International Review of Non-Attainment Area Air Quality Management Tools and Techniques

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Prepared by Ramboll Environ

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Final Report
INTERNATIONAL REVIEW OF NON-ATTAINMENT AREA AIR QUALITY MANAGEMENT TOOLS AND TECHNIQUES

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ACRONYMS AND ABBREVIATIONS

Acronyms and Abbreviations - General	
AEP	Alberta Environment and Parks
AAQ	Ambient Air Quality
AQ	Air Quality
AQM	Air Quality Management
BAU	Business As Usual
BPM	Best Management Practices
CEMS	Continuous Emissions Monitoring System
EIS	Environmental Impact Statement
GHG	Green House Gas
NAA	Non-attainment Area
PMF	Positive Matrix Factorisation
UNECE	United Nations Economic Commission for Europe
Acronyms and Abbreviations - Canada	
BLIER	Base-Level Industrial Emission Requirement
CAAQS	Canadian Ambient Air Quality Standards
CEPA	Canadian Environmental Protection Act
Acronyms and Abbreviations – United States	
BACM	Best Available Control Measures
BACT	Best Available Control Technology
CAA	Clean Air Act
CEMS	Continuous Emission Monitoring System
I&M	Inspection and Maintenance (program)
HAP	Hazardous Air Pollutant
LAER	Lowest Achievable Emission Rate
NAAQS	National Ambient Air Quality Standards
NEI	National Emissions Inventory
NESHAP	New Emission Standard for Hazardous Air Pollutants
NSPS	New Source Performance Standards
NSR	New Source Review
OTC	Ozone Transport Commission
OTR	Ozone Transport Region
PSD	Prevention of Significant Deterioration
RACM	Reasonably Achievable Control Methods
RACT	Reasonably Available Control Technology

RFP	Reasonable Further Progress
SIP	State Implementation Plan
USEPA	United States Environmental Protection Agency
WHO	World Health Organization
	Acronyms and Abbreviations – Europe
BAT	Best Available Technologies
BAT-AEL	Best Available Techniques Associated Emission Levels
BATNEEC	Best Available Techniques Not Entailing Excessive Cost
BREF	BAT Reference Documents
CAFÉ	Cleaner Air For Europe (Directive 2008/50/EC)
EEV	Enhanced Environmentally Friendly Vehicles
EU	European Union
ERC	Emission Reduction Commitments
IPPC	Integrated Pollution Prevention and Control
FAIRMODE	Forum for AIR quality MODeling in Europe
IED	Industrial Emissions Directive
NEC	National Emissions Ceiling
NFR	Nomenclature For Reporting
NSL	National Air Quality Cooperation Programme (Netherlands)
P&R	Park and Ride
LAURE	French law on “rational use of energy”
LEZ	Low Emissions Zone
LTCEV	French regulation 2015-992 for “energy transition for a green growth”
LV	Limit Value
NEC(D)	National Emissions Ceilings (Directive)
NeR	Netherlands Emission Guidelines for Air
PDU	French urban transportation plan
PPA	Protection Plan of Atmosphere
PREPA	French national atmospheric pollution emissions reduction plan
PUQA	French national air quality action plan
SNAP	Nomenclature for Sources of Air Pollution
SRCEA	French regional atmospheric pollution emissions reduction plan
UBA	German Federal Environment Agency (Umweltbundesamt)
IED	EU directive on emissions from industrial sources
CBA	Cost/Benefit Analysis
IS	Impact Study
ERS	French health risk assessment

TGAP	French general tax on polluting activities
AASQA	French regional air quality agencies
LCSQA	French air quality monitoring central laboratory
DREAL/DRIEE	French Regional environment, planning and housing agency
IMPEL	European Union Network for the Implementation and Enforcement of Environmental Law
	Acronyms and Abbreviations – Australia and Asia
AAQ	Ambient Air Quality
ADR	Australian Design Rule
ANZIC	Australian and New Zealand Standard Industrial Classification
EPA	Environment Protection Authority
EPP	Environmental Protection Policy
DoE	Department of the Environment
DGLC	Design Ground Level Concentration
EPM	Environmental Protection and Management (Hong Kong)
EPP	Environmental Protection Policy
GMR	Greater Metropolitan Region
GRUB	Generally Representative Upper Bound
LBL	Load Based Licensing
NEPM	National Environmental Protection Measure
NEPC	National Environment Protection Council
NPI	National Pollutant Inventory
NSW	New South Wales
PEM	Protocol for Environmental Management
POEO	Protection of Environment Operations
PHIC	Port Hedland Industry Council
PRP	Pollution Reduction Programs
RAT	Reasonably Achievable Technologies
SA	South Australia
SEPP	(Victoria) State Environment Protection Policies
UHAQMN	Upper Hunter Valley Air Quality Monitoring Network
UHPCS	Upper Hunter Fine Particle Characterisation Study
	Pollutant Species
CH_4	Methane
CO	Carbon monoxide
NOx	Nitrogen oxides
NO_2	Nitrogen Dioxide

O_3	Ozone
NH_3	Ammonia
Pb	Lead
PM	Particulate matter
PM_{10}	Particulate matter with aerodynamic diameter less than 10 um
$PM_{2.5}$	Particulate matter with aerodynamic diameter less than 2.5 um
SO_2	Sulphur dioxide
VOC	Volatile organic compound

EXECUTIVE SUMMARY

Alberta's Environmental Protection and Enhancement Act provides for the assessment and regulation of activities to minimize environmental impacts based on principles including continuous improvement and pollution prevention. In support of Alberta Environment and Park's (AEP's) implementation of the Act, Ramboll Environ conducted a jurisdictional review of regulatory strategies, tools, and practices used to manage and improve air quality in "non-attainment" areas (NAAs) where air quality has been identified as exceeding (or close to exceeding) established air quality goals or standards. Our review included leading jurisdictions around the world that have well-established, advanced air quality management programs in place, including jurisdictions in Australasia, North America and Europe.

A uniform questionnaire was used to help guide information collection for each selected jurisdiction. The questionnaire was designed to cover the major topics related to NAA management policies, programs, practices, and tools. Questions focused on five key areas: 1) the regulatory system; 2) applications of data and technology (tools); 3) stakeholder and public engagement processes; 4) assessment of degree of success, strengths and weaknesses; and 5) enforcement mechanisms. Use of a common set of questions for each jurisdiction was intended to facilitate the inter-comparison of management approaches between the various jurisdictions.

Results of this analysis revealed several features that are common to most jurisdictions:

- Basic control requirements for all large stationary (industrial) sources based on principles regarding best practices, availability, technical feasibility, and economic viability. These are based on the concept of pollution prevention and polluter pays. Emission control methods or technology clearinghouses are used in the U.S. and the EU to facilitate the proper specification of control requirements.
- Thresholds for identifying sources requiring the most stringent level of regulatory oversight are typically based on both industry type and level of emissions in all jurisdictions. However, specific definitions and thresholds vary from one jurisdiction to the next.
- Environmental reviews of major new projects are commonly (but not always) required. Our review suggests that both Australia and EU Member States rely heavily on the environmental review process to limit the air quality impacts of new sources whereas in U.S. NAAs this is largely handled by the non-attainment New Source Review regulations.
- Determining when modifications to existing sources should trigger requirements for installation of modern emission controls is a difficult issue that the U.S. appears to have had the most experience and success in addressing.

Official designation of geographic areas with prescribed boundaries in which air quality standards or goals are not being met as NAAs is only done under specific regulatory authority in the U.S. In Canada, the new AQMS process – which includes establishment of Canadian Ambient Air Quality Standards (CAAQS), identifying local air zones and regional airsheds, and classification of air zones by management level (red, orange, yellow, green) according to monitored air quality values relative to the CAAQS – forms the basis of an air quality management framework which the provinces and territories can utilize. In other jurisdictions, the concept of "non-attainment" is only

loosely applied to evaluations of ambient monitoring data from individual monitoring sites. While special measures are often prescribed for heavily polluted locations, there is no uniform application of specific procedures for NAAs prescribed in regulation (apart from the new "tiered procedure" ozone impact assessment methodology used in NSW, Australia).

While the economic costs of implementing emission reduction measures are generally easy to quantify, the economic benefits are often greater but less obvious and more uncertain. While not without controversy, rigorous and publically available cost/benefit analyses of U.S. air quality regulations have consistently demonstrated positive benefits when health impacts are taken into consideration. Other jurisdictions also use calculated costs of high pollution levels to evaluate the need for emission reductions and in many cases decisions are based on results of cost/benefit analyses.

Results from our review provide insights into the key characteristics of successful NAA management approaches, which may be of potential value to Alberta. We found that leading jurisdictions commonly employ regulatory approaches and management practices, which are consistent with the following key principles:

> **Transparency**: the promotion of clearly defined requirements with respect to actions, deadlines and expected outcomes developed via a public process in consultation with all stakeholders. The concept of transparency also extends to making all data and tools used in the NAA management process publically available. This would include, for example, ambient data, emission factors (along with data and analysis methods used in their development), complete detailed and up-to-date emission inventories, and technical model descriptions and modeling codes.
>
> **Equity**: the application of management methods which avoid placing undue burdens on any one group. This includes providing a level playing field for all source owners and operators as well as avoiding shifting of the burden of pollutant impacts onto any one group at the expense of another.
>
> **Scientific basis**: building a solid foundation for management actions based on collection of data of sufficient quantity and quality to support the actions and application of rigorous, peer reviewed scientific principles and procedures.

Consistent with the above key principles, components of an effective NAA management system identified by our review that Alberta may wish to consider include:

- Clearly and fully specified (as to level and form) ambient air quality standards (goals, while potentially useful, are generally not in themselves sufficient to drive emission reductions unless coupled to a clear path to achieving attainment);
- A firm set of deadlines for achieving attainment;
- An open and fair combination of incentives and penalties for missing attainment deadlines;
- A structured set of planning requirements and deadlines for achieving the use of appropriate air pollution prevention/control methods and technologies;

- Mandatory, rigorous and transparent data collection and reporting systems, including regularly updated comprehensive emission inventories;
- Data analysis (including modelling) programs that meet strict scientific criteria (including peer review) and are sufficient to fully quantify emissions from all sources and identify key source-receptor linkages;
- Full public accounting of costs and benefits of air quality regulations; and
- A strong public outreach program including extensive opportunities for public participation in the decision making process.

Specific recommendations for Alberta based on our review include:

- Careful consideration of implementation of emission offsets and minimum retrofit requirements for sources in NAAs. We further recommend that Alberta consider the potential benefits of requiring large sources to install Continuous Emission Monitoring Systems (CEMS) with respect to improved temporal allocation of emissions needed for accurate modeling and control strategy development, improved ability to provide equal enforcement of permitted emission limits for all such sources, and ability to implement cost-effective emissions trading programs.
- Perform emission inventory development and modeling analyses to determine the contributions of smaller sources to non-attainment and consider the extent to which benefits of emission reductions from these sources may outweigh the increased regulatory burden of lowering permitting thresholds or implementing new emission standards. We further recommend that Alberta work with Environment Canada and other provinces and territories to evaluate the potential costs and benefits of establishing national performance standards for new equipment that does not already meet the best standards routinely achieved in the U.S. or elsewhere.
- Evaluate the potential benefits of market-based programs in cases where use of traditional "command and control" emission reduction regulations would be overly burdensome. While considerable effort is required to establish and operate an orderly and effective market, existing examples in the U.S. may serve as a useful guide.
- Consider inclusion of NAA management program elements such as interim emission reduction milestones designed to insure incremental improvements towards attainment. A central problem faced by the most heavily polluted NAAs is resolving the conflict between attaining health-based air quality standards and the potentially significant costs of achieving the required emission reductions. While reaching attainment within the specified deadline may not be possible in some situations, a regulatory structure designed to force continuous incremental improvements provides a way to achieve some benefits in the near-term while allowing time for new ideas and technologies to bear fruit.
- A wealth of information about programs for reducing both on-road and off-road mobile source emissions is available from many leading jurisdictions. We recommend Alberta reference this extensive knowledge base if modelling evaluations suggest that additional mobile source controls are needed to achieve attainment. Examples of programs of potential interest include incentive programs for diesel engine retrofits, repowers and retirement of older trucks and equipment, reformulated fuels, idle reduction, promotion of transit options, and incentive programs for introducing low emission technology vehicles. As noted in our review, some jurisdictions still employ vehicle Inspection and Maintenance (I&M) programs. However, the cost effectiveness of these programs is highly dependent on local vehicle fleet characteristics

and program design; careful consideration of local conditions are recommended when considering adoption of any I&M program. Some other controversial mobile source programs used in other jurisdictions - such as driving restrictions or disincentives imposed only on older vehicles - seem unlikely to gain traction in Alberta and may violate the equity principle.

- As jurisdictions impose more stringent emission reductions on sources under their control, the relative contributions of long-range transport of pollutants from sources beyond their borders is increasing. Governments will therefore need to step up cooperative efforts to reduce upwind sources that are beyond their direct control. We recommend that Alberta promote and participate in such cooperative efforts.
- Management methods are rapidly evolving in many jurisdictions and reference is made in our survey to very recent or soon-to-be-implemented methods where appropriate. We recommend that this report be updated in the future to reflect these new developments.

1.0 INTRODUCTION

As described in the 2004 National Academy of Sciences report *Air Quality Management in the United States* (NAS, 2004), air quality management involves a continuous cycle of: setting standards or goals, assessing status with respect to the standards and goals, designing and implementing emission control strategies, and tracking progress. This process is repeated as new information becomes available on which to base revisions to the standards and goals and air quality status changes in response to changing emissions and environmental conditions. In practice, the management process involves an intricate and delicate balancing act between available resources and risk in which the balance point is continually changing as economic conditions and public perceptions shift, technology evolves and scientific advances reveal new risks and opportunities.

Primary tools used in air quality management include air quality monitoring data, data and models that relate air quality conditions to impacts on human health and the environment, emission inventories, models that relate emissions to air quality conditions, emission control technologies and options, public and stakeholder outreach, and regulations including enforcement mechanisms. These tools are used to set goals and develop regulatory strategies and air quality management plans to achieve the goals.

Areas with significant air quality problems where pollutant levels or associated impacts are out of attainment of established standards or goals ("non-attainment" areas) typically represent the greatest challenge facing air quality managers. Effective management of such areas also includes developing and implementing strategies for maintaining acceptable air quality once the areas are brought into attainment (maintenance areas), even in the face of continued economic expansion.

Alberta's Environmental Protection and Enhancement Act provides for the assessment and regulation of activities to minimize environmental impacts based on principles including continuous improvement and pollution prevention. In support of Alberta Environment and Park's (AEP's) implementation of the Act, we conducted a jurisdictional review of regulatory strategies and tools used to manage and improve air quality in "non-attainment" areas (NAAs). Our review included jurisdictions around the world that have well-established, advanced air quality management programs in place, including jurisdictions in Australasia, North America and Europe. We used results from the review to prepare recommendations for potential improvements to non-attainment area air quality management mechanisms in Alberta. Our study focused specifically on regulatory tools and practices for managing air quality in NAAs where air quality has been identified as exceeding (or close to exceeding) established air quality goals or standards. We did not examine how such goals and standards are set (see, for example, *The Air We Breathe: An International Comparison of Air Quality Standards and Guidelines*; Boyd, 2006).

1.1 Goals and Objectives

Our study was conducted in accordance with the following goals:

- Strengthen Alberta's current policy tools to provide effective management of ambient air exceedances;
- Improve non-attainment area (NAA) air quality management practices in the province of Alberta; and
- Ensure the management of air quality in Alberta aligns with leading jurisdictions.

In light of these goals, our study was designed to achieve the following objectives:

- Assessing systems and tools used by leading jurisdictions in regulating and managing non-attainment areas (areas exceeding established air quality limits and/or objectives);
- Identifying items to be used by the Department to inform policy and tool development for stressed airsheds in Alberta; and
- Recommending options for regulating NAAs in Alberta based on all the information reviewed and evaluated.

1.2 Scope and Methodology

Our jurisdictional review focused on leading jurisdictions with well-developed air quality regulatory programs including policies and tools for managing NAAs. We also took into consideration the extent to which the information we were looking for was readily available, the degree and nature of air quality impairment within the jurisdiction, and the extent to which the types of emissions sources and notable air quality issues facing the jurisdictions are comparable to conditions in Alberta. Based on these considerations, it was decided to focus our review on Canada, the United States, Europe, and Australia/Asia. In Canada, the United States, Europe, and Australia, we included both the national government programs (the European Union programs in Europe) as well as selected provincial, state and (EU) Member State jurisdictions as listed in Table 1.

Table 1 Selected jurisdictions.

Jurisdiction	Report Section
Canada (national)	2.1
Alberta	2.2.1
British Columbia	2.2.2
Ontario	2.2.3
Quebec	2.2.4
Saskatchewan	2.2.5
United States (national)	3.1
California	3.2.1
Texas	3.2.2
Louisiana	3.2.3

Jurisdiction	Report Section
Colorado	3.2.4
Pennsylvania	3.2.5
Minnesota	3.2.6
North Dakota	3.2.7
Wyoming	3.2.8
European Union	4.1
France	4.2
Italy	4.3
United Kingdom	4.4
Belgium	4.5
Netherlands	4.6
Poland	4.7
Germany	4.8
Australia (national)	5.1
New South Wales	5.2
Western Australia	5.3
State of Victoria	5.4
South Australia	5.5
Hong Kong	5.6.1
Singapore	5.6.2
Japan	5.6.3

A uniform questionnaire was developed in consultation with AEP to help guide information collection for each selected jurisdiction. The questionnaire was designed to cover the major topics related to NAA management policies, practices, and tools. Questions focused on five key areas:

1. The regulatory system;
2. Applications of data and technology (tools);
3. Stakeholder and public engagement processes;
4. Assessment of degree of success, strengths and weaknesses; and
5. Enforcement mechanisms.

Use of a common set of questions for each jurisdiction was intended to facilitate the inter-comparison of management approaches between the various jurisdictions. A copy of the questionnaire is provided in Appendix A. Our experience with using the questionnaire during the information collection process indicated that, while the topic areas covered in the questionnaire served as a useful guide, the format of the questionnaire made it difficult to consistently fill in complete answers to each question without undue repetition and that the types of requested information often didn't match up with the information available for a given jurisdiction. Thus, while the questionnaire was useful for guiding information collection, the complete descriptions of each jurisdiction's management approach are provided in the following sections in narrative

format based primarily on data collected in the form of annotations filled in on the questionnaire forms as well as from other sources (as noted in the references). For the sake of completeness, the questionnaire forms with annotations are provided as an appendix to this report (see Appendix 6).

2.0 CANADA

2.1 National Regulatory Framework – Airshed Management

2.1.1 National Regulatory Framework

At the national level, the Canadian Council of Ministers of the Environment (CCME)[ii] has been active in developing a framework and associated guidance to establish a common basis for Airshed Management across Canada. The CCME is a forum for addressing environmental issues of national and international concern and is composed of environment ministers from the federal, provincial and territorial governments.

In 2012, CCME implemented a new Air Quality Management System (AQMS) to guide work on protecting and improving air quality across Canada. CCME documents that are directly relevant to the implementation of AQMS and are available on the CCME website include:

- PN1475, "The Air Quality Management System Federal, Provincial and Territorial Roles and Responsibilities" (2012)
- PN1481, "Guidance Document on Air Zone Management" (2012)
- PN1483, "Guidance Document on Achievement Determination: Canadian Ambient Air Quality Standards for Fine Particulate Matter and Ozone" (2012)

The AQMS is intended to provide a comprehensive approach for improving air quality in Canada and includes primarily three components[iii]:

1. Canadian ambient air quality standards (CAAQS);
2. The management of air quality through local air zones and regional airsheds; and
3. Base-level industrial emissions requirements (BLIERs).

Canadian Ambient Air Quality Standards (CAAQS) for $PM_{2.5}$ and ground level O_3 were implemented under Canadian Environmental Protection Act (CEPA) 1999. Standards have been developed for 2015 and become more stringent in 2020 as shown in Table 2.

Table 2 Canadian Ambient Air Quality Standards.

Pollutant	Averaging Period	Standards (concentration) 2015	2020	Metric
$PM_{2.5}$	24-hour (calendar day)	28 µg m^{-3}	27 µg m^{-3}	The 3- year average of the annual 98th percentile of the daily 24-hour average concentration
$PM_{2.5}$	Annual (calendar year)	10.0 µg m^{-3}	8.8 µg m^{-3}	The 3-year average of the annual average concentrations.
Ozone	8-hour	63 ppb	62ppb	The 3-year average of the annual 4th-highest daily maximum 8-hour average concentrations.

[ii] http://www.ccme.ca/
[iii] http://www.ccme.ca/en/current_priorities/air

The federal, provincial and territorial governments have also initiated development of CAAQS for SO_2 and NO_2 through a process led by the CCME[iv]. The CAAQS provide the basis for defining whether a particular area is considered "in attainment" with air quality standards. While the terminology "non-attainment area" is generally not used in Canada, for the purposes of this report, an area that does not achieve the CAAQS will be considered a non-attainment area (NAA); CAAQS are therefore a key component to the AQMS. Management of the air quality is areas where the CAAQS are currently not being achieved typically involves identifying and addressing major sources of direct emissions of the pollutants (particulate matter sources), or sources of emissions of $PM_{2.5}$ and O_3 precursor compounds, such as NOx, SO_2 and VOCs. The Air Zone Management Framework provides the process for this.

The CCME "Guidance Document on Air Zone management" provides guidance on air zone management under the AQMS. It details the Air Zone Management Framework (AZMF) which provides guidance on the nature of management, monitoring and reporting actions to be implemented at an air zone level under the AQMS. Per the AZMF each air zone is assigned a color coordinated management level (i.e. Red, Orange, Yellow, and Green) . The guiding principles of the AZMF are Keeping Clean Areas Clean and Continuous Improvement. Under the AZMF, progressively more rigorous actions are to be implemented at an air zone level as air quality approached or exceeds the CAAQS.

Under the AQMS and AZMF, determination of compliance with CAAQS takes into account cumulative effects in that the monitored concentrations include contributions from all sources. The *Guidance Document on Achievement Determination: Canadian Ambient Air Quality Standards for Fine Particulate Matter and Ozone* describes how monitoring data is used to assess whether an Air Zone is in attainment of the CAAQS[v]. There are provisions for taking into account Transboundary Flows and Exceptional Events (TF/EE) using a "Weight of Evidence" Approach. These analyses are important, and directly impact the management level assigned to an air zone.

If a CAAQS is exceeded within an Air Zone, the area is assigned a Management Level of "Red" according to the AZMF with a corresponding goal for the Air Zone of "Achieving Air Zone CAAQS" through advanced air management actions. In this instance, an Air Zone Management Plan should be developed, that includes actions by various stakeholders and government to reduce relevant emissions. The Plan should include timelines, specific to the Air Zone, as well as air quality modelling to estimate the improvements to air quality expected to result from implementation of the actions. The Plan should be formally published and then implemented. The AZMF advises that Air Zone Management plans need to be implemented where necessary to achieve or work towards achieving the 2015 and 2020 CAAQS and should focus on the priority areas with unique air quality challenges or high population densities. The effectiveness of the plan needs to be considered as it is developed. There should be an indication that the emission control programs will result in meaningful emission reductions and address the unique challenges within each Air Zone. Progress towards achievement of air quality objectives as

[iv] Canada – United States Air Quality Agreement Progress Report 2014, https://ec.gc.ca/Air/D560EA62-2A5F-4789-883E-9F4DA63C58CD/AQA%20Report%202014%20ENG.pdf

[v] CCME, PN 1483, http://www.ccme.ca/files/Resources/air/aqms/pn_1483_gdad_eng.pdf

action plans are executed should be closely monitored through Progress Assessments and the Plan should be re-evaluated as necessary.

Emission inventories are an important tool that can be used to assist in the development of a Management Plan as they provide information on the potential contributions of sectors to overall air quality. Emission inventories are also required for air quality modelling. Both the Alberta Air Zone and Ontario Air Quality reports include a quantitative review of emissions data of key contaminants and are discussed subsequently in this report. One important publically available source of emissions data is the federal National Pollutant Release Inventory (NPRI) program. Facilities are required by the Canadian Environment Protection Act (CEPA, 1999) to report annually to the NPRI if they meet certain criteria that can include an employee threshold or other mass, concentration or activity thresholds, or if they have specified activities even without meeting the thresholds.

The base-level industrial emissions requirements (BLIERs) are minimum emissions standards or requirements that are implemented to establish a nationally-consistent minimum technology level for emission reductions regardless of air quality. Each province/territory maintains the ability to require higher levels of performance through more stringent requirements for a variety of reasons. In other words, the BLIERs represent minimum national standards and do not prevent individual provinces/territories from utilising or maintaining more stringent requirements. A key feature of BLIERS is that these emission requirements are broadly applied, regardless of whether or not the source is located in a NAA or in AZMF terminology, regardless of the Management Level assigned to the air zone.

The federal government has drafted the Multi-Sector Air Pollutant Regulations (MSAPR) that will include all the regulated BLIERs[vi]. The proposed MSAPR covers Stationary Spark-Ignition Engines, Non-utility boiler and heaters; and cement manufacturing sector, targeting emissions of NOx and/or SO_2. Other industrial sectors or equipment groups can be added to the regulations as new Parts and Schedules in the future[vii]. The current MSAPR specifies limits for:

- nitrogen oxides (NOx) emitted from modern (new) and original (existing), gaseous fuel-fired non-utility boilers and heaters used by industrial facilities;
- NOx emitted from modern and original stationary spark-ignition gaseous fuel-fired engines used by industrial facilities (i.e., those used for gas compression or back-up generators; and
- NOx and sulphur dioxide (SO_2) emitted from cement kilns.[viii]

BLIERs will apply to both existing and new sources. BLIERs can be developed to regulate NOx, SO_2, VOCs and/or PM through quantitative or qualitative requirements. Broadly-applied regulatory instruments such as BLIERS cover many types of sources, existing and new.

[vi] http://www.ec.gc.ca/lcpe-cepa/default.asp?lang=En&n=18BA1AA1-1
[vii] http://www.ec.gc.ca/lcpe-cepa/default.asp?lang=En&n=110F96E0-1#ws1E300ACB
[viii] http://ec.gc.ca/lcpe-cepa/eng/regulations/detailReg.cfm?intReg=220

2.1.2 Division of Responsibilities between Federal Government and the Provinces

The CCME has developed a guidance document that provides direction on the Roles and Responsibilities of the Federal Provincial and Territorial governments with respect to the various elements of the AQMS[ix]. CCME guidance reflects the general consensus among participating government agencies. Key points, taken directly from this document for the AQMS elements, are shown below along with some additional commentary:

Canadian Ambient Air Quality Standards

- All governments have a collective responsibility to prevent air quality from deteriorating, to work to ensure that air pollutant concentrations do not exceed the CAAQS within their borders, and to strive for continuous improvements in air quality.
- Governments will collaborate within the Canadian Council of Ministers of the Environment to establish, review and amend the CAAQS, with the appropriate involvement of stakeholders.
- The federal government will incorporate the CAAQS as objectives in the Canadian Environmental Protection Act, 1999. (CCME PN1475, 2012)

In addition to CAAQS, provinces typically have their own air quality standards or guidelines and may develop permitting or approvals processes to regulate industrial or commercial air emissions that consider the province-specific issues/context. For instance, Ontario has a comprehensive list of air quality standards and guidelines against which facilities must individually assess their compliance. Some further description of the Ontario local Air Quality Regulation (O. Reg. 419/05) and its requirement as relevant to the 'NAA' classification are described in subsequent sections.

Air Zones

- Provinces and territories will establish local air zones within their boundaries and will lead air quality management guided by the Air Zone Management Framework.
- The federal government will provide technical support of air quality monitoring for the air zones on federal and Aboriginal lands and for facilities on federal and Aboriginal lands. The federal government will work with the governments of Nunavut and Northwest Territories to help to manage air quality in those territories. (CCME PN1475, 2012)

Transboundary Air Pollution: Regional Airsheds

- The federal government will collaborate with provinces and territories to better understand the flow of air pollution among airsheds and may coordinate the actions required to address international and inter-jurisdictional transboundary air pollution.

[ix] CCME, "The Air Quality Management System Federal, Provincial and Territorial Roles and Responsibilities" PN 1475, October 2012

- The federal government will lead the actions and negotiations to address the transboundary flow of air pollutants originating from other countries with the involvement of affected provinces and territories. (CCME PN1475, 2012)

Defining the geographical boundaries of Air Zones is identified as being the responsibility of the Provinces. In assessing whether a particular air zone is in attainment of the CAAQS, transboundary effects can be taken into consideration by provinces using the weight-of-evidence approach described in CCME guidance (PN 1481, 2012). In the event that transboundary effects (i.e. from other provinces or countries) are thought to have air quality impacts that are not insignificant, the federal government may become involved such as supporting international negotiations with respect to air quality such as the ”Canada – United States Air Quality Agreement”.

Base-Level Industrial Emission Requirements

- Governments will work collaboratively within the Canadian Council of Ministers of the Environment through mutually agreed processes to develop, review and amend the base-level industrial emissions requirements (BLIERs) as necessary, with the appropriate involvement of stakeholders.
- Under the Canadian Environmental Protection Act, 1999, the federal government will regulate where feasible, to establish the BLIERs across Canada, which will function as a backstop to provincial and territorial instruments implementing the BLIERs.
- The provinces and territories may regulate or otherwise implement the BLIERs. Where provinces or territories opt not to implement a BLIER, the federal regulation or instrument could apply and the federal government would ensure compliance with the BLIER(s). (CCME PN1475, 2012)

Mobile Sources

- The federal government has the lead responsibility for regulating and implementing emission and fuel standards for new on- and off-road vehicles and engines, as well as emissions from marine, aviation and rail.
- Provinces and territories may enact further measures to reduce emissions from mobile sources, particularly with regulating the in-use fleet.
- The federal, provincial and territorial governments may work together to identify mobile source priorities, share information on best practices and effective action and collaborate to better address mobile source pollution. (CCME PN1475, 2012)

The Federal Government sets emission standards for new vehicles resulting in emission reductions as vehicle fleets turn over. Programs that provinces have developed for regulating the in-use fleet include Ontario’s Drive Clean[x] which requires recurring emission testing of vehicles typically of a certain age. These programs are designed to ensure that vehicles continue to meet emission levels as they age. Both federal and provincial programs respecting mobile sources have the net effect of reducing emissions of pollutants that have CAAQS or are precursors to

[x] https://www.ontario.ca/page/drive-clean

compounds with CAAQS, in all air zones regardless of the Management Level. This outcome is consistent with the objectives of AZMF.

Science, Monitoring, Modelling and Reporting

(a) Environmental and Health Science

- Federal, provincial and territorial governments will identify and assess environmental and health-related knowledge gaps and use science-based information to assess the impact of identified air pollutants of concern and inform Canadians and decisionmakers.
- Health Canada will investigate the impact of air pollution on human health and estimate the health benefits of emissions reductions. Provincial and territorial ministries may collaborate in this work.
- Federal, provincial and territorial governments will conduct targeted research on air pollutants, their fate and impacts. (CCME PN1475, 2012)

(b) Monitoring, Modelling and Reporting

- Governments will work collaboratively to ensure the most efficient and least burdensome reporting while enabling all governments to have the compliance information they need about industrial emissions.
- The federal, provincial and territorial governments will continue to coordinate the production of emissions inventories for air pollutants of concern.
- The federal government will lead the preparation of national emissions inventory information and provide expertise in atmospheric modelling.
- With support from the provinces and territories, the federal government will lead the preparation of a Canadian State of the Air Report, which will be compiled on a regular basis. The report will build upon provincial air zone reports and will inform on the air quality and trends within the six regional airsheds. (CCME PN1475, 2012)

Air Zone Management

- The federal, provincial and territorial governments will continue to collaborate and operate the National Air Pollution Surveillance (NAPS) network that ensures that air quality monitoring is available as outlined under existing federal, provincial and territorial agreements.
- Provincial and territorial governments will report regularly to their publics on air quality, on the achievement of the ambient air quality standards, and on the actions undertaken in air zones within their boundaries.
- To the extent possible, the federal government will provide input to the provincial and territorial reports for the air zones that include federal and Aboriginal land. (CCME PN1475, 2012)

The Federal government is responsible for leading the preparation of a Canadian State of the Air Report that discusses air quality in Canada's six regional airsheds (Figure 1). Each of these airsheds encompasses multiple Air Zones and can also span several Provinces. The State of the Air Report will be produced every five years, beginning in 2016.

Figure 1 Six Canadian regional airsheds.[xi]

The *Guidance Document on Achievement Determination: Canadian Ambient Air Quality Standards for Fine Particulate Matter and Ozone* (CCME, 2012) provides guidance for using CAAQS for the purposes of defining NAAs. Assessment of whether an Air Zone meets CAAQS under the AZMF is being generally completed at the provincial level, with a number of reports produced by individual provinces already available for the public.

Within the AZMF, provinces or delegated authorities are typically responsible for developing a management plan that would typically include: (1) *actions to be undertaken by governments and stakeholder to reduce emissions with short, medium and long-term milestones and targets*, and (2) *detailed modelling to show how planned actions will improve air quality*. (CCME PN 1481, 2012)

Reductions may be required at existing facilities as a result of provincial regulatory programs that fall outside of the AZMF if there is an indication that the facilities contribute to air pollution. This facility-specific assessment can be completed using dispersion models and provincial air quality standards and can lead to planning actions. For instance in Ontario, facilities that apply for a 'Site-Specific Standard' (SSS) are required to develop and implement a plan to reduce emissions from major sources of the compound for which the SSS is required.

There may be circumstances where programs are implemented that should result in emission reductions albeit without quantification of emissions. Examples of this include best management practice plans implemented to reduce road dust emissions at industrial facilities, and bylaws restricting or banning open burning, such as the Solid Fuel Burning Domestic Appliance Regulation[xii]. Such measures or programs, focussed on promoting practices that will reduce emissions, are often implemented by provincial or regional governments.

[xi] http://www.env.gov.nl.ca/env/env_protection/science/aqms.html
[xii] http://www.env.gov.bc.ca/epd/codes/solid-fuel/

Based on the AZMF and considering the nature of provincial approvals programs for industrial emissions, the detailed management of NAAs is primarily handled at the provincial level. Nonetheless, the Federal government supports consistency across the country, is involved in multijurisdictional issues and implements mechanisms such as BLIERs that generally have the outcome of improving baseline air quality. Given the multitude of factors and issues involved with managing air quality across Canada, significant involvement and collaboration is required by federal and provincial governments.

2.2 Provincial Review

This section outlines programs and issues that are specific to provinces with well-developed air quality management programs: Alberta; British Columbia; Ontario; Quebec; and Saskatchewan. A discussion of the progress by the Province with respect to the Air Zone Management Framework (AZMF) is first provided, followed by a review of the some provincial air quality legislation that could address emissions in NAAs.

2.2.1 Alberta

Air Zone / Air Quality Management Framework

Alberta is delineated into six Air Zones: Peace, Lower Athabasca, Upper Athabasca, North Saskatchewan, Red Deer, and South Saskatchewan. Figure 2 is taken from the recent Air Zone Report published by the province[xiii] and shows the geographic extent of Alberta's Air Zones. The zones are based on the Land Use Framework boundaries, the regions previously developed by Alberta to manage environmental cumulative effects. Any air zone determined to be in exceedance of the CAAQS is assigned a management level Red" with respect to the compound. Actions must be undertaken to achieve CAAQS. However, when an Air Zone has a management level "Orange" meaning that they are close to the CAAQS and are therefore planning actions for preventing CAAQS exceedances.

[xiii] Alberta Government, "Alberta: Air Zones Report 2011-2013", September 2015

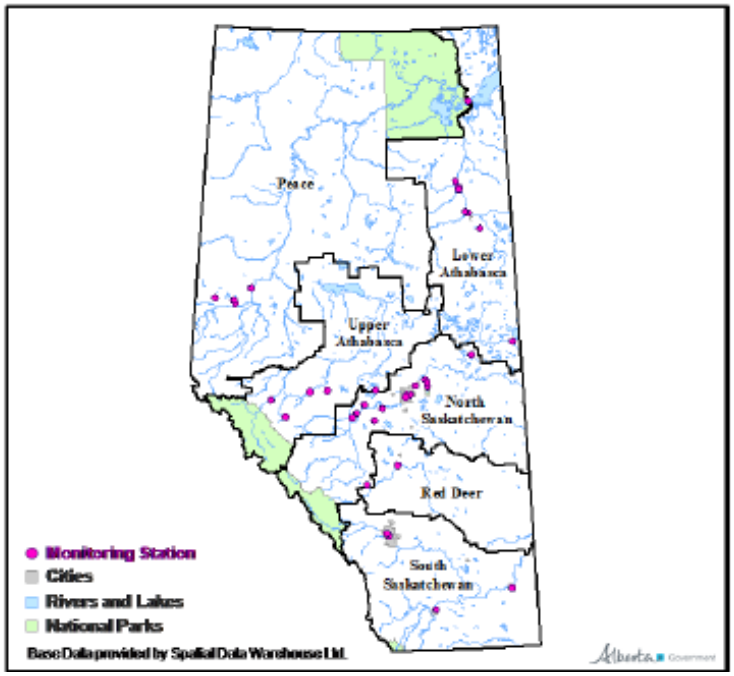


Figure 2 Alberta Air Zones.

The Alberta Air Zone Report (2011-2013) provides emission inventories for each of the Air Zones, outlining the importance of this tool in understanding the key sources of emissions. Specifically this tool facilitates a high level review that can identify sectors whose emissions should be considered when developing management plans. Prior to the AZMF, a management framework for $PM_{2.5}$ and ozone was developed by the Clean Air Strategic Alliance[xiv] in 2003, and resulted in a number of regionally-based[xv] efforts, including the development of management plans. The Alberta Air Zone Report made reference to some of these management plans such as the $PM_{2.5}$ Plan for the Capital Region[xvi] located within the North Saskatchewan air zone. Management plans for some Alberta air zones, or regions within air zones, are still in development including the plan for the Red Deer area[xvii].

Industrial Approvals / Provincial Air Regulation Requirements

In addition to the AZMF and the Land Use Framework, the Environmental Protection and Enhancement Act[xviii] (EPEA) requires that industrial facilities with designated activities[xix] obtain approvals to construct and operate new sources. Approvals may also need to be renewed after a set period of time, typically 10 years, to continue operations or amended if there are changes to

[xiv] http://casahome.org/
[xv] http://aep.alberta.ca/air/monitoring-and-reporting/ambient-air-monitoring/albertas-airshed-zones.aspx
[xvi] http://aep.alberta.ca/lands-forests/cumulative-effects/regional-planning/capital-region/documents/FineParticulateMatterResponse-Dec2014.pdf
[xvii] http://aep.alberta.ca/lands-forests/cumulative-effects/regional-planning/default.aspx
[xviii] Environmental Protection and Enhancement Act, Revised Statutes of Alberta 2000, Chapter E-12
[xix] Alberta Regulation 276/2003, With amendments up to and including Alberta Regulation 61/2015

the operations at a facility[xx]. A number of regulations have been made under the EPEA to support its requirements[xxi].

The province has published a number of documents that outline expectations of the regulator in applications for approval under the EPEA. For instance, the Alberta Air Quality Model Guideline (2013)[xxii] describes the requirements for dispersion modelling assessments that accompany EPEA approval applications. The dispersion modelling assessment needs to account for cumulative effects – the modelled contribution of emissions from other industrial sources that are nearby (e.g. within 5km) in addition to general background or baseline concentrations. In refined or advanced assessments, the 90th percentile of air quality monitoring data upwind of a site can be used to develop a baseline concentration (Air Quality Model Guideline). The predicted ground level concentrations, that include cumulative effects, are then compared to Alberta Ambient Air Quality Objectives (AAAQO)[xxiii] developed under the EPEA. Modelled exceedances of the AAAQOs with averaging periods of 24h or greater in applications for industrial approvals are considered unacceptable. In this instance, the applicant is required to revisit the design of the facility and/or develop a management plan to ensure that actual exceedances do not occur[xxiv], and should also contact the Director to discuss these steps.

Conditions in industrial approvals may include ambient air monitoring and source testing or continuous emissions monitoring. Approvals must also be renewed periodically. This approach to regulatory approvals generally results in implementation of emission controls on industrial sources seeking approval such that the AAAQO are met, taking into consideration some local cumulative effects.

2.2.2 British Columbia

Air Zone / Air Quality Management Framework

In British Columbia, there are a total of seven Air Zones (Figure 3) as follow: Georgia Strait; Coastal; Lower Fraser Valley; Southern Interior; Central Interior; Northwest; and Northeast. Air Zone Reports have been produced for all but one of the air zones[xxv]. Two of the air zones, Georgia Strait and Central Interior, are unable to meet the CAAQS for $PM_{2.5}$ and can be considered NAAs for the purposes of this report. The Air Zone Reports for these air zones outline actions taken to address the CAAQS exceedances, by reducing anthropogenic emissions of key compounds. More specifically, the Georgia Strait report focusses on actions to reduce emissions from wood smoke and open burning, including the Provincial Wood stoves Exchange Program[xxvi], Local by-laws[xxvii,xxviii] and development of an airshed-wide smoke control strategy[xxix].

[xx] http://aep.alberta.ca/air/approvals-applications.aspx
[xxi] http://aep.alberta.ca/air/legislation/regulations-and-codes.aspx
[xxii] http://aep.alberta.ca/air/modelling/documents/AirQualityModelGuideline-Oct1-2013.pdf
[xxiii] http://aep.alberta.ca/air/legislation/ambient-air-quality-objectives/documents/AAQO-Summary-Jun2016.pdf
[xxiv] http://aep.alberta.ca/air/monitoring-and-reporting/documents/AirQualityObjectivesIndustrial-Oct2013.pdf
[xxv] http://www.bcairquality.ca/reports/air-zone-reports.html
[xxvi] http://www.cvrd.bc.ca/index.aspx?NID=1410
[xxvii] http://cvrd.bc.ca/index.aspx?NID=1463
[xxviii] http://www.city.duncan.bc.ca/pdf/3089%20-%20Wood%20Burning.pdf
[xxix] http://seatoskyairquality.ca/burning-and-smoke-control-strategic-framework/

The Central Interior report focusses on actions to reduce emissions from biomass combustion, road dust and industrial sources (primarily the forestry industry like sawmills and non-forestry facilities like asphalt plants). The report also provides links to four local airshed plans.[xxx] [xxxi] [xxxii] [xxxiii]

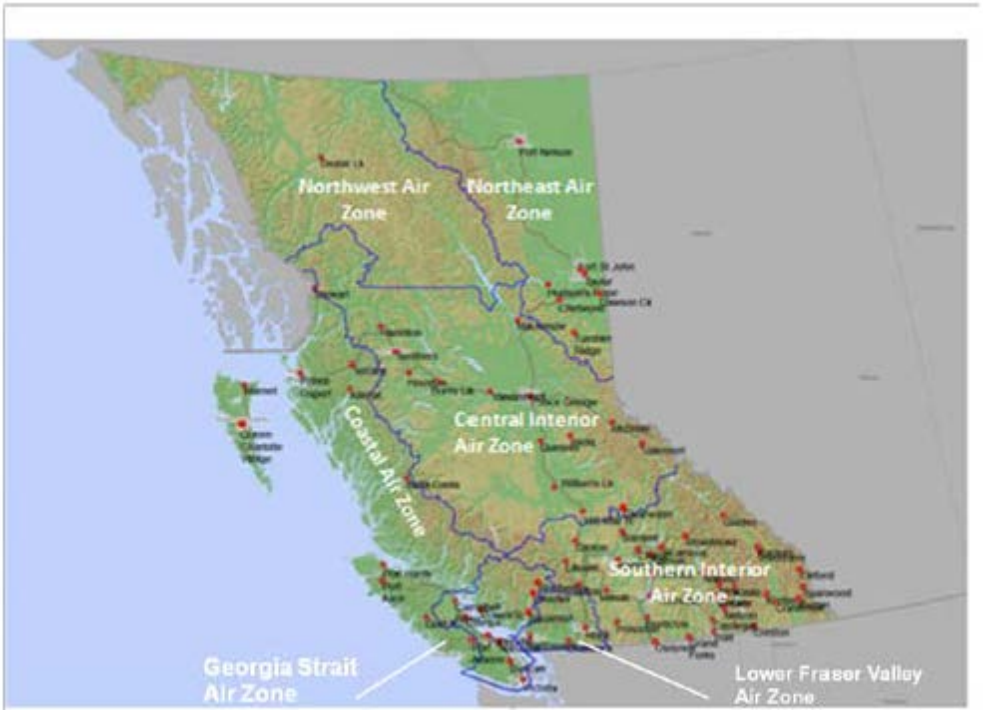


Figure 3 BC Air Zones.[xxxiv]

Industrial Approvals / Provincial Air Regulation Requirements

Similar to other provinces, B.C. has a permitting program, requiring various industrial facilities to obtain approval (i.e. authorization of discharge) for sources of air emissions. In B.C. there is a staged approach to effectively streamline assessment requirements and the review process related to the authorization of discharges as provided for in the Environmental Management Act (EMA) and regulations. This regulatory efficiency is accomplished by having simple requirements for lower-risk activities and only requiring more comprehensive assessments when justified by the potential level of risk. For the purposes of discharge authorizations, operations are classified as follows:

- High-risk operations, or those where development of a code of practice is impractical, require a permit or approval to authorize their discharges.

[xxx] https://web.archive.org/web/20150203200002/http://cleanairplan.ca/images/uploads/docs/CleanAirPlan2012.pdf
[xxxi] http://www.pgairquality.com/resources-reports
[xxxii] http://www.quesnelairshed.org/wp-content/uploads/2012/09/qamp-review.pdf
[xxxiii] https://breatheasywilliamslake.files.wordpress.com/2015/03/wlairshed_mgt_plan_final.pdf
[xxxiv] http://www.bcairquality.ca/plans/pdf/air_quality_man_system_fs.pdf

- Medium-risk operations must register under their specific code of practice or regulation, if required by that code or regulation. If a code of practice or regulation has not been developed, a permit or approval is required.
- Low-risk operations do not require formal authorization to discharge waste. However, the discharges must not cause pollution or present a risk to public health. (BC Air Quality Website[xxxv])

Schedules 1 and 2 of the Waste Discharge Regulation B.C. Reg. 320/2004[xxxvi] provide a listing of industries and activities that are considered "High" and "Medium" Risk operations respectively. A number of additional regulations, amendments and codes of practices have been implemented under the EMA or are currently under review[xxxvii]. The codes of practices are legally enforceable standards and are generally applicable to "Medium-risk" operations. Schedule 1 lists a total of 40 high-risk operations and they include chemical and chemical products industry, oil and natural gas industry, municipal solid waste management among several others. Schedule 2 lists a total of 27 medium-risk operations and they include asphalt plant industry, petroleum storage, wood processing industry among several others. Activities not explicitly identified in Schedules 1 and 2 are considered "Low-risk" and do not require approval, provided that they do not "cause pollution" as per 6(4) of the EMA. "Pollution" is defined by the EMA as *the presence in the environment of substances or contaminants that substantially alter or impair the usefulness of the environment*. [xxxviii]

Air permitting in the Lower Fraser Valley Air Zone has been delegated to Metro Vancouver[xxxix]. The BC Ministry of the Environment handles permitting throughout the rest of the province[xl]. A common theme present in air permitting guidance from both Metro Vancouver and the BC MOE, is that consultation with the regulator is recommended throughout the process suggesting that the regulators are taking an active role in improving the efficiency of the approvals process when warranted. For instance guidance by Metro Vancouver emphasizes that certain types of operations may not even require a permit and would be authorized instead under an emission regulation and that Metro Vancouver can assist applicants with this determination[xli]. Each facility operation is unique therefore the permitting requirements are determined by Metro Vancouver on a case by case basis.

The British Columbia Air Quality Dispersion Modelling Guideline (BC MOE 2015)[xlii] outlines the expectations for dispersion modelling assessments that accompany approvals applications for higher-risk sources. When developing a dispersion modelling plan for a particular application, consultation with the regulator is recommended so that initial input and feedback can be incorporated into the plan that will help make the comprehensive review more efficient. Similar to Alberta, the assessment must include cumulative effects through a consideration of

[xxxv] http://www.bcairquality.ca/regulatory/permits-approvals-codes.html, Accessed November 2015
[xxxvi] http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/50_320_2004
[xxxvii] http://www.bcairquality.ca/regulatory/permits-approvals-codes.html, Accessed December 2015
[xxxviii] http://www.bclaws.ca/civix/document/id/complete/statreg/03053_00
[xxxix] http://www.metrovancouver.org/services/Permits-regulations-enforcement/air-quality/apply-permit/Pages/default.aspx
[xl] http://www2.gov.bc.ca/gov/content/governments/organizational-structure/ministries-organizations/ministries/environment
[xli] http://www.metrovancouver.org/services/Permits-regulations-enforcement/PermitRegulationEnforcementPublications/AirPermitApplicationGuidance.pdf
[xlii] http://www.bcairquality.ca/pdf/bc-dispersion-modelling-guideline-2015.pdf

background concentrations. The guideline suggests acceptable approaches for the purposes of developing appropriate background concentrations in this regard:

- a network of long-term ambient monitoring stations near the source under study;
- long-term ambient monitoring at a different location that is adequately representative; and
- modelled background.

Overall, BC has a well-developed air quality management framework and an approvals process for industrial sources of emissions that require progressively more comprehensive analysis, based on the potential risk posed by and/or complexity of the operations.

2.2.3 Ontario

2.2.3.1 Air Zone / Air Quality Management Framework

In June 2015, Ontario made an official proposal to delineate the province into three Air Zones Categories signalling its commitment to implementing the AZMF[xliii]. The three zones are defined based on the characteristics of emission sources as follows:

- Zone 1 – Areas with limited pollution from either point or non-point sources or transboundary influence where the air quality management activities are focused on maintaining good air quality. The Majority of Northern Ontario would be considered Zone 1.
- Zone 2 – Areas under pressure from multiple sources including some or all of the following: non-point sources, smaller point sources, individual large industrial point sources, transboundary influences; where air quality management activities are focused on multiple broad-based initiatives targeting many sources. The Majority of Southern Ontario; Sault Ste. Marie; and the City of Greater Sudbury would be considered Zone 2.
- Zone 3 – Areas with a concentration of large industrial sources; where air quality management activities are focused on the abatement of local industrial emissions as well as non-industrial sources. The City of Hamilton and the Sarnia-Area would be considered Zone 3.

Ontario Regulation 419/05 (O.Reg.419/05) deals with permitting of industrial sources and has tools within it to address abatement of local industrial emissions and is discussed in more detail below.

[xliii] www.ebr.gov.on.ca, EBR Registry number: 012-4347

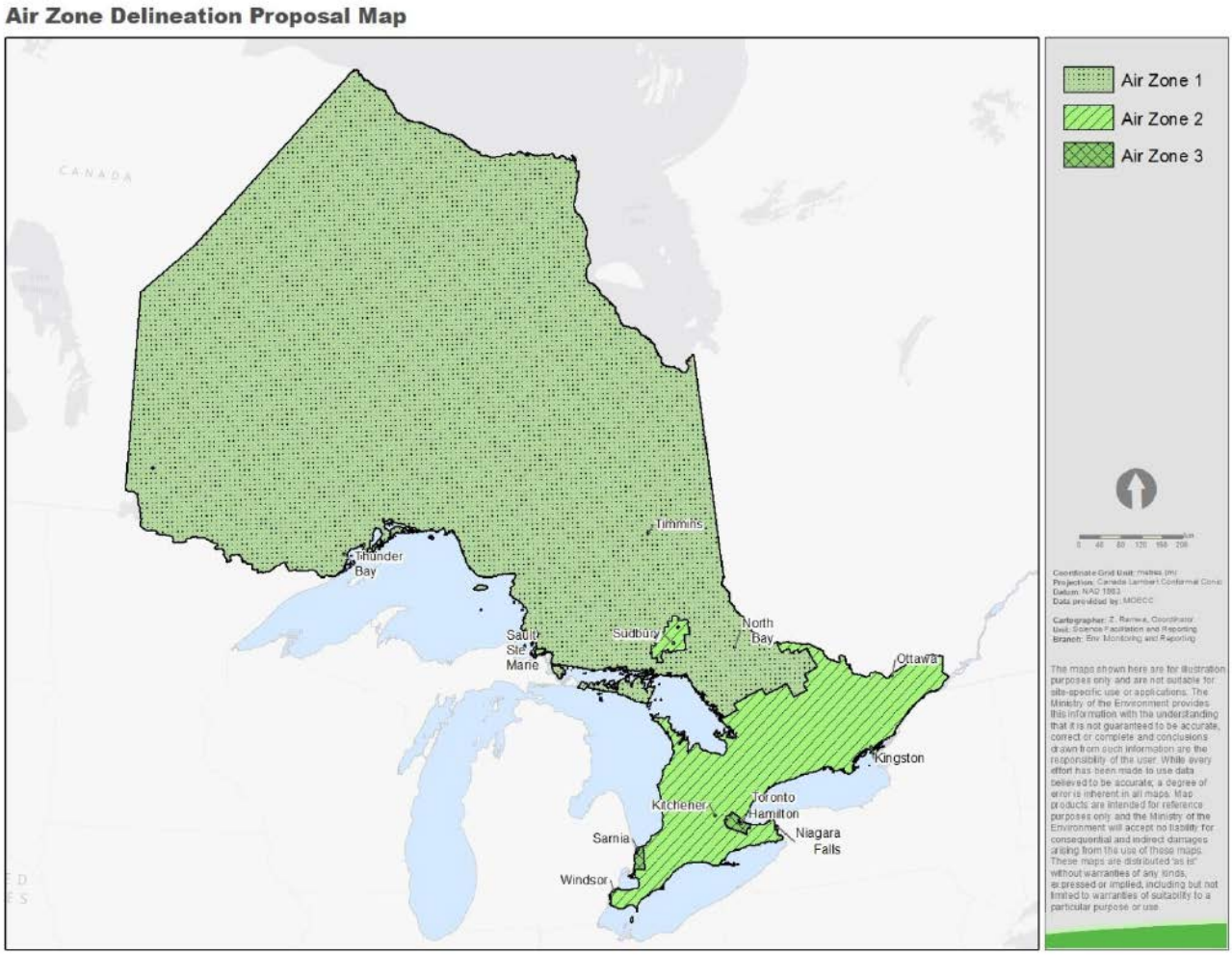


Figure 4 Proposed Ontario Air Zones.[xliv]

Formal Air Zone-specific reports under the AZMF, such as those discussed previously for Alberta and B.C., are not available for Ontario; however the Ontario government monitors air quality and has been publishing an annual report, entitled ”Air Quality in Ontario” for some time.

2.2.3.1.1 Air Quality in Ontario – An Annual Report

Ontario has been monitoring and reporting on provincial air quality for many years prior to AZMF guidance. PDF copies of the reports dating back to 2002 are available on the Ministry of the Environment and Climate Change’s website[xlv]. Features of the monitoring and reporting program generally align with the monitoring programs in other provinces and the AZMF however there are some distinctions. These reports summarize monitoring results from across the province for ozone, fine particulate matter ($PM_{2.5}$), nitrogen dioxide, sulphur dioxide, and carbon monoxide with comparisons to the Ontario Ambient Air Quality Criteria (AAQC). The Air

[xliv] http://www.downloads.ene.gov.on.ca/envision/env_reg/er/documents/2015/012-4347.pdf
[xlv] http://www.airqualityontario.com/press/publications.php

Quality in Ontario report may also provide a breakdown by sector of the total emissions in Ontario of key pollutants such as volatile organic compounds (VOCs) and oxides of nitrogen (NOx) as was the case in the report for 2013.

Historically $PM_{2.5}$ has been monitored in Ontario using Tapered Element Oscillating Microbalance (TEOM) instruments. Technical issues with making accurate measurements of $PM_{2.5}$ in cold weather using TEOM instruments had been noted and Ontario put effort into improving the accuracy of the monitoring network by experimenting with and adopting new technologies. Use of the Synchronized Hybrid Ambient Real-time Particulate (SHARP) 5030 for public reporting in Ontario began in January 2013. The use of the new technology has resulted in an increase in the measured annual average $PM_{2.5}$ concentrations as TEOMS previously underreported this parameter in colder weather.

In anticipation of the AZMF requirements, the 2013 Report[xlvi] includes a section that directly addresses Ontario's air quality in the context of the CAAQS. Across Ontario, $PM_{2.5}$ and O_3 are measured at 21 sites in communities having a population of at least 100,000. In 2013, the two $PM_{2.5}$ CAAQS (i.e. 24h and annual) were achieved for all 21 sites, however the ozone CAAQS was not achieved at 19 of the 21 locations based on raw monitoring results. Previous provincial studies have indicated that transboundary pollution is significant in Ontario[xlvii]. A weight of evidence (WOE) analysis, in accordance with the CCME guidance, was completed for four sites in the 2013 Report that concluded that transboundary pollution was a key factor in exceedances of the ozone standard at these locations. Ontario intends to complete a comprehensive analysis of transboundary influences at all stations as 2015 is the first year that achievement of the CAAQS is officially assessed.

2.2.3.1.2 Ontario's Shared Air Summit

Ontario hosted three shared air summits annually beginning in 2005. The focus of discussion was transboundary air pollution, smog and climate change. Stakeholders involved in these summits were academic, business, environmental and student leaders. The Ontario government made 10 commitments to address transboundary air pollution at the first summit. The commitments followed general themes including: creating or updating agreements with other provinces and states in the Northeast airshed, applying pressure to existing Canada-USA and multijurisdictional bodies to address the issues discussed at the summit, and supporting legal actions affecting transboundary air pollution occurring in States located in the Northeast airshed.

As part of the commitment to active involvement in legal issues, the Ontario government provided input on key topics. In September 2007 the government provided comment on the United States Environmental Protection Agency's (U.S. EPA's) plan to lower the NAAQC for ozone from 80 ppb to 75 ppb. In 2007, the Ontario government adopted the CWS of 65 ppb and pointed to scientific evidence supporting the more stringent limit to protect public health and welfare. The government continued its opposition in July 2008 when it provided an amicus brief to support 14 States, two cities and five non-governmental organizations involved in legal action against the U.S. EPA following the adoption of the less stringent standard in March 2008.

[xlvi] http://www.airqualityontario.com/downloads/AirQualityInOntarioReportAndAppendix2013.pdf
[xlvii] http://www.airqualityontario.com/downloads/TransboundaryAirPollutionInOntario2005.pdf

The government also provided an amicus curiae on behalf of the province supporting legal action that intended to force six of the heaviest emitting coal fired power plants in the United States to install modern emissions control technology (e.g. electrostatic precipitator for particulate matter control, flue gas desulphurization for SO_2 control, low NOx burners and/or catalytic reduction system for NOx control). The outcome of the appeal will set the precedent with respect to whether enforcement action under the U.S. Clean Air Act will be able to require older sources to install modern emissions controls.

Electricity generation using coal as fuel has emerged as a major issue within the overall discussion of transboundary air quality. In 2003 the Ontario government committed to closing five coal fired generating stations by 2007. As part of this commitment, Lakeview, the oldest facility in Ontario, was closed in 2005, however in that same year the deadline for closure of the other facilities was pushed back to 2009. The commitment was modified again in 2007 to ensure the cessation of coal as fuel by 2014 at the remaining four facilities. The Ontario government met its commitment with the closure of the last coal fired power generation station (Thunder Bay Generation Station) in 2014. The final version of the plan is contained in O. Reg. 497/07 under the Environmental Protection Act.

Industrial Approvals / Provincial Air Regulation Requirements

2.2.3.1.3 Ontario Regulation 419/05 - Local Air Quality

Under Section 9 of the Ontario Environmental Protection Act (EPA), any new or modified source is required to obtain an Environmental Compliance Approval (ECA; formerly Certificate of Approval or CofA) 'air permit' prior to construction or operation. The permit application requirements, including the methodology to assess the air impacts of the proposed new source(s), are largely specified in Ontario Regulation 419/05 (O. Reg. 419/05). O. Reg. 419/05, Air Pollution – Local Air Quality was introduced on November 30, 2005, and replaced Ontario Regulation 346, R.R.O. 1990, "General - Air Pollution". Approvals are issued by the Ontario Ministry of the Environment and Climate Change (MOECC).

O. Reg. 419/05 includes very prescriptive mandatory requirements that must be addressed in applications for air approvals (permits). This permitting program includes a requirement for dispersion modelling to predict ground level concentrations at points of impingement (POI) or location of maximum predicted ground-level concentration, which are typically defined as locations at or beyond the property line of the facility. A POI may also be located on a facility's property if there is child care facility present, or the facility itself is a healthcare facility, a senior citizens' residence /long-term care facility or an educational facility. Most of the Standards are based on Ambient Air Quality Criteria (AAQC), however they are subject to more rigorous requirements than AAQCs. Almost all of the Schedule 3 Standards are the same as the AAQCs, which are developed through the MOECC's standard setting process. In addition to the provisions provided directly within O. Reg. 419/05, the MOECC also has issued Guidance for Preparing an Emission Summary and Dispersion Modelling (ESDM) Report (Guideline A-10), and an Air Dispersion Modelling Guideline for Ontario (ADGMO) also referred to as Guideline A-11 that serve to clarify expectations of the ECA applications.

It is important to note that air dispersion modelling assessments as per the Regulation and associated guidance include the assessment of air quality impacts from the proponent's facility only; they do not account for background ambient air concentrations or cumulative effects (i.e., consideration of effects of neighbouring sources that also have significant emissions of like contaminants). Air Standards in Ontario are considered "effects-based" standards that are developed without consideration of technical or economic issues[xlviii]. As we will see later, they can be more stringent than standards in other provinces where cumulative effects are prescriptively considered.

Several years ago, as a result of an appeal of an approval, Ontario's Environmental Review Tribunal (ERT) found that the Ministry of the Environment and Climate Change (MOECC) must consider cumulative effects before issuing an approval. The MOECC has stated that they are in the process of developing a framework for assessing cumulative effects, but this has not yet been released in any form.

Routinely, the MOECC does not explicitly require a proponent to address cumulative effects in a permit application. The MOE states that they "consider" cumulative effects on every approval, although the overall approval process and O.Reg. 419/05 are reliant on the assumption that the "effects-based" air standards in Ontario are, in most circumstances, sufficiently conservative to be protective. However, in a few cases where public comment on applications has demanded it, typically where there is already a significant industrial presence, the MOECC has required the proponent to submit an assessment of cumulative effects focussed on specific contaminants.

For ECA applications, all compounds emitted from the facility need to be considered; ground level concentrations for compounds, for which no standard or assessment value has been published by the MOECC, still need to be modelled. The MOECC will evaluate whether the concentration of these compounds (i.e. those without a standard or assessment value) is acceptable with input from Ministry scientists/toxicologists. If the AERMOD model predicts POI concentrations resulting from a facility's emissions that are above the Schedule 3 standards (i.e. variable averaging period standards for AERMOD assessments), a facility can choose to abate emissions, if feasible in the short term, or otherwise has two alternative compliance options available to them: (1) requesting a site-specific standard (SSS); or (2) a sector/equipment-based technical standard. Both of these options involve evaluating technical feasibility of control measures to essentially develop and implement a plan for achieving emission control that is consistent with the best performing sources (in terms of emissions) within industry. Under these options the regulator directs attention to making meaningful emission reductions at major sources of emissions.

O.Reg. 419/05 Alternative Compliance Option #1 – Site Specific Standard (SSS)

> The SSS process results in the application of Best Available Technology at industrial facilities in Ontario that exceed provincial air quality guidelines. This is accomplished through a technology assessment and the development of a plan to implement technically feasible technologies to reduce emissions. The technologies or abatement

[xlviii] https://dr6j45jk9xcmk.cloudfront.net/documents/3278/190-guildeline-for-the-implementation-of-air.pdf

strategies are specifically chosen to reduce ground-level concentrations of target contaminants. Inherent in the requirements of the regulation is the guiding principle of continuous improvement. If a facility is unable to meet air quality standards even after implementing technically feasible measures to reduce emissions of certain pollutants, it will need to revisit the plans on a regular basis (typically every 5 years) to reassess feasibility of emission abatement actions.

In assessing what constitutes Best Available Technology for Ontario, a staged approach to evaluation of control measures is implemented. First technologies must be evaluated for technical feasibility and effectiveness in reducing emissions without consideration of economics. In general the most effective technology that is technically feasible needs to be selected. However the MOECC will also consider the cost effectiveness of solutions (i.e. cost per tonne reduction) and may allow facilities to delay actions on this basis.

In Ontario, industrial facilities that are requesting a site-specific standard are required to host a public meeting. Summary documents may be required to be posted on a company's website.

O.Reg. 419/05 Alternative Compliance Option #2 – Technical Standard

Technical standards have been developed for three industries so far: Foundries (PM/metals, VOC, SO_2); Forest Products (acrolein); and Pulp and Paper (multiple compounds)[xlix]. This approach to managing emissions relies on specifying detailed requirements for facilities within a sector that were unable to comply with one or more Schedule 3 standards. Emissions of specific compounds from sources or equipment covered by the applicable technical standard, are exempt from inclusion in the dispersion modelling assessment. Instead, compliance is based on meeting the requirements of the technical standard which mandate implementation of technology-based solutions and best practices to manage emissions. Therefore the Technical Standards are essentially what the province considers to be "Best Available Technology" for these sources. Other technical standards may be developed as stringent new air quality concentration standards for hexavalent chromium, benzene and other compounds take effect in 2016[l].

Linking back to the Air Zone framework, both of the proposed Zone 3 airsheds, the City of Hamilton and the Sarnia-Area contain industrial facilities that are unable to demonstrate compliance with the Schedule 3 standards. The alternative compliance mechanisms (i.e. site-specific standard; or technical standard) that these facilities are employing require assessment and review of emission reduction measures. Ramboll Environ is aware that in these proposed Zone 3 airsheds, reductions of emissions of particulate matter and various hazardous air pollutants (HAPs) are required at the industrial facilities. In Ontario stakeholders take an active role and participate in policy and guidance discussions that directly affect how sources within their respective Air Zones are regulated. This is especially true for Zone 3 areas in Ontario (i.e.

[xlix] http://www.ontario.ca/document/technical-standards-manage-air-pollution

[l] https://www.ebr.gov.on.ca/ERS-WEB-External/displaynoticecontent.do?noticeId=MTI0NTEw&statusId=MTg3NDk2

City of Hamilton and Sarnia-Area) where NGOs are active and comprehensive local air monitoring networks have been established.

2.2.3.1.4 Drive Clean Program

Ontario's Drive Clean[ii] is a mandatory test and maintenance program for both light and heavy duty vehicles that are required to meet emissions standards as a condition of vehicle registration or transfer of ownership (resale). The program was implemented in phases for light duty vehicles:

- Phase 1 (Greater Toronto Area and Hamilton, where mandatory emissions testing for Drive Clean began in April 1999);
- Phase 2 (urban and commuter areas from Windsor to Peterborough, where mandatory emissions testing began January 1, 2001);
- Phase 3 (the remainder of southern Ontario from Windsor to Ottawa, where mandatory vehicle emissions testing began on July 1, 2002).

In general, once a vehicle is 7 years old an emission test is required every two years for light duty vehicles and every year for heavy duty vehicles.

2.2.3.1.5 Other Ontario Air Quality Regulations/Programs

O. Reg. 127/01 AIRBORNE CONTAMINANT DISCHARGE MONITORING AND REPORTING

This regulation requires monitoring of contaminants and annual reporting from specific facilities, identified by NAICS code, in accordance with the Ministry of the Environment publication entitled "Step by Step Guideline for Emission Calculation, Record Keeping, and Reporting for Airborne Contaminant Discharge" dated April 2001.

R.R.O. 1990, Reg. 338 BOILERS

The regulation specifies fuel sulphur content for equipment used for the purpose of producing hot water or steam that uses fuel oil or coal with "grandfather" clauses that apply to equipment installed prior to the regulation. It provides an exemption for residences that contain not more than three families, comfort heating equipment, and Ontario Power Generation Inc. which is covered in a separate regulation.

O. Reg. 397/01 EMISSIONS TRADING

The regulation defines a framework for the trading of emissions of sulphur dioxide and nitrogen oxides for fossil-fuel-burning electricity generating facilities. It defines allowances and reduction credits that are available for trade. Electricity generation accounts for 15% of NOx and 25% of SO_2 production in Ontario and has therefore been targeted for regulation under the CAAP.

[ii] http://www.ontario.ca/page/drive-clean-test

O. Reg. 271/91 GASOLINE VOLATILITY

The volatility limit for gasoline is limited to 62 kPa by this regulation. Production requirements for refineries are defined for high ambient temperature episodes in summer. The intention is to minimize fugitive emission as a result of handling and distribution of fuel in the summer months. This regulation is credited with a portion of the success in achieving the Phase 1 benzene emission reduction targets of the CWS.

R.R.O. 1990, Reg. 349 HOT MIX ASPHALT FACILITIES

The regulation limits the emission to atmosphere of particulate and water droplets after a 15 minute start-up period from hot mix asphalt equipment.

O. Reg. 194/05 INDUSTRY EMISSIONS - NITROGEN OXIDES AND SULPHUR DIOXIDE

The regulation defines a framework for capping emissions of sulphur dioxide and nitrogen oxides for cement, non-ferrous smelting, petroleum, carbon black, flat glass, pulp and paper, and iron and steel sectors. It defines allowances and reduction credits that are available for trade. The basis for these targets is established based on Ontario's Industry Emissions Reduction Plan. Facilities subject to this regulation are still subject to O.Reg. 419/05 for NOx and SO_2 that require that ground-level local air quality impacts be assessed and reduced if unacceptable.

R.R.O. 1990, Reg. 350 LAMBTON INDUSTRY METEOROLOGICAL ALERT

This regulation applies the bubble concept to an area of high emissions intensity using an ambient monitoring network called the "Lambton Industry Meteorological Alert System" which restricts operations of facilities when the concentration of sulphur dioxide reaches 0.07 parts per million parts in air.

2.2.4 Quebec

Air Zone / Air Quality Management Framework

Quebec supports the objective of AQMS and will collaborate with other jurisdictions in implementation of key elements of the system. However Quebec has not formally adopted the AQMS framework. Despite this, Quebec does have an extensive air quality monitoring network across the province consisting of over 60 monitoring stations measuring one or more of the following parameters: ozone, $PM_{2.5}$, PM_{10}, SO_2, NO_2, CO, and H_2S and VOC, Polyaromatic Hydrocarbons (PAHs)[iii]. The Quebec government published a report on air quality in the province from 1975-2009 (Quebec, February 2012)[iiii] based on ambient data collected in this network. The report compares air quality to levels in Quebec regulations and World Health Organization (2005). Similar to reports from other provinces, high-level emission inventories showing contribution from different sectors (Transportation, Industry, Non-industrial combustion, other)

[iii] http://www.mddelcc.gouv.qc.ca/air/programme_surveillance/index.asp#historique
[iiii] https://www.inspq.qc.ca/pdf/publications/1432_BilanQualiteAirQcLienSante1975-2009.pdf

are provided for context. One important trend that was observed is that urban ozone concentrations, which have been increasing since 1990, have been attributed to reductions in NOx emissions from the transportation sector. This "NOx disbenefit" effect is a reflection of the fact that the urban core areas are characterized by low VOC/NOx ratios due to the large transportation-related emissions of NOx which reduces the ozone production rate relative to areas with larger VOC/NOx ratios. This is the reason that ozone levels are often found to be lower in core urban areas where NOx emissions are high relative to VOC and higher in downwind rural areas where NOx emissions are lower and the sufficient time has elapsed during transport to allow for more ozone to form[liv]. Under the low VOC/NOx conditions in the urban core, a marginal lowering of NOx emissions will result in higher ozone concentrations until the VOC/NOx ratio increases to a point at which ozone production becomes more limited by the availability of NOx.

Industrial Approvals / Provincial Air Regulation Requirements

Quebec has an Environmental Quality Act under which regulations targeting industrial air emission sources exist[lv]:

- Q-2, r.4.1 Clean Air Regulation
- Q-2, r.5 Regulation respecting industrial depollution attestations[lvi]
- Q-2, r.15 Regulation respecting mandatory reporting of certain emissions of contaminants into the atmosphere

The Clean Air Regulation includes fugitive particle emission standards, emission opacity requirements, VOC emission standards, fuel suphur content limits, emission limits from combustion equipment (PM, NOx), and air quality standards (Schedule K), and provides direction on periodic source testing requirements for specific source types. Compliance is based on meeting the requirements of the Clean Air Regulation. Tools for addressing non-attainment were not identified.

The City of Montreal regulates sources situated within its boundaries in accordance with "Règlement 90"[lvii]. The provincial Clean Air Regulation does not apply to sources covered by the by-laws of the city[lviii].

[liv] See Pg 22 of "https://www.inspq.qc.ca/pdf/publications/1432_BilanQualiteAirQcLienSante1975-2009.pdf" for further explanation
[lv] http://www2.publicationsduquebec.gouv.qc.ca/home.php
[lvi] Name of English version of Regulation Q-2 r.5 "Règlement sur les attestations d'assainissement en milieu industriel"
[lvii] http://ville.montreal.qc.ca/portal/page?_pageid=7237,75191583&_dad=portal&_schema=PORTAL
[lviii] http://www.mddelcc.gouv.qc.ca/air/atmosphere/articleRAA-201109pdf.pdf

2.2.5 Saskatchewan

Air Zone / Air Quality Management Framework

In Saskatchewan there are three active Air Zones: Southeast Saskatchewan Airshed Association (2005); Western Yellowhead Air Management Zone (2012); and Great Plains Air Zone (2014). Other Air Zones are Boreal Air Zone, Northeast Air Zone, and Grasslands Air Zone and have yet to be incorporated; all air zones are shown in Figure 5.

The Southeast Saskatchewan Airshed Association and the Western Yellowhead Air Management Zone have published an annual report[lix], although assessment is with respect to the Saskatchewan Ambient Air Quality Standards and not the CAAQS. Management plans have not been developed and air zones have not been assigned management levels (red, orange, yellow or green).

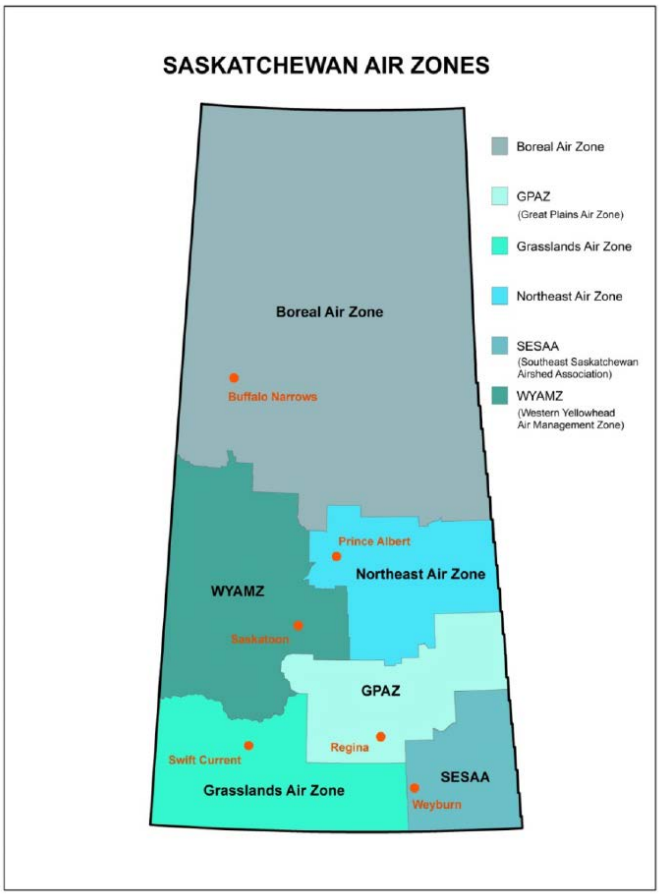


Figure 5 Saskatchewan Air Zones.[lx]

[lix] http://sesaa.ca/documents/2014_SESAA_AnnualReport.pdf
[lx] http://www.environment.gov.sk.ca/Default.aspx?DN=4d15e385-5d46-4de4-b551-dc71b52922f7, Air Zone Map.pdf

Industrial Approvals / Provincial Air Regulation Requirements

The provincial regulation of air emissions from industrial sources recently underwent a significant change in that the previous regulations and acts were repealed and replaced with updated legislation - Environmental Management and Protection Act (2010) and General Regulations Saskatchewan Environmental Code (the Code) [lxi].

Existing permits issued under previous regulations will remain in force until Jan 1, 2020, unless they expire sooner. Under the new regulations, facilities are required submit an environmental protection plan (EPP) instead of obtaining a permit[lxii]. The regulation identifies "results-based objective" of limiting the probability of an unacceptable adverse effect. The EPP must be signed by a "qualified person" who is of the opinion that the methods and components in the EPP will satisfy the results-based objective, including taking reasonable measures to:

- Site an industrial source facility in an acceptable location;
- Ensure that the ambient air quality standards are met[lxiii];
- Ensure that the applicable sector-specific emission limit standards are met[lxiv];[lxv];
- Calculate or measure annual air contaminant emissions;
- Minimize the effects on the environment of air contaminants (water quality, ecology);
- Minimize the release of fugitive air contaminants from industrial source facilities; and
- Include components on monitoring, recording and reporting.

2.2.6 Comparison of Provincial Frameworks

Based on the provincial review, Alberta and B.C. are furthest along in implementation of the Air Zone Management Framework. They have well-defined Air Zones, and have published reports that address the air quality in the Air Zones relative to CAAQS with the assignment of appropriate Management Levels. Management Plans have been or are being developed when required.

Ontario has made a proposal for delineating Air Zones, although monitoring data has been assessed at the Provincial level, and detailed analysis to assign Management Levels to individual Air Zones was not identified. Quebec has chosen not to implement the AZMF. In Saskatchewan plans are currently underway to establish air zones throughout the province.

Regarding mobile emissions management differences exist between provinces as well. AirCare, the vehicle monitoring program in B.C. targeting existing onroad light duty vehicles, ended after 2014[lxvi], to allow resources to be focussed instead on emissions of diesel particulate. In Ontario,

[lxi] http://www.publications.gov.sk.ca/details.cfm?p=31893
[lxii] http://www.qp.gov.sk.ca/documents/English/Regulations/Regulations/E10-22R2.pdf
[lxiii] https://envonline.gov.sk.ca/Pages/SEQS/Table20-SEQS-SAAQS.pdf
[lxiv] https://envonline.gov.sk.ca/Pages/SEQS/Table21-SEQS-EmissionLimit.pdf
[lxv] http://www.environment.gov.sk.ca/adx/aspx/adxGetMedia.aspx?DocID=b7db6174-3e9c-483f-8b78-503bd2f20ead&MediaID=b33d85b1-f01d-4a99-a818-68f0e8123f2a&Filename=Environmental+Guideline+for+SK+Asphalt+Plants+-+July+2015.pdf&l=English
[lxvi] https://news.gov.bc.ca/stories/aircare-to-end-after-2014-new-options-explored

emission testing under the Drive Clean program is still required for light duty vehicles. The only non-federal program specifically targeting off-road equipment that was identified is Metro Vancouver's Non-Road Diesel Engine Regulatory Program that encourages non-road diesel fleet turnover in the region through financial incentives[lxvii].

A unique similarity was noted for B.C. and Quebec; the management of industrial emissions in Vancouver and Montreal has been delegated to the municipal governments by the respective provinces.

It was observed that provincial permitting programs require a comprehensive air quality assessment that typically includes compounds beyond those with existing or proposed CAAQS. However there can be notable differences in the standards or ambient air quality objectives between provinces.

Finally, there are differences in how cumulative effects are treated provincially, especially in the context of industrial source approvals. Alberta, B.C. and Ontario all have well-established permitting programs for these sources. While Ontario has some of the most stringent standards (i.e., "effects-based"), its permitting program does not outline a consistent process for addressing cumulative effects. In contrast, both Alberta and B.C. consistently require a consideration of cumulative effects in modelling assessments for the purposes of obtaining an air permit, meaning there is a potential synergy with the AZMF as it inherently takes into account cumulative effects.

A summary of the comparison of Air Quality Management Tools is provided (Table 3).

Table 3 Comparison of Air Quality Management Tools.

Province	Air Zone Management Framework	Industrial Approvals / Air Regulations
Alberta	• Significant progress made; Air zones defined and have been assigned management levels • Prior to AZMF Alberta was actively managing regional air quality.	• Air Permitting process considers cumulative effects directly; overlaps with AZMF in this regard • Dispersion modelling required
British Columbia	• Significant progress made; Air zones defined and have been assigned management levels • Some Management Plans have been developed • $PM_{2.5}$ is primary issue	• Requirements more comprehensive for operations that pose greater risk to the environment as defined by regulations • High-risk activities require dispersion modelling assessments • Air Permitting process for high-risk activities considers cumulative effects directly; overlaps with AZMF in this regard
Ontario	• Zones established based on their characteristics (i.e. types of	• Does not consider cumulative effects directly

[lxvii] http://www.metrovancouver.org/services/Permits-regulations-enforcement/non-road-diesel/Pages/default.aspx

Province	Air Zone Management Framework	Industrial Approvals / Air Regulations
	sources) – this is different than other provinces that define zones based on geography without regard for types of sources • Implementation of AZMF is behind Alberta and British Columbia – management levels not yet assigned • Management plans not yet developed – however some mitigation efforts underway at industrial facilities • Transboundary ozone is likely main issue	• Air Zone Delineation seems to align with permitting program as there is reliance on Local Air Quality Regulation O.Reg.419/05 to mitigate industrial air emissions in 'non-attainment areas' through permitting requirements • Dispersion modelling required • New standards and models were phased-in sooner for industries considered to present greatest environmental risk
Quebec	• Not implementing AZMF, therefore no tools identified	• Some requirements for industrial facilities • Less emphasis on dispersion modelling, some simple dispersion calculations
Saskatchewan	• Air Zones are being defined • Management levels have not been assigned • Behind Alberta and British Columbia	• Environmental Protection Plan required instead of a permit • Dispersion modelling does not seem to be generally required

3.0 UNITED STATES OF AMERICA

3.1 National Program

Air quality management in the US is primarily based on provisions of the Clean Air Act (CAA) as most recently amended in 1990 which is designed to protect the public health and welfare from the deleterious effects of air pollution. Most CAA provisions are administered on the national level by the US Environmental Protection Agency (USEPA). Among other things, the CAA requires the USEPA to establish and regularly update air quality standards, review and approve plans submitted by states to achieve the ambient standards, control hazardous (toxic) air pollutants, protect visibility in scenic natural preserves, control emissions responsible for acid deposition (acid rain), issue operating permits for large stationary sources, protect the stratospheric ozone layer, and take other actions which may be needed to address newly identified or emerging issues such as climate change inducing emissions of greenhouse gasses (GHGs).

3.1.1 Guiding Principles

Air quality management in the U.S. is based on a number of guiding principles, including:

- Pollution prevention: methods for preventing emissions of air pollutants, including both methods for limiting activities that lead to emissions as well as application of control technologies, form the foundation of air pollution management;
- Polluter pays: entities responsible for causing pollution are responsible for the cost of cleaning it up;
- Fairness/Environmental Justice: management practices should not unfairly disadvantage any one group of people relative to others; in particular management approaches for reducing pollution in one area should not result in increased pollution in other areas; Public participation: public agency management actions are subject to public disclosure, review and comment.

3.1.2 National Ambient Air Quality Standards and Non-Attainment Areas

The CAA requires the USEPA to set National Ambient Air Quality Standards (NAAQS) to protect the public health and welfare throughout the US and requires states to develop enforceable plans known as State Implementation Plans (SIPs) to achieve the NAAQS. Primary NAAQS are designed to protect the public's health without consideration of associated costs. Nevertheless, costs and benefits of NAAQS implementation are estimated as part of the standard setting process and inevitably play into the politics of setting a new NAAQS. The CAA includes provisions specifying deadlines by which areas must achieve attainment of the primary NAAQS. Secondary NAAQS are designed to protect the public welfare, (e.g., damage to forests and agriculture). For secondary NAAQS, the CAA provides only that areas must achieve attainment "as expeditiously as practicable". NAAQS are currently in effect for six "criteria" pollutants (Table 4): carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particulate

matter with aerodynamic diameters of less than 10 µm (PM_{10}) and less than 2.5 µm ($PM_{2.5}$), and sulfur dioxide (SO_2). While individual States are free to set more stringent standards, the requirement for uniform national air quality standards highlights an underlying principle of national air quality management practices in the US: that the burden and benefits of air pollution control requirements should apply equally throughout the country.[lxviii]

Table 4 National Ambient Air Quality Standards (NAAQS).

Pollutant		Primary/Secondary	Avg. Time	Level	Form
Carbon Monoxide (CO)		primary	8 hours	9 ppm	Not to be exceeded more than once per year
			1 hour	35 ppm	
Lead (Pb)		primary and secondary	Rolling 3 month period	0.15 µg m^{-3}	Not to be exceeded
Nitrogen Dioxide (NO_2)		primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		primary and secondary	1 year	53 ppb	Annual Mean
Ozone (O_3)		primary and secondary	8 hours	0.070 ppm	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particle Pollution (PM)	$PM_{2.5}$	primary	1 year	12.0 µg m^{-3}	annual mean, averaged over 3 years
		secondary	1 year	15.0 µg m^{-3}	annual mean, averaged over 3 years
		primary and secondary	24 hours	35 µg m^{-3}	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24 hours	150 µg m^{-3}	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO_2)		primary	1 hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

Areas in which air quality does not meet (”violates”) the NAAQS may be officially designated by the USEPA as non-attainment areas (NAAs). NAAs may be classified as marginal, moderate,

[lxviii] For example, EPA regulations state that EPA will “assure fair and uniform application by all [EPA] Regional Offices of the criteria, procedures and policies employed in implementing and enforcing” the CAA (40 C.F.R. 56.3(a)) and that the Regional Offices “shall assure that actions taken under the [CAA] . . . [a]re as consistent as reasonably possible with the activities of other Regional Offices” (40 C.F.R. 56.5(a)(2)).

serious, severe, or extreme according to the degree of pollution. The concentration thresholds and regulatory requirements associated with each classification are specified by the USEPA and are different for each NAAQS. Numerous stringent regulatory requirements apply to NAAs as described below. NAA designations, classifications, and boundaries are based on State recommendations and are subject to USEPA review and approval. Boundaries are set using USEPA guidance specific to each pollutant. In general, boundaries are drawn on basis of ambient air quality data, locations of sources of emissions and exposed populations, prevailing meteorological conditions and airshed and jurisdictional boundaries. Specific considerations vary from one pollutant to the next. Preference is given to drawing NAA boundaries along political demarcations (cities, typically grouped by metropolitan statistical area [MSA], or county boundaries) taking the other factors into consideration. As a consequence of secondary formation in the atmosphere of $PM_{2.5}$ and ozone from primary precursor emissions, NAA boundaries for ozone and $PM_{2.5}$ typically cover larger areas (multi-county MSAs) whereas smaller areas may be allowed for pollutants such as lead for which the number of sources and associated local impact areas are limited.

As air quality in an NAA improves based on validated ambient measurements made using USEPA approved methods, states can petition USEPA to reclassify the area to "attainment" and submit a SIP revision to this effect. If approved by USEPA, such areas are reclassified as "maintenance" areas which must meet certain requirements specified in the revised SIP designed to avoid backsliding into nonattainment. Other areas are designated as attainment/unclassifiable (in recognition that many such areas have insufficient monitoring data to adequately characterize their attainment status). New stationary sources in such areas fall under the Prevention of Significant Deterioration (PSD) provisions of the CAA as described below. The PSD program is designed to limit the degree of air quality degradation of areas that are currently "clean."

3.1.3 State Implementation Plans

SIPs are required to contain a number of specific provisions as described below. Firstly, CAA Sec. 110 specifies elements of State Implementation Plans (SIPs) which states are required to prepare for each pollutant for which the USEPA has set a NAAQS regardless of whether or not any areas within the State have been classified as NAAs ("infrastructure SIPs"; see EPA, 2013):

- Enforceable emission limits and controls including implementation schedules and enforcement mechanisms necessary to maintain attainment (for areas classified as attainment/unclassifiable)
- Schedules and timetables for compliance
- Provisions for ambient air quality monitoring
- Provisions for air quality modeling capability
- Provisions to prevent emissions from sources within the State contributing significantly to nonattainment of NAAQS in any other State
- Abatement measures for interstate and international pollution
- Provisions to ensure State will have adequate personnel, funding and authority to carry implement the SIP
- Requirements regarding monitoring and reports from major stationary sources

- Consultation and public notification
- Prevention of Significant Deterioration (PSD) program elements (applies to attainment/unclassified areas)
- Major source permitting program elements, including permit fees
- Minor source permitting program elements for sources not requiring federal permits
- Implementation of any federal emission control programs for which the State has been delegated authority (NSPS, NESHAPS, Acid Rain – see below)
- Implementation of the Regional Haze program
- Provisions for participation by local governments (cities, counties)
- SIP revision provisions
- Contingency plans to implement source curtailment during emergency air pollution episodes

Secondly, Section 172 of the CAA specifies SIP requirements for NAAs. (see also http://www2.epa.gov/approved-sips). NAA SIPs must describe measures the State will take to bring area(s) into attainment within the USEPA-specified deadline(s). States with NAAs must include specific elements in their SIPs for each criteria pollutant(s) for which the area is in nonattainment based on the NAA classification (marginal, moderate, etc.) as specified in the applicable SIP requirements rule. NAAs with less severe pollution (marginal or moderate NAAs) typically have fewer required SIP elements and earlier attainment deadlines than more heavily polluted (serious, severe and extreme) areas. SIPs typically must contain numerous elements including:

- An inventory of emissions (including specifically a motor vehicle emissions budget for transportation conformity demonstration as described below),
- A nonattainment area New Source Review (NSR) program mandating Lowest Achievable Emission Rate (LAER; see description below) for new/modified sources and emission offset requirements set at a level designed to provide for "reasonable progress" towards attainment (but no less than a 1-to-1 offset),
- A set of control measures (Reasonably Available Control Technology [RACT] or Reasonably Achievable Control Methods [RACM]; see description below) for existing sources, and
- A future emissions budget consistent with achieving attainment.

More heavily polluted NAAs typically must also include:

- Best Available Control Measures (BACM) or Best Available Control Technologies (BACT) for existing sources (see description of BACM and BACT below),
- An attainment demonstration (usually based on modeling analyses) showing that the control measures included in the SIP will result in NAAQS attainment,
- A set of Reasonable Further Progress (RFP) provisions (i.e., a specified schedule of incremental reductions in emissions) designed to make rapid progress in moving towards attainment, and
- A set of contingency measures to be implemented if the SIP control measures prove to be inadequate.

Various emission control requirements apply to new/modified and existing sources in non-attainment areas is listed above:

- LAER is defined under the New Source Review program (see Sec. 3.1.4) as the more stringent of either 1) the most stringent limit contained in any State's SIP for the same type of source or 2) the most stringent emission limit achieved in practice for the given source type.
- RACT is defined in the regulations as "the lowest emission limitation that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility" (44 FR 53762; 17 September 1979) and is essentially the most stringent control technology requirement that has been adopted as a retrofit control of existing sources by a state or local air pollution control agency and incorporated into a SIP.
- RACM includes RACT and requires a demonstration that 1) the State has adopted all reasonable measures to meet the Reasonable Further Progress requirements and to demonstrate attainment as expeditiously as practicable and 3) that there are no additional reasonably available measures that would advance the attainment date or contribute to Reasonable Further Progress towards attainment.
- BACT is a case-by-case determination of emission limits determined to be achieved in practice by similar sources, taking costs and other impacts into consideration. The main difference between BACT and LAER is that the generally more stringent LAER does not allow consideration of costs to determine an appropriate limit.
- BACM is similar in concept to BACT but generally as applied to mobile sources and sources of PM.

Not all of the above SIP elements are required for each criteria pollutant and additional specific elements are required for some pollutants. Some of the most extensive requirements apply to ozone non-attainment areas as shown in Figure 6. Some of the more notable requirements include automobile inspection and maintenance (I&M) programs, a fee on major source emissions if an area misses the attainment deadline, and a requirement to implement transportation control measures sufficient to offset motor vehicle emissions growth (CAA Sec. 182(d)(1)(A)). SIP requirements include so-called "anti-backsliding" measures which essentially prevent areas from easing emission controls previously put in place or that were required to achieve attainment of older versions of the NAAQS; anti-backsliding measures are specified in the implementation rule for each new NAAQS revision. Pollutant-specific SIP measures as listed in http://www3.epa.gov/airquality/urbanair/sipstatus/nonattainment_req.html (see also specific pollutant SIP requirements rules such as the Ozone SIP Requirements Rule (80 FR 44 12264-12319; https://www.gpo.gov/fdsys/pkg/FR-2015-03-06/pdf/2015-04012.pdf).

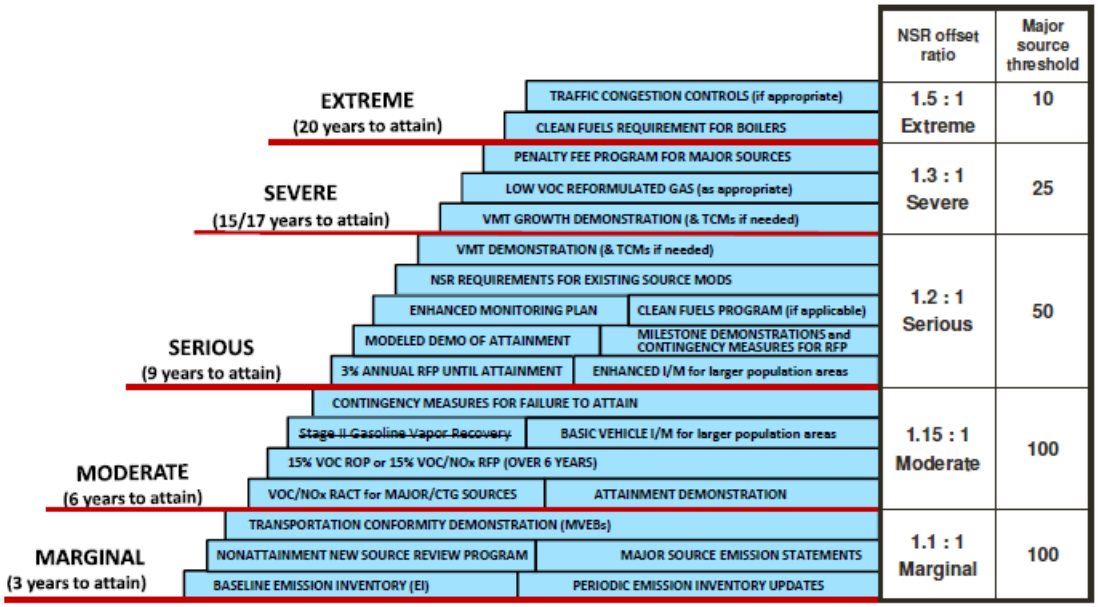


Figure 6 Overview of USEPA SIP planning and control requirements for 2008 8-hour ozone NAAQS non-attainment areas.

All control measures included in a SIP must meet four specific criteria:

1. Emission reductions achieved by the measure must be "surplus", i.e., no double counting allowed.
2. Emission reductions achieved by the measure must be quantifiable
3. Emission reductions achieved by the measure must be permanent, i.e., no backsliding allowed.
4. The control measure must be federally enforceable

In addition, the USEPA has prepared guidance for the inclusion in SIPs of voluntary and novel emission reduction measures which may be difficult to quantify and cannot be federally enforced.[lxix]

USEPA's SIP requirements include provisions for dealing with situations in which transport of emissions from neighboring jurisdictions outside of a state's control contributes significantly to non-attainment within the state:

- As noted above, states must demonstrate in their Sec. 110 "infrastructure" SIPs that sources within the State to not contribute to non-attainment in downwind states. Also, in recognition of the regional nature of ozone nonattainment in the eastern US, eleven northeastern states along with the District of Columbia and parts of northern Virginia were grouped together for ozone control purposes into the Ozone Transport Region (OTR) as part of the 1990 CAA amendments (Sec. 184). The Ozone Transport Commission (OTC) was created to manage

[lxix] http://www3.epa.gov/otaq/stateresources/policy/pag_guidance.htm

ozone non-attainment within the OTR. Thus states within the OTC are bound together for purposes of managing ozone air quality.

- Section 176A(a) of the Clean Air Act allows any downwind state to petition the EPA to add an upwind state to a transport region if the interstate transport of air pollutants from the upwind state contributes significantly to a violation of a NAAQS in the downwind state.
- In addition to the § 176A process, Sec. 126(b) of the CAA allows any state or political subdivision to petition the USEPA for a finding that a stationary source or group of stationary sources in an upwind state emits pollutants which is interfering with the attainment or maintenance of a NAAQS in violation of the CAA's "good neighbor provision" [Sec. 110(a)(2)(D)(ii)]. If the EPA finds that the source's emissions violate the good neighbor provision and grants the § 126 petition, the source must cease operations within three months, unless the source complies with emission limitations and compliance schedules established by the EPA.
- USEPA also developed an Overwhelming Transport Policy [http://www3.epa.gov/ttn/scram/guidance/guide/owt_guidance_07-13-05.pdf] designed to ease the burden on rural nonattainment areas which do not have any significant sources of ozone precursors but which are overwhelmingly affected by emissions from upwind states. Under this policy, such areas are eligible for extensions in their attainment dates commensurate with attainment in the upwind states.
- States in international border areas can submit "but for" attainment demonstrations in their SIPs which demonstrate that the area is or will be in attainment by the statutory deadline "but for" the impacts of sources not located within the US. This situation has been applied, for example, to PM nonattainment in Imperial County, CA which is located adjacent to large sources of emissions in Mexicali, Mexico.

Under the Sec. 176(c) of the CAA, federal government actions must "conform to", i.e., not interfere with the provisions and goals of non-attainment area SIP elements. Implementing regulations developed by USEPA distinguish between "transportation conformity" requirements which apply to federally funded transportation plans, programs and projects, and "general conformity" requirements which apply to all other federal actions. Transportation conformity rules apply to approval of transportation improvement plans and transportation projects by local Metropolitan Planning Organizations. Conformity in this context means that the action or project must not cause or contribute to any new violations, contribute to the number or severity of violations or interfere with SIP attainment deadlines or milestones. Transportation plan conformity is based on a determination that emissions from on-road vehicles under the plan are within the SIP transportation emissions budgets, i.e., the level of emissions from on-road vehicles used in the SIP attainment demonstration. Demonstrating conformity for individual projects may require a demonstration that the project does not cause or contribute to violations of the NAAQS and typically focusses on modeling of local "hotspot" CO and PM impacts.

NAA SIPs are generally due to USEPA within 3 years of the NAA designation although later deadlines apply for areas with more serious non-attainment problems, e.g., Serious and above ozone non-attainment areas have four years to develop their SIPs. Full implementation of SIP provisions must typically be completed the year before the applicable attainment data. The USEPA can issue a Federal Implementation Plan if a state fails to submit an approvable SIP by the designated deadline or for any federal programs such as NSPS, NESHAPS, or Acid Rain not

taken on by the state (see descriptions of these programs below). States failing to submit an approvable SIP by the deadline may be subject to withholding of funding for highway projects and a step-up in the level of offsets required for approval of new sources.[lxx] To avoid unnecessary delays and continued endangerment of public health, USEPA sets specific attainment deadlines for each NAAQS which vary by pollutant and the NAA classification – more severely polluted areas have later deadlines than less polluted areas. States may be granted limited extensions to the attainment deadline subject to certain conditions as specified in the CAA and USEPA guidance. Typically states that miss attainment deadlines apply for a "bump up" to a more severe NAA classification level which has a later attainment deadline. States in this situation must then submit SIP revisions consistent with SIP requirements for the more severe classification level.

3.1.4 New Source Review

New major sources or sources undergoing major modifications must comply with the provisions of USEPA's New Source Review (NSR) program. In NAAs, major sources are defined as sources exceeding the annual emission thresholds listed in Table 5; higher thresholds apply in attainment areas. Sources located in areas designated as attainment with respect to the NAAQS must comply with the Prevention of Significant Deterioration (PSD) program elements which are designed to limit the degradation of air quality in these relatively "clean" locations. The PSD program requires use of Best Available Control Technology (BACT), a case-by-case determination of emission limits determined to be achieved in practice by similar sources, and considering costs and other impacts. A detailed BACT determination involves a "top down" analysis in which all potential control options are first rank ordered from most to least stringent. Then, starting with the most stringent option, the costs and other impacts are analyzed, including calculation of the annual cost per ton of pollution prevented. Cost effectiveness is calculated with the assistance of USEPA guidance ("EPA Air Pollution Control Cost Manual", Report No. EPA/452/B-02-001) which provides information on control method cost calculations and amortization of capital costs. If the most stringent control option is deemed to be unacceptable, then the second most stringent option is analyzed, and so on. There is no "bright line" threshold value for acceptable cost effectiveness; the final BACT determination involves a negotiation with the permitting authority.

Sources seeking PSD permits are required to limit their downwind impacts below applicable PSD increments defined for two types of impacts areas: Class I and Class II. Class I areas (mostly national parks and wilderness areas) have significantly lower allowed PSD increments than all other (Class II) areas. Compliance with PSD increments and with the NAAQS is typically required to be demonstrated using air dispersion modeling. Additional impacts on visibility and on soils and vegetation may also be required to obtain a PSD permit.

[lxx] For example, in 2010, the U.S. EPA issued a finding that California had failed to submit a required element (CAA Section 185 fee program) with its ozone SIP. As a result, EPA announced that California must ensure that each ton of emissions created by a new stationary source of pollution is offset by a two ton reduction in existing stationary sources unless a complete SIP is submitted within 18 months.

Table 5 Major source emission thresholds.

Pollutant	Nonattainment Classification	Major Source Threshold
Ozone	Marginal	100 tpy of VOC or NOx
	Moderate	100 tpy of VOC or NOx
	Serious	50 tpy of VOC or NOx
	Severe	25 tpy of VOC or NOx
	Extreme	10 tpy of VOC or NOx
Particulate Matter (10µm)	Moderate	100 tpy
	Serious	70 tpy
Carbon Monoxide	Moderate	100 tpy
	Serious	50 tpy
Sulfur Dioxide, Nitrogen Oxides and Lead	--	100 tpy

New or modified major sources located in non-attainment areas must meet the Lowest Achievable Emission Rate (LAER) and emission offset requirements applicable to the area. LAER is defined as the more stringent of either 1) the most stringent limit contained in any State's SIP or 2) the most stringent emission limit achieved in practice for the given source type. Information on what has been required as LAER for air permits is maintained in USEPA's RACT/BACT/LAER Clearinghouse.[lxxi] The main difference between LAER and BACT is that LAER does not allow consideration of costs to determine an appropriate limit.

States are also required to develop NSR programs for minor sources. USEPA has minimal requirements for these programs, other than that they protect the NAAQS. As a result, State permit requirements for new and modified minor sources vary significantly, with some States requiring only that minor sources must comply with existing States rules, while other States require BACT, modeling and/or offsets for minor sources.

3.1.5 Emission Inventories

Under the CAA, states are required to periodically submit data on criteria pollutant, volatile organic compound (VOC), and ammonia emissions from anthropogenic sources to the USEPA; reporting of HAP emissions and emissions from prescribed burns and wildfires is also encouraged (Air Emissions Reporting Rule, 40 CFR 51 Subpart A). USEPA uses the submitted data together with additional internally developed information to prepare the National Emission Inventory (NEI) which is used for a variety of air quality management activities, including assessing the anticipated impacts of new regulations under consideration, SIP development, compliance demonstrations, emissions trading, and emissions trend analyses. The NEI is a

[lxxi] http://cfpub1.epa.gov/RBLC/

detailed and comprehensive inventory of criteria and hazardous pollutants from all emissions sources in the US.[lxxii] A revised NEI is prepared every three years.

Certain large sources (power plants, fluid bed catalytic cracking unit catalyst regenerators, sulfuric acid plants, and nitric acid plants) as listed in Appendix P to CFR Part 51) and sources falling under the Acid Rain Program and the Clean Air Interstate Rule, which are both national-level emissions trading programs, must install continuous emission monitors (CEMs) capable of measuring emissions on an hourly basis which are then required to be reported to the USEPA. Extensive quality assurance and quality control requirements apply to CEMs and the USEPA supports these requirements via development of approved measurement methods, calibration standards, protocols and guidance (http://www.epa.gov/airmarkets/emissions-monitoring).

States must report emissions annually for all large point sources (including sources with and without CEMs) as required under the Air Emissions Reporting Rule; emissions from major point sources as defined in the CAA must be reported once every three years.[lxxiii] States may also choose to submit emissions for smaller (”minor”) sources as point sources based on permit data to USEPA for inclusion in the NEI. Other stationary source emissions are reported as nonpoint sources at the county level.

States must also report their mobile source emissions, including on-road mobile and off-road mobile sources. States (other than California) must report on-road mobile source activity data to USEPA sufficient to allow EPA to calculate emissions for inclusion in the NEI using USEPA’s MOVES on-road mobile source emissions model. California uses the California-specific EMFAC model to calculate emissions for reporting to USEPA and therefore reports on-road emissions directly. Emissions from off-road mobile sources can be reported by states as inputs to EPA’s NONROAD model (which is now a part of the MOVES mobile source model) instead of the actual emission values, emissions from off-road sources not included in NONROAD (aircraft, locomotives and commercial marine) must be reported directly. California uses different methods for calculating off-road source emissions depending on the source category (see http://www.arb.ca.gov/msei/categories.htm).

Emissions for other source categories are typically developed by USEPA – states are not required to report emissions from these categories but are encouraged to review values developed by USEPA and provide updates and corrections.

3.1.6 Emission Standards

All new or modified stationary sources must, at a minimum, meet any applicable federal emissions standards as established under the New Source Performance Standards (NSPS) as specified in 40 C.F.R. Part 60. NSPS standards may be adopted for a specific source category (e.g., petroleum refineries) or for equipment that may be found at a variety of industrial sources (e.g., engines or boilers). These performance standards include limits on emissions of pollutants which have been determined by the USEPA to endanger public health or welfare, source testing,

[lxxii] http://www3.epa.gov/ttn/chief/eiinformation.html
[lxxiii] See 40 C.F.R. 51 Subpart A, Appendix A

and recordkeeping requirements but do not specify any specific technology or method that must be used to achieve compliance.. In setting NSPS, USEPA generally examines emission levels achievable with the best technologies that have been demonstrated and takes into consideration costs and other environmental impacts associated with each candidate technology.

Sources of air toxics must meet applicable National Emission Standards for Hazardous Air Pollutants (NESHAP) for air toxics. Unlike NSPS standards, NESHAP rules may contain requirements for both new/modified and existing sources of HAPs, although different limits may apply to each category. Before 1990, USEPA adopted NESHAPs regulating individual HAP pollutants using a health-risk based approach. See 40 C.F.R. Part 61. The CAA Amendments of 1990 altered this approach, mandating that USEPA develop NESHAPs for a source category or an equipment type. NESHAPs have been developed for numerous source categories including petroleum refineries, wood preserving, etc.[lxxiv] These new NESHAPs contain stringent Maximum Achievable Control Technology (MACT) standards for major HAPs sources and less stringent Generally Available Control Technology (GACT) standards for "area" sources (or non-major sources) of HAPs. For new sources, MACT standards are required to be no less stringent than the best controlled similar existing source. USEPA is required to review MACT standards at least every eight years to evaluate "residual risk," meaning the level of human health risk that may remain even after sources achieve compliance with NESHAP standards. In some cases, USEPA has made revisions to strengthen older NESHAP rules based on these residual risk evaluations. .

3.1.7 Title V Permitting Program

Under the 1990 amendments to the CAA, the USEPA was required to establish a federal operating permit program for all major stationary source sand certain other large sources (without regard to attainment or non-attainment area location). States were then required to develop programs to issue these operating permits, which must be approved by USEPA. These "Title V" permits (so named after the CAA Title V in which the program requirements are laid out) provide a permitted facility with a comprehensive listing of all applicable requirements under the CAA, including emission limits, operational requirements, and monitoring, recordkeeping, and reporting requirements. The Title V program is not directly related to the PSD program described above. Title V permits typically do not introduce new emission limits, but may contain expanded monitoring designed to ensure compliance with existing limits. This may include new testing or recordkeeping, or even new continuous monitoring for sources subject to USEPA's Compliance Assurance Monitoring rule found in 40 C.F.R. Part 64. Sources with Title V permits must submit semi-annual monitoring reports and annual compliance certifications documenting compliance. Title V sources are also required to provide prompt notification (often within 24 hours) of any deviation of a Title V permit condition. Title V permits are typically renewed every 5-years to include changes in requirements over time.

USEPA also reviews and comments on draft Title V permits issued by a State. USEPA may also object to the issuance of a Title V permit, requiring the State to re-issue the permit to address USEPA concerns. Members of the public may also petition USEPA to object to issuance of a Title V permit, which USEPA would either approve or deny in a formal response.

[lxxiv] http://www3.epa.gov/ttn/atw/mactfnlalph.html

For sources in Indian Country, USEPA typically establishes and operates the Title V permit program although tribes can apply to establish their own programs.

3.1.8 Market-Based Emission Control Programs

The USEPA has developed a number of market-based programs to reduce environmental impacts (EPA, 2001). During the 1970s, increasing attention was focused in the US on the ecosystem effects of acid precipitation resulting from long-range transport of sulfur dioxide and NOx emissions from large sources with tall stacks such as coal-fired power plants. Given the regional, multi-state scale of the problem, USEPA's strategy for reducing acidic emissions eventually focused on development of a cap-and-trade market for sulfur dioxide and NOx emission allowances. The USEPA Acid Rain Program began operations in 1995. In subsequent years, the USEPA developed a series of additional trading programs focused on further reductions of NOx emissions from large sources in the eastern US designed primarily to assist states with attainment of the $PM_{2.5}$ and ozone NAAQS. Affected sources are issued SO_2 and NOx emission allowances up to the program "cap" and are required to surrender a sufficient number of allowances to cover their emissions each year. Allowances may be bought, sold, traded or banked to cover emissions in future years. In addition, SO_2 allowances can be purchased at USEPA's annual SO_2 allowance auction under the Acid Rain Program (see http://www.epa.gov/airmarkets for more information). The SO_2 allowance auction uses a subset of withheld allowances not allocated to sources to stimulate trading and provide an adequate source of allowances for new sources.

USEPA vehicle emission reduction regulations also provide for emissions averaging, banking and trading (ABT) to provide automobile manufacturers flexibility in meeting emission standards on a fleet-average basis. A similar program exists for ozone depleting substances (chlorofluorocarbons and related compounds).

3.1.9 Mobile Source Programs

USEPA's Office of Transportation and Air Quality (OTAQ) regulates emissions from new on-road and off-road[lxxv] mobile source vehicles and engines and regulates fuel quality. This includes national emission standards for new on-road vehicles, off-road equipment of all types, locomotives, and new marine engines used on US flagged vessels. The US has also adopted the International Civil Aviation Organization (ICAQ) standards for gas turbine engines used on commercial passenger and freight aircraft. OTAQ has established certification requirements which includes required vehicle and engine emission measurement testing and reporting procedures, measures and reports emission factors, and develops models for developing mobile source emission inventories. National on-road vehicle standards apply to all states. As the first state to establish motor vehicle emission standards, California has an exemption from USEPA's standards although the California standards must be at least as stringent as the national standards.

[lxxv] On-road vehicles are self-propelled vehicles licensed for use on public roads. Off-road (also referred to as nonroad) sources include all types of motorized vehicles and equipment and engines that are not stationary, excluding on-road vehicles. Nonroad sources include a wide range of types including construction equipment (tractors, front-end loaders, etc.), lawn and garden equipment, off-road recreational vehicles, boats and ships, locomotives and airplanes.

Other states may opt in to the California program and thus far 13 states have (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Jersey, New York, Oregon, Pennsylvania, Rhode Island, Vermont, and Washington DC).

3.1.10 Voluntary and Incentive Programs

While much of the US national NAA air quality management program is derived from statutory requirements, the USEPA promotes and operates both voluntary and incentive programs for reducing emissions in recognition of the fact that such programs can provide important emission reduction benefits and that traditional "command and control" methods are expensive and in some cases may not provide sufficient emission reductions to achieve attainment (EPA, 2001(a)). EPA published the guidance on economic incentive programs (EPA, 2001(b)). This guidance applies to discretionary economic incentive programs (EIPs) and represents the agency's interpretation of what EIPs should contain in order to meet the requirements of the CAA. EIP programs are a very important part of attainment strategies in many ozone and $PM_{2.5}$ non-attainment areas (see for example discussion of EIPs in California below). EPA has also published guidance on voluntary and emerging[lxxvi] emission reduction measures (EPA, 2004). In general, SIP emission reduction credits for such programs is limited to 6% of total SIP reductions in recognition of the uncertain nature of the reductions that are likely to be achieved in practice.

3.1.11 Air Quality Monitoring

Ambient air quality monitoring in the US is primarily funded and performed by federal and state agencies with some metropolitan area networks funded by local agencies. States are required to perform monitoring sufficient to meet the minimum requirements specified in the regulations for each NAAQS designed to insure that potentially unhealthy conditions are properly identified. States are required to submit annual monitoring network plans to the USEPA.

USEPA also runs an air toxics monitoring program (http://www3.epa.gov/ttn/amtic/airtoxpg.html). While the required criteria pollutant and the toxics monitoring activities are focused on populated areas, background monitoring networks – primarily the CASTNET and IMPROVE networks – are federally funded networks designed to measure air quality at rural and remote locations and locations of special interest such as National Parks. The NCore network is made up of selected sites with more extensive, multi-pollutant measurements that go beyond the monitoring requirements for individual criteria pollutants and are designed to support a variety of air quality management objectives (http://www3.epa.gov/ttnamti1/ncore.html). Data from these and most other monitoring programs are reported to the Air Quality System (AQS) operated by the USEPA. Quality assured raw and summary data from AQS are made available to the public via a variety of on-line access methods (http://www3.epa.gov/air/airpolldata.html). Real time and forecast air quality conditions are made available via the AirNow web portal (http://www.airnow.gov/).

[lxxvi] Emerging measures are defined as measures or strategies which do not have the same high level of certainty in the quantification of emission reductions as do traditional measures.

The USEPA also insures the quality of air monitoring programs via development and publication of accurate and unbiased monitoring methods (http://www3.epa.gov/ttn/amtic/methods.html) and quality assurance and quality control guidelines and support programs (http://www3.epa.gov/ttn/amtic/quality.html). Monitoring designed to meet federal regulatory requirements must use Federal Reference or Equivalent (FRM/FEM) instrumentation and procedures and employ QA/QC procedures consistent with USEPA guidance.

3.1.12 Tools

3.1.12.1 Emissions Modeling

USEPA devotes considerable resources to producing accurate and up to date emission inventories for all source sectors. This includes development and maintenance of specialized emissions models for generating mobile source inventories. As described in Section 3.1.4, States are required to provide the USEPA with emissions and activity data on a regular basis. USEPA uses data on mobile source activities to generate emissions via application of the MOVES model which includes the latest versions of USEPA's on-road emissions model and USEPA's off-road equipment emissions model for off-road mobile sources other than locomotives, marine vessels and aircraft (previously known as the NONROAD model).

Emissions data are generally compiled as annual totals at the county level for each criteria pollutant. A significant exception is hourly data from large sources equipped with CEMs. Application of these emissions data in chemical transport (photochemical) models (CTMs) requires a considerable amount of processing to produce the spatially allocated (gridded), temporally allocated (hourly), and speciated emissions data required as input by the CTMs. For the two photochemical models commonly used in management of ozone and PM non-attainment areas (CAMx[lxxvii] and CMAQ[lxxviii]), emissions are most commonly processed using the SMOKE emissions processor which is publically available from the Community Modeling and Analysis System Centre.[lxxix]

3.1.12.2 Air Quality Modeling

Air quality modeling used to meet regulatory requirements and guide policy decisions generally must conform to USEPA's Air Quality Modeling Guideline (AQMG) which are codified in 40 CFR 51, Appendix W. In addition to developing and regularly updating the AQMG, USEPA operates the Support Center for Regulatory Atmospheric Modeling (http://www3.epa.gov/scram001/) which provides "leadership and direction on the full range of air quality models and other mathematical simulation techniques used in assessing control strategies and source impacts." (*ibid*).

[lxxvii] http://www.camx.com/
[lxxviii] https://www.cmascenter.org/cmaq
[lxxix] http://www.smoke.model.org/

Air quality modeling used in the development of SIP attainment demonstrations generally falls in one of two categories: Gaussian plume modeling using the AERMOD model (USEPA, 2004b) for simulating near-source impacts (up to within approximately 50 km of the source in simple terrain settings) from pollutants that can be treated as inert or with highly simplified chemistry assumptions (CO, Pb, SO_2, primary, i.e. directly emitted PM, and NO_2), and photochemical grid modeling with CAMx or CMAQ for simulating air quality with comprehensive chemical mechanisms for ozone and secondary PM formation over scales ranging from individual cities to the whole of North America. Various preprocessors are used to generate the meteorological data needed to drive these models.

3.1.12.3 Source Apportionment Methods

Assessing the relative contributions of different sources to air quality concentrations associated with violations of the NAAQS is an important step in the design of attainment strategies. Receptor-based source apportionment analyses are often used to examine source contributions to PM and VOCs with the Chemical Mass Balance method or factoring methods such as UNMIX[lxxx] or PMF[lxxxi]. While receptor modeling results can be useful for guiding control strategies and contributing to "weight of evidence" determinations included in SIP attainment demonstrations, in most cases a source-oriented dispersion modeling analysis must be included as the primary component of the attainment demonstration (EPA, 2014). Source-oriented models can also be used for source apportionment. While this is a trivial procedure when using inert models such as AERMOD, source apportionment is more complex when chemical transformations have to be taken into account as is done, for example in CAMx and CMAQ. The "brute force" approach involves simply comparing model runs in which emissions from an individual source are reduced or eliminated (zeroed out) to the base case run. But the long execution times for most photochemical model applications means this approach quickly becomes impractical if multiple sources or combinations of sources need to be examined. CAMx includes source apportionment routines for ozone (ozone source apportionment technology [OSAT] and Anthropogenic Precursor Culpability Assessment [APCA]) and for PM (PM Source Apportionment Technology [PSAT]) which allow the contributions of multiple selected sources or source groups to be calculated within a single model run. APCA differs from OSAT in that APCA reallocates ozone production that would otherwise have been assigned to uncontrollable biogenic sources under OSAT to that portion of the ozone production that is associated with controllable anthropogenic sources. Thus, ozone formed from biogenic VOC and anthropogenic NOx under VOC limited conditions is apportioned to the anthropogenic NOx sources rather than the biogenic VOCs.

3.1.13 Environmental Review under the National Environmental Policy Act

Under the National Environmental Policy Act (NEPA), projects which require a major federal action as defined in 40 CFR 1508.18 are subject to environmental impact review requirements under NEPA. Generally speaking, projects with significant federal involvement including all federal government sponsored projects, projects sponsored by other but using federal funding

[lxxx] https://www.epa.gov/air-research/unmix-60-model-environmental-data-analyses
[lxxxi] https://www3.epa.gov/scram001/receptorindex.htm

and projects requiring federal approvals must undergo a review and public disclosure of potential environmental impacts. If air quality impacts are identified as a potentially important impact during the scoping phase of the project, then an air quality impact analysis will need to be performed and made available for public review before the project can proceed. Some types of projects qualify for "categorical exclusions" from the NEPA review process but projects that do not qualify for a categorical exclusion may require a full review and impact evaluation published as an Environmental Impact Statement (EIS). As part of the review process, expected project impacts are compared to one or more alternatives including a "no action" alternative. See http://www.epa.gov/nepa/national-environmental-policy-act-review-process for additional information.

3.1.14 Summary of the US National Program

As described above, air quality management in the U.S. for non-attainment areas is based on provisions of the Clean Air Act which require that:

1. USEPA develop science-based ambient air quality standards (the NAAQS) adequate to protect public health and welfare;
2. USEPA establish national emission performance standards for new sources (and also for existing sources of hazardous air pollutants for which NAAQS have not been developed) and a requirement that states develop stationary source permitting programs;
3. States develop "infrastructure" SIPs which establish sufficient regulatory structures and capability (monitoring, permitting programs, etc.) to maintain acceptable air quality;
4. USEPA identify areas in which ambient air quality does not meet the NAAQS;
5. States develop non-attainment area SIPs which include sufficient federally enforceable measures for reducing emissions to a level which will result in attainment as demonstrated by technical analyses (including modeling) within the attainment deadlines specified by the USEPA as required under the CAA; and
6. Enforcement mechanisms to be used in the case that deadlines are not achieved, including required incremental emission reductions and economic sanctions.

It should be noted that developing and maintain the U.S. air quality management program described above has required a considerable investment in technical and regulatory resources needed to support full implementation of the CAA provisions.

3.1.15 Overall Assessment of the U.S. National Program

Overall, the U.S. air quality program has resulted in significant improvement in air quality throughout the country (see http://www.epa.gov/clean-air-act-overview/progress-cleaning-air-and-improving-peoples-health). Overall, aggregate emissions of criteria pollutants have decreased 69% between 1970 and 2014 despite significant economic growth. However, as new information on the health effects of air pollution is developed, air quality goals have continued to become more stringent as reflected by the lowering of concentration limits imposed by revised NAAQS over the years. For example, whereas at one time nearly all areas were in attainment of the SO_2 and NO_2 standards, recent tightening of these standards are identifying potential new

non-attainment areas. In addition new, more stringent O_3 and $PM_{2.5}$ NAAQS are challenging the EPA and states to come up with additional emission reductions and lengthening time to attainment. Achieving attainment with these standards has been made more challenging by significant growth in the southern and southwestern U.S. where weather and topography make achieving attainment more difficult. Growth has occurred not only population, but also in per capita VMT. In the most heavily polluted areas such as the Los Angeles Basin, SIP attainment demonstrations rely on assumptions regarding so-called "black box" emission reduction measures based on unspecified new technologies which have yet to be identified.

3.2 State Programs

This section outlines air quality management programs in each target state: California, Colorado, Louisiana, Minnesota, North Dakota, Pennsylvania, Texas and Wyoming.

3.2.1 California

3.2.1.1 Overview

California's air quality management program is generally regarded as the most comprehensive and aggressive in the world and has served as a model for many other jurisdictions. Many of the California's regulations have been "technology forcing," meaning its regulations have forced improvements in technology in order to meet new limits. This has resulted in successful reductions in emissions through new technologies such as 3-way catalysts for gasoline powered motor vehicles, hybrid and all electric vehicles, alternative fueled vehicles, diesel particulate filters, diesel oxidation catalysts and other technologies for controlling emissions from compression ignition engines, application of shore power for large ocean going vessels to reduce hoteling emissions, and many other programs as described below. California has also demonstrated that voluntary incentive programs with clear rules, guidelines and auditing can be very effective at reducing emissions. Beyond regulating traditional air pollutants of concern, California is also a world leader in development of GHG reduction programs, many of which have and will continue to reduce emissions of criteria pollutants and air toxics as an important side benefit. Despite this, the most populated areas of California have thus far failed to achieve attainment of the current ambient AQ standards for ozone and $PM_{2.5}$. These areas have each achieved orders-of-magnitude levels of reduction in emissions and ambient air concentrations over the past 40 years. However, over the same period, USEPA has significantly strengthened each NAAQS, requiring further emission reductions. This also comes as a result of economic, demographic, geographic and climatological factors that combine to produce air basins with extremely limited carrying capacities. Within California, the Los Angeles Basin and the San Joaquin Valley suffer from the most severe non-attainment problems due to limited carrying capacity as described above, large populations and intensive agricultural practices. Current ozone and $PM_{2.5}$ SIPs for the San Joaquin Valley and South Coast (Los Angeles) air basins include so-called "black box" measures consisting of unspecified new technologies to demonstrate attainment of the NAAQS within the statutory deadlines as allowed under the provisions of Sec. 182(e)(5) of the federal Clean Air Act.

3.2.1.2 Managing Agencies

Air quality in California is regulated at the State level by the California Air Resources Board (CARB) and at the local level by 35 local air quality management districts. Generally speaking, the local districts are charged with managing emissions from stationary sources and supplemental monitoring of air quality within their districts while CARB sets State-wide goals and policies and:

1. Compiles the California SIP from air quality plans developed by local air districts with non-attainment areas, adds State-wide elements, and submits the completed SIP to USEPA;
2. Sets and enforces emission standards for on- and off-road mobile sources, fuels and consumer products;
3. Sets State-wide health-based air quality standards;
4. Conducts research;
5. Monitors air quality State-wide;
6. Provides compliance assistance, education and outreach, and
7. Oversees and assists the local air districts.

CARB is also the key agency involved in implementing California's Greenhouse Gas (GHG) reduction program.

3.2.1.3 State Ambient Air Quality Standards and Regulations

The CARB has established California State ambient air quality standards (CSAAQS) at levels at least as stringent as USEPA's national standards (NAAQS) and which cover some additional pollutants including hydrogen sulfide and vinyl chloride. Local air districts are required to develop and implement air quality management plans to attain CSAAQS by "the earliest practicable date" and must reduce primary or contributing precursor emissions by a minimum of 5% per year or, if this is not possible, adopting control strategies that include "all feasible control measures on an expeditious schedule" [California Health and Safety Code Sec. 40914(b)(2)]. While the Health and Safety Code does not define "all feasible", Sec. 40406 defines a related term, Best Available Retrofit Control Technology (BARCT), as "an emission limitation that is based on the maximum degree of reduction achievable, taking into account environmental, energy and economic impacts by each class or category of source." California Health and Safety Code, section 40918(a)(2), requires nonattainment areas that are classified as moderate for the State ozone standard to include in their attainment plan the use of Reasonably Available Control Technology (RACT) for all existing stationary sources, and BARCT for existing stationary sources permitted to emit 5 tons or more per day or 250 tons or more per year of nonattainment pollutants or their precursors. This requirement applies to the extent necessary to achieve standards by the earliest practicable date. While the California Clean Air Act does not define RACT, RACT for existing sources is generally considered to be those emission limits that would result from the application of demonstrated technology to reduce emissions. Section 40922(a) requires an assessment of the cost effectiveness of each proposed control measure, including a ranking of measures from the least cost-effective to the most cost-effective. Section 40922(b) lists additional criteria that air districts should consider in reviewing potential control measures,

including technological feasibility, total emission reduction potential, the rate of reductions, public acceptability, and enforceability.

California air districts classified as nonattainment with respect to the California air quality standards must also include the following elements in the air quality plans applicable to non-attainment of State air quality standards. Many of these requirements are identical to or similar to requirements of federally required SIPs in NAAQS non-attainment areas. Permitting emission thresholds and other requirements depend on the severity of the nonattainment problem:

1. An emissions inventory;
2. A permitting program designed to achieve (via offsets and emissions banking) no net increase in emissions from existing sources above a certain size and requiring the application of BACT to new or modified sources with potential to emit more than the specified amounts;
3. Application of BARCT on all existing permitted stationary sources;
4. Measures to achieve use of a "significant number" of low-emission vehicles in motor vehicle fleets;
5. Transportation control measures (as prepared by the local transportation planning agency) to reduce growth in passenger vehicle trips and miles traveled per trip;
6. Area source and indirect source emission control programs such as measures to reduce evaporative emissions of VOCs from solvent use;
7. Public education programs to promote actions that reduce emissions from transportation and area sources;
8. Assessments and consideration of the cost effectiveness of control measures;
9. An annual schedule of upcoming regulatory measures and an annual progress report.

Plans must be updated and revised as necessary every three years. Since air quality management plans in California are developed by each local air district, the California Clean Air Act (CCAA) also requires CARB to periodically asses the contribution of transport of pollutants from upwind air basins to violations of the State air quality standards in downwind air basins and establish appropriate mitigation requirements applicable to sources in the upwind district. Local districts are required to address these "transport mitigation" requirements in their plans "commensurate with the level of contribution" of sources within their district to downwind air quality [Sec. 70600(b)]. Specific requirements for each identified upwind air basin in the State are included in Sec. 70600 *et seq* and generally include 1) adoption of all feasible control measures as expeditiously as practicable, 2) adoption of Best Available Retrofit Control Technology (BARCT) as defined in Sec. 40406 on all existing stationary sources as soon as practicable, 3) implementation of a permitting program designed to achieve no net increase in emissions from new or modified sources with emissions exceeding 10 tons/year and 4) adopt any additional control measures need to attain the State standards in designated downwind air basins (or portions thereof) for which sources in the upwind air district are largely responsible.

3.2.1.4 Regulation of Mobile Sources

As a result of the long and ground breaking history of air quality regulation in the Los Angeles Basin, California is the only U.S. State which has the independent authority under the federal CAA to regulate emissions from on-road vehicles beyond national emission standards set by the USEPA (other States may "opt-in" to California's on-road vehicle regulatory program). The federal CAA also contains provisions allowing California to independently regulate certain new nonroad engines and vehicles (i.e., those that are not federally pre-empted)[lxxxii], and in-use non-road engines and vehicles, provided that the USEPA issues California a waiver or authorization under Section 209 of the federal CAA.

California's on-road vehicle program includes requirements and incentives for the introduction of partial zero emissions and zero emissions vehicles (PZEVs and ZEVs) into the on-road fleet. CARB works with the California Bureau of Automotive Repair on the SMOG Check vehicle I&M program under which more frequent and intensive vehicle emission control systems checks are required in heavily polluted urban areas.

CARB has developed a number of State-wide rules controlling on- and off-road mobile sources beyond the CARB new engine/vehicle/equipment and fuels standards, including truck idling rules, cargo handling equipment, commercial harbor craft, port (Drayage) trucks, transport refrigeration units, (ship) on-board incineration, ship engine fuel regulations, shore power regulations, in-use off-road vehicle fleet (construction equipment) regulations, in-use large spark ignition off-road engine regulations, and off-highway recreational vehicles. CARB also has developed Gasoline vehicle refueling vapor recovery rules and portable equipment regulations.

Sources classified as new "farm and construction equipment" under 175 hp, locomotives and aircraft are pre-empted from California State control but CARB has passed an intrastate locomotive fuel rule and negotiated agreements with Class I railroads to reduce emissions at rail yards in Southern California.

3.2.1.5 Voluntary, Incentive and Market-Based Programs

California has adopted several major programs designed to incentivize the adoption of technologies and activities to reduce air emissions. California's incentive programs focus on mobile sources and transportation and include Carl Moyer grants which promote use of cleaner than required on- and off-road vehicles and equipment; Proposition 1B funding for introduction of cleaner equipment in goods movement applications; zero emission vehicle incentives including rebates and access to carpool lanes, lower-emission school bus program, and Air Quality Improvement Plan (Assembly Bill AB118) mobile source programs. Additional incentive programs have been developed by individual air districts. CARB also operates diesel engine and LSI off-road engine retrofit verification programs in support of its regulatory activities.

[lxxxii] Under CAA Sec. 209, locomotives and locomotive engines and new engines which are used in construction equipment or vehicles or used in farm equipment or vehicles and which are smaller than 175 horsepower are federally preempted and cannot be independently regulated by any State.

In addition to stationary source Emission Reduction Credit (ERC) programs developed by NAA air districts to facilitate development of new sources, the South Coast Air Quality Management District developed the RECLAIM cap and trade program which provides a mechanism for market trading of NOx and SOx emission credits between facilities emitting at least 4 tpy of either pollutant. RECLAIM was designed as an alternative to imposing a series of costly "command and control" regulations which would otherwise be required to meet the District's air quality goals. At the inception of the program in 1994, credits in the amount of each participating facility's allowed (permitted) SOx and NOx emission based on historical production levels were allocated to each facility. Participating facilities are then required to hold sufficient credits to cover their actual emissions on a quarterly and annual basis. If actual emissions are lower than allowed, facilities may sell the excess credits to other participating facilities on the open market. The total number of outstanding credits was reduced each year until 2003 to insure that total RECLAIM facility emissions would decrease over time and meet the District's air quality goals. Additional reductions have been instituted from time to time to meet federal Best Available Retrofit (BART) requirements under the Regional Haze Program.[lxxxiii] To make the program work, major sources must operate CEMS and report emissions daily while other sources must report emissions either monthly or every three months. To avoid significant spatial imbalances in the use of purchased credits to cover excess emissions, facilities located in the coastal zone cannot use credits originating from inland zone facilities. All trades are made publically available so that market participants can track prevailing prices. Trading of credit futures is allowed.

California NAA districts have also developed Mobile Source Emission Reduction Credit (MERC) programs which create tradable ERCs from application of mobile source control technologies that go beyond current regulatory requirements. Possible uses of MSERCs include delaying compliance with prohibitory rules, offsetting emissions from temporary sources, improving air quality in general (by retiring credits), and using credits as an alternative to controls otherwise required of industrial sources. CARB has issued guidelines for MERC programs (CARB, 1996). MERCs typically have short lifetimes given the rapid advance of mobile source emission control requirements. The San Diego APCD worked in conjunction with ARB and EPA to develop a special MERC program which generates series of MERCs suitable for meeting federal NSR offset requirements.[lxxxiv] MERCs used to meet offset requirements or other emission reduction requirements must be enforceable and legally binding.

While voluntary measures have been widely used in California as described above, the calculation of emission reductions achieved by these rules for purposes of setting future emission budgets and demonstrating future attainment of the NAAQS in California's SIP (the SIP creditable emission reductions) follows Federal rules governing SIP credit for voluntary programs as described in Sec. 1.1.9 above.

[lxxxiii] USEPA's Regional Haze Program was developed to improve visibility conditions in National Parks and Wildernesses. This program does not apply specifically to non-attainment areas and is therefore not discussed further in this report. Additional information is available at: http://www3.epa.gov/visibility/program.html.

[lxxxiv] http://yosemite.epa.gov/R9/r9sips.nsf/0/EDF174B6D5C9CAED882575D900795B22/$file/Final+Rule+27.1+TSD.pdf?OpenElement

3.2.2 Texas

3.2.2.1 Overview

Texas has a comprehensive non-attainment area air quality management program overseen by the Texas Commission on Environmental Quality (TCEQ). Non-attainment area (NAA) air quality management activities in Texas are primarily focused on ozone non-attainment in the Houston-Galveston-Brazoria (HGB) and Dallas - Fort Worth (DFW) areas although other areas in the State have been in near non-attainment for ozone. In addition, the El Paso area is currently designated as non-attainment for PM_{10}. Ozone non-attainment in Texas is associated with a variety of sources of VOC and NOx precursors including mobile sources, oil and gas production and, especially in HGB, petrochemical industries.

3.2.2.2 Managing Agencies

While the TCEQ is responsible for managing air quality throughout Texas, local organizations are actively involved in dealing with more local air quality issues related to non-attainment. These organizations include Councils of Governments (COGs, which are voluntary regional planning organizations), stakeholder groups such as Northeast Texas Air Care (which includes representatives from local governments, industries and environmental groups) and metropolitan planning organizations (MPOs, which have statutory authority to oversee distribution of federal transportation funds among other duties). COGs and MPOs work with cities and counties within their planning areas on transportation and land-use planning issues which can significantly impact local air quality.

Beginning in 1995, the Texas Legislature appropriated funds to support local air quality planning efforts of four near-nonattainment areas (Austin – San Marcos, San Antonio, Northeast Texas, and Corpus Christi) toward attaining the Federal Ozone National Ambient Air Quality Standards (NAAQS). By 2005, the areas had adopted Early Action Compacts into the Texas State Implementation Plan (SIP) or entered into an Ozone Flex Agreement with the TCEQ and the U.S. EPA. These programs prevented the areas from entering active nonattainment status under the 1997 eight-hour Ozone NAAQS through 2007.

Over the intervening years, various amounts of funding have been appropriated, and the areas eligible for the program have been revised, but the program continues to fund air quality planning activities to reduce ozone in areas not designated as nonattainment. These activities may be carried out through inter-local agreements or contracts and may include identifying, inventorying, and monitoring of pollution levels, modeling pollution levels and the identification, quantification, and implementation of appropriate locally enforceable pollution-reduction controls.

3.2.2.3 Stationary Source Control Program

As is typical of most states, some sources and facilities are considered *de minimis* (meaning they are of a sufficiently small size so as to be essentially inconsequential) and do not require

registration or authorization prior to construction. In Texas, this applies to certain categories of small sources classified as *de minimus* as determined by source type and in some cases by capacity. Other small facilities with emissions that do not meet *de minimis* criteria, but will not make a significant contribution of air contaminants to the atmosphere, may be permitted by rule. Some permits by rule (PBRs) do not require registration and simply require recordkeeping to document compliance with the requirements. Other PBRs require registration, technical review, and approval prior to start of construction. Sources that cannot meet the conditions of a PBR may qualify for a standard permit which authorizes the construction or modification of new or existing facilities that are similar in terms of operations, processes, and emissions, must be registered with the State and satisfy BACT requirements. Other non-major sources require site-specific permits which include public notice, BACT and an impacts analysis. Major sources are subject to Texas' EPA approved New Source Review (NSR) Program which includes programs for construction and operation. Prior to construction, new major sources or major modifications to sources in areas that are in attainment of the national ambient air quality standards (NAAQS) are subject to prevention of significant deterioration (PSD) review while major sources or major modifications to sources in areas not in compliance with the NAAQS are subject to Nonattainment NSR. To operate a major source in Texas, sources must obtain a Title V operating permit which may come in the form of a General Operating Permit (GOP) or a Site Operating Permit (SOP). In addition, Texas provides for Flexible Permits for some sources which contain an overall emission cap for all sources per pollutant, combination of multiple emission caps that cover groups of facilities, and/or individual emission limitations for individual facilities. Texas also has plant-wide applicability limit or PAL permits as an alternative and voluntary permit limit that an owner or operator can choose to implement and use to assess Major NSR applicability. A PAL does not authorize the construction or modification of any facility to emit air pollutants. A PAL establishes an annual emission rate below which new and modified facilities will not be subject to Major NSR for that pollutant.

3.2.2.4 Non-attainment Area Emission Reduction Measures

Texas has implemented a number of emission reduction programs applicable to ozone and PM nonattainment areas within the State (https://www.tceq.texas.gov/airquality/sip/sipstrategies.html). Rules included in the applicable SIPs include limitations on emissions from stationary point and area sources and (non-federally pre-empted) on-road and non-road mobile sources. A unique feature of the Houston area program are controls targeting emissions of highly reactive volatile organic compounds (HRVOCs) such as ethylene and propylene which have been found to be emitted in relatively large amounts from the area's large petrochemical complexes and to contribute significantly to ozone formation (https://www.tceq.texas.gov/airquality/stationary-rules/voc/hrvoc.html). In addition to various performance-based rules, HRVOC emissions are limited by the HRVOC Emissions Cap and Trade Program (HECT) in Harris County (https://www.tceq.texas.gov/airquality/banking/hrvoc_ept_prog.html). Also, point source NOx emissions are limited by the Mass Emissions Cap and Trade Program (MECT) in the eight-county HGB area.

The TCEQ has implemented numerous regulations that address NOx and VOC emissions from DFW and HGB sources. NOx emission controls on cement kilns are an important component of the DFW area ozone SIP. Cement kiln NOx emission rules limit NOx emissions per ton of clinker produced from each affected facility by establishing an ozone season NOx source cap for all cement kilns at each site in Ellis County. The source cap uses emission factors of 1.7 pounds of NOx per ton of clinker for dry kilns and 3.4 pounds per ton for wet kilns and clinker production during calendar years 2003 through 2005.[lxxxv]

3.2.2.5 Regulation of Mobile Sources

Texas has not opted-in to California's vehicle emissions standards program; vehicles in Texas must meet federal standards. Vehicle inspection and maintenance (I/M) program requirements apply to the El Paso, DFW and HGB non-attainment areas and to Travis and Williamson Counties. Texas has a rule restricting engine idling that is locally enforced in certain areas. Transportation control measures used in the DFW and HGB SIPs include introduction of alternative fueled vehicles in vehicle fleets, construction of bicycle/pedestrian paths to reduce VMT, construction of park and ride facilities to encourage carpooling and transit use, vanpool projects and HOV lanes to encourage carpooling, new mass transit projects, along with intersection and traffic signal improvements, grade separation, road widening, freeway corridor management projects and road patrol projects to improve traffic flow and thus reduce extra emissions associated with traffic congestion.

3.2.2.6 Voluntary, Incentive and Market-Based Programs

Texas has implemented emission reduction incentive programs such as the Texas Emission Reduction Program (TERP) which primarily provides funding for replacement of older, higher emitting vehicles and mobile equipment with newer, cleaner vehicles and equipment and repowering older vehicles and equipment with newer, cleaner engines. The TERP also includes programs specifically aimed at replacing older diesel and gasoline powered vehicles with new alternative fuel vehicles and funding to help construct fueling facilities to provide alternative fuels. TERP is similar to incentive programs operating in California and other states. TERP also includes some incentive funding for emission reductions from stationary sources via application of new technologies and energy efficiency measures. Since 2001, TERP's Diesel Emission Reduction Incentive program has replaced or upgraded over 15,623 vehicles and pieces of equipment and will reduce over 160,836 tons of NOx over the period that the grant recipients have committed to operate the vehicles and equipment in the eligible areas at an average cost effectiveness of $5,627 per ton of NOx reduced.[lxxxvi] Texas also has implemented the "Drive A Clean Machine" program to help pay for repair of older light-duty cars and trucks that do not pass emissions inspections or incentives for scrapping of those vehicles and the purchase of new, low emission light-duty vehicles. Examples of other incentive programs in Texas include the Houston-Galveston Area Council's Clean Cities/Clean Vehicles program which uses grant funding to promote low emission vehicle fleet options, construction of publically accessible

[lxxxv] https://www.gpo.gov/fdsys/pkg/FR-2009-01-14/pdf/E9-119.pdf
[lxxxvi] https://www.tceq.texas.gov/publications/pd/020/2014/texas-emissions-reduction-plan-(terp)-the-success-continues

alternative fueling infrastructure, heavy-duty engine repowers and scrapping of older vehicles. Other voluntary programs used in Texas to reduce motor vehicle emissions include employer-based commute programs (compressed work week, allowing/encouraging telecommuting, etc.).

3.2.3 Louisiana

3.2.3.1 Overview

Louisiana is home to many significant petrochemical industries and other industrial activities involved in servicing offshore oil and gas production in the Gulf of Mexico. Baton Rouge is a "marginal" NAA for the 2008 8-hour ozone NAAQS. Based on improved air quality and prior to the marginal ozone nonattainment area SIP submittal deadline, Louisiana submitted a request for re-designation to attainment and associated maintenance plan in June 2015. New Orleans currently has an SO_2 NAA for the 2010 SO_2 NAAQS.

3.2.3.2 Managing Agencies

Implementation of air quality regulations in Louisiana is performed by the Louisiana Department of Environmental Quality.

3.2.3.3 Stationary Source Control Programs

Louisiana operates federally required stationary source permitting programs. Sources emitting less than 5 TPY of any criteria pollutant and less than 15 TPY all criteria pollutants combined are exempt from Louisiana's minor source permitting requirements. Minor source general permits have been developed for Surface Coating and Fabrication and Crude Oil and Natural Gas Production.

New or modified major sources in Louisiana must submit an Environmental Assessment Statement as per Louisiana Revised Statutes, Title 30, Section 2018. The assessment Statement must disclose the environmental effects of the new source, include a cost/benefit analysis showing that the environmental costs are outweighed by the social and economic benefits, and show that there are no alternatives (alternative sites or mitigation measures) to building/modifying the source which would reduce environmental impacts without "unduly curtailing" non-environmental benefits.

3.2.3.4 Non-attainment Area Emission Reduction Measures

Control measures included in Louisiana's 1997 8-hour ozone SIP remain in effect under the anti-backsliding provisions. Specific VOC and NOx controls in the Baton Rouge nonattainment area include point source VOC and NOx controls (including 1.1:1 offsets), Stage I and Stage II vapor recovery, and a vehicle smog check I/M program.

3.2.3.5 Regulation of Mobile Sources

Louisiana has not opted in to the California vehicle emissions standards. Louisiana has an engine idling restriction rule. A vehicle smog inspection and maintenance (I/M) program is operating in the Baton Rouge ozone NNA.

3.2.3.6 Voluntary, Incentive and Market-Based Programs

Louisiana has a voluntary Ozone Action Day program designed to encourage voluntary reductions in ozone precursor emissions when high ozone conditions are forecast during the summer months.

3.2.4 Colorado

3.2.4.1 Overview

Colorado has a well-developed State air regulatory program. The Denver / Front Range communities area (Denver-Boulder-Greeley-Ft. Collins-Love) is in non-attainment of the 2008 ozone NAAQS and is anticipated to be “bumped up” from ”marginal” to ”moderate” classification in 2016. Air quality in this area is affected by numerous urban sources and significant oil & gas production in the Denver-Julesburg basin.

3.2.4.2 Managing Agencies

Colorado’s air quality regulatory program is implemented by the Air Quality Control Commission. The program is implemented by the Colorado Department of Public Health and Environment (CDPHE), Air Pollution Control Division. The Regional Air Quality Council (RAQC) is the lead air quality planning agency for the metropolitan Denver area and is charged with developing the SIP for the Denver area. Similarly, the North Front Range Metropolitan Planning Organization (NFRMPO) has been designated by the Governor as the lead air quality planning organization for the North Front Range region.

3.2.4.3 Stationary Source Control Program

Colorado’s air permitting program includes the delegated federal programs and minor source permitting for stationary sources as small as 1 ton/year for criteria pollutants in nonattainment areas. Small sources need only register with the CDPHE before beginning construction while larger sources must also obtain a construction permit and possibly an operating permit from CDPHE which may involve performing a dispersion modeling analysis.

3.2.4.4 Non-attainment Area Emission Reduction Measures

In connection with development of the Denver ozone SIP and Ozone Action Plan, Colorado recently removed permitting exemptions which had been in place for various smaller sources of VOCs to improve emission inventories and reduce emissions, required RACT for all VOC sources larger than 2 tons/year and NOx sources greater than 5 tons in the ozone NAA, expanded and tightened requirements of the vehicle inspection and maintenance (I&M) program in the Denver / Front Range region, expanded Denver-area controls on Reciprocating Internal Combustion Engines (RICE) State-wide, and required low-bleed pneumatic valve controllers among other requirements.

In 2014, Colorado adopted more stringent State-specific, State-wide emission control requirements for upstream oil and gas sources designed to reduce VOC emissions from this important source category. These controls were designed in part to assist with attainment of the ozone NAAQS in the Denver/Front Range region and help avoid potential future non-attainment issues in other parts of the State.

3.2.4.5 Regulation of Mobile Sources

Colorado has not opted in to the California vehicle emissions standards. Colorado on-road vehicle emission reduction programs include the Denver area I&M program (including diesel vehicles), oxygenated gasoline program, smoking vehicle hotline, and a clean diesel school bus retrofit program which is funded by the State using grant money provided by the USEPA. Colorado also has a rule restricting engine idling.

3.2.4.6 Voluntary, Incentive and Market-Based Programs

CDPHE has promoted a voluntary vehicle idle reduction program and operates an Air quality Action Day program in the Denver area focused on promoting voluntary emission reductions during high PM, ozone and carbon monoxide pollution events. The winter PM Action Day program also includes mandatory restrictions on residential wood combustion (combustion limited to devices approved by the State, including some USEPA certified wood heaters, stoves and inserts, and devices in homes where wood combustion is the only source of heat). New burning device installations of uncertified devices are prohibited in the Denver area.

3.2.5 Pennsylvania

3.2.5.1 Overview

Five areas within Pennsylvania are non-attainment for ozone, three areas are non-attainment for $PM_{2.5}$ and two areas are currently in non-attainment of the 2010 SO_2 NAAQS. Pennsylvania is part of the Ozone Transport Region (OTR) which includes 10 other northeastern States, the District of Columbia and portions of northern Virginia. As such, Pennsylvania's regulatory programs to reduce ozone precursor emissions are tied to those of the OTR.

3.2.5.2 Managing Agencies

Air quality management in Pennsylvania is overseen by the Pennsylvania Department of Environmental Protection (PADEP), Bureau of Air Quality. Two Pennsylvania counties (Allegheny and Philadelphia) have their own air quality management programs. The Pennsylvania Air Quality Partnership provides public information on air quality, including air quality alerts and programs to encourage voluntary actions to reduce pollution.

3.2.5.3 Stationary Source Control Program

PA NAAs have federally approved major and minor source permitting programs including general permits. Federal requirements for NAAs are incorporated into the PADEP permitting program and the permitting programs overseen by the Allegheny County Health Department (for the Pittsburgh non-attainment area) and the City of Philadelphia Department of Public Health (for the Philadelphia non-attainment area). For example, in Philadelphia, most sources including combustion sources rated at more than 250,000 BTU/hour and stationary internal combustion engines greater than 100 hp require both construction permits and either an operating permit or a license to operate. An operating permit is a document issued to an entire facility that lists all of the equipment and air pollution requirements. An operating permit must be renewed every five years. An air pollution license is issued to a specific piece of equipment and must be renewed annually, except for indefinite licenses, which are issued to certain small combustion units. If a facility has an operating permit, it does not also need air pollution licenses for its equipment. The specific type of construction and operating permit required depends on the size of the source.[lxxxvii]

3.2.5.4 Non-attainment Area Emission Reduction Measures

PA is part of the Ozone Transport Region. As part of the OTR, PA must promulgate regulations implementing VOC controls specified in Control Technique Guidelines (CTGs) State-wide. Other VOC control measures applied in Pennsylvania include regulations regarding VOC content of consumer products and architectural and industrial maintenance coatings.

The Philadelphia-Wilmington-Atlantic City $PM_{2.5}$ non-attainment area SIP, which covers portions of three states (Pennsylvania, New Jersey, and Delaware), was developed via collaboration via the OTC and the MANE-VU and MARAMA Regional Planning Organizations. Numerous emission control measures – most of them related to Federal or federally required programs – contributed to the emission reductions required to achieve attainment. This included USEPA's programs for reducing emissions from power plants, cement kilns and other large stationary combustion sources (the Clean Air Interstate Rule and its successor, the Cross-State Air Pollution Rule), federal emissions standards (NSPS and NESHAPS) and federal rules governing on-road and off-road mobile sources. Pennsylvania also adopted use of Best Available Technology (BAT) for new sources, lower emission limits on natural gas compression and

[lxxxvii] http://www.phila.gov/health/pdfs/airmanagement/AMS_Permits_Guide1711.pdf

processing facilities, reduced sulfur content requirements for fuel oil, and consumer products rules. A list of regulations included in Pennsylvania's SIP is available from EPA Region III.[lxxxviii]

3.2.5.5 Regulation of Mobile Sources

Pennsylvania has opted in to the California motor vehicle emissions program as have most other States in the Northeast. Under the Pennsylvania Clean Vehicles Program, model year 2008 and new passenger vehicles sold or leased and titled in Pennsylvania must meet the California Low Emission Vehicle (LEV) standards. Pennsylvania has an engine idling restriction rule.

3.2.5.6 Voluntary, Incentive and Market-based Programs

Pennsylvania operates a Clean Diesel Grant program incentivizing the retirement or retrofitting of older diesel vehicles. In addition, Allegheny County operates two incentive programs primarily aimed at reducing PM emissions:

- An incentive program for scrapping non-certified (older) wood stoves in Allegheny Co., and
- A diesel retrofit/repower incentive program for Neville Island.

3.2.6 Minnesota

3.2.6.1 Overview

Air quality management in Minnesota is primarily focused on proactively meeting federal requirements and limiting exposures to air toxics. Deposition of atmospheric pollutants to aquatic ecosystems is also a major focus area in Minnesota. There are no non-attainment areas in Minnesota other than a lead non-attainment area in the city of Egan (associated with a lead-acid battery processing facility). Aside from lead, maintenance areas exist in Minnesota as a legacy of prior non-attainment status for CO, SO_2, and PM_{10}. The last of these areas was re-designated to attainment/maintenance in 2001. Minnesota is a member of the Lake Michigan Air Directors Consortium (LADCO) which also includes Wisconsin, Illinois, Indiana, and Michigan. LADCO provides member States with technical resources and a forum for dealing with regional air quality issues including ozone and fine particle pollution, regional haze (visibility) and air toxics.

3.2.6.2 Managing Agencies

Implementation of air quality regulations and management practices in Minnesota is the responsibility of the Minnesota Pollution Control Agency (MPCA).

3.2.6.3 Stationary Source Control Programs

[lxxxviii] http://yosemite.epa.gov/r3/r3sips.nsf/SIPIndex!OpenForm&Start=1&Count=1000&Expand=4.2&Seq=5

MPCA operates the federal major source permitting programs and has a minor source permit program which includes several options depending on the source's annual emissions, type and business strategy (https://www.pca.State.mn.us/sites/default/files/aq2-29.pdf):

- Individual Total Facility permits are conventional permits tailored to each facility.
- Registration permits are simplified permits for smaller sources (emission less than 50% of the federal major source thresholds); no ambient impact analysis is required for a Registration permit.
- Capped emission permits are partially simplified permits setting a facility-wide cap on emissions designed for relatively simple sources that are too large to qualify for a Registration permit but with actual emissions less than 75 – 90% (depending on pollutant) of the federal major source thresholds.
- FlexCap Individual permits are similar to Individual Total Facility permits but are designed to allow facilities flexibility to make certain pre-authorized types of modifications without requiring a permit modification.
- Environmental Management System permits are available to sources with qualifying ISO 14001 Environmental Management Systems (EMSs), specify a facility-wide emissions cap, and allow for less paperwork requirements when making modifications and simplified record keeping and reporting, thus incentivizing sources to adopt ISO 14001 compliant EMSs.
- Minor source General permits are currently available in Minnesota only to 1) sources in the non-metallic mineral processing sector and 2) sources with potential emissions above the federal NSR thresholds but low actual emissions (Low-Emitting Facility General Permit) that began operating without the required permit (the most prominent examples of such a sources are auto body shops); the MPCA is currently offering an enforcement amnesty program for such facilities.

Minnesota has instituted a Mercury Reduction Plan requirement for sources of mercury to help reduce mercury releases to air and water in the State. This plan is designed to meet the mercury release reductions needed to meet federal water quality standards as identified in the State's mercury Total Maximum Daily Load (TMDL) study. The reduction plans must specify how each affected facility will meet the target emission limits set by the State.

Minnesota has a unique permitting requirement for sources located within South Minneapolis which has been heavily impacted by air pollution and has communities that are particularly susceptible to the deleterious effects of air pollution (Minn. Stat. § 116.07, subd. 4a). Sources applying for air permits within this area must complete a Cumulative Levels and Effects (CL&E) analysis that is designed to evaluate the cumulative pollution impacts within the context of all of the available environmental health related information within the source's modeled impact area. The CL&E requirement is somewhat similar to a cumulative PSD analysis but with expanded health-related impact evaluations and public engagement included (https://www.pca.State.mn.us/sites/default/files/aq1-42b.pdf).

The Minnesota Environmental Policy Act requires that new projects undergo an analysis of their potential environmental impacts prior to issuance of final approvals or permits by State agencies. For projects that don't automatically require development of an Environmental Impact Statement under MN rules, preparation of an Environmental Assessment Worksheet (EAW) may be

required (similar to an Initial Study under the California Environmental Quality Act). Information contained in the EAW is used to determine if the project has the potential for significant environmental impacts in which case a full EIS will be required. Air quality impacts are evaluated within the EAW and the EIS.

3.2.6.4 Non-attainment Area Emission Reduction Measures

There are no non-attainment areas in Minnesota aside for the Egan Pb non-attainment area. Minnesota's SIP development activities are therefore basically limited to development of the Section 110 infrastructure SIP elements for recently revised NAAQS.

3.2.6.5 Regulation of Mobile Sources

Minnesota has not opted-in to California's mobile source program. Minnesota currently requires a minimum 10% biodiesel (B10) blend for on-road and most off-road use during the warm weather months; the requirement is lowered to 5% (B5) during the cold weather months. This is scheduled to increase to 20% (B20) by 2018. Minnesota also has an engine idling restriction rule.

3.2.6.6 Voluntary, Incentive and Market-Based Programs

Similar to many other States, the MPCA administers a clean diesel grant preprogram to incentivize reductions in diesel emissions (https://www.pca.State.mn.us/air/grantsfinancial-assistance-clean-diesel-projects). Minnesota also has a pollution prevention assistance program known as the Minnesota Technical Assistance Program which is a partnership between the State of Minnesota and the University of Minnesota (http://www.mntap.umn.edu/).

3.2.7 North Dakota

3.2.7.1 Overview

North Dakota has not had any areas classified as non-attainment under the CAA and therefore has no non-attainment or maintenance areas. North Dakota law includes a provision prohibiting the Department of Health from adopting any rules providing for State administration of a program under the federal CAA (and other federal environmental laws) that may be more stringent than corresponding federal regulations which address the same circumstances.[lxxxix] However, State law allows for adoption of rules more stringent than corresponding federal regulations or rules for which there are no corresponding federal regulations, upon a written finding after public comment and hearing based upon evidence in the record, that corresponding federal regulations are not adequate to protect public health and the environment of the State.

[lxxxix] Similar provisions have been adopted by some other states; see Organ (1995) for a complete list and discussion of reasons and consequences.

3.2.7.2 Managing Agencies

Implementation of air quality regulations in North Dakota is performed by the North Dakota Department of Health (NDDoH), Division of Air Quality.

3.2.7.3 Stationary Source Control Programs

North Dakota's new/modified source construction permitting program includes exemptions for common smaller minor sources and some sources, notably including non-major oil and gas production facilities, for which other States such as California and Colorado may require construction permits. However, oil and gas production facilities that are not major sources must still file a registration packet with the NDDoH within 90 days after the first date of production. NDDoH has issued guidance to operators for complying with the registration process and complying with NDDoH regulations (NDDoH, 2011). The Division of Air Quality has discretion as to what constitutes an "insignificant" source: "Some sources or modification may represent such a minor impact to the air quality that a permit to construct is not required. In such cases, an application for a Construction Permit is required, at which point the Department will determine if a Permit is necessary. Should it be deemed that a Permit is not required, the Department will notify the source in writing as such."

3.2.7.4 Non-attainment Area Emission Reduction Measures

There are currently no non-attainment areas in North Dakota. SIP development activities are therefore basically limited to development of the Section 110 infrastructure SIP elements for recently revised NAAQS.

3.2.7.5 Regulation of Mobile Sources

North Dakota has not opted in to the California vehicle emission standards. Mobile source regulations in North Dakota follow federal law.

3.2.8 Wyoming

3.2.8.1 Overview

While air quality in Wyoming is generally good, unusual high ozone concentrations have been observed in the southwestern portion of the State during winter leading to a designation of marginal nonattainment for the ozone NAAQS in the Upper Green River Basin (UGRB). Elevated ozone in the UGRB has been linked to emissions from intensive oil and gas exploration and production activities and high photochemical ozone production rates during periods of calm winds and snow covered ground. Peak ozone levels in recent years have fallen below the NAAQS and EPA published a proposed finding of ozone attainment (relative to the 2008, 0.075 ppm standard) based on data from the 2012-2014 period. Wyoming is currently evaluating the

likely status of the area relative to the new 0.070 ppm standard. The only other NAA in Wyoming is the Sheridan moderate PM_{10} NAA. While recent PM_{10} levels have been below the NAAQS, the area has yet to be re-designated as a maintenance area. Elevated PM_{10} in Sheridan has been primarily linked to re-suspended dust from road sanding during winter.

3.2.8.2 Managing Agencies

Implementation of air quality regulations in Wyoming is performed by the Wyoming Department of Environmental Quality, Division of Air Quality. Regulations are reviewed and adopted by the State's Environmental Quality Council.

3.2.8.3 Stationary Source Control Program

New or modified sources require (at least) a construction permit, and in some cases an operating permit from WY DEQ. Wyoming has not established any *de minimus* emission levels exempting smaller sources but has rules explicitly exempting certain types of small sources (e.g., certain fuel burning equipment less than 25 BTU/hour) from permitting requirements. While Wyoming regulations allow the DEQ to issue General Permits to cover certain smaller standardized sources, we are not aware that the Air Quality Divisions has issued any such General Permits. Wyoming has developed specific Guidelines for permitting oil and gas production facilities. Since Wyoming requires that all new sources meet BACT but emissions from new oil and gas production sources may not be known prior to construction, the Guidelines specify "presumptive BACT" provisions for such sources. These presumptive BACT requirements are more restrictive (for example requiring a Leak Detection and Repair program) in the more intensively developed Upper Green River Basin.

Wyoming's air quality regulations include a "clean air resource allocation" provision which provides that sources which cease operations for a period of more than five years give up the "clean air resource" needed to accommodate the source's operation. This essentially limits the ability of owners of sources that have not operated for at least five years from resuming operations without having to re-evaluate the source's impacts in light of current air quality conditions.

3.2.8.4 Non-attainment Area Emission Reduction Measures

In response to the high ozone readings in the UGRB but before the area was found to be in nonattainment of the ozone NAAQS by EPA, WY DEQ instituted a voluntary emissions offset program for new sources. In anticipation of the development of an ozone NAA SIP for the area, WY DEQ developed an emissions banking and trading program policy under which companies that voluntarily provided more than the minimum offsets under the voluntary offset program were provided emissions credits useable towards future emission reduction requirements under the SIP (http://deq.wyoming.gov/media/attachments/Air%20Quality/Winter%20Ozone/Technical%20Documents/2011-1010_AQD_Sublette-County-Banking-Voluntary-Emissions-Reduction-

Policy.pdf). WY DEQ also prepared detailed emission inventories, performed increased ambient monitoring and air quality modeling, established a stakeholder working group (the Citizens Advisory Task Force) and an expert advisory group to help deal with the pending ozone nonattainment designation, and instituted a winter ozone forecasting process to inform the public when weather conditions conducive to ozone formation are expected to occur. When conditions conducive to high ozone levels are forecast, a related plan of voluntary actions designed to reduce VOC and NOx emissions is activated. Wyoming is participating in EPA's voluntary Ozone Advance program to reduce ozone levels.

3.2.8.5 Regulation of Mobile Sources

Wyoming has not opted in to the California vehicle emission standards. Mobile source regulations in Wyoming follow federal law.

3.2.8.6 Voluntary, Incentive and Market-Based Programs

Wyoming was awarded a $1.3 million dollar grant from USEPA in 2009 to reduce PM emissions from off-road diesel construction equipment used in the oil and gas industry in Sublette County in the UGRB via repowers, or retrofits of oxidation catalysts and particulate filters.

4.0 EUROPE

Non-attainment area (NAA) air quality management in Europe is based both on directives from the European Union (EU) with which member states are bound to comply and regulations, tools and procedures developed by each EU member state.

4.1 European Union (EU)

At the core of the EU are the Member States — the 28 states that belong to the Union (Figure 7) — and their citizens. The unique feature of the EU is that, although these are all sovereign, independent states, they have pooled some of their 'sovereignty' in order to gain strength and the benefits of size. Pooling sovereignty means, in practice, that the Member States delegate some of their decision-making powers to the shared institutions they have created, so that decisions on specific matters of joint interest can be made democratically at European level. The EU thus sits between the fully federal system found in the United States and the loose, intergovernmental cooperation system seen in the United Nations.

Decision-making at EU level involves various European institutions, in particular the European Commission, which represents the interests of the EU as a whole. It implements the laws with the Member States. With regard to environmental policy, the decision-making competences are shared between the EU and the Member States. This means that if legislation is passed at EU level, then these laws have priority. However, if no legislation is adopted at EU level, then the individual Member States may legislate at national level. The Directorate-General for Environment (DG Environment) is the European Commission department responsible for EU policy on the environment. DG Environment aims to protect, preserve and improve the environment for present and future generations, proposing and implementing policies that ensure a high level of environmental protection and preserving the quality of life of EU citizens. It also makes sure that Member States apply EU environmental law correctly and represents the EU in environmental matters at international meetings.

4.1.1 Guiding Principals

EU policy on environmental protection is based on several guiding principles, including:

> **Polluter Pays**: Potential polluters shall in general bear the costs of pollution prevention and control measures attributable to them, as well as of remediation. In the context of air quality management, this means that potential emitters of air pollutants shall bear the full costs of carrying out their activities in an environmentally sound manner, i.e. taking air quality (and other issues) into account. Different approaches to this principle can be found locally (i.e. at Member states level).
>
> **Integrated Approach**: Measures taken to reduce air pollution at one point or in one area shall not lead to an increase in air pollution elsewhere, or to an increase in pollution of

another environmental medium, based on the principles of integrated pollution prevention and control.

International Approach: The international trans-boundary nature of air pollution is recognised in two respects. First, Member States are not expected to achieve, independently, satisfactory air quality in respect of pollutants originating from outside their territory. Secondly, Member States are required to take into account the effects of their own emissions on other countries even when those emissions have no significant adverse effects within their own frontiers. Member States having a common border are expected to consult each other, when necessary, regarding air quality.

Natural Sources: According to the recital 15 in the 2008/50/EC directive, "Contributions from natural sources can be assessed but cannot be controlled". In Article 2 of this Directive, "contributions from natural sources' shall mean emissions of pollutants not caused directly or indirectly by human activities, including natural events such as volcanic eruptions, seismic activities, geothermal activities, wild-land fires, high wind events, sea sprays or the atmospheric re-suspension or transport of natural particles from dry regions". Consequently, as mentioned in Article 20(1), "Member States shall transmit to the Commission, for a given year, lists of zones and agglomerations where exceedances of limit values for a given pollutant are attributable to natural sources. Member States shall provide information on concentrations and sources and the evidence demonstrating that the exceedances are attributable to natural sources". Where the Commission has been informed of an exceedance attributable to natural sources, that exceedance shall not be considered as an exceedance for the purposes of the Air Quality Directive.

Public Information and Reporting: According to the articles 26 and 27 of the air quality directive, Member States shall ensure that the public as well as appropriate organisations are informed, adequately and in good time, of the ambient air quality, of any postponement decisions, any exemptions and air quality plans and programmes. The information shall be made available free of charge by means of any easily accessible media. Member States shall ensure that information on ambient air quality is made available to the Commission within the required timescale. In any event, for the specific purpose of assessing compliance with the limit values and critical levels and the attainment of target values, such information shall be made available to the Commission no later than nine months after the end of each year and shall include the list of zones and agglomerations in which the levels of one or more pollutants are higher than the limit values plus the margin of tolerance[xc] where applicable or higher than target values or critical levels.

[xc] "margin of tolerance" shall mean the percentage of the limit value by which that value may be exceeded subject to the conditions laid down in this Directive. This concept is detailed in more detailed below in this chapter

Figure 7 European Union and Member States (2015).

The implementation of the EU AQ regulation can be summarized by the 5 following steps:

1. Zones and agglomerations are declared by the Member States, covering the complete territory.[xci] The zones represent basic areas for which assessment and management provisions are prescribed.
2. Assessment of ambient air quality through monitoring, modelling, and objective estimation provides information on the compliance with the environmental standards and informs further air pollution abatement effort.[xcii] The assessment covers the minimum assessment requirements set in the directive as well as the additional assessment performed by the Member State such as source apportionment, in particular in agglomerations and areas with high pollution.
3. Management of air pollution: in order to reduce adverse effects of air pollution on health and environment, measures need to be taken.[xciii] A number of measures are taken at the Community level, such as fuel quality and product standards (for example EURO standards

[xci] http://ec.europa.eu/environment/air/quality/legislation/zoning.htm
[xcii] http://ec.europa.eu/environment/air/quality/legislation/assessment.htm
[xciii] http://ec.europa.eu/environment/air/quality/legislation/management.htm

for new vehicles). In certain areas it is necessary for Member States to take further measures to comply with the legislation. These air pollution reduction measures are compiled in air quality plans or programmes which describe how the measures are bringing concentrations below respective limit or target values by the attainment date.

4. Public information: Requirements contain minimum amount of information that needs to be provided to the public as regards to assessment of concentrations.[xciv] It also requires the public availability of abatement plans and programmes. Specific actions are needed when information and alert thresholds are exceeded, which inform the public on the health hazards and the recommended personal behaviour to minimize exposure.
5. Reporting of assessment results and the information on the plans and programs is required[xcv] to enable the Commission to assess compliance with the provisions of the directives, as well as to provide the Commission, the Member States, other stakeholders such as the European Environment Agency as well as the public with harmonized information on assessment and management of air quality.

The existing legislation is periodically being reviewed, providing opportunities to further develop legislation. Reviews are subject to the Comitology[xcvi] procedure as required in the legislation.

4.1.2 Air Quality Legislation

EU air quality legislation relies on several tens of directives and decisions. The most important concerning the NAAs are the followings:

- **Directive 2008/50/EC** (known as Air Quality Directive) and its four Daughter Directives on ambient air quality and cleaner air for Europe (entered into force on 11 June 2008).
- **Council Directive 96/62/EC** on ambient air quality assessment and management, commonly referred to as the Air Quality Framework Directive, which describes the basic principles regarding how air quality shall be assessed and managed in the Member States.
- **Council Decision 97/101/EC** establishing a reciprocal exchange of information and data from networks and individual stations measuring ambient air pollution within the Member States. This "EoI Decision" describes the procedures for the dissemination of air quality monitoring information by the Member States to the Commission and to the public
- **Commission Decision 2004/461/EC** laying down a questionnaire for annual reporting on ambient air quality assessment under Council Directives 96/62/EC and 1999/30/EC and under Directives 2000/69/EC and 2002/3/EC of the European Parliament and of the Council. This decision specifies the format and content of Member States' Annual Report on ambient air quality in their territories.
- **Commission Implementing Decision 2011/850/EU** of 12 December 2011, laying down rules for Directives 2004/107/EC and 2008/50/EC of the European Parliament and of the

[xciv] http://ec.europa.eu/environment/air/quality/legislation/public_info.htm
[xcv] http://ec.europa.eu/environment/air/quality/legislation/reporting.htm
[xcvi] Whereas Article 291 TFEU provides for a continuation of implementation of EU law through comitology, Article 290 TFEU introduced the delegated act which is now used to amend or supplement EU legislation, whereas beforehand this was also done through comitology

Council as regards the reciprocal exchange of information and reporting on ambient air quality.

EU ambient Air Quality legislation is completed by emission directives, such as:

- **Directive 2001/81/EC** of the European Parliament and the Council on National Emission Ceilings for certain pollutants (NEC Directive) sets upper limits for each Member State for the total emissions in 2010 of the four pollutants responsible for acidification, eutrophication and ground-level ozone pollution (sulphur dioxide, nitrogen oxides, volatile organic compounds and ammonia), but leaves it largely to the Member States to decide which measures – on top of Community legislation for specific source categories - to take in order to comply.
- **Directive 2010/75/EU** on industrial emissions (IED): The IED sets out the main principles for the permitting and control of installations based on an integrated approach and the application of best available techniques (BAT). On 7 January 2014, the IED repealed and replaced Directive 2008/1/EC on integrated pollution prevention and control (IPPC), Directive 2000/76/EC on waste incineration, Directive 1999/13/EC on activities using organic solvents and Directives 78/176/EEC, 82/883/EEC and 92/112/EEC, concerning titanium dioxide production. Note that this IED directive is completed by several sectorial directives.

It is important to note that the European Commission carried out a comprehensive review of existing EU air policy in 2011-2013, building on the 2005 Thematic Strategy on Air Pollution. A College of EU Commissioners gave a mandate for a review in January 2011,[xcvii] recognising the pressing need for action to improve air quality, which is a shared responsibility requiring joint efforts. The mandate focused on a number of immediate measures plus a requirement for a comprehensive review of EU's air policy by 2013 at the latest. The Commission adopted a new Clean Air Policy Package[xcviii] in December 2013, consisting of:

- A New Clean Air Programme for Europe with new air quality objectives for the period up to 2030,
- A revised National Emission Ceilings Directive with stricter national emission ceilings for the six main pollutants: SO_2, NOx, NMVOC, NH_3, fine particulate matter (PM) and methane (CH4), and
- A proposal for a new Directive to reduce pollution from medium-sized combustion installations. The review of air policy that preceded this package of measures revealed a gap in EU source legislation for smaller energy plants for street blocks or large buildings, and small industry installations (1-50 MW). This new instrument is designed to close this gap and make a significant contribution to reduce pollution of NOx, SO_2 and PM by setting limit values for new and existing installations, together with a simple registration scheme. In this way, the Directive will help deliver a significant part of Member States' emission reduction obligations. The Directive is also necessary to avoid possible trade-offs between air quality and increased biomass use, which may otherwise result in increased air pollution.

[xcvii] http://ec.europa.eu/transparency/regdoc/rep/10061/2011/EN/10061-2011-1944-EN-F-0.Pdf
[xcviii] http://ec.europa.eu/environment/air/clean_air_policy.htm

4.1.3 Overview of the Situation in EU

Many EU Member States are still falling short of agreed EU air quality standards, and the air pollution guidelines of the UN World Health Organization (WHO) are generally not being met. While EU air quality policy has brought significant reductions in concentrations of harmful pollutants such as particulate matter, sulphur dioxide (the main cause of acid rain), lead, nitrogen oxides, carbon monoxide and benzene, major problems remain. Fine particulates and ozone, in particular, continue to present significant health risks and safe limits for health are regularly exceeded. EU air quality standards and targets are breached in many regions and cities, and public health suffers accordingly, with rising costs to health care and the economy. According to the EU commission[xcix], air pollution caused over 400 000 premature deaths in 2010 as well as substantial avoidable sickness and suffering including respiratory conditions (such as asthma) and exacerbated cardiovascular problems. The overall external costs of these impacts ranged between €330-940 billion, including labour productivity losses and other direct economic damages valued at €23bn. The situation is especially severe in urban areas, which are now home to a majority of Europeans.

4.1.4 Ambient Standards

For the protection of human health and ecosystems, limit and target values for a number of air pollutants have been set in the Directive 2008/50/EC (see Appendix 1). "'Target value' shall mean a level fixed with the aim of avoiding, preventing or reducing harmful effects on human health and/or the environment as a whole, to be attained where possible" and "'limit value' shall mean a level fixed on the basis of scientific knowledge, with the aim of avoiding, preventing or reducing harmful effects on human health and/or the environment as a whole, to be attained within a given period - attainment date - and not to be exceeded once attained". Unlike limit values, target values need only be achieved "where possible" (2008/50/EC, Recital 9) and without incurring "disproportionate cost." (2008/50/EC, Article 17).

Guiding principles used by the EU in setting ambient standards are:

- Effects-based approach - Ambient air quality standards (limit values and target values) for pollutants are set according to their scientifically observed or estimated effects on human health and/or on the environment and are not based on the technological or economic feasibility of achieving them.
- Universality - The same standards apply in general throughout the EU. There are, however, provisions for special zones (e.g. for nature protection).
- Practicality - The difficulty of achieving compliance with standards within a short time leads to the recently introduced concept of margins of tolerance or - in earlier legislation - timescales for compliance.

[xcix] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52013DC0918

4.1.5 Ambient Air Quality Monitoring

At the EU scale, ambient air quality monitoring is required in accordance with Annex III of Directive 2008/50/EC. According to the Recital 14 of the Directive 2008/50/EC, “Fixed measurements should be mandatory in zones and agglomerations where the long-term objectives for ozone or the assessment thresholds for other pollutants are exceeded. Information from fixed measurements may be supplemented by modelling techniques and/or indicative measurements to enable point data to be interpreted in terms of geographical distribution of concentrations. The use of supplementary techniques of assessment should also allow for reduction of the required minimum number of fixed sampling points.”

Two types of sampling scales (macro and micro) are described in part B and C. Moreover, Annex V provides the “Minimum number of sampling points for fixed measurement to assess compliance with limit values for the protection of human health and alert thresholds in zones and agglomerations where fixed measurement is the sole source of information”. The same Annex mentions that “the number of sampling points for fixed measurement shall be calculated taking into account emission densities, the likely distribution patterns of ambient-air pollution and the potential exposure of the population”, and provides minimum number of stations depending on the maximum concentration, the agglomeration’s population (for diffuse sources) and the surface of the territory (for point sources).

Annex III of the Air Quality Directive provides recommendations about sampling points siting, at macro and microscale. Annexes V and IX provide information on the minimum number of sampling sites, depending on the maximum concentration, the agglomeration’s population (for diffuse sources) and the surface of the territory (for point sources).

Decision 2011/850/EU, in its Annex II - (D), lists the "Classification of station in relation to predominant emission sources relevant for the measurement configuration for each pollutant" as one of the pieces of information that Member States should report:

> **Background Station**: Located such that its pollution levels are representative of the average exposure of the general population within the type of area under assessment. The pollution level should not be dominated by a single source type (e.g. traffic), unless that source type is typical within the area under assessment. The station should usually be representative of a wider area of at least several square kilometers.
> **Industrial Station**: Located in close proximity to single industrial sources or industrial areas, in a location that should represent the highest concentrations to which the population within the zone are exposed to. A wide range of industrial sources can be considered here, including: a) thermal power generation; b) district heating plants; c) refineries; d) waste incineration/treatment plants, dump sites; e) mining, including gravel, oil, natural gas; f) airports; or g) ports.
> **Traffic Station**: Located in close proximity to a road, such that the pollution level for the specific pollutant is determined predominantly by the emissions from road traffic on distinct major roads in a location that should represent the highest concentrations to which the population are exposed to within the zone. As per ANNEX III of Directive

2008/50/EC, for all pollutants, traffic-orientated sampling probes shall be at least 25 m from the edge of major junctions and no more than 10 m from the kerbside.

Standard methods for sampling are required according to the regulated pollutants monitored (NO_2, O_3, $PM_{2.5}$, PM_{10}, SO_2, CO, Pb, As, Cd, Ni, PAH, Benzene). Annex VI of directive 2008/50/EC describes reference methods for assessment of concentrations of sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter (PM_{10} and $PM_{2.5}$), lead, benzene, carbon monoxide, and ozone.

4.1.6 Non-attainment Areas

The term "non-attainment areas" is not used in the EU legislation, but can be defined for purposes of this review as the zones or agglomerations where the levels of pollutants in ambient air exceed any limit or target value. The Directive 2008/50/EC defines in Article 4 that "Member States shall establish zones and agglomerations throughout their territory. Air Quality assessment and air quality management shall be carried out in all zones and agglomerations". According to Article 2 of this directive, "'Zones' shall mean part of the territory of a Member State, as delimited by that Member State for the purposes of air quality assessment and management". "Agglomeration' shall mean a zone that is a conurbation with a population in excess of 250 000 inhabitants or, where the population is 250 000 inhabitants or less, with a given population density per km^2 to be established by the Member States".

Each Member State is responsible and shall designate at the appropriate level the competent authorities and bodies responsible for ensuring air quality within its territory, and for designating agglomerations and zones on the basis of air quality management considerations within each country (Directive 2008/50/EC, Article 3). Moreover (Recital 5), "when assessing ambient air quality, account should be taken of the size of populations and ecosystems exposed to air pollution. It is therefore appropriate to classify the territory of each Member State into zones or agglomerations reflecting the population density". "Zones and agglomerations" shall be considered as areas designated by Member States for the purposes of both monitoring and assessing air quality. The Directive 2008/50/EC gives Member States a great deal of discretion as to how they divide their territory into zones and agglomerations. Member States must ensure that "throughout their zones and agglomerations" levels of these pollutants do not exceed the limit values by the relevant deadlines (2008/50/EC, Article 13). It is important to note that the limit values apply "throughout" each zone and agglomeration. This means that limit values apply everywhere within a zone or agglomeration, other than areas not defined as "ambient air" as per Article 2 and Annex III, Section A of the Air Quality Directive:

- Workplaces (which are governed by EU health and safety legislation);
- The carriageways of roads and central reservations (unless there is regular pedestrian access to such reservations);
- Locations where members of the public do not have access and there is no fixed habitation.

4.1.7 Non-attainment Area Planning Requirements

According to Article 23(1): "Where, in given zones or agglomerations, the levels of pollutants in ambient air exceed any limit value or target value, plus any relevant margin of tolerance in each case, Member States [as per Air Quality Directive, Article 23] shall ensure that air quality plans are established for those zones and agglomerations in order to achieve the related limit value or target value specified in Annexes XI and XIV". Elements to be included in the air quality plans are listed in Annex XV of the Air Quality Directive (reproduced here in Appendix 2). In Article 2, "'margin of tolerance' shall mean the percentage of the limit value by which that value may be exceeded subject to the conditions laid down in this Directive". In most cases, margins of tolerance are applied when limit values are to be met in future years. For NO_2, for example, the margin for annual limit value was 50 % on 19 July 1999, decreasing on 1 January 2001 and every 12 months thereafter by equal annual percentages to reach 0 % by 1 January 2010 which corresponds to the date by which limit value was to be met. These margins are specified in the Directive 2008/50/EC.

In the event of exceedances of those limit values for which the attainment deadline is already expired (as is currently the case since all such deadlines have expired as of 1 January 2015), the air quality plans must specify appropriate measures designed to keep the exceedance period as short as possible. The air quality plans may additionally include specific measures aiming at the protection of sensitive population groups, including children. Where air quality plans must be prepared or implemented in respect of several pollutants, Member States must, where appropriate, prepare and implement integrated air quality plans covering all pollutants concerned.

If exceedances (or number of allowed exceedances for short-term values) of the limit values plus the margin of tolerance (MOT) are found in a certain year, MS have to report the exceedances to the Commission before the 1 October of the following year (2008/50/EC directive). These exceedances trigger plans and programs that have to be drawn up to attain the limit value no later than two years after the end of the year during which the exceedances were observed. The table below summarizes the schedule for assessment and plans and programs.

Table 6 Timetable for reporting on exceedances in a particular year. The assessment must be done every year, the plans and programmes must be updated regularly.

		Year	Year+1				Year+2			
			I	II	III	IV	I	II	III	IV
1/Assessment	Monitoring									
	Further analysis									
	Report to Commission									
2/Plans and Programmes	Development									
	Report to commission									

Annex XV of the Air Quality Directive lists the main measures which can be implemented by Member States:

"(a) Reduction of emissions from stationary sources by ensuring that polluting small and medium sized stationary combustion sources (including for biomass) are fitted with emission control equipment or replaced;
(b) Reduction of emissions from vehicles through retrofitting with emission control equipment. The use of economic incentives to accelerate take-up should be considered;
(c) Procurement by public authorities, in line with the handbook on environmental public procurement, of road vehicles, fuels and combustion equipment to reduce emissions, including the purchase of:

— new vehicles, including low emission vehicles,
— cleaner vehicle transport services,
— low emission stationary combustion sources,
— low emission fuels for stationary and mobile sources;

(d) Measures to limit transport emissions through traffic planning and management (including congestion pricing, differentiated parking fees or other economic incentives; establishing low emission zones);
(e) Measures to encourage a shift of transport towards less polluting modes;
(f) Ensuring that low emission fuels are used in small, medium and large scale stationary sources and in mobile sources;
(g) Measures to reduce air pollution through the permit system under Directive 2008/1/EC[c], the national plans about large combustion plants under Directive 2001/80/EC[ci], and through the use of economic instruments such as taxes, charges or emission trading;
(h) where appropriate, measures to protect the health of children or other sensitive groups."[cii]

According to the Article 24 of the Air Quality directive, "Member States shall draw up action plans [i.e., emergency action plans] indicating the measures to be taken in the short term in order to reduce the risk or duration of such an exceedance, where, in a given zone or agglomeration, there is a risk that the levels of pollutants will exceed one or more of the alert thresholds". As indicated in Article 2(10) "'alert threshold' shall mean a level beyond which there is a risk to human health from brief exposure for the population as a whole and at which immediate steps are to be taken by the Member State". Where there is a risk that the alert threshold for just ozone will be exceeded, Member States must draw up such short-term action plans only when there is a significant potential, taking into account national geographical, meteorological and economic conditions, to reduce the risk, duration or severity of such an exceedance. The Decision 2004/279/EC details the geographical, meteorological and economic conditions for which Member states have to draw up short-term actions plans for ozone. In other words, countries in which there is no significant potential for reducing the risk of exceedances through short-term action plans would not need to prepare such plans.

[c] Replaced in 2010 by the Industrial Emissions Directive (2010/75/EU)
[ci] Replaced in 2010 by the Industrial Emissions Directive (2010/75/EU)
[cii] This does not in any way relieve the Member State from responsibility of assuring that ambient air quality standards are met at other locations.

4.1.8 Other Requirements

4.1.8.1 General

The EU doesn't provide specific provisions concerning emissions control in NAAs, except the Annex XV of the Air Quality Directive which lists the main recommended measures which can be considered for implemented implementation by Member States in through Air Quality Plans (see Appendix 2).

Emission control strategies and Impact assessment rules apply to all of the EU territory. According to the Article 11 of Directive 2010/75/EC, "Member States shall take the necessary measures to provide that installations are operated in accordance with the following principles:

(a) all the appropriate preventive measures are taken against pollution;
(b) the best available techniques are applied;
(c) no significant pollution is caused;
(d) the generation of waste is prevented in accordance with Directive 2008/98/EC;
(e) where waste is generated, it is, in order of priority and in accordance with Directive 2008/98/EC, prepared for re-use, recycled, recovered or, where that is technically and economically impossible, it is disposed of while avoiding or reducing any impact on the environment;
(f) energy is used efficiently;
(g) the necessary measures are taken to prevent accidents and limit their consequences;
(h) the necessary measures are taken upon definitive cessation of activities to avoid any risk of pollution and return the site of operation to the satisfactory state defined in accordance with Article 22."

4.1.8.2 Maintaining Clean Air

In zones and agglomerations where the levels of sulphur dioxide, nitrogen dioxide, PM_{10}, $PM_{2.5}$, lead, benzene and carbon monoxide in ambient air are below the respective limit values specified in the directive 2008/50/EC, Member States are required to maintain the levels of those pollutants below the limit values and to endeavour to preserve air quality, compatible with sustainable development.

4.1.8.3 Emission Limits and Inventories

In the National Emission Ceilings Directive (2001/81/EC), the EU set upper limits for each Member State for the total emissions in 2010 of the four pollutants responsible for acidification, eutrophication and ground-level ozone pollution (SO_2, NOx, VOCs, NH3), but left it largely to the MS to decide which measures – on top of European Community legislation for specific source categories – will need to be taken in order to comply. The National Emissions Ceilings have recently been reviewed as part of The Clean Air Policy Package. Member States must now

meet new national emission reduction commitments ("reduction commitments") applicable for 2020 and 2030 for SO_2, NOx, NMVOC, NH3, fine particulate matter ($PM_{2.5}$) and methane (CH4).

No emission inventories are required by the EU at the zones or agglomerations level; this local scale is managed by each Member States. Only national emission inventories are required by the EU (NEC Directive). Member States have to report their emission inventories to the EEA and the European Commission in order to monitor progress and verify compliance. At larger scale (i.e. National), EU Member States together with Central and Eastern European countries, the United States and Canada have negotiated the "multi-pollutant" protocol under the Convention on Long-Range Transboundary Air Pollution (the so-called Gothenburg protocol, agreed in November 1999). The emission ceilings in the protocol are equal or less ambitious than those in the NEC Directive.

According to the National Emission Ceilings (NEC) Directive (2001/81/EC), each Member State must prepare emission inventories and provide the total emissions of the four pollutants responsible for acidification, eutrophication and ground-level ozone pollution: SO_2, NO_x, VOCs and NH_3. As mentioned above, ceilings have been recently reviewed as part of the Clean Air Policy Package to ensure attainment of new national emission “reduction commitments” applicable from 2020 and 2030 for SO_2, NO_x, NMVOC, NH_3, fine particulate matter ($PM_{2.5}$) and methane (CH_4). EU and international policies have reduced some air pollution problems in recent decades. Sulphur dioxide emissions (the cause of acid rain) have been cut by more than 80% in the past two decades, and nitrogen oxides and VOCs by 40-50%, for example. Despite this, the EU is far short of its long-term objective as outlined in the agreed 7th Environmental Action Programme, which is to achieve levels of air quality that do not have significant negative impacts on human health and the environment. **EU national emission ceilings** are upper limits for total emissions of certain air pollutants that Member States will have to respect by a certain date, to push down background concentrations and limit transboundary air pollution. Existing ceilings are in place for 2010, as set out in the UNECE Gothenburg Protocol in 1999 and the EU National Emission Ceilings Directive, NECD (2001/81/EC). New ceilings (which are called national emission reduction commitments) for 2020 were agreed upon recently in a revised Gothenburg Protocol, and are proposed for 2020 and 2030 in a revised NECD as part of the Clean Air Policy Package.

The Directive 2008/50/EC differentiates two major groups of sources: diffusive (including urban sources) and point sources (Annex III and V). At EU scale, emissions required by NECD and HTAP must be reported using the Nomenclature For Reporting (NFR) and Selected Nomenclature for sources of Air Pollution (SNAP) sectors which are developed as part of the European LRTAP (Long Range Transport of Atmospheric Pollution)/EMEP (European Monitoring and Evaluation Programme). SNAP sector are described in EMEP/EEA, 2013 guidebook. Eleven SNAP sectors are available such as Combustion in energy and transformation industries, road transport, other mobile sources and machinery, etc. In each SNAP sector NFR could be considered as sub-sector. For example, Road transport SNAP sector is divided into 7 NFR sub-sector such as passenger cars, LDV, HDV, etc. A table of these sectors is provided in Appendix 3.

The Commission presented on December 2013, its new Clean Air Policy Package, including a proposal for a new NEC directive. The proposed new NEC directive (coming into force in 2016) replaces the existing one from 2001 by keeping the current 2010 emission caps in place up to 2020, after which they will be replaced by percentage Emission Reduction Commitments (ERCs) for 2020, in line with those already adopted in 2012 under the LRTAP Convention's Gothenburg Protocol. In addition, the new directive establishes more far-reaching legally binding ERCs to be achieved by 2030, as well as intermediate reduction targets for 2025. The latter are defined by a linear trajectory between the emission levels in 2020 and 2030. The country-by-country ERCs for 2020 and 2030 are contained in Annex II of the directive. While the 2001 NEC directive covered four pollutants – SO_2, NOx, NMVOCs and NH_3 – the new one is also extended to cover fine particulate matter ($PM_{2.5}$), with ERCs from 2020, and methane (CH_4), with ERCs from 2030. The ambition level of the proposed revised NEC directive, in order to achieve ambient air quality goals, is to cut EU-wide emissions of SO_2 by 81 per cent; NOx by 69 per cent; NMVOCs by 50 per cent; ammonia (NH_3) by 27 per cent; particulate matter ($PM_{2.5}$) by 51 per cent; and, methane (CH_4) by 33 per cent by 2030, compared to the emission levels in the base year 2005.[ciii]

4.1.8.3.1 Integrated Industrial Emissions Directive

Directive 2010/75/EU on industrial emissions targets the largest industrial, agricultural, and waste treatment installations. The directive includes a methodology to use "best available techniques and to limit imbalances in the Union as regards the level of emissions from industrial activities, reference documents for best available techniques" (Recital 13). This applies across EU to all the industrial sectors listed in the directive, regardless of air quality. Emission levels related to the BAT are the emission standards, but air quality plans can require complementary limitations locally, e.g. reducing the production or the activity during pollution events.

4.1.8.3.2 Sector-specific Directives

A number of EU directives have been developed regarding emissions from specific source types:

- Directive 2012/33/EU (EU, 2012) amending Directive 1999/32/EC as regards the sulphur content of marine fuels, Directive 1999/32/EC on reduction of sulphur content of certain liquid fuels (EU, 1999b), and Directive 2003/17/EC (amending Directive 98/70/EC) relating to the quality of petrol and diesel fuels (EU, 2003a).
- Directive 94/63/EC on the control of volatile organic compound (VOC) emissions resulting from the storage of petrol and its distribution from terminals to service stations (EU, 1994) and Directive 2009/126/EC on Stage II petrol vapour recovery during refuelling of motor vehicles at service stations (EU, 2009a).
- Directive 1999/13/EC on the limitation of emissions of VOC due to the use of organic solvents in certain activities and installations (EU, 1999a).
- Directive 2004/42/EC on the limitation of the total content of VOCs in certain paints and varnishes and vehicle refinishing products in order to prevent or reduce air pollution resulting from the contribution of VOCs to the formation of tropospheric ozone.
- The Marine Pollution Convention, MARPOL73/78 (IMO, 1973), which is the main international convention on preventing ships polluting from operational or accidental causes.

[ciii] http://ec.europa.eu/environment/air/pdf/TSAP.pdf

Annex VI sets limits on air pollution from ships for sulphur oxides (SOx), NOx, VOC and PM from ship exhausts, and prohibits deliberate emissions of ozone-depleting substances. For international shipping, tighter shipping fuel standards and emission standards at IMO/MARPOL level resulted in the recent revision of the Sulphur Content of Fuel Directive (adopted as 2012/33/EU).

- The United Nations Economic Commission for Europe (UNECE) Protocol on Persistent Organic Pollutants (POPs) obliges parties to reduce their emissions of polycyclic aromatic hydrocarbons (PAHs) to below their levels in 1990 (or in an alternative year between 1985 and 1995). For the incineration of municipal, hazardous and medical waste, it lays down specific limit values.
- The UNECE Protocol on Heavy Metals targets three particularly toxic metals: cadmium, lead and mercury. According to one of the basic obligations, parties will have to reduce their emissions for these three metals below their levels in 1990 (or an alternative year between 1985 and 1995). The Protocol aims to cut emissions from industrial sources, combustion processes and waste incineration. It also introduces measures to lower heavy metal emissions from other products, such as mercury in batteries, pesticides, paint, etc. The Protocol was most recently amended in 2012, to adopt more stringent emission controls.
- The Nitrates Directive, i.e. Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources (EU, 1991). In particular, the implementation of agricultural practices that limit fertiliser application and prevent nitrate losses helps reduce agricultural emissions of nitrogen compounds to air.
- Finally, the Euro Regulations set standards for road vehicle emissions (see Regulation of Mobile Sources below).

4.1.8.4 Emission Reduction Technology Selection

Emission control technology selection guidance and procedures apply in Europe without regard to the attainment or non-attainment status of the area in which the source is located.

According to Article 14(3) of the IED, Best Available Techniques (BAT) conclusions shall be the reference for setting the permit conditions to new and existing installations covered by the Directive. According to article 15(2) of the IED, emission limit values and the equivalent parameters and technical measures in permits shall be based on the best available techniques, without prescribing the use of any technique or specific technology.

BATNEEC (Best Available Techniques Not Entailing Excessive Cost; also referred to as Best Available Technology or BAT) is the primary emission standard requirement for sources in Member States. BATNEEC seeks to strike a balance between using state-of-the-art techniques (including technologies) to minimise emissions, and the cost of doing so. The Industrial Emissions Directive (IED) 2010/75/EC, provides the determination of Best Available Techniques (BAT) references through exchange information between MS, industries, Non-Governmental Organizations and the European Commission. In order to define BAT and the BAT-associated environmental performance at EU level, the Commission organises an exchange of information with experts from Member States, industry and environmental organisations. This work is co-ordinated by the European IPPC Bureau of the Institute for Prospective Technology

Studies at the EU Joint Research Centre in Seville (Spain). This process results in BAT Reference Documents (BREFs); the BAT conclusions contained are adopted by the Commission as Implementing Decisions. The BREF documents including the BAT are publically available on the EU website[civ]. For a given industrial sector, a BREF document provides:

- A review of technical and economical state-of-the art techniques;
- An inventory of available technologies;
- An emissions and consumption inventory;
- A choice of what technique is the Best available among others;
- A description of emergent techniques.

For each specific industrial sector and for all of the EU zone, a BREF lists the reference documents that have been drawn (or are planned to be drawn) as part of the exchange of information carried out in the framework of Article 13(1) of the Industrial Emissions Directive (IED, 2010/75/EU). It contains the Best Available Techniques (BAT) reference documents that have been adopted under both the IPPC Directive (2008/1/EC) and the IED. BREFs adopted under the IED provide "BAT conclusions", which correspond to the parts of BAT reference document laying down the conclusions on best available techniques, their description, information to assess their applicability, the emission levels associated with the best available techniques, associated monitoring, associated consumption levels and, where appropriate, relevant site remediation measures.

Several BREFs concern industrial sectors with potential area and/or fugitive emissions, including:

- Common Waste Water and Waste Gas Treatment/ Management Systems in the Chemical Sector
- Waste treatment
- Emissions from Storage
- Iron and Steel Production (including open stockyards)

All these documents include BAT for limiting atmospheric emissions. All the BREFs are available through the related European Commission / JRC portal:
http://eippcb.jrc.ec.europa.eu/reference/

Related to the BAT conclusions, BAT-AEL (Best Available Techniques Associated Emission Levels) give a range of emission levels obtained under normal operating conditions using the best available techniques (or a combination of BAT). These levels are generally expressed in mg/Nm^3 for each source.

For new installations in the EU, the provisions of the IED apply from 7 January 2013. For setting permit conditions, all relevant BAT conclusions adopted in accordance with Article 13(5) and published before the permit is issued shall be applied for the purpose of Articles 14, 15 and 16 of the IED and the installation shall immediately comply with those conditions. Around 50,000

[civ] http://eippcb.jrc.ec.europa.eu/reference/

installations undertaking the industrial activities listed in Annex I of the IED are required to operate in accordance with a permit (granted by the authorities in the Member States). This permit should contain conditions set in accordance with the principles and provisions of the IED.

Recently a proposal (COM/2013/0919) has been submitted to introduce provisions on emission limit values and monitoring requirements for SMEs (Small and Medium-sized Enterprises). This proposal is the result of Stakeholder and Public consultations highlighting "failure to limit pollution from significant point sources or from products" originating from SMEs, in which most of the medium combustion plants are operated. On 10 November 2015, the Council adopted a new directive to limit the emissions from combustion plants of medium size. These new rules are part of the clean air legislative package, which aims at improving air quality in the EU. This new directive sets emission limit values for certain pollutants, namely SO_2, NOx and dust. These limits will be applied for new and existing combustion plants of medium size (between 1 and 50 MW).

Beside the IED, the Environmental Impact Assessment (EIA) Directive (85/337/EEC) is in force since 1985 (with amendments codified by Directives 2011/92/EU and 2014/52/EU) and applies to a wide range of public and private projects. This EIA Directive:

- Provides a list of projects concerned by EIA, depending on activity or size of the project, e.g. surface in m2 for urban constructions;
- Describes the content of the assessment performed by the developer: description of the project, impacts assessment, mitigation measures and non-technical summary;
- Specifies that projects shall comply with the EU regulations (e.g. AQ standards);
- Requires from Member States the information of the public concerned by the project and the possibility for this public to express an opinion.

There are no specific emission offset ratios prescribed in EU regulations.

Several recommendations are mentioned in Plan and Programmes to achieve Compliance section of the Handbook on the Implementation of EC Environmental Legislation (pp.212, 213). The types of mechanism that may be used to reduce pollution emissions include:

- controlling or suspending polluting activities to control pollution levels during short-term events when limit values or alert thresholds for pollutants are in danger of being exceeded;
- regulation of either emission levels or the type of installations allowed, using either existing or new legislation;
- economic incentives, such as differential taxation or subsidies, to encourage reductions in emissions, for example through fuel substitution; and
- closure of installations that cannot meet the emission standards necessary to comply with ambient air quality limits.

4.1.9 Regulation of Mobile Sources

On-road vehicles must conform to European-wide emission standards as specified in the Euro Regulations for road vehicle emissions. The Euro 5 and 6 standards are set in Regulations (EC) No 692/2008 and No 595/2009. The Communication CARS 2020 sets out a timetable for implementation of the Euro 6 vehicle standards in real-world driving conditions, and for the revision of the Non-road Mobile Machinery legislation. No specific programs are provided or requested by EU for "non-attainment" areas.

EU rules on vehicle checks date from 1977, they set minimum standards for vehicle checks and have only been marginally updated since. There are three main pieces of legislation:

- Directive 2009/40/EC fixes minimum standards for the periodic roadworthiness tests of motor vehicles - these are the regular vehicle checks required by law. The Directive applies to passenger cars, buses and coaches and heavy goods vehicles and their trailers, but not to scooters and motorbikes.
- Directive 2009/40/EC is complemented by Directive 2000/30/EC, which provides the requirement to control the technical state of commercial vehicles in between periodic inspections (with technical roadside inspections). These are additional on-the-spot roadside checks for commercial vehicles.
- Directive 1999/37/EC on registration documents for vehicles sets out the requirements for the issuing of registration certificates, their mutual recognition and the harmonised minimum content of vehicle registration certificates.

The pollutant emissions from road vehicles are regulated separately for light-duty vehicles (cars and light vans) and for heavy-duty vehicles (trucks and buses). For light-duty vehicles, the emission standard currently in force is Euro 5/6, as defined by Regulation 2007/715/EC.
The preparation of Euro 5/6 was based on input by industry stakeholders that was reviewed by a panel of independent experts. The Euro 5/6 standards are formulated using a split-level approach, which means that politically relevant aspects are contained in a main instrument that is agreed via co-decision by Council and European Parliament, while technical aspects are regulated by means of implementing legislation to be prepared by the Commission supported by a Committee. The Regulation has been politically agreed by the institutions in December 2006 and formally adopted by the Council on 30 May 2007.

Euro 5 entered into force in September 2009. The main effect of Euro 5 was to reduce the emission of particulate matter from diesel cars from 25mg/km to 5mg/km. Euro 6 entered into force in January 2014 and mainly reduced the emissions of NOx from diesel cars further, from 180mg/km to 80mg/km.

The legislation currently in force for heavy-duty vehicles is Directive 2005/55/EC (agreed in co-decision) and Directive 2005/78/EC (implementing provisions) amended by the Regulation No 595/2009. This legislation defines the emission standards currently in force, Euro VI. In addition, "this Regulation defines the legal framework for type-approval of motor vehicles, engines and replacement parts for heavy duty vehicles with respect to their emission performance. It also establishes rules on:

- in-service conformity of vehicles and engines;
- durability of pollution control devices;
- on-board diagnostic (OBD) systems
- accessibility of vehicle OBD and vehicle repair and maintenance information;
- measurements of fuel consumption and CO2 emissions."

For vehicles in use there is legislation on periodic inspections at which the state of maintenance of the vehicle is checked (Directive 96/96/EC), i.e. Member States shall implement periodic inspections programs, with test frequencies depending on the vehicle categories: passenger vehicles (more or less 8 passengers), ambulances/taxis, carriage of goods (more or less 3500 kg). 2-wheels are not concerned.

Concerning the Non-Road Mobile Sources, Directive 2012/46/EU (amending Directive 97/68/EC) provides measures (mainly through limit emission levels) against the emission of gaseous and particulate pollutants from internal combustion engines to be installed in non-road mobile machinery.

4.1.10 Voluntary, Economic Incentive, and Market-Based Programs

Europe does not provide any rules on economic incentives. Such programs are mainly managed by Member States in support of their overall strategy for complying with European AQ directives. Only the price of fuel is Environment-dependant. The Energy Taxation Directive, i.e. Directive 2003/96/EC restructuring the Community framework for the taxation of energy products and electricity. This establishes minimum taxes for motor fuels, heating fuels and electricity, depending on the energy content of the product and the amount of CO_2 it emits. It aims at promoting energy efficiency and use of less-polluting energy products.

4.1.11 Tools

4.1.11.1 Modelling

FAIRMODE[cvii] recommends the use of models for Air Quality Plans in particular for designing monitoring networks when models are used in combination with monitoring and for determining the number of fixed monitoring sites that are required.

The Air Quality Directive does not recommend a list of specific models to be used, but FAIRMODE proposes several criteria:

- The model has the appropriate spatial and temporal resolution for the intended application
- The model is adequately validated for the particular application and well documented
- The model contains the relevant physical and chemical processes suitable for the type of application, the scale and the pollutant for which it is applied
- The relevant emission sources for the application are adequately represented

- Suitable meteorological data is available

FAIRMODE compiled a list (Table 7) of typical model characteristics, formulation and processes for different scales and pollutants (FAIRMODE, 2010).

Table 7. List of typical model characteristics, formulations and processes, for the various scales and pollutants needed for air quality assessment (extracted from FAIRMODE, 2010).

	Area of Assessment		
Description	Local/hotspot (1 – 1000 m)	Urban/agglomerate (1 – 300 km)	Regional (25 – 10 000 km)
Model type	Gaussian and non-Gaussian parameterised models Statistical models Obstacle resolving fluid dynamical models Lagrangian particle models	Gaussian and non-Gaussian parameterised models Eulerian chemical transport models Lagrangian particle models	Eulerian chemical transport models Lagrangian chemical models
Meteorology	Local meteorological measurements Obstacle resolving fluid dynamical models Diagnostic wind field models	Mesoscale meteorological models Localised meteorological measurements Diagnostic wind field models	Synoptic/mesoscale meteorological models
Chemistry	Parameterised or none	Ranging from none to comprehensive, depending on application	
Emission modelling	Bottom up traffic emissions Source specific emissions	Bottom up and/or top down emission modelling Emission process models	Top down emission modelling Emission process models
Compounds PM_{10}	Local/hotspot No chemical processes	Urban/agglomerate Deposition Secondary inorganic particle formation	Regional/continental Deposition Primary (combustion) particles Secondary inorganic and organic particles formation Suspended dust Sea salt
$PM_{2.5}$	No chemical processes	Deposition Secondary inorganic particle formation	Deposition Secondary inorganic and organic particle formation
NO_2	Simple photo-oxidant chemistry Statistical/empirical relations	Limited photo-oxidant chemistry Photo-stationary scheme Statistical/empirical relations Deposition	Deposition Full photo-oxidant chemistry
NOx	No chemical processes	No chemical processes Full photo-oxidant chemistry for larger scales	Full photo-oxidant chemistry
O_3	As in NO_2	As in NO_2	As in NO_2
SO_2	No chemical processes	Deposition Secondary inorganic particle formation	Deposition Secondary inorganic particle formation Full photo-oxidant chemistry

	Area of Assessment		
Pb	No chemical processes	Deposition No chemical processes	Deposition Specialised chemical schemes
Benzene	No chemical processes		Deposition Full photo-oxidant chemistry
CO	No chemical processes	No chemical processes	Full photo-oxidant chemistry
Heavy metals and BaP	No chemical processes	Deposition Specialised chemical schemes	Deposition Specialised chemical schemes

In order to assess cost and benefit of measures, the European Commission and the member States use Integrated Assessment Models (IAM), which simultaneously address health and ecosystem impacts of particulate pollution, acidification, eutrophication and tropospheric ozone. The most used IAM in Europe is the GAINS[cv] model, developed by IIASA and a European consortium for more 10 years. The GAINS Model allows assessment of emissions on a medium-term time horizon, by 5 years steps until 2030. GAINS includes and is linked to a lot of tools/modules, as described in. Figure 8.

Global Development of IAM have been made recently through 2 major programs, EC4MACS and APPRAISAL, both supported by EU and lead by European agencies or laboratories (IIASA, INERIS, JRC, University of Brescia,…).

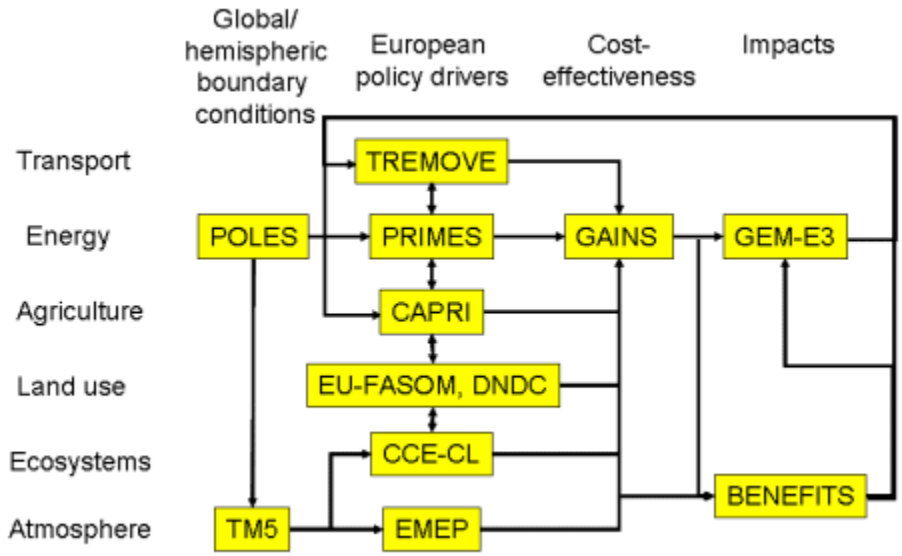


Figure 8 GAINS model structure (2008).

4.1.11.2 Source Apportionment

According to the 2008/50/EC Directive, source apportionment can be required for:

[cv] http://gains.iiasa.ac.at/gains/ANN/index.login?logout=1

- identifying whether exceedances are due to natural sources or to road salting/ sanding (articles 20 and 21)[cvi],
- preparing air quality plans (Annex XV A),
- quantifying transboundary pollution (Annex IV A),
- informing the public (Annex XVI) and,
- in the past, for demonstrating eligibility for postponement of PM10 and NO2 limit value attainment (COM/2008/403).

The Joint Research Center (JRC), which is the in-house science service of the European Commission, has the initiative for the harmonisation of source apportionment approaches. This initiative was launched in collaboration with the European networks in the field of air quality modelling (FAIRMODE[cvii]) and measurements (AQUILA[cviii]). Three general approaches are considered:

- Emission inventories which are detailed compilations of the emissions from all source categories in a certain geographical area and within a specific year. Emissions are estimated by multiplying the intensity of each relevant activity (activity rate) by a pollutant-dependent proportionality constant (emission factor).
- Receptor models (RMs) apportion the measured mass of an atmospheric pollutant at a given site to its emission sources by solving a mass balance equation. These models have the advantage of providing information derived from real-world measurements, including estimations of output uncertainty.
- Source Oriented Models (SOM): mainly Chemical Transport Models (CTM, such as CAMx[cix], CMAQ[cx] or CHIMERE[cxi]), but also Gaussian and Lagrangian models, using Sensitive Analysis and/or Source Apportionment (SA) Techniques.

Note that the Receptor Models (RM) Intercomparison Exercise were recently published by FAIRMODE in order to provide a guide and a European harmonised protocol prepared within the framework of the JRC initiative for the harmonisation of source apportionment with receptor models (European guide on Air Pollution Source Apportionment with Receptor Models, 2014). The objective of this document is to disseminate and promote the best available methodologies for source identification using Receptor Models, and to harmonise their application across Europe. In addition, it aims at making results of source apportionment studies more accessible to experts involved in the development and assessment of pollution source abatement measures.

The same intercomparison exercise is currently under way for Source Oriented Models (SOM) and led by FAIRMODE.

[cvi] Member States shall transmit to the Commission, for a given year, lists of zones and agglomerations where exceedances of limit values for a given pollutant are attributable to natural sources. Member States shall provide information on concentrations and sources and the evidence demonstrating that the exceedances are attributable to natural sources.
[cvii] http://fairmode.jrc.ec.europa.eu/
[cviii] https://ec.europa.eu/jrc/en/aquila
[cix] http://www.camx.com/
[cx] https://www.cmascenter.org/cmaq/
[cxi] http://www.lmd.polytechnique.fr/chimere/

According to FAIRMODE recommendations (FAIRMODE, 2012), "There is an increasing need to demonstrate whether and to what extent exceedances of limit values can be attributed to natural sources, human practices (road salting and sanding), and transboundary pollution. In the context of the preparation and implementation of air quality plans and short-term action plans, there is also a need to identify and quantify the contribution of the main pollution sources in order to efficiently design abatement measures and assess their effectiveness".

The two main modelling approaches considered in FAIRMODE are Receptor (RM) and Source oriented Models (SOM) described in the previous section. Note that CTMs are widely used by Member states for Air Quality assessment, forecasting and Source Apportionment.

4.1.12 Reporting Requirements and Enforcement Mechanisms

4.1.12.1 Reporting Requirements and Public Engagement

Complete and efficient data collection and reporting are essential components of air quality management. Most EU directives impose a duty to report to the Commission on their implementation, and, in the case of directives requiring air quality monitoring to be undertaken, to report the results and the degree of compliance to both the Commission and the public. To provide consistency, guidance on the Commission Implementing Decision laying down rules for Directives 2004/107/EC and 2008/50/EC of the European Parliament and of the Council as regards the reciprocal exchange of information and reporting on ambient air (Decision 2011/850/EU) are mandatory for each MS.

In addition, formal questionnaire shall be used by MS for reporting, they are free to continue to use the original questionnaire under decision 2004/461/EC, but are strongly encouraged to use the new questionnaire even if no information of the assessment under 4th Daughter Directive or the new directive 2008/50/EC is provided, as it has minor modifications on Form 0 and Form 2 to facilitate submission and processing.

The directives require Member States to ensure that up-to-date information on ambient concentrations of the different pollutants is routinely made available to the public, especially where and when AQ standards are not met (NAAs). This is done by providing information on websites, teletext, in press and also by public displays. The information needs to be updated as appropriate to the averaging periods. The relation to the different limit and target values needs to be clear. When information or alert thresholds are exceeded, Member States need to inform the public about the exceedance and the actions that are eventually taken.

On the Community level a number of sources exist that provide information to the public:

- AirBase[cxii] is the public air quality database system of the EEA based on the information from the continuous monitoring of air quality, collected under the Exchange of Information Decision 97/101/EC and the EEA priority data flows. It contains information submitted by the participating countries throughout Europe.

[cxii] http://acm.eionet.europa.eu/databases/airbase/

- The database on ozone contains a lot of information about ozone exceedances in summer. The EEA has developed a website to provide the public with Europe-wide near real time data on ozone.[cxiii] The website also contains multiple links to national and regional air quality websites.
- The CDR contains a collection of documents delivered by each country, concerning various topics, including air quality.[cxiv]

According to the Article 26 in Directive 2008/50/EC, "Member States shall ensure that the public as well as appropriate organisations such as environmental organisations, consumer organisations, and organisations representing the interests of sensitive populations, other relevant health-care bodies and the relevant industrial federations are informed, adequately and in good time, of air quality plans". Moreover, "Member States shall make available to the public annual reports for all pollutants covered by this Directive. Those reports shall summarise the levels exceeding limit values, target values, long-term objectives, information thresholds and alert thresholds, for the relevant averaging periods. That information shall be combined with a summary assessment of the effects of those exceedances".

The public participation described in the Directive 2003/35/EC (the Public Participation Directive) can be summarized in the following bullets:

- Plans and programmes. The participation concerns decision-making procedure, expression of comments and opinions. More specifically, the Public Participation Directive requires Member States to ensure that the "public" is given early and effective opportunities to participate in the preparation and modification or review of the plans or programmes required to be drawn up under a list of EU environmental directives[cxv]. The Public Participation Directive leaves considerable discretion to Member States to decide who "the public" is for participating in plans and programmes: "Member States shall identify the public entitled to participate [...], including relevant non-governmental organisations meeting any requirements imposed under national law, such as those promoting environmental protection"[cxvi]. Public participation must take place early, when all options are open and before any final decision is made on the content of the air quality plan or before a plan is submitted to the legislative bodies for adoption. In the case of a local authority, this means that participation must take place before the plan is submitted to the municipal council.
- Participation in decision-making procedure concerning projects which are subject to Environmental Impact Assessments (EIA). Where a full EIA is carried out, the "public concerned" has the right to participate in the decision whether or not to grant consent to the project. The public concerned is defined as the public affected or likely to be affected by, or having an interest in, the decision.
- Industrial permits: participation in the procedure of issuing a permit for new installations; issuing a permit for any substantial change in the operation of an installation; updating of a permit or permit conditions for an installation.

[cxiii] http://www.eea.europa.eu/maps/ozone/welcome
[cxiv] http://cdr.eionet.europa.eu/
[cxv] Public Participation Directive Article 2 and Annex I
[cxvi] Public Participation Directive, Article 2(3)

A Stakeholder Expert Group (EG) was mandated by European commission between 2011 and 2013[cxvii] to review European air quality policies and provide to European Commission recommendations and improvements of the Air Quality Directive.

4.1.12.2 Enforcement

It is the Commission's responsibility under Article 17(1) to ensure that both the Treaty on European Union and the Treaty on the Functioning of the European Union (EU, 2007) as well as measures adopted pursuant to them are correctly applied. The Commission is therefore often referred to as the "Guardian of the Treaties". With over 200 legal acts to monitor in 28 Member States, this is a major task in the environmental field.

These legislative measures cover all environmental sectors, including Air Quality.
On 7 March 2012 the Commission adopted a Communication Improving the delivery of benefits from EU environment measures: building confidence through better knowledge and responsiveness. The Communication sets out ideas aimed at providing Member States with tools to improve implementation on the ground. It complements 2008 Commission Communication on implementing European Community Environmental Law which sets out the Commission's enforcement strategy to tackle breaches of the European Union's environmental protection laws. Both of them fit within a wider Commission strategy for improving implementation of EU law announced in a previous Communication: A Europe of Results - Applying Community Law of 2007.

4.1.12.2.1 The Infringement Procedure

The Commission can bring infringement cases in three situations:

- Where the Member State fails to transpose a directive into national legislation by the relevant deadline and communicate this to the Commission.
- Where the Member State transposes a directive into national legislation, but fails to do so correctly.
- Where the Member State transposes the directive into national legislation, but fails to ensure that the provisions of the directive are actually implemented in practice – for example, failing to ensure that limit values are complied with.

At every stage the Commission has complete discretion as to whether and when to act. The Commission does not make any documents relating to infringement cases publically available. However, it will normally issue a press release whenever it issues a reasoned opinion or refers a Member State to the European Court of Justice (ECJ) to inform the public that action has been taken. The Commission usually announces decisions on infringement cases on the third Wednesday of each month, and will publish a press release on the following website: http://ec.europa.eu/environment/legal/law/press_en.htm

[cxvii] http://ec.europa.eu/environment/air/review_air_policy.htm

4.1.12.2.2 Strengths of the Infringement Procedure (Andrews, 2014)

- Financial penalties - in the case of air quality, where the breaches are widespread, longstanding, have a major impact on human health and in many cases involve wealthy Member States, these fines could amount to hundreds of millions of Euros. For this reason even the mere possibility of a fine is usually taken very seriously by Member States.
- Strategic overview - the Commission has a good overview of the bigger picture i.e. it can compare the compliance situation in different Member States.
- Resources - the Commission can draw on the resources of a large body of officials and lawyers.
- The duty of sincere cooperation – Member States are obliged by the Treaty to cooperate with the Commission.

4.1.12.2.3 Weaknesses

- Limited powers - the Commission has limited powers of inspection when it comes to environmental matters (in contrast with competition law, for example, where it is bestowed with draconian powers). It is therefore reliant on information provided to it by Member States. This has two unfortunate consequences:
  - First, Member States are not always as helpful as they might be in providing the Commission with evidence of their own wrongdoing. Further, the Commission adheres to the so called "Golden Principle" (which flows from the Treaty) that it must trust the information provided to it by Member States;
  - Second, Member States are not required to provide information to the Commission on breaches of air quality limit values until nine months after the end of the calendar year in which it took place.
- Limited resources - the Commission has limited resources to properly fulfil its role as Guardian of the Treaty. For this reason the Commission favours a "decentralised" model of enforcement - where it focuses its limited resources on cases of failure by Member States to properly transpose EU directives and cases of major, systemic breaches of EU law. For other cases, it relies on legal action taken by EU citizens before national courts to ensure compliance.
- Unlimited discretion - the Commission has absolute discretion as to if and when to take legal action against Member States, and whether to proceed to each stage in proceedings. While an infringement case is open, there will be an ongoing negotiation between the Commission and the Member State. In this respect the process resembles a political negotiation rather than a legal process.
- Political pressure - the Commission faces considerable political pressure from Member States not to pursue legal action, particularly where there is a prospect of a fine in round two proceedings. It is particularly vulnerable to such pressure given its dual roles as both the initiator and enforcer of EU legislation, which often conflict.

Delay - the combined effect of these four problems is that the infringement process is very slow. It typically takes around four years to move from letter of formal notice to the first court judgment. It can then take several more years to reach second court judgment, at which point the court may issue a fine. By contrast, national legal action can proceed relatively quickly.

Figure 9 below describes the Infringement process and related timescales.

Figure 9 Infringement process (Andrews, 2014).

4.1.12.2.4 Member State Enforcement Responsibilities

According to the Article 3 of the Air Quality Directive concerning responsibilities, « Member States shall designate at the appropriate levels the competent authorities and bodies responsible for the following:

(a) assessment of ambient air quality;
(b) approval of measurement systems (methods, equipment, networks and laboratories);
(c) ensuring the accuracy of measurements;
(d) analysis of assessment methods (i.e. any method used to measure, calculate, predict or estimate levels);
(e) coordination on their territory if Community-wide quality assurance programmes are being organised by the Commission;
(f) cooperation with the other Member States and the Commission. »

According to the Article 30 of the same directive, "Member States shall lay down the rules on penalties applicable to infringements of the national provisions adopted pursuant to this Directive and shall take all measures necessary to ensure that they are implemented. The penalties provided for must be effective, proportionate and dissuasive".[cxviii]

The management of inspection and maintenance program are delegated to Member States as mentioned in Article 23(1) in IED directive: "Member States shall set up a system of environmental inspections of installations addressing the examination of the full range of relevant environmental effects from the installations concerned." With objectives indicated in Recital 26: "operators should regularly report to the competent authority on compliance with permit conditions. Member States should ensure that the operator and the competent authority each take necessary measures in the event of non-compliance with this Directive and provide for a system of environmental inspections. Member States should ensure that sufficient staff are available with the skills and qualifications needed to carry out those inspections effectively."

IED directive only states on what is needed to perform this part in AQ management, as indicated in Article 3(22), "environmental inspection' means all actions, including site visits, monitoring of emissions and checks of internal reports and follow-up documents, verification of self-monitoring, checking of the techniques used and adequacy of the environment management of the installation, undertaken by or on behalf of the competent authority to check and promote compliance of installations with their permit conditions and, where necessary, to monitor their environmental impact."

4.1.12.3 Current Actions

Regarding exceedance of the Limit Value for PM_{10}, the European Commission has initiated a procedure against 17 Member States (Austria, Belgium, Bulgaria, Czech Republic, Germany,

[cxviii] Where Member State enforcement has not resulted in compliance with directives, enforcement action may be taken at the EU level as described in Sec. 5.

Greece, Spain, France, Italy, Hungary, Latvia, Portugal, Poland, Romania, Sweden, Slovakia, and Slovenia).

4.1.13 Assessment

4.1.13.1 Summary

The present Air Quality situation in EU can be summarized as follows:

- Many EU Member States are still falling short of agreed EU air quality standards;
- While EU air quality policy has brought significant reductions in concentrations of harmful pollutants such as SO_2, NO_2, Lead, CO and Benzene, major problems remain;
- Fine particulates and ozone, in particular, continue to present significant health risks and safe limits for health are regularly exceeded;
- EU air quality standards and targets are breached in many regions and cities, and public health suffers accordingly;
- At the moment over a third of EU's Air Quality Management Zones exceed the limit values for PM_{10} and a quarter exceed limit values for nitrogen dioxide NO_2.
- Seventeen Member States are currently subject to infringement proceedings for PM_{10} non-compliance. There are six procedures under way for NO_2, and one for SO_2.

4.1.13.2 Stakeholder Assessments

A recent review of air quality management in the EU by the Stakeholder Expert Group (ECORYS, 2013) identified the following key issues:

- **Transport / vehicle emissions**. Implementation of EURO 6/VI and discussions in CARS21 (Competitive Automotive Regulatory System for the 21st Century). The Stakeholder Expert Group underlined the importance of an ambitious implementation of EURO 6/VI for the solution of current air quality and emission problems regarding NO_2/NOx.
- **Air quality problems in urban areas (critical areas)**. An urban approach is necessary for developing an action plan and an urban forum. As regards support at the EU level, Member States could make better use of EU structural funds, and the EU cities pilot project[cxix] could serve as a good basis for future initiatives such as an EU urban air quality action plan.
- **Shipping emissions**. Actions/legislation are needed on reduction measures of sulphur emissions and particulate matter from shipping to protect human health and ecosystems.
- **Climate and air linkages**. . According to presentations of the EU Commission (CLIMA A.4 and JRC) during the first meeting of the Expert Group Review, "Implementing measures to significantly reduce greenhouse gas emissions will have significant co-benefits for air quality since it will reduce NOx and PM emissions significantly. This can lead to air quality cost savings and health benefits in the order of €27 billion in 2030 and €88 billion in 2050 […] Further integration of both policies (emissions of air pollutants and GHG) would allow

[cxix] Air implementation Pilot - Lessons learnt from the implementation of air quality at urban level, EEA, 2013

harvesting the win-win potential if reductions in specific sectors or through specific measures are designed to optimise their beneficial effects for air quality and "saving the Arctic" without compromising on the objective for the global climate. E.g. ozone reduction measures, especially through CH4, are an absolute no-regret policy for air pollution and climate. Furthermore, known climate friendly PM measures (wood pellets, diesel particulate filter, coal brickets) constitute 10-20% of PM reduction potential. Also reducing emissions of air pollutants will have a fast impact on global mean temperature."

The Air Implementation Pilot - Lessons Learnt from the Implementation of Air Quality at Urban Level, was published in 2013 by the European Environmental Agency (EEA).[cxx] Considerable progress has been made in the past twenty years in improving urban air quality (see Figure 10), but issues remain. The Air Implementation Pilot's objective was to help to identify and address the reasons underlying this 'gap' in implementation of air quality policy in 12 European cities (which can be considered as NAAs), and thereby draws lessons of wider relevance. 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 main conclusions of this assessment project are summarised below.

On local emission inventories:

- There is hardly any information exchange between European cities concerning the methodology used to compile emission inventories;
- Obtaining representative emission factors (coefficients that quantify the emissions or removals per unit activity and, together with the activity data, allow to estimate the emissions of an activity) is a common problem;
- Another problem commonly voiced by the cities concerns the quality and availability of input activity data (for instance, traffic data, especially for heavy-duty vehicles or local energy data).

On modelling activities:

- There are difficulties associated with the input data:
  - Cities had difficulties with: estimating background concentrations and contributions of transport from upwind countries, estimating emissions uncertainties in various source sectors, and dealing with the lack of data on fugitive emissions;
  - There is a general lack of good quality meteorological data in urban areas.
- There are technical difficulties, such as how to account for the specificities of urban topography (hot spots, biases at kerbside), and specific model processes (coupling, sub-grid scale processes);
- There are overestimations or underestimations in the results between various models;
- The computational time is long and consumes lots of resources;
- The complexity of the results, and the work required to validate them makes them difficult to interpret.

[cxx] http://www.eea.europa.eu/publications/air-implementation-pilot-2013

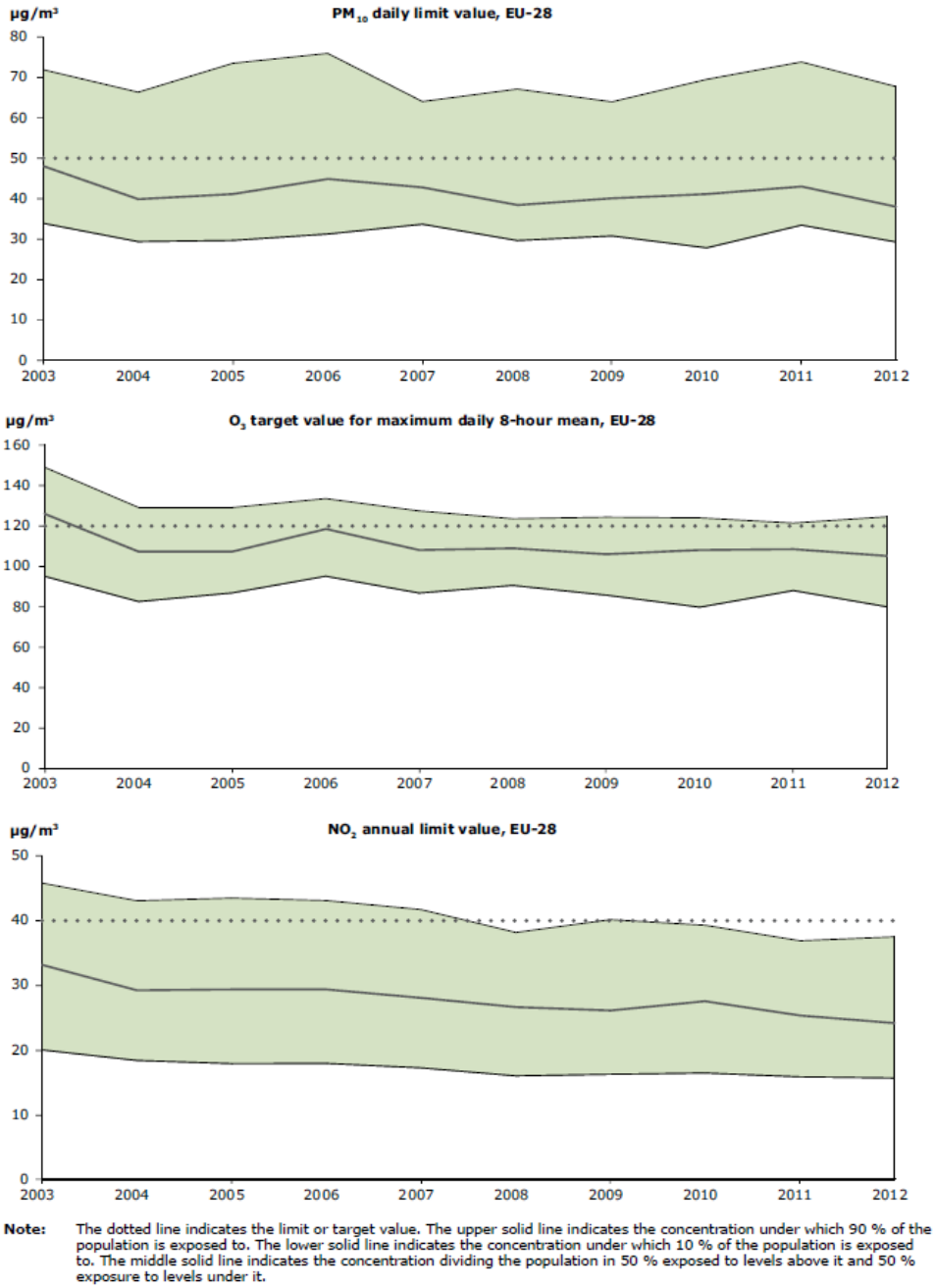


Figure 10 Development of population-weighted concentrations in urban agglomerations in the EU-28 for PM_{10}, O_3 and NO_2, for 2003-2012 period (EEA Air quality report, 2014).

On monitoring networks:

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).

On management practices, various challenges were identified:

- In estimating the effects of measures: before the implementation of the measures, the most commonly used tools to forecast their effects were emissions analysis, air quality modelling, and impact studies. After implementation, the most frequently used tools were measurements from the monitoring networks; estimations of the changes in emissions; the use of indicators; and estimations of the changes in fleet composition. The problem of estimating effects seems less difficult in the post-implementation phase than the pre-implementation phase, as several robust assessment methods are available.
- Cost and benefit estimation seems to be the most complex issue, according to feedback from the city experts. The difficulty is that investment in measures should not be seen only from the perspective of pollutant mass reductions, but instead more overall approaches should be taken (considering the economic, social, urban, and other effects of the measure). It also appears that the current economic situation is a clear limiting factor for the implementation of further air quality measures
- Implementation challenges were technological, cultural, legal, political, and economic. Chief among the legal challenges is the way that competences may be split between different levels (state/region/municipality). Political realities also constitute a challenge in the sense that air quality does not always rank very high on political agendas. Other challenges raised by the cities included a lack of human resources and funding in the context of the current economic situation.

On information to the public:

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. The presence of air quality issues in the media could be enhanced by presenting in the media the results of the reports already produced by cities, and the results of reliable and credible forecasting systems to inform the public about current and expected pollutant concentration levels. The use of smartphone applications and social media websites appear to be one of the most cost-effective ways of reaching a large share of the population.

The adoption of a common system of indicators, with comparable indices and colour codes would make information more comparable and more understandable at the European level.

4.1.13.3 Recommendations

As mentioned above, the "Review of Provisions for air Quality Measurement, Air Quality Modelling, Management Framework, Assessment, and Public Information; and Stakeholder Consultation Support" published in June 2013 by ECORYS (ECORYS, 2013) compiled the Stakeholder EG Recommendations after their Air Quality Directive survey for the revision of the current Air Quality Legislation. Some of these recommendations are presented in the following bullets:

- Standardise compliance projections;
  - In air quality plans, projections of future air quality levels need to be made in order to see whether the plans are adequate to meet the air quality standard. Member States have widely varying approaches to this, and the credibility of the projections is not always clear, leading to an uneven playing field. Member States are also very different in their capabilities to make projections. There are several possibilities for harmonising the compliance projections.
- Do not relate air quality plans to zones;
  There is no good reason for relating air quality plans to zones (Art. 23.1 of the AQD), which are very diverse in size and population. Although this does not seem to be a major problem for Member States, a change could be considered. Relevant sources may be located outside the zone where the exceedance takes place. The administrative linkage between air quality plans and zones are useful to facilitate management of the exceedance, however the lack of conjunction between zones and agglomerations and sub-national administrative boundaries (e.g. local authorities) makes it difficult to join up national and local management plans. For this reason it may be preferable to allow the link between air quality plans and zones to be broken but to retain flexibility for Member States.
- Reduce assessment / reporting for standards that are largely met;
- Clarify the definition of the "risk of exceedance" which triggers the requirement for a short-term action plan;
- Reduce the administrative burden regarding the development of short-term action plans;
  - The development of such plans is associated with an administrative burden and the effectiveness of the plans is questionable in some cases.
- Promote the assessment of synergetic measures in air quality plans and promote the consideration of conflicts with other policies in the development of air quality measures;
- Promote development of integrated national or regional air quality strategies or plans by Member States;
- Provide more guidance on air quality monitoring station siting and monitoring network design, give more detailed station siting requirements for hotspots, and require Member States to report on how their air quality monitoring network was designed and established;
- Require that the public is informed about exceedances of Limit Values as soon as they occur;
- Harmonise air quality indices in the EU & Develop a Common Air Quality Index.

4.2 France

4.2.1 Air Quality Legislation

Air quality management in France is based on French law as laid out in the 96-1236 legislation on air and the rational use of energy (LAURE) published in December 30, 1996 and codified in the Code of Environment. The legislative provisions and regulations related to air quality appear in articles L220-1 to L228-3 and R221-1 to D228-1. In addition, the French regulation 2015-992 dedicated to the energy transition for a green growth (LTECV) provides provisions such as reduction of GHG emissions by aircrafts (10% in 2020 and 20% in 2025 from the reference year 2010) civil aviation (article 45), limited road traffic areas (articles 48-49), bicycle allowance (article 560) mobility (article 51), and a national atmospheric pollutant emissions reduction plan (PREPA).

4.2.2 Ambient Standards

As described in Section 1.1, the Environmental European legislations provide standards for some pollutants from several works and in particular those led by WHO (World Health Organization). Within a context of threshold exceedance, Member States are required to implement actions in order to comply with standards as quickly as possible. Limit and target values for a number of air pollutants have been set in the Directive 2008/50/EC (see Appendix 1).

4.2.3 Planning Areas

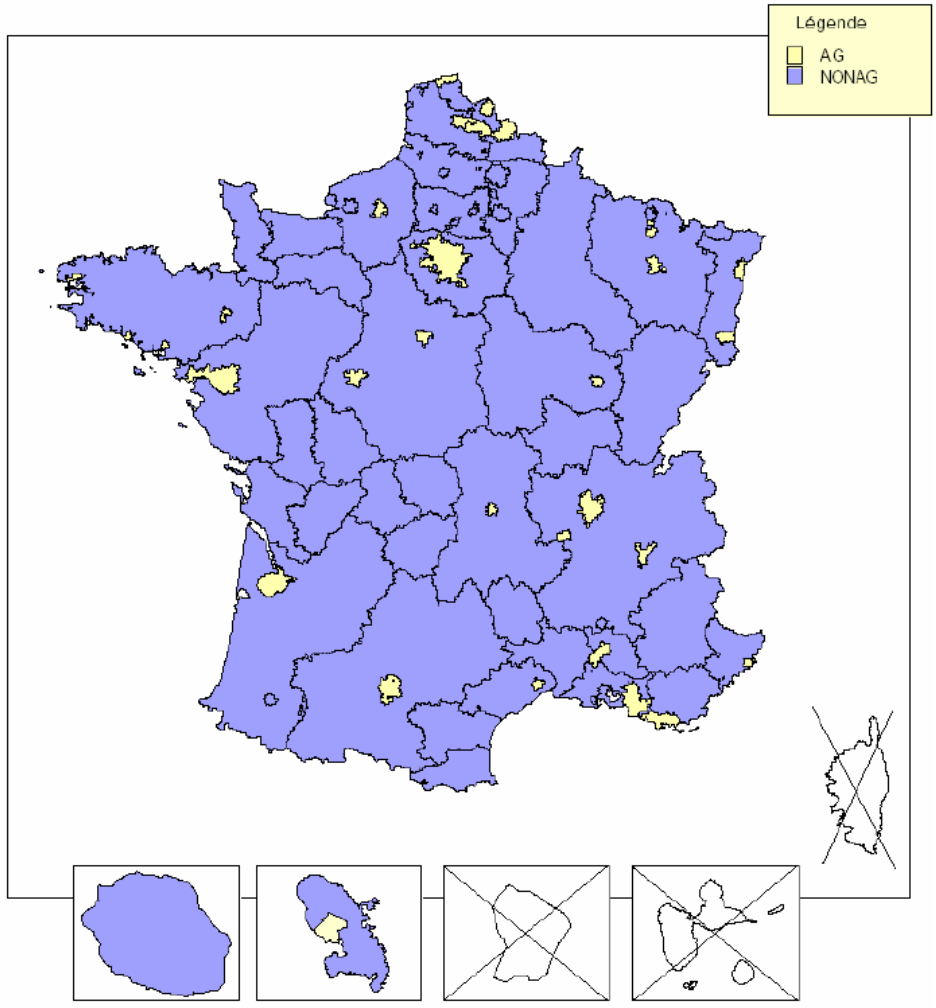
The determination of “zones and agglomerations” in France follows the EU directive 2008/50/EC. A list of these areas is published and regularly updated (see http://www.lcsqa.org/dispositif/zonages). As of early 2015, 36 zones (including areas with exceedances of AQ Limit Values (LV) and agglomerations greater than 250,000 inhabitants) covering 47% of the French population were required to develop a Protection Plan of Atmosphere (PPA). The procedure for developing PPAs is provided in the Code of Environment (articles L222-4 to L222-7 and R222-13 to R222 36). The PPA defines objectives and measures required by the legislation or public/stakeholders in order to lower the concentration of pollutants to a level below the thresholds set at European or French levels in areas where exceedances exist or could be possible. Regarding one of these pollutants, PM_{10}, several agglomerations are currently not compliant with standards (15 areas since 2005). Among those, 11 zones (Marseille, Toulon, Paris, Douai-Béthune-Valencienne, Lille, Grenoble, Lyon, la Zone Urbaine Régionale de Rhône-Alpes, Nice, la Zone Urbaine Régionale de PACA and Martinique) are now subject to a litigation procedure. The main PM_{10} sources in the French cities are residential heating (wood combustion), road traffic (almost 70 % of the fleet is composed by diesel cars in France), industry and more distant sources such as agricultural activities (generating secondary PM), Saharan dust, and polluted plumes from east of EU.

The objectives and measures in the PPA are defined for each zone, depending on the local sources and the local context. For example, the PPA of Marseille urban area in South of France includes 37 actions:

- 23 for the transportation sector (including speed limitations for cars, improvement of the traffic management, increasing of the modal report, reduction of the airport and ports emissions, etc.)
- 8 for the Industrial sector, corresponding mainly to emissions reduction for PM, NOx, VOC and PAH. Measures include more control by the local authorities and the anticipate transposition of EU directives (e.g. for medium size combustion plants).
- 5 for the residential / agricultural sector (use of more efficient heating devices, prohibition of wood burning, etc.)
- 1 transversal measure.

20 of these measures are mandatory, 15 are volunteers and incentives, and 2 are support actions (e.g. information/sensitization of the population).

French Air Quality areas are shown in Figure 11. Two nomenclatures are generally used: AG for agglomerations, i.e. zones with a population of at least 250,000 inhabitants; and NONAG (Non Agglomeration), limited by administrative boundaries (region and county).



Note: An indication of the names of the zones shown in the map is not yet available.

Figure 11 French Air Quality areas (insert maps represent Caribbean French Islands).

The 36 French PPAs are shown in Figure 12. There are 28 validated PPAs (in purple), one PPA under revision, and seven are in the process of being drawn up.

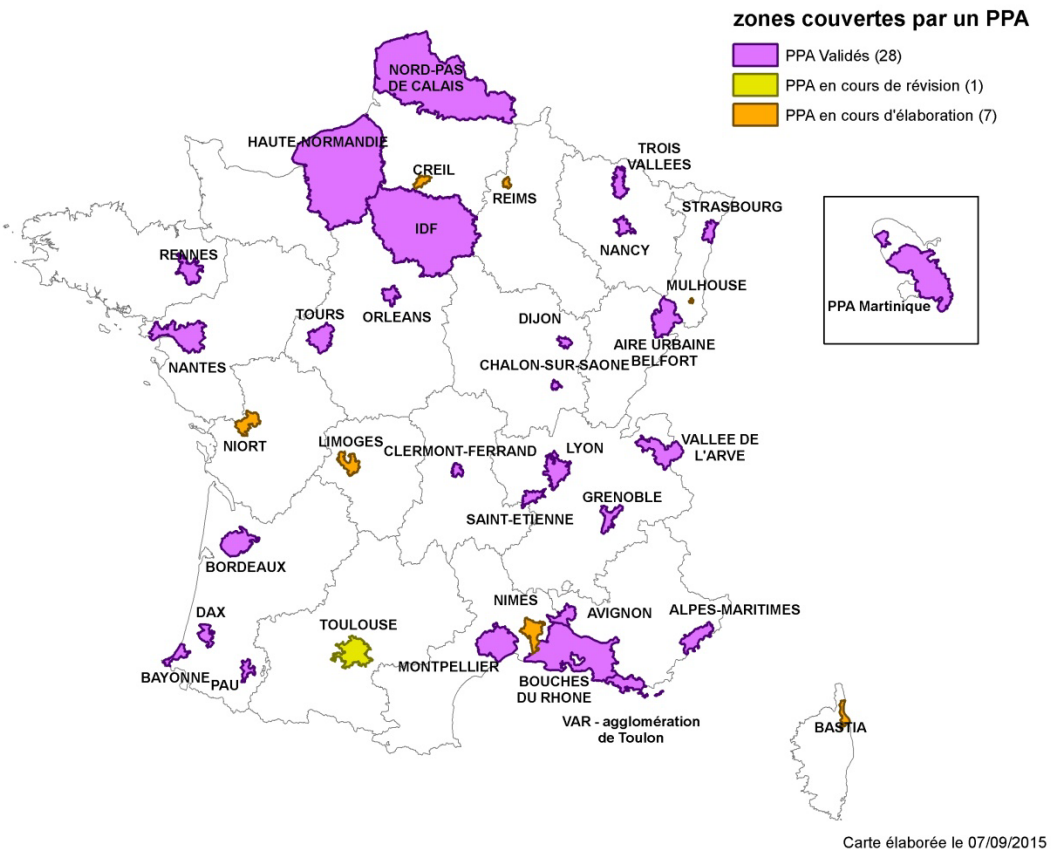


Figure 12 Map of the 36 French PPAs (last update: 7th September 2015).

In addition, other areas can be subject to (non-permanent) emergency measures (short term action plans). Information and alert thresholds are defined in order to trigger sanitary recommendation broadcasting (Decision of August 20, 2014) and short-term regulatory measures to reduce emissions or population exposure during pollution peaks. A pollution episode is characterized:

- By surface criteria, i.e. a surface greater than 100 km2 with an exceedance (determined by a background modelling) of ozone, NO_2 and/or PM_{10} limit values, which are the pollutants of most concern in France;
- Or by population criteria:
  - In counties with less than 500,000 inhabitants: at least 50,000 inhabitants must be impacted by an exceedance of ozone, nitrogen dioxide and/or PM_{10} with modelling background estimation

    - In counties with more than 500,000 inhabitants: at least 10% of the population must be impacted by an exceedance of ozone, nitrogen dioxide and/or PM_{10} with modelling background estimation
- Or by considering local situation (incised valleys, road traffic proximity, etc.).

4.2.3.1 Area Planning Requirements

Various regulatory and planning actions are implemented at different levels in France. At the national level, all sectors of activity are concerned by the energy transition regulation (LPTE-CV), the emission ceilings and the national Air Quality action plans. At the local level, each PPA focuses on the primary local sources in order to reduce pollution background and provide efficient short-term actions during pollution episodes.

4.2.3.1.1 National Scale

According to European requirements, France must respect national emissions ceiling and ambient air LV for pollutants. For many years now, source pollution regulations within various sectors have been available which include public policy tools used to reduce pollution. In this context, main State actions can be summarized as follows:

- Energy transition
    - Promotion of low pollutant vehicles;
    - Possibility for mayors to implement restricted road traffic areas;
    - Economic incentives to replace high pollutant vehicles;
    - Reinforcement of AQ territorial planning tools;
    - Development of the mobility plan;
    - Implementation of mandatory action plans.
- Particle plans:
    - Reduction of 30% of $PM_{2.5}$ by 2030 for various sectors such as industry, services, domestic heating, agriculture;
    - Improvement of data on particle characteristics and sources.
- AQ action plans (PUQA):
    - Encourage the development of “green” transport and mobility measures through economic incentives;
    - Regulate vehicles flows within high pollution areas;
    - Provide tax incentives for most AQ deserving vehicles or transport solutions;
    - Raise awareness and promote communication actions to change behaviours.
- Emergency measures decree in case of pollution peak (short term action plans)
    - Management of air pollution peaks
    - Creation of a list including recommendations and measures to reduce emission in various sectors such as agriculture, industry, etc.
- PREPA (Pollutant emission reduction plans). The main objective is to reduce emissions from major licensed sources based on PPA and SRCEA measures in order to be compliant with national emission ceiling and background pollution reduction. The PREPA will be published by decree by June 30, 2016 as provided for by article 64 in the

TECV regulation. This plan will take into account social and economic issues, implementation delays and linkages with existing public policies. The PREPA will include concrete actions within all sectors of activity to ensure compliance with emission reduction objectives for major pollutants (gas and particles) as mentioned in the NEC directive (see EU jurisdiction) and other Air quality objectives such as concentration limits (Directive 2008/50/EC) by 2020 and beyond. It will include measures at various levels of importance depending on their efficiency to reduce pollutants emission, their cost-benefit ratio and their feasibility. These measures will be selected based on ex-ante and multi-criteria analysis. This PREPA will replace previous action plans.

- European litigation

All of regulations and decrees regarding air quality are available here:
http://www.developpement-durable.gouv.fr/Surveillance-de-la-qualite-de-l,40976.html

Moreover, French air quality regulation has gradually strengthened over the years. This includes technical prescriptions for combustion plants, taxation of new pollutants within the general tax on pollutants activity (TGAP), revision of income tax provisions concerning company vehicles, conditions of certification for heavy vehicles retrofit systems, vehicles classification, and establishment of local authorities' new competences for local air quality management.

4.2.3.1.2 Regional Scale (Integrated Approach):

Climate Air Energy regional schemes (SRCAE) are drawn up by both the regional prefect and the president of the regional council. SRCAEs constitute the framework for local and regional authority actions in terms of GHG emission reductions, development of renewable energy sources and Air Quality improvement (Decree n°2011-678 of 16 June 2011). SRCAE can act on land use and spatial local planning policies such as urbanism and mobility. Up until now all of SRCAE have been adopted.

4.2.3.1.3 Local scale (PPA)

At the local scale, the PPA is required to be implemented in case of a violation of the ambient standard(s) and for agglomerations with more than 250,000 inhabitants as described above. These plans are based on the following elements:

- The establishment of a conversation with public and stakeholders;
- The assessment of measures already implemented regarding identified emissions sources;
- An exhaustive list of major emitters constraining by their current and expected level of emissions;
- A good knowledge of the current air quality and its predictable evolution within concerned areas;
- A regular review of the PPA through national and local indicators.

Each PPA must include:

- Information needed to inventory and evaluation of the air quality within area considered;

- List main preventive and corrective measures (temporary and permanent) in order to reduce emissions from mobile and stationary sources of atmospheric pollutants, use resources efficiently and meet national legislation objectives. Temporary measures can be the decrease of the speed limits on the main roads during pollution events. Permanent measures can be the development of more efficient public transport in a part of the area;
- Lay down sustainable permanent applications and emergency measures to reduce in a chronical way atmospheric pollutions;
- Lay down arrangements of alert initiation procedures.

Each PPA is independent from the other because the major sources can be different in each zone. Each PPA is drawn up by the regional prefect in consultation with local authorities and stakeholders and under the direction of the French state. The PPA must be compatible with French AQ legislation (LAURE Decision) and SRCAE regional plan (Integrated plan Climate / Air / Energy) and must set out appropriate measures so that any exceedance period can be kept as short as possible. The air quality plans additionally include specific measures aiming at the protection of sensitive population groups, including children.

Measures implemented in PPA areas concern all emission sectors: transport, industries, agriculture, residential. These measures shall be validated by national, local authorities and stakeholders. The prefect shall consider two types of measures:

- Policy measures within a context of pre-existing administrative policies:
  - Measures under the Classified facility directive (ICPE);
  - Measures under the general administrative policy (public health, traffic circulation, etc.).
- Measures under the administrative policy dedicated to PPA (articles R222-33 to R222-35 of the Code of Environment), in particular:
  - Specific measures for combustion installations;
  - Specific measures for vehicles inspection program.

Implementation of PPAs is subject to an annual report and a five-year evaluation. The prefect can address a revision of the PPAs after this evaluation. Before validation by prefectural decision, each PPA shall be submitted to several steps:

- Consolidation phase (i.e., checking that actions are compliant with the legal framework) by the DREAL/DRIEE (regional environment, planning and housing agency) in concertation with local authorities and stakeholders;
- Validation phase by County council for Environmental, health and technological risks;
- Consultation phase of stakeholders and public (3 months);
- Public survey (one to two months), which is an administrative procedure allowing to get the opinion of the local population concerning the plan. A summary of this opinion is prepared by a commissioner and sent to the authorities. An argumentation is required if the regional prefect finally decides to go against the public advice.

4.2.3.2 Area Plan Contents

This section provides a summary of the air quality action plan for the Paris region within the Ile de France PPA[cxxi]. Planning in this region has focussed on addressing traffic-related pollution for three main pollutants: NO_2, PM_{10} and $PM_{2.5}$. A total of 1.8 million people in the region are exposed to these high pollutant concentrations. Paris has implemented measures to achieve compliance with the exceedances of the limit value for NO_2 and PM_{10}. Most of the measures are taken at local administrative level, although for PM_{10} some measures involve both local and regional administrative levels. "Technical" measures represent 69% and 56% for NO_2 and PM_{10}, respectively, while "educational" measures are the second largest group. The major part of the measures addresses traffic sources, and affects the conurbation and regional area. Most of the measures are expected to achieve concentration reductions in the medium term.

The evaluation of the measures and their classification in groups indicates that in Paris, most of the measures can be classified as related to traffic, including technological and infrastructure measures such as, for instance, increasing the supply of transport or the harmonization of delivery of goods, and limiting traffic emissions such as, for instance, limitation of traffic speed to 20 km/h during peak pollution events.

Most of the measures have been implemented to reach compliance with limit values for both pollutants, NO_2 and PM_{10}, except for the measures involving agriculture, which exclusively seek to reduce PM_{10} concentrations in the atmosphere. An example of these agricultural measures is the limitation of the exceptions to the prohibition of open burning of green waste. Another measure exclusively dedicated to improve PM_{10} levels in the city is the ban on wood burning in Paris.

Major conclusions in the previous Paris region PPA (2005-2010) were the following:

- Retrofit systems on passenger cars are not sufficient;
- Conditions on road traffic restriction and triggering alert threshold for ozone pollution peak have to be updated;
- Improvement of highest pollutant vehicles is needed;
- Controls on two-wheeled vehicles (smoke and noise) enforced by the police were correctly applied;
- Success was achieved with respect to measures dedicated to the reduction of emissions from aircraft ground operations (limitations on the use of the Auxiliary Power Units);
- NOx waste combustion emissions reduction was successfully implemented.

[cxxi] Air Implementation Pilot, Lessons learnt from the implementation of air quality legislation at urban level, EEA 2013.

4.2.4 Regulation of Emissions from Industrial Facilities

4.2.4.1 IED context

France is subject to the European directive concerning the Emission of Industrial activities (IED). The general transposition of the IED into national law was previously done and introduced into the code of the Environment (Section 8 in Title V of Chapter I of Book V). Consequently, BAT and BREFs conclusions must be applied across the French territory. Concretely, when the BAT conclusions are published (sector by sector), concerned facilities have generally one year to provide a cost/benefit analysis (and if necessary ask for a derogation to the local authorities), and between 3 and 5 years for complying with the comply with the BAT AEL (Associated Emission Levels).

4.2.4.2 Permitting process

As defined at national level, any industrial or agricultural operation likely to generate risks or cause pollution or nuisance is a Classified Installation (Facility) for the Protection of Environment (ICPE). Activities under the classified facilities legislation are listed in a nomenclature imposing a permit or declaration system, depending on the significance of the risks or inconvenience that may be caused. The legislation of classified facilities provides the State with the following powers:

- allow or refuse the operation of a facility;
- enforce certain technical requirements;
- Evaluation / Monitoring of the emissions;
- Sanction.

In case of a new industrial facility / activity or significant modification of the activities, the operator shall report:

- A new activity within the scope of the nomenclature of classified installations ;
- An increase in storage or production volumes ;
- The transfer of a production line or storage area within the facility (likely to result in a change in noise level, change in risk areas…);
- A change in storage conditions (for example, accident scenarios can be modified by switching from underground to overhead storage conditions) ;
- An extension of operating periods (likely to affect noise, traffic, exposure time…)
- A change in raw materials or processes making it necessary to review associated risks ;

In this case, the installation shall renew environmental permit and declaration procedure. Note that there is no expiry date for permits.

Throughout the lifecycle of the facility, the operator can implement changes in their activity and provide sufficient information according to the level of installation change:

- Non-significant changes[cxxii]: the operator must simply notify the inspectorate.
- Significant changes, resulting in no significant hazards or inconvenience: the operator is required to notify the Inspectorate of classified facilities. These changes must be presented to the CODERST (Council Department of the Environment and Health and Technology Risks). Additional requirements are defined to take these changes into account.
- Significant changes likely to result in significant hazards and annoyances: a permit application shall be made according to the code of environment. In this last case, HRA and IEM can be required according to the 1.10.5 section above.

Within NAAs (or PPA areas), local authorities can ask to the operator to provide an action plan including:

- A Cost/Benefit analysis of technical solutions allowing reduction of the emissions.
- On this basis, a description of the technical approaches implemented to reduce the emissions and comply with regulatory thresholds (e.g. derived from BAT conclusions).
- A time-schedule for the implementation of the control measures and the compliance with emission thresholds.
- A detailed monitoring program of the emissions.

An environmental impact assessment (through an Impact Study) is required for new facilities requiring an environmental permit and for existing facilities which are not compliant with IED requirements. The Impact Study must present an analysis of the direct and indirect, temporary and permanent effects of the activities on health and the environment, and the measures considered by the applicant to eliminate, limit and if possible compensate for the nuisance of the installation as well as an estimate of associated expenses. It must include a health risk assessment (HRA, or ERS in French) which focuses on the description and quantification of health risks due to local population's exposure to pollution. Moreover, since the August, 9, 2013, an integrated approach is required by the authorities, so the health risk assessment must be associated with an Environmental Condition Assessment (Interpretation de l'Etat des Milieux, IEM), including all media (air, water, soils). This IEM shall be based on measurements in the environment and integrate the background and potential cumulative pollution, in order to determine:

- If past and current emissions (for existing facilities) contribute to an environmental degradation;
- If the actual degradation is compatible with the uses of the environment (typically by local population: housing, local production of vegetables, etc.), including current and future industrial activities. If this is not the case, suitable actions must be undertaken by the operator, based on more efficient control technology or alternative process.

Within the HRA, two risk indicators are used and compared to references (i.e. ratio to reference concentrations or toxicological values): Risk index (RI) for threshold effects and Excess of

[cxxii] Significance is determined by local authorities and is generally considered to be an increase of less than 10% of the emissions of a facility without any vulnerability in the environment.

Individual Risk (EIR) for non-threshold effects (i.e. carcinogenic effects). All the media are considered, generally Air, soils and vegetables for atmospheric emissions.

Through the coupled IEM study a matrix is used in order to assess the impact of the industrial activity on local population and provide additional measures in case of vulnerability (Table 3).

Table 8. IEM results interpretation.

Comparison to Standards	Range in the risk management	Interpretation
$C < C_{reference}$	RI: < 0.2 EIR: $< 10^{-6}$	The state of media is compatible with industrial activities
$C < C_{reference}$ (with potential future update)	IR: between 0.2 and 5 EIR : between 10^{-6} and 10^{-5}	Environment is vulnerable. Areas of uncertainties which need a more careful consideration
$C > C_{reference}$	IR: > 5 EIR: $>10^{-4}$	Industrial activities are not compliant with environment

Local authorities generally require the applicant to prepare a cost/benefit analysis when control measures are required and to evaluate the feasibility of these measures. A quantitative impact assessment (using dispersion modeling) is required for IED facilities.

As indicated in the French legislation (Code of Environment), a cumulative Impact assessment for a specific project with others known projects which:

- were subject to an environmental permit authorization and a public survey; and
- were subject to an impact assessment study including the public conclusion of the administrative authority;

shall be considered in order to assess potential health effect on exposed population. Cumulative impact in term of multi-pollutant from one installation must be considered as well. For the cumulative impact assessment, a modelling approach can be used incorporating all sources and baseline datasets.

Fugitive emissions from large industrial complexes must be compliant with the emissions limit decided by prefectural decision (within or not the PPA).[cxxiii] In case of noncompliance, the operator is required to take low-cost to moderate reductions measures such as retighten flange connections. If the cost of reducing the emissions is too high, the operator can choose to reduce other pollution sources to be compliant with local decisions.

4.2.4.3 PPA areas

There are no specific requirements concerning the permitting process and IED transposition in PPA areas. However, the application of the BAT AEL (emission limit values based on BAT) can be anticipated and considered as a specific action in the PPA, i.e. comply as soon as possible

[cxxiii] No specific methods are required for determining fugitive emissions. Fugitive VOC emissions are generally calculated from an annual mass balance.

with the BAT conclusions for existing facilities - and directly comply for new facilities.

More generally, PPA can require more stringent emission limit values for specific sectors and/or require that operators provide specific cost/benefit analyses to reach this objective. For example, in the previous version of the PPA (2005-2010) for Paris region, main waste incinerators were required to limit their NOx emissions to 80 mg/Nm^3.

4.2.5 Area and Mobile Source Programs

The French State has mainly transposed the European directive to reduce atmospheric pollutant emissions, in particular for inspection and maintenance programs, best practices, new engines, etc. and included this transposition in regional (SRCEA) and national (PREPA) plans.

Vehicles are issued an Air Quality Certificate which identifies the vehicle's emissions classification with respect to age, fuel use, and other factors. These certificates are used in a variety of programs to promote the use of lower emitting vehicles in place of higher emitting vehicles. Incentive funding is provided for retirement and retrofitting of older diesel vehicles. Programs are also in place to restrict vehicle use during high pollution episodes. Other programs are designed to promote the use of alternative modes of transportation.

Emissions from agricultural activities have also been targeted in France, including improvements to methods of applying fertilizer and pesticides to limit PM, VOC and NH3 emissions, use of low technology coverings for slurry storage, and limitations on open burning (burning of green waste is generally prohibited).

Each PPA includes specific measures for the reduction of pollution which are strongly dependent on existing industrial activities, density of population and transport. Some of these measures are applied in case of exceedance or potential health risk. However several key measures are usually implemented:

- Permanent reductions of vehicle speed on motorways where feasible;
- Limitation of old vehicles circulation[cxxiv];
- Definition of Low emission zones;
- Reduction to the minimum necessary of the use of Auxiliary Power Unit by aircrafts;
- Forest fire and slash-and-burn farming bans.

In addition to these measures, the urban travel plans (PDU) relate to conurbations of more than 100,000 inhabitants and aim at reducing motor vehicle traffic by optimizing transport organization within these conurbations. This is one of the planning tools designed to reduce the level and effects of air pollution on health and environment instituted by the law on air and the rational use of energy dated December 30, 1996. It is established and implemented by the competent authorities in terms of transport. Each urban travel plan:

[cxxiv] Currently done via incentives for replacing old vehicles but could in the future limit areas where older vehicles would be allowed to operate.

- Defines the organizational principles for the transport of people and goods, traffic and parking, within the scope of urban transport,
- Aims at ensuring sustainable balance between mobility and access requirements on one hand and the protection of health and the environment on the other,
- Should enable the coordinated use of all modes of travel by promoting those that are the least polluting and energy consuming,
- Specifies the measures to be implemented in terms of management and operation, and aims at limiting the use of cars.

4.2.6 Voluntary, Incentive, and Market-Based Measures

There are two forms of public financial support in favour of the environment and energy savings, largely related to investment:

1. Direct project aids: subsidies and refundable advances, depending on the amount of the investment. These subsidies are not automatic and are allocated by decision-making bodies following examination of an application presenting the project, evaluating its relevance with regards to the policies and priorities supported and budgets available. The main financial support concerning Air and odours prevention are provided by:
   - the French Environment and Energy Management Agency (ADEME), in the fields of air pollution, energy (renewable energy sources, energy savings), environmental management, contaminated sites and soil, waste, clean transport,
   - the water agencies, for the prevention and treatment of water pollution (reduction at source, treatment equipment, reduction in water intake etc.),
   - the regional councils, according to the policies defined by each regional council. These policies are often formalised in a contract with the State and ADEME or ADEME and the Regional Council,
   - European structural funds, managed by regional prefectures, with a policy defined in each region. Depending on the themes and organisation selected in each region, the applications are examined by ADEME and/or State services (DREAL).

2. Tax incentives, in the form of exemptions, tax credits and tax relief, or accelerated tax write-off (to accelerate investment write-off deduction from the taxable result and therefore reduce the profit tax paid at the time of the investment). Tax incentives are provided for:
   - Certified energy savings or air quality control equipment
   - Adjustment of motor vehicle tax (according to CO_2 emissions per km);
   - Total or partial exemption of the tax on vehicle registration for LPG, NGV and electric vehicles;
   - Exceptional write-off for these vehicles and associated equipment (compressors, accumulators etc.);
   - Greater local business tax relief for heavy goods vehicles compliant with certain environmental standards.

A negative economic incentive is implemented in France via the General Tax on Polluting Activities (TGAP). This tax is applicable to any operator of an industrial or commercial facility or public institution of industrial and commercial nature for which certain facilities require a permit. According to the principle "Polluter pays", this tax concerns operations considered as polluting. The amount of tax depends on the activity and products. The tax calculation is different according to the industrial sector and includes generally several parts. For example the tax due by a waste treatment facility can depend on the total emission, but also on the waste amount treated during a year. The taxable event is the operation during a calendar year of an installation whose nature or volume represents specific risks to the environment. The TGAP is payable as of 1st January each year, or subsequent to the start-up of the facility, or sometimes the start-up of a new activity. In any case, the tax is payable for the entire year. It is payable by the individual or corporation operating the facility as of the due date. In the case of a facility closure or if a change in a facility is likely to modify its situation with respect to the TGAP, the operator must declare this event to the local Prefect within one month.

The TGAP was set at 743 M€ for the period 2009-2012) and was modified in 2013 to reduce substantially atmospheric PM concentrations. Consequently, taxation rates were increased for dust, sulphur oxides and NMVOCs. In addition, emission thresholds above which industrials are accountable decreased tenfold.

Moreover, there are tax incentives in favor of air pollution control:

- tax credits for certified energy savings or air quality control equipment;
- Adjustment of motor vehicle tax (according to CO_2 emissions per km);
- Total or partial exemption of the tax on vehicle registration for LPG, NGV and electric vehicles;
- Exceptional write-off for these vehicles and associated equipment (compressors, accumulators etc.);
- Greater local business tax relief for heavy goods vehicles compliant with certain environmental standards.

4.2.7 Tools

In French legislation, there is no list of required modelling tools. For Impact assessment, modelling approaches are generally required and ADMS or AERMOD (Gaussian models) are commonly used. Regional AQ agencies (AASQA) usually implement regional models as a support for PPAs drawn up such as CHIMERE and CAMx that are able to apportion source pollutions. PREV'AIR is the national platform for air quality forecasting and management. This platform is developed by the INERIS institute, Météo France, CNRS and LCSQA (Air quality monitoring central laboratory).

In addition to regional models, regional AQ agencies apportion sources pollution using their monitoring network and receptors models such as CMB (chemical Mass Balance) and PMF (Positive matrix Factorization).

4.2.8 Reporting, Status, and Enforcement

4.2.8.1 Reporting

A classified facility, either one holding a permit or one that is only required to register with the government under the declaration regime, can be inspected. The objective is to check the regulatory compliance of the installation in order to protect the interests noted in the Code of Environment. Classified facilities inspectors (DREAL) carry out these inspections.

When necessary, a laboratory (approved by the Ecology Ministry) can be contracted by the Inspectorate of classified facilities to carry out sampling and analyses of one or several specific elements of the installation. These analyses are paid for by the operator.

These inspections do not preclude the self-monitoring process, as the permit order for an installation can stipulate the permanent monitoring by the operator of their emissions and/or impact on the environment, i.e. self-monitoring. The results, with commentary on compliance with the limit values applicable to the installation, must be sent to the Inspectorate of classified installations.

According to 2008/50/EC and 2010/75/EC directives, the French State reports every year to the European commission the situation of exceedances over AQ zones, PPAs measures to reduce pollution and tools/methods dedicated to the attainment of European AQ objectives.

4.2.8.2 Status

A number of areas in France are in violation of EU ambient standards for PM_{10} and NO_2. Since 2005, PM_{10} standards are not met within 15 French areas. After an initial letter of formal notice of non-compliance in 2009, a reasoned opinion in 2010 and a decision of referral procedure from the Court of Justice of the European Union in 2011 without legal force, the European Commission sent France a complementary formal notice in February 2013 and extended the procedure. It is now alleged by the EU that France failed to comply with PM_{10} standards and with action plans required by the Air Quality Directive (AQD). PPAs and national plans such as the particle plan, PUQA and PREPA were implemented by France in response to EU requests and to improve air quality.

The EU LV for NO_2, which entered into force in 2010 (2008/50/EC directive), is regularly exceeded in more than 25 agglomerations. France failed to comply with its NEC for NOx (as specified in the 2001/81/EC directive) in 2010. This exceedance is mainly due to modifications in the methodology used to calculate emission inventories.

Within areas with high levels of pollution, PPAs have resulted in substantial emission reductions leading to significant decrease in pollutant concentrations, especially for SO_2 and benzene which are emitted by identified and very controlled industrial facilities However, most of the PPAs have been strengthened and renewed recently, reflecting the fact that most of the air quality standards are still not being met, particularly for PM_{10} and NO_2 in large cities, due to difficulties

in achieving significant traffic reductions and in accelerating the introduction of cleaner vehicles (as noted above, almost 70% of the passenger cars in France have a diesel engine)

One of the most effective PPA implementations has been in the Arve Valley (a polluted valley between Leman Lake and Mont-Blanc Mountain). In this area many years of PM_{10} measurements have shown numerous exceedances due to wood-heating systems and open-burning of green waste. As an incentive, the Arve valley PPA includes the air-wood fund designed to reduce PM_{10} residential wood combustion emissions through use of high performance heater systems. In addition the Arve valley PPA bans open-burning of green waste.

4.2.8.3 Enforcement

The implementation of the actions defined in the PPAs (as well as short-term action plans) is under the responsibility of the local authorities (the prefect) who represent the French State locally (at regional level). The procedure provides that the implementation of PPAs is subject to an annual report and a five-year evaluation. The prefect can address a revision of the PPAs after this evaluation, namely if the AQ standards are not met.

A sanctioning regime is not enforced in France, but European Court of Justice may apply penalties to Member States in case of uncontrolled air quality limits exceedances. The European Commission can bring infringement cases where the Member State fails to ensure that the provisions of the directive are actually implemented in practice – for example, failing to ensure that limit values are complied with.

4.2.8.4 Public and Stakeholder Involvement

Public and stakeholder involvement processes are specific to each PPA. In general, the PPA, approved by prefectural decision, suggests the implementation of regulatory and voluntary measures defined and proposed in consultation with local stakeholders (authorities, general public, manufacturers and other stakeholders). Before approval each PPA proceeds through:

- The development by the DREAL according to the French Ministry of Ecology's directives in cooperation with public and stakeholders;
- The validation by the departmental council of environment and health and technological risks (CODERST);
- A consultation of all concerned local authorities (3 months);
- A public survey phase (1 to 2 months).

4.3 Italy

4.3.1 Air Quality Legislation

Italian air quality regulations are primarily based on requirements of the European Directive 2008/50/EC, prepared by the European Commission and Parliament, composed by members from all the Member States. The applicable EU directives have been transposed into Italian laws and regulations, including Decree 155/2010 which is the Italian transposition of Directive 2008/50/EC. Conditions for authorization of industrial facilities are specified in Legislative Decree n. 152/2006.

4.3.2 Ambient Standards

Italian Decree 155/2010 prescribes the same ambient standards as in Directive 2008/50/EC.

4.3.3 Planning Areas

Non-attainment areas (NAA) are defined in Italy along boundaries of municipalities affected by concentrations exceeding ambient standards for one or more pollutants. A single NAA may be composed of several grouped municipalities. The affected Municipalities are identified on the basis of monitoring or modelling activities. The EU framework of zones and agglomerations is also used in Italy. There are four administrative levels in Italy:

- The state and central government;
- The Regions and the autonomous provinces;
- The Provinces;
- The Municipalities.

Regions are almost fully delegated responsibility for Health and Environmental issues, under the coordination of the State. Each Region has to prepare the Air Quality Plan for its own territory.

4.3.3.1 Area Planning Requirements

Italian Regions must prepare an Air Quality Plan in compliance with Italian regulation (Decree 155/2010), in coordination with the Ministry. Regions must adopt the Air Quality Plan which provides measures in order to achieve the air quality targets and manage the main emission sources having an influence on such areas of exceedance. The Region is responsible to guarantee the consistency of the tools defined in the Air Quality Plan for different NAAS within the territory of jurisdiction. Air Quality Plans are formally approved by the Regional Parliament and then forwarded to Ministry of Environment and to the National Institute for Environmental Protection and Research (ISPRA).

Air Quality Plans and other Plans/Programs (National, Regional, Provincial and Municipal) are subjected to the Strategic Environmental Assessment (SEA). The stakeholders involved in the inquiry for SEA approval for each Plan/Program include public authorities in charge for the issuing of all other Plans: as a consequence, SEA inquiry can be considered a tool for the coordination and harmonization of the Plans.

According to Italian regulation (Decree 155/2010) Air Quality Plans are adopted in order to:

- Meet the limit values reported in the Decree 155/2010 (Italian transposition of Directive 2008/50/EC);
- Ensure a high level of protection for the environment and human health.

These results should be achieved through short-, medium-, and long- term actions, no better defined in the regulation at National level. Each Air Quality Plans identifies the timeline for short-, medium-, and long-term actions and relevant actions. Short-term actions are aimed at fixing situations that show the potential exceeding of the "Alarm limits" specified in Italian regulation D.Lgs. 155/2010 (which are the same as the limit values specified in EU Directive 2008/50/EU).

According to Italian regulation (Decree 155/2010 – Italian transposition of Directive 2008/50/EC), Air Quality Plans must include:

1. Localisation of excess pollution
   a) region;
   b) city (map);
   c) measuring station (map, geographical coordinates).

2. General information
   a) type of zone (city, industrial or rural area);
   b) estimate of the polluted area (km^2) and of the population exposed to the pollution;
   c) useful climatic data;
   d) relevant data on topography;
   e) information on the human and natural resources requiring protection from air quality impacts in the zone.

3. Responsible authorities
   a) Names and addresses of persons responsible for the development and implementation of improvement plans.

4. Nature and assessment of pollution
   a) concentrations observed over previous years (before the implementation of the improvement measures);
   b) concentrations measured since the beginning of the project;
   c) techniques used for the assessment

5. Origin of pollution
   a) list of the main emission sources responsible for pollution (map);
   b) total quantity of emissions from these sources (tonnes/year);
   c) information on pollution imported from other regions.

6. Analysis of the situation
   a) details of those factors responsible for the exceedance (e.g. transport, including cross-border transport, formation of secondary pollutants in the atmosphere);
   b) details of possible measures for the improvement of air quality.

7. Details of those measures or projects for improvement which existed prior to Decree 155/2010, i.e.:
   a) local, regional, national, international measures;
   b) observed effects of these measures.

8. Details of those measures or projects adopted with a view to reducing pollution following the entry into force of this Directive:
   a) list and description of all the measures set out in the project;
   b) timetable for implementation;
   c) estimate of the improvement of air quality planned and of the expected time required to achieve these objectives.

9. Details of the measures or projects planned or being researched for the long term.

10. List of the publications, documents, work, etc., used to supplement information required under this Annex.

Methods and procedures reported in air quality plan may include:

- measures in relation to motor-vehicle traffic;
- emission limit values, operating provisions and limitations, location criteria and other conditions for the authorization of industrial facilities listed in Part Five, Title I, of Legislative Decree n. 152/2006.
- emission limit values, provisions and location criteria for solid waste treatment plants (waste recovery and treatment plants, incinerators and landfills) that produce air emissions. Wastewater treatment plants are not included, since according to Italian regulation wastewater are not “waste”;
- emission limits and conditions for the use of fuels in stationary fuel combustion sources allowed by Legislative Decree n. 152/2006;
- provisions to prevent or limit the emissions that occur during the activities and agricultural practices related to crops, farms, spreading of fertilizer;
- limits and conditions for air emissions of ships at berth;
- specific actions aiming at the protection of sensitive population groups, including children, may also be considered in the framework of those plans.

Air Quality Plans should be updated by each Region within 18 months from the end of the year in which any new exceedances is registered. Air Quality Plans should be also updated in case of any variation of the zoning and of the monitoring network (Air Quality Plans divide regional territories into “zones” and “agglomerations” and also into Attainment Areas and Non-Attainment Areas).

Each Regional Air Quality Plan is independent of the others. However:

- the Air Quality Plans are developed under the coordination of the Ministry of Environment, that ensures a uniform application of the regulation in all Regions;
- the Air Quality Plans must be consistent with requirements reported in Plans and Programs for the reduction of emissions of GHG gases and different regional Plans (i.e. energy plans, plans of traffic and transportation; etc.), prepared by different Authorities (art. 9 number 11 D.Lgs.155/2010). The difficulty of coordination of different Plans is a point of weakness of the Italian system.
- The Regions of Northern Italy signed an agreement for a joint approach for the management of the air quality. In addition to the six involved Regions (Emilia Romagna, Lombardia, Piemonte, Veneto, Valle d'Aosta and Friuli Venezia Giulia) the agreement was also signed by the Ministry of Infrastructure and Transport, the Ministry of Environment, the Ministry of Economic Development, the Ministry of the Agriculture. It contains the methods, the procedures and the measures that must be envisaged in the Regional Air Quality Plans.

4.3.3.2 Area Plan Contents

Although the approach taken in developing Air Quality Plans varies from region to region, air quality modelling is utilized in some cases for the assessment of positive/adverse impacts of different scenarios/alternatives. The modelled scenarios represent conditions that are in compliance with National, Regional and local Plans/Programs. In particular the modelled scenarios take into account the targets (in term of air emissions reduction) reported in:

- Domestic Energy Plan;
- Local Energy plans;
- Traffic and transportation plans;
- Industrial development plan;
- More stringent regulations specified by law.

Then the comparisons of different scenarios (and related positive/adverse impacts) are in most cases carried out on the basis of qualitative (narrative) approach, considering:

- The results in term of air quality improvements (numerically evaluated by the mean of air quality modelling);
- The difficulties in scenario implementation, also considering “political” difficulties;
- The implementation costs, for the Public Administration.

Possible actions are:

- Adoption of transportation planning (limited traffic zone, suspension of circulation);
- Restriction of use of low impact fuels (i.e. natural gas);
- Restriction for industrial air emissions;
- Restriction of use of efficient condensing boilers.

4.3.4 Regulation of Emissions from Industrial Facilities

According to Italian regulations, a permit is required for any industrial source of air emissions (minor or significant sources; within or not within a NAA).
For major projects, a full EIA is required or IPPC permit is required. Major projects are defined as those listed in:

- Annexes I and item 2 in Annex 2 of the EU EIA Directive (2011/92/EU);
- Annex I of the EU IED Directive (DIRECTIVE 2010/75/EU).

These Annexes are reproduced here in Appendix 4. In other cases (minor sources) a permit issued by local authorities is required. The permit is periodically renewed (the calendar is differentiated for different sources). The location of the site within a NAA does not modify the permitting procedure.

The permit is periodically renewed (the calendar is differentiated for different sources).

The approaches adopted by the different Regions in Italy are rather diverse. According to European and domestic regulation, industrial emissions should be within the range of BAT-Associated Emission Levels (BAT-AEL). Some Air Quality Plans do not differentiate requirements between industrial sites located or not located within NAAs and only confirm the need to achieve the BAT-AEL. In other cases, Regions set lower specific limits or specific constraints, asking for the achievement of the Best in Class BAT and BAT-AEL. Best in Class BAT –AEL is the lowest value of the range of the BAT emissions limits (reported in the BREF or in the BAT Conclusions). Best in Class BAT-AEL is usually mandatory for new developments; existing developments are usually asked to implement an upgrading plan that, in the long term (generally 3 – 5 years), will allow the achievement of the Best in Class BAT and Best in Class BAT-AEL. In few cases, Air Quality Plans ask to compensate (offset) any new permitted (additional) emission in NAAs with a plan for emission abatement of existing emissions. The requirement for emission offsets is not applied uniformly. Regions may ask for the compensation in full of the air emissions from new sources (i.e., 1 to 1 offsets); offset ratios greater than 1 to 1 are not typically required. Where offsets are used, the Air Quality Plan (or the authority in charge) requires evaluation of the air emission impacts of the new and reduced existing sources through a dispersion modelling and verification that the new source using offsets does not imply a worsening of the local air quality.

In most cases, only a permanent in-stack concentration limit is defined. In other Air Quality Plans, more restrictive (temporary) concentration limits are required in period of adverse

meteorological situations. In a very limited number of cases, a limit in terms of annual (mass) emission is defined for the most significant facilities (refineries, power plants, etc.).

Within the framework of the periodic renewal of the Integrated Pollution Prevention and Control (IPPC) permit (the IPPC permits last 5 or 10 years), existing developments are usually asked to implement an upgrading plan that, in the long period, will allow the achievement of the Best in Class BAT and Best in Class BAT-AEL.

The permit issued for the operation of existing sources may include the following limitations:

- Permanent limitations to the allowed activities or production capacity;
- Temporary limitations to the allowed activities or production capacity in case of adverse meteorological conditions;
- Application of BAT or Best In Class BAT;
- Limitations to the use of fuels (only sulphur free fuels allowed);
- Severe monitoring programme (continuous monitoring).

Provisions for emission trading between facilities are not included in the Italian regulation (beside GHG emissions) and inter-facility trading is not generally accepted. However, an emissions bubble approach may be applied to a single, multi-source facility. In addition, Authorities have in the past accepted increases in emissions from new or modified facilities in exchange for the source owners helping to finance emission reductions at certain State-owned companies.

Domestic regulation does not include the definition of unified criteria regarding cost/benefit analyses and such analyses are not mandatory. In most cases, a cost/benefit analysis is not included.

For development plans that require a modification of the Municipality Plan, a SEA is also required. The stakeholders involved in the inquiry for SEA approval include public authorities in charge for the issuing of all other Plans, among which, the Air Quality Plan. As a consequence, SEA inquiry can be considered a tool for the coordination and harmonization of the Plans. If the development has a significant impact –in terms of potential worsening of air quality- the development is not approved (this happened many times in Italy). The determination of what constitutes a “significant” impact is left to the discretion of the authorities in charge of issuing the permit.

4.3.4.1 Fugitive Emissions

Fugitive emissions from the industrial sector throughout Italy are monitored and controlled applying the LDAR method (Leak Detection and Repair, EPA 453/R95). LDAR is considered BAT for oil refinery and bulk chemical plants. Local authorities can also require LDAR for other types of facilities that use large amounts of solvents or have other large VOC sources.

Diffuse emission from wastewater ponds are controlled according to a case by case approach, defined in the permit for operation and it may include control of wastewater quality (for example, pH control for the reduction of inorganic acids or bases) or pond roofing with suction and treatment of the air.

4.3.4.2 Cumulative Impact Assessment

The approach to evaluating cumulative impacts varies from Region to Region. The Italian regulatory framework does not specifically include requirements for cumulative air impact assessment. In absence of a national regulatory framework, the authors of modelling applications used in the permitting for the new/modified sources apply international guidelines methods for the assessment of cumulative impacts. Only some Regions, within the Air Quality Plan, define the sources that should be included in the cumulative impacts assessment and methods for impact assessment.

Generally, for the assessment of cumulative impacts the following approaches are used, in Italy:

- 24-hour average modelling predictions are added to the measured daily background (contemporaneous period);
- Monte Carlo modelling used to combine 24-hour average modelling predictions with background data (can be multiple years and multiple stations).

4.3.5 Area and Mobile Source Programs

There is not a uniform approach to control area and mobile sources emissions in NAAs in Italy. Usually air quality plans provide short to medium term and long term actions such as:

4.3.5.1 Short-medium term actions

Air Quality Plans may include:

- Definition of Limited Traffic Zone (LTZ) and tickets for entering in urban areas;
- Motor vehicles traffic banned on specific days, planned (i.e. Ecological Sunday) or unplanned, in case of adverse meteorological situations (emergency response);
- Circulation prohibited for old vehicles (i.e.≤ EURO 3 standard, traffic limitations based on odd/even licence plates)

4.3.5.2 Long term actions

Air Quality Plans may envisage:

- Redesigning of traffic plans;

- Enhancement of services of public transportation;
- Improvement of the sustainable transport (public transport with low environmental impact, expand bikeways, encouragement to use car/scooter/bike pooling/sharing);
- Limitations to the circulation of old vehicles;
- Limitations to distribution of goods in urban areas.

For the improvement of air quality, the Air Quality Plan established a permanent Limited Traffic Zone (named Area C) with some restrictions (tickets for entering, circulation prohibited for old vehicles and for large goods vehicles). The application of such measures has shown good results in term of air quality improvement (the number of days with exceedances to the limits is reduced). A project for even further limitations designed to reduce vehicle emissions is currently under evaluation.

4.3.6 Voluntary, Incentive, and Market-Based Measures

There are mainly two forms of public financial support in favour of the environment and energy savings as explained in the following:

1. Tax incentives, in the form of exemptions, tax credits and tax relief, or accelerated tax write-off (to accelerate investment write-off deduction from the taxable result and therefore reduce the profit tax paid at the time of the investment). Tax incentives are provided for:
    - Purchasing a plug-in electric vehicle (the amount of these incentives usually depends on battery size and the vehicle). Electric vehicles are exempt from the annual circulation tax or ownership tax for five years from the date of their first registration. In the region of Lombardy, electric vehicles are exempt from the annual ownership tax;
    - Scrapping old cars and commercial vehicles up to 3.5 tonnes. Grant schemes for the conversion of an existing vehicle or the purchase of an autogas vehicle have been in place for several years, though they have changed over time and have lapsed on occasion. In May 2014, grants were reintroduced for the purchase of autogas and other alternative-fuel vehicle;
    - Energy efficiency improvements to existing buildings since 2007. The national program provides tax credits to households and companies for single retrofit measures such as thermal insulation, installation of solar panels, and replacement of heating and air-conditioning systems, or for comprehensive retrofit work.

2. Negative economic incentive is implemented in Italy with the Ministry Decree 449/1997 (modified by Decree 416 dated of 26/10/2001). This Decree introduces a tax directly proportional to the amount of NOx and SO_2 emitted by the power sector. The tax applies to “large combustion plants” designed for production of energy (electricity or heat), with the exception of those that directly use the energy in a manufacturing process.
   The Tax is due at the rate of 53.20 Euro per metric ton/year of sulfur dioxide emitted and 104.84 Euro per metric ton/year of nitrogen oxides. The tax is defined based on fiscal and

financial aspects only, without any reference to real external costs. The tax shall be paid in advance, in quarterly installments based on the emissions of the previous year.

Furthermore, some Italian cities, such as Milan, have implemented a traffic pollution charge for motorists travelling within designated traffic restricted zones. The main purpose of this urban toll is to reduce traffic congestion in the city center limiting the use of private cars and motorcycles with consequently reduction of the pollution levels of the air.

4.3.7 Tools

Generally Regions perform forecast activities using source-oriented models (Gaussian models) to evaluate air quality; however some Regions have used hybrid Eulerian models (i.e. CAMx or Chimere[cxxv]) to perform scenario analysis, to evaluate the improvement of air quality achievable with the measures and actions listed in the plans.

The ambient air modelling is often applied to evaluate impacts of industrial activities (especially for activities that fall under the umbrella of the Industrial Emission Directive 2010/75/EU) in case of modifications or new builds especially in NAA and in case of increase in air emissions. The ambient air modelling encompasses cumulative effects. The most used approach is to add 24-hour average modelling predictions to the daily background (contemporaneous period) to describe total cumulative impact. The regulatory framework does not specifically include requirements for cumulative impact assessment.

4.3.8 Status, and Enforcement

4.3.8.1 Status

Twenty Italian Regions have prepared and approved Air Quality Plans. However only three Air Quality Plans (those issued by Emilia Romagna, Friuli Venezia Giulia and Umbria Regions) are complying with regulation currently in force (Decree 155/2010 – Italian transposition of Directive 2008/50/EC); the other 17 were approved in compliance with former regulation (hereinafter “old Air Quality Plans”). The old Air Quality Plans include generic measures related to traffic and industrial facilities but they don’t contain measurable targets with clear deadlines for actions, and are not coordinated with other Regions’ Plans. The new Air Quality Plans instead reports specific measures related to traffic and industrial facilities. However, since in Italy the main emission source is the traffic, most measures are related to traffic restrictions, both in terms of short term actions (limitations to odd/even plates circulation, suspensions of circulation for certain time periods or specific days) and long term actions (limited traffic zones, redesigning of traffic plans, enhancement of services of public transportation, improvement of the sustainable transport).

Different policy tools within NAAs were implemented in Italy, mostly related to traffic management since transportation is often the main source of air emission (especially in the most populated areas) and contribute the most to the ambient air concentrations. As a matter of

[cxxv] For reference cf Europe Questionnaire

example and according to the Regional Emission Inventory (INEMAR) the traffic is responsible for the 64% of total PM_{10} emissions in Milan.

4.3.8.2 Enforcement

Regions are required to issue the Air Quality Plan and update it according to a calendar defined in the national regulation. In case of delay, the Ministry can ask for its quick preparation. Implementation of actions defined in the Air Quality Plans is under the responsibility of the Region themselves. While Air Quality Plans identify actions to be undergone in the short-, medium-, and long term, detailed deadlines are not usually reported. If the short-term goals (set forth in terms of ambient air pollutant concentration) are not achieved, Regions may impose emergency measures (i.e. traffic limitations, etc.), in the aim of a quick (but temporarily) improvement of the air quality. The national government can exercise direct control over local authorities if necessary via appointment of a special commissioner who has the power to replace the local authority.

A sanctioning regime is not actually enforced. The 2008/50/EU Directive and the its Italian transposition (Decree 155/2010) set out general principles for air quality obligations, which applies to Authorities and not to private companies or private citizens; therefore the decree 155/2010 does not include a section for the definition of infringement penalties. As discussed in the European Union above, the European Court of Justice may apply penalties to Member States in case of failure to achieve legal limits set for Air Quality by the Directive.

4.3.8.3 Public and Stakeholder Involvement

Public hearings are envisaged in the framework of inquiry for the SEA (Strategic Environmental Assessment), necessary for the approval of the Air Quality Plans. Stakeholders involved in the public hearings include:

- Authorities with decision making power (Steering Committee);
- Other institutional stakeholders with advisory role;
- Non-Governmental Organizations;
- Citizens.

A Steering Committee is in charge for the approval of the Plan; the approval must include a specific answer to all requests of clarifications and observations received during the Public Hearing.

4.4 United Kingdom

4.4.1 Air Quality Legislation

Local authorities have a duty under section 83(1) of the UK 1995 Environment Act to designate those areas where the air quality objectives are unlikely to be, or are not being, met as air quality management areas. These areas have to be designated officially by means of an 'order'.

Section 84(1) of the Environment Act 1995 requires local authorities to carry out a Further Assessment of existing and likely future air quality in an air quality management area within 12 months of designation. They must also consult on it and make it available to the public.

The Environment Act 1995 does not prescribe any timescale for preparing an Action Plan. However, the Government and the Mayor of London expect them to be completed between 12-18 months following the designation of any air quality management areas.

4.4.2 Ambient Standards

The 2007 Air Quality Strategy establishes the policy for ambient air quality in the UK. It includes the National Air Quality Objectives (NAQOs) for the protection of human health and vegetation for 11 pollutants including NO_2, PM_{10}, $PM_{2.5}$, SO_2, CO, Pb, benzene, and 1,3-butadiene. Those NAQOs included as part of LAQM are prescribed in the Air Quality (England) Regulations 2000 and the Air Quality (Amendment) (England) Regulations 2002. The NAQOs are policy objectives. Local authorities are not required to achieve them, but have to work towards their achievement.

The NAQOs apply to external air where there is relevant exposure to the public over the associated averaging periods within each objective. Guidance is provided within Local Air Quality Management Technical Guidance 2009 (LAQM.TG (09)) issued by Defra for Local Authorities, on where the NAQOs apply. The objectives do not apply in workplace locations, to internal air or where people are unlikely to be regularly exposed (i.e. centre of roadways).

4.4.3 Planning Areas

Within the UK, under Part IV of the Environment Act 1995, each local authority (LA) area is required to carry out a Review and Assessment of air quality at specified intervals to determine those locations where the objectives set by the Air Quality Regulations will not be achieved by the required dates. This process is known as Local Air Quality Management (LAQM). Those areas where the objectives will not be met and where there is relevant exposure, must be declared as Air Quality Management Areas (AQMA). For each AQMA, the LA is required to develop an Air Quality Action Plan to put into place measures to reduce pollutant concentrations. It is up to each LA to determine where the boundary of the AQMA should be set, in some instances they can be as small as one house and in other locations they may encompass the whole borough.

4.4.3.1 Area Planning Requirements

Where a local authority identifies a potential NAA a Detailed Assessment, should be carried out by the 30th April the following year to formally identify the need to declare an AQMA and its appropriate size and location. The Detailed Assessment would be reviewed by the English Government's Department which has responsibility for the Environment Food and Rural Affairs (Defra) and assuming its findings are accepted the council would declare the identified area as an AQMA.

Once an AQMA has been identified section 84(1) of the Environment Act 1995 requires local authorities to carry out a Further Assessment of existing and likely future air quality within 12 months.

Following designation of an air quality management area, an air quality Action Plan should be completed between 12 – 18 months following the date of designation although there is no specific enforcement mechanism for meeting this deadline. Once a local authority has produced its final action plan, a first Action Plan Progress Report must be submitted by the end of the following April.

In the majority of cases each LA works independently to carry out the Review and Assessment of Air Quality process, produce an air quality action plan etc. Some local authorities band together to share resources, but they would still be required to produce individual reports. In producing an action plan, the LAs can choose which policy tools to use, and are not obliged to use any of the tools. However, the final plan must be submitted for Defra for approval.

To assist LAs, Defra and the Devolved Administrations for Scotland, Wales and Northern Ireland, have produced policy and guidance documents from which are useful in the preparation of Air Quality Action Plans. LAQM Policy guidance (PG09) is published by each country separately; links to the relevant documents are provided below:

- Defra LAQM.PG(09)
- http://webarchive.nationalarchives.gov.uk/20130402151656/http://archive.defra.gov.uk/environment/quality/air/airquality/local/guidance/documents/laqm-policy-guidance-part4.pdf
- Welsh Assembly Government LAQM.PG(09)W
- http://gov.wales/docs/desh/policy/090608airqualitypolicyguideen.pdf
- Scottish Government LAQM.PG(09)
- http://www.gov.scot/Topics/Environment/waste-and-pollution/Pollution-1/16215/PG09
- Department of Environment Northern Ireland LAQM.PG(09)
- http://www.airqualityni.co.uk/news-and-reports/useful-guidance

4.4.3.2 Area Plan Contents

An air quality Action Plan must include the following:

- quantification of the source contributions to the predicted exceedances of the relevant objectives; this will allow the Action Plan measures to be effectively targeted;
- evidence that all available options have been considered;
- how the local authority will use its powers and also work in conjunction with other organisations in pursuit of the air quality objectives;
- clear timescales in which the authority and other organisations and agencies propose to implement the measures within its plan;
- where possible, quantification of the expected impacts of the proposed measures and an indication as to whether the measures will be sufficient to meet the air quality objectives. Where feasible, data on emissions could be included as well as data on concentrations where possible; and
- how the local authority intends to monitor and evaluate the effectiveness of the plan.

4.4.4 Air Quality Monitoring

Monitoring fulfils a central role in the Review and Assessment process, providing the necessary sound scientific basis for assessment of compliance with the objectives of the Air Quality Strategy. It is up to each local authority to carry out appropriate monitoring to assist in demonstrating whether or not there is a significant risk of a prescribed Air Quality Strategy objective being exceeded in a relevant location, enabling Air Quality Management Areas to be identified, and appropriate action taken. Guidance on how and where to carry out monitoring is included within LAQM TG(09).

4.4.5 Emission Inventories

The UK has a web based National Atmospheric Emissions Inventory (NAEI). The NAEI is funded by DECC, Defra, The Welsh Government, The Scottish Government and The Department of Environment, Northern Ireland. The NAEI compiles estimates of emissions to the atmosphere from UK sources such as cars, trucks, power stations and industrial plant. These emissions are estimated to help to find ways of reducing the impact of human activities on the environment and our health. The inventory provides information both on air pollutants and greenhouse gas emissions.

4.4.6 Regulation of Emissions from Industrial Facilities

Air pollution emissions from industrial sources are controlled under the Environmental Permitting Regulations. Within England, the main contributor to non-attainment is from vehicle emissions and not industrial sources given the highly urbanized nature of the country and the limited amount of heavy industry. There are no specific requirements for industry within non-attainment areas. The Environmental Permitting Regulations set out the type and size of processes requiring an environmental permit to operate. The EU EIA Regulations (Directive 2011/92/EU) apply to major development. In the UK, these are implanted as the Town and Country Planning (Environmental Impact Assessment) Regulations. Additionally, the LA can request air quality assessments for all new development within a NAA.

The Environmental Permitting Regulations classifies industrial installations into three groups Part A1 (the largest and most polluting as listed in the EU directive) permitted by the Environment Agency, Part A2 less polluting permitted by the Local Authority and Part B which only emit air pollutants which are also permitted by the local authority. For Part A1 processes the EU has produced a series of BREF notes setting out appropriate BAT AEL (associated emission limits) and other management techniques to prevent emissions. Similar less stringent guidance is produced by Defra for Part A2 and Part B processes. New sources would need to demonstrate that they meet BAT and the appropriate emission limits.

New industrial emissions resulting in significant emissions of a pollutant for which an NAA has been declared is unlikely to be allowed as neither the Environment Agency nor the Local Authority would grant a permit. Alternatively they may be required to employ more stringent emission control than in areas not covered by an AQMA. Where existing industry is generating significant emissions an improvement timetable would be put in place to reduce emissions as far as possible within an acceptable timeframe.

Industrial emissions which are permitted under the Environmental Permitting Regulations are required to use Best Available Techniques (BAT) to minimise emissions of pollutants and to meet specified emissions criteria. This would include cost/benefit considerations. The BAT and emissions criteria are determined at European level for major industry. In applying for an environmental permit, the industrial facility would have to demonstrate how it complies with BAT. Where an existing industry is considered to be resulting in excessive emissions an improvement timetable would be implemented to gradually improve the emissions so that they comply with BAT. New development must demonstrate that it is using BAT to minimise emissions and would also be expected to demonstrate that the predicted emissions would not result in a significant effect on air quality. The Environment Agency has provided guidance on what is considered to be significant effect within H1.[cxxvi]

Permitted processes, i.e. those which come under the Environmental Permitting Regulations [EPR], would be required to comply with emission limits set within the relevant process guidance notes. These would have taken account of the requirement of the Large Combustion Plant Directive. Emission limits may also be set in relevant planning guidance documents for combustion plant such as combined heat and power plant which would not be large enough to fall under EPR. Additionally, the Clean Air Act, which is an older piece of legislation applying to the whole of the UK that has been largely replaced by other, more specific, regulations mentioned above, is still applicable to the prevention of emissions of fumes, dark smoke and odour from smaller sources.

[cxxvi] H1 is the Environment Agency's cross sector guidance for assessing environmental risks from industrial installations. Annex F relates to air quality (Environment Agency, December 2011, H1 Environmental Risk Assessment Framework, Annex F – Air Emissions).

4.4.6.1 Fugitive Emissions

Fugitive emissions from industrial activities would be included within the permitting process outlined above. Generally, these emissions would be controlled through management plans to prevent releases rather than setting strict emission limits.

4.4.6.2 Cumulative Impact Assessment

The EIA regulations require that consideration is given to cumulative impacts. Furthermore, when local authorities request air quality assessments for schemes (developments) not falling within the EIA regulations (such as smaller scale residential developments with relatively minor impacts), they can request that consideration be given to cumulative impacts. There are no specific regulations for how cumulative impacts are to be accounted for. Typically, cumulative assessments are limited to traffic emissions, and these would be modelled with a suitable traffic model as a separate scenario. Local diffuse industrial emissions are taken into account within the estimated background pollution concentrations maps produced by Defra and therefore in most instances the use of this data would be sufficient to include other industrial sources into an air quality assessment for planning purposes. Where a significant individual source is identified then this would be assessed as a separate source.

4.4.7 Source Classification

For those areas declared as AQMAs, within 12 months of declaration the local authority must also carry out a Further Assessment to supplement the information provided in the earlier Review and Assessment work. Part of this work includes a detailed source classification exercise, known as source apportionment, to identify the predominant sources that contribute to the air quality exceedances within each AQMA.

There is no official system to classify sources for regulatory purposes under the LAQM regime. However guidance is provided on how to carry out source apportionment work to identify the predominant sources that contribute to an exceedance. The guidance suggests the following categories:

- regional background, which the authority is unable to influence;
- local background, which the authority should have some influence over;
- local sources, which will add to the background to give rise to the hotspot area of exceedances. These will be the principal sources for the local authority to control within the Action Plan.

Since the Action Plan will propose to influence emissions from local sources, it will also be important to separate these sources into:

- Stationary sources (if relevant) potentially dealing with each source separately;

- Vehicle type potentially split among cars, vans and lorries, taxis and buses and coaches. Potentially split by age or according to local or through traffic if these are significant issues;
- Vehicle emissions split between moving and stationary traffic, if congestion is a significant issue;
- Other relevant factors such a road gradients that give rise to excess emissions if these are significant.

4.4.8 Emission Control Technology Selection

For England, Defra has produced the following practice guidance to assist LAs in the action planning process:
Practice Guidance on economic principles for the assessment of local measures to improve air quality.

This guidance sets out a methodology for local authorities to provide cost benefit analysis of various measures they may implement to improve air quality.

- The general guidance which can be applied to any improvement measure/scheme is accompanied by a set of more specific guidance for certain schemes for improving local air quality including:
  - designating low emission zones (LEZ);
  - encouraging the uptake of low emission vehicles (LEV); and
  - encouraging the uptake of retrofitted abatement equipment on vehicles.

4.4.9 Emission Offsets

There are no specific emission offset ratio(s) prescribed in regulations or policy. The National Planning Policy Framework Guidance provides the following general guidance with regard to mitigating impacts from development proposals but these are not confined to development in NAAs '*contributing funding to measures, including those identified in air quality action plans and low emission strategies, designed to offset the impact on air quality arising from new development.'* There is no overarching mechanism tying the level of funding to the level of emission although some individual LAs have produced their own strategies to cover this. Within London, the GLA has introduced the notion of new development being Air Quality Neutral and produced target emission benchmarks for building emissions and transport sources. Where a development cannot meet the emission benchmarks additional mitigation is required either to reduce emissions or in the form of a financial contribution to allow for offsetting.

4.4.10 Emission Reductions

Defra has produced the following policy guidance to assist local authorities on introducing low emission zones:

- Practice Guidance on low emission zones
- Some local authorities have introduced low emission zones to reduce emissions within AQMAs. For example Oxford City Council has introduced a low emission zone for buses within the centre of Oxford.

4.4.11 Area and Mobile Source Programs

Defra has produced a policy guidance documents for the retrofitting of abatement onto vehicles (*Practice Guidance on measures to encourage the uptake of retro-fitted abatement equipment on vehicles*) and for encouraging the introduction of low emission vehicles (*Practice Guidance on measures to encourage the uptake of low emission vehicles*) but no vehicle replacement or retrofit programs are currently in place. Suggested measures provide by Defra for local authorities to consider when formulating an Action Plan include:

- Smarter travel choices;
- Sustainable travel guides;
- Car sharing and car clubs;
- Travel plans;
- Buses, in particular retrofitting emission controls to buses;
- Freight, developing freight management plans;
- Taxis, encouraging the purchase of cleaner taxis;
- Development planning, including features designed to reduce reliance on motorized transport, avoiding new development in areas with poor air quality, and encourage roadside setbacks;
- Urban traffic management;
- Vehicle parking;
- Low Emission Zones;
- Raising awareness – education.

Additionally, the UK Government introduced a vehicle scrappage scheme in 2009, but this was primarily to encourage new car sales. Under the scheme the UK Government paid owners of cars greater than 10 years old £1,000 to scrap the cars.

The UK Government is currently funding a Plug-in Car Grant to encourage motorists to purchase ultra-low emission vehicles. The grant, which offers motorists up to £5,000 of the price of an electric car, has been extended for all categories of vehicle and aims to build on the recent growth of the plug-in car market.

4.4.12 Voluntary, Incentive, and Market-Based Measures

There are no specific economic incentives prescribed in regulations or policy to manage air quality in non-attainment areas and no such programs are known to be in place at the present

time other than the vehicle programs described above. Defra has produced a policy guidance document: *Economic Principles for the Assessment of Local Measures to Improve Air Quality*[cxxvii]

4.4.13 Reporting, Status, and Enforcement

4.4.13.1 Reporting

In order to ensure that local authorities implement the measures within an Action Plan by the timescales indicated within that plan, Defra and the Mayor of London expect authorities to submit annual action planning Progress Reports once the final Action Plan has been drawn up. These Progress Reports list the measures within the Action Plan and include the timescales by when they are/were due to be implemented and give an update on progress in terms of implementing or developing them. Where possible, quantified impacts of measures should be included.

The Environment Act 1995 does not prescribe any timescale for preparing an Action Plan. However, the Government expect them to be completed between 12-18 months following the designation of any air quality management areas.

Within England Defra has the authority to approve plans. The Greater London Authority (GLA) also has to approve plans for London.

4.4.13.2 Status

Within England, on-road vehicles are one of the main sources contributing to non-attainment with primary impacts being NO_2, PM_{10} and $PM_{2.5}$. Many NAAs arise either due to large volumes of traffic on busy urban roads in inner city locations or where dispersion is constrained in town centre locations due to the presence of buildings in close proximity of the roads. Neither of these issues is easy to resolve. The tools available to local authorities to manage air quality are relatively weak and can do little to significantly reduce road vehicles or result in a significant change in the type of vehicles the public buy.

Within Europe emissions from road vehicles are controlled by legislation with increasingly tighter emission limits gradually being introduced for new vehicles. These tighter emission limits (Euro 6) were projected to result in improved ambient air quality and therefore a reduction in NAAs. However, the expected improvements have not been realised for a number of reasons, including an increase in the number of diesel vehicles on the road network and the emission limits being set for laboratory conditions rather than real world driving cycles. The significant uptake in new diesel vehicles within England and the rest of the UK has led to greater NOx emissions compared with their petrol equivalents. Purchases of these vehicles were encouraged by the government to meet the UK's carbon commitments, but this has been to the detriment of air quality.

[cxxvii] Defra, February 2009, Local Air Quality Management - Practice Guidance 1, Economic Principles for the Assessment of Local Measures to Improve Air Quality

In July 2013 Defra published a consultation document seeking changes to the LAQM process. After an initial round of consultation a second consultation document was published in December 2014. The main changes which are proposed are as follows:

- Remove some of the pollutants from the process for which no NAA have been declared (benzene, 1,3 butadiene, carbon monoxide, lead);
- Streamline the reporting process, in particular remove the need for Further Assessments;
- Improve and update the policy and technical guidance.

The Defra web site includes a number of case studies show casing the successful implementation of air quality action plans which have used the various policy tools, including the introduction of a low emission zone targeted at buses within Oxford City Centre which has been effective at reducing NO_2 and PM_{10} concentrations within the city centre. Further information on a number of case studies can be found at the following link: http://laqm.defra.gov.uk/action-planning/case-studies.html. Overall, however it has been concluded that generally the existing action plans have had little success at reducing the size and number of NAAs within the UK.

4.4.13.3 Enforcement

Part IV of the Environment Act 1995 requires the Secretary of State to publish a national Air Quality Strategy and established the system of LAQM, for the designation of air quality management areas, which commenced in 1997.

The air quality objectives set out in the Air Quality (England) Regulations 2000, as amended by the Air Quality (England) (Amendment) Regulations 2002, provide the statutory basis for the air quality objectives under local air quality management in England. Those regulations are derived from European Directives and prescribe the attainment dates for meeting air quality objectives. Not all of the objectives contained in the Air Quality Strategy are included with in the local air quality management system, and this includes the new limit value for $PM_{2.5}$ that is contained in Directive 2008/50/EC on ambient air quality.

Section 82 of the Environment Act 1995 provides that every local authority shall review the air quality within its area, both at the present time and the likely future air quality. Section 83 requires local authorities to designate an air quality management area where air quality objectives are not being achieved, or are not likely to be achieved within the relevant period, as set out in the Air Quality (England) Regulations 2000 Regulations. Once an area has been designated, Section 84 requires the local authority to carry out an assessment and then to develop an Action Plan for the air quality management area.

Where the objectives are unlikely to be met, the local authority must take action to work towards the objectives. Local authorities also have a continuing commitment to work towards meeting the air quality objectives beyond the deadlines set out in the regulations. An objective, for example, which was due to be met by 2005 must now be met each subsequent year.

Whilst the Local Authorities must produce air quality action plans to work towards meeting the air quality objectives, the air quality objectives in the Air Quality Strategy are a statement of policy intentions or policy targets. As such, there is no legal requirement for the Local Authorities to meet these objectives, and no system in place to enforce compliance. However at EU level there is a legal requirement for the UK to meet the ambient concentrations set out in the EU Ambient Air Quality Directives. Due to potential noncompliance with the directive, the UK is facing the possibility of fines from the European Commission. Central government has threatened to pass some of these fines onto those Local Authorities with AQMAs. Potential ways in which the affected Local Authorities might avoid such fines have not been indicated.

4.4.13.4 Public and Stakeholder Involvement

The Environment Act 1995 provides the statutory basis for consultation and liaison in respect of local air quality management. The Government and the Mayor of London expect local authorities to continue to work closely with other local authorities, agencies, businesses and the local community to improve local air quality. Local authorities need to exchange data with other agencies and neighbouring local authorities. There is no specific requirement for public notices, although information should normally be readily available through a council's web site. There would be a public review and comment period at many stages within the Review and Assessment process.

Schedule 11 of the 1995 Act requires local authorities to consult:

- the Secretary of State;
- the Environment Agency;
- the highways authority ;
- in London, the Mayor (for London authorities only);
- all neighbouring local authorities;
- the county council (if applicable to English local authorities);
- any National Park authority;
- other public authorities as appropriate; and
- bodies representing local business interests and other organisations as appropriate.

For the purposes of the 1995 Act, authorities must consult on their:

- air quality review and assessment;
- further air quality assessment in an air quality management area; and
- preparation or revision of an air quality action plan.

Local authorities are also expected to consult on the declaration, amendment or revocation of any air quality management areas.

4.4.14 Tools

Defra has produced a large range of tools to assist local authorities in their Review and Assessment of air quality work. These range from monitoring tools, background concentration prediction tools, emission tools, screening tools and road traffic tools. A full list can be found at the following (http://laqm.defra.gov.uk/documents/LAQM-Tools-List-v1.2.pdf).

Additionally Defra has produced a series of guidance documents to assist local authorities with their action planning work including:

- Practice Guidance on economic principles for the assessment of local measures to improve air quality;
- Practice Guidance on low emission zones;
- Practice Guidance on measures to encourage the uptake of low emission vehicles;
- Practice Guidance on measures to encourage the uptake of retro-fitted abatement equipment on vehicles; and
- Practice Guidance Worked Examples.

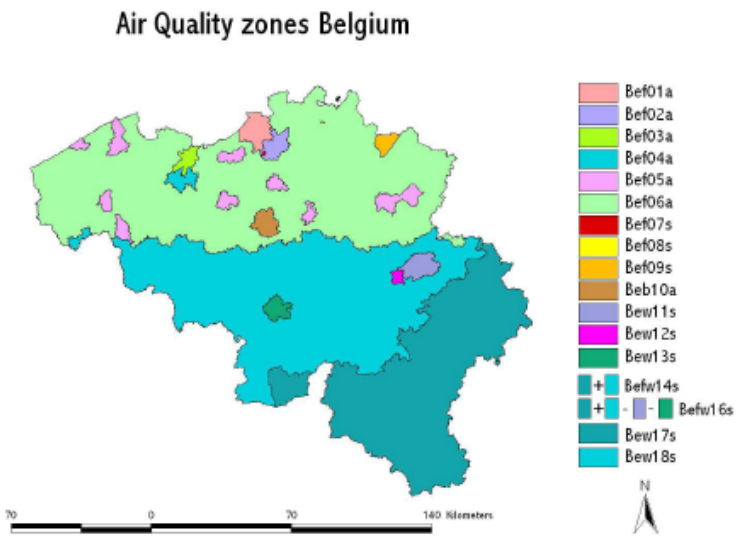
Most air quality modelling in the UK has utilised the ADMS suite of models, in particular the ADMS Urban model (http://www.cerc.co.uk/environmental-software/ADMS-Urban-model.html).

4.5 Belgium

4.5.1 Administration of Air Quality Regulations

Belgium is divided into 3 main regions: Brussels-Capital, Wallonia and Flanders. Each region developed their own air quality directives, regulations and monitoring stations network. More specifically, the Wallonia region entrusted the management of air quality over the Wallon territory to the Public Scientific Institute Services (ISSeP). Brussels-Capital entrusted the IBGE (Brussels Environnement Institute) and Flanders entrusted the Vlaamse Milieumaatschappij (VMM) institute.

The "Intergewestelijke cel voor het Leefmilieu – Cellule interrégionale pour l'Environnement" (IRCEL-CELINE), which can be translated as Interregional committee for the Environment, is an agreement of cooperation between the Belgium State and the three mentioned above regions (Brussels-Capital, Wallonia, Flanders). This committee focuses mostly on the structuring/reporting of environmental data provided at European level. IRCEL-CELINE publishes annual reports of the current air quality over the entire territory (the latest available report is for the 2012 year). IRCEL-CELINE reports also air concentrations pollutants required at EU level over zones and agglomerations shown in Figure 13: three large zones defined following administrative boundaries and more local zones (agglomerations) were delimited according to European directive obligations.



Zone code	Zone name
Bef01a	PORT OF ANTWERP
Bef02a	ANTWERP
Bef03a	PORT OF GHENT
Bef04a	GHENT
Bef05a	CITIES>50000 inhabitants
Bef06a	FLANDERS
Bef07s	HOBOKEN
Bef08s	BEERSE
Bef09s	LOMMEL
Beb10a	BRUSSELS
Bew11s	LIEGE
Bew12s	ENGIS
Bew13s	CHARLEROI
Bew14s	WALLONIE
Bew16s	WALLONIE II

Figure 13 Air quality zones in Belgium.

Beyond this committee, there are no national air quality regulations and each region shall respect their own directives, which must be at least compliant with European Air Quality Directives. For example, Air quality in Wallonia is regulated by the directive of Wallonia Government dedicated to the assessment and management of ambient air quality (M.B. 01.09.2010) modified by the erratum 30.09.2014. This directive is a transposition of the AQ European directives.

According to available information, this review focuses mainly on Brussels and Antwerp urban areas (which can be both considered as NAAs), with the objective to highlight main differences/specificities with others European Member States. Note that Antwerp is divided in 2 air quality zones (the city and the port). In both of these cities, the European air quality standards related to NO_2 (annual average) and PM_{10} (daily thresholds exceedances) are still not met, although reductions in pollution have been observed during the last ten years. Traffic is one of the most important sources of pollution in the cities, with for Brussels a 72% share for PM_{10} and a 61% share for NO_x. Antwerp remains an Industrial city with an important port, refineries and petrochemical industries.

In June 2015, EU regulators referred Belgium and Bulgaria to the bloc's top court, charging that air quality in these Member States "poses a major risk to health" with excessive levels of PM_{10} and nitrogen dioxide.

In Antwerp, all air quality activities are undertaken at the regional level by the Flemish Environment Agency (VMM), or, in the case of action plans and reporting, by the Flemish Environment Administration.

Apart from that, the Antwerp Port Authority (APA) supplies information for some specific emission sources. It also delivers air quality maps as a result of its modelling activity, exploits some supplementary measuring points for PM, and provides information to the public on an ad hoc basis.

The municipal environment unit also delivers air quality maps from its modelling activities, cooperates in the implementation of action plans, and informs the public on local air quality. Finally, the Belgian Interregional Environment Agency (IRCEL) produces national air quality maps from its modelling, informs the public in cases of high-pollution episodes, and reports assessment results to the European Commission.

4.5.2 Air Quality Plans

Antwerp and Brussels have designed AQ Plans, sent to the EU by the Belgium State. Time extensions have been requested by Belgium. The Commission granted a time extension for compliance with the annual NO_2 limit values for two of the three zones requested.

The Wallonia region has designed an integrated Air-Climate Plan (PACE) for the 2014-2022 period. The PACE included Wallonia Government measures and programs in order to be compliant with further European pollutants emissions limits up to 2022. In addition PACE includes a long term vision (2050), especially for GHG. The document compiles some integrated measures which should be implemented by various sectors:

- Industry:
  - Implementation of emissions quota system based on the European Emissions Trading System for GHGs;
  - Improvement of the efficiency of energy used for processes;
  - Promotion of low environmental impact fuels, renewable heat and power sources and cogeneration;
  - Integration of lifecycle activities analysis;
  - Construction of low environmental impact buildings;
  - Refurbishment of old buildings;
  - Reduction of auxiliary power consumption (lighting, standby equipment, household appliances, etc.).
- Transport:
  - Employer-based trip reduction programs;
  - Promotion of low emission transportation modes such as bicycles, car sharing, etc.;

- Minimization of transport emissions via incentives to reduce private passenger vehicle trips, adoption of battery electric vehicles and clean transportation research and development and traffic management.

- Agriculture:
  - Management of nitrogen emissions;
  - Promotion of low environmental impact fuels, renewable heat and power sources and biomass cogeneration;
  - Application of EU agricultural policies, maintaining carbon pools and managing forests.

4.5.3 Air Quality Monitoring

Urban areas of Brussels and Antwerp are covered by a significant monitoring stations network, according to the EU requirements as shown for Antwerp in Figure 14. The measurements concern NO_2, PM_{10}, $PM_{2.5}$, CO, SO_2, metals and PAH.

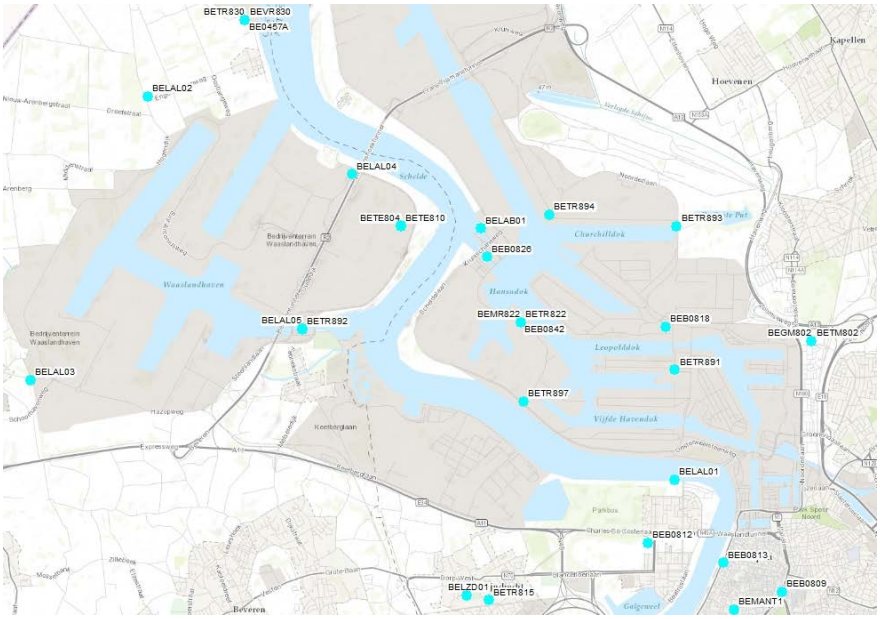


Figure 14 AQ monitoring network in Antwerp.

4.5.4 Emission Inventories

Brussels and Antwerp have both performed emission inventories (EIs), using a conventional, common classification scheme such as SNAP (30) or NFR (31) when identifying the pollution sources in their EIs. The *Air Implementation Pilot : Lessons learnt* (EEA, 2013) highlights that Antwerp is the only city (among 12 other EU cities) whose the emission inventory covers all the emission sources, including agriculture, re-suspension of road dust, and emissions from construction activity. It is also the only city with Malmö to cover black carbon (BC), an agent that is both an indicator for traffic-related air pollution and a short-lived climate forcer.

4.5.5 Regulation of Emissions from Industrial Facilities

According to the Air Implementation Pilot (EEA, 2013), some of the measures implemented by Antwerp in its Air Quality Plan affected the industrial sector (e.g. retrofitting of installations with enhanced abatement technology). Antwerp also highlighted three measures aimed specifically at port emissions. One of these measures was to increase awareness of emissions by promoting eco-sailing practices, and two were technological: the installation of a hybrid-powered crane and a programme of subsidies for low-emission cargo-handling equipment. Most measures are still on-going, meaning that they have been implemented and continue to be in place.

4.5.6 Area and Mobile Source Programs

Brussels has a clean bus fleet with almost 70% Euro V, Enhanced Environmentally Friendly Vehicles (EEV) or buses equipped with particle filters. The municipal vehicle fleet, however, is less environmentally friendly with only 25% of passenger cars and heavy and light duty vehicles meeting or exceeding Euro 5/V standards.

Public administrations with more than 50 vehicles in their fleet are evaluated on the basis of 'ecoscore' indicators that take into account greenhouse gas emissions (CO_2), air pollution (PM_{10} and NO_2) and noise. Also, public transport contracts have been subject to environmental indicators for their renewal since 2012.

4.5.6.1 Traffic and Mobility Management

The Brussels city undertakes capacity management for main roads and is expanding the 30km/h zones, in particular in the "hyper-centre" (i.e., the inner city core) and in all residential areas. The modal share of cars in the city was planned to decrease by 6% by 2015 and by 20% by 2020. In 2010 the share of cars was still very high (42.6%). The metropolitan area has a share of private motorised transport of 33.5%. Cycling targets for 2020 are particularly impressive, from 3.5% in 2010 in the inner city to 20% in 2020.

Brussels aims at reducing space for cars in favour of bicycles and buses. The Mobiris mobility centre manages traffic centrally and is to become a multimodal information centre: you can gather information about Cambio (car sharing), Villo (bike sharing), Collecto night taxis (taxi sharing), workplace travel plans, travel plans for schools and events, and awareness raising programmes. The region funds the Taxistop carpooling centre, which is an awareness action database and manager. Cambio car sharing was launched in 2004. By 2010 it had 180 vehicles, 60 stations, and 5,000 members. Vehicles in the Cambio program are late model low emission cars and electric vehicles.

4.5.6.2 Promotion of Public Transport

In Brussels, public transport almost doubled its modal share between 1998 and 2010, reaching 28%. This was achieved through a diversity of measures implemented during the last five years: the seating capacity of buses increased by 13%, 17 new bus night lines were created, and bus frequencies were raised. From 2015 onwards, the number of seats will be raised again by 7%. A New “Plan Directeur” bus will evaluate and improve measures.

A new tram line has been opened and others have been extended or increased in frequency. Further comprehensive improvements are planned for the coming five years (raising the number of seats by 6%). Additionally, the Metro frequency has been increased.

4.5.6.3 Promotion of Walking and Cycling

The share of bicycles in Brussels has been very low (2.5%), but the city has ambitious plans to raise it to 20% by 2020. The municipality plans to expand the number of bicycles and cycle lanes. The bicycle plan targets 100% of bikeable roads, creating cycling connections with neighbouring regions, developing 70km of cycling corridors along the train lines, better road signs and a higher possibility for intermodality between bicycle and public transport. For example, bicycles can be carried on public transport for free except during rush hours. Since May 2009, the Villo bike rental system has been offered at 360 stations with 4,000 bikes as of the end of 2013 (almost doubled since 2010).

Awareness building measures such as "Friday Bike Day", "Bike to Work", "Bike Experience", guided bike tours, bike rentals in parks, etc. promote the modal shift to cycling. Walking is being promoted by expanding pedestrian (car free) zones to 10 km in 2016, to 20 km in 2020 and to 40 km in 2040. Brussels aims to increase the share of pupils living less than 1km from their schools who walk to school to 70% in 2016 and 80% in 2020.

After a study on effects of a Low Emission Zone (LEZ) in Brussels, the Ministry decided not to introduce an LEZ on the basis of environmental performance criteria. The impact of low-emission zones was determined for various scenarios in 2015 and 2020. They determined the effects on traffic flow redistribution, composition of local vehicle stock, traffic emissions and air quality. Socio-economic effects were also considered. They also looked at the costs incurred by the government for the introduction of low-emission zones, and identified possible obstacles for implementation. However, in May 2013 Brussels adopted a “Zone d’Action Prioritaire pour l’Air” (Priority Air Action Zone) which allows the municipality to introduce temporary or permanent restrictions on mobility and transport and to use subsidies to promote air quality.

So far no restrictive measures have been launched using the “Code bruxellois de l’Air, du Climat et de la Maîtrise de l’Energie” (Bussels Code of Air, Climate and Energy Management). An integration of climate and air pollution policy is characteristic of the strategy on the national and city levels. But this provision has not been used so far.

4.5.7 Voluntary, Incentive, and Market-Based Measures

Aside from the traffic measures and programs incentivising alternative modes of transportation described above, Brussels has worked out a parking concept with 4 zones regulating about 60% (approx. 135,000) of all parking spaces in Brussels. The parking concept aims to decrease the number of parking spaces by 16% until 2018. Also, parking prices have increased, especially regarding parking duration: Parking prices range from €1.50 to a maximum of €3.50 per hour. Prices increase with every additional hour of parking. Parking duration is limited to 2-3 hours. Since 2006, the Brussels region has had a system to encourage individuals to get rid of their cars called the "Bruxell'Air" subsidy (a scrappage scheme including incentives to buy new bicycles[cxxviii] and join car sharing schemes). Enterprises get investment premiums for buying electric cars.

4.5.8 Public and Stakeholder Involvement

- Brussels municipality has a comprehensive programme for communicating with the public about air quality. Brussels provides a website with extensive information on air quality, current measurement values, interactive information on stations and background information about legislation. There is an info phone and SMS alarm service, but only a general mail contact to the Institut Bruxellois pour la Gestion de L'Environnement (Brussels Institute for Environmental Management). Furthermore, public TV channel RTBF provides air quality bulletins, which are also to be found in print media and radio spots, in addition to awareness raising activities. When developing air quality plans, the public is consulted. Special communication possibilities are given to journalists.
- Concerning Antwerp, the competent authorities for informing the public on issues related to air quality lies with the regional authorities, i.e. the local region shares responsibility with the national government.

4.5.9 Assessment

Two main challenges highlighted in the Air Implementation Pilot study for improving air quality in the Antwerp's air quality zones are:

- For the Antwerp City zone: Transboundary pollution and the high amount of traffic on the ring road running around the edge of the city
- For the Port of Antwerp zone: The large share of background concentrations, the large influence of meteorological conditions on changes in PM_{10} levels, and the high density of NO_x emitters, all of which obliges the area to take more stringent measures than those needed in less industrialised areas.

[cxxviii] Copenhagen is one of Europe's most prolific cycling cities. It has a very high share of cycling and the continuous promotion of cycling is part of the long-term mobility management program. Current measures are outlined in the "good, better, best – Bicycle Strategy 2011-2025". They include the creation of PLUSnet, a network of 'Bicycle Superhighways" on very congested routes. Many measures have already been accomplished, such as intersections granting priority to cyclists in many cases. Bicycles can also be brought onto all trains and in the metro with only a few restrictions during rush hours. Furthermore, the city also has had a bike-sharing system since 1995 and is currently reforming it.

The PACE 2014-2022 project for the Wallonia region highlights that the AQ standards are still not met in the region, although emission reductions have occurred. Lack of progress in reduction of diesel vehicle NOx emissions is contributing to the continued non-attainment. Figure 15 below (according to Hausberger, 2010) shows that the NOx emissions for recent diesel cars are not decreasing which is an on-going source of concern throughout the EU.

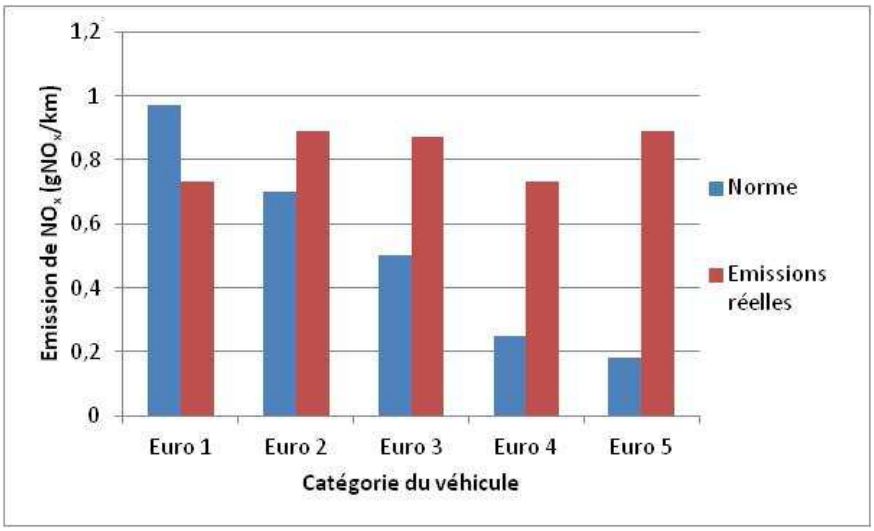


Figure 15 Theoretical and real NOx emissions for diesel cars.

4.6 Netherlands

4.6.1 Administration of Air Quality Regulations

The Netherland central government is responsible for national environmental policy directed to contributing to sustainable economic development and to the health and safety of people by maintaining and improving the quality of the environment. At the national level, almost all national legislation on the environment is incorporated in the Environmental Management Act.[cxxix] This act sets out an integrated approach to environmental management in the Netherlands and provides the legal framework by defining the roles of national, provincial or regional, and municipal government.

The Act stipulates the tools to be used in environmental management including:

- Environmental quality criteria for emissions and discharges of harmful substances such as greenhouse gases and heavy metals to air, water and soil.
- Environmental impact assessment is a prerequisite for the construction of major infrastructure such as oil refineries, nuclear power plants, chemical plants, roads, railways, and oil and gas pipelines.

[cxxix] https://www.government.nl/topics/environment/contents/roles-and-responsibilities-of-central-government/environmental-management-act

- Environmental permits: In addition to regulations for the emission of substances harmful to the environment, large companies, such as chemical plants, are required to obtain environmental permits that stipulate limits for the discharge of substances harmful to the environment.
- Environmental reporting is directed to stimulating companies to make production cleaner and more environmentally friendly. Many companies such as those involved in metal processing and chemical production are required to publish an annual environmental report. The Ministry is responsible for ensuring that the reporting requirement of the EU Pollutant Release and Transfer Register (PRTR) are met. Those companies and organisations required to prepare an Integrated PRTR report on waste, air emissions (greenhouse gases), and discharges into water sources are listed in the Publicatieblad van de Europese Unie Bijlage II van de EG-verordening PRTR.
- Enforcement: the Human Environment and Transport Inspectorate is largely responsible for ensuring the provisions of the Environmental Management Act are enforced. Enforcement is also a task of the municipalities, the police and the justice system.
- The Netherlands has a long tradition of consultation and cooperation of government bodies, stakeholder organisations, and citizens. Within this framework, policy on national and international issues is prepared by central government and forms the basis for legislation ratified by the Dutch Parliament.
- Policy related to the provinces and municipalities is devolved to government at these levels, closer to the people and on the principle of promoting public participation in democracy.
- The Ministry of Infrastructure and the Environment is responsible for developing policy in the national context and the provinces are responsible for translating these guidelines into the regional context. The municipalities have the power and financial means to develop and implement local policy on spatial planning and the environment. Close cooperation between all levels of government inherent in the Dutch system ensures the necessary checks and balances.

While national policy on environment is the responsibility of the Ministry, provincial governments are responsible for translating these guidelines into the regional context. The 12 provincial governments develop regional policy and draw up regional plans setting out the zoning guidelines for the location and expansion of residential, industrial and commercial areas within cities, towns and villages. Environmental management policy is related to spatial planning and directed to creating a healthy environment with clean air, water and soil by regulating emissions from road transport, industry and other sources. To this end, provincial authorities are responsible for granting environmental permits stipulating the limits, for example, for emissions and noise hindrance. The Provinces are also responsible for enforcement of environmental regulations by large companies. Provincial authorities play a key role in stimulating the use of sustainable energy and in meeting targets for the production of renewable energy such as wind energy, and for provision of adequate space for the construction of wind energy parks.

Implementing national policy and strategy on environmental management is largely decentralised to municipal governments. These authorities prepare local regulations and have both the legal and financial means to implement and enforce decisions and regulations.

The municipalities are responsible for preparing regulations for implementing and enforcing the regulations in the national Environmental Management Act, which covers matters such as separated waste collection, disposal of hazardous waste, air quality, and noise nuisance, and environmental permits for industrial and commercial activity.

The National Air Quality Cooperation Programme (NSL) provides national, regional and local measures to meet air quality standards. It takes account of the desired and planned land development projects. The government, provinces and municipalities work together within the NSL. The main focus of the NSL has been on reducing NO_2 and PM_{10} concentration levels. The authorities must check the air quality situation every year. If it is found that progress towards the NSL targets is not on schedule, extra measures will have to be taken. These may include national or local measures.

4.6.2 Air Quality Plans

Beside the national program and in order to meet the AQ standards at all locations in Amsterdam, agreements have been made among the state, provincial and municipal authorities in the National Air Quality Collaboration Programme (Nationaal Samenwerkingsprogramma Luchtkwaliteit, NSL). The Amsterdam measures are set out in the 2011 Clean Air Plan for Amsterdam (Plan Schone Lucht voor Amsterdam). This plan was evaluated and adjusted in 2013. The current set of measures will be continued with the goal of achieving the NO_2 standard in all locations as quickly as possible. It has been calculated previously that, with the current measures and without additional measures by the national government or by European authorities, this goal will be achieved by 2021. The municipality does not want to wait that long, however, and is therefore taking extra measures and according to it, last exceedances of the standard will be solved by the end of the current Municipal Executive term.

According to the Clean Air section of *Sustainable Amsterdam*,[cxxx] the measures already set out in the current Clean Air Plan for Amsterdam (Plan Schone Lucht voor Amsterdam) are:

- Implement an Electric Transportation Subsidy Programme;
- Implement a Euro6/alternative fuels Subsidy Programme;
- Further rollout of tailored programme to promote clean transport among corporate frequent road users;
- Further rollout of measures for sustainable goods transportation, such as constructing smart goods transfer stations and offering exemption windows for emission-free distributors;
- Preparation of Cleaner Parking Plan (implementation per 1/1/2016);
- Implementation of location-specific measures (particularly for traffic circulation).

The College of Mayor and Alderpersons has indicated that it wants to see a rapid, (cost) efficient and lasting improvement of the air quality. This will be achieved by implementing a comprehensive set of measures that consist of a combination of incentives and regulatory

[cxxx] sustainableamsterdam.com

requirements. Measures are designed to provide clarity for the long term (2025) so that residents, businesses and visitors have a clear practical perspective:

- Confer with representatives of public transportation companies, cargo transporters, delivery companies, taxis and touring coaches to reach agreements on encouraging, facilitating and regulating clean transportation. Set a clear target per group (preferably emission-free transportation within the A10 ring road by 2025) and make agreements about the staged realisation of this goal.
- Work out stimulating and facilitating measures to optimally facilitate entrepreneurs who opt for emission-free transportation, by offering privileges or eliminating obstacles (calculate the effects, practical elaboration, planning, legal possibilities, etc.)
- Establish a clear regulatory measure per category (incl. implementation plan and phases). The goal is to establish an environmental zone for delivery vehicles (per 1 January 2017, minimally Euro III diesel, vehicles not older than 1/1/2000), taxis (no later than 1 January 2018, minimally Euro 5 diesel), coaches (no later than 1 January 2018, minimally Euro IV diesel) and to further implement and tighten in 2020 the environmental zone for freight lorries. The staged realisation is aimed at establishing a zone that is as clean as possible, preferably emission-free by 2025, taking operational management and coping capacity into account as much as possible. Agreements will also be made with these groups on a set of suitable stimulating measures (e.g. rollout of exclusively emission-free taxi ranks or extra facilities for touring coaches within the A10 ring road) and on how the municipality can facilitate this development.
- Introduce age criteria for parking licences, for diesel not older than 1/1/2000 (minimally Euro 4) and petrol not older than 1/7/1992 (minimally Euro 1) as a regulatory measure for private vehicles (elaboration of a 2013 Council Decision).
- Collaborate with the Municipal Transport Authority (GVB) to achieve an emission-free public bus service in 2026.
- Collaborate with the GVB to research means of cleaning up the municipal ferry services (feasibility, costs, effects on air quality).
- Promote smarter logistics by facilitating and stimulating the further use of the three cargo hubs and by providing space for two further sustainable cargo hubs.
- Research the possibility to introduce an environmental zone for two-stroke scooters. The already implemented plan to move these scooters on to the roadway has already mitigated much of the harm to cyclists' health. The municipality furthermore continues to discuss means of accelerating the cleanup of these vehicles with the national government.
- Research means to clean up other sources of air pollution, including mobile equipment.
- Research the contribution of car sharing to air quality.

Aside from this citywide approach and the implementation of generic measures, the city of Amsterdam is also taking targeted measures to ensure that the air quality in the most persistent problem areas improves as quickly as possible. Even if the standard is attained everywhere, the city intends to continue to monitor the most heavily affected areas. Wherever possible, and without displacing the problem to elsewhere, the city plans to opt for location-specific solutions that are good for the air quality, the traffic flow and accessibility.

Improving traffic flows is an effective measure – for instance, by introducing smart solutions in the circulation, by a better alignment of traffic lights, by combining the different traffic flows more effectively and by a better distribution of traffic. The citywide focus on traffic flow through the mobility strategy, and the focus on traffic flow at specific heavily affected areas through the air quality strategy, can thus reinforce each other.

Concrete local actions and measures planned by the Amsterdam city:

- Monitor and investigate the most heavily affected locations;
- Research concrete location-specific measures;
- Implement measures.

4.6.3 Air Quality Monitoring

Amsterdam has an advanced air quality-measuring network, managed by the Municipal Health Service (GGD). In the coming years, the municipality will actively seek to make available knowledge accessible and comprehensible, as far and as effectively as possible. This could include, for example, real-time insight into air quality and smog levels.

4.6.4 Emission Inventories

According to TNO (Coenen, 2011), the emission inventory in The Netherlands has a long history. In 1974 it was set up for the assessment of the emissions of pollutants to air and water of major industrial plants in the Netherlands. Over the years methodologies were developed to estimate emissions of all industrial activities. Also non industrial sectors were included in the inventory such as agriculture, consumers and waste sector. At this moment the inventory covers all possible sources of air pollution and water contamination. The inventory has an annual cycle which results in a national database which is used to fulfil all (inter)national obligations to report data on emissions such as UNFCC, CLRTAP.

In recent years vast effort has been made to speed up and streamline the data-process of the emission inventory and the subsequent reporting from the database. By means of state of the art Web technology, emission experts can upload all emission data to the database. After the necessary QA/QC procedures the database is published on the internet together with graphics and maps which can be presented based on the user preferences.

4.6.5 Regulation of Emissions from Industrial Facilities

4.6.5.1 Large Combustion Sources

Large combustion plants are large logistic units, such as power stations and combustion equipment at large chemical companies. The emission limits for large combustion plants are laid

down in the Activities Decree[cxxxi], which is the country's implementation of the EU IED Directive. As such, these sources must satisfy BAT requirements.

4.6.5.2 Mid-sized Combustion Sources

In the Netherlands, requirements for mid-sized combustion plants (boilers, engines, turbines with nominal capacity over 400 kW but less than 50 MW) are laid down in the Activities Decree. The Decree sets emission limit values (ELV) for NO_x, SO_x, PM and C_xH_y (based on best available techniques) and gives provisions on maintenance. With regard to biomass installations, the Activities Decree applies irrespective the nominal capacity. The ELVs depend on the type of plant (boiler, engine or gas turbine) and the type of fuel used (solid, liquid or gaseous). New plants must meet the ELVs now. Existing plants must meet the limit values from 2017.

In the Netherlands, an increase in the use of biomass is expected. For that reason, ELVs are given for the use of biomass in wood-fired boilers and bio-oil fired engines, for example. The ELVs for NO_x for natural gas-fired stationary engines are important parts of the Activities Decree. In the Activities Decree, the ELV is further tightened to 100 mg/Nm3. This ELV plays an important role in reducing industrial NOx emissions as about 10% of the electricity in the Netherlands is generated by gas engines in a CHP application (Combined Heat and Power). To meet the ELV, a SCR (Selective Catalytic Reduction) is needed. In the Netherlands, SCR is considered as BAT.

Emissions monitoring requirements are performed by separate measurements. For boilers, a single set of measurements is required once the ELVs have come into force. Measurements for engines and gas turbines are also required after the ELVs have come into force, and measurements should be repeated every four years. Measurements should be performed by an accredited laboratory. For certain NOx abatement techniques, however, continuous measurements are required. Continuous measurements should meet the requirements of the quality assurance standard EN-14181. The background information is provided in a Manual Measurement of air emissions.[cxxxii]

Emissions that are not regulated by the general binding rules of the Activities Decree are subject to permits. The emission limits for most substances emitted to air by industrial sources are set by the Netherlands Emission Guidelines for Air (NeR). The NeR is a national guideline, aimed at harmonising the environmental permits in the Netherlands with respect to reducing of emissions to the air. The system of the NeR was derived from the German TA Luft in the 1990s.

The NeR does not have a legally binding status. In practice, however, it functions as an important guideline for the competent authorities during the permitting process. The content of the NeR is monitored by representatives of the competent authorities (provinces, municipalities and the national government) and the representative bodies for trade and industry.

[cxxxi] http://rwsenvironment.eu/subjects/environmental/activities-decree/
[cxxxii] http://rwsenvironment.eu/subjects/air/emission/

General concentration standards are given for each substance or class of substances. In most cases, a threshold value is given above which implementation of measures should be considered. This threshold value is called the mass flow limit. The concentrations given in the NeR are upper limits for the concentration in the waste gas flow of a specific relevant source.

Along with the general concentration standards, the NeR also contains special provisions for specific activities and branches of industry. In the NeR, these are called special regulations.

If a proposed project does 'not make a significant contribution' (NIBM) to air pollution, then no assessment against the air quality limit values is required. Proper spatial planning (zoning and other land use management activities) is always a requirement. The NIBM implementation rules are set out in the Order in Council 'Not Make a Significant Contribution' (NIBM Decree[cxxxiii]) and the Ministerial Regulation 'Not Make a Significant Contribution' (NIBM Regulation[cxxxiv]). The NIBM Regulation establishes quantitative limits for specific projects. A new development with no more than 500 houses and 1 access road, for instance, is always defined as not making a significant contribution. However, there are also other ways that governments and promoters can prove a project does not make a significant contribution to air pollution.

4.6.6 Mobile Source Programs

Amsterdam has a low emission zone (LEZ) only for commercial and heavy goods vehicles, which was defined in 2008. Only Heavy Goods Vehicles (HGVs) that meet the Euro IV or Euro V standards and retrofitted Euro III less than 8 years old are allowed in the zone. Fines are rather steep at €230. Vehicles are automatically scanned and thus enforcement is close to 100%. Nevertheless, there are some exemptions and short-term permits with daily fees.

The city believes an LEZ for passenger cars would arouse too much aversion. Also, the city did not tighten up the LEZ because it thinks that this would not be cost-efficient. In comparison, the city of Utrecht introduced an LEZ also for cars in January 2015. Amsterdam plans to expand the LEZ to include delivery vans older than 15 years (Euro 2) by 2017. That is very late compared to other cities in Europe and also in the Netherlands.

According to the website "Soot free for Climate" (supported by EU fundings), 44.7% of the city of Amsterdam's municipal fleet is either Euro 5 or electric vehicles, 37.9% are Euro 4 and 17.5% were either Euro 3 or Euro 2. The proportion of older vehicles remains higher than the city's clean municipal fleet target for 2015. The municipality has recently decided to cancel the financial stimulation for cleaning the municipal fleet, as retrofitting the remaining vehicles retrofit or substitution would not be cost-effective.

For the bus fleet, new buses have been required to comply with best-available technology, suggesting a high share of Euro 5 & 6 or other low emission vehicles.

[cxxxiii] http://wetten.overheid.nl/BWBR0022815/2012-06-20
[cxxxiv] http://wetten.overheid.nl/BWBR0022816/2013-03-22

4.6.6.1 Traffic and Mobility Management

The city of Amsterdam offers several mobility management instruments. They have park & ride strategies, conduct dialogues with businesses and other stakeholders and provide traveller information tools. Mobile and social applications are mostly developed by private actors. The municipality does not offer car-pooling programmes. No new facilities for vulnerable groups are to be built within a range of 300 m of a highway or 50 m of a provincial road (though it is possible to deviate from these rules).

Speed limits are set to 30 km/h in residential areas. Overall, there is a speed limit of 30 km/h on 90% of the roads.

The Amsterdam city states that 32% of traffic movement in the city is by bicycle compared to 22% by car and 16% by public transport. In the city centre, 48% of traffic movement is by bicycle. The city does not set future modal split targets. It is however expected that there will be a continuing move towards sustainable transport, with increasing bicycle use and decreasing car traffic.

4.6.6.2 Promotion of Public Transport

The Amsterdam public transport system is well developed and relies on buses, trams, ferries and a metro network. The municipality has stated that it will carefully develop its system as long as measures are cost-efficient. There are plans to increase the speed of trams on important routes and plans to improve the train service. The city is restructuring their network step by step. For example, they are abolishing the underutilized A-tramline and substituting it with other existing lines. Also, as a consequence of the new North-South metro line scheduled to be finished in 2017, the municipality expects that the number of bus lines will be reduced.

4.6.6.3 Promotion of Walking and Cycling

Amsterdam is one of Europe’s cycling capitals and in the inner city and adjacent areas 50% of all trips are made by bicycle. To cope with an increase in cycling a "Meerjarenplan Fiets 2012-2016" (several year bicycle plan) has been adopted, funded with €57 million, in order to remove urgent deficits, for example in the number of parking racks, or the safety and capacity of the existing infrastructure. 38,000 parking spaces will be created and the most important 15 kilometres of the cycling routes will be improved, rather than creating more bike lanes. In the long run, before 2020 another 38,000 bicycle racks are planned. In comparison, estimates show that another 80,000 are probably needed. There is no bicycle sharing programme (75% of all inhabitants have a bicycle), but there is a service called Public Transport Bicycle for visitors (with about 500 bicycles, not provided by the municipality). With regard to walking, the city has a pedestrian network in the inner city.

4.6.7 Tools

Air quality modelling at national/regional scale is generally performed using the LOTOS-EUROS model, with which the formation and dispersion of ozone, particulate matter, nitrogen dioxide, heavy metals and persistent organic pollutants across Europe can be calculated. The model is capable of simulations down to a resolution of 1 km2. LOTOS-EUROS is being developed in cooperation with the national environmental agency and institute (MNP/RIVM) and is being used for scientific applications and in a policy support role. Figure 16 below of modeled annual average NO_2 concentrations clearly shows high concentrations downwind of very busy roads (in red) and lower concentrations near less busy roads (yellow).

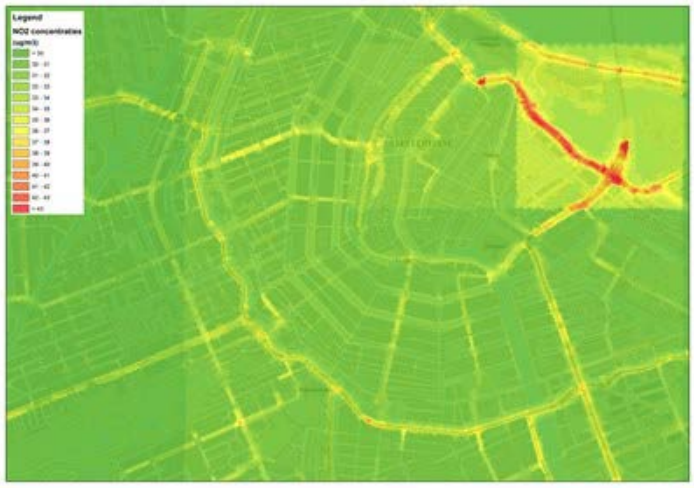


Figure 16 Annual average NO_2 concentrations in Amsterdam.[cxxxv]

4.6.8 Voluntary, Incentive, and Market-Based Measures

Amsterdam has extensive parking management, with different goals including accessibility as well as improving public space and air quality. Amsterdam plans focus on reducing the number of cars parked on the streets; also they have increased paid parking from 117400 in 2008 to 129029 in 2012 so as to discourage driving in the city centre. And at the same time about 5000 new parking spaces are planned be created outside of the city centre in the following years to encourage use of park and ride facilities.

Amsterdam is split into various zones that have different on-street parking rates and lower rates for clean vehicles.

In Amsterdam, P+R (for Park and Ride) means that visitors who come to Amsterdam by car can park their car further away from the city centre and travel to the city centre by public transport. Parking permits are granted to residents in areas where paid parking is in force and the number of permits is limited. As a result, in some districts, for instance in the centre of Amsterdam, the waiting list for a parking permit can be so long that it takes several years before a permit is

[cxxxv] https://www.tno.nl/en/focus-area/urbanisation/environment-sustainability/health-and-the-city/tno-contributed-to-healthy-routes-in-amsterdam/

issued. The 2013 Council decision introduces age criteria for availability of parking licences for private vehicles: diesel not older than 1/1/2000 (minimally Euro 4) and petrol not older than 1/7/1992 (minimally Euro 1).

Other economic measures include e-mobility subsidies like a purchase subsidy for vehicles or a 1000€ towards installation of charging points.

Amsterdam hasn't implemented a congestion charge for all vehicles entering the city center but a Low Emission Zone has been implemented for delivery trucks. The city has implemented other measures to reduce car-traffic in the city and has reduced car traffic by 25% since the mid-1990s.

4.6.9 Public and Stakeholder Involvement

In Amsterdam there are three offices working on improving air quality and increasing public awareness. The city states that between July 2012 and August 2013 alone, 53 activities within the context of the strategic communication plan Clean Air were undertaken, including promotion activities and the production of infographics. There are an interactive map, reports, data download, twitter and a newsletter. Direct contact is possible via the GGD health service. There is great amount of data on the health impact of air pollution at the municipal level. However, in our inquiries it seemed that is not well communicated.

4.6.10 Assessment

As reported in the 2009 *European Green City Index*[cxxxvi] , the main air quality concerns in the Netherlands in general and in Amsterdam in particular are high levels of $PM_{2.5}$ and NO_2. Sources within the Netherlands and cross-border transport from heavily industrialized areas in Germany and Belgium contribute to these air quality issues. Implementation of air quality programs is largely the responsibility of local municipal governments with regional cooperation managed via the NSL. Much of the attention on emission reduction efforts have been focussed on reducing road traffic emissions in a variety of ways. While we do not have direct practical experience with air quality management in the Netherlands, our review supports conclusions reached in the Green City Index report which notes that Amsterdam in particular "has a highly developed environmental action programme with measurable environmental goals and regular reviews" while noting some deficiencies with respect to the level of public participation in the programme.

4.7 Poland

4.7.1 Administration of Air Quality Regulations

In order to protect human health and the environment, the Council of the European Union drew up a directive with air quality standards in April 1999. With the act of 13 April 2012 amending the Act on the Environmental Protection Law and other acts (Dz.U. of 2012, item 460) the Polish government transposed the EU directive into national legislation. Accordingly, the limit value for

[cxxxvi] http://www.siemens.com/entry/cc/en/greencityindex.htm

particulate matter was set at 50 micrograms per cubic meter of air, which may be exceeded on a maximum of 35 days a year. The average annual value for nitrogen dioxide was set at 40 µg m^{-3}.

4.7.2 Air Quality Monitoring

The Inspection for Environmental protection is monitoring air quality in Poland. Its tasks are performed by the Chief Inspector for Environmental Protection assisted by the General Inspectorate for Environmental Protection and voivodes (governors) supported by voivodship (administrative district or province) inspectors for environmental protection, as heads of voivodship inspections for environmental protection. In 2013 air quality was monitored in 809 automatic stations, 983 manual stations and in 1,137 stations in which passive methods are used. Stations are installed in traffic areas, urban background areas and rural areas depending on a voivodship. Usually in those voivodships where exceedances are the highest, there are more measuring stations. The full map of the stations is available online.[cxxxvii] Data are published by annual reports on air quality for European Commission.[cxxxviii]

In every zone in Poland there was at least one limit value exceeded last year. A significant part of these exceedances is due to the widespread burning of cheap coal in old home stoves in densely populated cities. Benzo(a)pyren concentration found to exceed limit values in 91 per cent of the zones - the highest index was noted in Łódzka zone – 14 times more than the limit, and in Małopolska zone – 16 times more. PM_{10} was exceeded in 78 per cent of the zones and $PM_{2,5}$ in over a half of the zones.[cxxxix] Moreover there are two zones with an exceedance of arsenic in Lubuskie and Dolnośląskie voivodships. NO_2 was noted over the limit in four major cities of Poland: Wroclaw, Krakow, Warsaw and in the agglomeration of Górny Śląsk. Almost all of Opolskie and Dolnośląskie voivodships were classified as C zone due to ozone limits exceedance. The cleanest areas are Zachodniopomorskie, Warmińsko-mazurskie, Lubelskie and Podlaskie voivodships.

4.7.3 Air Quality Plans

For O_3 and PM_{10}, the territory is divided in Air quality zones according to the EU regulation. Zones exceeding the EU AQ standards can be considered as NAAs. The zones for PM_{10} are presented in Figure 17.

[cxxxvii] http://powietrze.gios.gov.pl/gios/site/measuringstation/I
[cxxxviii] http://cdr.eionet.europa.eu/pl/eu/annualair
[cxxxix] http://powietrze.gios.gov.pl/gios/site/documents/download/101280

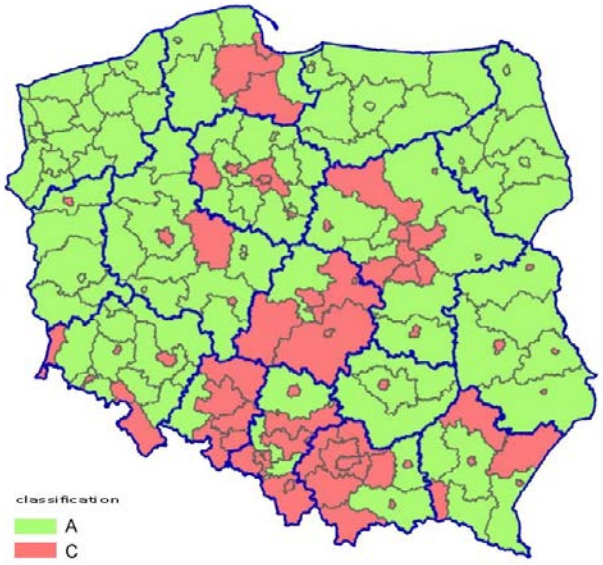


Figure 17 Zones determined on the basis of 24-hour concentrations of PM_{10} particulate matter. Classes in color derive from results of ambient air quality for 2008; blue lines denote voivodship (province) boundaries (source: CIEP/SEM).

According to the Clean Air Initiative website supported by the EU (LIFE+ program):[cxl]
"The EU Air Quality Directive was transposed with two-year-long delay and its implementation has not been full. For example Article 23 (1), the second sentence of the Cleaner Air For Europe (CAFÉ) Directive (EU Directive 2008/50/EC), stating that "in the event of exceedances of those limit values for which the attainment deadline has already expired, the air quality plans shall set out appropriate measures, so that the exceedance period can be kept as short as possible." should be regarded as improperly transposed into Polish legislation. The national provisions on air protection programmes do not require these documents to ensure that the period in which limit values are exceeded is reduced to the minimum. The Regulation of the Minister of the Environment on air protection programmes and short term action plans states that air protection programmes have to comply with 'a schedule of measures and expenses, including respective medium term measures, drawn up for a period of no longer than five years, and long term measures, for a period of no longer than ten years,' which clearly counters the purpose of Article 23 of the CAFE Directive."

"Moreover, the amendments to the Act on Environmental Protection Law, introduced by the Act of 28 May 2012, stipulate that with respect to the zones for which air protection programmes have been adopted and where air quality norms have been exceeded, the Board of the Voivodship (administrative district) is obliged to prepare a review of the programme within three years of the day on which the resolution of the Voivodship Parliament on the air protection programme was adopted. The three-year-long period during which air quality norms are exceeded clearly will not ensure that the period with exceedances is as short as possible. Air Quality Plans were prepared for each zone and agglomeration, but sometimes with some delay. Sixteen air quality plans have been prepared for each administrative district. The time to comply

[cxl] http://legal.cleanair-europe.org/legal/poland/

with the limit values differs in each plan. For example in Air quality plan for Małopolskie and Śląskie voivodship compliance is planned to be achieved in 2020. Usually all the measures set in air quality plans have been implemented. Nevertheless there are some doubts whether these measures where adequate and effective or whether setting them complied with the aims of the Directive."

"There are no Low Emission Zones in Poland so far and no plans in the Polish Parliament to introduce them."

Warsaw's first air protection program was prepared and adopted in 2007 by an ordinance of the Voivode of Mazovia dated 24 December 2007, on establishing the Warsaw agglomeration's air protection program. In 2013, the program was replaced by the air protection program for the Warsaw agglomeration established by the Mazovian Voivodeship Board and adopted by the Regional Council of the Mazovian Voivodeship (it defined the permitted levels of particulate matter PM_{10} and nitrogen dioxide). Air protection programs due to the exceedance of permitted $PM_{2,5}$ and benzo(a)pyrene levels were created.[cxli]

In recent years, Warsaw carried out measures aimed at improving air quality. Due to the impact of specific emission sources on the city's air quality, measures limiting transport emissions and low communal emissions are particularly important.

Warsaw's air protection program includes several elements:[cxlii]

- Educational campaigns aimed at raising public awareness in the scope of:
  - Environmental benefits of public transport systems usage or alternative systems of transportation (cycling, walking);
  - Dangers of waste incineration in household furnaces;
  - Benefits of connection to centralized heat sources;
  - Thermal retrofitting;
  - Promotion of advanced low emission heat sources, and others;
- Introduction of new green areas along transport routes; planting of shrubs/trees on existing squares and revitalization of green urban areas;
- The use of appropriate arrangements limiting emissions of nitrogen dioxide and PM_{10} in the local zoning plans with regard to e.g. development patters ensuring the city's ventilation, introducing protective greenery (particularly along routes), development of public spaces and establishment of a ban on the use of solid fuels in buildings (when using individual heating systems), the reorganization of the transportation system and the introduction (city center) of closed traffic zones.

- The Warsaw city co-finances liquidation of low emission coal-fired sources i.e. by installing solar and heating pumps.

[cxli] https://infrastruktura.um.warszawa.pl/sites/infrastruktura.um.warszawa.pl/files/indicator_5_warsaw.pdf
[cxlii] City of Warsaw application for the 2018 European Clean Cities award;
https://infrastruktura.um.warszawa.pl/sites/infrastruktura.um.warszawa.pl/files/indicator_5_warsaw.pdf

- Specific actions of the city of Warsaw concern the expansion of heating systems and systematic connection of industrial facilities, municipal companies and public utility buildings to the heating network (liquidation of coal-fired heating),
- Each year in Warsaw, municipal buildings and public utility buildings previously heated by individual coal - fired sources are connected to a central heating network (to limit low communal emissions). In 2014, within the Network heating in municipal buildings program, 11 buildings (8 924 m2) in the Praga-Południe and Praga-Północ districts were equipped with central heating and domestic hot water installations. Within this project, 77 buildings of an area of 58 614 m2 were provided with heat in the years 2010-2014.
- Works related to the maintenance/expansion of green areas are commenced. New plantings in parks and along transport routes have been made. Measures aimed at enriching biological diversity and enhancing biologically active areas resulting in air quality improvement are commenced i.e. the Flower Meadows project carried out by the Ursynów district (part of a park is to be transformed into a flower meadow by ceasing the mowing of grass and sowing of seeds).

4.7.4 Mobile Source Programs

Warsaw's mobile source programs include:[2]

- A variety of measures aimed at promoting public transport, including modernization of the bus fleet, introduction of alternative fueled and zero emission busses, metro line construction, construction of new tram connections, park and ride parking facilities and prioritizing of buses by designating bus lines.
- Promotion of bicycle use with self-service city bike rentals and expansion of cycling infrastructure.
- Road and transport activities carried out in connection with The Transportation System of Warsaw: Sustainable Development Strategy up to the year 2015 and successive years, including the Sustainable Development Plan for Warsaw's Public Mass Transit System.

Concrete short and long-term measures described in the air protection programs of Warsaw currently carried out:

- expansion of the bicycle paths system and cycling infrastructure, including;
- Construction of bicycle path segments linking existing paths, particularly in the downtown area;
- Construction of bicycle facilities located near key destination spots (universities, schools, local and state administration buildings, cultural sites) and public transport hubs;
- Proper organization of cycling traffic/automobile traffic.
- Modernization and renovation of roads within the Warsaw agglomeration, including liquidation of unpaved surfaces,
- Water street cleaning during spring-fall seasons;

[2] City of Warsaw application for the 2018 European Clean Cities award; https://infrastruktura.um.warszawa.pl/sites/infrastruktura.um.warszawa.pl/files/indicator_5_warsaw.pdf

- Development/implementation of the Plan for Sustainable Development of Public Transport, including:
  - creation of a coherent management system of public transport vehicles;
  - Integration of the public transport system in the Warsaw agglomeration (coordination of timetables);
  - Passenger information system at stops, informing on current conditions and possibilities of transport and occurring disruptions in the system's functioning;
  - Development and modernization of the public transport system, including:
    - Introduction of a joint and inexpensive ticket for agglomeration journeys;
    - Pricing policy aimed at promoting the public transport system (particularly for multiple journeys – monthly/quarterly tickets);
- The development and increase of the share of environment- friendly public transport;
- Introduction of low-carbon fuels and technologies;
- Modernization of public transport infrastructure (in particular rail transport system);
- Construction of new/modernization of existing interchanges/hubs;
- Organization of a system of secure parking areas on the outskirts of the city including convenient public transport system to the city center (P&R).

4.7.5 Public and Stakeholder Involvement

Air quality assessments in Warsaw are carried out by the Mazovian Voivodeship Inspector for Environmental Protection (WIOŚ). WIOŚ also informs about the levels of air substances. The results obtained from measuring stations in Warsaw constitute an element of the Air Quality Assessment System. An application outlining current air quality levels is available on the system's website. In order to present the air pollution level, a so-called *air quality index* was used. It takes into consideration the most adverse current concentration level of all measured substances. Measured concentration levels of specific substances are also available (Figure 18 below).

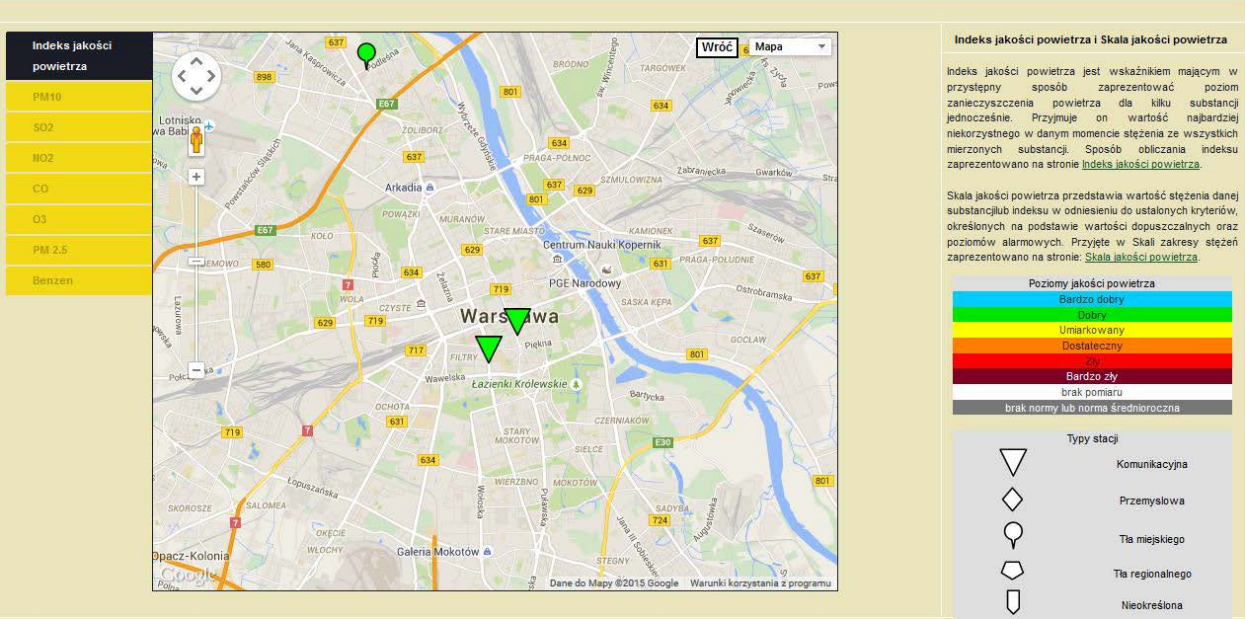


Figure 18 Public information about concentrations and air quality index observed in Warsaw. (source: WIOS)

In June 2015, the Mazovian Voivodeship Inspector for Environmental Protection in Warsaw launched an air pollution prognosis in the Mazovian Voivodeship (including in Warsaw). Each resident can check the level of air quality at any time (Figure 19).

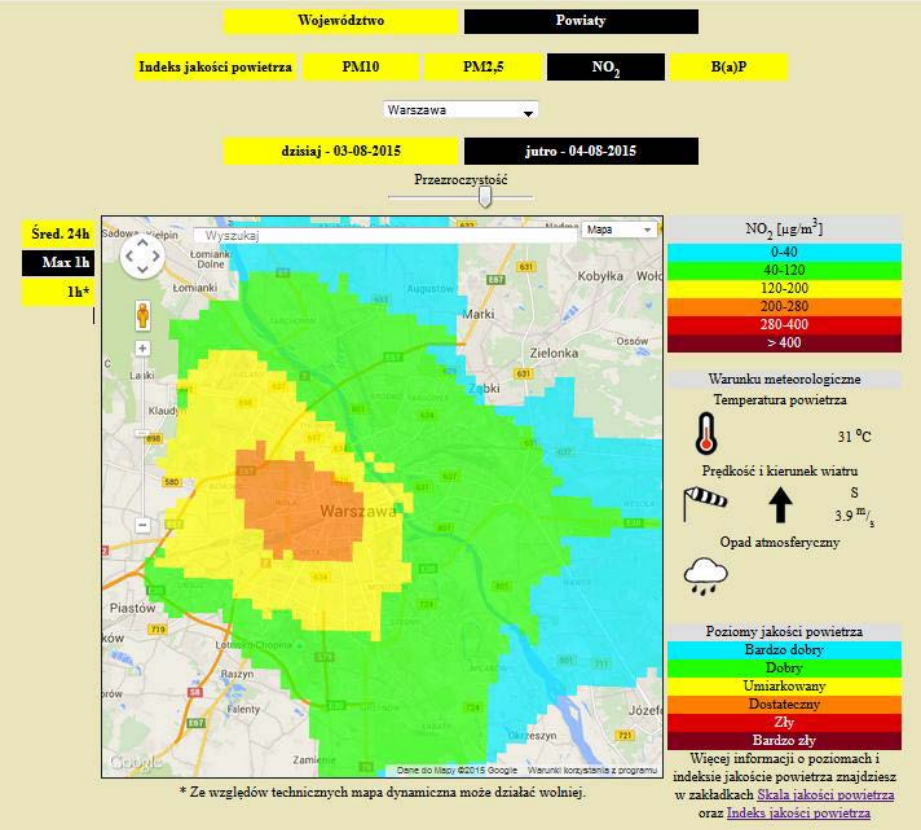


Figure 19 Air quality forecast map for Warsaw. (source: WIOS)

4.7.6 Assessment

Poland suffers from severe air pollution as summarized in recent news reports such as the following:

From the Radio Poland news website[cxliii], 22 December 2015:
"According to the daily Gazeta Wyborcza, Poland has the most polluted air in the entire 28-nation bloc. Recently, the European Commission sent a second opinion on the matter to the government, with the EC's Environment Press Officer Iris Petsa telling the daily that "there are constant infringements and Poland isn't doing anything about it". Poland will have two months to initiate a legislative process to combat poor air quality in the country, otherwise the European Court of Justice may start to impose fines which could reach up to PLN 4 billion (around EUR 1 billion), according to the Supreme Audit Office in Warsaw. The human cost is also high, remarks Gazeta Wyborcza, which cites Łukasz Adamkiewicz from the Health and Environment Alliance, who says that "2.5 million Poles suffer from chronic lung disease" due to air pollution. In southern Poland pollution is rife, with the level of toxic PM_{10} dust particles in the city of Kraków above the maximum limit for 150 days a year, while in the Silesian cities of Gliwice and Zabrze the limit is exceeded 125 days annually".

[cxliii] http://www.thenews.pl/

From The Guardian website, April 2015:

"Kraków, an elegant city dotted with the remnants of its history as Poland's royal capital, suffers from the dirtiest air in a country plagued by severe pollution.[cxliv] Much of it is created by the widespread burning of cheap coal in old home stoves, producing smoke rife with carcinogens like dioxins and benzo(a)pyrene, as well as the small sooty particles that are strongly linked to heart, breathing and even cognitive ailments. The cars that clog Kraków's roads and the coal-fired power plants nearby add to the problem."

"But the city is trying to change that. Ranked by the European Union as having Europe's third dirtiest air[cxlv], topped only by Pernik and Plovdiv in Bulgaria, Kraków became the first in Poland to approve a ban on the use of solid fuels such as coal and wood for home heating. 'Get a Grant, Replace your Furnace', a post in Kraków, tells householders how they could get financial support for the changeover from coal."

"Scheduled to come into force in 2018, the new law was deemed invalid last year by a regional court – but it remains on the books until an appeal is decided. Meanwhile national politicians, with the backing of Poland's right-leaning government, are seeking to circumvent the decision with a bill that would give regional authorities throughout the country the power to regulate coal, vehicles and other sources of pollution."
"With €100m from Brussels (i.e. the EU), Warsaw and the regional authority, Kraków officials are also pushing forward with financial incentives aimed at getting city residents to junk their old coal stoves in favour of gas, electricity or a hookup to Kraków's district heating system, which pumps heat to users from large central boilers. The city is reimbursing eligible residents for the full cost of a new boiler, but the fraction covered will fall as the ban's start date draws closer."

"With an estimated 30,000 coal boilers scattered around Kraków, change won't be easy, or cheap. The fuel, some call "Polish gold", is embedded in the country's culture and history, providing nearly 90% of its electricity and giving Poles a feeling of freedom from their feared neighbour Vladimir Putin and his gas pipelines. And for users, at least, it is a lot less expensive than the alternatives."

4.8 Germany

4.8.1 Regulatory Structure

The German government bases air pollution control on four strategies:

- Laying down environmental quality standards
- Emissions reduction requirements according to the best available technology
- Product regulations
- Laying down emission ceilings

[cxliv] http://www.env-health.org/news/latest-news/article/heal-in-poland-highlights-air
[cxlv] http://www.eea.europa.eu/data-and-maps/figures/percentage-of-urban-population-resident-in-areas-where-pollutant-concentrations-are-higher-than-selected-limit-target-values-eea-member-countries-2

Germany's air quality system is built around 5 main policy instruments:

1. Federal Immission Control Act and Implementing Ordinances:
Air quality control in Germany is mainly governed by the Act on the Prevention of Harmful Effects on the Environment Caused by Air Pollution, Noise, Vibration and Similar Phenomena (the Federal Immission Control Act or BImSchG) and its implementing ordinances and administrative regulations.[cxlvi] In addition, there are also provisions on air quality control at Länder (states) level. There are 16 Länders in Germany - see Figure 20 below.

2. Technical Instructions on Air Quality control (TA Luft):
The TA Luft are a modern instrument for German authorities to control air pollution. They contain provisions to protect citizens from unacceptably high pollutant emissions from installations as well as requirements to prevent adverse effects on the environment. In addition, it lays down emissions limit values for relevant air pollutants from installations. Existing installations must also be upgraded to the best available technology.

3. Amendment to Ordinance on small Firing Installation (1. BImSchV):
The 1. BImSchV, which entered into force in March 2010, was an important step towards reducing particulate matter emissions from small firing installations such as stoves and tiled stoves. More specifically, the amended requirements for new installations and modernisation of existing installations will achieve an average reduction in particulate matter emissions of 5 to 10% in the affected residential areas.

4. Implementation of the directive on industrial emissions:
A large share of the emissions reduction necessary to meet the targets above will be achieved by the implementation of the directive on industrial emissions.

5. Transboundary air pollution control policy:
A significant share of the airborne pollution load is transported over long distances from neighbouring countries. For this reason, shaping a transboundary air pollution control policy is of strategic importance for air quality in Germany. The German government is therefore actively involved in the constructive dialogue on air pollution control measures both at European and international levels. One example of this is the cooperation with the Geneva Convention on Long-range Transboundary Air Pollution.

Germany also has provisions on air quality control implemented at the Länder (state) level.

A list of the local regulation texts is provided in Appendix 5.

[cxlvi] Immission in this context refers to concentrations of contaminants in the environment.

Figure 20 German states.

4.8.2 Ambient Standards

As described in Section 1.1, the Environmental European legislations provide standards for some pollutants from several works and in particular those led by WHO (World Health Organization). Within a context of threshold exceedance, Member States are required to implement actions in order to comply with standards as quickly as possible. Limit and target values for a number of air pollutants have been set in the Directive 2008/50/EC (see Appendix 1).

4.8.3 Air Quality Monitoring

According to the Section 44 of BImSchG dedicated to Monitoring Air Quality:

"1) In order to monitor air quality, the competent authorities shall conduct tests at regular intervals in accordance with the requirements of the ordinances pursuant to section 48a subsection (1) or subsection (1a).
(2) The Land governments or the competent authorities they designate are authorised to establish by ordinance test areas where the nature and extent of air pollution which is not covered by subsection (1) above and which may cause harmful effects on the environment must be determined either over a specified period or continuously and where the circumstances that are conducive to the development and dispersion of the air pollution must be investigated."
The air monitoring network of the Federal Environment Agency (Umweltbundesamt - UBA) operates measuring stations far away from densely populated areas and cities. Local sources of pollutants, such as industrial sites or power stations, should not affect the measurements. Situated in rural areas, the stations of the Federal Environment Agency measure the quality of air masses transported over long distances and across national frontiers.
Unlike the UBA, Germany's Länder operate measuring stations in cities, in conurbations, in areas with high traffic density as well as in rural regions, in order to monitor and determine local and regional air quality.

Each air monitoring station in Germany (Federal or Länder) has a specific measuring program and works with specific measuring instruments. Information both on stations currently in operation and on stations that are no longer operational is available at the Federal Environment Agency's stations database[cxlvii].

4.8.4 Emission Inventories

According to the Section 46 of BImSchG, "The competent authorities shall prepare emission inventories where this is necessary to implement binding decisions of the European Communities". In order to implement any obligations arising from intergovernmental agreements of binding decision of the European Commission, emission inventories shall be prepared by the Federal Government (Section 37 of BImSchG).

4.8.5 Planning Areas

According to Article 23 of the European Air Quality Directive, Germany – as other Member States – shall ensure that air quality plans are established where the levels of pollutants in ambient air exceed any limit value or target value.

[cxlvii] http://www.envit.de/stationen/public/language.do;jsessionid=301985B5B53A47A60F18CE16DCEDC92E?language=en

4.8.5.1 Area Planning Requirements

According to Section 47(1) Part V of BImSchG[cxlviii] "If the immission[cxlix] limits [ambient concentration limits] specified in an ordinance pursuant to section 48a subsection (1), including any margins of tolerance defined therein, are exceeded, the competent authority shall draw up a clean air plan that defines the necessary measures for achieving a durable reduction of air pollution and conforms to the requirements of the ordinance". The clean Air plan shall define "the measures to be taken in the short term" (47(2)), "be paid to the objectives of regional planning; due regard shall be paid to the principles and other requirements of regional planning" (47(3)) and cover all relevant pollutants with no compliance (47(4)). In addition, "The measures shall, on the basis of the respective contribution to the total emissions and in accordance with the principle of proportionality, be applied to all those emitters who are partly responsible for immission[cl] values being exceeded" (47(4)).

According to the section 47 (2), if there is a risk that the immission limits or alert thresholds are exceeded, the competent authority shall draw up an action plan defining the measures to be taken in the short term. The measures defined in the action plan shall be such as to ensure that the risk of these values being exceeded is reduced or that the period during which these values are exceeded is shortened. Actions plans may be part of clean air plans mentioned above.

As per Section 45 (BImSchG), additional requirements for the air quality plans include:

"(1) The competent authorities shall take the necessary measures to ensure compliance with the immission values laid down in an ordinance pursuant to section 48a ("Ordinances on Emission and Immission Values"). These include in particular plans pursuant to section 47 ("Clean Air Plans, Action Plans, Land Ordinances").

(2) The measures pursuant to subsection (1) above
a) shall be in line with an integrated approach for the protection of air, water and soil;
b) shall not contravene any provisions for the protection of health and safety in the workplace;
c) shall not cause significant impairment to the environment in other Member States".

4.8.5.2 Area Plan Contents

Air quality plans must include a comprehensive emissions inventory covering all source sectors and a set of emission control measures necessary to meet air quality goals based on the results of air quality and human exposure modeling. Most plans focus primarily on NO_2 and PM and the contributions of mobile sources. Since on-road vehicle emission control technologies are specified at the EU level, local plans focus on accelerated introduction of newer, cleaner

[cxlviii] Act on the prevention of Harmful Effects on the environment caused by Air Pollution, Noise, Vibration and Similar Phenomena (Federal Immission Control Act)
[cxlix] In Germany, "immission" is the term used in reference to the amount of a pollutant in the environment, i.e., a concentration value.
[cl] "Immissions" as used herein shall mean any air pollution, noise, vibration, light, heat, radiation and similar effects on the environment which affect human beings, animals and plants, soil, water, the atmosphere as well as cultural objects and other material goods

vehicles, promotion of alternative fueled and zero emission vehicles, transportation control measures, promotion of alternative transportation modes (public transit or bicycles/walking), and integrated land use planning.

AQ Plans are expected to include source apportionments with respect to both spatial origin and different source groups. Source apportionment with respect to pollution sources quantifies the contributions of various source groups, e. g. road traffic (RT), industrial sources (Ind), domestic combustion (DC), other traffic (OT), long range transport (LRT), and other sources (OS). The analysis of source apportionments (IVU Umwelt, 2013) in the AQ Plans shows that, over the last years, more and more plans compiled due to NO_2-exceedances include source apportionments: 77 % contained spatial apportionments and 69 % contained apportionments with respect to source groups. For PM_{10}, the fraction for spatial source apportionments has been over 80 % since the analysis in 2007. Apportionments with respect to the main source groups have risen continuously to a current figure of 57 %.

The share of source groups is generally calculated by means of dispersion models. These included the large-scale air pollution. On the other hand, air quality monitoring data are evaluated together with meteorological data.

Air quality plans must be prepared every five years (Clean Air – Made in Germany[cli]) and can be revised each year. The scheme of reduction measures needed in an air quality plan is published in the 2015 UBA document: “Inventory and effectiveness of measures to improve air quality”.

4.8.6 Regulation of Emissions from Industrial Facilities

Generally, any alteration of the location, nature or operation of an installation subject to licensing shall require a licence if the alteration may lead to adverse effects. A licence shall be required under any circumstances if the alteration or extension of the operation of an installation subject to licensing reaches in itself the capacity limits or installation sizes stated in the annex to the Ordinance on Installations Subject to Licensing (*Verordnung über genehmigungsbedürftige Anlagen*). A licence shall not be required if the adverse effects due to the alteration are obviously minor.

In the case of installations subject to licensing, this Act on the Prevention of Harmful Effects on the Environment Caused by Air Pollution, Noise, Vibration and Similar Phenomena (Federal Immission Control Act - BImSchG[clii]) shall:

- “ensure integrated prevention and control of any harmful effects on the environment caused by emissions to air, water and soil by securing the participation of the waste management sector in order to achieve a high level of protection for the environment as a whole and

[cli] www.german-sustainable-mobility.de
[clii] Act on the Prevention of Harmful Effects on the Environment Caused by Air Pollution, Noise, Vibration and Similar Phenomena (Federal Immission Control Act - BImSchG) (*Bundes-Immissionsschutzgesetz*), September 2002

- ensure protection and the taking of precautions against any hazards, significant disadvantages and significant nuisances caused in any other way."

According to the Part I of BImSchG, General Provisions, Section 3(6), ""Best available techniques" as used herein shall mean the state of development of advanced processes, establishments or modes of operation which is deemed to indicate the practical suitability of a particular technique for restricting emissions levels to air, water or soil, for guaranteeing installations' safety or for preventing or reducing any effects on the environment with a view to achieving a high level of protection for the environment as a whole. When determining the best available techniques, special consideration shall be given to the criteria listed in the Annex". Criteria to be taken into account when determining best available techniques, bearing in mind the cost and benefit of any measures considered and the principles of precaution and prevention, all in relation to installations of a given type, shall in particular include the following:

1. Use of low-waste technology;
2. Use of less hazardous substances;
3. Furthering of recovery and recycling of the substances generated and used in the processes and, where appropriate, of the waste produced;
4. Comparable processes, facilities or methods of operation which have been tried with success on an industrial scale;
5. Technological advances and changes in scientific knowledge and understanding;
6. Nature, effects and volume of the emissions concerned;
7. Commissioning dates for new or existing installations;
8. Length of time needed to introduce the best available technique;
9. Consumption and nature of raw materials (including water) used in the process and their energy efficiency;
10. Need to prevent or reduce to a minimum the overall impact of the emissions on humans and the environment and the risks to them;
11. Need to prevent accidents and to minimize the consequences for humans and the environment;
12. Information published by the Commission of the European Communities pursuant to Article 16 (2) of Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control (OJ EC No. L 257, P. 26) or by international organizations.

The "Best Available Techniques" used in Germany are essentially the same as the BAT specified in EU Directive 2010/75/EU on industrial emissions (IED).

There is no offset ratio (such as defined by the US EPA).

The interim European reduction targets for emissions in 2020 compared to 2000 are as follows:

- sulphur dioxide by 82%
- nitrogen oxides by 60%
- volatile organic compounds by 51%
- ammonia by 27%
- particulate matter ($PM_{2.5}$) by 59%

A large share of the emissions reduction necessary to meet the targets above will be achieved by the implementation of the European directive on industrial emissions (IED). Implementation of BAT conclusions developed as per the IED generally is expected to occur with 3 to 5 years following publication of each BAT conclusion.

4.8.7 Area and Mobile Source Programs

According to the Section 40 of BImSchG which is dedicated to traffic restriction, "The competent road traffic authority shall restrict or ban motor vehicle traffic in accordance with relevant road traffic regulations, if such is provided for by a clean air plan or action plan issued under section 47 subsection (1) or (2). The road traffic authority may, in agreement with the competent authority responsible for immission control, grant exemptions from any bans or restrictions on motor vehicle traffic, if so required by unpostponable and overriding reasons related to the common good". In this context LEZ (Low Emission Zone) were defined in which specific vehicle traffic reduction are applied.

A number of Germany's cities have designed Low Emission Zones (LEZ) whose purpose is to improve the air quality within these zones and thus protect public health. Below some considerations concerning the LEZ implemented in Berlin, extracted from « Sustainable Urban Transport Project (SUTP): The Sustainable Urban Transport Guide Germany »[cliii] :

"The EU has set stringent limit values for these pollutants and threatens countries with financial fines for breaching them. However, these limits are still being exceeded in Berlin, which is why the city has introduced a "low emission zone." A low emission zone is a defined urban area in which limit values are often exceeded and where only low-emission vehicles can be driven. In Berlin this is the area within the city rail ring, home to just over a million people. Contraventions incur a fine, currently set at €80. Federal law defines four categories ranging from slightly lower emission to ultra-low emission vehicle. Vehicles receive a windscreen sticker in different colours to show which category they belong to. It is at the discretion of the local authorities to decide, on the basis of local pollution conditions, which category of vehicle should be prohibited from entering the low emission zone and which exemptions may be granted."

"Berlin emission zone is a defined urban area since January 1, 2008, as there was no other obvious way of quickly achieving a sufficient reduction in air pollution levels. Motor vehicles in Berlin are still major contributors to particulate pollution and are almost solely responsible for nitrogen oxide pollution. The low emission zone was introduced in two phases to give owners time to buy newer model vehicles or, for diesel vehicles, to retrofit their vehicles with particulate filters certified by the Federal Motor Transport Authority.[cliv] Initially vehicles with the highest emissions were prohibited, and the other three categories – red, yellow and green – were still allowed to enter the low emission zone. The second phase began on January 1, 2010. Since then, only vehicles that have a green sticker, i.e. the cleanest category of vehicles at present, are allowed within the zone. Continual monitoring of air quality has shown that the introduction of

[cliii] http://www.german-sustainable-mobility.de/wp-content/uploads/2015/01/sut-travel_guide_berlin.pdf
[cliv] http://www.stadtentwicklung.berlin.de/umwelt/luftqualitaet/umweltzone/en/foerderung.shtml

the low emission zone has been effective: it has significantly speeded up the replacement of old vehicles by low-emission ones. This has meant that particulate emissions are 50% lower than the predicted trend and nitrogen dioxide emissions are 20% lower. Despite this success, low emission zones, which have now also been introduced in over 300 other European cities and agglomerations, are the subject of heated public debate. Nevertheless, the fact that limit values are still being exceeded means that low emission zones remain a necessity. Other transport policies designed to further lower the percentage of motor traffic in the city's overall traffic volume promise to reduce pollution further."

Note that the last Air Quality Plan for Berlin (2011-2017) includes several other measures concerning mobile and urban sources:

- Improvement of the municipal transport bus fleet
- Improvement of the municipal vehicle fleet
- Support of natural gas vehicles
- Promotion of ecological means of transport
- Parking space management
- Environmentally sensitive traffic management
- Speed limits on main roads
- Traffic ban for trucks in Silbersteinstraße in Berlin-Neukölln
- Communication of sustainable mobility
- Testing of particulate filter retrofitting for passenger ships
- Dust emissions from construction sites
- Intensified street cleaning

In Stuttgart, a comprehensive retrofitting programme of buses was introduced by the end of 2006. 40% of buses comply with Euro V standard, 25% with EEV (Enhanced Environmentally Friendly Vehicles), 60% are equipped with diesel particulate filter (DPF). New vehicles must have a closed filter. Euro IV standard is fulfilled by 100% of the buses since 2009. Hybrid buses are being tested with diesel and fuel cell technique.

Despite the positive benefits of the intensive Baltic Sea shipping industry, both in economic and tourism terms, the burden on the environment remains a pressing, unsolved problem. High levels of pollution were the motivation for the Lubeck-led EU project, "New Hansa." In Lubeck-Travemunde, 95% of SO_2, 75% of NO_x and 50% of CO_2 emissions were found to originate from ships. A solution is the supply of the vessel with power from a shore-based source via a plug-in connection, thus allowing it to shut down its auxiliary engines. The system is conceived to allow on-board personnel to take the necessary actions independently and without interruption of the power supply. Moreover, electricity can be provided at various voltages, frequencies and power levels via the single on-shore connection according to the ship‘s specific requirements. In Lubeck, the local energy utilities provide eco-power, which further reduces the impacts on the environment. Having initially faced some legal and technical problems, the pilot project in Lubeck has been successfully implemented and is now ready to be transferred to 23 other Baltic ports.

4.8.8 Voluntary, Incentive, and Market-Based Measures

According to the Environmental Tax Reform (ETR) at European level, Germany implemented economic incentives through two laws, which endorse five steps of energy tax increases over a period of 5 years (Unsere Steuern von A–Z. Ausgabe 1999 German Federal Ministry of Finance, Berlin) with various exemptions in fishery and agriculture. While these incentives target CO_2 emissions, they produce important co-benefits in terms of reductions in emissions of other pollutants (typically PM and NOx).

4.8.9 Tools

Most common air dispersion model used at urban scale in Germany is the IMMIS model which consists of:

- Calculation of traffic-induced emissions;
- A Gaussian multi-source dispersion model
- A Screening program for the evaluation of air pollution in city streets
- An air pollutant's transmission calculation in street canyons
- An estimation of noise pollution in streets canyons

At regional scale, REM-CALGRID (RCG) is mostly used. It is a chemical transport model development designed to fulfill the requirements of the ambient air quality framework directive 96/62/EC of the European Commission. It is an Eulerian grid model of medium complexity that can be used on the regional and the urban scale for short-term and long-term simulations of oxidant and aerosol formation.

AUSTAL 2000 is the most used model for regulatory purposes. Developed by Jaenicke Consulting, it's a Lagrangian model allowing to take into account several industrial sources.

4.8.10 Reporting, Status, and Enforcement

4.8.10.1 Reporting

Our review of publicly available sources of information on air quality in Germany suggests that information on status and trends is available and regularly updated (see for example the 2015 air quality report[clv]).

4.8.10.2 Status

In Berlin, industry, power plants and businesses cause around 36 % of the nitrogen oxide emissions and 13 % of the particulate matter emissions (PM_{10}). In addition, certain mobile machines that account for around 12 % of the particulate matter emissions in Berlin are used in industry and business. More than 90 % of the nitrogen oxides in these sectors arise from large

[clv] http://www.umweltbundesamt.de/en/press/pressinformation/air-quality-2015-nitrogen-dioxide-pollution-still

combustion plants, i.e. from power plants. Exhaust gas concentrations have already fallen significantly below the prescribed limit values and reflect the best available technique. There are no other reasonable measures for these installations. Since the exhaust emissions of these installations are discharged through high stacks and are thus well diluted, the share of nitrogen dioxide pollution in the urban background and on roads is low and achieves only around 2 % on main traffic roads. Particulate matter emissions from industry and business only slightly contribute to air pollution on main roads, with less than 2 % of the total, because of increased urban background concentrations. At local level, particulate matter emissions, especially those from mechanical and diffuse processes such as recycling building rubble, producing concrete or the handling of dusting materials, but also exhaust gases of continuously running mobile machines, may lead to increased particulate matter concentrations in the immediate area of such installations. In unfavourable weather conditions, this may contribute to exceedances of the daily limit value. The primary aim of the measure described in the following is to reduce the local pollution of diesel soot emissions from mobile machines and stationary engines. Part of the planning measures is to develop concepts of measures to avoid neighbour conflicts in cases of settlements of new installations.

Example of successfully implemented measures in the Berlin Air Quality Plan (2005-2010):

- Low emission zone (introduction of a low emission zone as an emission based traffic ban). By implementing the low emission zone 10 exceedance days of the 24-hours limit value on roads were avoided. Thanks to the low emission zone, the nitrogen dioxide pollution for roads decreased by more than 5 %.
- Improvement of the municipal transport bus fleet (complete achievement in retrofitting with particulate filters; and retrofitting to EURO 5 standard/enhancement environment-friendly vehicle [EEV] standard). The annual mileage performance of the BVG buses comes to approximately 88 million kilometres. Thus, by means of the fleet modernisation at the end of 2010 and compared to the fleet of 2004, 37 t of diesel soot and 732 t of nitrogen oxide (9 t of which is nitrogen dioxide) can be avoided on an annual basis.
- Support of natural gas vehicles (Federal government supported the purchase of 1,000 natural gas taxis, about 100 natural-gas powered driving school vehicles and 150 natural gas delivery vehicles). These natural gas vehicles accordingly avoided 3 tons of diesel soot and 35 tons of nitrogen oxide per year

Implemented measures in Berlin showed that the extent and duration of limit value exceedances of particulate matter and NO_2 can be considerably reduced by 2015 through the examined package of measures, but that exceedances will still occur. While the air quality limit value for NO_2 will likely be achieved on all roads by 2020 (according to the future trend scenarios), this is deemed unlikely for PM_{10}. This is because the PM_{10} pollution increasingly derives from the input of particulate matter from outside Berlin.

Further potential measures taken at the level of the city to reduce air pollution have been presented in the Berlin Air quality Plan (2011-2017) and can be classified in five fields of measures:

- Land-use, urban- and landscape planning

- Transport
- Heat supply
- Building/construction sector
- Installations in industry and business

In Germany, many measures to improve air quality have been implemented during the last years. Assessing their effectiveness, however, is not an easy task. Effects of almost all measures are small with respect to the total concentration, which itself shows a strong variability independent of the measures (e.g. due to varying meteorological conditions). Nevertheless, there are assessments available that are based on monitoring data, scenario modelling, or a combination of both approaches.

The status of air quality plans and action plans published in Germany up to 30.11.2012 has been described and thoroughly analysed (IVU Umwelt, 2013).

Focusing on four sample measures, the following reduction potentials have been assessed:

4.8.10.2.1 Low Emission Zone (LEZ)

Reduction potentials to reduce concentration levels for LEZs highly depend on the level of access restriction. Evaluation studies of actual LEZ implemented in the years 2008–2011 result in reduction potentials of up to 10% for NO_2, 7% for PM_{10} and 10% for $PM_{2.5}$. A high reduction potential of up to 19% for soot (black carbon) is particularly mentioned. It has to be noted, that a LEZ's reduction potential decreases the later it is being implemented, as the fraction of the vehicle fleet that is banned decreases due to the general modernization of the vehicle fleet. Theoretical assessments of future scenarios, e. g. an intensified penetration of 50% of Euro-6/VI vehicles in the fleet in 2015 would lower annual mean values of the total NO_2-concentration by up to 20%.

4.8.10.2.2 Environmental Traffic Management (ETM)

ETM denotes traffic management that also focuses on environmental aspects (example from the city of Munich). This is achieved with temporary dynamic measures that are tailored to the local pollution levels with respect to both spatial and temporal aspects and are activated only if the current air quality situation requires action.
The reduction potentials of ETM strongly depend on the activation rate of the respective measure. For the total concentration, they range from a few percentage points at the low end up to 15% or up to 10 limit exceeding days (PM_{10}) in specific designs. Thus, reduction potentials of ETM are in the same range as reduction potentials of LEZs.

4.8.10.2.3 Truck transit bans

The reduction potential of truck transit bans strongly depends on local conditions, notably on the share of trucks in overall road traffic and the expected compliance rate. As trucks have a higher reduction potential for non-exhaust emissions of particulate
matter due to re-suspension and abrasion, reductions of the PM_{10} annual mean value by several percentage points can be expected even with lower truck shares. The theoretical potential to

reduce total concentrations is always higher for NO_2 than for PM_{10} and can reach more than 10% if truck share and compliance rate are suitably high (e. g. 6% truck share, 80% compliance rate in 2015).

4.8.10.2.4 Speed limits of 30 or 40 km/h on major roads

Reducing speed limits on major roads from 50 to 30 or 40 km/h is a measure that is especially difficult to quantify. The reduction potentials for pollutants caused by road traffic were assessed to 18 % for NO_x, 15 % for NO_2 und 30 % for PM_{10}.

4.8.10.3 Enforcement

BlmSchG, Section 53 states: "Operators of installations subject to licensing shall appoint one or several officers responsible for immission control (immission control officers) if this is deemed necessary in view of the type and size of the installations on account of:

1. The emissions released by the installations;
2. Technical problems concerning emission control or;
3. The susceptibility of the products, if used for the intended purpose, to cause any harmful effects on the environment due to air pollution, noise or vibrations."

When preparing air quality plans every five years, intensive public consultation has to take place. Before it comes into effect, city council has to agree on it. Although this democratic participation is positive, the actual effect of the plan on air quality is limited in many municipalities. Measures stated in the plan may never be implemented and other city council decisions may even be contradictory. Currently, the European Union, as the highest controlling authority, is starting to become more involved in enforcing measures of the air quality plan for all Member States.

4.8.10.4 Public and Stakeholder Involvement

According to the Section 46a of BImSchG, "The public shall be provided with relevant information on air quality as required by any ordinances pursuant to section 48a subsection (1). The competent authority shall without undue delay announce to the public any non-compliance with alert thresholds determined as immission values in ordinances pursuant to section 48a subsection (1) through radio, television, the press or in other ways."

According to the section 47 of BImschG, "the competent authority shall ensure participation of the public in drawing up or changing clean air plans […]. The drawing up of a clean air plan or changes to such a plan as well as information on the procedure of public participation shall be made public in an official gazette and in other appropriate ways. The proposed new or changed clean air plan shall be laid open for public inspection for the period of one month; comments may be addressed in writing to the competent authority until two weeks after the end of the inspection period; the deadline shall be announced in the public notice pursuant to the second sentence above. The competent authority shall take due account of the comments made within the deadline when deciding on the adoption of the plan. The competent authority shall give

public notice of the adopted plan in an official gazette and in other appropriate ways. The public notice shall describe the area concerned and give an overview of the most important measures. A copy of the plan including a description of the procedure of public participation and a statement of the grounds on which the decision was based shall be laid open for public inspection for a period of two weeks."

5.0 AUSTRALIA / ASIA

5.1 Commonwealth of Australia

The Australian Government Department of the Environment (DoE) is responsible for developing national policies, programs and legislation for air quality management, administered by the Commonwealth at a national level as well as in conjunction with states and territories.

Legislation related to air quality management at a national level includes vehicle emissions standards *(*Motor Vehicle Standards Act 1989), fuel standards as per the Fuel Quality Standards Act, 2000[clvi] and the establishment of the National Environmental Protection Measure (NEPM) for Ambient Air Quality.

There is no national designation of non-attainment areas. The responsibility for monitoring and managing attainment of ambient air quality standards is deferred to individual states and territories.

5.1.1 Fuel Standards Act

The Fuel Quality Standards Act 2000 provides the legislative framework for setting national fuel quality and provides information on fuel quality standards monitoring, compliance and enforcement for Australia. Fuel quality standards prohibit the supply of leaded petrol and have reduced the level of sulphur in diesel fuel to 10 ppm. Australia adopted a Euro 3-equivalent sulphur limit for petrol (150 ppm) in 2005, and a Euro 4-equivalent sulphur limit for diesel (50 ppm) in 2006, to support the introduction of the equivalent vehicle emission standards. From January 2008, a 50 ppm limit was applied to higher octane grades of unleaded petrol to support Euro 4 petrol vehicles. Since January 2009 the sulphur limit in diesel has been further reduced to 10 ppm, primarily to support the introduction of new emissions standards for heavy-duty vehicles. The Australian Government is currently in the process of reviewing the Fuel Quality Standards Act.

5.1.2 Motor Vehicle Standards Act 1989

National vehicle emission standards (exhaust emissions) and the timing for implementation are set out in the Australian Design Rules (ADRs)[clvii]. Ongoing tightening of ADRs and harmonisation with EU limits has achieved reductions in emissions of lead, carbon monoxide, nitrogen oxides, hydrocarbons and particles.

[clvi] https://www.environment.gov.au/atmosphere/fuelquality/standards/index.html
[clvii] https://infrastructure.gov.au/roads/environment/emission/index.aspx

5.1.3 National Environmental Protection Council

The National Environment Protection Council (NEPC) was established under the National Environment Protection Council Act 1994,[clviii] with two primary functions:

10. To make National Environment Protection Measures (NEPMs),
11. To assess and report on the implementation and effectiveness of NEPMs in participating jurisdictions (states and territories).

NEPM for Ambient Air Quality

Under the National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM), national reporting standards were initially prescribed for 24-hour average PM_{10} concentrations (NEPC, 1998). The AAQ NEPM was varied in 2003 to include 'advisory reporting standards' for $PM_{2.5}$ (NEPC, 2003) and again in 2015 to adopt these 'advisory reporting standards' as formal standards for $PM_{2.5}$ (NEPC, 2015). The latest variation also introduces an annual reporting standard for PM_{10} and establishes long term goals for $PM_{2.5}$, to be achieved by 2025 (NEPC, 2015, 2003, 2015).

The goal of the NEPM is to achieve National Environment Protection Standards, assessed by each state and territory in accordance with a monitoring protocol. The monitoring protocol is prepared by each state and territory, specific to the requirements of that state or territory, and includes details on how it plans to monitor, assess and report air quality under the measure. The monitoring plan for New South Wales (NSW), for example, includes the regions to be monitored, the monitoring requirements for each region (including physical and demographic characteristics, emission sources, pollutants not required to be monitored, monitoring network), siting and instrumentation, accreditation and reporting

The desired environmental outcome is ambient air quality that allows for the adequate protection of human health and well-being. Although no formal classification of "non-attainment" areas exist, the states and territories measure ambient air quality in accordance with a monitoring protocol and report compliance on an annual basis.

"Regions" are defined in the monitoring protocol for the purposes of assessing monitoring under the NEPM. Regions are defined as areas surrounding population centres, and typically based on a population threshold of 25,000, using the Australian Bureau of Statistics (ABS) "urban centre" metric (except for Type 2 regions, see below). Three types of regions are defined, as follows:

- Type 1 - A large urban or town complex with a population of 25,000 people or more requiring direct monitoring and contained within a single airshed.
- Type 2 - A region with no one population centre with 25,000 people or more but with a total population of 25,000 or more, and with significant point source or area based emissions as to require a level of direct monitoring. The NEPM guideline for the selection of regions does not define or nominate a threshold for what is considered a "significant" emission source but

[clviii] http://www.scew.gov.au/coag-strategic-priorities/governance-and-legislation

rather leaves this to states and territory judgement, based on a structured and transparent approach.

- Type 3- A region with a population of 25,000 people or more but with no significant point or area based emissions, so that ancillary data can be used to infer that direct monitoring is not required.

Compliance (attainment) with the NEPM standards is determined based on a monitoring stations performance, assessed against the categories of "Met", "Not Met" and "Not Demonstrated" (if data are less than 75% complete). To determine compliance for the region, some monitoring stations are required within populated areas which are expected to experience relatively high concentrations, providing a basis for reliable statements about compliance within the region as a whole. These stations are called generally representative upper bound (GRUB) for community exposure sites. GRUB stations are performance monitoring stations located to monitor the upper bound of the distribution of pollutant concentrations likely to be experienced by portions of the population, while avoiding the direct impact of local sources. They are located at sites where the pollution gradient is low (they are not peak stations). If the AAQ NEPM Standards are met at GRUB sites, it is therefore assumed that most of the total population of the region will be exposed to air that meets the Standards. The other type of monitoring sites are population-average sites, which are used in addition to GRUB sites, to measure ambient air quality experienced by the majority of the population. .

Each jurisdiction in Australia has the responsibility to develop and implement regulations, policies and programs to achieve (or improve on) attainment of the AAQ NEPM goals. Each state/territory has developed a monitoring protocol specific to that state, and each state has its own approach to non-attainment air quality management (if applicable or needed).

There are also common national regulatory instruments that apply to all states; for example wood heater smoke in winter is an issue in most of the lower latitude states, in some cases contributing to non-attainment (informally if areas not designated). The adoption of the Australian Standard for wood heaters (which has efficiency and emission standards) is required in most states, either through regulation or programs/policies/initiatives.

National Pollution Inventory NEPM

The National Environment Protection (National Pollutant Inventory) Measure[clix] establishes the NPI database, listing national information on pollutant emissions and waste transfers. Facility operators determine their own emissions and transfers, and diffuse emissions from households and other sources like motor vehicles are estimated by government agencies Implementation of the NPI NEPM is the responsibility of each participating jurisdiction, who have their own legislative frameworks to ensure there is compliance with the NEPM.

Facilities which have activities associated with one or more of the subset of Australian and New Zealand Standard Industrial Classification (ANZSIC) codes are required to report on their

[clix] https://www.comlaw.gov.au/Details/F2008C00620

emissions and transfers if they have tripped one or more of the reporting thresholds. Where an emissions threshold is not tripped, no reporting under the NEPM is required.
An individual business is assigned to an industry category based on its predominant activity, and it is simply a way of grouping business into categories such as mining, construction, manufacturing etc.

5.1.4 National Plan for Clean Air

On 15 December 2015 Australia's Environment Ministers established the National Clean Air Agreement (Agreement), focusing on actions to reduce air pollution and improve air quality through cooperative action between industry and government at the national, state and local level. Three initial actions have been agreed under the Clean Air Agreement:

- The introduction of emission standards for new non-road spark ignition engines and equipment (such as garden equipment and marine outboard motors);
- Measures to reduce air pollution from wood heaters, including the adoption of new emission and efficiency standards for new wood heaters and sharing best management practices across jurisdictions;
- Strengthened ambient air quality reporting standards for particle pollution.

The implementation of actions will be through a combination of state and national actions. For example, the strengthened standards for PM is a national action which all states will need to comply with.

5.1.5 Australian Standards

Australian Standards are developed by Standards Australia, a peak non-government organisation responsible for developing technical standards. Australian Standards have been developed to provide technical guidance on, for example, ambient air quality monitoring methods, wood heater efficiency and emissions.

5.2 New South Wales

5.2.1 Regulatory System

The statutory framework for managing air emissions in NSW is provided in the Protection of the Environment Operations (POEO) Act 1997 Act[clx]. The NSW Environment Protection Authority (EPA) is responsible for regulating air emissions under the POEO Act and through the licensing of industrial activities.

The primary regulations for air quality made under the POEO Act are:

- Protection of the Environment Operations (Clean Air) Regulation 2010[clxi]

[clx] http://www.legislation.nsw.gov.au/maintop/view/inforce/act+156+1997+cd+0+N
[clxi] http://www.legislation.nsw.gov.au/maintop/view/inforce/subordleg+428+2010+cd+0+N

- Protection of the Environment Operations (General) Regulation 2009[clxii]

The POEO (Clean Air) Regulation provides regulatory measures to control emissions from wood heaters, open burning, motor vehicles and fuels and industry. The POEO (General) Regulation provides regulatory measures to:

- Administer environment protection licences.
- Establish Load Based Licensing (LBL), which sets limits for pollutant loads emitted by holders of environmental protection licences and then links licence fees to the pollutant load
- Give effect to and require compliance with the National Pollutant Inventory
- Create the Upper Hunter Air Quality Monitoring Network.
- Prescribe requirements in respect of pollution incident response
- Prescribe the appropriate regulatory authority for certain activities.

The other relevant piece of legislation is the Environmental Planning and Assessment Act (1979)[clxiii], which is the principal piece of legislation used in NSW for the approval of new development. Although not specifically used to regulate air quality, approvals (permits) for new development require an Environmental Impact Statement or Statement of Environmental Effects and where emissions to air occur, this will include an air quality impact assessment.

5.2.2 Monitoring

The Ambient Air Quality NEPM requires all states and territories to monitoring PM_{10}, $PM_{2.5}$, NO_2, SO_2, CO and ozone to demonstrate compliance with NEPM goals. Monitoring needs to be undertaken in accordance with a monitoring protocol and each state has developed a monitoring plan, including identification and definition of NEPM regions[clxiv] for compliance monitoring. The Ambient Air Quality NEPM requires all states and territories to report results of monitoring on an annual basis to inform attainment of the air quality goals.

The best example of ambient air monitoring in a non-attainment area is the Upper Hunter Valley Air Quality Monitoring Network (UHAQMN). The UHAQMN consist of 14 sites continuously measuring PM_{10} and three sites continuously measuring $PM_{2.5}$ (Figure 21). The monitoring is used to inform local communities on pollution levels and identify which sources may have resulted in exceedances. The UHAQMN may be used in future to inform proactive/reactive dust management for operating coal mines, for example by requiring certain mines to cease activity when pollutant levels are increasing. While not formalised or regulated, we are aware that it is under consideration. The UHAQMN sites are not used to determine compliance under the NEPM, as the region is not currently designated as a NEPM region.

The NSW EPA also commissioned the Upper Hunter Fine Particle Characterisation Study (UHPCS) (Hibberd et al, 2013) which reports chemical composition of $PM_{2.5}$ mass for based on monitoring at two locations and identifies a number of “factors” (such as industry, sea salt, soil)

[clxii] http://www.legislation.nsw.gov.au/maintop/view/inforce/subordleg+211+2009+cd+0+N
[clxiii] http://www.austlii.edu.au/au/legis/nsw/consol_act/epaaa1979389/
[clxiv] See discussion of NEPM regions in the attached memo on Australian Commonwealth air quality management.

using positive matrix factorisation techniques (PMF) to also describe each component of the $PM_{2.5}$ mass. A similar study is also underway in the Lower Hunter around the Newcastle port and city area as was described above in terms of the regional monitoring network funded by industry. A similar regional monitoring network has been installed for the Lower Hunter and Newcastle Port area and the EPA has also commissioned another particle characterisation study for the Lower Hunter.

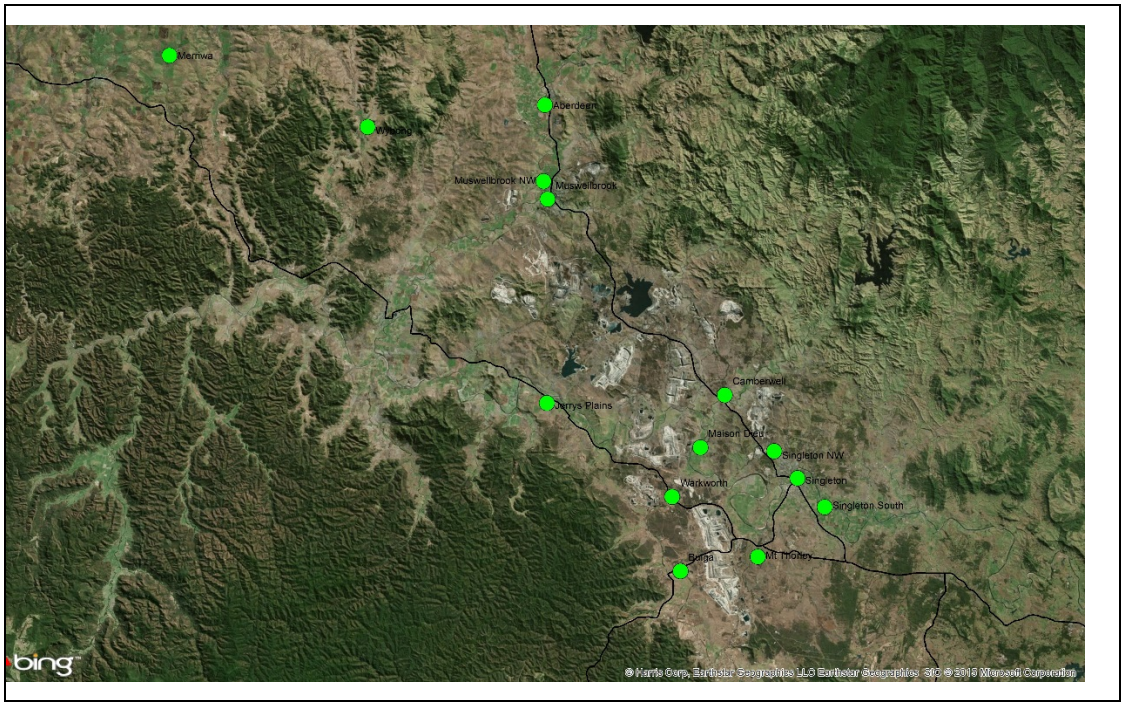


Figure 21 Upper hunter valley air quality monitoring sites.

5.2.3 Planning Areas

As noted in Section 5.1, formal classification using the term 'non-attainment areas' does not exist in NSW (or other states), however all states and territories measure ambient air quality in accordance with the AAQ NEPM monitoring protocol and report compliance on an annual basis. Compliance (i.e. attainment) with the NEPM standards is determined based on monitoring station performance, assessed against the categories of "Met", "Not Met" and "Not Demonstrated".

Regions are defined for the purposes of assessing compliance, i.e. attainment (NEPM Peer Review Committee, 2001a). Regions are defined as areas surrounding population centres, using a population threshold of 25,000. Three types of regions are defined, as follows:

- Type 1 - A large urban or town complex with a population of 25,000 people or more requiring direct monitoring and contained within a single airshed.

- Type 2 - A region with no one population centre with 25,000 people or more but with a total population of 25,000 or more, and with significant point source or area based emissions as to require a level of direct monitoring.
- Type 3- A region with a population of 25,000 people or more but with no significant point or area based emissions, so that ancillary data can be used to infer that direct monitoring is not required.

The Australian Bureau of Statistics (ABS) "urban centre" population data is generally recommended for defining geographical boundaries for regions, although it is acknowledged that this isn't suitable for Type 2 regions.

As noted in Section 1.1, each jurisdiction (state or territory) in Australia has the responsibility to develop and implement regulations, policies and programs to improve compliance with AAQ NEPM goals. While there are no specific regulatory requirements specific to NAAs in NSW, some of the EPA initiatives, guidance documents and policy instruments discussed below can be considered relevant to non-attainment for the purpose of this review.

Regions in the NSW GMR (and other states) were established for the purpose of assessing attainment of NEPM goals and a "region" is in compliance when either all stations in the region demonstrate compliance or the region meets approved pollutant screening criteria. The Upper Hunter Valley was investigated as a Type 2 region but the decision was made not to designate the region. This decision appears to have been predominantly based on the fact that the Upper Hunter Valley region may have distinct airsheds, rather than one single airshed, based on topography and locations of emission sources. The Upper Hunter Valley has extensive coal mining activity and power generation. Based on recent monitoring data the region would be non-compliant for daily exceedances of PM_{10}, if it was formally recognised under the NEPM. If a formal system for classification of NAAs existed, it is likely that this region would be included and therefore for the purposes of this review, the policy tools discussed below can be considered applicable to NAA.

Although not formally classified as NAAs, the NSW EPA has implemented policies and initiatives to deal with non-attainment in some regions/area, for example:

- Ozone pollution in the NSW Greater Metropolitan Region has led to a non-attainment classification system in NSW EPA guidance for ozone assessment. Relevant to the second dot point, the NSW EPA's "Tiered Procedure for Estimating Ground-Level Ozone Impacts from Stationary Sources" (ENVIRON, 2011) introduces, for the first time, the concept of non-attainment classification for areas of NSW Greater Metropolitan Region (GMR) (discussed in more detail below). Under the tiered procedure, regions are classified as "attainment" or "non-attainment" based on the region meeting or exceeding an "acceptance limit" expressed as 82% of the NEPM standard (based on 5-years of data). The acceptance limit is based on the screening procedures developed under the NEPM to determine the monitoring needs of a region (NEPC, 2007). If the maximum 5 year average is below the "acceptance limit" (1-hour average of 82 ppb or 4-hour average of 65.2 ppb) the area is in attainment. If the maximum 5 year average is above the "acceptance limit", the area is in non-attainment.

- The Upper Hunter Valley region has a high concentration of open cut mining and coal fired power generation. Particle pollution in the Upper Hunter Valley is a key priority of the EPA and if a formal system of NAA designation existed, the region may well qualify. Policy tools and initiatives for the region are such that it could be considered, informally, a NAA.
- Fine particle pollution in the Sydney Greater Metropolitan Region and other rural areas is another key priority for the EPA and non-compliance with annual $PM_{2.5}$ goals would mean that if a formal NAA classification system existed, there are regions that may be designed for fine particles. $PM_{2.5}$ was not included when the AAQ NEPM was first established and when regions were classified for compliance monitoring. This is being reviewed based on the recent NEPM variation and adoption of formal reporting standards for $PM_{2.5}$.

As previously mentioned, the NSW EPA's Tiered Procedure introduces a framework for ozone assessment. The assessment requirements, under the framework, differ for attainment and non-attainment areas and the process to follow is shown in Figure 22. Under the Tiered procedure for ozone assessment in the GMR, new sources in non-attainment areas that result in an increase in ozone above the maximum allowable increment[clxv] are required to consider Best Available Technologies (BAT) and / or emission offsets (see Sec. 4 for a description of BAT as defined in the EU). Following consideration of BAT, if the new source still cannot demonstrate compliance under the tiered procedure, they would enter into discussions with the EPA and more stringent requirements may be required at this stage. The consideration of offsets needs to be decided on in cooperation with the EPA.

The tiered procedure prescribes emissions thresholds to determine if ozone assessment is required. The emission thresholds differ for attainment and non-attainment areas. For non-attainment areas, more stringent emissions thresholds are outlined for 'serious', 'severe' and 'extreme' non-attainment.

Where ozone assessment is required, the tiered procedure prescribes a "significant impact level" of 0.5 ppb for both attainment and non-attainment areas. The limit of 0.5 ppb is specified taking into consideration ambient ozone measurement and reporting limits. The 'maximum allowable increment' differs between attainment and non-attainment areas. For attainment areas, this is region specific, defined as the 25% of the difference between the 5-year average 1-hour and 4-hour maximums for the region and the relevant Air NEPM Standard. For ozone non-attainment, 1 ppb was selected as an increment comprising 25% of the residual, selected in line with US Prevention of Significant Deterioration increments defined for Class 2 areas, which are designed to allow moderate, controlled growth.

When the predicted ozone impact from new or modified emissions sources are above the maximum allowable increment in attainment areas there is a requirement to consider reasonably achievable technologies (RAT) within a Best Management Practice (BMP) determination.[clxvi] In non-attainment areas, there is a requirement to consider BAT and/or emissions offsets. Following consideration of BAT, if the new source still cannot demonstrate compliance under the tiered

[clxv]

[clxvi] RAT refers to control technology that is both reasonably available, and technologically and economically feasible. Reasonable relates to the application of judgement in arriving at a decision, taking into account: mitigation benefits, cost of mitigation versus benefits provided, community views and the nature and extent of potential improvements. Feasible relates to engineering considerations and what is practical to build.

procedure, they would enter into discussions with the EPA and more stringent requirements may be required at this stage. Further details can be found in ENVIRON (2011).

The tiered procedure for ozone assessment is only applicable to stationary sources above a certain emission threshold. Some recent examples of sources that triggered the framework are a proposed Energy from Waste facility and a proposal with 36 3MW gas engines, both located in non-attainment areas.

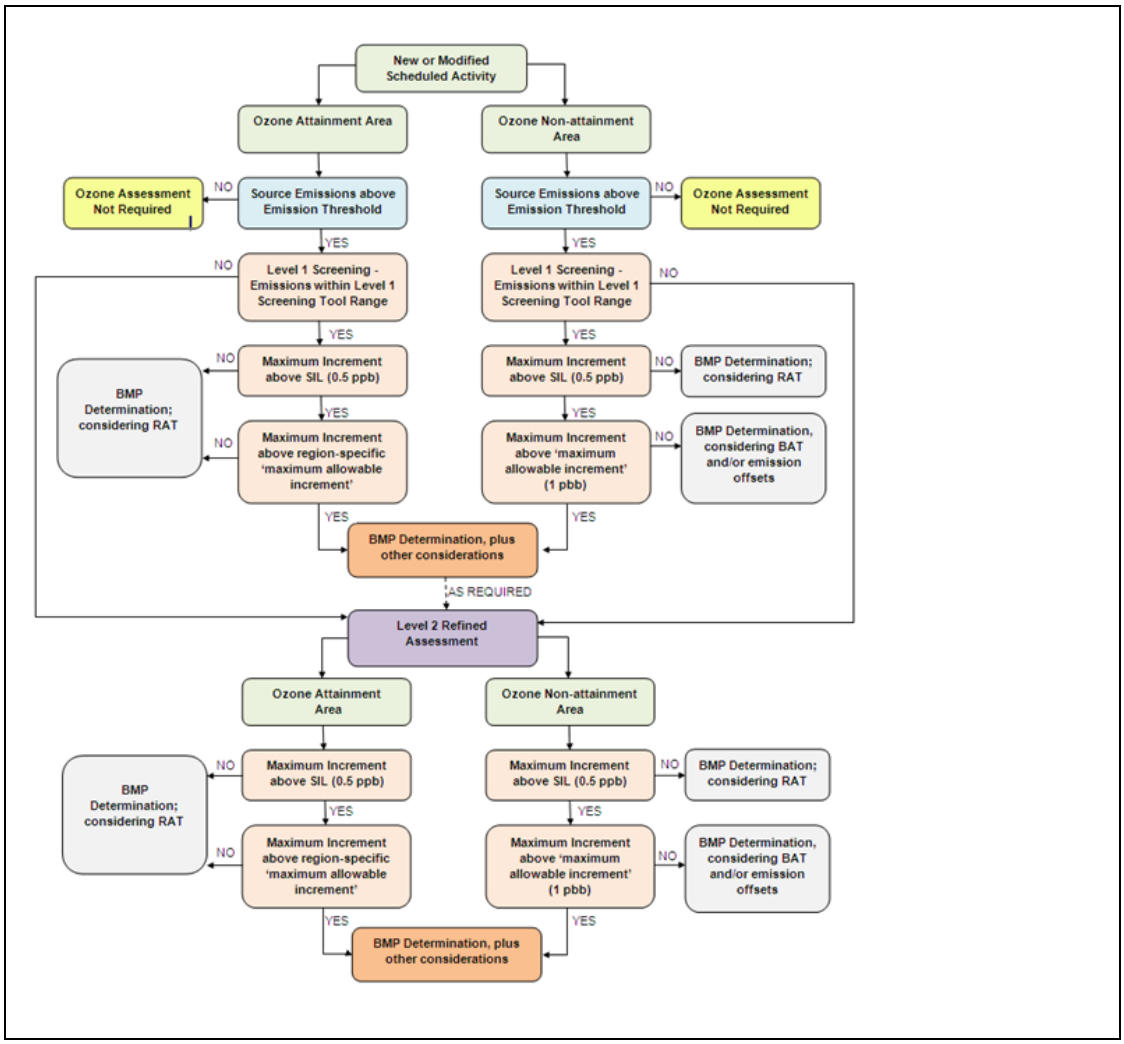


Figure 22 Ozone assessment framework showing pathways for attainment and non-attainment areas.

Under the POEO Act, the EPA can issue a pollution reduction programs (PRPs), a legally binding instrument which forms part of an environment protection licence. PRPs are designed to achieve improved environmental outcomes (i.e. continual improvement or compliance) (EPA, 2014). An example applied to areas where non-attainment is a concern is the so-called "Dust Stop" program, a series of PRPs issued to coal mine environment protection licences. The PRPs require coal mines in NSW to develop a site specific best practice determination and to

implement best practice emissions controls for their largest sources of fugitive dust. Although the PRPs are applicable to all coal mines, the Hunter Valley in particular was a focus for 'Dust Stop'. As mentioned previously, if a formal system of NAAs existed for NSW, the Hunter Valley would likely qualify.

Fine particle pollution is another key priority for the EPA. Urban areas of Sydney and some rural areas of NSW are, in some years, non-compliant or close to non-compliant with the NEPM standard for annual average $PM_{2.5}$ (8 µg m^{-3}). Specific regulations have been developed which focus on fine particle non-attainment (see cruise ship example below). Other policy initiatives to programs aim to address fine particle pollution in rural areas (i.e. wood heater programs).

The NSW EPA "Action for Air" is an air quality management plan for the Greater Metropolitan Region covering Sydney, the Lower Hunter and the Illawarra and focuses on regional air pollution. The strategies in Action for Air address the two pollutants of primary concern - ground-level ozone and fine particle pollution. It hasn't been updated since 2009 however actions and EPA initiatives identified in the plan (and described above) are ongoing.

Although not strictly distinguishing NAA to other areas, a recent amendment to the POEO Act, POEO (Clean Air) Amendment (Cruise Ships) Regulation 2015[clxvii] introduces the requirement for cruise ships berthed or operating within the boundary of Sydney Harbour to use low sulfur fuel. While the legislation is not put in place due to formal non-attainment of goal, exposure to $PM_{2.5}$ and SO_2 in urban areas around Sydney Harbour is recognised as an issue and the need for government action was recognised to ensuring that NSW residents have the same standard of protection from shipping emissions as that enjoyed by people in North America and Europe (NSW EPA, 2015).

The closest example to a specific plan for a NAA is the Upper Hunter Particles Action Plan[clxviii] and forms part of an overall 10 year plan for the state of NSW. The goal is to outline a range of measures to improve air quality in the Upper Hunter and to better inform the public about ambient air quality. The plan's target is to reduce long-term average ambient $PM_{2.5}$ concentrations in Singleton and Muswellbrook to an annual average of less than or equal to 8 µg m^{-3}, consistent with the NEPM standard for $PM_{2.5}$. [clxix]

The following actions are outlined in the plan:

- Action 1: Development consent conditions. Used to specify management measures, monitoring requirements and compliance goals for operating coal mines.
- Action 2: Improve links between consent conditions and environment protection licences. This would ensure consistency in how compliance is assessed and reported.
- Action 3: Continued inspection of mining operations and enforcement of conditions. To help ensure mining operations are implementing dust management measures outlined in their approval, licence or statement of commitments.

[clxvii] https://www.epa.nsw.gov.au/resources/air/cruiseships-regulation-2015.pdf
[clxviii] http://www.epa.nsw.gov.au/resources/aqms/20130158uphunterapap.pdf
[clxix] See discussion of Australian Commonwealth air quality management in attached memo

- Action 4: Implement the Dust Stop program. A pollution reduction program aimed at reducing PM emissions from major sources at coal mines, i.e. hauling and dozers.
- Action 5: Rehabilitation outcomes. To ensure progressive rehabilitation is achieved to minimise fugitive dust from exposure areas.
- Action 6: Commence diesel emissions management review of mine sites. As part of the NSW EPA action on non-road diesel they are focusing on coal mines as a significant user of diesel fuel to identify options for reducing emissions, i.e. through retrofit of pollution control devices, vehicle upgrade programmes.
- Action 7: Further monitoring of dust along the rail corridor. This is a significant community concern and the EPA is committed to understanding the extent of the issue.
- Action 8: Development of guidance material for Director General's requirements. This refers to the assessment requirements for new approvals (permits) and in terms of air quality impacts from coal mines would outline specific requirements such as cumulative assessment.
- Action 9: Implementation of the strategic regional land use plan. Aimed at avoiding land use conflict between mining, agriculture and horse breeding, for example.
- Action 10: Promote the Clean Machine Program in the Upper Hunter. As part of the NSW EPA action on non-road diesel, this refers to retrofit of pollution control on existing vehicles.
- Action 11: Promote and support local government participation in the wood smoke program. This forms part of the broader action on wood smoke and includes emission and efficiency standards for new wood heaters, voluntary replacement programs, education of community.
- Action 12: Engage stakeholders, including land holders, community, mining industry.
- Action 13: Reporting air quality data. The NSW EPA is committed to reporting data from the UHAQMN in near real time.
- Action 14: Regulate ongoing industry funding of monitoring network. The UHAQMN is funded by the mining industry, through regulation, with fees apportioned according to the size of operations (material removed, footprint of exposed areas).
- Action 15: Updating the NSW Air Emission Inventory. The latest 2013 calendar year inventory is due for release in 2016.
- Action 16: Independent air quality advice to the Government. The NSW EPA operates independently and provide advice on air quality to Government.
- Action 17: Release the results of the Upper Hunter fine particles study. This is a fine particular characterisation study, based on monitoring data.
- Action 18: Develop a model of $PM_{2.5}$ in the Upper Hunter. Regional primary particle model of the Upper Hunter.

5.2.4 Emission Inventories

The NSW EPA have developed a regional emission inventory for the NSW Greater Metropolitan Region (GMR) covering all sources and 850 substances (criteria pollutants, organics, metals, GHGs). The NSW GMR region covers about 75% of the population of NSW and would likely cover NAAs if formally prescribed for NSW. The inventory provides for the 'evidence based approach' favoured by the EPA for policy and regulatory initiative. It is used to identify the contribution made by each source in various regions of the GMR (Sydney, Illawarra, Hunter, urban, non-urban). The NSW GMR Emissions Inventory, which provides much of the evidence based data for policy tools for air quality management, categorise/group sources as follows:

- Biogenic/geogenic.
- On-road mobile.
- Off-road mobile.
- Commercial.
- Domestic-Commercial.
- Industrial.

The current inventory is compiled for 2008 and is updated every five years (2013 inventory should be available in 2016). The inventory is fully documented and described here[clxx].

The National Pollution Inventory also provides data on emissions from certain heavy industries (with facility sizes above specified thresholds). Industries self-report annual emissions in the form of NPI reporting. Facilities which have activities associated with one or more of the subset of Australian and New Zealand Standard Industrial Classification (ANZSIC) codes are required to report on their emissions and transfers if they have tripped one or more of the reporting thresholds.

Industrial sources in the NSW GMR inventory refers to facilities that are licenced by the EPA, through an Environmental Protection Licence (EPL), also referred to as Scheduled premises. Scheduled activities are listed in the POEO (General) Regulation and typically defined based on a production threshold which varies by industry type, for example:

- Ceramic production > 15,000 tpa.
- Phosphate production > 20,000 tpa
- Crushing, grinding or separating >30,000 tpa.
- General electricity works >30MW.
- Metropolitan electricity works (gas turbines) >20 mega litres fuel
- Mining for coal > 500 tpd, > 4 Ha disturbance

The list of scheduled activities and production threshold are set based upon the potential for environmental harm.

Licencing doesn't formally differ for NAA, however certain activities in metropolitan areas (i.e. electricity generation) are licenced differently. The difference in licencing is primarily related to NO_x emissions and the management of ozone impacts in the urban areas of Sydney and Wollongong, and specifies more stringent emission limits in this area.

5.2.5 Environmental Review of New Development

The NSW Environmental Planning and Assessment Act (1979) is the principal piece of legislation used in NSW for the approval of new development and under the Act, environmental

[clxx] http://www.epa.nsw.gov.au/air/airinventory2008.htm

assessment is required for new or modified development applications. The level of assessment is dictated by the type of development proposal; for example if it is State Significant (Part 3A of the Act) and full environmental assessment is required (typically an Environmental Impact Statement (EIS). Other development falls under Part 4 of the act and local government is the approval authority. Requirements for environmental assessment may be less onerous, for example only requiring a "Statement of Environmental Effects (SEE).

Generally, air quality impact assessment (AQIA), including cumulative effects analysis, is required for an EIS, assuming the development has emissions to air. The requirements for AQIA are no different for areas that might be classified as NAA (if a formal system existed) although the level of detail for cumulative analysis might be greater.

Under the Tiered procedure for ozone assessment, a source emissions threshold is set for when ozone assessment is required. For non-attainment areas, more stringent emissions thresholds are outlined for 'serious', 'severe' and 'extreme' non-attainment.

New sources of emission to air must demonstrate that:

- Compliance with source emission limits can be achieved.
- Compliance with ambient impact assessment criteria can be achieved.
- No additional exceedances of the impact assessment criteria would occur.
- Best management practices are considered, which might include RAT or BAT.

Once operational, new sources are regulated through approval conditions issued by the approval authority (local government such as the Local Council) or state government (the Department of Planning and Environment). Scheduled premises under the POEO Act are also regulated through conditions placed in their Environmental Protection Licence.

5.2.6 Cumulative Impact Assessments

The Environmental Planning and Assessment Act (1979) is the principal piece of legislation used in NSW for the approval of new development, however no specific requirements for cumulative air impact assessment is specified under the Act.

Cumulative air impact assessment is generally required for all permitting of all new or modified significant sources of emissions to air. For state significant development under the Act, the requirements for cumulative assessment will be outlined in the Secretary's Environmental Assessment Requirements (SEARs).

The SEARs typically reference the requirements in the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (the Approved Methods) (NSW EPA, 2005).

Current guidance on cumulative impacts is limited. Section 7 of the Approved Methods describes how dispersion modelling results are to be interpreted against the prescribed impact assessment criteria. For "criteria" pollutants both the increment impact and total impact (increment plus

background) must be reported. Guidance is provided on how much background data are required (one year of continuous measurements) and on suitable sources of ambient monitoring data. For areas where existing exceedances of the impact assessment criteria already occur, a proponent is required to demonstrate that no additional exceedance would occur as a result of the proposal.

Section 7 also describes how the cumulative impact of emissions from several facilities needs to be considered. However it is noted that no guidance is provided on how other emissions sources are considered in cumulative assessment, for example whether emissions from other facilities are considered in dispersion modelling or through existing monitoring data.

The NSW EPA is in the process of updating the Approved Methods and as part of this review they commissioned Ramboll Environ to review approaches to cumulative air assessment. The review (not yet published) included our recommendation for a framework which acknowledges airshed management areas, with specific provisions for cumulative assessment in these areas. It is not known if this recommendation will be included in updated guidance, however it would set the framework for identification of NAA, either formally by the EPA or dynamically as air quality assessments are produced within specific areas.

5.2.7 Stationary Source Controls

Existing industrial development (all areas) are managed under the POEO regulations and have emission limits prescribed in their Environmental Protection Licences (EPLs) (applies to all scheduled activities listed under the regulation). EPLs also manage emissions to air by specifying monitoring requirements, required emission controls and management etc. The approval authority (local or state government) will also issue a Development Consent which may include conditions related to the management of air emissions. No distinction is made between attainment and non-attainment areas, however there is provision in the POEO (Clean Air) Regulation to have more stringent emission limits in certain areas for certain sources, for example NO_x sources for electricity generation in Metropolitan areas of Sydney.

We are not aware of an example of the application of emissions offsets as yet for NSW. Current guidance is that if offsets are considered, it should be on a case by case basis and discussed with the EPA. The Interim OEH Nitrogen Oxide Policy for Cogeneration in Sydney and the Illawarra provides a framework for the application of NO_x offsets [clxxi]

New developments in both attainment and non-attainment areas need to be able to demonstrate compliance with both source emission limits and ambient impact assessment criteria specified by the NSW EPA. This applies for all areas, however in regions where non-compliance is already an issue (i.e. areas that might be classified as NAA if a formal system existed) there may be more scrutiny applied to the modelling predictions, cumulative assessment, proposed emission controls etc. Impact assessment criteria are generally set at the same level as NEPM standards (with some exceptions, for example an impact assessment criteria are set for TSP and annual average

[clxxi] Ibid footnote #8

PM_{10}).[clxxii] Emissions limits are prescribed in the POEO (Clean Air) Regulation. Significant new sources of NOx and VOCs in ozone NAAs need to follow the requirements in the tiered ozone procedure described in Sec. 5.2.3. Following consideration of BAT, if the new source still cannot demonstrate compliance under the tiered procedure, they would enter into discussions with the EPA and more stringent requirements may be required at this stage.

A typical approach for emission controls programs might include some or all of the following:

- Estimate emissions for base case and a business as usual (BAU) future scenarios.
- Use dispersion modelling to estimate future air quality for the BAU scenario.
- Consider range of options in terms of emission reduction and future air quality improvements and compare against BAU
- Evaluate the cost and benefit of various options, including health costs and benefits. This might follow a damage cost approach (based on emission reduction) or impact pathway approach (based on AQ projections).
- Sensitivity analysis.
- Selection of a preferred option.
- Consultation with industry and stakeholders.
- Develop policy or guidance.

Example of the approach for emission reduction options for non-road diesel emissions can be found here, and generally follows the approach outlined above (identification of policy options and evaluation of the cost and benefit of various options based on emission reductions and changes to air quality). [clxxiii clxxiv clxxv].

Best management practice (BMP) is a guiding principle in the POEO Act. In defining BMP, consideration should be given to what are reasonable and feasible avoidance and mitigation measures. For NAAs under the tiered ozone procedure, BAT needs be considered for a BMP determination.

Although not normally for NAA, modification and/or emission reductions can be regulated through a modification to a facility's Environmental Protection Licence, for example in the form of a Pollution Reduction Program (PRP). An example of this is the so called "Dust Stop" PRP process whereby all coal mines were required to implement best practice PM controls for key dust sources (haul road dust, bull dozers on overburden).

The Interim OEH Nitrogen Oxide Policy for Cogeneration in Sydney and the Illawarra indicated than EPA was in the process of defining BAT for natural gas fired engines and turbines, however we are not aware that this has ever been published. This policy has somewhat been superseded by the Tiered procedure for ozone assessment (ENVIRON, 2011).

[clxxii] The latest NEPM review will incorporate annual standard for PM10. The TSP impact assessment criteria were first set by the National Health and Medical Research Council in 1996. The annual PM10 impact assessment criteria was set by the EPA as an interim reporting standard in 1998, and has remained since.

[clxxiii] http://www.epa.nsw.gov.au/resources/air/140586NonrdDiesInfoRpt.pdf

[clxxiv] http://www.epa.nsw.gov.au/resources/air/nonroaddieselrpt.pdf

[clxxv] http://www.epa.nsw.gov.au/resources/epa/140075coalminestudy.pdf

The Interim OEH Nitrogen Oxide Policy for Cogeneration in Sydney and the Illawarra[clxxvi] provides a framework for NOx offsets, including the following requirements:

> **Enduring** – offset actions implemented by the licensee must be implemented before or from the time the NO_x emissions from the activity occur. Ideally, they would offset the NO_x emissions for the whole time that the new NO_x source operates. However, some abatement actions may only provide a benefit for a limited period. In these cases the licensee will need to source new offsets when the original ones expire.
>
> **Quantifiable** – the impacts and benefits must be reliably estimated. There must be estimation and verification techniques available that are acceptable to EPA. Where there is an unacceptable level of scientific understanding about how the offset benefits will be achieved, EPA will consider applying ratios of greater than 1:1 to account for the risk and uncertainty of abatement
>
> **Targeted** – EPA will accept reductions in NO_x or VOCs emissions from other sources as an offset for new NO_x emissions.
>
> **Supplementary** – the offsets must be beyond existing requirements and not already being funded under another scheme. An offset proposal cannot include pollution abatement actions if they are already required under federal, state or council legislation, or any other legal requirements, or if Government funds them. This includes actions required by an environment protection licence condition (including pollution reduction programs, although this may be subject to negotiation). Credit will not be given for work that would have happened anyway (e.g. decommissioning a plant that was already scheduled for closure).
>
> **Enforceable** – the requirement to offset all new NOx emissions must be clearly stated in the development consent conditions and will become implemented as licence conditions. Conditions relating to green offset schemes or works are permitted under section 69 of the POEO Act. Penalties for non-compliance with licence conditions are up to $1 million for a corporation (section 64).

As previously discussed, there is a requirement for BAT to be implemented in non-attainment areas under the tiered procedure for ozone, where ozone impacts with new sources operating are predicted to exceed a maximum allowable increment. The proponent for a new source would need to complete a best management practice determination and outline BAT for their specific proposal. Following consideration of BAT, if the new source still cannot demonstrate compliance under the tiered procedure, they would enter into discussions with the EPA and more stringent requirements may be required at this stage.

The Interim OEH Nitrogen Oxide Policy for Cogeneration in Sydney and the Illawarra provides guidance for BAT emission performance for co-generation in the Sydney and Illawarra regions, both of which are subject to ozone non-compliance[clxxvii].

[clxxvi] Ibid footnote #8

The NSW EPA load-based licensing (LBL) scheme is an example of the polluter pays principle and is applied to all licenced facilities (not just those in NAAs). LBL sets limits on the pollutant loads emitted by holders of environment protection licences and links licence fees to pollutant emissions (as set out in the POEO (General) Regulation 2009). Each licensee must submit an annual return.[clxxviii] Provision is made to enter into load reduction agreements [clxxix] to obtain fee savings in return for future pollutant load reductions (EPA, 2001). Licence fees are used to cover administrative expenses and to fund other regulatory programs.

From 1 July 2016, the EPA are moving to a risk-based system for the calculation of administrative fees, based on the type of activities being undertaken (fee-based activities), the scale of these activities, and a licensee's environmental management category. The risk assessment examines site specific risks posed by each licensed premises to identify any environmental issues that a licensee needs to address and where the EPA needs to focus its regulatory attention. The EPA also examines the licensees' environmental management performance, which includes recognising any environmental systems and operations a licensee has put in place.

Based on the results from the risk assessments licensees are allocated an overall environmental risk level (1, 2 or 3 - with 3 being the highest risk). Licensees with a higher risk level will receive an increased level of regulatory and compliance oversight, whereas licensees with a lower risk level will benefit from reduced red tape and reduced regulatory burden. Higher risk activities might include coal mining (particularly in constrained airsheds) or waste management facilities, which have existing odour issues. An example of a low risk activity might be marinas and boat repair facilities.

This risk based approach allows the EPA to better target regulatory efforts towards high risk and poor performing licensees. The system also provides financial incentives for licensees to improve environmental performance and compliance.

Another example of polluter pays isn't related to formal NAAs, however was established due to concern regarding air quality within the Newcastle inner city and port area. Community concern regarding compliance has prompted the EPA to establish the Newcastle Local Air Quality Monitoring Network (NLAQMN) in August of 2014. The POEO Act (General) Amendment (Newcastle Air Monitoring) Regulation 2015 was used to establish a funding model for the monitoring network which proportions costs to industries in the port area based on their annual emissions levels[clxxx]. The industries with the highest emissions will pay the higher proportion of the total cost under the funding model. This may therefore provide an incentive for industry to reduce emissions or at least better understand their actual emission levels.

A similar amendment to the POEO (Upper Hunter Air Quality Monitoring Network (Regulation) 2013) provides for the ongoing funding of the Upper Hunter Air Quality Monitoring Network by

[clxxvii] http://www.epa.nsw.gov.au/resources/air/20110442CogenNOx.pdf
[clxxviii] http://www.epa.nsw.gov.au/licensing/lbl/annualreturn.htm
[clxxix] http://www.epa.nsw.gov.au/licensing/lbl/loadredagree.htm
[clxxx] http://www.epa.nsw.gov.au/air/newcastle-NLAQMN-reg.htm

requiring holders of licences for electricity generation and coal mining in the Upper Hunter region (Upper Hunter licence holders) to pay an environmental monitoring levy. The levy is based on annual emissions and the amounts of material (i.e. overburden, coal) moved by each mine[clxxxi]. There is no emissions or amount of material threshold below which no levy is payable.

Cost benefit analysis underpins the development of the regulations and policies in NSW. For example, recent cruise ship legislation to induce low sulphur fuel (described above) used net present value and benefit cost ratio to select a preferred option for emission reduction from cruise ships. Health benefits were also considered in the analysis. As well as low sulphur fuel, other options considered included shore power, emission control areas and voluntary agreements.

The NSW EPA has developed a methodology for valuing health impacts from changes in particle emissions and has developed an air quality appraisal tool to assist in placing a monetary value on the air quality impacts of transport and land use developments (PAEHolmes, 2013a,b). The NSW EPA has also commissioned a study to identify and analyse a range of emission abatement initiatives and develop a Marginal Abatement Cost Curve (MACC) model to assist in assessing the practicability of each identified initiative from a number of perspectives including economic, environmental and social impacts as well as technical feasibility (SKM, 2010) [clxxxii]

5.2.8 Area and Mobile Source Controls

The POEO Act requires that all necessary practicable means are used to prevent or minimise air pollution in NSW. Initiates in NSW related to emission reduction focus on fine particles and ozone.

The PRP process described above is useful regulatory tool used to initiate emission reduction for licenced premises. The application of the “dust stop” PRP process for coal mining is an example where the tool could be relevant to non-attainment areas, for example if the Upper Hunter were designed under a formal system.

Requirements relating to emission reductions from wood heaters are also set out in Part 2 of the POEO (Clean Air) Regulation[clxxxiii]. All slow combustion heaters sold in NSW are required to meet the emission limits specified in Australian Standard AS/NZS 4013:1999: Domestic solid fuel burning appliances - method for determination of flue gas emission.

There are certain rural areas of NSW where wood smoke contributes significantly to fine particle pollution, including areas where the NEPM annual average $PM_{2.5}$ are exceeded. If a formal classification exists for NSW, some rural areas may be included as NAAs. There are also a number of wood smoke initiatives underway in NSW, aimed at reducing emissions.

[clxxxi] http://www.epa.nsw.gov.au/aqms/amendpoeoenvmonitorlevy.htm
[clxxxii] http://www.epa.nsw.gov.au/air/costcurves.htm
[clxxxiii] http://www.epa.nsw.gov.au/air/poeocleanair.htm

The EPA is proposing amendments to the current wood heater regulatory framework in NSW, via an amendment to the POEO (Clean Air) Regulation 2010, to give local councils powers to introduce additional controls on wood heater installation.

The EPA have also provided resources for local councils[clxxxiv] to tackle wood smoke issues and developed the 2014 Wood Smoke Reduction Program which offered funding to assist local communities address air pollution caused by wood heaters through the following options:

- Community education programs about the health impacts of wood smoke pollution and how best to operate wood heaters.
- Smokey chimney surveys by councils and appropriate educational/enforcement action
- Targeted cash incentives to replace old, polluting wood heaters and fireplaces with cleaner alternatives.

On-road mobile sources are regulated at a national level through the Motor Vehicle Standards Act (1989) with national emissions standards set in the Australian Design Rules (ADRs) and the Fuel Quality Standards Act (2000).

Off-road mobile sources are not regulated at state or national level, although policy measures for off-road diesel are under consideration in the National Plan for Clean Air[clxxxv]. Off-road diesel vehicles are, however, included in fuel quality standards.

Not specific to NAA, but the EPA's smoky vehicle program is implemented to fulfil regulatory responsibilities under the POEO Act and POEO (Clean Air) Regulation. EPA and other officers who have been trained in smoky vehicle observation can observe and report smoky vehicles and issue the owner of a smoky vehicle used for commercial purposes with a $400 fine.

The EPA's Clean Machine Program supported diesel emissions reductions from non-road diesel equipment by promoting procurement of lower emitting equipment, better worksite practices, and subsidising retrofitting of heavily polluting machines with exhaust emissions after-treatment devices (partial flow diesel particle filters; see http://www.emitec.com/en/technology/catalyst-substrates/pm-metalit.html). The Clean Machine Program ran from 2011 to 2014, during which time the NSW Government provided almost $806,000 in subsidies to retrofit 141 diesel machines.

There are no regulations or standards in place to control emissions from non-road diesel engines in NSW or Australian. The EPA commissioned a study to gather information and scope possible actions for cleaner new non-road diesel engines in Australia (ENVIRON, 2010). The study found significant health benefits can be achieved by implementing national standards for emissions from non-road diesel engines and equipment. However developing a national approach may be a lengthy process and national emissions standards will not address pollution from existing fleets. Therefore, the EPA has developed other actions targeting non-road diesel engines at NSW coal mines. They have assessed practises currently used at NSW coal mines to reduce non-road diesel

[clxxxiv] https://www.epa.nsw.gov.au/woodsmoke/index.htm
[clxxxv] http://www.scew.gov.au/coag-strategic-priorities/national-plan-clean-air

emissions and considered the costs and benefits of additional options to reduce non-road diesel emissions from NSW coal mines.

5.2.9 Voluntary and Incentive Programs

Under the load-based licensing (LBL) scheme provision is made to enter into load reduction agreements[clxxxvi] to obtain licence fee savings in return for future pollutant load reductions. Fee savings could be used to finance process modifications that result in reduced emissions or installation of emissions control equipment. The LBL scheme also provides the infrastructure for emissions trading,[clxxxvii] enabling emissions to be controlled from groups of licensees as well as from individual premises by allowing licensees to buy and sell credits for reducing emissions.

5.2.10 Tools

Under the Tiered procedure for ozone assessment, the NSW EPA has developed a screening tool for assessing impacts of new NO_x and VOC emission sources in non-attainment areas of NSW. The screening tool is identified in recent guidance issued by the US EPA (US EPA, 2015a; US EPA 2015b) as the only example of a reduced form ozone modelling approach that uses a state of the science chemical transport model at its foundation. The approach involves a photochemical modelling analysis for hypothetical new emissions sources tracked using the Higher-order Decoupled Direct Method (HDDM) to calculate sensitivity coefficients for ozone to addition of NO_x and VOC emissions. The resulting ozone sensitivity coefficients allow impacts to be estimated for NO_x and/or VOC sources within the same metropolitan area (ENVIRON, 2011).

There have been limited modelling studies for non-attainment areas in NSW. Photochemical modelling of the NSW GMR was applied to develop the Tiered procedure and screening tool for assessing new emission sources of NO_x and VOCs (previously described).

A primary particle modelling study of the Upper Hunter Valley was used to identify sources which were likely to contribute to future non-compliance of NEPM goals. The study is designed to inform how emission reductions should be targeted and focused on sources including power generation, non-road diesel, mining (fugitive) and wood heaters (study not published).

The Sydney Particle Study[clxxxviii] aimed to provide an improved understanding of the particle sources the population in the Sydney region is exposed. The study comprised observation (measurement) programs and the development and implementation of a modelling framework. Data and modelling tools from the study are being used by the Office of Environment and Heritage to develop its particle models to account for chemical transformation and secondary particle formation. Advanced particle modelling will provide more evidence to guide NSW air policy in future years.

[clxxxvi] http://www.epa.nsw.gov.au/licensing/lbl/loadredagree.htm
[clxxxvii] http://www.epa.nsw.gov.au/licensing/emissionstrading.htm
[clxxxviii] http://www.environment.nsw.gov.au/resources/aqms/SydParticleStudy10-13.pdf

5.2.11 Public Engagement

As there is no formal NAA management process in place in NSW, there are no specific requirements for public/stakeholder engagement related to NAA. However, in developing new regulation, the NSW EPA will consult with industry and public stakeholders (typically via workshops) and provide an opportunity for public submission.

5.2.12 Enforcement

The failure of the state to achieve the objectives of the Ambient Air Quality NEPM doesn't appear to have strong enforceability from the commonwealth government, or at least we are not aware of penalties for non-compliance.

State regulatory tools for existing sources under the POEO (Clean Air) and POEO (General) Regulations are strongly enforceable, with penalties for non-compliance.

The approval authority for new emissions sources is the NSW Department of Planning and Environment, with the EPA only providing an advisory technical role to assist with the approval. However, without support from the EPA, a new emission source may be unlikely to get approval. In this sense, the tiered procedure for ozone assessment provides a system for assessing new sources of NOx in NAA with a certain degree of enforceability.

Other measures that could be considered NAA policy tools (i.e. PRP issued under EPLs), also have a strong degree of enforceability under the POEO (Clean Air) and POEO (General) Regulations.

5.2.13 Assessment

The different levels / responsibilities of national (commonwealth) legislation and state legislation may present challenges for future NAA management in NSW, for example, the future regulation of off-road diesel emissions sources would need to be regulated at the national level and therefore challenging for states to introduce NAA policy tools where these are major contributing sources.

The introduction of formal NAA management would provide benefits for air quality management in certain areas of NSW, for example in the Upper Hunter Valley coal mining region, formal classification may provide more clarity and guidance around new source approvals and planning.

The only example of NAA management (the tiered procedure for ozone assessment) was only released last year and it is too early to comment on the success of implementation or if reductions in air pollutants were obtained. The dust stop PRP process is another example of a policy program designed to reduce particle emissions from coal mining, however the success of the program has not been measured in terms of reduction in ambient air pollutants, and would be difficult to do so.

5.3 Western Australia

5.3.1 Kwinana

Kwinana is a heavy industrial area located approximately 30 km south of Perth, the State's capital city. The Kwinana Industrial Area includes industry such as aluminium refining, oil refining, cement manufacturing, nickel refining, chemical manufacturing, petroleum storage, fertiliser storage, power generation.

Historically, the most significant air quality issue to have arisen in Kwinana is the impact of SO_2 caused by the combustion of sulphur-containing fossil fuels. The arrival of natural gas to Kwinana in the early 1980s vastly improved the air quality in the region. However the environmental regulator recognised the potential for air quality in the Kwinana area to revert back to a degraded state as the cost of natural gas increased. An Environmental Protection Policy (EPP) was developed for the Kwinana area in 1992.

The current version of the EPP is the *Environmental Protection (Kwinana) (Atmospheric Wastes) Policy 1999* (Kwinana EPP). The Policy is made under the provisions of the Western Australian *Environmental Protection Act 1986*. Implementation of the Policy is through issuing licences to premises that discharge SO_2 in the Kwinana region, and is enforceable under the provision of the *Environmental Protection Act 1986*.

The objective of the Kwinana EPP is to maintain acceptable air quality in the Kwinana area, rather than to manage 'non-attainment'. The key aspects of the Kwinana EPP are as follows:

- Identifies the area covered by the policy and three regions industrial, buffer zone and rural/residential) within that area;
- Establishes through associated regulations the air quality objectives for SO_2 and particulates (with the opportunity for other pollutants to be added at later dates);
- Allows the environmental regulator to establish a procedure for determining and applying limits on the emissions from each industrial source so that the cumulative impact of all these emissions does not exceed the air quality objectives; and
- Requires the industries to monitor ambient SO_2 concentrations at various locations in the environment (additional to the environmental regulator's ongoing monitoring program) and also to monitor emissions (SO_2 mass emission rate, temperature and volume) from the various industrial sources so that the achievement of policy objectives can be both verified and enforced.

There are three geographic areas defined in the Kwinana EPP; Areas A, B and C. Area A (industrial) is the area on which heavy industry is located. Area B (buffer) is outside Area A and is zoned for industrial purposes from time to time under local or state planning legislation. Area C (residential) is beyond Areas A and B, predominantly rural and residential. The boundaries between each of the policy areas were based upon predominant land use.

The ambient air quality 'standards' and 'limits' for SO_2 and particulates that apply within each of the policy areas are defined in the Policy. The 'standards' and 'limits' that apply in Area A are

less stringent than those that apply in Areas B, and the most stringent criteria apply in Area C. The 'standards' and 'limits' for SO_2 have been set for 1-hour, 24-hour and annual averaging periods, with the most important of these being the 1-hour averages with respect to controlling air quality in Kwinana. 'Standard' means the ambient concentration that it is desirable not to exceed. 'Limit' means the ambient concentration that shall not be exceeded.

The 'standards' and 'limits' established for SO_2 in Kwinana differ from the NEPM standards (the national ambient air quality standards in Australia). For Area C of the Policy, the 'standards' are more stringent than the corresponding NEPM standards for SO_2, whilst the 'limits' are less stringent. However, the EPP 1-hour 'standard' is nominally defined as a 99.9^{th} percentile concentration on an annual basis and is therefore thought to be equivalent to the national standard which allows one exceedance per year.

The Kwinana EPP establishes the procedure for determining and applying environmental regulatory limits for the emissions of SO_2 from each industrial source located in the Kwinana industrial area, so that the cumulative impact of all these emissions does not exceed the ambient air quality objectives ('standards' and 'limits'). The environmental regulatory limits for emissions of SO_2 are referred to within the Policy as the 'maximum permissible quantities'. They are define as mass emission rates (mass of SO_2 emitted per unit time), and can be expressed as constant values, or as formulae describing variations or on a statistical (probabilistic) basis so that emission variability can be accommodated. The Policy provides for a redetermination of the 'maximum permissible quantities' as and when required (e.g. to accommodate new industries or variations to existing industry emissions). If the ambient monitoring records an exceedance of the 'standard' or the 'limit', but the 'maximum permissible quantities' have not been exceeded, then no offence has occurred. However, such an event may trigger a review of the 'maximum permissible quantities'.

The DISPMOD air dispersion modelling tool is an integral part of the Policy, used to assess the cumulative SO_2 impacts in the Kwinana area. The model takes in data describing the industrial emissions and local meteorology to provide ground-level concentration predictions over the Kwinana region, and is used to determine the 'maximum permissible quantities' for individual industrial sources. The DISPMOD model was developed by the State environmental regulator and is specifically designed to manage coastal shoreline fumigation due to both a thermal internal boundary layer and a mechanical internal boundary layer.

Individual industrial sources of SO_2 are required to monitor their emissions (at the point of discharge) to demonstrate compliance with the 'maximum permissible quantities',[clxxxix] as well as monitor ambient pollutant concentrations at various nominated locations in the environment so that the achievement of the Policy objectives can be both verified and enforced. The ambient air quality monitoring program is conducted jointly by Kwinana industries. The emissions and ambient monitoring results have been used to improve the prediction capabilities of DISPMOD.

The Kwinana EPP has been an effective tool for managing the air quality impacts of industrial emissions of SO_2 in Kwinana. Currently the SO_2 levels in the Kwinana area are well below the

[clxxxix] Monitoring requirements are outlined in each facility's environment protection licence, including the parameters to be measured, frequency and monitoring method. Monitoring requirements might include stack surveys and / or CEMS.

ambient air quality objectives, and the Policy continues to ensure that acceptable air quality is maintained into the future.

5.3.2 Goldfields Region

Kalgoorlie-Boulder is the regional centre for the Goldfields region of Western Australia. In the early 1980s, mineral processing of refractory gold ore and nickel sulphide ore resulted in high emissions of SO_2 in the area, and resulted in poor air quality in the city of Kalgoorlie-Boulder and surrounding communities. An Environmental Protection Policy (EPP) was developed for the Goldfields region in 1988, and has undergone several reviews since 1988.

The current version of the EPP is the *Environmental Protection (Goldfields Residential Areas) (Sulphur Dioxide) Policy 2003* (Goldfields EPP). The Policy is made under the provisions of the Western Australian *Environmental Protection Act 1986*. Implementation of the Policy is through issuing licences to premises that discharge SO_2 in the Kalgoorlie-Boulder region, and is enforceable under the provision of the *Environmental Protection Act 1986*.

The objective of the Goldfields EPP has been to progressively reduce the SO_2 concentration in the ambient air within the identified residential areas of the Goldfields region and to achieve an ambient air quality that complies with the NEPM standards.

The Goldfields EPP sets SO_2 concentrations for the identified residential areas in the Goldfields region that industries must adhere to and monitor. The maximum 1-hour average SO_2 concentration permitted in the ambient air at any place within the EPP boundary has been progressively reduced from 0.35 ppm in 2003 to 0.25 ppm in 2008 and onwards. This SO_2 concentration represents the minimum level of air quality considered acceptable, exceedances of which may be prosecuted. These maximum permitted SO_2 concentrations do not apply outside of the residential areas that are 'protected' under the EPP.

The Goldfields EPP also specifies a concentration of 0.2 ppm that is desirable not to exceed, with similar provisions for a progressive reduction each year of the number of allowable exceedances, from three in 2003 to one in 2008 and onwards. This concentration is comparable to the corresponding NEPM standard. . If 0.2 ppm is exceeded on more than the allowable days for a particular year within the Goldfields EPP area, then this must be reported to the Minister for Environment.

Implementation of the Goldfields EPP is achieved through issuing licences that are consistent with the EPP to premises that discharge SO_2 in the Goldfields region. The licences do not however prescribe the methods to be used to achieve the maximum permitted SO_2 concentrations, which must be developed and implemented by the licensees themselves. Licence conditions also require licensees to monitor the concentration of SO_2 at specified locations in protected areas and report the results of monitoring in a specified manner. Data from this monitoring programme, which the Kalgoorlie-Boulder industries undertake jointly, allows the environmental regulator to assess the improvement of air quality over time, and compliance with the licence conditions and EPP requirements. The data also provides evidence for enforcement

action should that be necessary. Monitoring data are also reviewed by industry on an ongoing basis to evaluate situations where the maximum permitted air quality concentrations are approached or exceeded. The findings of these evaluations are then used by industry to refine their air quality control strategies. Attributing high ambient monitored values to specific sources is generally based on an analysis of prevailing wind directions and, in some cases, dispersion modeling.

Under local government planning requirements, proposals for residential development in Kalgoorlie-Boulder are required to be consistent with the Goldfields EPP; namely that development is to be contained within the four protected areas outlined in the Policy during the life of the Policy. For new industries that may emit SO_2, the onus is on the proponent to demonstrate that air emissions can be managed such that the cumulative emissions from the proposed industry, together with existing industries, comply with the EPP requirements within the protected areas.

The improvement in Kalgoorlie-Boulder's air quality over time has been significant,[cxc] thus the intended purpose of the Goldfields EPP has been achieved. The staged improvement approach that has been adopted in this Policy has enabled each industry to refine their SO_2 control strategies and develop and test alternative emission reduction options.

5.3.3 Port Hedland

Port Hedland is the largest iron ore and other bulk commodity export port in the world, located in the Pilbara region of Western Australia. The most significant air quality issue to have arisen in Port Hedland is the impact of dust from bulk material handling (i.e. iron ore) upon adjacent residential areas. In 2009, the environmental regulator expressed concern at current dust levels, emerging health research, and current land use planning controls.

The Port Hedland Air Quality and Noise Management Plan ('the Plan') was subsequently developed by the Port Hedland Dust Management Taskforce, in 2010. The Taskforce's objective was to develop a comprehensive management plan and implementation strategy for ongoing dust and noise reduction and air quality management in Port Hedland. The Taskforce is led by the Western Australian Department of State Development, with representatives from industry, State and Local Governments.

The Plan has been adopted by the Western Australian Government, however it does not have any specific legislative backing other than being accepted as an interim measure by the environmental regulator. An EPP, under the provisions of the Western Australian *Environmental Protection Act 1986*, has not been developed for Port Hedland.

The key elements of the Plan are as follows:

- Health risk assessment and analysis – to identify the level of risk posed by Port Hedland dust to residents;

[cxc] http://www.epa.wa.gov.au/epadoclib/EPPGoldDiscuss71209.pdf

- Environmental management controls – including the determination of an appropriate air quality assessment criteria for Port Hedland that sets a target for monitoring, assessing and managing air quality through an integrated monitoring program that informs continuous improvement and further research.
- Land use planning - including a structure plan and strategy that incorporates planning controls;
- Industry initiatives - continuous improvement initiatives including the continuing implementation of management plans, the establishment and operation of Port Hedland Industries Council (PHIC), and reporting to the community; and
- Governance - including the assignment of clear responsibilities for implementation and reporting of the Plan.

The air shed over Port Hedland is high in particulate matter enriched with iron oxide generated from iron ore industries. The potential health risk from this type of particulate matter is unclear, so a number of studies have been commissioned to investigate and assess the available evidence on health risk. The study findings are expected to provide more conclusive evidence on long term health effects of exposure to iron oxide enriched dust.

An interim guideline has been established for PM_{10} in Port Hedland of 70 µg m^{-3} (24-hour average) with an allowance for 10 exceedances per year, to be met at and beyond a specified monitoring station. The interim guideline was set in 2010 by the Port Hedland Dust Management Taskforce in their Port Hedland Dust and Noise Management Plan[cxci]. The standard was to be reviewed after five years following the completion of a health risk study for Port Hedland. The interim guideline is based on a health risk management regime that is believed to be appropriate for Port Hedland, taking into account the unique dust composition. As such, although the plan makes reference to the NEPM standard for PM_{10}, the conclusion is that the NEPM standard may not be an appropriate measure for Port Hedland on the basis that the national standards were developed for an urban environment and never intended for iron ore dusts. The interim guideline is not as stringent as the corresponding NEPM standard for PM_{10}, and does not include criteria for $PM_{2.5}$. Further, the interim guideline only applies to residential areas that are located beyond the area immediately adjacent to the port, on the basis that the interim guideline is expected to be achievable in this area.

The interim guideline is reflected in the project approvals and licences issued to industries in Port Hedland. Provisions have been made for the environmental regulator to take into account natural background dust events and dust emissions attributable to third parties, when determining compliance with the PM_{10} interim guideline. Notwithstanding, although project approvals and licences are enforceable under the provisions of the Western Australian *Environmental Protection Act 1986*, the contribution of natural background dust events, and source apportionment amongst multiple industry sources, would make enforcement difficult in Port Hedland.

The air quality monitoring program in Port Hedland consists of an ambient monitoring network that uses continuous and filter-based particulate monitoring techniques, a number of

[cxci] http://www.dsd.wa.gov.au/docs/default-source/default-document-library/ph_air_quality_noise_management_plan_0310?sfvrsn=8

comprehensive meteorological monitoring sites, and industry fence-line dust monitoring programs. The siting of fence-line particle monitors is intended to generally be aligned with adjacent ambient air monitors, both upwind and downwind of primary dust sources. This arrangement provides data on the contribution of different industry sources to air quality events. Monitors must be identical across industries for comparability, with cumulative data providing a sound basis for air quality management strategies.

Land use planning mechanisms and modifications to the built environment are key elements of the Plan that are aimed at reducing the community's exposure to dust in Port Hedland. Fundamentally the planning mechanisms are designed to discourage residential and other sensitive land use development in the areas adjacent to the Port that are impacted the most by dust, and to encourage future residential development in more suitable locations. The Plan also includes measures to modify the built environment within the areas most impacted by dust, by implementing best practice building design guidelines and mechanisms, to minimise dust exposures.

Port Hedland industries have a major role in ensuring the success of the Plan. The key industries have come together to establish the Port Hedland Industry Council (PHIC), in order to provide a more coordinated approach to the management of cumulative dust impacts. The stakeholders that make up the PHIC are the Pilbara Port Authority and the mining and mineral companies that export bulk commodities through the port. The interim guideline for PM_{10} in Port Hedland is part of a continuous improvement framework within which industry can work to reduce emission over time, and guides the development of statutory management plans companies are required to have in place to manage dust generated by their operations.

The Plan for Port Hedland clearly allocates responsibility for implementing, monitoring and enforcing regulatory standards, land use planning and industry initiatives. The key roles and responsibilities are assigned to state government agencies (environmental regulator, Health Department, Department of Planning), the relevant local government (Town of Port Hedland), PHIC, and the Port Hedland Port Authority.

5.4 State of Victoria

5.4.1 State Environmental Protection Policies

Air quality management in Victoria is guided by State Environment Protection Policies (SEPPs), made under the Environment Protection Act (1970). The SEPP (Ambient Air Quality) (AAQ) outlines air quality objectives and goals for the state and incorporates the National Environment Protection Measure (NEPM) standards plus other goals, monitoring and reporting protocols. The SEPP (AAQ) outlines the monitoring and reporting required under the NEPM (Ambient Air Quality) for compliance assessment against the categories of "Met", "Not Met" and "Not Demonstrated".

The SEPP (Air Quality Management) (AQM) sets the framework for managing emissions to air and includes requirements for cumulative assessment of new emissions sources in Works Approval submissions. Design criteria for Class 1, 2 and 3 indicators are set for the purpose of

assessing new emission sources or modifications to existing sources. Class 1 indicators are common or widely distributed air pollutants which are established as environmental indicators in the SEPP (AAQ) and may threaten the beneficial uses of both local and regional air environments.

Class 2 indicators are hazardous substances that may threaten the beneficial uses of the air environment by virtue of their toxicity, bio-accumulation or odorous characteristics and Class 3 indicators are extremely hazardous substances that are carcinogenic, mutagenic, teratogenic, highly toxic or highly persistent.

The design criteria are set at a different level and form to ambient air quality objectives outlined in the SEPP (AAQ)), which are equivalent to the NEPM standards.

The SEPP (AQM) also sets intervention levels, used to assess local air quality monitoring data to determine if the beneficial uses are being protected and are set higher than design criteria and ambient air quality objectives. For Class 1 indicators intervention levels are set at 20% above the ambient air quality objectives. Schedule C of SEPP (AQM) provides guidance for modelling and cumulative assessment of new emissions sources. Cumulative assessment requires consideration of background concentrations and other sources of emissions. Guidance for what other existing sources to include is limited and there are no provisions for including future committed development. Specific regulatory modelling guidance is provided for AERMOD (EPA Victoria, 2013a; EPA Victoria, 2013b).

Under the SEPP (AQM) the EPA may identify priorities and strategies for reducing emissions from particular sources for the purpose of air quality management in a region, for example through the development of an Air Quality Improvement Plan or a Protocol for Environmental Management (PEM).

For example specific requirements for the mining and extractive industries are outlined in the PEM for Mining and extractive industries (EPA Victoria, 2007). Assessment criteria specific to the assessment of mining and extractive industry can differ from the SEPP (AQM) design criteria and in some cases (i.e. PM_{10}) reflect the magnitude and form of intervention levels, which are 20% higher than the ambient air quality objectives. The PEM acknowledges that under certain circumstances, the assessment criteria may not be achievable at the closest sensitive location to the operation. In these circumstances, where the predicted impact extends into urban areas or townships, the PEM allows for an assessment of impact at locations representative of the general population (i.e. town centre) against the more stringent SEPP (AAQ) objectives.

Also incorporated under the SEPP (AQM) is the PEM for *Minimum Control Requirements for Stationary Sources* (EPA Victoria, 2002). This PEM provides a protocol for emission management from stationary sources and outlines minimum control requirements and emission limits for particular industries (EPA Victoria, 2002).

5.4.2 Air Quality Control Regions

The SEPP (AQM) includes the establishment of Air Quality Control Regions. Air Quality Control Regions are defined geographically as the *Port Phillip Air Quality Control Region* and *Latrobe Valley Air Quality Control Region.* Air Quality Control Regions are defined as areas where adverse regional air quality impacts may be expected, on the basis of population size or density, industrialisation, projected development or meteorological characteristics.

The Air Quality Control Regions of Port Phillip contains most of Victoria's population and industry while the Latrobe Valley is the most significant industrial centre outside Port Phillip where the bulk of electricity is generated (EPA Victoria, 2001). Although not strictly defined as NAAs, special provisions for air quality management exist for Air Quality Control Regions.

New sources may be required to reduce emissions to a greater extent than the general requirements for the purposes of improving or maintaining regional air quality. A permit (works approval) application for a new large emissions source may be refused unless emissions reductions for other sources are able to offset emission increases and impacts. Very large emissions sources are defined for the Port Phillip region based on being approximately 1% of the total regional emissions, as follows:

>1,000 tonnes of NOx
2,000 tonnes of VOCs
>200 tonnes of PM.

For these very large emissions sources defined above in or around air quality control regions, a cumulative regional impact assessment is also required (EPA Victoria, 2015) and under the SEPP (AQM), Air Quality Improvement Plans may need to be developed in Air Quality Control regions, requiring air quality forecasting and regular air quality reporting (no examples of air quality improvement plans have been found.

5.5 South Australia

The principal regulation for air pollution in South Australia is the Environment Protection (Air Quality) Policy 1994.

Guidance for assessing new or existing emissions sources is outlined in the South Australian (SA) EPA guidelines for air quality impact assessment (SA EPA, 2006), which require dispersion model predictions to be assessed against design ground level concentrations (DGLC). DGLC are set at a level lower than the NEPM standards, with the inference that a new source can only consume a proportion of the available space below the standard. Furthermore, two different DGLCs are specified for NO_2, one for the Adelaide metropolitan region, to account for the fact that this is a constrained airshed, and another for areas outside the metropolitan region. There are two power stations located within the Adelaide metropolitan area, which in combination with vehicle emissions have resulted in higher ambient level of NO_2 that have prompted the more stringent standards.

The South Australian (SA) Environmental Protection Agency (EPA) recently released the draft Environment Protection (Air Quality) Policy 2016 (draft AQ EPP) following review of the legislation and policies used in the regulation and management of South Australia's air quality.

The draft AQ EPP allows EPA to take a 'whole of air shed' approach to managing specific areas of concern and set air quality objectives for the area. Under the draft AQ EPP the EPA is able to declare that localised air quality objectives apply for the management of air quality in specific areas. Currently the EPA manages non-attainment areas via the implementation of improvement plans and license conditions to specific industry.

The draft EPP represents a consolidation of the current Air Quality, Burning and Solid Fuel Heater policies and simplification of the administration of air quality legislation in SA. Maximum emission limits, ground level concentrations and odour levels have been incorporated into the draft AQ EPP following a review and benchmarking exercise by the EPA, and updating of criteria where necessary. The updated criteria have been incorporated into the draft AQ EPP as Schedules, allowing the EPA to review and update them on a regular basis under provisions of the current *Environmental Protection Act 1993.*

The draft AQ EPP also makes provisions for the EPA to manage specific areas of concern by declaring localised ambient air quality criteria. A person carrying on an activity in such an area must ensure that any pollutants named in the declaration do not exceed any ambient concentrations declared for that pollutant. This is a mandatory provision and it is an offence not to comply with the localised air quality objectives. The draft AQ EPP can modify ground level concentrations or stack emission limits to declare localised air quality objectives. Compliance is evaluated at ground level using a testing, monitoring or modelling method approved by the EPA, however it is not specified how compliance is determined with respect to other source impacts or background / baseline.

In addition to the changes described above, the draft AQ EPP includes requirements for all solid fuel heaters sold and installed in SA to comply with relevant Australian Standards, bringing SA into line with other jurisdictions around Australia. Prohibitions have been introduced on selling firewood with a moisture content exceeding 20% and people are required to limit the impacts of 'excessive' wood smoke from their solid fuel heaters.

5.6 Other Asia Pacific Jurisdictions

5.6.1 Hong Kong

The regulatory framework in Hong Kong is entirely related to NAA air quality management, as there are no current areas of attainment. Policy, programs and emission reduction targets for NAA seek to achieve attainment of ambient air quality objectives across Hong Kong by 2025, with a focus on Hong Kong's own pollution sources and also regional pollution from connected airsheds (Pearl River Delta). With this in mind, regional emission reduction targets have been established for 2015 and 2020 achieved through key priorities outlined in the Clean Air Plan for

Hong Kong[cxcii]. Policies and programs for improving local air quality are focused on reducing roadside air pollution through aggressive tail-pipe controls, transport management and urban planning initiatives. Examples include:

- Incentivise the replacement of pre-Euro V diesel commercial vehicles.
- Funding replacement of catalytic converters.
- Age limits for new diesel commercial vehicles.
- Designate low emission zones, where only the cleanest buses are allowed
- Inspection and maintenance programs for commercial vehicles.
- Taxation increases for private cars.
- Reducing shipping emissions through mandated low Sulphur fuel and future Emission Control Zones.
- Specifying emissions allowances for power generation with reductions required to be achieved from control technologies and fuel switching.

For assessing new emission sources, the Hong Kong Environmental Protection Department (EPD) have developed "*Guidelines on Assessing the Total Air Quality Impacts*[cxciii]", which require three tiers of emissions sources to be considered; primary, secondary and other contributors.

Tier 1 or primary contributors are the project induced emissions sources and are often the major contributor to local air quality impacts. Tier 2 are the secondary contributors to local air quality impacts. A broad rule of thumb applied for local air quality impacts is that emissions sources within a 500m radius of the project are identified and included in an air quality assessment. If other significant sources exist that influence local air quality, this radius of influence may be extended. Tier 3 refers to background or baseline air quality for the region which is not already accounted for in Tier 1 or 2 emissions sources.

There are two approaches prescribed to represent Tier 3 contribution for analysis of 'total' impact, as follows:

- Chemical transport modelling based system, whereby gridded meteorological and air quality data are extracted from the regional scale model, on an hour by hour basis, and used to drive the Tier 1 and Tier 2 local scale models and determine the Tier 3 contribution.
- Observation based system whereby hourly meteorological data and air quality measurement from one or more monitoring stations are used (drive the Tier 1 and Tier 2 local scale models and determine the Tier 3 contribution).

The guidance notes that either system, if applied correctly, will produce "*statistically valid results to meet EPD's EIA requirements*". In applying the observation based approach, a longer term average of the most recent 5 years of data should be used for present and future background. However, this was considered an interim approach, while the PATH[cxciv] modelling system was developed, and from 2014 the use of the PATH system should be adopted. The

[cxcii] http://www.enb.gov.hk/en/files/New_Air_Plan_en.pdf
[cxciii] http://www.epd.gov.hk/epd/english/environmentinhk/air/guide_ref/guide_aqa_model_g2.html
[cxciv] *Pollutants in the Atmosphere and their Transport over Hong Kong* (ERM-HK, 2000).

PATH model is a regional photochemical modelling system which incorporates regional and Hong Kong emission inventories, meteorological data and chemical reaction features for predicting the ambient concentrations for Hong Kong. Predictions are available for multiple years (2015, 2020 and 2030) and for multiple pollutants (SO_2, NO_2, RSP (PM_{10}) and O_3. For FSP ($PM_{2.5}$), there is no model available at present and the concentration and the number of exceedances is estimated by assuming that the level of FSP is roughly equal to 70% of RSP based on observations at existing air quality monitoring stations (ARUP, 2009). Guidance is also provided to avoid double counting in the tiered emissions approach. PATH accounts for Tier 2 emissions and would need to be removed from the emissions grid to avoid double counting. For the observation based approach, the guidance notes that the choice of monitoring station should discount the contribution from Tier 2. This implies that monitoring stations that are not significantly influenced by Tier 2 emissions sources should be used.

5.6.2 Singapore

In contrast to Hong Kong, there are no designated NAA within Singapore and therefore no specific regulatory action related for NAA air quality management. Air quality in Singapore is generally in the good to moderate range, the exception being when impacted by transboundary haze from land and forest fires and targets outlined by Ministry of Environment and Water Resources are mostly related to maintaining current levels of air quality.

Air pollution control is regulated under the Environmental Protection and Management (EPM) Act and its regulations, including the EPM (Vehicular Emissions) Regulations and the EPM (Air Impurities) Regulations (which sets emission standards for air pollutants).

The National Environment Agency (NEA) sets ambient air quality targets for Singapore and enforces the regulatory framework for air quality management, including:

- Enforcement of smoky vehicles, anti-idling policies under the EPM (Vehicular Emissions) Regulations.
- Source Emissions Test Scheme for industries.
- Off-road diesel engine emission standards.

Before industries are allowed to operate in Singapore, they are screened to ensure they do not pose un-manageable pollution problems and can comply with air emissions standards. The screening process will ensure the location is suitable and compatible with existing land use and can comply with pollution control requirements outlined in the Code of Practice on Pollution Control[cxcv]. The information that the new emission sources needs to submit depends on the type of facility, for example certain 'special' industries are required to submit a pollution control study. Industry has to be sited within designated industrial areas, such as Jurong Island where majority of Singapore's chemical industries are located (so called Chemical Cluster). The NEA has

[cxcv] https://www.ura.gov.sg/uol/guidelines/development-control/change-use-premises/sections/~/media/User%20Defined/URA%20Online/Change-of-Use/Guidelines%20and%20Requirements/Use%20Classes/coppc_2002.ashx

developed an SO_2 emissions inventory to track and report SO_2 emissions, primarily in the Chemical Cluster and are working with industries to reduce emissions.

5.6.3 Japan

Only limited information about Japan's approach to non-attainment air quality management was available for this study. Under the Japanese Air Pollution Control Act, the Ministry of the Environment (MOE) has set ambient air quality standards for SO_2, CO, NO_2, PM_{10}, $PM_{2.5}$ and photochemical oxidants as well as several toxic air pollutants.[cxcvi] The MOE has also established national emission standards based on in-stack concentration limits.[cxcvii] More stringent standards based on emissions mass flux can be set in heavily polluted areas ("control areas" which are similar to NAAs). A total of 24 areas have been designated as SO_2 "control areas" and 3 areas as NOx "control areas". In addition to the national laws, eight municipalities including Tokyo, Osaka and others have enacted local air quality ordinances.[cxcviii]

Motor vehicle emission standards are jointly developed by the ministries of Environment, Transport, and Industry; current (2016) standards are comparable to the US 2010 and Euro VI standards. Emission standards for non-road engines were first promulgated in 2005. At one point starting in the early 1990s, on-road vehicle PM and NOx emissions in certain designated heavily polluted prefectures were regulated by prohibiting any in-use commercial and passenger diesel vehicles which had not been retrofitted from renewing their license registrations (the "Automotive NOx and PM Law"). Newly purchased vehicles were already designed to meet existing tailpipe standards. This law is now outdated as the affected vehicles have been retired.

[cxcvi] https://www.env.go.jp/en/air/aq/aq.html
[cxcvii] An English translated version of the Japanese Air Pollution Control Act is available at: http://www.japaneselawtranslation.go.jp/law/detail/?id=2146&vm=04&re=01&new=1
[cxcviii] https://www.jetro.go.jp/ttppoas/special/env_rep2_english/env_rep_03_1.html

6.0 SUMMARY AND RECOMMENDATIONS

6.1 Summary

Our review of non-attainment area management practices shows that differing social and political systems in each jurisdiction lead to different approaches to the management of air quality:

The federalist system of government in the U.S. is compatible with strong, centralized and uniform national "top down" air quality regulation. Historically, this system developed in response to concerns that many states do not have the political will to impose costly regulations on their own, in part because such states could be placed at an economic disadvantage relative to neighboring states. Nevertheless, states carry much of the burden of implementing the U.S. national regulations and are free to enact more stringent regulations if they so choose. The U.S. National Ambient Air Quality Standards (NAAQS) are set on the basis of health and welfare impacts and are clearly specified by regulation in terms of concentration limit, averaging time, design value or "form" (e.g., annual 98^{th} percentile of daily maximum 1-hour value averaged over three consecutive years), and detailed procedures for processing ambient data for comparison with the standard. Regulations implementing the NAAQS also include pollutant-specific monitoring requirements and the U.S. Clean Air Act and implementing regulations specify the consequences of NAAQS violations. A uniform set of attainment planning requirements are implemented via a non-attainment area (NAA) classification system. This level of specificity in standard setting and clear consequences for violations is not found in other jurisdictions. As a result of these factors, the U.S. air quality management system is the most extensive, rigorous and rigorously enforced system of any of the jurisdictions analyzed in this study.

In Canada, the Provincial governments bear the primary responsibility for environmental regulation with support from the federal government. This has led to varying approaches to dealing with air quality regulations. In 2012, the Canadian Council of Ministers of the Environment (CCME) implemented a new Air Quality Management System (AQMS) to guide work on protecting and improving air quality across Canada. Elements of the AQMS include Canada-wide ambient standards, establishment of local air zones and regional airsheds, and Base-Level Industrial Emissions Requirements (BLIERs) which are nationally-consistent minimum emissions standards or requirements. Provinces and Territories are currently working on implementation of the new AQMS, which includes classifications of air zones by their status with respect to the Canada-wide standards.

In Australia as in Canada, states and territories are responsible for environmental regulations. Similar to Canada, the Australian national (commonwealth) government regulates motor vehicles and transportation fuels and has established national ambient air quality standards. While the national standards are used for reporting purposes, there is no national system for designation of non-attainment areas.

The governing structure of the EU in which Member States retain their basic sovereignty but have decided to allow certain decisions of joint interest to be made democratically at the EU level, results in a significant degree of diversity in the manner in which air quality is regulated by the Member States. While EU-wide ambient standards are used for reporting purposes, there is no system for formally establishing non-attainment areas. Enforcement of EU directives related to air quality is a slow process that has yet to be fully exercised – a number of actions against non-complying member states are currently pending but Member State sovereignty concerns have thus far prevented any concrete actions from being imposed in response to these violations.

Our review included a brief examination of NAA management practices in Hong Kong, Singapore and Japan but only limited information was collected. Hong Kong has established regional emission reduction targets and focused its program on reducing emissions from on-road vehicles, marine vessels and power production. Singapore's program is focused on maintaining the generally acceptable present levels of air quality. Information on Japan's programs was not readily available.

Features common to most jurisdictions include:

- Basic control requirements for all large stationary (industrial) sources based on principles regarding best practices, availability, technical feasibility, and economic viability. These are based on the concept of pollution prevention and polluter pays. Emission control methods or technology clearinghouses are used in the U.S. and the EU to facilitate the proper specification of control requirements.
- Thresholds for identifying sources requiring the most stringent level of regulatory oversight are typically based on both industry type and level of emissions in all jurisdictions. However, specific definitions and thresholds vary from one jurisdiction to the next.
- Environmental reviews of major new projects are commonly (but not always) required. Our review suggests that both Australia and EU Member States rely heavily on the environmental review process to limit the air quality impacts of new sources whereas in U.S. NAAs this is handled by the non-attainment New Source Review regulations.
- Determining when modifications to existing sources should trigger requirements for installation of modern controls is a difficult issue that the US appears to have had the most experience and success in addressing.

Official designation of geographic areas with prescribed boundaries in which air quality standards or goals are not being met as "non-attainment" areas (NAAs) is only done under specific regulatory authority in the U.S. In Canada, the new AQMS process - which includes establishment of Canadian Ambient Air Quality Standards (CAAQS), identifying local air zones and regional airsheds, and classification of air zones by management level (red, orange, yellow, green) according to monitored air quality values relative to the CAAQS– forms the basis of a NAA management framework which the provinces and territories can utilize. In other jurisdictions, the concept of "non-attainment" is only loosely applied to evaluations of ambient monitoring data from individual monitoring sites. While special measures are often prescribed for heavily polluted locations, there is no uniform application of specific procedures for NAAs prescribed in regulation, although the new "tiered procedure" ozone impact assessment

methodology used in NSW, Australia includes the concept of a non-attainment designation for some areas in the Greater Metropolitan Region of NSW.

Most jurisdictions with large urban areas continue to be particularly and often primarily concerned with managing impacts from on-road mobile sources which are the dominant contributors to NO2, PM and O3 non-attainment. National new motor vehicle emission regulations and fuel formulation requirements are in place in Canada, the U.S., the E.U. and Australia, and vehicle emission control systems inspection programs are used in ozone NAAs in the U.S.. California and some U.S. ozone NAAs also have special gasoline formulation requirements designed to further reduce emissions. A wide variety of regulations and incentive programs aimed not only at reducing gasoline and diesel vehicle emission factors at the national (or EU) level, but also at accelerating replacement of older vehicles, reducing overall VMT, and introducing alternative fueled vehicles are used at the local level. One technique that is used in some EU countries but not elsewhere is placement of restrictions or economic disincentives on the operation of older vehicles in certain heavily congested areas at certain times (either by time of day/week or as a temporary measure during poor air quality conditions). Such measures are controversial in that they cause inconvenience and may disadvantage lower income drivers.

While the economic costs of implementing emission reduction measures are generally easy to quantify, the economic benefits are often greater but less obvious and more uncertain. While not without controversy, rigorous and publically available cost/benefit analyses of U.S. air quality regulations have consistently demonstrated positive benefits when health impacts are taken into consideration. Experience in the U.S. in general and in California in particular has shown that economic growth and clean air are not anti-correlated. Other jurisdictions also use calculated costs of high pollution levels to evaluate the need for emission reductions and in many cases base decisions on cost/benefit analyses.

6.2 Evaluation and Recommended Considerations

Our review of non-attainment area (NAA) air quality management methods in leading jurisdictions around the world provides insights into the key characteristics of successful NAA management approaches which may be of potential value to Alberta. We found that leading jurisdictions commonly employ regulatory approaches and management practices which are consistent with the following key principles:

> **Transparency**: the promotion of clearly defined requirements with respect to actions, deadlines and expected outcomes developed via a public process in consultation with all stakeholders. The concept of transparency also extends to making all data and tools used in the NAA management process publically available. This would include, for example, ambient data, emission factors (along with data and analysis methods used in their development), complete, detailed, and up-to-date emission inventories, and technical model descriptions and modeling codes.
>
> **Equity**: the application of management methods which avoid placing undue burdens on any one group. This includes providing a level playing field for all source owners and

operators as well as avoiding shifting of the burden of pollutant impacts onto any one group at the expense of another.

Scientific basis: building a solid foundation for management actions based on collection of data of sufficient quantity and quality to support the actions and application of rigorous, peer reviewed scientific principles and procedures.

Our review of international NAA air quality management practices illustrates the primary requirements of an effective management system based on the above principles and the major pitfalls to be avoided. We recommend that Alberta consider including the following proven effective management system elements in its NAA management system:

- Clearly and fully specified (as to level and form) ambient air quality standards (goals, while potentially useful, are generally not in themselves sufficient to drive emission reductions unless coupled to a clear path to achieving attainment);
- A firm set of deadlines for achieving attainment;
- An open and fair combination of incentives and penalties for missing attainment deadlines;
- A structured set of planning requirements and deadlines for achieving the use of appropriate air pollution prevention/control methods and technologies;
- Mandatory, rigorous and transparent data collection and reporting systems, including regularly updated comprehensive emission inventories;
- Data analysis (including modeling) programs that meet strict scientific criteria (including peer review) and are sufficient to fully quantify emissions from all sources and identify key source-receptor linkages;
- Full public accounting of costs and benefits of air quality regulations;
- A strong public outreach program including extensive opportunities for public participation in the decision making process.

Ambient air quality measurement methods and numerical models for simulating meteorology, pollutant transport and dispersion, and chemical transformations have improved tremendously in recent decades and are adequate for meeting current air quality management challenges. However, additional work is need on the development of models for predicting the influence of climate change on air quality. We recommend Alberta consider utilizing the full suite of currently available state-of-the-art, fully vetted models and techniques.

Uncertainties in emission inventories continue to be a significant problem for ozone and PM air quality management in many locations. Major uncertainties remain in quantifying natural sources of emissions and emissions from certain types of area sources such as upstream oil and gas operations. Development of mobile source inventories also continues to be a challenging problem due to lack of data on real-world driving cycles and the dominant contributions of engines/vehicles with malfunctioning emission control systems. We recommend that state-of-the-art mobile source emission models reflecting local conditions and capable of providing appropriate spatial and temporal allocations of emissions be used for effective NAA management and that these models be regularly validated as vehicle technologies change.

While most jurisdictions, including Alberta, have systems in place for regulating emissions from new sources to a level where they at minimum are not modeled to result in violations of ambient standards (taking cumulative impacts into account), the problem of achieving acceptable air quality in current NAAs is more difficult. This requires not only a system for accommodating growth in the form of new sources that does not further exacerbate the non-attainment problem but reductions in emissions from existing sources. In the U.S., emission offsets are required for new or modified sources within an NAA and existing sources are required to employ Reasonably Achievable Control Technology standards at a minimum. Additional controls may also be imposed as part of the strategy for achieving attainment included in the State Implementation Plan. Requiring emission offsets in NAAs and the use of market-based trading programs of emission offsets other than for GHGs (see discussion below) are important management strategies under the U.S. system. Offsets are also potentially allowed under the recently developed Tiered Procedure for ozone assessment in the Greater Metropolitan Region of New South Wales, Australia and some local jurisdictions in Italy use offsets as a management tool. We recommend that Alberta give careful consideration to the implementation of emission offsets and minimum retrofit requirements to achieve attainment. We further recommend that Alberta consider the potential benefits of requiring large sources to install Continuous Emission Monitoring Systems (CEMS) with respect to improved temporal allocation of emissions needed for accurate modeling and control strategy development, improved ability to provide equal enforcement of permitted emission limits for all such sources, and ability to implement cost-effective emissions trading programs.

For NAAs in which numerous smaller stationary sources are found to contribute significantly to non-attainment, jurisdictions have the option of reducing the source size threshold or adding additional source categories to the list of sources within the NAA requiring permits. Various levels of permitting requirements ranging from detailed, site-specific for the largest sources to simple registration or “general permits” for smaller sources can be instituted as has been done, for example, in Texas and Colorado. This is useful for limiting the regulatory burden and cost of the permitting program and maintaining public acceptance while still allowing for some level of control and providing data for improving emission inventories. Some categories of equipment such as various types of boilers, etc. can perhaps best be regulated by requiring conformance with widely used performance standards such as U.S. EPA’s New Source Performance Standards (NSPS) and National Emission Standards for Hazardous Air Pollutants (NESHAPs). We recommend that Alberta perform emission inventory development and modeling analyses to determine the contributions of smaller sources to non-attainment and consider the extent to which benefits of emission reductions from these sources may outweigh the increased regulatory burden of lowering permitting thresholds or implementing new emission standards. We further recommend that Alberta work with Environment Canada and other provinces and territories to evaluate the potential costs and benefits of establishing national performance standards for new equipment that does not already meet the best standards routinely achieved in the U.S. or elsewhere.

A problem faced by jurisdictions dealing with non-attainment is identifying the relative contributions of different sources to the exceedance events and then deciding on which sources should bear the burden of emission reductions. In the simplest case, a large industrial source or complex of sources can be identified as the overwhelming contributor to non-attainment. In the

US, this has typically been dealt with by defining a NAA covering the immediate vicinity of the facility and applying the NAA regulatory mechanism to control the facility's emissions. Examples include Pb, older NO_2, and some PM_{10} NAAs. Currently, states and the U.S. EPA are working through the process of identifying SO_2 NAAs around large SO_2 sources. For ozone and $PM_{2.5}$ (where secondary PM is a major contributor) NAAs, the situation is usually more complex as the universe of potentially contributing sources is typically quite extensive. Modeling tools for identifying the relative contributions of sources to ozone and $PM_{2.5}$ non-attainment by individual source, source category or geographic grouping are available as are optimization tools for selecting combinations of controls which minimize overall costs. A useful constraint is a set of requirements that all candidate control measures must satisfy which can be adapted from the U.S. model: emission reductions must be surplus, permanent, enforceable, and quantifiable. With regard to the last requirement (quantifiable), some reasonably conservative allowance for measures such as voluntary programs who's effects may be difficult to accurately quantify may be appropriate. As a practical matter, candidate control measures must also be both technically feasible and generally acceptable to the public. Another often cited criterion is that control measures must be "fair", in other words that they do not unduly disadvantage any one group. We recommend that Alberta consider the application of the full suite of emission inventory development and source attribution and apportionment tools to provide a solid foundation for the selection of control strategies.

Market-based programs have proven value if properly set up and administered as evidenced by the success of the RECLAIM program in the Los Angeles area and U.S. EPA's clean air markets. Such programs should be based on free market principles and be fully transparent with rules that are fair to all participants. While considerable effort is required to establish and operate an orderly and effective market, existing examples in the U.S. may serve as a useful guide. An important feature of well-designed programs is a mechanism that mitigates the potential for development of local pollutant "hotspots" within the vicinity of sources that choose to purchase emission credits rather than reduce emissions. We recommend Alberta consider the development of market-based programs in cases in which use of traditional "command and control" emission reduction regulations are judged to be overly burdensome.

A central problem faced by the most heavily polluted NAAs is resolving the conflict between attaining health-based air quality standards and the potentially significant costs of achieving the required emission reductions. In the Los Angeles Basin, for example, current projections indicate that attainment of current NAAQS will require an amount of NOx emission reductions equivalent to eliminating nearly all mobile source emissions (SCAQMD, 2013). While this goal may seem unobtainable and may in fact not be obtained within the specified deadline, the current regulatory structure is designed to force continuous incremental improvements, thus providing some benefits in the near-term while allowing time for new ideas and technologies to bear fruit. We recommend that Alberta consider inclusion of NAA management program elements such as interim emission reduction milestones designed to insure incremental improvements towards attainment. We are not aware of any need for Alberta to consider provisions for the inclusion of unspecified future control technologies (i.e., "black box" measures) in its attainment plans as has been done in Los Angeles.

Many jurisdictions have legislation, regulations, standards, guidelines, etc. related to both on-road and off-road mobile sources. A wealth of information about program implementation, cost, and efficacy is available. We recommend Alberta reference this extensive knowledge base if modeling evaluations suggest that additional mobile source controls are needed to achieve attainment. Programs of potential interest include incentive programs for diesel engine retrofits, repowers and retirement of older trucks and equipment, reformulated fuels, idle reduction, promotion of transit options, and incentive programs for introducing low emission technology vehicles. As noted in our review, some jurisdictions still employ vehicle Inspection and Maintenance (I&M) programs. However, the cost effectiveness of these programs is highly dependent on local vehicle fleet characteristics and program design; careful consideration of local conditions are recommended when considering adoption of any I&M program.

It seems unlikely that some of the more controversial methods of reducing on-road vehicle emissions used in Europe, such as driving restrictions or disincentives imposed only on older vehicles, are likely to gain traction in Alberta and may violate the equity principle. However, consideration of the above regulatory and incentive programs, along with various other ways of addressing emissions from older vehicles such as vehicle scrappage programs, might be of interest to Alberta.

As jurisdictions impose more stringent emission reductions on sources under their control, the relative contributions of long-range transport of pollutants from sources beyond their borders is increasing. Governments will therefore need to step up cooperative efforts to reduce upwind sources that are beyond their direct control. We recommend that Alberta promote and participate in such cooperative efforts.

Management methods are rapidly evolving in many jurisdictions and reference is made in our survey to very recent or soon-to-be-implemented methods where appropriate. This report should be updated in the future to reflect these new developments.

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APPENDIX 1

ANNEX I OF IED DIRECTIVE

APPENDIX 2

ANNEX XV OF AIR QUALITY DIRECTIVE

APPENDIX 3

SNAP SOURCE CATEGORY CODES

APPENDIX 4

ANNEXES I AND II OF EIA DIRECTIVE

APPENDIX 5

LIST OF LOCAL REGULATIONS IN GERMANY

List of Local Legislation (Germany)

Federal Pollution Control Act [Bundes-Immissionsschutzgesetz BImSchG] – German Federal law governing the harmful environmental impact of air pollution, noise, vibration and the like as amended in the announcement of 17 May 2013 (BGB I S. 1247) Version of the announcement of 26 September 2002 (BGB I S. 3830), last amended by Article 2 of the law of 24 February 2012 (BGB I S. 212)

1st Federal Pollution Control Act [Bundes-Immissionsschutzgesetz BImSchG] – Ordinance on small and medium-sized combustion plants of 26 January 2010 (BGB I S. 38)

4th Federal Pollution Control Act [Bundes-Immissionsschutzgesetz BImSchG] – Ordinance on installations requiring a permit of 2 May 2013 (BGB I S. 973)

11th Federal Pollution Control Act [Bundes-Immissionsschutzgesetz BImSchG] – Eleventh Ordinance on the implementation of the Federal Pollution Control Act (Ordinance on emissions reporting) as amended in the announcement of 5 March 2007 (BGB I S. 289), last amended by Article 9 of the Ordinance of 2 May 2007 (BGBL. I S. 1021)

35th Federal Pollution Control Act [Bundes-Immissionsschutzgesetz BImSchG] – Ordinance on the marking of low-emission vehicles with a small share in the pollution load of 10 October 2006 (BGBI. I S. 2218), last amended by Article 1 of the Ordinance of 5 December 2007 (BGBl. I S. 2793)

39th Federal Pollution Control Act [Bundes-Immissionsschutzgesetz BImSchG] – Thirtyninth Implementing Regulation of the implementation of the Federal Pollution Control Act (Ordinance on air quality standards and emission ceilings) of 2 August 2010 (BGBl. I S. 1065)

Environmental Impact Assessment Act [Gesetz über die Umweltverträglichkeitsprüfung UVPG] as amended in the announcement of 24 February 2010 (BGBl. I S. 94), last amended by Article 5 (15) of the law of 24 February 2012 (BGBl. I S. 212)

206 Road Traffic Regulation [Straßenverkehrsgesetz StVG] as amended in the announcement of March 2003 (BGBl. I S. 310, 919), last amended by Article 2 (118) of the law of 22 December 2011 (BGBl. I S. 3044)

Road Traffic Act [Straßenverkehrsordnung StVO] – Road Traffic Act of 6 March 2013 (BGBl. I S. 367)

Road Traffic Approval Order [Straßenverkehrs-Zulassungs-Ordnung StVZO] of 26 April 2012 (BGBl. I p. 679), last amended by Article 2 of the order of 19 October 2012 (BGBI. I p. 2232)

Vehicle Registration Law [Fahrzeug-Zulassungsverodnung FZV] of 3 February 2011 (BGBl. I p. 103), last amended by Artcile 1 by the law of 13 January 2012 (BGBI. I p.103)

Berlin Tendering and Procurement Law [Berliner Ausschreibungs- und Vergabegesetz], 08/07/2010, GVBI. p. 399

Pollution Control Act of the State of Berlin [Landes-Immissionsschutzgesetz Berlin LImSchG Bln], GVBl. p. 735, ber. GVBl. 2006 p. 42

Administrative Order on Procurement and Environment [Verwaltungsvorschrift Beschaffung und Umwelt VwVBU] – federal administrative order on the application of environmental protection requirements for the procurement of works, supplies and services (GVBl. of 2 November 2012) **GVBI** = Gesetz- und Verordnungsblatt (Journal of Laws and Ordinances) **BGBl** = Bundesgesetzblatt (Federal Law Gazette) **BGB** = Bürgerliches Gesetzbuch (Civil Code of Germany)

APPENDIX 6

JURISDICTIONAL QUESTIONNAIRES

(Available as a separate volume.)