures that EU measures remain proportionate and do not lead to higher costs than required taking into account the different situations in the Member States (and urban areas) across the EU.

7.4. Effectiveness

The review yielded a mixed picture with respect to the effectiveness of national and local measures implemented by the Member States. Whilst Member States have revamped their national and local actions to reduce air pollution in the wake of enforcement procedures, their effectiveness is generally insufficient to enable reaching the EU air quality standards (See section 4).

Among the most successful local actions to address PM and NO_2 are: favouring public transport use whilst upgrading public transport fleets (through retrofitting old diesel vehicles with particulate and/or NO_x traps or alternative fuel purchase programmes, increasingly also electric vehicles); establishing access restrictions for the most polluting vehicles (e.g. low emission zones); road pricing and/or parking fee policies reducing traffic and improving traffic flows (thereby improving also the efficiency of catalytic equipment), speed limits on highways passing through high population density areas (also improving the traffic flow), greening taxi fleets, and facilitating cycling and walking. Impacts are increased where modal shifts can reduce short distance trips (representing up to 50% of vehicle use in urban areas), also because the 'light-off' time required for catalytic equipment to reach maximum efficiency is harder to achieve for shorter trips.

Actions have enabled the respective limit values to be met, or the number of zones in exceedance to be reduced, as well as reduction in population exposure. The low emission zone in Berlin, for example, gradually reduced the PM_{10} exceedance area from 27% to 7% between 2008 and 2012 whilst reducing the number of citizens exposed to levels exceeding the EU air quality standard from 21% to 5%. Limiting the maximum speed along the A13 beltway in Rotterdam reduced PM_{10} emissions in the area by between 25 and 35% leading to air quality improvements of 4 $\mu g/m^3$ at 50m from the roadside. The contribution of the highway to the city's overall PM_{10} pollution was reduced by 34%. NO_2 related emission benefits ranged between 15 and 25% leading to air quality improvements of 5µg/m3 at 50 m from the roadside. The contribution of the highway to the city's overall NO_2 air pollution was reduced by 25%. Other benefits yielded by the measure included a 15% CO_2 emission reduction and a 50% reduction in noise levels. In some cases of advanced air quality management, actions focused on reducing PM and NO_2 emissions from diesel equipment on construction sites and other small and medium scale combustion installations.

National actions influencing air quality both positive and negative include fuel and vehicle taxation and/or subsidies, scrappage schemes, public transport infrastructure projects.

National and local actions have been most successful where they were designed and implemented in a well-researched and integrated manner, i.e. based on robust emission inventories containing relevant information for the area under consideration as well as robust air quality models able to integrate the relevant local and regional dimension as well as the meteorological and topographic information in an appropriate manner.

Effective actions has often been hampered by a lack of political will to establish and/or maintain effective actions which in turn could be linked to the often poor capacity to conduct in-depth ex-ante analysis or timely ex-post assessments to help gathering public support. The effectiveness of low emission zones and/or differentiated road pricing systems has been vitiated by the real world emission issue (the lack of reduction in light-duty diesel emissions across successive Euro classes); and by the increasing share of diesel vehicles also promoted through favourable national tax structures. In other cases, traffic related air quality management cases were challenged on the grounds of limiting free movement of goods.

7.5. Main orientations for the future

In addition to the source categories that contribute to the present exceedance situation, a number of issues preventing better compliance have been identified relating to Member State Competent Authorities' technical capacity for assessing and managing air quality as well as general and specific governance issues.

Limited capacity to assess and manage air quality problems and impacts

In general, and with a few notable exceptions, the capacity of competent authorities to assess and manage air quality remains weak and has not been brought to the level required for dealing with the increasingly complex air quality challenges.

Whilst the analysis suggests that there is are no major compliance problems with the minimum criteria set for air quality monitoring and the establishment of national emission inventories as required by the AAQD and NECD, the capacity of competent authorities to use the available information for identifying the major sources contributing to the national and/or local air quality problems and for assessment the cost-effectiveness of abatement strategies and policies is limited, and this has often prevented the development, implementation, and monitoring of cost-effective strategies.

The ***lack of adequate emission inventories at local level*** is a particular problem where national emission inventories may not be representative for the local situation. Missing, under- or over-estimated emission categories may lead to ill-targeted air pollution policies or prevent the development of cost-effective measures all together. This has been a particular problem, for example, for taking timely action on certain important source categories such as domestic heating.

The ***lack of adequate air quality modelling*** (or expert modelling capacity) to assess national air quality and the effectiveness of national and local action is another problem that has been identified. Whilst various forms of air quality models are widely available, there analysis suggested that there is no systematic use made of them (compared for example to the practice in the US). Increased use of dispersion models could help assess the impacts of new sources in the area or the impact of large emission sources outside but upwind of the area. Atmospheric chemistry models can assist in predicting the impacts of air quality management measures taking into account meteorological and topographic conditions. Modelling is typically required also to ensure that trends in "background pollution" are duly taken into account. Many competent authorities have limited or no access to such important contextual information.

The EEA Pilot exercise also suggested that ***cost-effectiveness data and/or assessment tools are generally lacking*** at national and/or local level. Hence, local authorities are often forced to invest a considerable amount of time and resources to obtain such information or, where that is not possible, drive forward policies on a limited knowledge base.

Where competent authorities are well equipped, cost-effectiveness analysis often ignores the transboundary impacts of measures taken (or rejected) at national level.

Governance deficiencies preventing better coherence of air quality and other policies

The technical capacity problems that have contributed to the present state of poor compliance have in many cases been compounded by certain **governance deficiencies** and **poor public information**.

As a general principle, Member States' national governments are accountable for the implementation of EU legislation. In the case of the AAQD, national authorities have often delegated substantial responsibilities to regional and local authorities in line with the determination of air quality zones and agglomerations linked to the assessment and management of the respective air pollutants covered by the Directive. Whilst this is compatible with the air quality legislation, this sub-delegation has often taken place without foreseeing **adequate dialogue to reconcile air quality issues across zones and agglomerations and between the local and national governments**.

In a number of cases, local or competent authorities have been faced with problems that could not be solved adequately without the assistance of the national government. Typical problems have related to managing transport emissions, notably where exceedances were driven by diesel vehicles but national governments maintained tax incentives that promoted these vehicles. Other cases include where local air quality management needs required management of pollution sources outside the boundaries of the local authorities. Governance deficiencies ***also extended to the Member States' interventions at EU level,*** where certain authorities of a Member State argued for stricter EU measures whilst others from the same Member State argued the contrary. Better alignment of positions has proven possible after the Commission made Member States aware of the contradicting positions yet in a number of cases, the lack of detailed information referred to above, prevented Member States from taken fully informed positions.

Similar governance issues emerged with respect to the ***implementation of the NECD***. Contrary to the assessment and management of air quality standards, national emission inventories, projections, and plans and programmes related to the national emission ceilings have been (quite logically) managed at the national level. In doing so, however, little account has been taken of the needs at regional and local level, notably where a substantial part of the air quality exceedances are linked to background pollution. Recent initiatives to bring the NECD and AAQD experts closer together at the level of EU expert group meetings have started to enhance the prospect for more coherence between the management of these instruments.

Efforts from competent authorities and policy makers continue to be hampered by a relatively ***poor understanding of air pollution issues by the general public***. Whilst there is generally good access to air quality data and reports, it remains a challenge for citizens and consumers to take informed decisions considering the state of air pollution in their region and/or the environmental performance of products in relation to air pollution.

8. INTERNATIONAL ACTION TO REDUCE AIR POLLUTION

8.1. Objectives, scope and approach

Pollution sources external to the EU contribute substantially to EU air quality and impacts significantly on human health and the environment. For pollution formed in the atmosphere from precursor emissions (such as secondary particulate matter and ground-level ozone) the influence of long range transport becomes crucial. In particular for ozone, background concentrations in the EU are substantially influenced by ozone production and transport in the entire northern hemisphere.

Hemispheric methane emissions (an important ozone precursor) are a particular driver of the EU ozone background.

Historically, the principal international instrument is the UN Economic Commission for Europe (UNECE) LRTAP Convention, which covers Europe but also includes North America (the USA and Canada).

The Convention has 51 Parties within the region and it has generated a knowledge base on air pollution, its impacts and effective management which continues to provide a solid basis for air policy in the EU and beyond.

The 1999 'Gothenburg' Protocol to the CLRTAP is the most important instrument from the perspective of EU air quality policy, and has recently been revised (2012). It covers all the main pollutants, and sets the agenda for upcoming air quality issues (for instance on Short- Lived Climate Pollutants such as black carbon).

8.2. Monitoring, Evaluation, and Enforcement Provisions

The LRTAP Convention provides for extensive provisions for monitoring of air quality, emissions and policy implementation.

The European Monitoring and Evaluation Programme (EMEP) has the long term objective to provide the Parties with an objective assessment of air pollution emissions, transmission in the atmosphere and the air pollution concentration and deposition over the entire European part of the UNECE region (except North America). The Parties report their emissions and air quality data to the EMEP centres that annually evaluates and provides reports on emissions, air quality and transboundary fluxes of all pollutants covered by the Convention protocols.[282] It conducts method development for inventories and air quality assessment and provides guidance to Parties including the EU on better methods. EMEP thus provides the backbone for the application of EU legislation through methodologies and standards for inventories, projections and air quality assessments, as well as methods inter-comparisons and modelling.

EMEP also plays an increasingly important role in international cooperation beyond the Convention area, in particular in Asia. The EU has therefore jointly with the USA taken the co-lead for the Convention Task Force on Hemispheric Transport of Air Pollution to reinforce the monitoring and evaluation of hemispheric transport of air pollution, including also Short-Lived Climate Pollutants

Work under the Working Group on Effects collects information from the Parties on air pollution effects in order to establish the critical loads and levels for ecosystems, crops, materials and cultural heritage. The collected information under the International Cooperative Programmes is evaluated and annually reported to Parties including the EU[283]. Again the CLRTAP concepts of critical loads and levels are also central in EU legislation and a part of the NECD objectives and the 7th EAP objectives. The air pollution health effects are assessed by the joint CLRTAP/WHO Task Force on Health which systematically collects and reviews air pollution health impacts and provides scientific basis for CLRTAP and EU health impact assessments and cost-benefit analyses.

282 EMEP main webpage http://www.emep.int/
283 WGE web page http://www.unece.org/env/lrtap/workinggroups/wge/welcome.html

Work under the Working Group on Strategies and Reviews systematically collects information on how Parties have implemented their obligations and the CLRTAP holds now a data basis on the various policies and measures implemented by the Parties to meet their obligations. The 2010 review of policies and measures is currently ongoing and not yet finalised. In addition to the general reviews of policies specific task forces have been reviewing the specific protocols on Heavy Metals and POPs for their effectiveness and sufficiency. The POPs Protocol was revised in 2009 and the Heavy Metals Protocol in 2012.

8.3. Relevance

While the geographical coverage of CLRTAP is appropriate for addressing some European problems (acidification and eutrophication), others such as methane, ozone and particulate matter have a wider geographical perspective, involving emissions from India and China in particular.

Also other international initiatives are worth mentioning in the latter context. The first is the Climate and Clean Air Coalition, which was set up to co-ordinate action of its members on the main Short-Lived Climate Pollutants (SLCPs, methane, ozone and black carbon). The second is the Global Methane Initiative[284] which stimulates international action for methane emission reduction. Finally, the Global Atmospheric Pollution Forum[285] under the auspices of the International Union of Air Pollution and Prevention Associations is raising awareness and advocating action in regions where air pollution management is still weak, such as in South East Asia and Africa.

8.4. Effectiveness

The Gothenburg Protocol

The Gothenburg Protocol presently has 26 Parties, of which 23 are EU or EU Member States. Six EU Member States have not yet ratified. Two more countries have deposited their ratification instrument but their accession needs approval by the current Parties (in December 2013 at the earliest.)

The Protocol played an important role in the pre-accession period for the EU 12, as the obligations in the Protocol largely reflected EU legislation at that time. Whilst the Protocol may have lost some of its added value following EU enlargement (when many CLRTAP Parties joined the EU), it remains an important forum for sharing experience with other Convention Parties, including the Eastern European, Caucasus and Central Asian Countries such as the Russian Federation, Ukraine and Belarus, as well as the US and Canada.

The Protocol was successfully amended in 2012 to strengthen the existing reductions commitments for SO_2, NO_x, NH_3 and VOC and introduce new reduction commitments for $PM_{2.5}$, to be attained from 2020 onwards. The amendment also updated the minimum performance standards for industrial emissions, which are now broadly in line with existing EU legislation. It is also the first Multilateral Environment Agreement to include binding obligations to monitor and abate SLCPs, such as black carbon.

Importantly, the 2012 amendment also allows a flexible approach for new Convention Parties to ratify the Protocol, which improves the prospect of ratification by Eastern European, Caucasus and Central Asian countries (including the Russian Federation). This was a main objective for the EU in the negotiations to amend the Protocol. A broadening of the ratification towards the east will not only

284 http://www.globalmethane.org/gmi/
285 http://www.sei-international.org/gapforum/

yield additional environmental benefits for the EU but also (potentially) a significant market extension for green products. [286]

The Climate and Clean Air Coalition

The Climate and Clean Air Coalition [287] (CCAC) was formed in 2012 to coordinate and extend action on reducing SLCPs such as black carbon, methane and hydrofluorocarbons (HFCs) largely based on the conclusion of the UNEP integrated assessment on black carbon and tropospheric ozone[288]. The CCAC thus aims at supporting fast action to simultaneously improve public health, food and energy security and climate. The focus of the work is to raise awareness of SLCP impacts and mitigation strategies, enhance and develop new national and regional actions, promote best practices and showcase successful efforts, and improve scientific understanding of SLCPs impacts and mitigation strategies. The Coalition has only recently been established, but a number of concrete projects have been initiated, such as action on improving domestic heating and cooking in developing countries, which are beneficial for both indoor and outdoor air quality and climate. The Coalition now comprises 70 countries and organisations, including the European Commission, and is increasing rapidly to become a major player in international action on SLCPs.

8.5. Efficiency

The CLRTAP and in particular the Gothenburg Protocol has been instrumental in the policy development of effective air pollution strategies across Europe. The effects-oriented policy of the Gothenburg Protocol, underpinned by scientific and technical knowledge has been endorsed by the EU and subsequently applied in EU legislation such as the NECD. In particular the scientific work under the European Monitoring and Evaluation Programme (EMEP), including its various science centres and task forces, the Working Group on Effects and the International Cooperative Programmes have provided important cornerstones for the EU in developing and applying a knowledge-based approach for air pollution policy.

The Convention has also provided an important platform to strengthen the wider international coordination on the scientific basis for air pollution and on the exchange of experience and information on best practices. Provided that more countries from Eastern Europe will ratify and implement the amended Protocol, it can potentially deliver significant direct benefits to EU air quality by reducing transboundary air pollution from the East.

9. COHERENCE OF THE OVERALL FRAMEWORK

The aim of the policy framework is to implement an optimized set of measures to reduce air pollution impacts in the EU. In broad terms, that entails (i) controlling the international impacts of our and our neighbouring states' pollution; (ii) bringing down background and transboundary pollution within the EU, and (iii) stimulating complementary action to deal with the regional and local contribution.

9.1. International pollution

The international framework in which EU air policy is embedded has the twin aims of reducing EU pollution impacts on air quality in neighbouring countries, and reducing their impact on EU air quality. The need for such co-ordination is still clear and the scale of the required co-ordination

286 I.e. products with lower environmental impact over the lifecycle compared with other similar products.
287 http://www.unep.org/ccac/
288 http://www.unep.org/publications/contents/pub_details_search.asp?ID=6201

depends on the transport scale for the relevant pollutants. For most pollutants, the effective scale is the EU and its neighbours to the east on the Eurasian landmass, which is covered by CLRTAP.

However for ground-level ozone and some aspects of particulate matter, such as black carbon, the relevant scale is the entire northern hemisphere. North America is included in CLRTAP (the USA and Canada) but effective control will involve extending international co-operation to include also China and India.[289]

In terms of the coherence between international action and EU action, there is a particular issue at the moment arising from the recent revision of the Gothenburg Protocol of the CLRTAP, which must be transposed into EU law.

9.2. Background and transboundary pollution within the EU

With regard to background and transboundary pollution within the EU, the main regulatory control mechanism is a ceiling on emissions of the relevant pollutants per Member State. The ceilings allow substantial discretion to Member States on how to achieve the relevant reductions. While this is legitimate on subsidiarity grounds, there are two caveats. The first is that the framework for meeting the required reductions (emission projections combined with national programmes) was not effectively implemented in practice.[290] If this control mechanism is to be used again, those aspects must be strengthened and and/or modified in order to ensure better effectiveness.

The second caveat is that effective implementation of emission ceilings has been facilitated by EU action on sources.[291] This is true not only of those source categories which can only be regulated at EU level (products), but also of action on other sources where efficient and cost-effective. An example is the support provided by the Large Combustion Plants Directive to the achievement of the sulphur dioxide emission ceilings.

The combination of EU source legislation with national emission ceilings is thus an effective framework to reduce background and transboundary pollution, so long as the individual pieces of legislation are effective.

9.3. Local pollution

The approach to regulating the local contribution to ambient air quality has been to set ambient air quality standards which apply everywhere in the EU, and to allow discretion to national, regional and local authorities to develop the complementary measures (building on background reductions) needed to meet them.

In principle this is a sensible approach, but problems arise where there is insufficient control of background and transboundary pollution. The obligation to meet the ambient standards remains but then local reductions need to carry more of the burden than anticipated.[292] There are also problems where the relevant pollution source is a product. For example, local diesel emissions are the main driver of local NO_2 concentrations; but regulation of emissions is an EU competence, and the taxation

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289 See Executive Summary of Assessment Report of CLRTAP Task Force on Hemispheric Transport of Air Pollution, op cit., p5.
290 See evaluation of NECD above, section 'Efficiency'.
291 See Table 14 above.
292 See 'PM workshop Brussels, 18-19 June 2012', op cit, pp5-6, 9.

policies favouring diesel have often been national. Those tools that are available at the urban level are then strained to the limit.[293]

In addition to this, the compliance approach implemented at national level has often been deficient. As highlighted above for the emission ceilings, so for ambient air quality standards: action plans were often put in place late, without adequate supporting analysis or effective co-ordination.

One further question is whether local action is more effectively driven by ambient air quality standards or by an exposure reduction approach. Both have their merits: the ambient air quality standards ensure a minimum level of air quality for all, while the exposure reduction concept drives reduction even in those areas compliant with limit values, where substantial health problems remain.[294]

9.4. Analytical framework for the Thematic Strategy on Air Pollution

The TSAP was designed to set cost-effective objectives for reduction in air pollution impacts on health and the environment, and to marshal the appropriate combination of measures at local, national and regional, and international level to deliver those objectives. The analytical approach has assured substantial coherence between the various legislative instruments, but improvements are possible as outlined in section 3.5.

10. CONCLUSIONS AND ORIENTATIONS FOR THE REVIEW

10.1. Validity of objectives and scope, and overall coherence

The review has confirmed that the overall structure of air quality policy is logical and coherent. However, a better match must be ensured (in practical implementation) between source controls, ceilings and ambient air quality standards. This is required in particular to ensure that local achievement of ambient air quality standards is not compromised by (a) failure to limit pollution from significant point sources or from products,[295] or (b) high background concentrations resulting from the overall (Member State or transboundary) emission burden. The review examined for each individual policy instrument the extent to which its objectives and scope remain valid:

- For the Thematic Strategy, the underlying analytical framework remains valid for the current review, although some improvements are identified. The impacts identified in 2005 remain the priorities today (with the exception of acidification); an updated review should focus on the scope for further reducing these in the period up to 2030 (beyond which the uncertainties in the analysis become large). It should also focus on greater coherence across the range of policy instruments (including untapped synergies between the AAQD and the NECD).
- For the Ambient Air Quality Directives, the health relevance of the pollutants and standards of the original policy has been reviewed by WHO, and confirmed, with the caveat that the level at which certain standards are currently set (mainly for PM) provides only incomplete protection for human health. As compared with 2005 there is additional evidence on the chronic impacts of ozone and NO_2, which reinforces the rationale for the respective standards.
- The scope and objectives of the NEC Directive are out of line with the latest scientific findings and international agreements. The NECD must be adapted to focus better on health by

293 Ibid.

294 As indicated previously, no more robust conclusion is currently possible on the exposure reduction approach given that the first compliance deadline is 2015. See, 'Review of the Air Quality Directive and the 4th Daughter Directive', op cit, p64 section 4.4.3.

295 For instance the issue of real-world emissions from light-duty diesel vehicles – see section **Fehler! Verweisquelle konnte nicht gefunden werden.** for details.

introducing a ceiling for $PM_{2.5}$, and on short-lived climate pollutants (black carbon and methane) in line with the 2012 amendment of the Gothenburg Protocol. Objectives must be extended to 2020 to fulfil the Gothenburg requirements, and strengthened for the period 2025-30 to deliver further reductions in background pollution to enable levels of air quality that are closer to those recommended by the WHO and CLRTAP .[296]

- For the EU source controls the scope and objectives also remain broadly valid. Updated emissions data and projections confirm that the sectors driving the relevant pollutant emissions were correctly identified. In the short term, the main priority is the full implementation of the existing legislation and in particular the resolution of the real world emissions issue for light duty diesel vehicles. In the longer term the main gaps relate to combustion from small and medium installations, and ammonia emissions from agriculture.
- The scope, objectives, and coherence of international action under the CLRTAP remain relevant to co-ordinate action in the northern hemisphere on the key air quality drivers. The recently amended Gothenburg Protocol usefully extended the scope to include action on short-lived climate pollutants (notably black carbon), and flexibility has increased thereby also enabling a broader participation. Further action should focus on facilitating ratification by Eastern European, Caucasus and Central Asian Countries, action on short-lived climate pollutants (including also methane, black carbon and ozone) and extended exchange of scientific and technical co-operation with other regional groups notably in Asia and North America.

10.2. Main outstanding problems

Based on the above analysis, the following main outstanding problem relates to the fact that the health and environmental impacts of air pollution in the EU remain large. This conclusion is set out further in Chapter 3.3.1 of the main impact assessment. Two specific problems related to these substantive impacts were identified as follows.

- EU air quality standards are widely exceeded in densely-populated areas
- The EU is not on track to meet its long-term air quality objective

The summary conclusions from the above review related to these specific problems are set out in Chapter 3.3.2 and 3.3.3 of the main impact assessment.

10.3. Main drivers of the outstanding problems

The review allowed further more to identify the main drivers for the aforementioned problems. They relate partly to the pollution sources themselves, and partly to the failure to manage air quality effectively and efficiently ("governance issues"). The main drivers are summarised in the main body of the impact assessment for each problem in turn as follows.

- Main drivers causing exceedance of EU air quality standards (See Chapter 3.4.1 of the main impact assessment report)
  - Diesel emissions drive the NO_2 and NO_x compliance problems (See Chapter 3.4.1.1 of the main impact assessment report)
  - Small scale combustion and concentrated local pollution drive the worst PM compliance problems (See Chapter 3.4.1.2 of the main impact assessment report
  - Poor co-ordination between national and local action, and lack of capacity at regional and local level (See Chapter 3.4.1.3) of the main impact assessment report

- The main drivers preventing the EU to stay on track towards meeting its long-term air quality objective (See Chapter 3.4.2 of the main impact assessment report)

[296] Annex 4 section 5.

- The remaining health impacts from PM and ozone are driven by emissions from a range of sectors (See Chapter 3.4.2.1 of the main impact assessment report)
- Agricultural ammonia emissions drive the remaining health impacts (See Chapter 3.4.2.2 of the main impact assessment report)
- Sustained background pollution means local action alone cannot effectively reduce impacts (See Chapter 3.4.2.3 of the main impact assessment report)
- There remain gaps in the information base for assessing and managing air pollution (See Chapter 3.4.2.4 of the main impact assessment report)

10.4. Orientations for the review

The conclusions from the review on the outstanding problems and drivers have formed a robust basis for further assessments and defining the policy objectives for the updated EU air quality policy framework (see section 4). As indicated during the review process documented in this annex, the problems identified in the review can be addressed by modification (rather than replacement) of the existing policy framework. The required modifications should take place in a stepwise manner as follows.

Based on experience with the existing policy framework, setting ambitious ambient standards in the absence of measures to control transboundary pollution, and emissions at source, generates large-scale non-compliance. It is thus proposed to move to a staged approach whereby transboundary and source controls are brought forward first, and then once they are implemented, ambient air quality standards (mainly for PM) are reduced building on the resultant reductions in background concentrations delivered.

On that basis, a sensible order for the further policy revision would be first of all i) a revision of the TSAP to set the future EU policy framework to 2030; and ii) a simultaneous revision of the NECD to control transboundary pollution and limit background pollution concentrations. Once these are in place and broad-based compliance with the current standards has been achieved, a revision of the AAQD could be envisaged to bring standards closer to the WHO guideline values and address outstanding issues (such as the appropriate balance between limit values and exposure reduction obligations).

These orientations have been taken into account when designing the policy options for further action as described in the main impact assessment report from Chapter 4 onwards.

APPENDIX 4.1 SPECIFIC EVALUATION STUDIES LAUNCHED FOR INDIVIDUAL POLICY INSTRUMENTS AND THE DETAILED QUESTIONS ADDRESSED

All reports are available at http://ec.europa.eu/environment/air/review_air_policy.htm unless otherwise specified.

1. THE THEMATIC STRATEGY ON AIR POLLUTION (TSAP)

Data sources:

- Quantitative review of experience with implementation of the 2005 TSAP (TSAP report 2 of Service Contract ENV.C.3/SER/2011/0009)

Questions addressed

- What underlying factors led to differences in emissions as compared with projections in 2005 TSAP?
- What were the substantive impacts on emissions?
- How did the implementation cost projections compare with actual experience?
- To what extent will the environmental objectives of the TSAP be achieved?

2. THE AMBIENT AIR QUALITY DIRECTIVES (AAQD)

Data sources:

- Review of the health evidence on the pollutants regulated by the Ambient Air Quality Directive (2 grant agreements with WHO).
- EEA report No 4/2012, 'Air Quality in Europe'.
- EEA report No 7/2013, Air Implementation Pilot, Final Report
- Specific contract on implementation of the Air Quality Directive and the 4th Daughter Directive (ENV.C.3/FRA/2009/0008 Service request 6, final report 10 December 2012)
- Workshop on PM (ENV.C.3/FRA/2009/0008 Service request 7, final report October 8 2012)
- Modelling compliance with NO2 and PM10 air quality limit values in the GAINS model (ENV.C.3/SER/2011/0009 Report #9)

Questions addressed:

- Are the pollutants addressed by the legislation the most relevant for health protection?
- Are the levels at which the standards are set appropriate for health protection?
- How effective is the management framework of the Directive?
- What are the health impacts of the pollutants?
- What is the status of air quality in Europe, the trends and the compliance picture?
- What are the underlying emission levels and their trends?
- What are the main reasons for non-compliance?

3. THE NATIONAL EMISSION CEILINGS DIRECTIVE (NECD)

Data sources:

- EEA report No 14/2012, 'Evaluation of progress under the EU National Emission Ceilings Directive' assessing

- Specific contract, 'Services to assess the reasons for non-compliance with the emissions ceilings set in the National Emission Ceilings Directive', (Specific Agreement 5 under Framework Contract ENV.C.3/FRA/2011/08)

Questions addressed:

- What are the evolution of emissions, state of compliance and the extent to which the NECD environmental objectives are achieved?
- What are the main reasons for non-compliance, (a) based on objective analysis and (b) as identified by the Member State?
- When is compliance likely to be achieved?
- Will the reasons for non-compliance of the NECD 2010 ceilings affect the ability of a Member State to meet its new 2020 emission reduction commitments under the Gothenburg Protocol?
- Recommendations for modification to the management framework of the Directive.

4. SECTOR POLLUTION CONTROL POLICIES

Data sources:

- Future emissions of air pollutants in Europe – current legislation baseline and the scope for further reductions (ENV.C.3/SER/2011/0009 Report #1)
- Emissions from agriculture and their control potentials (ENV.C.3/SER/2011/0009 Report #3)
- The potential for further controls of emissions from mobile sources in Europe (ENV.C.3/SER/2011/0009 Report #4)
- Emissions from households and other small combustion sources and their reduction potential (ENV.C.3/SER/2011/0009 Report #5)
- Specific review of emissions from shipping (Special report under ENV.C.3/SER/2011/0009)

Questions addressed:

- What are the main emissions from the sector, their sources, and abatement options?
- What existing policies and regulations impact on future emissions from the sector?
- What are the costs, emission reductions and compliance implications of implementation of current legislation for each sector?
- What is the further reduction potential in the sector?

APPENDIX 4.2 EU VERSUS INTERNATIONAL AIR QUALITY STANDARDS

International air quality standards for PM10 (μg/m^3 unless otherwise stated)

Statistics	EU	CH	US	JP	CN	KR	IN	WHO
Ann. av.	40	20	-	-	40 I 100 II 150 III	70	60	70 (IT-1) 50 (IT-2) 30 (IT-3) 20 (AQG)
	Ann. mean of min. 90% of yearly measurements	Ann. mean	50 Annual arithmetic mean, averaged over 3 years (Standard revoked in 2006) Sec. st.1 & Prim. st.2		Ann. mean Zone I: residential areas Zone II: commercial areas Zone III: industrial areas	Ann. mean	Ann. mean; min. 104 meas. p.a. at a particular site taken twice a week; 24 hourly at uniform interval.	Annual arithmetic mean
24 hr av.	50	50	150 Sec. st.[297] & Prim. st.[298]	100	50 I 150 II 25 III	150	100	150 (IT-1) 100 (IT-2) 75 (IT-3) 50 (AQG)
	35 d. p.a. admitted	1 d. p.a. admitted	1 d. p.a. admitted, on avg. over 3yrs	daily mean	daily mean Zone I: residential areas Zone II: commercial areas Zone III: industrial areas	daily mean	24 hrly values shall be complied with 98% of time in a year. 2% of values may exceed limit but not on 2 consecutive days.	3 d. p.a. (99th percentile)

[297] **Secondary standards** provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.
[298] **Primary standards** provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly.

International Air Quality Standards for PM2,5 (µg/m³ unless otherwise stated)

Statistics	EU	CH	US	JP	CN	KR	IN	WHO
Annual av.	25	-	12 Secondary st.1 15 Primary st.2	15	40 I 100 II 150 III	-	40	35 (IT-1) 25 (IT-2) 15 (IT-3) 10 (AQG)
	Annual arithmetic mean of minimum 90% of measurements per year < 2015		Three year average of the weighted annual mean[299]		Annual arithmetic mean; Zone I: residential areas; II: commercial areas; III: industrial areas		Annual arithmetic mean of minimum 104 measurements p.a. at a particular site taken twice a week 24 hourly at uniform interval.	Annual arithmetic mean
24 hours av.	-	-	35 Secondary st.1 & Primary st.2	35	50 I 150 II 250 III	-	60	75 (IT-1) 50 (IT-2) 37,5 (IT-3) 25 (AQG)
			Three year average of the 98th percentile of daily means	Annual 98th percentile values at designated monitoring sites in an area	daily mean; Zone I: residential areas; II: commercial areas; III: industrial areas		24 hly values monitored shall be complied with 98% of the year; 2% may exceed the limit but not on two consecutive days.	3 days per year admitted (99th percentile)
Other	Exposure 20 3 calendar year running ann. mean of a set of urban background stations <2015							

[299] The EPA tightened the constraints on the spatial averaging criteria by further limiting the conditions under which some areas may average measurements from multiple community-oriented monitors to determine compliance (see 71 FR 61165-61167). [where "Federal register" "Vol. 71" 61164 - follow] *In this review, the Staff Paper concluded that it is appropriate to retain a concentration-based form that is defined in terms of a specific percentile of the distribution of 24-hour PM2.5 concentrations at each* ***population oriented monitor*** *within an area, averaged over 3 years.*

International Air Quality Standards for NO2 (µg/m^3 unless otherwise stated)

Statistics	EU	CH	US	JP	CN	KR	IN	WHO
Annual av.	40	30	100 Secondary st.1 & Primary st.2	-	40 I 40 II 80 III	57 {0,03 ppm}	40	40 (AQG)
	Annual arithmetic mean of minimum 90% of measurements per year	Annual arithmetic mean	Annual arithmetic mean		Annual arithmetic mean Zone I: residential areas Zone II: commercial areas Zone III: industrial areas		Annual arithmetic mean of minimum 104 measurements per year at a particular site taken twice a week 24 hourly at uniform interval.	
hourly av. [or ½ h]	200	100	100 Primary st.2	-	120 I 120 II 240 III	188 {0,1 ppm}	80	200 (AQG)
	18 hours per year admitted	95o Percentile of ½ hourly values per year admitted			hourly mean Zone I: residential areas Zone II: commercial areas Zone III: industrial areas		1 hour means shall be complied with 98% of time in a year. 2% of the values may exceed the limit but not on two consecutive days.	
24 hours av.		80 Daily mean 1 day per year admitted		113 Daily mean {0,06 ppm} [within zone 0,04-0,06 ppm or below]	80 I 80 II 120 III daily mean	113 {0,06 ppm}		

International Air Quality Standards for Ozone (µg/m3 unless otherwise stated)

Statistics	EU	CH	US	JP	CN	KR	IN	WHO
1 hours av.	-	120	-	120 {0,06 ppm}	120 I 160 II 200 III	200 {0,1 ppm}	180	-
		1 hours per year admitted	238 (Standard revoked on 2005 in all US except 14 areas)	For all photochemical oxidants. That are oxidizing substances such as ozone and peroxiacetyl nitrate produced by photochemical reactions.	1 hour mean Zone I: residential areas Zone II: commercial areas Zone III: industrial areas		1 hour monitored values shall be complied with 98% of time in a year. 2% of the values may exceed the limit but not on two consecutive days.	
8 hours daily max	120 {Target Value}	-	160 {0,075 ppm} Secondary st.1 & Primary st.2	-	-	120 {0,06 ppm}	100	240 (Hi-L) 160 (IT-1) 100 (AQG)
	25 days per year admitted over 3 years		Three year average of the 4th highest daily maximum 8 hourly means (< 2007-2024)				8 hour monitored values shall be complied with 98% of time in a year. 2% of the values may exceed the limit but not on two consecutive days.	
Other	AOT40 18K May-Jul sum of values of difference between max 8h mean and 40 ppb	½ hourly av. 100 98o Percentile of ½ hourly values per month admitted						

Sources

CH: OIAt of 16/12/1985 (at 15/07/2010) 814.318.142.1;
<http://www.admin.ch/ch/i/rs/c814_318_142_1.html>
JP: Environmental Quality Standards in Japan <http://www.env.go.jp/en/air/aq/aq.html>
CN: National Ambient Air Quality Standards
<http://cleanairinitiative.org/portal/knowledgebase/countries/country_overview/China/Air%20Quality%20and%20Co-Benefits?page=4>
<http://transportpolicy.net/index.php?title=China:_Air_Quality_Standards>
KR: National Ambient Air Quality Standards
<http://www.airkorea.or.kr/airkorea/eng/information/main.jsp?action=standard>
IN: National Ambient Air Quality Standards
<http://cpcb.nic.in/National_Ambient_Air_Quality_Standards.php>
NZ: Resource Management (National Environmental Standards for Air Quality) Regulations
<http://www.mfe.govt.nz/laws/standards/air-quality/index.html>
WHO: Air Quality. Guidelines for Europe (World Health Organization)
<http://www.euro.who.int/__data/assets/pdf_file/0005/74732/E71922.pdf>
US: National Ambient Air Quality Standards (NAAQS) <http://www.epa.gov/air/criteria.html>

APPENDIX 4.3 EXAMPLES OF NATIONAL AND LOCAL AIR QUALITY MANAGEMENT MEASURES

A set of broad categories of measures can be distinguished based on information obtained through the Time Extension Notifications for PM_{10} and NO_2, exchange of information in the context of on-going infringement cases, and various targeted workshops and projects. These categories are shown in Table 44 below. Further details illustrating practical implementation experience is provided in Appendix 4.4 for the case of Dresden. The potential of fiscal measures to promote emission reduction measures is provided in Appendix 4.5. Further information on experience with national and local measures is referred to in Appendix 4.6 summarizing the experience with the Air Implementation Pilot.

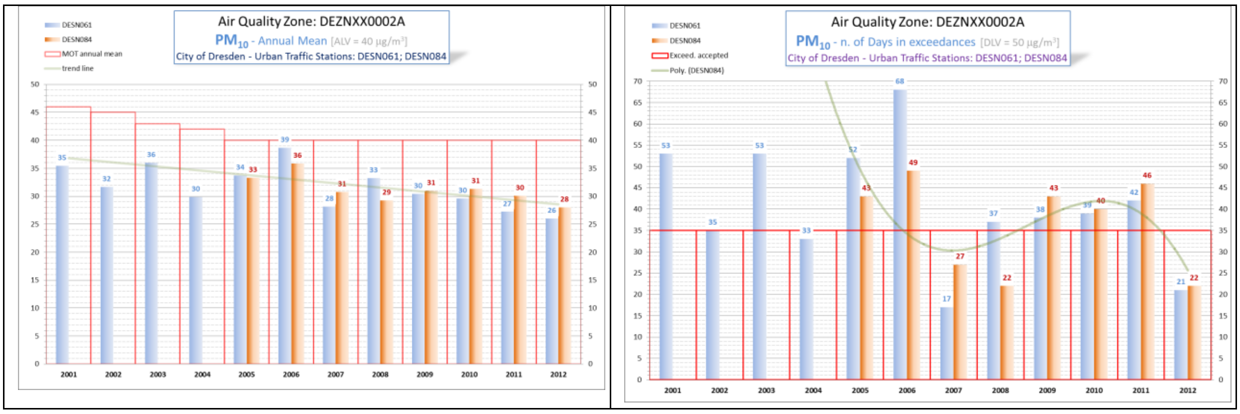
Table 44: Example of National and Local Measures by Source (Sub)Category

Emission source / sectors	Subcategories	Measures / Examples
Transport	Road Transport / traffic management	• Road pricing (e.g. London, Gothenburg) • Speed-limits (e.g. Rotterdam) • Low Emission Zones (e.g. Berlin) • Parking fees (e.g. Torino) • Car sharing (e.g. Cambio) • Bus or Heavy Occupancy Vehicles
	Road Transport / fleet management	• Green Public Procurement (Ultra Low emission or alternative fuelled vehicles) • Retrofitting standards (e.g. for buses, municipal service vehicles, trucks,…)
	Road Transport / inter-modality	• Kiss & Ride road and rail infrastructure • Pedestrian zones and dedicated bike lanes, …
	Road Transport / Promoting Public Transport	• Green taxis • Green buses (LPG, CNG cars and buses) • …
	Maritime Transport / Promoting clean Marine Ports	• Electricity at berth (Hamburg) • Differentiated fees • Remote sensing of emissions (JRC) • Retrofitting vessels • Discharge services • Alternative fuel infrastructure (Low sulphur fuels, LNG,…) • Clean intermodality
	Maritime Transport / Fleet management	• Retrofitting (inland, SSS) • LNG (SSS, inland) • Scrubbers …

	Air Transport / Clean Air Ports	• Public Transport Access • Differentiated fees
	Rail Transport / fleet management	• Retrofitting (diesel) railcars • Electrification • …
Energy	Large and medium sized combustions installations	• Permitting (upper range BAT/ beyond); • Promote energy efficiency • Promote RES, • District Heating and Cooling (Torino) • Fuel taxes (Denmark) • Carbon pricing (ETS)
	Small combustion installations	• Labels and/or standards for clean wood / biomass stoves (IT, DK) • Fuel switching (Dublin) • Permitting
Industry	Iron & Steel Cement …	• Permitting according to best Available Technologies or beyond (national / local competence!) • Joint clean air and climate change pilot projects
Agriculture		• Manure management conditions (BE, NL, DE) • Agriculture burning restrictions • Animal rearing criteria (CLRTAP) • Fertilizer Management • Food and feeding strategies
Economic incentives / general		• Greening vehicle taxation (differentiated registration tax, road tax, fuel tax) • NOx Funds (Norway) • Off-set systems (US) • Tradable permits (NL, California)
Public Information		• Promotion campaigns, on-site training and inspection for energy efficiency and RES • Awareness and actions at citizen level
Other		• Measures funded by the EU Cohesion Fund.

APPENDIX 4.4: ILLUSTRATING LOCAL ACTION TO REDUCE AIR POLLUTANT --THE DRESDEN CASE

This appendix offers further illustration of local measures implemented in the case of Dresden (Germany). Dresden is a town of about 517 000 inhabitants, situated in the river basin of the river Elbe in Eastern Germany. There is a wide mix of industries, but heavy industry is not dominant. It is an important traffic junction. Part of the city is densely built. This results in higher average temperature in these areas, resulting in less heating in winter, but also in less natural ventilation. Dresden has succeeded in reaching the limit values of PM10 and NO2 over the past years. There was no application for a Time Extension Notification (TEN) for PM10, but a TEN for NO2 was granted in 2011. The figure below shows the trends for PM10 and NO2 air quality levels from 2001.



The below paragrahs describe the measures taken in Dresden with respect to emissions from combustion installations, transport, and other sectors.[300]

Combustion installations

Already in the period from 1989 till 2000 Dresden already took many local measures related to emissions from combustion installations that resulted in a decrease of PM emissions from large and small combustion installations by about 99% and 97% respectively. These measures included:

- decommissioning of coal fired district heating plants
- fuel switch in district heating plants towards gas
- fuel switch in domestic heating installations
- modernising domestic heating installations

Whilst this reduction potential of PM emissions is no longer available for Dresden in future, they constitute good examples for other cities that have not yet taken such measures. It is noted that these reductions in Dresden were achieved without a significant increase in the use of renewable energy which could thus remain available options for going further (ground water heat pumps, solar).

Transport

[300] Source: Luftreinhalteplan für die Landeshauptstadt Dresden 2011.

The local emission inventories established by Dresden indicated a significant contribution from transport. For example trucks are responsible for about 74% of NOx and about 60% of PM10 emissions. On that basis, several measures have been implemented to address transport from the period starting from the 1999-2010 onwards. These measures include:

- urban planning measures –including the development of new residential areas close to existing road infrastructure; use of designated areas in the city to avoid residential expansion over a large area, and reconversion and upgrading of derelict areas and brownfields
- infrastructure development measures –such as changing the structure of the main roads from radial to tangential thereby avoiding that traffic first has to go to the city centre before leaving town again for the right direction; construction of bypasses for transit traffic; replacing top layers of roads; improving traffic signs taking into account local and regional traffic flows; improved intermodality (e.g.bus/metro, park and ride, bike and ride, construction of an intermodality logistics centre); expansion of public transport, especially metro and local train; construction of a railway link with the airport; electrification of railway tracks; purchase of cleaner buses; eliminate barriers (e.g. river and railway crossings); and promotion of non-motorised traffic (expansion and upgrading of pedestrian and cycling lanes, elimination of crossings and barriers, better traffic signs)
- traffic management –including improved use of existing infrastructure; preferential road access for public transport; intelligent traffic flow controls with real time information (e.g. green wave); speed limits (e.g. 30 km/h zones), traffic information with details on construction site related barriers , parking options for passenger cars as well as tourist buses, and intermodality options; promotion of car-sharing; traffic control and guidance for trucks; and speed limits on motorways close to town.
- mobility management including better or preferential access for cleaner vehicles; coordination with mobility plans for big employers (e.g. work-related traffic of staff); and combined tickets and e-tickets for public transport

Some results are remarkable: the city managed to increase the share of bicycle use in transport from 9.7% in 2003 to 12.3 % in 2009.

<u>Other measures</u>

Due to the specific nature of the city with its densely built city centre, special attention has been devoted to improve the heat balance and increase natural ventilation and the flow of fresh air from the surrounding area by constructing and expanding city parks and urban green. An analysis of the major fresh air flows from the area surrounding the city was done and based on the findings the following measures were taken:

- shifting the long term urban planning strategy towards a more compact city with concentration of energy efficient "city cells" in an ecological network; liberating environmental corridors; create a mix of functionalities (e.g. living, working, spending free time , sport, tourism); and ensuring ventilation and create/protect city zones with low concentrations of pollutants
- develop environmentally functional spaces and corridors such creating and linking woody areas; establishing green corridors that are wide enough and that integrate private and public green; making sure that corridors are nearby for all citizens; developing green "junctions" ; and making the corridors accessible for pedestrians and cyclists.
- developing criteria for the compact city's "city cells" to make them fit in the green urban structure by promoting active climatic elements such as vegetation, water works, solar

energy, heat pumps, green roofs; promoting natural ventilation; replacing asphalt roads by other surfaces that retain less heat, linking green areas with public spaces such as schools, hospitals

It is furthermore noted that a part of these measures (e.g. speed limits) were coordinated with local noise plans or measures for urban green (parks, green corridors) and urban planning in general.

Although the measures mentioned above were mostly local, some required at least some cooperation or coordination with other levels of government or companies to get the best results.

APPENDIX 4.5 MARKET BASED INSTRUMENTS (MBIS) FOR PROMOTING CLEAN HOUSEHOLD HEATING APPLIANCES

This appendix contains the summary of a JRC-IPTS study conducted in support of this review to assess the potential for using market based instruments to contribute to reducing the emissions of particulate matter of less than 10 micrometres (PM10) from household heating appliances in the framework of the review of the Thematic Strategy on Air Pollution (TSAP).

The study focused on the assessment of the economic and environmental impacts of possible scrappage policies for promoting the accelerated replacement of existing heating appliances by cleaner ones. Under this policy programmes, households replacing an old appliance by a cleaner one would receive a subsidy from the government. This subsidy would compensate households for the residual value of the appliance scrapped and the opportunity costs of the early investment in a new one.

Two different scenarios have been analysed: 1) a "Scrappage All" scenario where all the different types of conventional appliances that do not incorporate any emission control technology ("non-controlled" appliances) are replaced, and 2) "Scrappage SHB" scenario where only "non-controlled" firewood and hard coal fired manual single house boilers (SHB) are replaced. It has been assumed that the scrappage programme would be in force for 3 years (between 2018 and 2020). For each of these scenarios, the study further focused on the effects of different levels of replacement of the "non-controlled" appliances and the size of subsidies relative to the investment costs.

Results for the EU-27 show that a scrappage programme designed to replace all types of "non-controlled" appliances and with subsidies limited to 20% of the investment costs, could contribute to the reduction of the emissions of PM10 from household heating appliances in 2020 by 18% (-79 kt), with an average annual reduction of 7.4% (-22 kt/year) for the period 2018-2030. This early replacement would increase average annual investment costs of the period 2018-2030 by 11% (+1.5 billion €/year). Total subsidies to compensate households for the early replacement would amount to 9.4 billion € during the period 2018-2020. Health benefits of this policy scenario would total between 0.9 and 2.7 billion €/year. This scheme would increase the Gross Value Added (GVA) by 2.3 billion €/year.

The scrappage mechanism which only targets SHB and with subsidies limited to 20% of the costs could achieve 9% of the reduction resulting from the previous "Scrappage All" scenario, while cutting the abatement costs and subsidies to 3.7% and 4.9% respectively. This mechanism would reduce PM10 emissions in 2020 by -3% (13.3 kt) and the average emissions of the period 2018-2030 by -0.7% (2.1 kt), the costs would increase by 0.5% (55.6 million €/year). Total subsidies during the period 2018-2020 would sum to 411 million €. Health benefits would range from 147 and 424 million €/year. Around 50% of the investment costs and subsidies, and 61% of the reduction in PM10 emissions would be generated by the accelerated replacement of SHB in Poland. This scrappage mechanism would increase the GVA by 106 million €/year; 42% of the total increase in the GVA would be in Poland, 11% in Germany, 8.5% in Slovenia and 7% in the United Kingdom.

APPENDIX 4.6 LESSONS LEARNED FROM THE "AIR IMPLEMENTATION PILOT"

The Air Implementation Pilot brought together 12 cities across the European Union and was jointly run by the cities themselves, the European Commission, and the European Environment Agency (EEA). It aimed at better understanding the challenges cities faced in implementing air quality policy, and also encouraged the cities to share their experiences, so they could learn from each other and see what has worked and what has not worked in other cities. The pilot also aimed to develop common proposals to help improve implementation of air policy. The pilot lasted for 15 months, starting in March 2012. It consisted of several workshops held with representatives of the European Commission's Directorate General of Environment; the EEA; the EEA's Topic Centre on Air Pollution and Climate Change Mitigation; and representatives of the cities participating in the pilot. Eight cities originally took part in the pilot: Berlin, Dublin, Madrid, Malmö, Milan, Ploiesti, Prague, and Vienna. Four more cities subsequently joined at the end of 2012: Antwerp, Paris, Plovdiv, and Vilnius. The cities were selected so as to ensure a representative sample of the diversity of Europe's urban areas. The selection aimed at including cities from different parts of Europe, of different population sizes, with different administrative traditions, and with a variety of sources of pollutants. The pilot focused on five 'work streams', where lessons for implementation could most usefully be drawn. The lessons learned and recommendations for further action are provided below.

Local emission inventories

Although 11 of the 12 cities have emission inventories[301], the pilot uncovered a great variety of methodologies used to compile these inventories. This variety means that the cities' emission inventories are often not comparable with one another, or with the emission inventories of the regions within which they are located. Cities have problems taking into account all sources of pollution, due to the difficulty in finding available data, or because of the difficulty in appropriately quantifying different sources.

The pilot project concluded that better input data and more guidance are needed on inventory methodology.

Modelling and the use of air quality models

For air quality modelling[302], there was also a great diversity of models used by the cities. Because air quality models make use of emission inventories, often the shortcomings of these inventories carry over to the modelling activities. Additional issues encountered by the cities related to the other input data used in models, such as meteorological information, and background concentrations of pollutants. Another difficulty when applying models at urban level was how to accurately reflect the specificities of urban topography, such as pollution hot spots on kerbsides. Finally, many city representatives said that the results of their models were often highly complex, and therefore difficult to interpret, consuming a lot of resources and computational time. This complexity also makes the subsequent validation of the results more difficult.

301 Emission inventories are sets of data that show what pollutants are emitted into the air, where, and from which sources.
302 Models are the computer‑based tools that help to understand air pollution processes.

The pilot project concluded that greater training in modelling was needed, along with improved input data (including meteorological data, background concentrations, and the specificities of each city's topography).

Monitoring networks

On monitoring networks[303], the pilot project found that most of the cities had the necessary number of monitoring stations required by the relevant directives. However, the criterion for the macro‑scale siting of ozone stations (their distribution between urban and suburban locations) has not always been met in the cities participating in the Air Implementation Pilot.

The cities' experts therefore recommended addressing this issue of the location of monitoring stations. Some experts also suggested that the air quality directives provide more detailed requirements for measuring stations. These requirements would stipulate the macro-siting (where the stations are located with respect to major pollution sources) and micro-siting (where the stations are sited with respect to their immediate surroundings, such as their height, proximity to the kerb, etc.), as well as the representativeness of the stations (the spatial area over which the value measured at the station can be accepted as meaningful).

Air quality management practices

The pilot project examined trends in concentrations of three air pollutants: nitrogen dioxide, particulate matter and ozone and the effect of measures taken to improve air quality for those pollutants. No clear trend in concentrations of these pollutants could be seen in the monitoring stations considered. Nevertheless, some commonalities did emerge in the management measures taken by the cities. In most of the cities, and in agreement with the main pollutant sources identified, more than the 50 % of the implemented measures are traffic related. Other measures focused on the domestic, commercial and industrial sectors. Another common theme emerged among all the cities: how to define and assess the effects of measures. The cities' experts also expressed a common uncertainty regarding how best to assess the costs and benefits of measures to abate pollution. Again, some of the deficiencies identified in previous work streams have implications that carry over: improvement of inventories and modelling tools, for instance, would better enable cities to assess which of their measures were most effective in improving air quality. Further support was also requested in the form of proposals for new EU legislation. Examples included: standard methodologies to measure emissions from boilers, regulations for domestic stoves, and improved vehicle emissions data to help ascertain the effect of traffic measures on air quality.

Public information.

This work stream focused on how the cities kept their citizens informed about air quality. The pilot project showed that, by and large, air quality information that is required by legislation to be made public is promptly provided by the cities to the public, mostly through dedicated air quality internet sites. In general, the cities underuse mass media, social media websites, and new technologies like smartphone applications. Most of the participating cities lacked feedback on the interest of their citizens in air quality issues. There is thus room for cities to increase the presence of air quality issues

[303] These are the networks of sampling stations located across cities that take regular measurements of air quality.

in the media and for them to develop their smartphone and social media presences. The adoption of a common Europe-wide index for air quality, using the same colour codes to facilitate comprehension, would also help make air quality information comparable across Europe.

Next steps

The Air Implementation Pilot identified a number of challenges which cities face in implementing EU air quality policy that would have to be taken up in the present air quality policy review. This would include further consideration how EU action can best support local, regional and national authorities in addressing them. Options could include:

- financing of improved management and capacity-building through the forthcoming revision of the LIFE regulation (3);
- the development of a broader network of cooperation on the urban air quality challenge across the EU, with regular information exchange, capacity building, and a common database of measures;
- promoting and enabling increased use of other EU funding opportunities, such as the structural funds, particularly to address local drivers of persistent non-compliance with EU air-related legislation.

One possibility that has been discussed is to package all the European measures related to urban air quality in a single programme, which would then be one of the accompanying documents to a revised Thematic Strategy on Air Pollution. For its part, the EEA will continue to support its member countries and the European Commission in their aim to improve the implementation of environmental policy.

ANNEX 5 FUTURE AIR QUALITY PROJECTIONS ASSUMING NO CHANGE IN CURRENT POLICIES

1. METHODOLOGY FOR PROJECTING FUTURE EMISSIONS AND AIR QUALITY IMPACTS

Projections for future emission scenarios under alternative hypotheses have been prepared using the GAINS suite of models. This toolbox[304] brings together an ensemble of interlinked models with the objectives to simulate future emission scenarios and cost-effective emission reduction strategies; this is done following an upstream causal chain that includes standard Commission projections on economic development, energy, transport, agriculture and climate change mitigation policies to estimate emission levels for pollutants, which are subsequently used to determine concentration/ deposition patterns across Europe and finally impacts on human health, ecosystems, agricultural crops and the built environment.

2. MAIN ASSUMPTIONS AND RELATED UNCERTAINTIES

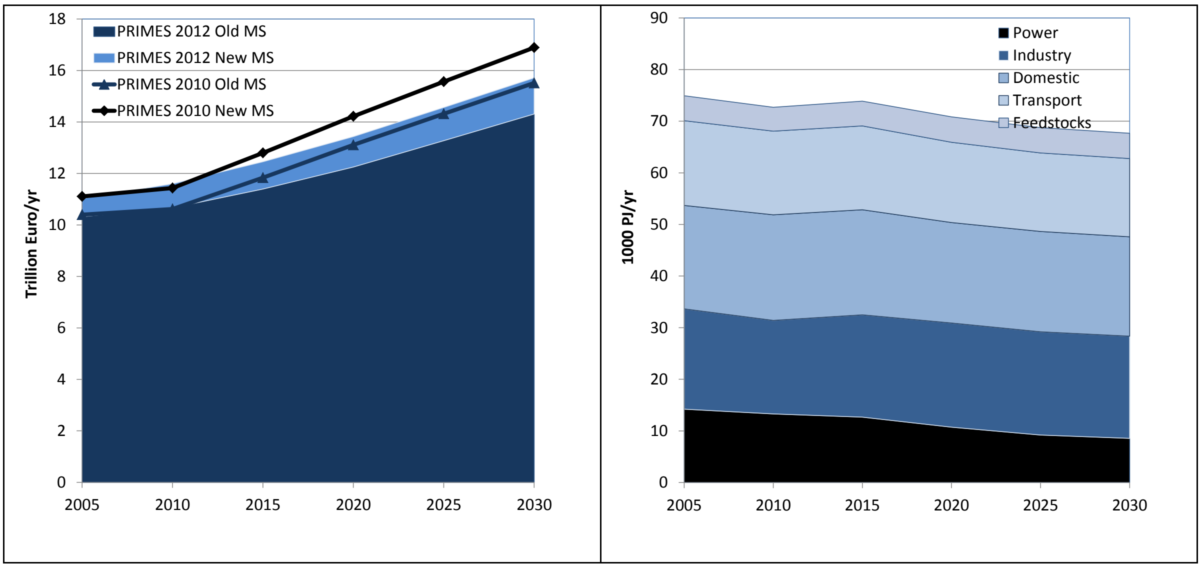
Baseline emissions are determined under standard Current Legislation assumptions described in chapter 2 below. Other important assumptions relate to economic growth, national energy balances, and agriculture.

[304] See description on the webpage of the EC4MACS Life+ project, which developed the latest update of the GAINS Integrated Assessment Modelling (IAM) toolbox

The baseline emission scenario has been developed based on and consistent with the draft 2012-3 EU Reference energy projection coordinated by Commission services ENER, CLIMA and MOVE. For the energy and CO2 reference scenario, the PRIMES energy system model operated by the National Technical University of Athens is used. Energy-related activity data and the evolution of fuel prices are taken from this scenario. It uses macroeconomic assumptions which are based on DG ECFIN/ Economic Policy Committee short and medium term growth projections and on the DG ECFIN/ EPC Ageing Report 2012 for long term GDP growth and population trends. Projections for agricultural activities are those developed with the CAPRI model in the context of the same EU Reference projection.

Despite a doubling in economic activity by 2050, the baseline scenario suggests a stabilisation of energy consumption, as energy efficiency policies will successfully reduce energy demand in households and industry. On a sectorial basis, the rapid penetration of energy efficiency measures maintains constant or slightly decreasing energy consumption despite the assumed sharp increases in production levels and economic wealth.

Figure A5.1: economic growth (left-hand side) and energy use by sector (right-hand side) in the E previosu PRIMES 2010 reference energy projections.



The adopted policies for renewable energy sources are expected to increase biomass use by more than a factor of two thirds in 2030 compared to 2005, and to triple energy from other renewable sources (e.g., wind, solar). In contrast, coal consumption is expected to decline by 40% by 2030, and oil and natural gas consumption is calculated to be 20% lower than in 2005, as shown in the following table.

Table A5.1: energy consumption by source up to 2030, EU 28.

PJ	2005	2010	2015	2020	2025	2030
Coal	13,3	11,8	11,1	9,9	9,0	7,3
Oil	28,6	26,0	24,7	23,1	22,2	21,8
Gas	18,8	18,6	18,2	17,0	17,0	16,6
Nuclear	10,8	9,9	9,6	8,1	7,6	8,4
Biomass	3,6	5,2	5,7	6,3	6,4	6,4
Other Renewables	1,6	2,5	3,8	5,3	6,2	7,0
Total	76,7	74,0	73,1	69,7	68,4	67,5

3. EU POLICIES INCLUDED IN THE CURRENT LEGISLATION (CLE) BASELINE

In addition to the energy, climate and agricultural policies that are assumed in the different energy and agricultural projections, the baseline projections consider a detailed inventory of national emission control legislation (including the transposition of EU-wide legislation).[305] They assume that these

[305] For CO2, regulations are included in the PRIMES calculations as they affect the structure and volumes of energy consumption. For non-CO2 greenhouse gases and air pollutants, EU and Member States have

regulations will be fully complied with in all Member States according to the foreseen time schedule. For air pollutants, the baseline assumes the regulations described in the tables below.[306] The baseline assumes full implementation of this legislation according to the foreseen schedule.

Table A5.2: Legislation considered for SO2 emissions

- Directive on Industrial Emissions for large combustion plants (derogations and opt-outs are considered according to the information provided by national experts)
- BAT requirements for industrial processes according to the provisions of the Industrial Emissions directive.
- Directive on the sulphur content in liquid fuels
- Fuel Quality directive 2009/30/EC on the quality of petrol and diesel fuels, as well as the implications of the mandatory requirements for renewable fuels/energy in the transport sector
- MARPOL Annex VI revisions from MEPC57 regarding sulphur content of marine fuels
- National legislation and national practices (if stricter)

Derogations under the IPPC, LCP and IED directives granted by national authorities to individual plants are considered to the extent that these have been communicated by national experts to IIASA.

Table A5.3: Legislation considered for NOx emissions

- Directive on Industrial Emissions for large combustion plants (derogations and opt-outs included according to information provided by national experts)
- BAT requirements for industrial processes according to the provisions of the Industrial Emissions directive
- For light duty vehicles: All Euro standards, including adopted Euro-5 and Euro-6, becoming mandatory for all new registrations from 2011 and 2015 onwards, respectively (692/2008/EC), (see also comments below about the assumed implementation schedule of Euro-6).
- For heavy duty vehicles: All Euro standards, including adopted Euro-V and Euro-VI, becoming mandatory for all new registrations from 2009 and 2014 respectively (595/2009/EC).
- For motorcycles and mopeds: All Euro standards for motorcycles and mopeds up to Euro-3, mandatory for all new registrations from 2007 (DIR 2003/77/EC, DIR 2005/30/EC, DIR 2006/27/EC). Proposals for Euro-4/5/6 not yet legislated.
- For non-road mobile machinery: All EU emission controls up to Stages IIIA, IIIB and IV, with introduction dates by 2006, 2011, and 2014 (DIR 2004/26/EC). Stage IIIB or higher standards do not apply to inland vessels IIIB, and railcars and locomotives are not subject to Stage IV controls.

issued a wide body of legislation that limits emissions from specific sources, or have indirect impacts on emissions through affecting activity rates.

306 The analysis does not consider the impacts of other legislation for which the actual impacts on future activity levels cannot yet be quantified. This includes compliance with the air quality limit values for PM, NO_2 and ozone established by the Air Quality directive, which could require, inter alia, traffic restrictions in urban areas and thereby modifications of the traffic volumes assumed in the baseline projection. For methodological reasons it is also difficult to reflect the impact of some other relevant directives such as the Nitrates Directive.

- MARPOL Annex VI revisions from MEPC57 regarding emission NOx limit values for ships
- National legislation and national practices (if stricter)

For NO_x emissions from transport, all scenarios presented here assume from 2017 onwards real-life NO_x emissions to be 1.5 times higher than the NTE Euro-6 test cycle limit value. This results in about 120 mg NO_x/km for real-world driving conditions, compared to the limit value of 80 mg/km. As portable emissions measurement systems (PEMS) will only be introduced gradually, between 2014 and 2017 emission factors of new cars are assumed at 310 mg NO_x/km. Also, inland vessels are excluded from Stage IIIB or higher emission controls, and railcars and locomotives not subject to Stage IV controls.

Table A5.4: Legislation considered for PM10/PM2.5 emissions

- Directive on Industrial Emissions for large combustion plants (derogations and opt-outs included according to information provided by national experts)
- BAT requirements for industrial processes according to the provisions of the Industrial Emissions directive
- For light and heavy duty vehicles: Euro standards as for NOx
- For non-road mobile machinery: All EU emission controls up to Stages IIIA, IIIB and IV as for NOx.
- National legislation and national practices (if stricter)

Table A5.5: Legislation considered for NH3 emissions

- IPPC directive for pigs and poultry production as interpreted in national legislation
- National legislation including elements of EU law, i.e., Nitrates and Water Framework Directives
- Current practice including the Code of Good Agricultural Practice
- For heavy duty vehicles: Euro VI emission limits, becoming mandatory for all new registrations from 2014 (DIR 595/2009/EC).

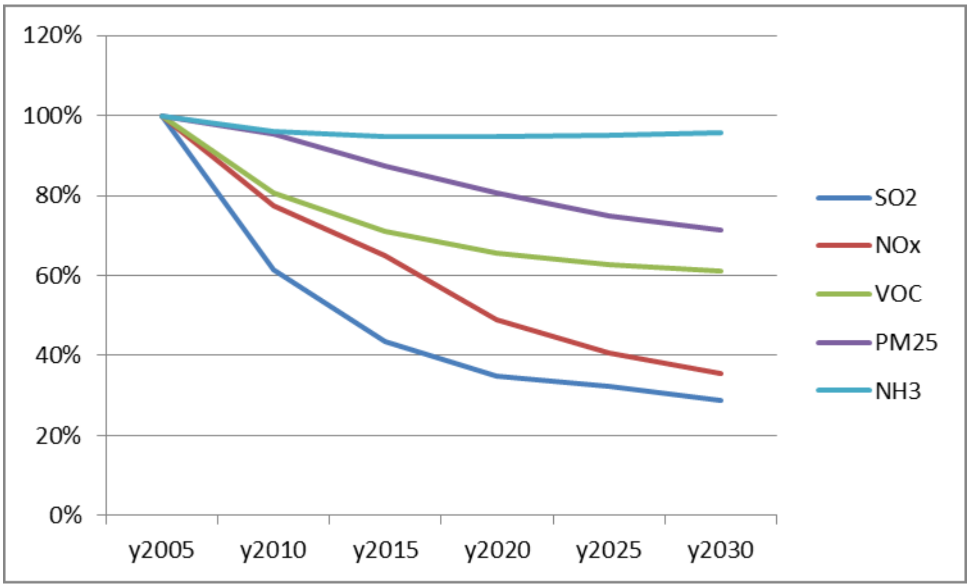
Table A5.6: Legislation considered for VOC emissions

- Stage I directive (liquid fuel storage and distribution)
- Directive 96/69/EC (carbon canisters)
- For mopeds, motorcycles, light and heavy duty vehicles: Euro standards as for NOx, including adopted Euro-5 and Euro-6 for light duty vehicles
- EU emission standards for motorcycles and mopeds up to Euro-3
- On evaporative emissions: Euro standards up to Euro-4 (not changed for Euro-5/6) (DIR 692/2008/EC)
- Fuels directive (RVP of fuels) (EN 228 and EN 590)
- Solvents directive

- Products directive (paints)
- National legislation, e.g., Stage II (gasoline stations)

4. FUTURE AIR POLLUTANT EMISSIONS UNDER THE CURRENT POLICY SCENARIO

On the same time horizon, as a consequence of the structural changes in the energy and transport sectors and the progressing implementation of emission control legislation, SO2 emissions will fall drastically. The largest reductions are foreseen for the power sector, which is projected to cut its emissions by almost 90% in 2050 compared to 2005. NOx emissions may drop by more than 65% in the coming years provided that the EURO 6 emission standards are effectively implemented. Legislation directed at other pollutants reduces PM2,5 emissions by about 40%. In contrast to the other air pollutants, only minor changes are expected for NH3 emissions. VOC emissions will decline by 40% in the EU27, and converge on a per-capita basis across Member States.



More detail is provided below on a pollutant-by-pollutant basis

4.1. Sulphur dioxide

Progressing implementation of air quality legislation together with the structural changes in the energy system will lead to a sharp decline of SO_2 emissions in the EU; in 2025 total SO_2 emissions would be almost 70% below the 2005 level. Most of these reductions come from the power sector. Full implementation of the available technical emission control measures could bring down SO_2 emissions by up to 80% in 2025 vs 2005.

SO2 emissions	*2005*	*2010*	*2015*	*2020*	*2025*		*2030*	
EU28, kilotons					CLE	MTFR	CLE	MTFR
Power generation	5445	2739	1375	937	824	608	637	436
Domestic sector	623	624	520	467	399	250	336	213
Industrial combust.	1100	695	640	616	605	362	613	355

Industrial processes	743	626	578	577	570	344	575	345
Fuel extraction	0	0	0	0	0	0	0	0
Solvent use	0	0	0	0	0	0	0	0
Road transport	36	7	6	5	5	5	5	5
Non-road mobile	215	137	109	71	37	29	37	29
Waste treatment	2	2	2	2	2	1	2	1
Agriculture	7	8	8	9	9	0	9	0
Sum	8172	4837	3238	2685	2451	1598	2214	1383

4.2. Nitrogen oxides

Also for NO_x emissions, implementation of current legislation will lead to significant declines, and for 2025 a 60% reduction is estimated. These changes emerge from measures in the power sector, and more importantly, from the implementation of the Euro-6 standards for road vehicles. Full implementation of additional measures for stationary sources could bring NO_x emissions in 2025 68% down compared to 2005. The sensitivity of these projections towards uncertainties about future real-life emissions from Euro-6 standards as well as the potential for further emission cuts from 'Super Ultra-Low Emission Vehicles' (SULEV) is explored in Chapter 5 of the main IA.

NOx emissons	*2005*	*2010*	*2015*	*2020*	*2025*		*2030*	
EU28, kilotons					CLE	MTFR	CLE	MTFR
Power generation	2879	1908	1513	1172	1055	636	906	517
Domestic sector	632	619	580	532	506	417	471	389
Industrial combust.	1253	913	898	884	901	492	929	503
Industrial processes	213	184	172	174	171	137	172	137
Fuel extraction	0	0	0	0	0	0	0	0
Solvent use	0	0	0	0	0	0	0	0
Road transport	4905	3751	2994	1890	1210	1210	887	887
Non-road mobile	1630	1400	1156	914	748	632	661	513
Waste treatment	8	7	6	6	5	1	5	1
Agriculture	16	17	19	21	21	1	21	1
Sum	11538	8799	7338	5591	4617	3526	4051	2947

4.3. Fine particulate matter

Progressing introduction of diesel particle filters will reduce PM2.5 emissions from mobile sources by about two thirds up to 2025; the remaining emissions from this sector will mainly originate from non-exhaust sources. While this trend is relatively certain, total PM2.5 emissions in Europe will critically depend on the development for small stationary sources, i.e., solid fuel use for heating in the domestic sector. The anticipated decline in solid fuel use for heating together with the introduction of newer stoves would reduce emissions from this sector by ~17% in 2025. However, more stringent product standards could cut emissions by up to two thirds.

Overall, total PM2.5 emissions in the EU-28 are expected to decline by 25% in the CLE case, while additional technical measures could cut them by up to 60% compared to 2005.

PM2,5 emissions	*2005*	*2010*	*2015*	*2020*	*2025*		*2030*	
EU28, kilotons					CLE	MTFR	CLE	MTFR
Power generation	132	92	70	63	60	25	53	21
Domestic sector	573	695	653	597	523	230	465	156
Industrial combust.	85	72	73	75	73	38	76	37
Industrial processes	213	190	196	199	199	138	201	139
Fuel extraction	9	8	8	7	7	7	6	6
Solvent use	0	0	0	0	0	0	0	0
Road transport	270	217	149	115	104	104	102	102
Non-road mobile	123	99	74	53	41	33	35	27
Waste treatment	88	88	89	89	90	64	90	64
Agriculture	155	155	164	171	172	53	172	54
Sum	1647	1616	1477	1370	1269	692	1201	607

4.4. Ammonia

Although NH_3 emissions are subject to targeted controls in the agricultural sector and will be affected as a side impact of emission legislation for road transport (i.e. by improved catalytic converters), only slight changes in total emissions in the EU-28 are expected up to 2030.

Due to the absence of effective wide-spread legislation on the control of NH_3 emissions from the agricultural sector, the baseline shows only little change in NH_3 emissions over time. For 2025, a 5% decline in the EU-28 is estimated. However, EU-wide application of emission control measures that are already implemented in some countries could cut NH_3 by about one third.

Ammonia emissions	*2005*	*2010*	*2015*	*2020*	*2025*		*2030*	
EU28, kilotons					CLE	MTFR	CLE	MTFR
Power generation	14	22	22	25	24	22	23	20
Domestic sector	19	22	23	22	20	20	19	18
Industrial combust.	4	5	5	5	5	8	6	8
Industrial processes	78	73	74	75	75	28	75	28
Fuel extraction	0	0	0	0	0	0	0	0
Solvent use	0	0	0	0	0	0	0	0
Road transport	128	88	67	54	48	48	46	46
Non-road mobile	2	2	2	2	2	1	2	1
Waste treatment	166	174	174	174	173	173	173	173
Agriculture	3518	3292	3336	3338	3311	2267	3319	2274
Sum	3928	3678	3702	3693	3658	2566	3663	2568

4.5. Volatile organic compounds

The future trend in VOC emissions is strongly determined by measures for mobile sources and by dedicated controls of solvents emissions.

Further implementation of the Euro-standards will eliminate almost all VOC emissions from road vehicles. Legislation on solvents is expected to cut VOC emissions from this sector by about 20% in 2025 relative to 2005. However, there remains significant potential for further reductions for VOC emissions from solvents. Together with additional measures in households, these could cut total VOC emissions in the EU-28 by two thirds, compared to the 37% reduction in the baseline case.

VOC emissions	*2005*	*2010*	*2015*	*2020*	*2025*		*2030*	
EU28, kilotons					*CLE*	*MTFR*	*CLE*	*MTFR*
Power generation	176	196	185	181	172	132	162	117
Domestic sector	987	1080	1026	911	813	195	736	156
Industrial combust.	53	56	60	69	77	77	85	85
Industrial processes	943	875	878	884	815	659	819	663
Fuel extraction	538	385	364	332	305	254	289	242
Solvent use	3600	3037	2882	2795	2584	1364	2603	1375
Road transport	2047	1100	593	392	293	293	257	257
Non-road mobile	657	538	414	355	314	259	281	223
Waste treatment	133	120	95	89	86	74	84	74
Agriculture	125	126	137	146	146	0	146	0
Sum	9259	7512	6635	6152	5604	3308	5460	3191